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Prepared by

(signature)

Stéphane D'Aoust

Reviewed by

(signature)

Adrien Comeau
Executive Summary

On 24 February 2010, Council approved the Ottawa River Action Plan (ORAP), a collection of 17 projects to improve the overall health of the Ottawa River and to bring the City in compliance with all provincial targets and, in some cases, exceed those targets. The ORAP was developed in accordance with the Municipal Class Environmental Assessment (EA) master planning requirements with public consultation held in the fall of 2009. This fulfilled Phase 1 of the Class EA process for the Combined Sewage Storage Tunnel (CSST) Project.

The purpose of the CSST Project, in conjunction with other ORAP projects, is to achieve Council’s objective of having zero combined sewer overflow (CSO) events during the Control Period (defined in the Ministry of the Environment’s Procedure F-5-5 as 15 April to 15 November) for the Design Year (also referred to as the average year).

The CSST Project is being implemented as a Schedule ‘C’ project in accordance with the requirements of the Municipal Class Environmental Assessment (EA) process. The Municipal Class EA is divided into five phases. Phase 1 for this project was completed through the Ottawa River Action Plan consultation process. This phase identified and described the problem and service level target: to achieve a service level for combined sewer overflows (CSO) of zero overflows during the swimming season in the “Design Year” (1 June to 30 September), while accepting some overflows during years with more severe wet weather than the Design Year and/or during very large rain events.

This Environmental Study Report documents the Environmental Assessment for the CSST Project. As part of this process, a wide range of conceptual alternatives were considered, including storage tanks, storage shafts, in-river storage, short and long tunnels of various alignments, as well as combinations of tanks and tunnels. A formal screening and evaluation process was developed and followed, and a preferred alternative was identified. The preferred alternative includes three major components, to be implemented in two phases:

- Phase 1:
  - an East-West Tunnel (EWT), capturing overflows in Lebreton Flats (from the West End Regulators), at the Rideau Canal north of Wellington (from the Rideau Canal Regulator), and in New Edinburgh (the Keefer Regulator).
  - a North-South Tunnel (NST) along Kent Street, interconnected to the Core Tunnel near Slater

  Phase 1 is to be implemented in the near-term, following the preliminary timeline discussed below. In conjunction with other ORAP projects, Phase 1 provides sufficient storage to achieve CSO control targets mandated by Council. These two tunnels total over 6 km in length providing over 43,000 cubic metres of storage (including allowances for growth and climate change).

- Phase 2:
  - an East Tunnel from the Keefer Regulator to the Robert O. Pickard Environmental Centre
Phase 2 is to be implemented in the future, subject to funding. This Phase will improve significantly the overall reliability of the sewer system by creating redundancy for the Interceptor Outfall Sewer and will further improve CSOs control (for rainfall events larger than those found in the Design Year).

Diversion structures and short diversion sewers will also be needed as part of Phase 1. Also, pending additional and more detailed analysis to be completed during the preliminary design, odour control facilities are recommended at the upstream end of the East-West tunnel near Lebreton Flats, at the southern terminus of the Kent St. tunnel near Catherine and near the new diversion chamber on the Rideau Canal Interceptor near City Hall. The exact location and character (above or below grade) of the odour control facilities has not yet been finalized.

During the development of this project, a cost-saving opportunity to integrate this project with the O’Connor Flood Control Measures was identified. Several low-lying areas in the Glebe/O’Connor area have been previously identified as being at risk of flooding. To reduce this risk, a flood mitigation plan was previously developed that consisted of several large sewers and other measures to be implemented over many years. The estimated cost to implement this plan is over $120 million. The integration opportunity consists of using the North-South tunnel along Kent Street as a major flood-relief pipe during rare, extreme rainfall events, to channel excessive runoff away from flood-prone areas to the Ottawa River. This integration will not affect the CSST’s ability to achieve CSO control targets mandated by Council.

Extensive consultation has taken place as part of this project, and in several cases exceeded Municipal Class EA requirements:

- Public Open Houses in late 2009 undertaken as part of ORAP.
- Public Open Houses in March/April of 2010.
- Public Open Houses in June of 2010.
- Public Open House in June of 2012
- Communications and meetings with Ward Councillors.
- Presentations to the Business Advisory and Environment Advisory Committees in the late-summer/early-fall of 2010.
- Communications with key representatives of the Ottawa River Keeper.
- Communications and a July 2012 meeting with Kitigan Zibi First Nations community.
- Communications with First Nations via the Algonquins of Ontario consultation office.
- Communications and meetings with various federal departments; extensive communications and meetings with NCC.
- Communications with provincial agencies.
- Communications and meetings with Rail Implementation Office.
- Project information web page on Ottawa.ca.
- Mailing list of over 80 identified public interest groups and individuals wishing to be part of the Project contact list.

Short term environmental impacts are expected and mitigation measures have been identified as part of this Schedule C Environmental Assessment. Overall, the project, in conjunction with other ORAP projects, will significantly reduce the frequency and volume of CSOs to the Ottawa
River. This will lead to improvements to the quality and health of the Ottawa River, to the ultimate benefit of natural environment and all communities that enjoy and depend on it.

Most potential environmental effects resulting from the Project following implementation of mitigation measures will be small in size and temporary in nature. Numerous mitigation measures have been proposed to reduce or eliminate effects on Valued Environmental Components (VECs) through all phases of the Project (i.e. site preparation, construction and operation).

VECs were determined based on consultation, standard EA scoping methods and derived from the criteria developed for evaluating alternatives. The following is a list of all VECs considered for this EA:

Physical Environment:
- Air quality/Odour/Dust
- Ambient Noise

Terrestrial Environment:
- Vegetation
- Animals
- Avifauna

Aquatic Environment:
- Fish and fish habitat

Socio-economic Environment:
- Heritage/Historical
- Archaeology
- Recreation
- Aesthetics
- Local Economy
- Land Use
- Safety

Despite implementation of best practices and mitigation through good design, some residual environmental effects will remain. For those cases additional monitoring and follow-up programs have been recommended.

The planning level cost estimate for Phase 1 is $161 million (2012 dollars), including allowances for construction, engineering and project delivery, but excluding land costs.

Subject to approval from Federal Departments regarding the use of Federal lands for some components of the project, an aggressive implementation timeline for Phase 1 components (excluding components in Lebreton Flats being implemented by the LRT consortium) is presented below:
• Preliminary, Detailed Design and Value Engineering   Q2/2013 to Q4/2014
• Tendering and Contract Award   Q1/2015 to Q2/2015
• Construction   Q3/2015 to Q2/2018
• Commissioning   Q3/2018
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1.0 Phase 1 – Problem Definition

1.1 INTRODUCTION

The City of Ottawa is conducting an Environmental Assessment (EA) and Functional Design to identify and develop a preferred solution that will provide additional storage facilities in the combined sewer area and thereby reduce combined sewer overflows (CSOs) to the Ottawa River. This is one of seventeen projects included in the City’s Ottawa River Action Plan (ORAP). It is being conducted under the Municipal Class EA process.

When implemented, the project will help to:

- Reduce CSOs from the Ultimate Combined Sewer Area (UCSA). The UCSA is the areas that are planned to remain combined upon completion of the separation program;
- Improve water quality in the Ottawa River; and,
- Become fully compliant with Ministry of Environment’s Procedure F-5-5
- Achieve council’s mandate

1.2 BACKGROUND

Like most municipalities, the City of Ottawa has combined sewers in older areas of the City, which transport sewage and stormwater runoff in the same pipe. These older systems were designed to overflow when it rains to prevent flooding and basement backups. This impacts the water quality of the Ottawa River.

1.2.1 Study Area

The City of Ottawa plans to provide additional storage capacity for combined sewage within the UCSA of the City (Figure 1-1). The existing Interceptor-Outfall Sewer (IOS) collects and transports wastewater (sanitary) and some stormwater from west to east across the city to the wastewater treatment plant. The IOS cannot handle all of the stormwater runoff that enters the sewer system during wet weather. This project deals with the frequent and large volume overflows from three locations: West End, Rideau Canal and Keefer regulators (Figure 1-2). Other locations also overflow, but generate much smaller volumes which will be controlled in the future through other projects.
1.2.2 Problem Statement

Currently, the City of Ottawa meets most but not all provincial CSO control targets with regards to CSOs being discharged to the Ottawa River. The City is required to meet targets set out in the Ministry of the Environment (MOE) Procedure F-5-5 (MOE, 2001) for the capture and treatment of flows from the combined sewer area (CSA). The primary criterion to which all municipalities with combined sewer systems must comply concerns the “volume” of overflows permitted. The City currently better this target. For municipalities with downstream beaches affected by CSOs, an additional criterion applies concerning the “number” of overflows permitted during the swimming season, regardless of the size of the overflows and the impact of those overflows on beach closures.

The City’s CSA Pollution Prevention Control Plan (PPCP) (City of Ottawa, 2008), sets out the activities required to meet the minimum requirements of MOE Procedure F-5-5 and provides consideration to meeting objectives beyond those stipulated in the procedure, in particular capturing all of the CSA wet weather flow. The City’s ORAP is a working plan that encompasses the recommendations of the PPCP and which includes 17 projects to address stormwater and wastewater discharges to the Ottawa River. The City has been in compliance with MOE’s volumetric criterion for several years, and has further improved system performance with the recent commissioning of ORAP Project 1: (Real Time Control).
1.2.3 Opportunity

The PPCP has identified that storage within the Ultimate Combined Sewer Area (UCSA) is the most cost effective way of further reducing CSO beyond the minimum provincial targets. The purpose of the Combined Sewage Storage for the UCSA and the Sewer Separation Projects (Projects 3 and 5 of the ORAP) is to bring the City into compliance with and even surpass the “numeric” target set by the province, which is a maximum of two (2) overflow events during the swimming season, during the “Design Year.”

The Combined Sewage Storage Project will identify and develop, in form and function, the preferred alternative for providing additional storage to reduce CSOs within the Ultimate Combined Sewer Area. The project will be designed to attain the targets identified as part of the ORAP, as mandated by City Council. The design basis is thus to provide a level of control that, for the representative Design Year (1980), results in zero (0) overflow events during the swimming season. The Combined Sewage Storage Project must provide, at minimum, a level of protection that achieves the “Beach Protection” requirements defined within Section 9 of the Ministry of Environment’s Procedure F-5-5.

1.2.4 Ontario Environmental Assessment Act

Ontario’s Environmental Assessment (EA) Act was passed in 1975 and was first applied to municipalities in 1981. The EA Act requires the study, documentation, and examination of the environmental effects that could result from major projects or activities.

The objective of the EA Act is to consider the possible effects of these projects early in the planning process, when concerns may be most easily resolved, and to select a preferred alternative with the fewest environmental impacts.

The EA Act defines environment very broadly as:

a) Air, land or water

b) Plant and animal life, including humans

c) Social, economic, and cultural conditions that influence the life of humans or a community

d) Any building, structure, machine, or other device or thing made by humans

e) Any solid, liquid, gas, odour, heat, sound, vibration, or radiation resulting directly or indirectly from human activities

f) Any part or combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario

In applying the requirements of the EA Act to projects, two types of EA planning and approval processes are identified:
Individual EAs (Part II of the EA Act): projects for which a Terms of Reference and an Individual EA are carried out and submitted to the Minister of the Environment for review and approval.

Class EAs: projects are approved subject to compliance with an approved Class EA process; provided that the appropriate Class EA approval process is followed, a proponent will comply with Section 13(3) a, Part II.1 of the EA Act.

1.2.5 Municipal Class Environmental Assessment

The approved Municipal Class Environmental Assessment (Class EA) document prepared by the Municipal Engineer’s Association in 2000, amended in 2007 & 2011 documents an approved Class EA process. There are five phases of assessment in the Class EA document. The five phases include:

- Phase 1: Definition of the Problem
- Phase 2: Identification and Assessment of Alternative Solutions and Selection of a Preferred Solution
- Phase 3: Identification and Assessment of Alternative Sites/Design Concepts and Selection of a Preferred Site/Design
- Phase 4: Preparation of an Environmental Study Report (ESR)
- Phase 5: Implementation

The Class EA planning and design process is shown in Figure 1-3.

The Class EA document places projects into three possible schedules, depending on their characteristics (that is, Schedule A, B, or C projects). The schedule under which a project falls determines the planning and design phases that must be followed. This project falls under Schedule C projects which require more detailed study, public consultation, and documentation as they may have more significant impacts. Projects categorized as Schedule C must proceed through all five phases of assessment. An Environmental Study Report (ESR) must be completed and available for a 30-day public review period, prior to proceeding to implementation (Phase 5).
If public concerns regarding this project cannot be resolved, any person may request a Part II Order. Should the Minister of Environment deem that this is necessary; an Individual Environmental Assessment may be directed. If no concerns are expressed to the Minister of the Environment within thirty (30) days of filing the ESR and notification thereof, the project will proceed in accordance with the recommendations of the ESR.

In summary, the planning and design process undertaken for the CSO Storage Project addresses all the requirements for the Municipal Class EA.

1.2.6 ORAP

The City of Ottawa has a working plan to protect water quality in the Ottawa River. The Ottawa River Action Plan (ORAP), adopted by council February 2010, identified seventeen projects that will enable the City to improve water quality in the watershed and to ensure compliance with provincial regulations. The following is a listing of the ORAP projects:

   Project 1: Implementation of Real Time Control
   Project 2: Critical Combined Sewer Overflow and Storm Outfall Monitoring
Project 3: Combined Sewer Overflows Storage for Ultimate Combined Sewer Area
Project 4: Review and Implement Sewer Interconnection Program
Project 5: Sewer Separation outside the Ultimate Combined Sewer Area
Project 6: Development of a Wet Weather Infrastructure Management Plan
Project 7: Implementation of a Wet Weather Infrastructure Management Plan
Project 8: Installation of Floatable Traps in Combined Sewer Area Catchbasins
Project 9: Pinecrest Creek / Westboro Stormwater Management Retrofit Pilot
Project 10: Eastern Subwatersheds Stormwater Retrofit Plan
Project 11: Implementation of Stormwater Management Retrofit Plans
Project 12: R.O. Pickard Environmental Centre Effluent Dechlorination
Project 13: Water Environment Strategy
Project 14: Monitoring and Source Control Programs
Project 15: Wastewater and Drainage Environmental Quality Management System
Project 16: Updates to the Ottawa River Bacterial Water Quality Computer Model
Project 17: Public Outreach and Education

This project is being planned as a Schedule C project in accordance with the requirements of the Municipal Class Environmental Assessment, 2007. The Municipal Class EA is divided into five Phases. Phase I for this project was completed through the ORAP consultation process. This Phase identified and described the problem and opportunity: To achieve a service level for CSO of zero overflows during the swimming season in the “Design Year,” while accepting some overflows during years with more severe wet weather than the Design Year and/or during very large rain events.

1.3 PHASE 1 PUBLIC AND AGENCY CONSULTATION

Phase 1 of the MCEA consultation process for the Combined Sewage Storage Project was initiated as part of the ORAP consultation process in November and December 2009. Details can be found under separate cover (City of Ottawa 2010). Phase 1 included a series of open houses inviting the public with an opportunity to review the three levels of CSO Control options being considered and to discuss their relative costs and benefits.

1.3.1 Notice of Study Commencement and Public Open House

The Notice of Study Commencement and notice of the first Public Open house, attached in Appendix A, was placed in Ottawa area newspapers for two consecutive weeks in the Ottawa Citizen and LeDroit dating November 20, and 27, 2009.

Four Public Open Houses were held at different locations throughout the City:

- Central: Monday, November 23, from 6 to 8 p.m. at Landsdowne Park, Salon E 1015 Bank Street
- West: Thursday, November 26, from 6 to 8 p.m. at Ron Kolbus Lakeside Centre, Britannia Park
• South: Monday, November 30, from 6 to 8 p.m. at Nepean Sportsplex Halls C & D 1701 Woodroffe Avenue

• East: Tuesday, December 1, from 6 to 8 p.m. at the Royal Canadian Legion Branch 632 (Orleans) 800 Taylor Creek Drive

As a result of analysis carried out and feedback from the community collected at these open houses City staff recommended that Council endorse Option B. Option B represents a level of CSO control equivalent to “zero (0) CSOs per year during the swimming season in the “Design Year””. This service level is more stringent than the provincial requirement of two (2) combined sewer overflows per year; and, will be a significant improvement from the current average of thirty (30) overflows per year.

Option B consists of the construction of one or more storage facilities that will temporarily store sanitary and combined sewer flows during wet weather events to minimize the number of discharges to local rivers. The exact size and location of the storage facilities and any ancillary works is the subject of this report and of this EA. The scope of Option B as presented in fall 2009 has been modified to allow for consideration of the needs of growth, system redundancy, and flood relief, where cost effective to do so.

1.3.2 Notice of Public Meeting of the Planning & Environment Committee

Notice of the Public Meeting of the Planning & Environment Committee ran one time in the following area media on Friday, February 5, 2010:

• LeDroit
• The Ottawa Citizen
• EMC – Kanata
• EMC – Manotick
• EMC – Nepean/Barrhaven
• EMC – Orleans

• L'Express
• EMC - West Carleton
• EMC - Stittsville / Richmond
• EMC - Ottawa West
• EMC - Ottawa East
• EMC - Ottawa South

1.3.3 Public meeting of the Planning & Environment Committee

Consideration of Option B as the preferred level of service took place at a Public Meeting of the Planning & Environment Committee on February 9, 2010. The public was invited to attend and make presentation to the Committee on the preferred level of CSO control to be pursued under the Class EA.

Council approved the plan on February 24, 2010.
2.0 Phase 2 – Alternative Solutions

Following approval from council the Project proceeded through the next phases of the MCEA process by first identifying a long list of preferred alternative solutions.

2.1 ALTERNATIVE SOLUTIONS

Phase 2 of the Municipal Class EA process requires identification and evaluation of reasonable alternative solutions. Solutions for combined sewage storage could consist of any combination of localized (independent) or inter-linked storage tanks, tunnels or other forms of linear (i.e. pipe) storage facilities. Identification of potential alternative solutions for combined sewage storage was carried out in a two-step process. First, a long list of potential alternative solutions was developed and screened to narrow the number of alternative solutions down to a smaller number of reasonable alternatives for more detailed evaluation.

In order to be considered as a viable alternative, a storage solution must be deemed to be able to meet the functional objectives as well as be constructible and operational at an acceptable level of risk. These are minimum requirements in order to be considered as a feasible alternative.

The preferred configuration and location of these facilities is highly dependent on the specific volume determined to be required to meet the performance objectives, as well as where it makes the most sense functionally and operationally to place them.

2.2 COMBINED SEWAGE STORAGE REQUIREMENTS

Estimates of storage requirements are determined accounting for future intensification and growth within the service areas tributary to the CSO control locations. In addition, the consideration of climate change/uncertainty and its potential impacts on the sizing of the storage facilities is incorporated in the analysis. Based on a comprehensive literature review, the rainfall events from the “design year” were increased by 15% to account for climate change/uncertainty.

Table 2-1 provides a summary of the estimated overflow volumes at the three proposed control sites. The storage requirements are based on capturing all of the potential overflows during the “design” year (1980). It is interesting to note that a 15% increase in the rainfall results in a 72% increase in the storage requirements. This shows that the existing system is being used to its maximum potential and that relatively small increases in rainfall input can lead to a much longer proportion of the ensuing runoff period exceeding the system’s capacity and having to be stored to avoid overflows.

Table 2-1: Summary of Storage Requirements

<table>
<thead>
<tr>
<th>Potential Overflow Events</th>
<th>Storage Requirements (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>West End</td>
</tr>
<tr>
<td>1980 (“Design Year”)</td>
<td>4,300</td>
</tr>
<tr>
<td>1980 with 15% allowance for climate change</td>
<td>10,500</td>
</tr>
</tbody>
</table>
2.3 COMBINED SEWAGE STORAGE ALTERNATIVES

A total of five (5) alternative combined sewage storage solutions were formulated including variations in configuration, such that a total of eleven (11) options have been identified.

The following options were developed as part of the environmental assessment:

- **Alternative 1 - Storage Tanks**
- **Alternative 2 - Short Tunnels**
  - a. East-West tunnel - South
  - b. East-West tunnel - North
  - c. Hurdman-Lyon/Kent Tunnel
  - d. Somerset Wastewater Storage Facility
  - e. Opportunities with DOTT
- **Alternative 3 - Long Tunnel to ROPEC**
- **Alternative 4 - Tank-Tunnel Hybrids**
  - a. East Tunnel Hybrid
  - b. West Tunnel Hybrid
  - c. Lyon/Kent Tunnel Hybrid
- **Alternative 5 - In-River Storage**

2.3.1 Alternative 1: Storage Tanks

This alternative is based on the provision of individual storage tanks to store excess combined sewage before potential overflows. The alternative tank locations identified (Figure 2-1) are based on lands that are currently vacant and, to the extent possible, owned by the City or a public entity. To the extent possible, the inlet pipe to the tanks would be drawing off the combined sewage downstream of the regulators. In the case of the Rideau Canal Interceptor, three of the alternate tank locations are adjacent to the Rideau Canal Interceptor, upstream of the IOS, with the intent of backing up the water within the Rideau Canal Interceptor by raising the dam downstream of the regulator and providing a new regulator near the tank.

Assuming an average storage height of approximately 4 m to 5 m, tank footprints range from 35 m by 35 m up to 70 m by 70 m, respectively, for the smaller and larger tanks. Alternatively the storage may be provided in deeper tanks (up to 50 m deep) with a smaller footprint (also referred to as vertical shafts). These facilities are essentially the same as normal tanks with the exception that the footprint may be significantly reduced. Assuming an active storage depth of 40 m, the shaft footprints would vary between 12 m and 28 m diameter, respectively to accommodate the smaller and larger storage needs.
Combined Sewage Storage Environmental Study Report

ALTERNATIVE 1 STORAGE TANKS

Project No. 163400965

Stantec Consulting Ltd.
1505 Laperriere Avenue
Ottawa ON Canada
K1Z 7T1
Fax: (613) 722-2799
Phone (613) 722-4420

Legend

Collectors/Trunks
Potential Storage Tank Location

OPTION W-A
OPTION W-B
OPTION R-A
OPTION R-B
OPTION R-C
OPTION K-A
OPTION K-B
OPTION K-C

WEST NEPEAN COLLECTOR
INTERCEPTOR OUTFALL SEWER
RIDEAU CANAL INTERCEPTOR
RIDEAU RIVER COLLECTOR

Scale

Permit Seal

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Potential Storage Tank Location

Collectors/Trunks

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OPTION K-C

WEST NEPEAN COLLECTOR
INTERCEPTOR OUTFALL SEWER
RIDEAU CANAL INTERCEPTOR
RIDEAU RIVER COLLECTOR

Scale

Permit Seal

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2.3.2 Alternative 2: Short Tunnel Options

2.3.2.1 Alternative 2a: Short Tunnel - South

This alternative is based on the provision of an approximately 4,400 m long, 2.80 m to 3.65 m diameter tunnel south of the current IOS alignment. A range of tunnel diameters is presented to accommodate a range of storage needs considering climate change/uncertainty (refer to Table 2-1). With this option the tunnel would run under Laurier or Slater Street and then along Cumberland Street (Figure 2-2). Overflows from the Rideau Canal Interceptor could be directed to the tunnel via a diversion sewer or by increasing the height of the weir at the existing regulator and adding a new regulator at the intersection of the Rideau Canal Interceptor and the tunnel.

2.3.2.2 Alternative 2b: Short Tunnel - North

This alternative is based on the provision of an approximately 4,400 m long, 2.80 m to 3.65 m diameter tunnel north of the current IOS alignment. Again, a range of tunnel diameters is presented to accommodate a range of storage needs considering climate change/uncertainty (refer to Table 2-1). With this option the tunnel would run along Wellington Street, Mackenzie Avenue and St. Patrick Street or alternatively along Sussex Drive and Boteler Street (Figure 2-3).

2.3.2.3 Alternative 2c: Hurdman/North-South Tunnel

This alternative is based on a 4,600 m long tunnel that would run north from approximately Hurdman Station, west along Catherine Street and north along Lyon or Kent Streets to the IOS (Figure 2-4).

2.3.2.4 Alternative 2d: Somerset Wastewater Storage Facility

This alternative consists of implementing the previously considered Somerset Wastewater Storage Facility (SWSF) design (with necessary modifications), which originally included CSO and flood control storage totaling over 66,000 m³. This tunnel alignment terminates on the west side of the Rideau River and is too deep to drain by gravity (Figure 2-5). A deep pumping station will therefore be required. Note that an underground storage tank will be required at the east end to capture and store potential overflows from the Rideau River Collector – this was not part of the original SWSF design.

2.3.2.5 Alternative 2e: Opportunities to Combine Tunnel with DOTT

This alternative is based on capitalizing on opportunities offered by the future implementation of the Downtown Ottawa Transit Tunnel (DOTT). It consists of combining a portion of the core combined sewage storage tunnel with the DOTT (Figure 2-6). Effectively, this consists of oversizing the future DOTT to accommodate the storage needs for the West End and Rideau outfalls (between 20,000 m³ and 35,000 m³). Under this alternative, a portion of the combined DOTT/CSO tunnel area would need to be dedicated to combined sewage storage. Based on the current DOTT profile, a pump station would be required near Metcalfe Street to dewater the combined sewage storage tunnel. A storage tank at the Keefer site would also be required.
ALTERNATIVE 2C HURDMAN/NORTH-SOUTH TUNNEL

Environmental Study Report
City of Ottawa
Combined Sewage Storage

Legend
- New Overflow Regulator
- Hurdman-Catherine-North-South Tunnel
- LRT Tunnel/Track
- Ex. Collectors/Trunks
- Potential Storage Tank Location

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Stantec Consulting Ltd.
1000 Langevin Avenue
Ottawa ON Canada K1Z 7T1
Phone (613) 722-4420
Fax: (613) 722-2799
www.stantec.com

Client Number - 163400965
Issued A

Project No. Sheet No.

Potential Storage Tank Location
NEW OVERFLOW REGULATOR
INTERCEPTOR OUTFALL SEWER
OPTION W-A
OPTION W-B
OPTION K-A
OPTION K-B
OPTION K-C
REDAU CANAL INTERCEPTOR
RIDEAU RIVER COLLECTOR
~ 3.7m DIAMETER TUNNEL

NOTE: THE EXISTENCE, LOCATION AND ELVATION OF UTILITIES AND/OR CONCEALED STRUCTURES AT THE PROJECT SITE ARE NOT REPORTED ON THIS DRAWING. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY AND BE RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELVATION OF UTILITIES AND/OR CONCEALED STRUCTURES.
2.3.3 Alternative 3: Long Tunnel to ROEC

This alternative is based on the provision of an approximately 11,900 m long, 2.4 m diameter tunnel to effectively twin the IOS between the West End regulator and the City’s wastewater treatment plant (ROEC). Preliminary alignment options (Figure 2-7) are based on paralleling the IOS or following, to the extent possible, existing roadways or easements either north or south of the IOS. Within the core, the alignment would be the same as that described for Alternative 2a or 2b.

2.3.4 Alternative 4: Tunnel/Tank Hybrid Solutions

2.3.4.1 Alternative 4a: East Tunnel/Tank Hybrid

This alternative is based on a combination of Alternatives 1 and 2a or 2b where a 2,200 m long, approximately 3.7 m to 4.8 m diameter tunnel is provided in the eastern portion of the core to provide storage for the Rideau Canal Interceptor and Keefer overflows and a tank would accommodate storage needs in the West End (Figure 2-8).

2.3.4.2 Alternative 4b: West Tunnel/Tank Hybrid

This alternative is based on a combination of Alternatives 1 and 2a or 2b where a 1,900 m long, approximately 3.7 m to 4.9 m diameter tunnel is provided in the western portion of the core to provide storage for the West End and Rideau Canal Interceptor overflows and a tank would accommodate storage needs at the Keefer regulator (Figure 2-9).

2.3.4.3 Alternative 4c: North-South Tunnel/Tank Hybrid

This alternative is based on Alternative 1 with the implementation of a 1,700 m long tunnel that would run north along Lyon or Kent Streets from roughly Catherine Street to the IOS to effectively replace the storage tank required near the Rideau Canal Interceptor (Figure 2-10). Storage tanks would be required near the West End regulator and near the Keefer regulator.

2.3.5 Alternative 5: In-River Storage

This alternative is based on the implementation of a Dunker-style flow balancing system, relying on a bladder-like enclosure near the outfalls (Figure 2-11) that would be pumped back to the sanitary collection system after an event. This alternative would require the extension of the tailrace sewer to the Ottawa River to a point just downstream of the aqueduct outlet.
ALIGNMENT A

ALIGNMENT B

ALIGNMENT C

INTERCEPTOR OUTFALL SEWER

RIDEAU RIVER COLLECTOR

APPROX. 2.4m DIAMETER TUNNEL

REFER TO ALTERNATIVES 2A & 2B FOR POSSIBLE ALIGNMENTS IN CORE
2.4m DIAMETER TUNNEL

NEPEAN WEST NEPEAN COLLECTOR

NEW OVERFLOW REGULATOR

INTERCEPTOR OUTFALL SEWER

RIDEAU RIVER COLLECTOR

RIDEAU CANAL INTERCEPTOR

WEST NEPEAN COLLECTOR

OPTION W-A

OPTION W-B

OPTION K-C

OPTION K-B

OPTION K-A
3.0 Phase 2 – Development of Alternative Solutions

3.1 EVALUATION CRITERIA

The criteria used in the evaluation of alternatives are based, in part, on the criteria developed for the Regional Master Plan for Water, Wastewater and Transportation, a complete list of which can be found in Volume 2 of the “Planning and Environmental Assessment Summary Report” prepared by the former Region of Ottawa-Carleton. Referring to the criteria previously developed, the project team, in conjunction with the City of Ottawa, came up with a list of criteria with which to evaluate the alternatives. The criteria have also been further adjusted based on comments received from various project stakeholders, including federal and provincial review agencies and the general public.

The evaluation criteria fall into four categories and consider the technical, environmental, social, and economic impacts of the project on the study area. A list of the individual criteria and their respective categories, as well as an explanation of their indicators, is provided in Table 3-1.

<table>
<thead>
<tr>
<th>Table 3-1: Evaluation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>Technical</td>
</tr>
<tr>
<td>T1 Construction Risks</td>
</tr>
<tr>
<td>T2 Schedule</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>T3 Flexibility</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>T4 Reliability/Complexity</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Natural Environment</td>
</tr>
<tr>
<td>N1 Impact on Significant Natural Features (Terrestrial/Aquatic)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>N2 Impact on Ecological processes</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>N3 Impact on quality of receiving water</td>
</tr>
<tr>
<td>Socio-Cultural</td>
</tr>
<tr>
<td>S1 Effect on urban greenspace/open space</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>S2 Cultural heritage values or features</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 3-1: Evaluation Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rationale for Inclusion / Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>Duration of construction</td>
</tr>
<tr>
<td></td>
<td>Permanent structures that would impact views or aesthetics</td>
</tr>
<tr>
<td></td>
<td>Impacts to recreational activities (events, pathways, boating)</td>
</tr>
<tr>
<td></td>
<td>Impacts due to odours and/or operation and maintenance activities</td>
</tr>
<tr>
<td>S4</td>
<td>Compatibility with current zoning, NCC, Parks Canada, PWGSC plans and/or existing MOE policies.</td>
</tr>
<tr>
<td></td>
<td>Effect on potential site development</td>
</tr>
<tr>
<td>S5</td>
<td>Potential for flooding and ponding during the full range of wet weather events.</td>
</tr>
<tr>
<td>S6</td>
<td>Ownership - City owned versus publicly owned versus private</td>
</tr>
<tr>
<td></td>
<td>Possible access restrictions - site security requirements</td>
</tr>
<tr>
<td></td>
<td>Right of way or land acquisition needed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economy</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Number/extent of businesses affected (during and/or after construction)</td>
</tr>
<tr>
<td></td>
<td>Duration of construction/impact</td>
</tr>
<tr>
<td></td>
<td>Loss of opportunity costs</td>
</tr>
<tr>
<td>E2</td>
<td>Capital cost</td>
</tr>
<tr>
<td></td>
<td>Cost of property / easement</td>
</tr>
<tr>
<td>E3</td>
<td>Operation &amp; maintenance costs</td>
</tr>
</tbody>
</table>

3.2   ANCILLARY BENEFITS AND COST-EFFECTIVENESS

The evaluation of alternatives has also considered ancillary benefits that one alternative may have over others. Preference has thus been given to alternatives that can cost-effectively provide added benefits that go beyond just the minimum level of control of CSOs to the Ottawa River, such as:

- Mitigating Against Uncertainty: Alternatives that can cost-effectively provide added storage volume and reliability to address future change and uncertainty on issues such as climate change, growth needs, potential changes in regulations, and modeling uncertainties are favoured.

- Providing Added Operational Flexibility: Alternatives that can also provide flexibility, reliability and redundancy to ensure the long-term robustness of the operation of the overall core collection system are favoured.

- Providing Opportunity to Further Enhance Level of Service: Alternatives that can cost-effectively provide for added protection against basement flooding and/or provide further control of CSOs are favoured.

3.3   EVALUATION METHODOLOGY

Because there are a large number of potential alternatives for the provision of combined sewage storage, a two-step process was followed to narrow the long list of alternatives down to a smaller number of reasonable alternatives for more detailed examination.
The first step in the evaluation was carried out in a qualitative fashion where alternative solutions were compared and ranked against each other using a “High”, “Medium”, or “Low” impact ranking system with a “High” being least desirable. This type of evaluation represents the degree to which each alternative achieves City policy objectives and/or is preferred over other alternative solutions. A matrix was used to document and summarize the rating of each alternative against each criterion. The matrix evaluation of alternatives was used to short-list, or identify, the alternatives that were deemed to merit further consideration. Generally, the alternatives that were determined to have two or more “high” impact rankings were eliminated from further consideration.

<table>
<thead>
<tr>
<th>Impact Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>This score indicates that the alternative solution will have a Low Impact on that environmental component and is more desirable.</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>This score indicates that the alternative solution will have a Medium Impact on that environmental component and is neutral.</td>
</tr>
<tr>
<td>HIGH</td>
<td>This score indicates that the alternative solution will have a High Impact on that environmental component and is less desirable.</td>
</tr>
</tbody>
</table>

The following sections provide a brief description of the reasoning employed in the rating of the alternatives. The matrix showing the rationale for the evaluation is provided in Appendix B.

### 3.4 EVALUATION OF TECHNICAL CRITERIA

#### 3.4.1 Construction Risks

The alternatives that rely on the deep tanks in clay overburden (at Rideau Canal Interceptor) or tanks adjacent to the Rideau River and within the regulatory floodplain were ranked as having high construction related risks due to their extensive shoring needs and/or the possibility of excessive groundwater infiltration during construction.

While the construction of any tunnel has inherent risks, it is believed that tunnels that require transitions from rock to soft ground (clays) or tunnels in soft ground involve more risk than rock tunnels since they carry a greater possibility of overhead settlements. Hence, rock tunnels were given a medium rank while combination rock and clay tunnels were given a high rank.

Note that overburden soil contamination may be present at some of the tank sites identified. While such an occurrence would be an inconvenience to the project and lead to an increase in cost it is unlikely to have a significant impact on the overall project.

#### 3.4.2 Schedule

In-river storage is the alternative with the shortest implementation time due to its very modest infrastructure needs. However, the approval needs for this unusual system would likely be quite onerous and approval of this alternative is not a given considering the potential environmental and socio-cultural impacts to the Ottawa River.
Underground tanks are typically constructed using common open excavation techniques and therefore can generally be implemented in a slightly shorter timeframe than tunnels. For example, tanks could be tendered individually and constructed concurrently while tunnels would likely be tendered as a single contract to obtain better unit rates. This would not prevent multiple tunnel segments from being built concurrently.

One of the greatest potential impacts on the implementation of combined sewage storage is the possible conflicts with the construction of the DOTT especially in the West End, which is a prime candidate for a staging area for the DOTT and one of its transit stations. Combining the two projects (Alternative 2e) would increase the complexity of the design and likely lead to a longer design and implementation timeline since both projects would be hinged on one another.

The need for sub-surface easements associated with tunnel elements also has the potential of impacting the overall project implementation timeline. It is believed that it may be possible to reduce the need for such easements with further refinement to the conceptual alignments.

The alternatives that were considered to be most affected by the DOTT in combination with a number of other above noted concerns were rated as having a high impact. All others, with the exception of in-river storage system were rated medium.

### 3.4.3 Flexibility

A storage tunnel aligned with the IOS is considered to provide the best operational flexibility among the alternatives since sections of the IOS may be effectively twinned by a new tunnel. Both the IOS and the new tunnel may be used for storage and sanitary flows may be diverted into the new tunnel offering system redundancy and allowing the possibility to inspect and maintain the IOS. Most storage tunnel alternatives also provide the opportunity to share the available storage among the key overflow locations resulting in the most efficient use of the available volume. Storage tanks on the other hand do not offer the ability to share volume or provide any system redundancy. In some instances (Alternatives 2c and 4c) some of the tunnel elements may provide flow conveyance and offer some flood relief to flood prone areas.

### 3.4.4 Reliability/Complexity

The complexity of a solution will generally provide an indication of its long term reliability. As such, storage systems that rely on pumping for dewatering after a wet weather event will typically also need some type of flushing system. Both these systems increase the operational needs and complexity of the solution resulting in lower reliability than solutions that do not need such systems to meet the CSO control targets. Passively operated tunnels which drain by gravity offer the simplest and most reliable operation.

The location where excess combined sewage is drawn off from the collectors also influences the reliability and complexity of the alternatives. Locating diversions structures upstream of overflow regulators may result in a less effective use of the available storage and may require more sophisticated controls (such as Real Time Control) to “track” or even “predict or forecast” when the collector is on the verge of overflowing and react accordingly. The further away the diversion is from the overflow point, the more complex and conversely the less reliable the solution may be. The solution will likely be less effective if the diversion is located a significant distance upstream of the regulators and that there are lots of combined contributions.
downstream of the proposed diversion point. Therefore, the SWSF is not as reliable and is more complex to operate than a tunnel located further north.

The need for seasonal deployment and retrieval of the in-river storage system curtains and the need for occasional dredging of the facility further increase the complexity of this alternative.

3.5 EVALUATION OF NATURAL ENVIRONMENT CRITERIA

3.5.1 Significant Natural Features

With the exception of the in-river storage systems, all of the alternatives are rated as having low potential impact on significant natural features since they are all located within previously disturbed urban environments and/or manicured parks.

The In-river storage is expected to have some impacts on the Ottawa River’s riparian area which may be considered a significant feature.

3.5.2 Ecological Processes

As with the previous criteria, the in-river storage system is expected to have some localized impacts to fish and benthic habitats in the Ottawa River with the introduction of a barrier to fish passage and possibly smothering part of the river bottom with sediments and organic matter present in the combined sewage.

3.5.3 Receiving Water Quality

All alternatives are expected to provide significant improvements in receiving water quality by targeting a considerable reduction in CSO occurrences. The in-river storage was provided a medium rating since it will only operate during the open water season and would not provide any CSO control during late fall, winter or early spring wet weather events.

3.6 EVALUATION OF SOCIO-CULTURAL CRITERIA

3.6.1 Urban Green Space/Open Space

The implementation of combined sewage storage will lead to some temporary disruption of open space and may also result in the loss of some green space and vegetation removal where control buildings and/or access hatches are required. Underground tanks are expected to have the largest impact on open spaces since each tank will require an above ground control building to house controls and instrumentation for the pumping, flushing and odour control systems.

3.6.2 Cultural Heritage Values/Features

The amount of previous archaeological assessment is unknown for most sites. The likelihood of archaeological material is expected to vary depending on the proposed sites and construction methods and is expected to be highest for the underground tank sites along the Rideau Canal Interceptor and the Rideau River Collector.
High cultural heritage values are associated with tank sites at Confederation Park, Rideau Hall and Stanley-Sussex and the in-river storage system at the mouth of the Rideau Canal, a UNESCO World Heritage Site. Medium cultural heritage values are associated with tank sites at City Hall (Festival Plaza) and along Queen Elizabeth Driveway.

As a general rule, the construction of a tunnel and its access shafts are expected to lead to less localized surface disturbance than underground tanks.

A Stage 1 Archaeological Assessment was completed as part of this Project and can be found in Appendix H

3.6.3 Disruption to Community

The temporal and spatial extent of construction disruptions vary with each alternative and will be most important near the tanks and/or main tunnel construction accesses.

The construction of tanks and/or tunnels in the City core will lead to some disruption of the community since a significant amount of rock and soil material will need to be excavated and hauled away and new materials such as concrete brought in. For deep underground tanks, the volume of rock and soil may be significantly larger since the vast quantity of overburden material above the tank may have to be handled twice – taken off-site to allow tank construction and brought back in as backfill above the tank.

Permanent disruptions will be related to the presence of control buildings (tanks) and access hatches (tunnels). While control buildings may be quite imposing, the hatches are generally more inconspicuous. In the case of the in-river storage, the buoy/curtain system and pump stations are expected to impact views and may also disrupt recreational activities on the river (kayaking/boating).

3.6.4 Consistency with Planning Policies/Processes

Infrastructure planned within existing right-of-ways or City property will generally be most compatible with existing zoning and planning policies. Alternatives which rely on non-City property have the potential of impacting current or planned land uses. For example, underground tank locations in the West End would impact future development plans if implemented.

As for in-river storage system, it was given a high impact rating since it would not be consistent with item 6g of the MOE Procedure F-5-5, which requires that any storage and treatment capacity provided should be maintained outside of the control period.

3.6.5 Level of Service

With the exception of Alternatives 2c and 4c, which incorporate a north-south tunnel element that may also provide flood relief during extreme runoff events, the proposed alternative solution are not expected to improve the current level of flood protection.
3.6.6 Property Issues

While efforts were made to locate above and below grade infrastructure within City property limits, all alternative solutions have components which will impact land currently owned by the Government of Canada and/or private property owners. The National Capital Commission (NCC) has expressed concerns with underground storage tanks on lands under the control and management of the Government of Canada. The NCC encouraged the City to examine all other feasible options prior to proposing any permanent infrastructure on property they manage. They have specifically opposed preliminary tanks sites at Confederation Park, Rideau Hall and Stanley-Sussex.

The City has also expressed concerns with tank site W-B stating that it may interfere with the constructions of the DOTT (site has been identified as a construction staging area) and that a tank would limit the site's future development potential.

Based on the foregoing, alternative solutions which rely on multiple tanks were rated high (undesirable) whereas alternatives necessitating only a single tank and some tunnels were rated medium. Only one alternative, the Somerset Wastewater Storage Facility was rated low assuming that it may be located entirely within City owned lands. The interconnection of this solution with the Rideau River Collector may impact federally-owned lands on the east side of the river.

3.7 EVALUATION OF ECONOMIC CRITERIA

3.7.1 Impacts on Businesses and Land Owners

The implementation of combined sewage storage is expected to cause some localized disruptions, both temporary and permanent, which may impact businesses and land owners. Tunnel storage will require construction access shafts and maintenance access shafts at regular distances. The greatest impact associated with these will be during construction where access to and around the immediate area may be impeded. Once the facility is commissioned, the disruptions are expected to be infrequent and short-lived.

The majority of underground tank locations are not adjacent to businesses and therefore are not expected to cause significant disruptions. The tank locations identified in Lebreton Flats would result in an opportunity loss since the land is earmarked for development and the construction of an underground tank would significantly impact development opportunities and associated long term revenues from the development. Hence, alternatives relying on the Lebreton Flats tanks were rated as having a high negative impact.

3.7.2 Affordability

The in-river storage system is expected to be the lowest capital cost alternative based on its modest infrastructure needs.

While underground storage tanks are generally more cost effective than tunnels, they were considered comparable at this stage of the study considering the depth of the proposed tanks (approximately 15 m to 25 m to invert) combined with expected ground conditions (clay for the locations along the Rideau Canal, proximity to Rideau River for the New Edinburgh Park
location, possible contamination in West End). With the exception of the combined DOTT-Storage tunnel, where economies of scale may be possible, all other tank and/or tunnel alternatives are expected to have high capital costs.

3.7.3 Sustainability

Storage tunnels that are drained by gravity and flushed by diverting dry weather flow through them are anticipated to have the lowest operational burden. Conversely, underground tanks or tunnels that rely on pump stations for dewatering and mechanical flushing systems to scour accumulated sediments are anticipated to have higher operation and maintenance needs. In-river storage systems are also expected to have high operation and maintenance needs with pump stations, annual deployment/retrieval of floating curtains, occasional dredging of accumulated material on the river bottom and environmental monitoring.

3.8 SUMMARY OF EVALUATION OF LONG LIST OF ALTERNATIVES

The benefits and disadvantages of each of the long list of alternatives are summarized in Table 3 2.
Table 3-2: Summary of Evaluation of Long List of Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1:</td>
<td>• Common construction methods thus capital costs for tanks may be lower compared to linear storage (i.e. tunnels).</td>
<td>• Construction risks leading to cost escalation are elevated. Rideau Canal tanks would be deep (~20 m to tank bottom) clay excavation and would require significant shoring. The New Edinburgh Park tank (~15 m deep) may be prone to high groundwater infiltration.</td>
</tr>
<tr>
<td>Storage Tanks</td>
<td>• Some opportunities to locate tanks on City property</td>
<td>• Drawing off flows upstream of Rideau Canal regulator will likely lead to oversizing of tank</td>
</tr>
<tr>
<td></td>
<td>• Most of the land near the regulators are publicly owned (City/NCC/Federal)</td>
<td>• Tank dewatering and flushing systems increase complexity, operation/maintenance costs and reduce reliability</td>
</tr>
<tr>
<td></td>
<td>• Implementation period of 18 months is possible</td>
<td>• Relatively large footprint. Some sites will result in loss of development opportunities. Control buildings may further impact available green/open space</td>
</tr>
<tr>
<td>Alternative 2a: Short</td>
<td>• Tunnel may be used as a partial flow diversion for maintenance on the IOS and diverted sewage may be used for flushing of storage tunnel</td>
<td>• Tanks do not provide the flexibility to share storage volume</td>
</tr>
<tr>
<td>Tunnel South</td>
<td>• Avoids geotechnical concerns in around Rideau &amp; Nicholas Streets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ability to share storage volume between overflow points</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Flexibility to add volume by extending tunnel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Less land is required to accommodate alternative (compared to tanks)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Offers opportunities to consolidate overflows at single location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Offers redundancy for part of the IOS and provides opportunities to share storage volume with IOS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Drainage by gravity (no pumping required) reduces operational complexity, operation/maintenance costs and increases reliability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diversion sewers difficult to build, particularly at the Rideau Canal site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drawing off flows upstream of Rideau Canal regulator will likely lead to oversizing of tunnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Possible conflicts with proposed DOTT need to be avoided</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Maintenance access shafts are spread over the length of tunnel and may trigger the need for subsurface easements</td>
</tr>
</tbody>
</table>
## Table 3-2: Summary of Evaluation of Long List of Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| **Alternative 2b: Short Tunnel North**            | • Tunnel may be used as a partial flow diversion for maintenance on the IOS and diverted sewage may be used for flushing of storage tunnel  
• Ability to share storage volume between overflow points  
• Flexibility to add volume by extending tunnel  
• Less land is required to accommodate alternative (compared to tanks)  
• Offers opportunities to consolidate overflows at single location  
• Offers redundancy for part of the IOS and provides opportunities to share storage volume with IOS  
• Offers opportunities to share storage volume with Interceptor Outfall Sewer (IOS)  
• Drainage by gravity (no pumping required) reduces operational complexity, operation/maintenance costs and increases reliability | • Must contend with difficult geotechnical conditions immediately east of Rideau Canal.  
• Diversion sewers difficult to build  
• Possible conflicts with proposed DOTT need to be avoided  
• Maintenance access shafts are spread over the length of tunnel and may trigger the need for subsurface easements |
| **Alternative 2c: Hurdman Lyon/Kent Tunnel**       | • Opportunity to provide flood relief for the O'Connor (Glebe) area  
• Some opportunities to locate tanks on City property | • Requires underground storage tanks at east and west end, therefore same disadvantages as Alternative 1  
• Significant tunneling through soft ground, increasing settlement risk and construction cost  
• Among the most expensive of alternatives |
| **Alternative 2d: Somerset Wastewater Storage Facility** | • Opportunity to provide flood relief for the O'Connor (Glebe) area | • Requires deep pumping station, increasing complexity and operating costs  
• Limits opportunities for future expansion  
• Requires underground storage tank at east end, therefore same disadvantages as Alternative 1 |
| **Alternative 2e: Opportunities to Combine Tunnel with DOTT** | • Cost saving opportunities as a result of combining the two projects | • Requires pumping station at Metcalfe Street, increasing complexity and operating costs  
• Requires underground storage tank at east end, therefore same disadvantages as Alternative 1  
• Dual purpose tunnel increases risks and complexity  
• Coordination of timelines would increase complexity and implementation time |
<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Alternative 3: Long Tunnel to ROPEC | • Ability to share storage volume between overflow points and opportunities to share storage volume with IOS  
• Tunnel may be used as a flow diversion for maintenance on the IOS and diverted sewage may be used for flushing of storage tunnel  
• Provides full redundancy for IOS and long-term system reliability  
• Provides potential added conveyance capacity to ROPEC for future needs  
• Smaller tunnel bore may result in more competitive pricing (more common size of TBMs) and therefore offer cost-effective opportunities for oversizing and enhancing performance beyond minimum requirements  
• Less land is required to accommodate alternative (compared to tanks) | • Soft ground tunneling east of Blair Road increases overhead settlement risks  
• Possible need for extensive underground easements (east of Keefer)  
• Maintenance access shafts are spread over the length of tunnel and may trigger the need for subsurface easements  
• Longest implementation time  
• Amongst the most expensive of alternatives |
| Alternative 4a: East Tunnel Hybrid   | • Avoids geotechnical concerns in around Rideau & Nicholas Streets  
• Ability to share storage volume between overflow points  
• Alternative offers opportunities to share storage volume with IOS | • Possible conflicts with Chateau Laurier foundations (north alignments)  
• Tunnel routing is near embassies (northeast alignments)  
• Drawing off flows upstream of Rideau regulator will likely lead to oversized tunnel (south alignment)  
• Alt. 4b (south alignment) needs pumping to discharge to RCI.  
• Possible conflicts with proposed DOTT (south alignment)  
• Tank does not provide flexibility to share storage volume with the same concerns as raised under Alternative 1.  
• Can’t divert flows from IOS in City core |
| Alternative 4b: West Tunnel Hybrid   | • May be used as a partial flow diversion for maintenance on the IOS and flushing of storage tunnel.  
• Avoids geotechnical concerns in around Rideau & Nicholas Streets  
• Ability to share storage volume between overflow points  
• Alternative offers redundancy for part of the IOS and provides opportunities to share storage volume with IOS | • Tunnel routing is near embassies (northeast alignments)  
• Drawing off flows upstream of Rideau regulator will likely lead to oversized tunnel (south alignment)  
• A south alignment would need pumping to discharge to RCI.  
• Possible conflicts with proposed DOTT (south alignment)  
• Tank does not provide flexibility to share storage volume with the same concerns as raised under Alternative 1 |
| Alternative 4c: Lyon/Kent Tunnel Hybrid | • Possibility of dual-purpose tunnel providing flood control for O’Connor area and CSO control for Rideau Canal Regulator  
• Alignment avoids geotechnical concerns in around Rideau & Nicholas Streets  
• Alternative may require fewer easements than other tunnel alternatives | • Tanks and north-south tunnel alignment do not provide flexibility to share storage volume  
• Does not provide ability to divert IOS flows during maintenance  
• Tank dewatering and flushing systems increase complexity, operation/maintenance costs and reduce reliability |
### Table 3-2: Summary of Evaluation of Long List of Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 5: In-River Storage</td>
<td>• Low capital costs</td>
<td>• Can only operate during ice free conditions once enclosure system is deployed</td>
</tr>
<tr>
<td></td>
<td>• Highly flexible</td>
<td>• System will impact the recreational use of river (heavy public use of river near West End and Rideau Canal locations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Significant aesthetic impacts expected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• John St. storage volumes will have to account for stormwater inputs downstream of regulators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Higher risk of not receiving approvals from Review Agencies and MOE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operational costs with deployment/retrieval as well as repairs to curtains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No CSO control in winter period when system is removed</td>
</tr>
</tbody>
</table>

### 3.9 SHORT LIST OF ALTERNATIVES

The initial screening of the long list of alternative solutions proceeded by identifying which alternatives merit further consideration based on the rankings assigned to individual evaluation criteria within each criteria category. A detailed screening is provided in Appendix B. Generally two or more high impact rankings of individual criteria within a criteria category resulted in a high impact rating for the criteria category as summarized in Table 3-3. One or more high impact rankings of the criteria category resulted in the elimination of the alternative from further consideration.

A short list of alternatives was formulated with the alternative solutions which were retained in each criteria category. They are:

- Alternative 2a: Short Tunnel South of IOS;
- Alternative 2b: Short Tunnel North of IOS; and,
- Alternative 3: Long Tunnel - Lebreton Flats to ROPEC

### 3.10 EVALUATION OF SHORT-LISTED ALTERNATIVES

#### 3.10.1 Approach

A comparative evaluation of the short-listed alternatives was completed using the “reasoned argument” method of evaluation. Advantages and disadvantages of each alternative were identified and examined in greater detail for each criterion. A comparative analysis of the advantages and disadvantages was conducted to select a preferred alternative.
3.10.2 Investigations

3.10.2.1 Heritage/Archaeological

Evaluation of archaeological and/or heritage concerns are generally limited to those parts of the project where surface disturbances will occur, in this case specifically the potential access points from the ground surface to the proposed tunnels. Assessment of archaeological and/or heritage concerns was based on existing archaeological potential models from the City of Ottawa (ASI 1999; City of Ottawa 2010) and the National Capital Commission (Laliberté 1998), the Federal Heritage Building Review Office (FHBRO) list of Federal heritage buildings, some previous archaeological investigations at Strathcona Park and knowledge of the project area.

3.10.2.2 Natural Environment

The evaluation of natural environment concerns was generally limited to those parts of the project where surface disturbances will occur, in this case specifically the potential access points from the ground surface to the proposed tunnels. Assessment of natural environment was based on a review of the following sources:

- Available orthophotography and satellite imagery for the study area
- Natural Heritage Information Centre database maintained by the MNR
- City of Ottawa Official Plan
- Available background information for the study area, including Urban Natural Areas Environmental Evaluation Study (Muncaster and Brunton 2005)

A field reconnaissance of each of the proposed alignments was completed in September 2010, to identify natural environment constraints as determined from field observation.
## Table 3-3: Summary of Screening of Long List of Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria Categories</th>
<th>Short-Listed Yes/No</th>
<th>Impacts/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical</td>
<td>Natural Environment</td>
<td>Socio-Cultural</td>
</tr>
<tr>
<td>1 Storage Tanks</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a Core Tunnel - South</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2b Core Tunnel - North</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2c Hurdman /North-South Tunnel</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2d Somerset Wastewater Storage Facility</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2e Opportunities with DOTT</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Long Tunnel to ROPEC</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a East Tunnel Hybrid</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4b West Tunnel Hybrid</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4c North-South Tunnel Hybrid</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 In-River Storage</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Refer to Appendix B for full evaluation matrix.
3.10.2.3 Environmental (Phase 1 ESAs)

A qualitative assessment was undertaken of possible environmental concerns that may have adversely affected the quality of soil and groundwater within and in the vicinity of the alignment alternatives under consideration. Contaminant impacts to soil and groundwater could present technical risks to the construction of the proposed infrastructure in several ways: i) potential health and safety risks to workers during construction, ii) elevated costs associated with the assessment, management, treatment and disposal of contaminant impacted material, iii) potential effect on the selection and cost of construction materials that are not compatible with contaminants that might be discovered, and iv) present issues of liability that may attach to the City should the proposed infrastructure exacerbate the migration of existing contamination to neighbouring properties.

The assessment of environmental contaminant issues of concern was accomplished by applying modifications to the Phase I Environmental Site Assessment (ESA) process which is designed to determine if there is evidence of actual or potential environmental contamination impacts at a site that may present adverse effects to humans or the environment on the subject and neighbouring sites. This qualitative assessment process does not entail intrusive field sampling, which normally would be proposed during a subsequent stage of assessment during functional, preliminary, or detailed design.

The modified assessment comprised a search of the available historical aerial photographs, federal, provincial and private databases, and other pertinent historical information. A list of information sources is provided in Appendix C.

A reconnaissance of the properties on or adjacent to each of the proposed alignments was completed on August 25 and 27, 2010, to identify sites that may pose a concern as determined from field observation.

The scope of work was limited to five areas of interest, as opposed to assessing the entire length of each alignment alternative, which were assessed for possible impacts of contamination on the project. The areas of interest were defined as those places where significant surface construction or disturbance would likely be required within the proposed alignment alternatives. If the CSO project dictates a tunnel would be constructed at depth, assuming not open cut construction, possible contamination impacts were discounted as the tunnel segments likely would be beneath potential impacts associated with surface and near surface-derived contaminant releases.

3.10.3 Analysis of Short Listed-Alternatives

3.10.3.1 Technical

Alternative 2b (Short Tunnel North) will provide for a less complex operation at the Rideau Canal flow control site however, it is subject to significantly greater construction risks and constraints due to irregular geotechnical features (faults, deep canyon) and other physical features (Parliamentary Precinct, Chateau Laurier, American Embassy). These constraints are expected to have significant impacts on construction schedules as well as pose a significant risk for the escalation of construction costs. For these reasons, the south alignment (2a) is the preferred option within the Short Tunnel Alternative. The south alignment is thus also
considered to be the preferred tunnel alignment through the City core for the Long Tunnel Alignment (Alternative 3).

Comparing the two Alternatives (Short vs. Long Tunnel), the Long Tunnel leads to additional ancillary benefits in that it provides full redundancy for the IOS over its entire length and could provide additional conveyance capacity for future needs, if required.

Geotechnical

The following text is excerpted from a technical input provided by Golder (2010). A copy of the technical memo is attached (Appendix D).

All of the tunnel alignments being considered will likely involve tunneling under private property. Where this is the case, the design team will need to confirm that the tunnel will not impact existing building foundations on those properties (even though the contemplated tunnels would be in bedrock for the most part). Even for properties which are not currently occupied by high-rise buildings, the presence of the tunnel might limit the future development of the site, by restricting the future feasibility of deep foundations and parking structures.

Alternative 2a (Short Tunnel South)

Through the ‘Downtown’ area the tunnel would be constructed entirely in rock and with significant cover. East of about Bank Street, the bedrock transitions from limestone to shale and then, back to limestone for the remainder of the route. Some faulting is associated with those transitions. In the area near the Rideau Canal crossing the bedrock surface appears to dip down with minimal cover through this section (5 m above the tunnel crown) and there is even the risk of mixed-face conditions (if the rock surface undulates downward between the boreholes). Along Cumberland, where the tunnel would be aligned approximately north-south, the bedrock surface is located well above the crown. Where the alignment turns easterly towards the Rideau River crossing, there may again be only about 5 m of cover above the tunnel crown, and this would include the section beneath the Rideau River.

The proposed profile will apparently be located entirely in bedrock and the design is probably feasible for tunnel construction. In the area of the Rideau Canal crossing, there is the risk of mixed-face conditions and additional review of the geotechnical data will be required. An alignment on the north side of the proposed corridor would probably be preferred. In the area of the Rideau River crossing, there may be limited rock cover with the risk of mixed face conditions. However the more likely risk is of having excessive water inflow into the tunnel due to a direct hydraulic connection to the river (via fractures in the bedrock). The existing IOS was however successfully constructed beneath the river in close proximity to this alignment and at the same level, so the proposed design is presumably feasible.

This alignment involves a section of tunnel through generally less competent shale (between about Bank Street and the Rideau Canal). The faulting associated with the bedrock transitions may present some localized technical challenges. For example, localized grouting may be required to control the groundwater inflow, or rock bolting could be required for roof support. However it is not expected that these issues present a significant negative issue in terms of selection of this alternative.
Alternative 2b (Short Tunnel North)

The Short Tunnel North through the ‘Downtown’ area (along Wellington) would be constructed entirely in rock and with significant cover. In the area of the Rideau Canal crossing, immediately west of the Chateau Laurier hotel, there is a localized dip in the bedrock surface (apparently a filled bedrock valley). Minimal cover is expected through this section, and even the risk for mixed-face conditions. There is a similar but even larger and deeper filled valley feature in the area of the Wellington/Rideau intersection with Sussex Drive. Along Mackenzie the bedrock surface is located well above the crown (but dipping down to the north).

It is undesirable to extend the tunnel into the filled valley in the area of the Rideau-Sussex intersection. That valley is filled with water-bearing sand and gravel. Tunneling through this area would probably require a change in tunneling equipment which would require that a shaft be constructed in this very congested area. The sand and gravel deposit might also need to be dewatered, which would be challenging to do in this congested area and might cause settlement of nearby buildings. Alternatively the sand and gravel could be grouted to solidify it and make it feasible to tunnel through the valley using rock tunneling equipment. However this grouting would be complicated and expensive to carry out, especially in this congested area.

The Wellington/Rideau-Mackenzie intersection may form a pinch-point where the tunnel alignment is restricted to a very narrow corridor by the IOS, the right-of-way limits, and the filled valley to the east. A much more detailed assessment of this particular area would be required before it could be confirmed that routing the tunnel through this area is technically feasible.

Similar to the alignment of the Short Tunnel South, in the area of the Rideau River crossing, there may be limited rock cover with the risk of mixed face conditions. However the more likely risk is of having excessive water inflow into the tunnel due to a direct hydraulic connection to the river (via fractures in the bedrock). The existing IOS was however successfully constructed beneath the river in close proximity to this alignment and at the same level, so the proposed design is presumably feasible.

Alternative 3 (Long Tunnel to ROPEC)

The geotechnical conditions for the City core portion of the Long Tunnel are as described above for the Short Tunnel North or South (2a or 2b).

Between the Keefer Regulator and Blair Road the tunnel would be constructed entirely in rock and with significant cover. East of Blair Road the ground surface level dips down considerably in elevation. The bedrock surface undulates through this section and then also dips down to more than 25 m depth. In the transition zone, the rock level is quite irregular and a filled bedrock valley appears to be present. East of about Rebecca Crescent, the rock surface is entirely below the tunnel level and the construction would be carried out within a thick deposit of silty clay.

The proposed alignment and profile will likely follow the alignment and profile of the existing IOS or, even if a different alignment is followed, the ground conditions will likely be similar. The construction would involve tunneling in rock for the west part of the alignment and then tunneling in clay for the east part of the alignment, with a complicated transition zone in between.
The rock surface undulates through the transition zone such that there might not be a quick transition from rock to clay. These conditions are not well suited to mechanized tunneling methods. Ground improvement (such as grouting) could be required to locally solidify the overburden until a convenient location was reached for a shaft to be installed so that the tunneling equipment could be changed. A detailed geotechnical investigation program would be required to define the conditions in the transition, and there would still be an elevated risk of ground changes during tunneling. The overlying ground has also been developed with a residential subdivision and there might not be a convenient location at which to locate a shaft or carry out an extensive ground improvement program.

The tunnel would be constructed in clay beneath numerous private residences and the potential of excessive settlements exists if the construction equipment and methods are not appropriate. Available information indicates that the IOS was constructed without causing excessive settlements of the overlying ground. Some of the contemplated routes closer to the Ottawa River may be beneficial in that fewer private residences are located along the route thereby reducing the settlement risks of soft ground tunneling. However, a northern alignment may result in more soft ground tunneling and a greater risk of alternating rock to soft ground conditions. A more detailed review of ground conditions would be necessary before refining the alignment.

**Environmental Contamination Risk**

Several qualitative criteria were used to rank the sites according to the level of environmental concern associated with each. The criteria considered the historical land use, the current land use, and the period of operation of the activity of concern, among other site conditions. The levels assigned to each site are described below.

**Significant** - Significant level of concern associated with the site. This designation is assigned in most cases to a site within or adjacent to the proposed alignment, where there is an existing or historical activity of concern, with known environmental impacts. A qualitative estimate of the shallow groundwater flow direction and the magnitude of the on-site operation also are considered in the evaluation of sites of potential environmental concern. This designation implies that the site may require further assessment, which may include intrusive investigation of the local soil and groundwater quality, unless a reasonable rationale can be provided to exclude the site from intrusive assessment. Further phased intrusive assessment, if warranted, typically occurs during the design stages of the project. The typical scope of work entails a limited environmental soil and groundwater sampling program and possibly hydrogeological field assessment that could be preferably combined with the required geotechnical investigations to achieve logistical efficiencies.

**Moderate** - Moderate level of concern associated with the site. This designation is assigned generally to a site within or adjacent to the proposed alignment, where there is an existing or historical activity of concern, but with no known environmental impacts. A qualitative estimate of the shallow groundwater flow direction and the magnitude of the on-site operation also are considered in the evaluation of sites of potential environmental concern. It is generally unlikely that further intrusive assessment of soil and groundwater quality will be required to evaluate sites that are designated a moderate level of concern, but where there is a record of known occurrences that could adversely affect the area (e.g., spills), a limited intrusive assessment may be warranted.
Minor - Minor level of concern associated with the site. This designation is assigned generally to a site within or adjacent to the proposed alignment, or where there is evidence of an environmental concern that has been managed, or there is evidence of existing regulatory supervision. In addition, a site may be classified as a minor level of concern if it is unlikely that there could be an adverse impact on the assessment area based on current and historical land use, inferred permeability of the local soils, and if the operation is of relatively small-scale/duration. No intrusive environmental assessment is recommended for sites designated a minor concern.

During the assessment, two locations were categorized as a significant environmental concern, one location was categorized as a moderate environmental concern, and two locations were categorized as minor environmental concerns. A description of the environmental concern at each location and the rationale for the rank assigned to each is presented in Appendix C.

Table 3-4 presents a qualitative summary of the rankings of the alignment options according to the possible environmental concerns associated with each. The level of environmental concern was ranked from 1 to 3, corresponding to a minor, moderate, or significant concern. A corresponding qualitative risk score was calculated by totaling the product of the number of site of concerns and the ranking for each adjacent “area of interest”. Finally the qualitative risks were ranked; the greatest number representing an alignment/combination of alignments that represents the greatest relative qualitative risks associated with possible environmental impacts within or adjacent to the alignment.
<table>
<thead>
<tr>
<th>Alternative Alignment</th>
<th>Area of Interest</th>
<th>Neighbouring Sites with Environmental Contamination Concerns</th>
<th>Level of Environmental Contamination Concern*</th>
<th>Ranking of Environmental Concern</th>
<th>Qualitative Risk Score for Area of Interest</th>
<th>Total Qualitative Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 2a: Short Tunnel South</td>
<td>Tunnel Storage at west end of Laurier Avenue</td>
<td>Former location of City Iron and Bottles Co. from 1902 to 1950</td>
<td>Minor</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction at Laurier Avenue West and Rideau Canal</td>
<td>RPAM Corporate Services as registered generator of hazardous waste. Approximatley 90 meters from construction activities. 151-litre spill of hydraulic oil at Military Stores Building in 2005. No remedial activity documented. Approximately 100m up-gradient of construction activities. Former location of boat builder, painter and military stores.</td>
<td>Significant</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 2b: Short Tunnel North</td>
<td>New overflow dam, northwest of the canal and Wellington Street</td>
<td>Fairmont Chateau Laurier registered as a generator of hazardous waste from 1991 to 2010.</td>
<td>Moderate</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>West end of tunnel in LeBreton Flats Area</td>
<td>Listed as part of LeBreton Flats as a contaminated site on federal land. Phase III ESA and PRQA study under review by Health Canada and Environment Canada</td>
<td>Minor</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Alternative 3: Long Tunnel to ROPEC</td>
<td></td>
<td>No new concerns beyond those outlined above for the tunnel portion through the City core.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The level of concern assigned to a location may change if the area of construction activity is altered from that proposed to date.
Utility and/or Infrastructure Conflicts

Potential utility/infrastructure conflicts with the proposed infrastructure increase the overall risks associated with the proposed alternatives. Resolving such conflicts may involve costly relocations (when feasible) or design alterations to accommodate the conflicts.

The high density of shallow utilities and infrastructure in the downtown core will be a consideration when locating access shafts to the proposed storage tunnels for all alternatives.

Following is an overview of potential conflicts that have been identified at this time.

Alternative 2a (Short Tunnel South) – Potential conflicts between the proposed Downtown Ottawa Transit Tunnel (DOTT) and the Short Tunnel South have been identified at the West End of the tunnel and again at their crossing near Waller Street. Based on plan and profile drawings of the preliminary design of the DOTT the Short Tunnel South could be aligned to avoid direct conflict with the current vertical and horizontal alignment of the DOTT. To avoid conflicts with the DOTT and associated transit station near the Rideau Canal, the storage tunnel must be located south of Laurier Avenue. Note that the final design of the DOTT is expected to be underway in early 2013 and its vertical and horizontal alignment may be adjusted. The proposed short tunnel will likely pass under the High Pressure Transmission Main (HTPM) located along Albert St. west of Commissioner and/or the Fleet St. discharge along Commissioner and Bronson Ave. There is also a potential that the proposed tunnel will pass under a 750mm diameter watermain at Laurier Ave. and the Rideau Canal.

Alternative 2b (Short Tunnel North) – A number of potential conflicts have been identified between the Short Tunnel North and existing infrastructure such as: the IOS (near the Rideau Canal and possibly in lower town for Alignment A); and utility tunnels on/and originating from Parliament Hill. Potential conflicts between the proposed DOTT and the Short Tunnel North have been identified in the West End (near Brickhill St.) and near the Rideau Canal (if the storage tunnel is located to the south of the IOS). The proposed short tunnel will likely pass under the High Pressure Transmission Main (HTPM) located along Albert St. west of Commissioner and/or the Fleet St. discharge along Commissioner and Bronson Ave.

Alternative 3 (Long Tunnel to ROPEC) – The potential conflicts identified under Alternatives 2a or 2b also apply to this alternative. The extension of the storage tunnel to the wastewater treatment plant (WWTP) may involve the need to cross the IOS. Since these are essentially at the same elevation, it may involve the need for a special junction chamber or force a lowering of the storage tunnel profile to the WWTP. Existing tunnels leading to the WWTP may be in conflict with the proposed storage tunnel along Shefford Ave. Given the need for more access shafts (Long Tunnel is 3 times longer than Short Tunnel alternatives), Alternative 3 will have to deal with more shallow utilities through implementation.

3.10.3.2 Natural Environment

Alternatives 2a (Short Tunnel South) and 2b (Short Tunnel North) will have very little impact on significant natural environment features. Both alignments are predominantly urban and there are no natural woodlands, provincially significant wetlands or ANSiIs along these alignments. Aquatic features are common to both of the Short Tunnel Alternatives: Rideau River, Rideau Canal and the aqueduct in Lebreton Flats. None of the short-listed alternatives are expected to
directly impact any of these aquatic features; however, each may potentially impact riparian habitat along the Rideau River at New Edinburgh Park.

In addition to the aquatic features identified for the Short Tunnel Alternatives, Alternative 3 (Long Tunnel to ROPEC), will pass under or alongside several additional urban waterways (from 1 to 12, depending upon the alignment) and urban natural areas (Beechwood Cemetery Woods, Richelieu Park and Rockcliffe Air Base Woods).

### 3.10.3.3 Socio-cultural

#### Property Issues

Alternative 2a (Short Tunnel South) will predominantly follow City-owned roads; however, subsurface easements will be required for lands owned by the federal government at LeBreton Flats, Confederation Park, Bordeleau Park and New Edinburgh Park, as well as for privately owned lands between Rideau Canal and Rideau River (possibly including the University of Ottawa).

Alternative 2b (Short Tunnel North) will have similar property issues as Alternative 2a, excluding Confederation Park, and will also have site security requirements along Wellington Street in the vicinity of Parliament Hill.

Alternative 3 (Long Tunnel to ROPEC) shares the property issues associated with the Short Tunnel Alternatives, as well as additional requirements for subsurface easements (public and private) between the Rideau River and ROPEC, depending on the alignment.

#### Heritage

Each of the three alternatives fall within one or both of the existing archaeological potential models that cover the project area. Archaeological potential models use a series of topographic, hydrologic and historic land use based characteristics that are associated with the presence of archaeological resources and thus identify areas where it is more likely that archaeological resources might be found. It is anticipated that some level of archaeological assessment will be required, either Stage 2 archaeological assessments prior to construction of project access or archaeological monitoring of construction activities.

At several locations, including the intersection of Wellington at Lyon and at all locations on or near the Rideau Canal there are concerns related to listed heritage buildings or sites, including the Rideau Canal, a UNESCO World Heritage Site. Depending on the nature and length of construction activities it should be anticipated that specific mitigation measures will be required for any work at these locations.

A summary of the archaeological and heritage concerns for each alignment is provided in Table 3-5.
### Table 3-5: Summary of Archaeological/Heritage Concern for each Alignment Alternative

<table>
<thead>
<tr>
<th>Alignment Alternative</th>
<th>Element/ Area of Interest&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Archaeological/Heritage Concerns</th>
<th>Level of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 2a: Short Tunnel South</td>
<td>Booth/ Wellington</td>
<td>Area of Archaeological potential (City of Ottawa) – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Lyon or Kent/Laurier</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Laurier/Slater</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Laurier/Metcalfe</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Laurier/City Hall</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Mackenzie King/ Queen Elizabeth Dr.</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required; National Heritage and Unesco World Heritage site in close proximity</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Rideau Canal</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required; National Heritage and Unesco World Heritage site; listed heritage buildings in close proximity</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Laurier/ Cumberland</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required; listed heritage buildings in close proximity</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Cumberland/ Bruyere</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Strathcona Park</td>
<td>Area of Archaeological potential (City of Ottawa) – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Keefer/River Lane</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td>Alternative 2b: Short Tunnel North</td>
<td>Booth/Wellington</td>
<td>Area of Archaeological potential (City of Ottawa) – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Wellington/ Lyon or Kent</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required; listed heritage buildings in close proximity</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Wellington/ Rideau Canal</td>
<td>Area of Archaeological potential – Stage 2 AA and/or archaeological monitoring likely required; National Heritage and Unesco World Heritage site; listed heritage buildings in close proximity</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Cumberland/ Bruyere</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Strathcona Park</td>
<td>Area of Archaeological potential (City of Ottawa) – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Keefer/River Lane</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td>Alternative 3: Long Tunnel to ROPEC (from Rideau R. to ROPEC)</td>
<td>Strathcona Park</td>
<td>Area of Archaeological potential (City of Ottawa) – Stage 2 AA and/or archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Keefer/River Lane</td>
<td>Area of Archaeological potential (City of Ottawa) – archaeological monitoring likely required</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

<sup>a</sup> - Element/Area of interest is based on potential access points. The level of concern assigned to a location may change if the area of construction activity is altered from that proposed to date.
3.10.3.4 Economic

Opinion of Probable Costs

Preliminary opinion of probable costs were prepared for the three short listed alternatives for evaluation purposes. Details of the opinion can be found in Appendix E. A range of expected tunneling costs in Ottawa was established based on the consultant teams experience and discussions with three Ontario-based tunneling contractors. It must be noted that limited geotechnical information is available and that the number/location/complexity of the shafts is unknown at this time. No allowances were made for any major tunneling problems based on rock or soft ground quality, groundwater issues, contamination, or crossing faults. These uncertainties and associated risks are accounted for in the contingency allowance. Furthermore, no allowance was made for any odor control at this juncture as it is assumed that it would be comparable between alternatives.

A 76% allowance is applied to the capital cost estimates to account for the engineering design and support during construction, utility impacts and relocations, project management (City) and contingency (30% of capital costs plus above allowances). A detailed breakdown of the cost allowance is provided in Appendix E. Note that a more detailed opinion of probable cost is developed later in the process (as part of Phase 3 of the environmental assessment) for the recommended solution (refer to Section 5.2).

The opinion of probable costs was developed by establishing a few estimates to represent a possible range of probable costs for a range of tunnel sizes. These estimates were subsequently used to develop all-inclusive unit cost regressions for both the high and low cost ranges to help facilitate the generation of multiple estimates. The opinion of probable costs is summarized in Table 3-6.

Table 3-6: Opinion of Probable Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>I.D. (m)</th>
<th>L (m)</th>
<th>V (m³)</th>
<th>$ Low</th>
<th>$ High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt 2a/b: Short Tunnel - Minimum Volume</td>
<td>2.75</td>
<td>4,400</td>
<td>26,100</td>
<td>$90M</td>
<td>$105M</td>
</tr>
<tr>
<td>Alt 2a/b: Short Tunnel - Maximum volume</td>
<td>3.65</td>
<td>4,400</td>
<td>46,000</td>
<td>$105M</td>
<td>$115M</td>
</tr>
<tr>
<td>Alt 3: Long Tunnel to ROPEC</td>
<td>2.44</td>
<td>11,900</td>
<td>55,600</td>
<td>$180M</td>
<td>$225M</td>
</tr>
</tbody>
</table>

Alternative 2a/b (Short Tunnels, North or South) – At this juncture, the costs for the two Short Tunnel alternatives are expected to be within the same range. While additional risks may be associated with the north alignment (geotechnical, Light Rail Transit conflicts, land ownership), the alternatives are not sufficiently detailed at this point in time to capture these risks in the costs. Hence, it is estimated that a Short Tunnel would cost in the range of $90 to 115 million.

Alternative 3 (Long Tunnel to ROPEC) – The estimate for the Long Tunnel alternative was developed using a 2.44-m diameter tunnel which provides more than the estimated 43,000 m³ of storage volume. This size is considered to be among the most common and cost effective tunnel sizes and a smaller diameter may not result in a significant cost reduction. It is estimated that a Long Tunnel would cost in the range of $180 to 225 million.
Operation and Maintenance Needs

The operational and maintenance requirements is expected to be similar for the short listed alternatives where routine inspection and maintenance will be required for the new infrastructure including the tunnel itself, the gates, weirs, flow and level sensors, access shafts, diversion chambers, flushing mechanism and odor control units. The Long Tunnel would be three times longer than the shorter Short Tunnels and therefore will have more tunnel length and associated access shafts to inspect and maintain.

3.11 DEVELOPMENT OF THE PREFERRED SOLUTION

In summary, the Short Tunnel South (Alternative 2a) is the preferred alternative as it is believed to carry significantly less construction risks and constraints than its northern counterpart. These risks and constraints are expected to have significant impacts on construction schedules as well as pose a significant risk for the escalation of construction costs. The Short Tunnel South is also more cost effective at providing the necessary combined sewage storage volume when compared to the Long Tunnel Alternative.

Following the evaluation of the short-listed alternatives the City’ Technical Advisory Team and the Consulting Team assessed how the proposed CSO Control Tunnel could be integrated into the overall system in consideration of other major long-term system needs and opportunities. This assessment resulted in a long-term vision which consists of a long tunnel to ROPEC combined with a North-South tunnel (Refer to Figure 3-1). A North-South tunnel is recommended as part of O’Connor Area Flood Control Measures Project to resolve system surcharge and reduce basement flooding risks within the City Core. The long-term vision was developed based on the merits of the short-listed alternatives in context of not only CSO control, but also in context of the City’s overall wastewater infrastructure needs. Upon consideration for the phased implementation of the long-term vision evolved the recommended near-term solution: a combination of the Short Tunnel South (Alternative 2a) with a North-South Tunnel. The merits of this long-term vision, and a near-term implementation alternative, are compared to the other short-listed alternatives in Table 3-7.
THE CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS. DO NOT SCALE THE DRAWING. ANY ERRORS OR OMISSIONS SHALL BE REPORTED TO STANTEC WITHOUT DELAY. THE COPYRIGHTS TO ALL DESIGNS AND DRAWINGS ARE THE PROPERTY OF STANTEC. REPRODUCTION OR USE FOR ANY PURPOSE OTHER THAN THAT AUTHORIZED BY STANTEC IS FORBIDDEN.

***THE EXISTENCE, LOCATION AND ELEVATION OF UTILITIES AND/OR CONCEALED STRUCTURES AT THE PROJECT SITE ARE NOT GUARANTEED BY THE ENGINEER. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND CONCEALED STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT, OR PERSON(S) OF ITS INTENTION TO CARRY OUT ITS OPERATIONS***
### Table 3-7: Cost-Benefit Evaluation of Alternatives

<table>
<thead>
<tr>
<th>Alternative 2a</th>
<th>Alternative 3</th>
<th>Long Term Vision</th>
<th>Recommended Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Tunnel South</td>
<td>Long Tunnel</td>
<td>Long Tunnel (2a Alignment) + N-S Tunnel</td>
<td>Short Tunnel (2a) + N-S Tunnel (Phased Implementation)</td>
</tr>
<tr>
<td>Council’s CSO Control Objective is attained with possibility to exceed with a future tunnel extension</td>
<td>Council’s CSO Control Objective is attained with possibility to exceed</td>
<td>Council’s CSO Control Objective will be exceeded</td>
<td>Council CSO Control Objective is attained with possibility to exceed with a future tunnel extension</td>
</tr>
<tr>
<td>No local flood control benefits or added level of service provided</td>
<td>No local flood control benefits or added level of service provided</td>
<td>North-South Tunnel provides local flood control benefits within the O’Connor Area*</td>
<td>North-South Tunnel provides local flood control benefits within the O’Connor Area*</td>
</tr>
<tr>
<td>Future tunnel extension to ROPEC provides opportunity for additional volume and conveyance capacity without oversizing in near-term</td>
<td>Long-tunnel pro opportunity for ad volume and convey capacity</td>
<td>Long-tunnel pro opportunity for add volume and convey capacity</td>
<td>Future tunnel extension to ROPEC provides opportunity for additional volume and conveyance capacity without oversizing in near-term</td>
</tr>
<tr>
<td>Operational flexibility and redundancy for IOS through City Core with possibility to improve with a future tunnel extension</td>
<td>Operational flexibility for over entire length ROPEC</td>
<td>Operational flexibility for over entire length ROPEC</td>
<td>Operational flexibility and redundancy for IOS through City Core with possibility to improve with a future tunnel extension</td>
</tr>
<tr>
<td>Estimated Cost</td>
<td>$90 - $115 M</td>
<td>$180 - $225M</td>
<td>$215 - $265M</td>
</tr>
</tbody>
</table>

a - The North-South Tunnel provides a critical component of the O’Connor Area flood control measures. While some localized flood control benefits will be immediate, the full flood control benefits of the North-South Tunnel will not be apparent until all the flood control measures within the O’Connor Area are in place.

b – The estimated costs represent the range of storage requirements (Design Year and Design Year + 15% allowance for climate change) and uncertainties with the costs of tunneling. Odour control and land costs are excluded. A more detailed opinion of probable cost is developed for the recommended solution as part of Phase 3 of the Environmental Assessment under Section 5.2.

The comparison in Table 3-9 clearly shows that, by integrating a North-South Tunnel and considering overall collection system needs, the long-term vision provides significantly more benefits than the short-listed alternatives. A near-term implementation of a short (East-West) tunnel along with a North-South Tunnel provides for:

- A cost-effective solution that meets the project objectives;
- Has the added advantage of integrating flood control in the solution; and,
- Provides full flexibility to further enhance performance and operational flexibility (with the option to extend the tunnel in the future).
The combined costs of the Short Tunnel South Alternative (2a) implemented as a stand-alone CSO control solution ($90 to $115M) and the North-South Tunnel component of the O’Connor Area flood control measure ($35 to $40M) are estimated at $125 to $155M. The planning-level cost estimate of implementing them concurrently as a dual purpose solution is $115 to $150M resulting in a potential cost savings of $5 to $10M.

The inclusion of the North-South Tunnel provides a portion of the combined sewage storage capacity and a cost-benefit in that this component is an integral element in a planned flood control solution for the O’Connor (Glebe) area. The integration of the North-South Tunnel in the overall solution allows for a phased implementation of the ultimate solution with the potential to implement the Short Tunnel through the core at a smaller diameter than if it were implemented on its own. The reduced diameter would also lead to a reduction in the near-term investment and deferral of these funds to be used in the future extension of the tunnel. A combination of a Short (East-West) Tunnel and the North-South Tunnel both using a 2.44-m diameter tunnel would accommodate the minimum storage volume requirement (Table 2-1). In order to meet the larger storage volume requirement (with 15% allowance on Design Year events), the combination of the East-West tunnel and the North-South Tunnel would require a 3.05-m diameter tunnel.

The recommended preferred solution is illustrated in Figure 4-1 and consists of the implementation of a 4,400m long, 3.05 m diameter East-West tunnel through the City core interconnected with a 1,600 m long, 3.05 m diameter North-South tunnel along Kent or Lyon Street for a combined storage volume of approximately 43,000m³. This solution would accommodate the larger storage volume requirement to account of Climate Change (Design Year with a 15% allowance).

At this stage of the EA process, recommended corridors for both the East-West and North-South Tunnels are illustrated recognizing that further investigations and design work is necessary to finalize the alignments. The alignment is refined as the EA process progresses, as documented later in this report.

The East-West tunnel extends between Lebreton Flats and roughly John St. whereas the North-South tunnel extends between Catherine St. and roughly Wellington St. where it connects to the south end of the existing Kent St. storm tunnel (2,400mm diameter). Consideration was given to utilizing the existing CSO outfall at Kent St. but its configuration and capacity does not allow us to achieve our design objectives.

3.12 PHASE 2 PUBLIC AND AGENCY CONSULTATION

Phase 2 of the MCEA was initiated in January 2010. Shortly after, a Technical Advisory Team (TAT) was formed to begin advising on the alternative solutions.

The TAT was composed of various City Department representatives who were responsible for advising on technical aspects of the Project. The composition of the TAT varied with individual expertise dependent on the given stage of the Project.
Since this Project was part of the ORAP process, selected representatives were kept informed of the Projects’ process. Representatives were also invited to attend planned TAT meetings or consulted through ad-hoc meetings on an as-required basis.

Internal Stakeholders or City representatives not otherwise obligated by the responsibilities of the TAT were also consulted as part of the alternatives development process. This group provided expertise as needed throughout the Project life cycle. These parties attended planned TAT meetings or consulted through ad-hoc meetings on an as-required basis.

Project briefings for the local Ward’s Councilor offices were offered through and coordinated by the City’s Project Manager.

Regulatory Agencies that may have an interest in the Project were also informed throughout the Project life cycle. Letters were sent at the commencement of phase 2 for the Project to all identified Agencies to ascertain their interest in the study.

A comprehensive list of general public and interest groups was drafted in the early stages of the Project. The list of groups identified leaders that were contacted for invitation to public open houses. Letters were sent at the commencement of phase 2 for the Project to all identified groups to ascertain their interest in the study. The complete list was also offered the opportunity for consultation through ad-hoc meetings on an as-required basis throughout the Project life cycle. No requests were made for meetings by these groups during phase 2.

Consultation for phase 2 of the MCEA process also included meetings with the general public through two sets of public open houses. Attendees were asked if they wished to be added to the Project contact list to receive further updates.

A complete list of all Agencies, groups and individuals that received notification about the Project can be found in Appendix A.

Up to 84 interest groups and individuals were part of the Project contact list throughout the Project life cycle. Consistent with the Freedom of Information and Protection of Privacy Act, public lists developed as part of this study have not been included.

A copy of the letters sent to all Agencies and groups can be found in Appendix A.

The consultation program was flexible to permit requests for additional presentations, meetings at the request of stakeholders. However, it was also aggressive to target the Public at most opportune occasions and availability. For example, public open houses were avoided during the summer months as many people are out of town on vacation.

All comments received during the Project life cycle from anyone were considered by the Project Team.
3.12.1 First Nations and Aboriginal Consultation

The Ministry of Aboriginal Affairs and Indian and Northern Affairs Canada were consulted to identify potentially affected communities that may have an interest in the project. Consultation with First Nation and Aboriginal communities included the Kitigan Zibi Anishinabeg, Métis Nation of Ontario Consultation Unit and the Algonquins of Ontario Consultation Office which represents Algonquin communities in the Ottawa River watershed. Letters were sent at the commencement of phase 2 for the project to the listed communities to ascertain their interest in the study. Correspondence sent to communities is provided in Appendix A. No meetings with First Nations or Aboriginal groups were conducted during phase 2 of the project.

3.12.2 Website

The Project websites were launched to provide up-to-date information through the Project life-cycle and available in both French and English.


The website contained information from the public open houses (i.e. poster boards) to allow stakeholders to view the public information if unable to attend or to follow up from the public open houses. All communication materials contained the path to the website in an effort to encourage the public to fill-out and submit questionnaires distributed at various Project milestones. All communications materials were appended with key personnel contact information for both the Project and the MCEA process. All communications materials, including presentations, were available in both English and French.

A copy of the Project website pages is included in Appendix A.

3.12.3 Notice of Public Open Houses

Notice of the first public open house was published in daily and weekly newspapers on the specified dates below. Copies of the ads placed in the daily newspapers can be found in Appendix A.

**Daily newspapers:**
The Ottawa Citizen  Tues. March 16, 2010  Fri. March 19, 2010  Fri March 26, 2010

**Weekly newspapers:**
Orléans Star  Fri March 19, 2010  Fri March 26, 2010
L’express  Fri March 19, 2010  Fri March 26, 2010
Notice of the second public open house was published twice in the Ottawa Citizen and LeDroit on May 28 and June 11, 2010. Copies of the ads placed in the daily newspapers can be found in Appendix A.

Notification for both public open houses was sent to the entire Project contact list.

### 3.12.4 Public Open House #1

The first public open houses held during phase 2 of the Project outlined the specific objectives of the project and presented evaluation criteria as well as the long-list of alternatives being considered. All materials presented and distributed for this open house can be found in Appendix A.

The open houses were held in both central and east locations to target the residents closest to the proposed Project infrastructure. The central location was held March 30, 2010 at the Tom Brown Arena and was attended by four members of the public. The eastern location was held April 1, 2010 at the Bob MacQuarrie Recreation Centre and was attended by eleven members of the public.

The format of the public open house (as was the same for all additional public open houses) was informal so that attendees can casually flow through. Poster boards displayed on easels were arranged throughout the room and consultants and City staff were on hand to provide additional information and answer any questions.

A presentation at 7:00 pm gave the public an overview of the public open houses purpose and current stage of the Project.

All consultation-related documents were provided in English and French. The package was compiled of resource documents that were created by the Project team to help members of the public understand the project, request further information and/or provide feedback on the Project. In addition to verbal comments, the Project Team representatives encouraged visitors to submit written comments regarding the information presented.

Members of the public that were unable to attend a public open house and did not have access to the internet could request that a hard copy resource information package be mailed to them. An online version of the questionnaire was also made available by request on the City of Ottawa’s website. Additional comments could also be received via either of the emails or fax numbers contained on several resources, the presentation, poster boards or website. A duration of 30 days was available to receive public comment on materials presented. A total of four completed questionnaires were received, no additional comments were received after the 30 day time period.
3.12.5 Public Open House #2

A second round of public open houses was held during phase 2 of the Project to present the short list of alternative solutions being considered, the evaluation of the alternative solutions and the recommended Preferred Alternative Solution. All materials presented and distributed for this open house can be found in Appendix A.

The open houses were held in both central and east locations to target the residents closest to the proposed Project infrastructure. The central location was held June 16, 2010 at the Montgomery Legion and was attended by nine members of the public. The eastern location was held June 15, 2010 at the Shenkman Arts Centre and was attended by four members of the public.

All consultation-related documents were provided in English and French. The package was compiled of resource documents that were created by the Project team to help members of the public understand the Project, request further information and/or provide feedback on the Project. In addition to verbal comments, the Project Team representatives encouraged visitors to submit written comments regarding the information presented.

Members of the public that were unable to attend a public open house and did not have access to the internet could request that a hard copy resource information package be mailed to them. An online version of the questionnaire was also made available by request on the City of Ottawa’s website. Additional comments could also be received via either of the emails or fax numbers contained on several resources, the presentation, poster boards or website. A duration of 30 days was available to receive public comment on materials presented. One completed questionnaire was received; no additional comments were received after the 30 day time period.

3.13 PUBLIC AND AGENCY CONSULTATION RESULTS

Consultation during phase 2 of the MCEA process has affected the outcome of the Project. Key points have been compiled and summarized from documentation of the following items:

Internal Consultation

- 5 TAT meetings

External Consultation

- 6 meetings with Federal Agencies
- 4 meetings with the DOTT team (monthly meetings)
- 1 meeting with City Property Representatives (regular)
- 1 presentation to the Business Advisory Committee
- 1 presentation to the Environmental Advisory Committee
- 1 meeting with the Canada Lands Corporation; and,
1 meeting with the University of Ottawa.

Public Consultation

- recorded notes from comments made during Q & A at both public open houses; and,
- questionnaires (5) submitted from both public open houses.
- All additional comments received from anyone by any other form of communication (i.e. email).

Consultation during phase 2 of the Project involved discussions focusing on refining the long list of alternatives and developing a defensible set of criteria to evaluate the long list of alternatives.

Internal technical meetings held with TAT members during phase 2 of the Project worked to evaluate the list of alternatives considered, refine the evaluation criteria used to result in the short list of alternatives carried forward.

Involved federal agencies helped the Project team identify other key agencies to contact. Targeted meetings held with key federal agencies discussed land use conflicts with proposed project infrastructure. NCC and Parks Canada provided considerable feedback to help shape the criteria to evaluate alternatives.

Concerns were raised by the University of Ottawa with respect to potential impacts from tunneling vibrations and further raised the question whether existing contamination that could exist on-site could be spread. Current research indicates that tunneling at the proposed depth should not affect at surface properties, however, vibration monitoring will be recommended. With respect to existing contamination, Phase 1 and 2 Environmental Site Assessments to determine areas of contamination are to be completed as required prior to physical works.

Feedback from the public and interest groups was generally very supportive of the project. Concerns voiced by the public were primarily related to potential for Project construction to cause disruption to communities. Concerns for timelines have been noted by key federal agencies as well and the Project team has proposed construction schedules that limit conflicts and disruption. Further refinement of the Project schedule will occur during the detailed design phase.
4.0 Phase 3 – Alternative Design Concepts for Preferred Solution

The following section provides a description of the alternative design concepts that were considered as part of the functional design process for the preferred solution. For the most part, these are related to tunnel alignments and associated construction and operation and maintenance accesses. The potential environmental impacts of these alternative design concepts are presented along with potential mitigation measures.

4.1 DESCRIPTION OF PREFERRED SOLUTION

The preferred solution for meeting the City’s immediate CSO control objectives, while respecting future infrastructure needs, is a combination of an East-West Tunnel (EWT) and a North-South Tunnel. The CSO control objectives will be achieved by storing excess combined sewage originating from three (3) main overflow locations associated with four (4) major collectors (Booth St. Sewer, Cave Creek Collector, Rideau Canal Interceptor and Rideau River Collector) and releasing the sewage back to the Interceptor-Outfall Sewer (IOS) when capacity is available.

Figure 4-1 depicts the preferred solution. The East-West tunnel will essentially twin the IOS through the downtown core from Lebreton Flats to its outlet to the IOS at Stanley Park. The solution includes provisions for future expansion of the tunnel to ROPEC for additional conveyance capability and storage capacity. Key attributes and benefits of the solution are summarized as follows:

- East-West Tunnel (EWT) (3.0m diameter, 4,400 km long) along Slater or Laurier from Lebreton Flats to Stanley Park. The tunnel elevation is slightly above that of the IOS, allowing gravity drainage to the IOS following storage events;

- North-South Tunnel (NST) (3.0m diameter, 1,600 km long) along Kent connected to the East-West tunnel with high level overflow to the Ottawa River (also referred to as the Kent Street Tunnel). The tunnel will flow south to north to the connection with the EWT. The tunnel extends north of the connection to the EWT at an upward slope to the outlet;

- The solution meets the target CSO control objectives in the near term with the potential for future tunnel extension for additional storage;

- Together with the EWT, the NST provides significant reductions in the frequency and volume of CSOs originating from the overall combined sewer catchment area by means of storing and later treatment of overflows;

- The NST also provides a dual functionality in offering flood relief for the O’Connor catchment area;

- Future extension of the EWT to ROPEC will provide the opportunity for additional volume and conveyance capacity without costly oversizing in the near-term;
Rideau River Collector

RIDEAU CANAL INTERCEPTOR

Proposed East-West Tunnel outlet chamber
(with outlet gate)

RCI Diversion Chamber & Pipe to Tunnel
(c/w bending weir and isolation gate)

Proposed Kent St Tunnel

Connections at Catherine, McLeod & Florence

Existing 2400mm Kent St Storm Tunnel

Increase in dam height to 52.70m.

Tunnel Overflow

Proposed Kent St Tunnel would connect
to south end of existing Kent St Storm Tunnel.

East-West Tunnel outlet chamber

Proposed RRC Diversion Chamber

Interceptor Outfall Sewer

East-West Storage Tunnel

Mid-Point Staging Area

Interceptor Outfall Sewer

West Nepean Collector

Cave Creek Collector

Proposed Kent St Tunnel
Connections at Catherine, McLeod & Florence

Legend

Existing collectors

Proposed Storage Tunnels

Proposed Modifications to Overflow Control

Proposed Access and/or Diversion Structures

Notes

*** THE EXISTENCE, LOCATION AND ELAVATION OF UTILITIES AND/OR CONCELAED STRUCTURES AT THE PROJECT SITE ARE NOT GUARANTEED BY THE ENGINEER. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND/OR STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT, OR PERSON(S) OF INTENTION TO CARRY OUT ITS OPERATIONS ***

FIGURE 4-1

City of Ottawa
Combined Sewage Storage
Environmental Study Report

RECOMMENDED PREFERRED SOLUTION

Stantec Consulting Ltd.
1505 Laperriere Avenue
Ottawa ON Canada
K1Z 7T1
Phone (613) 722-4420
Fax (613) 722-2799
www.stantec.com

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W:\active\1634_00965_Ottawa_CSO_Storage_EA\planning\report\ESR - Evaluation Report\Figures\4-1 Board_Tunnel_Core.mxd
• The EWT provides operational flexibility and redundancy for the IOS through the City Core with the possibility to provide redundancy for the full length of the IOS with a future tunnel extension.

### 4.1.1 Performance Objectives

The objective of the proposed EWT is to control all combined sewer overflows (CSO) originating from the three afore-mentioned locations within the Ultimate Combined Sewer Area during the swimming season in the “Design Year” (1980) while accepting some overflows during years with more severe wet weather than the design year and/or during very large rain events.

The total storage requirement to meet this objective in the design year, adjusted for climate change, is 42,800m³ (details regarding the required volume are provided in Section 2.0). The total available storage within the preferred solution is summarized in Table 4-1.

<table>
<thead>
<tr>
<th>Tunnel</th>
<th>Dimensions</th>
<th>Available Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-West tunnel (EWT)</td>
<td>4,400m x 3.0m diam.</td>
<td>31,100m³</td>
</tr>
<tr>
<td>North-South Tunnel (NST)</td>
<td>1,600m x 3.0m diam.</td>
<td>11,300m³</td>
</tr>
<tr>
<td>East End Surge Shaft</td>
<td>7.0m depth x 15m diam.</td>
<td>1,200m³</td>
</tr>
<tr>
<td>TOTAL</td>
<td>-</td>
<td>43,600m³</td>
</tr>
</tbody>
</table>

A performance assessment of the proposed storage solution using model simulations of the events from the Control Periods of the last 12 years on record (1998 to 2009) indicate that no overflows would have occurred in 3 of those 12 years. For the same 12 years, large rainfall events would have caused 9 overflow occurrences for an average of 0.75 events per year. The total estimated overflow volume for these 12 Control Periods is 1,742,000 m³ (median of 73,000m³/year) with the September 9, 2004 and July 31, 2006 events accounting for 45% and 27% of the total overflow volume, respectively. The estimated overflow volume contribution to the Ottawa River with the storage solution is distributed as follows: 30.0% at West End (Tailrace Sewer), 22.5% at Rideau Canal, 2.5% at Kent St. storm tunnel and 46.0% at Keefer (John St. Sewer).

### 4.1.2 Control Philosophy

The EWT and NST will store excess combined sewage from the pertinent collectors/regulators and discharge stored sewage by gravity to the IOS once the event has passed.

Filling of the storage tunnels will be passive in that excess combined sewage in the collectors of interest would be preferentially directed to the storage tunnels instead of the River. The profiles of the storage tunnels are slightly higher than that of the IOS allowing them to be drained by gravity to the IOS once capacity is available. A modulation gate at the east end of the East-West tunnel will control the draining process to the IOS.
The operational philosophy of the preferred solution is generally as follows:

- The storage tunnel will fill by gravity through the use of new diversion chambers on the collectors of interest;
- If the tunnel reaches its full capacity inlet control structures from the three afore-mentioned overflow locations will close. At this point, excess combined sewage will overflow to the Ottawa River through their respective collector overflows. In the case of the NST, inflows from flood-prone areas would continue to flow into the tunnel to prevent sewer surcharge and basement flooding in the O’Connor Area; these flows would then overflow into the Ottawa River via the existing Kent Street storm tunnel.
- Once the wet weather flow event has passed, and capacity is available in the IOS a control gate at the outlet of the storage tunnel would open to drain the storage tunnel by gravity. The control gate would be automated based on locally measured levels within the tunnel and the IOS or WWTP;
- Once drained, the tunnel may be flushed to re-suspend and transport to the IOS any debris that may have settled in the bottom of the tunnel during the storage operations. This may be done by diverting dry weather flow through the tunnel or by holding back some water and releasing it after the tunnel is dewatered. This operation could be done remotely from the WWTP;
- Odour control facilities would be fully automated to initiate treatment of air expelled from the tunnel as it fills up, upon sensing a storage event.

CSO’s will occur during severe runoff events when the storage tunnels are filled to capacity. Under such an event, isolation gates at the West End, Rideau Canal and Keefer would close and excess combined sewer will overflow to the Ottawa River through their respective collectors. In the case of the North-South Tunnel, inflows from the Catherine, McLeod and Florence St. sewers would not be controlled in an effort to prevent sewer surcharge and basement flooding in the O’Connor Area. Excess combined sewage from this area would be directed to the North-South Tunnel and under severe runoff events would overflow via the existing Kent St. storm tunnel. In essence, the introduction of the North-South Tunnel would shift some of the CSO’s that occur during severe runoff events from the Rideau Canal Interceptor to the existing Kent St. storm tunnel.

The system will be integrated with the existing Real-Time Control (RTC) system for remote control via the central wastewater Supervisory Control and Data Acquisition (SCADA) system. System Operators will thus be able to monitor the system’s operation and respond to emergency conditions in similar fashion to the existing RTC system. All control gates will be automated and controlled based on local real-time tunnel water level measurements. Control sites outfitted with control gates will either be equipped with a stand-alone Programmable Logic Controller (PLC) connected to the SCADA system or will be integrated into a nearby RTC site’s communications and control system.

4.1.3 Functional Components

The EWT and NST tunnels will capture CSOs from several collectors along their respective reaches. Key capture sites and other key control sites along the tunnels are summarized below:
ALONG THE EWT:

- **West End (Lebreton Flats):** Located at the upstream end of the EWT (near Booth St. and Alvert St.), this site conveys flow from the Cave Creek Collector (CCC), Booth Street Sewer (BSS), and on occasion the West Nepean Collector (WNC), into the EWT when capacity is available. The diversion chambers will also isolate the EWT from these collection systems when it is full. Primary control of inflow to the EWT will be via a new diversion chamber on the BSS with a new sewer to convey flow from the CCC to the diversion chamber. During construction, the site will also act as the exit shaft for the Tunnel Boring Machine (TBM).

- **Rideau Canal Interceptor:** (near Queen Elizabeth Dr. and Slater) This site will convey excess flow from the Rideau Canal Interceptor to the EWT via a new diversion chamber on the RCI located upstream of the existing Rideau Canal Regulator. Modifications to the existing RCI overflow, along the Canal Locks north of Wellington Street, will be required to force a backup of flow to the upstream diversion chamber during overflow events. A mid-point construction shaft is sought at, or in the vicinity of, this site in order to remove tunnel spoils from the excavation of the western half of the tunnel. This will provide for a faster, more cost-effective means of constructing the tunnel.

- **Rideau River Collector/IOS Connection:** This site will convey excess flow from the Rideau River Collector via a diversion sewer from the John St. sewer, located downstream of the Keefer Regulator (Queen Victoria and River Lane), to the EWT. The site is located at the end of the EWT and acts as the control point for draining the EWT/NST to the IOS. This site will be the primary staging area for tunneling for the eastern half of the tunnel to the RCI site.

ALONG THE NST:

- **Catherine:** Located at the upstream end of the NST (Catherine and Kent), this site conveys flow from the future Catherine East Sewer and Catherine West Tunnel into the NST, where flow is then conveyed to the EWT. This site will also be equipped with an access shaft to the tunnel for inspection and maintenance procedures.

- **McLeod:** This site (McLeod and Kent) will convey flow from local combined sewers (and future flood control, trunk-level measures) along McLeod to the NST via a vortex drop shaft.

- **Florence:** This site (Florence and Kent) will convey flow from local combined sewers along Florence to the NST. An inline gate will be used to store water upstream in the tunnel for flushing of the NST following storage events.

- **NST Outlet:** This site (Wellington and Kent) will provide a connection to the existing Kent Street Storm tunnel and outlet to the Ottawa River. It will act as an emergency high-level overflow for the EWT and a tunnel outlet for flood relief within the O’Connor drainage area.
4.1.4 Operational Considerations

4.1.4.1 Access Structures

In order to ensure that adequate access is provided for periodic maintenance, cleaning and inspection of the EWT and NST, additional access locations along the tunnels are proposed.

Access shafts to the tunnels will be provided at the following locations in addition to the functional sites noted previously:

- NST/EWT Junction: (Kent and Slater) The NST south of the EWT drains towards the EWT and the NST north of the EWT slopes upward to the NST overflow location.
- Midway between RCI and RRC on the EWT along Cumberland Street near the intersection of Clarence (Lower Town).

The final location of accesses should be located off of traffic lanes of busy roadways to reduce potential traffic impacts and to ensure worker safety.

4.1.4.2 Tunnel Flushing

It is anticipated that periodic flushing of the EWT and NST may be required following storage events to prevent the buildup of debris/sediment within the tunnel and to reduce the risk of subsequent odours forming and being released from the tunnel.

EWT: The West End RTC Regulator would be configured to redirect the WNC and BSS inflows from the IOS to the EWT to flush the EWT for a period of time during dry weather conditions. The total approximate dry weather flow of the BSS and WNC is 950L/s (200L/s from the BSS and 750L/s from the WNC), which would produce flushing velocities in the order of 1.15m/s.

NST: A flushing gate is proposed on the NST, which would be used to store combined wastewater in the upstream reaches of the tunnel after the tunnel has been drained. The location of the flushing gate would be selected in order to store a volume of water to produce a sufficient scouring velocity when released (in the order of 1.15-1.5m/s for a 10-15 minute period). Side weirs are proposed on either side of the flushing gate to provide a passive bypass around the gate in the event of gate malfunction, blockage or failure.

4.1.4.3 IOS Redundancy (Partial)

The existing IOS was built in the 1960’s and will require inspection and subsequent cleaning and rehabilitation in the future. The EWT essentially provides a ‘twinning’ of a portion of the IOS. This allows the City to redirect much of the flows normally conveyed by the IOS into the EWT. This provides operators with much greater flexibility in the future for maintenance, inspection and cleaning purposes. In the event of a major IOS failure within the downtown core, the EWT could also be used to capture and convey the bulk of existing inflows to the IOS with a connection back to the IOS at the RRC junction in Stanley Park.
Flow from some collectors can be diverted to the EWT via manipulation of the RTC modulation and isolation sluice gates, while some locations will require temporary diversion structures (i.e. inline dams or weirs) to redirect flow away from the IOS to the EWT.

4.1.4.4 Odour Control

The new CSST will be operated in a fill-and-drain mode with combined sewage being diverted into the tunnel during wet weather events. Upon completion of a wet weather event, wastewater stored in the tunnel will be released by gravity back to the IOS as capacity allows.

Air will be expelled from the tunnels during the filling sequence. Stored wastewater within the tunnels following a storage event may have the potential to produce odours, which may in turn create complaints from area residents and/or businesses if not treated.

Because the tunnel will not operate continuously, air movement within the tunnels will be comprised of both air friction drag and air displacement. In order to mitigate potential odour production by the tunnels, odour control systems on the upper end of each tunnel (i.e. Lebreton Flats and Catherine) would draw air from the tunnel as it fills, allowing exhausted air to be treated at specific locations during events.

Additional odour treatment may be warranted at the RCI site (i.e. the new diversion chamber) where air from within the RCI runs the risk of being released adjacent to the Rideau Canal during overflow events. If necessary, an opportunity may also exist to provide a tandem system to deal with existing odour issues noted by the NCC and Parks Canada along the Rideau Canal locks and near the existing Rideau Canal Regulator.

4.2 EVALUATION OF ALTERNATIVE DESIGN CONCEPTS

4.2.1 Evaluation Criteria

As with the Phase 2 of the EA, the evaluation criteria used to evaluate the alternative design concepts fall into four categories and consider the technical, environmental, social, and economic impacts of the project on the study area. The criteria have been adjusted based on comments received from various project stakeholders, including review agencies and the general public.

A list of the individual criteria and their respective categories, as well as an explanation of their indicators, is provided in Table 4-1.

<table>
<thead>
<tr>
<th>Table 4-1: Evaluation Criteria</th>
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<tbody>
<tr>
<td>Criteria</td>
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<tr>
<td><strong>Technical</strong></td>
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<td><strong>T1</strong></td>
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<td><strong>T2</strong></td>
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### Table 4-1: Evaluation Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rationale for Inclusion / Indicator</th>
</tr>
</thead>
</table>
| T3 Flexibility | • Potential for addressing other system issues and/or future regulatory changes such as treatment of stormwater discharges  
• Works provide additional system benefits such as flood control or system redundancy |
| T4 Reliability/Complexity | • Complexity of operation and maintenance of the infrastructure  
• Ability to consistently meet Council directive for CSO control  
• Ability to achieve and maintain level of service (basement flooding) |

### Natural Environment

| N1 Impact on Significant Natural Features (Terrestrial/Aquatic) | • Disruption to mature vegetation or trees;  
• Potential impacts on significant natural areas;  
• River crossings or riparian area disruptions |
| N2 Impact on Ecological processes | • Disruption to wildlife linkages  
• Potential effects on known fish habitat |
| N3 Impact on quality of receiving water | • Number and volume of wastewater overflows |

### Socio-Cultural

| S1 Effect on urban greenspace/open space | • Quality and quantity of open space  
• Urban tree removal  
• Loss of use during construction |
| S2 Cultural heritage values or features | • Symbolic cultural value - cultural landscapes  
• Potential for heritage significance - built heritage  
• Requirement for special architectural treatments  
• Potential for archaeological significance |
| S3 Disruption to community | • Duration of construction  
• Traffic disruptions  
• Permanent structures that would impact views or aesthetics  
• Impacts to recreational activities (events programming, pathways, boating)  
• Impacts due to odours and/or operation and maintenance activities |
| S4 Consistency with planning policies/processes | • Compatibility with current zoning, NCC, Parks Canada, PWGSC plans and/or existing MOE policies.  
• Effect on potential site development |
| S5 Impact on level of service | • Potential for flooding and ponding during the full range of wet weather events. |
| S6 Property Issues | • Ownership - City owned versus publicly owned versus private  
• Possible access restrictions - site security requirements  
• Right of way or land acquisition needed  
• Land impacts and/or encumbrances including long term impacts to land use and ability to develop the land |

### Economy

| E1 Impact on businesses and land owners | • Number/extent of businesses affected (during and/or after construction)  
• Duration of construction/impact  
• Loss of opportunity costs |
| E2 Affordability | • Capital cost  
• Cost of property / easement |
| E3 Sustainability | • Ease of operation & maintenance and associated resource costs |
4.2.2 Ancillary Benefits and Cost-Effectiveness

As with the evaluation of alternative solutions (Section 3.0), consideration was given to ancillary benefits that design concepts may have over others. Preference is given to alternatives that can cost-effectively provide added benefits that go beyond just the minimum technical requirements, such as:

- Providing added operational flexibility: Alternative concepts that can also provide flexibility, reliability and redundancy to ensure the long-term robustness of the operation of the collection system are favoured.

- Providing opportunity to further enhance level of service: Alternatives that can cost-effectively provide for added protection against basement flooding and/or provide further control of CSOs are favoured.

4.2.3 Evaluation Methodology

The evaluation of the alternative design concepts was carried out in a qualitative fashion where alternative concepts were compared and ranked against each other using a “High”, “Medium”, or “Low” ranking system with a “High” being least desirable. This type of evaluation represents the degree to which each alternative is preferred over other alternative concepts. A matrix was used to document and summarize the rating of each alternative against each criterion. The matrix evaluation of alternatives was used to identify the alternatives that were deemed to merit further consideration.

4.3 ALTERNATIVE DESIGN CONCEPTS

The following provides a description and evaluation of the alternative design concepts that were developed and considered as part of the functional design process. Since the majority of the proposed works are located below grade and considering that the construction method will likely be trenchless for the greater part of the alignment, most of the alternative design concepts are primarily focused on the components that may have an impact at surface. These are:

- The connection points to the existing collector/sewers, including diversion chambers and sewers;

- The construction staging areas – EWT East End, Mid-Point and West End; and NST North End;

- The intermediate maintenance access points; and,

- The control buildings and odor control facilities.
4.3.1 East-West Tunnel Alternative Alignments near the West End Regulators

The following alternative East-West tunnel alignments near the West End regulators were considered as part of the environmental assessment:

1. Alignment W1: Old Wellington St. Corridor
2. Alignment W2: Empress/Transitway
3. Alignment W3: Albert to Booth

The following alternative Cave Creek Collector Diversions were also considered as part of the environmental assessment:

1. North Alignment: Transitway
2. South Alignment: Lloyd St.

4.3.1.1 Functional Description

The following describes the functional requirements for the capture of additional combined sewage from the Booth Street Sewer (BSS) and the Cave Creek Collector (CCC), with their respective flow control chambers being collectively referred to as the West-End Regulators.

The current overflow points for these sewers are located along the old Wellington St. and former Lloyd St. corridors. The upstream end of the proposed EWT must thus be near these overflow points to minimize the extent to which new overflow diversion sewers will be necessary to convey overflows to the proposed EWT. The extension of diversion sewers could further encumber lands in the area and result in higher capital and operation and maintenance costs. The upstream end, or western terminus, of the EWT will thus be located in LeBreton Flats in order to accept excess combined sewage (sanitary sewage and storm runoff) originating from the CCC and the BSS.

Alternative alignments for the extension of the EWT to LeBreton Flats are depicted in Figure 4-2 and discussed in Section 4.3.1.2.

Flow Control Structures for Interception and Capture of Overflows

**EWT Inlet Chamber:** The EWT inlet chamber’s purpose is to convey CSOs from the BSS and CCC into the EWT. The inlet chamber is proposed to be constructed on the existing BSS overflow pipe along the segment that is located between the existing RTC-operated Booth Street Regulator and the former Lloyd-Booth Regulator. The chamber is proposed to be equipped with a weir to preferentially direct CSOs into the EWT rather than to the River (via the Tailrace overflow).
A 3000mm diameter diversion sewer will convey flow from the Inlet Chamber to the upstream end of the EWT. The location of the inlet chamber and the alignment of the sewer will be restricted by adjacent property ownership. Alternatives are discussed in Section 4.3.1.2.

**CCC Diversion Sewer:** A new overflow weir chamber is proposed on the CCC upstream of the existing overflow. The chamber will be equipped with a side weir to convey flow to a new 1524mm diameter sewer that conveys flow to the EWT Inlet Chamber and ultimately to the EWT. The existing Lloyd-Preston regulator is equipped with a 1200mm (W) x 305mm (H) orifice that controls peak flows to the IOS to 1 m³/s. Flows exceeding 1 m³/s would then spill over the new side weir to the EWT. The existing overflow side weir to the Tailrace (which flows to the River) would either be removed or raised.

A new chamber is proposed where the CCC diversion sewer crosses over the IOS to provide an alternate connection of the CCC to the IOS. The chamber would be equipped with a drop pipe to the IOS, with a removable stop gate installed over the opening to the drop pipe and stop log rails over the chamber outlet. In the event that maintenance or emergency work on the existing Lloyd Street 1050mm diameter sewer is required, Operations Staff would manually manipulate the stop gate to convey dry weather flow to the IOS. The chamber is proposed to be designed to allow installation of an isolation gate in the future to replace the function of the existing Lloyd-Preston Regulator.

Two alignments for the CCC diversion sewer to the EWT were considered (following the Lloyd Street corridor and following the Transitway). These alternatives are discussed in Section 4.3.1.2.

**Operational Control and Support Facilities**

**Inlet Chamber:** In addition to housing a flow control weir, the Inlet Chamber to the EWT is proposed to incorporate an isolation gate and actuator as well as level metering equipment. The isolation gate will provide the ability to isolate the EWT from CSOs under high water level conditions in the EWT. The control and power supply equipment for the chamber is proposed to be housed within the existing control vault for the West End RTC Regulator.

**Supervisory Control Facilities:** Remote control and monitoring of the site is proposed and would require that the site be connected to the central City of Ottawa wastewater SCADA system. Due to the Inlet Chamber’s close proximity of the existing West End RTC regulators’ underground control vault, integration with the existing control panel and SCADA system is preferred to reduce capital costs and operational complexity.

A new concrete encased ductbank would be required from the Inlet Chamber to the existing RTC control vault located at the northeast corner of Booth Street/Albert Street. The ductbank will house new power cables for the actuator, along with instrumentation and control wiring.

**Odour Control Facility/Facilities:** An odour control facility is proposed at the West End site. Located at the upper end of the EWT this facility would be designed to draw air from the tunnel as it fills, allowing exhausted air to be treated. Due to the scarcity of available land parcels in the area, a below grade facility could be considered as an alternate to an at-surface facility. In both cases, the odour control facility would be connected to the EWT via underground ductwork.
The system would treat air for most events, but air would be exhausted directly to the environment during very large rainfall events via a blow stack to prevent oversizing the odour facility to handle large infrequent events.

The location of the facility is somewhat flexible but should be located in the general vicinity of the Inlet Chamber or EWT TBM exit shaft. At this time it is considered that the odour control facility can be located anywhere within the zone identified on Figure 4-3. The final preferred location of the odour control facility within the identified zones will be established at the next stage of design development.

![Lebreton Flats](image)

Figure 4-2: EWT Alternative Alignments – West End

4.3.1.2 Discussion of Alternative EWT Alignments near the West End Regulators

Three (3) alternative alignments are being considered within Lebreton Flats, combined with two potential alignments through the City Core (along either of Slater or Laurier Streets). The selection of the preferred tunnel alignment in the vicinity of the Rideau Canal Interceptor will dictate if a Slater St. or Laurier Ave. alignment is followed.
Alignment W1: Old Wellington St. Corridor

The first set of alignments considered strives to keep the new infrastructure adjacent to the existing Interceptor Outfall Sewer (IOS) and the proposed LRT route. Sub-alignment W1a follows the Wellington St. right of way, from west of the Transitway to east of Brickhill where the alignment would diverge towards either Slater or Laurier. Sub-alternative W1b is located adjacent to the proposed LRT alignment to Commissioner St. where it heads south to Slater St. Note that this alignment was added in the fall of 2012 following receipt of new geotechnical information from the Albert St. reconstruction project which indicated that the bedrock surface along Albert St. is much lower than originally anticipated. This information revealed that a rock tunnel along Slater and Albert Streets west of Bronson Ave. would be in mixed face and would carry high risks.

Consideration is given to keeping the turning radius within tunneling limits (≥100m) to reduce the cost associated with hand mining activities.

Figure 4-3: Location of Control Building/Odour Control Facility – West End

Alignment W2: Empress/Transitway

The second alignment considered strives to align the new infrastructure within existing/future ROWs and to minimize impacts on developable land parcels.
This alignment would run along the Wellington St. ROW to the current Transitway alignment, then south to Albert St and subsequently east to Slater or Laurier. With this alignment it is assumed that a section of the EWT will be constructed using open cut methods and that a few pipe bends will be necessary along with man access for maintenance. The location of this access point can likely be selected to avoid the LRT.

**Alignment W3: Albert to Booth**

This alignment would run along Albert Street between Empress and Booth Street with the west terminus of the EWT located to the north-east of Booth and Albert intersection. A new overflow diversion chamber would be provided along the old Wellington corridor just east of Booth Street and an overflow diversion sewer would run south between the diversion chamber and the end of the EWT. East of Booth Street, W3 would follow the same alignment as W2, with the same benefits/challenges of W2 from that point on.

A new overflow diversion sewer is necessary to direct the CCC overflows from the Lloyd-Preston Regulator to the proposed EWT. Two possible alignments for the CCC overflow diversion sewer are illustrated on [Figure 4-2](#).

**North Alignment: Transitway**

The first alignment for the CCC overflow diversion sewer heads east from the Lloyd-Preston regulator along the Transitway alignment to the Old Wellington easement where it would join up with the BSS and inlet chamber to the EWT.

**South Alignment: Lloyd St.**

The second alignment for the CCC overflow diversion sewer heads south along the west side of the Lloyd Street easement to the Old Wellington easement where it would join up with the BSS and inlet chamber to the EWT. With alternative alignment W-3, the diversion sewer may continue south to the EWT at Albert.

4.3.1.3 Evaluation of EWT Alternative Alignments near the West End Regulators

**Evaluation of Technical Criteria**

The most significant technical issues anticipated for the west end of the EWT include:

The constructability of the linear segments. Recent geotechnical information indicates that the bedrock elevation along Albert St., between Booth and Empress/Transitway, is approximately 48m which is essentially at the obvert (top) of the proposed EWT. This would limit the western extent to which the proposed EWT may be tunnelled using a standard, cost-effective Tunnel Boring Machine (TBM) approach. Specialized construction techniques and/or ground improvement methods would be required to implement the works along Albert St. using trenchless technologies. While highly disruptive and expensive, specialized open trench methods such as secant walls may be employed.

Based on the geotechnical information available at this time, it appears that more rock cover (to elevation 51m) may be available along alignment W-1b potentially allowing standard tunneling further west than with alignments W1a, W2 and W3. The use of open trench methods for the construction of the EWT along Albert and/or the Transitway will be quite disruptive due to the
depth of the proposed infrastructure (approximately 18m to the invert with the bedrock being at 15m from surface). However, open trench methods allow the construction of sharp bends in the EWT alignment which would help in limit future encumbrances to development parcels.

Avoiding conflicts with existing infrastructure or the proposed LRT. The existing right of ways (Albert, Booth, Old Wellington and Old Lloyd) are encumbered by some deep large-diameter sewers and a high pressure water transmission main. The proposed LRT alignment also runs in an east-west direction and currently follows the Old Wellington St. corridor just east of the existing Transitway. These existing or future encumbrances have affected the alternative alignments. Some alternative alignments, such as W-3, may provide redundancy to some of the sewers segments over which NCC has build-over rights e.g. West Nepean Sewer.

**Evaluation of Natural Environment Criteria**

From a natural environment perspective, no significant advantage or disadvantage is apparent between the alternative EWT alignments at the west end. With the exception of the area adjacent to Slater St. west of Bronson Ave., there are very few mature trees along the proposed alignments or in the vicinity of the proposed diversion/inlet chambers. The trees bordering Slater will not be impacted if the construction of the EWT is undertaken using trenchless methods along Slater (to be confirmed through future geotechnical investigation).

All alignments are expected to provide the same performance in terms of CSO control.

**Evaluation of Socio-Cultural Criteria**

One of the greater concerns is the potential impacts on the future land use within Lebreton Flats. This area is currently owned by the City of Ottawa and the NCC (with a number of land transfers between the two owners pending) and is slated for development with some high densities in the area of the future LRT station at Booth St. At this time, the development plans for the parcels along Albert St. and the future LRT are not advanced enough to provide definitive direction as to which areas will become or remain road right of ways. From a land-development perspective, consultation with the NCC and the City revealed that sewer alignments along existing right of ways W-2 and/or W-3 (Albert St. and Transitway) are favored over alignments that cross larger land parcels (W-1) with a potential for residential/commercial development. This would limit future encumbrances to development parcels.

Considering that construction may be undertaken using open cut methods and that the EWT is quite deep, there is the potential for significant traffic disruption during construction with alignments W-2 and W-3. These impacts may be mitigated by temporarily moving traffic to the adjacent vacant parcels. This, however, would require close coordination with traffic re-routing plans to be developed by the LRT contractor, and could impact the construction schedule (and cost) of the LRT project.

**Evaluation of Economic Criteria**

Based on the limited geotechnical information available at this time, it appears that the implementation of the EWT in the west end will be a challenging undertaking. While tunneling appears possible along alignment W1-b east of the Transitway, tunneling this alignment may require special measures to deal with shallow rock cover. Alignment W1-b offers the best
tunneling opportunities, and therefore the lowest potential construction cost considering the extensive shoring needs and disruptions expected along the other alignments.

Other considerations include the cost of underground easements and future encumbrances on land for Alignment W-1.

### 4.3.1.4 Summary of Evaluation of Alternative Alignments near the West End Regulators

Table 4-2: Summary of Evaluation for Alternative Alignments near the West End Regulators

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
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</table>
| W1a/b        | • Minimizes impacts on NCC owned land parcels west of Brickhill St. outside of the Old Wellington St. ROW.  
• Bedrock elevation higher along W1b, tunneling methods could effectively be used over a longer distance, thus reducing the required distance of open-cut and associated costs. | • W1a may cut across the City owned parcel north of Albert and east of Brickhill.  
• Parcels north of Albert are being considered as staging areas for the LRT construction and may conflict with its implementation.  
• May conflict with existing Vortex drop shaft to the IOS within the Wellington St. ROW at Brickhill. |
| W2           | • Minimizes impacts on land parcels north of Slater/Albert. Parcels north of Albert are being considered as staging areas for the LRT construction.  
• A shorter section of EWT would run under/along the proposed LRT corridor | • Need a few sharp pipe bends near Old Wellington ROW along with nearby man access for maintenance. This will increases implementation costs.  
• Impacts primarily City owned land parcels.  
• Tunneling considered very risky northwest of escarpment due to low bedrock elevation. This segment would likely need to be implemented using highly disruptive open cut methods.  
• Parcels north of Albert are being considered as staging areas for the LRT construction and may conflict with its implementation.  
• Extensive traffic disruptions expected along Albert St. |
| W3           | • Minimizes impacts on land parcels north of Slater/Albert, specifically:  
  o Parcels north of Albert being considered as staging areas for the LRT construction.  
  o City parcels north of Albert being considered for future build-over.  
  • Eliminates potential conflicts with LRT alignment. | • CCC would require a 150m long overflow diversion sewer provided along the old Lloyd St. & Wellington St. corridors. This will increases implementation costs.  
• Tunneling considered very risky west of Bronson due to low bedrock elevation. This segment of sewer would likely need to be implemented using highly disruptive open cut methods. This area is already congested and would pose significant challenges during construction.  
• May need to widen right of way along Booth between Old Wellington and Albert to accommodate sewer access, diversion chamber and overflow diversion sewer. This could impact NCC lands.  
• CCC overflow diversion sewer may impact NCC parcel. |

### 4.3.1.5 Preferred Alignment

Based on the evaluation of the alternative alignments, W1-b is deemed to be preferable over alignments W2 and W3. Alignment W1-b carries the least risk from a construction standpoint.
and is expected to result in significantly less traffic disruptions to than the other alternative alignments.

4.3.2 East-West Tunnel Alternative Alignments near the Rideau Canal Interceptor

The following alternative East-West tunnel alignments near the Rideau Canal Interceptor were considered as part of the environmental assessment:

1. Alignment C1: Confederation Park
2. Alignment C2: South of Laurier, diversion chamber in Confederation Park
3. Alignment C3: South of Laurier, diversion chamber South of Laurier Ave

4.3.2.1 Functional Design Requirements near Rideau Canal

The following describes the functional requirements for the capture of additional combined sewage from the Rideau Canal interceptor; this sewer is the largest remaining contributor of CSOs to the River:

Interception and Capture of Overflows from the Rideau Canal Interceptor

The Rideau Canal Interceptor (RCI) diversion chamber is proposed to connect the RCI to the EWT in order to capture CSOs upstream of the existing regulator. Flow is proposed to be conveyed to the diversion chamber and to the EWT via a bending weir which activates when the flow rate in the RCI exceeds the capture rate of the existing Rideau Canal Regulator (RCR) at the Rideau Canal Locks, or when the IOS reaches capacity, whichever comes first. The RCI diversion site consists of a diversion chamber on the RCI, a drop and access structure on the EWT and a control building or vault to support the power supply and monitoring requirements for the site.

RCI Diversion Chamber: The proposed diversion chamber is to be equipped with a lateral or side bending weir and isolation sluice gates complete with powered actuators. The lateral or side bending weir is designed such that the crest level is set to allow passage of the maximum capture rate at the new regulator. Once the flow rate exceeds the maximum target capture rate at the downstream RCR, the bending weir is activated by the increase in water level and excess flows are sent to the EWT. Alternatives for locating the RCI Diversion relative to the alignment options for the EWT are evaluated in Section 4.3.2.4.

Overflow Control Structure: In order to force the overflow to enter the EWT at an upstream location, which is higher in elevation than the existing regulator, it is necessary to safely cause water to rise in RCI to the point of diversion when overflows occur at the RCR (i.e. only under wet weather flow conditions). For the weir and regulator to function properly, the existing overflow dam downstream of the RCR will need to be raised (elevation of at least 52.7m) to prevent overflows when subjected to the “Design Year” (1980).
Functionally, this overflow dam must be located in a new structure on the overflow pipe between the RCR itself and the next downstream manhole (i.e. before the first drop structure on the overflow). Given the space limitations around the Rideau Canal Regulator and along the overflow pipe, it is considered that the only practical location for the overflow control structure/dam is at a downstream manhole a short distance of the regulator (refer to Figure 4-4).

![Rideau Canal](image)

**Figure 4-4: Rideau Canal Overflow Control Chamber Location**

**Existing Regulator Modifications:** Similarly, in order to protect the existing RCR from becoming flooded during larger overflow events, it will be necessary to make minor modifications within the existing regulator. This change is relatively minor and consists of raising an internal chamber wall that separates the RCI from the regulator.

**Mid-Point Staging Area for Tunnel Construction**

For long tunnels, the project costs (related to production and schedule) of hauling and removing all tunnel spoils and debris at a single tunnel access location becomes very significant. For tunnels of the length proposed for the EWT, a mid-point staging area for mucking/debris removal can provide a cost savings in the order of 40% of the cost of tunneling the western half of the East-West tunnel without a mid-point staging area. The RCI site is thus proposed to be used as the primary staging area for the western half of the EWT for primary tunnel access and mucking/debris removal. Once construction of the tunnel is completed from the RRC Keefer site...
to the RCI site, the primary staging area for tunneling would be located at the RCI for construction of the western half of the tunnel. Alternatives for locating the mid-point staging area are evaluated in Section 4.3.2.6.

**Operational Control and Support Facilities**

**RCI Downstream Overflow Control Chamber:** The Downstream Overflow Control Chamber is proposed to incorporate a dam with modulating flow relief gates and actuators. The control and power supply equipment for the Flow Control Chamber is proposed to be housed within the existing control vault for the Rideau Canal Regulator.

**RCI Diversion Chamber:** The RCI Diversion Chamber is proposed to house isolation gates and actuators, a bending weir and associated level metering equipment. The control and power supply equipment for the RCI Diversion Chamber will be housed within a nearby control building or underground vault. Potential locations for the control building/vault are within the zone identified on Figure 4-5. This should preferably be housed within the same building or vault as the odour control system, if provided.

**Supervisory Control Facilities:** Remote control and monitoring of the site is proposed and would require that the site be connected to the central City of Ottawa wastewater Supervisory Control and Data Acquisition (SCADA) system. Communications with the site is proposed to be provided by means of fibre optic cables, thus avoiding the need for a SCADA communications tower which would cause visual impacts in this high-profile, high-use area. Fibre optics represents a more expensive solution from a life-cycle cost perspective, but is deemed preferable due to the visual impacts of a SCADA tower at the site.

**Odour Control Facility/Facilities:** Both the NCC and Parks Canada have noted past incidences where odours haveemanated from the RCI in the area of the Rideau Canal RTC regulator. It is understood that these incidents were observed in the vicinity of the existing RCR during dry weather conditions. The emanation of odorous air from sewer manholes under certain conditions is not unusual in urban areas, especially municipalities with combined sewers. Given the lack of details related to these complaints, the City, Parks Canada and the NCC recognize that further documentation and study of the particular situation in the vicinity of the Rideau Canal Locks is required in order to properly characterize the risk and develop appropriate mitigation measures for the existing situation. It has been agreed that the existing odour problems will be investigated separately from the EWT.

While potential odorous air from within the EWT can be prevented from locally escaping the tunnel and having an impact at surface, the configuration and operation of the new flow diversion and overflow control structures on the RCI have the potential to occasionally alter the air-flow dynamics within the RCI during larger wet weather flow events (i.e. approx. 15 times per year). During such larger wet weather flow events, changes in air-ventilation within the RCI could potentially increase the risk of expelling odorous air at surface upstream of the existing Rideau Canal Regulator, in the general vicinity of Festival Plaza (City Hall) and/or Confederation Park.

For the purposes of this Class EA, it is considered that an odour control facility will be necessary to mitigate this risk. It is currently considered that the odour control facility will be provided from
within a building or vault in the general vicinity of the RCI Diversion Chamber site to provide odour control of entrained air in the RCI.

The proposed odour control building or vault will house the odour control system in conjunction with site control and communications equipment. It is estimated that the building footprint will be in the order of 12 m x 12 m.

The odour control building or vault will be equipped with a duct to convey airflow from the RCI to the odour control system. Site power and communications will be housed within the odour control building. At this time it is considered that the odour control facility can be located anywhere within the zone identified on Figure 4-5. The final preferred location of the odour control facility within the identified zones will be established at the next stage of design development, in consultation with the NCC and Parks Canada.

4.3.2.2 Description of EWT Alternative Alignments near the Rideau Canal Interceptor

Within the preferred corridor identified in the Phase 2 Alternatives Evaluation, the recommended alignment for the EWT as it approaches the Rideau Canal Interceptor (RCI) is along either
Slater or Laurier Streets, depending on the preferred alignment alternative selected for the crossing of the EWT with the RCI.

Excess combined sewage (sanitary sewage and storm runoff) originating from the RCI will be directed to the EWT via a diversion chamber. The diversion chamber has to be situated on the RCI which is located along the west edge of Queen Elizabeth Drive. As illustrated in Figure 4-6, three alternate alignments are being considered for the proposed EWT to accommodate an interconnection with the RCI.

There are three primary factors that impact and differentiate the selection of the preferred tunnel alignment within this corridor and the selected connection point to the Rideau Canal Interceptor (RCI). These are:

**Tunnel Construction Feasibility and Risks:** The construction of deep rock tunnels, such as the EWT, can represent significant risks if conducted under uncertain or potentially challenging ground conditions. Preferably, the tunnel should be constructed under consistent and competent rock conditions with sufficient rock cover (typically requiring a minimum of 2 pipe diameters of cover, depending on the quality/integrity of the rock).
Conditions where the rock cover is insufficient, especially where the rock becomes less competent or the tunnel boring machine (TBM) risks breaking through the rock surface, and/or situations where the TBM is expected to encounter mixed-face soil conditions should be avoided as much as possible. Otherwise, the risk of delays and added costs will be significantly increased. Furthermore, these non-preferred tunneling conditions can also lead to excessive dewatering of the overburden soil layer that, in turn, can result in settlement damage to nearby buildings. Mitigation of these risks will lead to further costs and delays. Where these conditions are prevalent, the feasibility of proceeding should be questioned. These considerations, as well as potential conflicts with the proposed Light Rail Transit Tunnel alignment, were key reasons for selecting, during the Phase 2 alternative assessment, a EWT alignment corridor between Slater and Laurier, as opposed to further north along Wellington Street and in closer proximity to the Rideau Canal Regulator, where soil/rock conditions are known to be unfavorable and where managing conflict with the LRT would be challenging.

Figure 4-7: Historical Borehole Information for Alternate Tunnel Alignments

Within the preferred alignment corridor, it is clear from historical borehole logs (illustrated in Figure 4.7) that the depth to rock surface north and south of Laurier Avenue varies significantly and that the available rock cover at the northern perimeter of Confederation Park is consistently higher and better than that which is expected to exist in the vicinity of and south of Laurier Avenue.

**Hydraulic Performance and Flooding Risks:** Ideally the interception of the remaining overflows from the RCI would be achieved with a connection and flow diversion immediately downstream of the existing flow regulator. Given that a tunnel alignment in proximity to the existing regulator is not possible at this location, it will be necessary to intercept and divert flows...
to the EWT at an upstream location along the RCI. As previously illustrated in Figure 4-5, this will require the construction of a flow control chamber downstream of the existing Rideau Canal Regulator. This flow control chamber will effectively act as a dam to raise water level along the RCI when overflows occur. The flow control dam will cause flow levels to rise to a safe elevation where it then can spill to the tunnel at an upstream (higher) flow diversion location.

In order to minimize the risk of exacerbating existing flooding risks along the RCI during major rainstorm events, the downstream flow control chamber will need to be configured such that it will control maximum upstream water levels to a safe elevation. However, the further south that the diversion to the EWT is located, the higher the dam and maximum operating levels must be set to maintain the same CSO capture objectives.

Given space constraints along the Rideau Canal Interceptor as it parallels the Rideau Canal, the most practical northerly location for a diversion chamber is at the northeast corner of Confederation Park. The difference in required operating water levels between a flow diversion chamber located at this location and one in proximity to a southerly tunnel alignment along Laurier Avenue is in the order of 1 m. This means that the downstream dam elevation would need to be raised by an additional metre in order to maintain the same level of CSO capture. Compared to a diversion structure located further north, this upstream location would thus lead to additional flooding risks during major rainstorm events and would require further mitigation to maintain lower operating levels during these larger events.

**Impacts on Public Spaces:** In order to minimize direct impacts to private property owners and/or residents within those properties, the alternative design concepts have evolved on the basis of locating infrastructure on lands that are currently vacant and, to the extent possible, owned by the City or a public entity.

Given the location of existing infrastructure (i.e. the RCI and RCR) within the City’s central core and the functional requirements of the project, feasible locations for locating the required infrastructure are limited to highly valued and utilized public spaces. This has the potential to inconvenience and impact both visitors to and residents who use these spaces. All feasible alternatives must incorporate mitigation measures to minimize both construction related and long-term impacts on programmed event schedules, existing and future designated uses, and the functional character of these public spaces.

The development and evaluation of the alternative design concepts recognize these lands as being very important to the general public’s enjoyment of the City’s downtown core and that the aforementioned issues are priority considerations for the public agencies that are the designated stewards of the affected public lands (i.e. NCC, Parks Canada and the City of Ottawa).

**4.3.2.3 Discussion of EWT Alternative Alignments near the Rideau Canal Interceptor**

The recommended corridor for the EWT near the Rideau Canal is along either Slater or Laurier Streets. Excess combined sewage (sanitary sewage and storm runoff) originating from the Rideau Canal Interceptor (RCI) will be directed to the EWT via a diversion chamber and associated sewer. The diversion chamber has to be situated on the RCI which is located along the west edge of Queen Elizabeth Drive.
The alternative alignments for the EWT as it crosses and connects to the Rideau Canal Interceptor are illustrated in Figure 4-6 and are further described below.

It should be noted that, in addition to a relatively small staging area for the construction of the diversion chamber from the RCI to the EWT, a larger staging area is also required to provide for a mid-point spoils/debris removal shaft for tunnel construction. With some of the alignments under consideration, the construction staging area that will be established for the construction of the diversion chamber and its connection to the EWT could be expanded to also serve as a staging area for mid-point tunnel spoils/debris removal, thereby minimizing the extent of affected areas. The evaluation that follows within Section 4.3.2.4 considers construction staging areas that are only suitable in size for the construction of the diversion chamber. Options for larger mid-point staging areas (i.e. for tunnel spoils/debris removal) are evaluated separately in Section 4.3.4 and consider alternatives that are either combined with or independent of the preferred location of the staging area for the construction of the RCI diversion/connection.

Alignment C1: Confederation Park

This alignment runs along the northern edge of Confederation Park. Given the feasible tunnel alignments, this is also the most northerly location for placing the diversion chamber on the RCI. The EWT alignment would be located near the diversion chamber resulting in the possibility of a compact construction area for the diversion chamber and sewer. The construction staging area for the diversion chamber and the interconnection with the EWT is shown on Figure 4-6. A staging duration of approximately 8 months within Confederation Park is anticipated to construct the diversion chamber and the interconnection to the EWT. Should construction staging for the purposes of accommodating a mid-point tunnel construction and spoils removal shaft also be provided at this location, the staging area requirements would be larger and the construction duration within the park would be extended to a total duration of up to 18 months.

Under Alternative C1, the invert (bottom) of the proposed tunnel near the RCI is at elevation 43.2m (obvert at elevation 46.2m) resulting in a tunnel depth of 19m. In general, the rock surface elevation in this area slopes down from the north to the south.

Information collected in the mid 1960’s by Public Works as part of the investigation for the proposed “National Museum” (never built) on this site indicates that the park area is underlain by limestone in the east and shale in the west (over 35 boreholes). The rock surface ranges from E.L. 61.0m near Elgin and Slater, to E.L. 55.0 to 57.0m along the Rideau Canal and south to the Laurier Bridge. This provides a safe rock cover for the proposed EWT along the Alternative C1 alignment (i.e. provides approximately 3 tunnel diameters). The bedrock is overlain by 7 to 15m of overburden comprised of rubbish fill, sensitive clay (increasing in thickness to the south) and glacial till. Several northwest striking fault zones were intercepted by boreholes put down within the park.

Alignment C2: South of Laurier, diversion chamber in Confederation Park

This EWT alignment is located for the most part south of Laurier between Nicholas and Elgin Streets. To the west of City Hall, the EWT is shown on Figure 4-6 as being aligned under Confederation Park to Slater Street, but could also head west along Laurier. This alternative assumes a diversion chamber in Confederation Park with a 150m long diversion sewer to take flows south from the RCI to the EWT.
Given the depth of this diversion pipe (~15-19 m), and the potential disruption to the park and Laurier Avenue, this sewer would either be hand mined or tunneled to minimize surface disturbances. In all likelihood, tunneling at the greater depth would be preferable to reduce the risks of encountering mixed-face tunneling conditions.

With this option, the construction staging area for the diversion sewer and interconnection is proposed to be located in front of City Hall (Festival Plaza). This staging area could also be the primary staging area for tunneling west of this point until the EWT is completed. The available area for staging at this location is smaller than the area that is available for the two other alignments (Figure 4-6). A smaller staging area will lead to added construction costs in having to manage construction activities and materials storage within a constrained area. This will result in reduced productivity and likely a longer construction duration.

Along Laurier Ave., boreholes put down during the investigations for the City Hall structure indicate deeper shale bedrock, with bedrock surface elevations typically at around E.L. 53.0m, but as low as E.L 50.5m (total of 7 boreholes).

In this area the rock cover would typically be less and could potentially be limited to 4m with rock of uncertain quality. This is less than 1.5 times the tunnel diameter (1.5xD) and much less than the 3xD cover available in the northern end of the park. The bedrock in this area is overlain by 15 to 20 m of overburden comprised of surficial fill, up to 10 m of sensitive clay, and about 4 to 7 m of glacial till containing boulders. Given the depth of the proposed tunnel and type of overburden materials it is impractical to use open cut methods in this area as a means of circumventing potential problems with the structural integrity of the roof of the tunnel given the thin rock cover. The above factors represent added risk and raise concerns in regards to the viability of the construction in this alternate location.

With Alignment C2, a significant surface disturbance, in the form of a construction access shaft, will be required in Confederation Park to construct the RCI diversion chamber. The spatial and temporal extent of the anticipated surface disturbances will be larger because of the need for construction accesses at two separate locations with a construction duration of approximately 8-12 months at Festival Plaza (City Hall) and approximately 8 months within Confederation Park to construct the diversion chamber and diversion sewer. Should construction staging for the purposes of accommodating a mid-point tunnel construction and spoils removal shaft also be provided at either the Confederation Park or Festival Plaza location, the staging area requirements would be larger and the construction duration would be extended to a total duration of up to 18 months.

The diversion pipe from the diversion chamber to the EWT will be significantly longer (150m) than with the other alignments (C1 and C3) and will also encumber Confederation Park along the eastern side of the park. The pipe would need to be constructed at a depth of at least 15 m and likely 19 m.

The shallower installation is not likely to be feasible given the rock elevations south of Laurier. Even at a 19 m depth, the tunneling of the diversion pipe will have increased cost and risk due to the thin rock cover previously noted when moving south (i.e. when compared to an equivalent length of pipe with adequate rock cover). Under alignments C1 and C3, the diversion sewer would be less than 25m long and would likely be installed in an open trench.
If the EWT was to head west along Laurier past Elgin, the total pipe encumbrances within public spaces would be reduced to a 150 m long flow diversion pipe from the RCI to the EWT.

**Alignment C3: South of Laurier, diversion chamber South of Laurier Ave**

This alignment is located south of Laurier Ave. between Elgin and Nicholas Streets and relies on a diversion chamber that would be constructed near the eastbound off-ramp between Laurier Ave. and Queen Elizabeth Drive. This alignment has the same tunnel construction risks and concerns as Alignment C2 with respect to rock elevations, but effectively eliminates impacts to Confederation Park and eliminates the need for a costly diversion sewer.

The available area for construction staging of the diversion chamber and interconnection is located in front of the Drill Hall (illustrated in Figure 4-6). This area is equivalent to that of alternative C1, however further discussions are required with the NCC, DND and/or Parks Canada with respect to the use of this land for this purpose.

The ultimate staging area may be smaller than illustrated which would have an adverse impact on project implementation costs and schedule.

**4.3.2.4 Evaluation of EWT Alternative Alignments near the Rideau Canal Interceptor**

The following sections provide a description of the reasoning employed in the evaluation of the alternatives. The matrix showing the rationale for the evaluation is provided in Appendix F.

**Evaluation of Technical Criteria**

**Rock Cover:** Based on a review of the available historical geotechnical information along the southern alignments (approximately 25 boreholes in the vicinity), it does not appear as though the tunnel will "daylight" through the rock but the thickness of rock cover over the tunnel for Alternatives C2 and C3 appears to be minimal (as low as 4m) and is expected to be problematic, particularly if the top of the rock is fractured. Therefore, significant concerns regarding minimal rock cover and potentially difficult ground conditions exist with the southern alignments, irrespective if fractured rock exists. The northern C1 alignment through Confederation Park is expected to provide a significantly thicker and safer rock cover.

Inadequate and/or poor quality rock cover will impact the construction of the tunnel along the southern C2 and C3 alignments (i.e. difficulty in supporting the roof of the tunnel and/or necessitating a different tunneling technology). Given that an alignment alternative with significantly less risk is available (C1), this raises concerns in regards to the viability of the construction for C2 and C3.

**Dewatering Induced Settlement Impacts:** A shaft along the southern C2 and C3 alignments will extend into the shale bedrock at depth (i.e. to the invert of the tunnel) and will be open for many months. Dewatering will result in drainage of the surrounding bedrock, which will then ‘under drain’ a surrounding area, and could lead to draw-downs in the bottom portion of the thick overlying sensitive clay. This increases the risk of settlement of adjacent raft/footing structures if the clay is stressed beyond its pre-consolidation pressure. The record structural drawings for City Hall indicate that, although the nearest part of the building’s underground parking garage is supported on piles, the main part of the building is supported on the clay with a raft foundation.
Hence the increased risk from the combined effects of the raft loading and the under-drainage, causing overstress of the sensitive clay, leads to consequential settlements in the area which may affect the structural integrity of City Hall.

The Rideau Canal structures (i.e. canal walls) are not likely vulnerable to settlements from dewatering as they do not place a significant enough stress on the clay due to their low weight (compared to a tall building such as the City Hall structure).

To the north, the National Arts Center (NAC) is supported by footings on rock while the MacKenzie King Bridge) is supported on piles. Based on information available, it appears that the southernmost portions of the NAC underground parking structure are also supported on piles. Neither structure is therefore likely vulnerable to settlements from dewatering under Alternative C1. Furthermore, with a thicker rock cover, there is much less risk that tunneling will induce dewatering that could lead to settlement of adjacent building foundations.

In order to better quantify the potential impact on surrounding structures, information on the hydraulic conductivity of the bedrock is needed such that a hydrogeologic analysis could be carried out to determine the zone of influence of the dewatering.

Geotechnical data on the compressibility of the clay deposit at depth would allow an assessment of the actual loading on the raft. An analysis could then be carried out of the combined stress effects.

**Shoring:** A construction/access shaft along the southern C2 and C3 alignments for the construction of the diversion chamber and/or diversion sewer will involve higher shoring costs than the northern alignment C1. Based on available data, the adjacent City Hall parking garage is founded at about E.L 63.0m. The rock is much deeper, generally at about elevation E.L 51.0 to 55.0m. As such, a portion of the shaft excavation in the soil would extend several metres below founding level, and in close proximity to the parking garage. To avoid settlement of foundations, a stiff and watertight shoring system would be needed for the excavation shaft. Additionally, a 200m long section of the tunnel would also need to be made watertight by grouting both upstream and downstream of the shaft.

**Space:** The available area in front of City Hall (Festival Plaza) is smaller than the area available for Alignments C1 and C3 due to loading constraints on the underground parking garage and the presence of the ice skating rink. A constrained site for Alternatives C2 will result in increased costs, and likely longer construction duration, due to lower production rates.

Alignment C2 will require 2 access shafts and impacts 2 locations and possibly 3 if the tunnel staging area is on the east side of the Rideau Canal, as opposed to 1 location with alignments C1. This effectively lengthens the construction schedule and will ultimately increase costs.

**Evaluation of Natural Environment Criteria**

The areas that could be impacted by construction access points to build the diversion chamber and sewer are located within urban parks or park-like environments. While some mature trees may be impacted, these are not considered to have any significant value from a natural environment perspective.
Evaluation of Socio-Cultural Criteria

Surface Disturbances and Disruption of Public Spaces: From a public impact perspective, the construction period will disrupt the use of public spaces for a period of at least 8 months and up to 18 months, with Alternatives C1 and C2 having the greatest impact. Alternative C1 will mostly impact Confederation Park (8 mo.), while Alternative C2 will impact on both Confederation Park (8 mo.) and Festival Plaza (8 to 18 mo.). Note that the above construction durations assume that a mid-point construction staging area for tunnel debris removal will be provided elsewhere. In either option, an additional 10 months of local construction activity will occur if the staging areas for the RCI diversion/EWT connection are also to be used for the construction of the western half of the EWT. Refer to Section 4.3.2.1 which reviews alternatives for locating the EWT mid-point staging areas.

From the perspective of cumulative impacts, Alternative C2 impacts on up to 11% of the total usable land area in both Confederation Park and Festival Plaza, while Alternative C1 impacts on 6% of this same total area over 8 months.

Although Alternative C3 would only impact up to 5% of usable land area, it would have additional cumulative impacts on local traffic on Laurier and Queen Elizabeth and impact DND’s Change of the Guard, which is a major tourist draw.

Both Confederation Park and Festival Plaza are considered to be sites of national significance. Festival Plaza also has a restrictive covenant affecting what the City can build and do at this location.

Alternative C2 also presents the highest cumulative impact in terms of temporary loss of use of park/public land when Confederation Park and Festival Plaza are considered as a whole. NCC have informed the City, as part of discussions regarding the Rink of Dreams, that they consider Festival Plaza to be a site of National significance, as it is on the ceremonial route. Note that there is a restrictive covenant in favor of the NCC on Festival Plaza potentially restricting what the City can build and do at this location.

Hydraulic Constraints and Risk to Private Property: Given the feasible tunnel alignments, the location of the connection to the RCI is constrained by the RCI profile and existing buildings NAC/bridges (Slater to Laurier corridor). The most northerly location feasible for the RCI connection chamber is roughly 25m south of the McKenzie King Bridge. As the diversion chamber is moved further south, as is the case for Alignment C3, the downstream control level in the RCI is increased and subsequently the risk of flooding within the sewershed during major rainfall events increases compared to diversion options further north.

A hydraulic analysis was undertaken to quantify the impacts of moving the Rideau Canal Interceptor diversion chamber further south. A total of six scenarios were evaluated including:

1. Existing conditions – Hydraulic model assumes no O’Connor Trunk Level Measures (TLM) are in place, as described in O’Connor Flood Control Trunk Level Measures - Preliminary Design Report (Stantec 2012).

2. Interim Conditions - Hydraulic model assumes that only the Core Sewage Storage Tunnel (EWT) and Kent Street Tunnel (NST) are implemented along with a dam (bending weir crest @ 52.7m) downstream of the RCR. This assumes a north diversion structure within Confederation Park.
Future Conditions: Hydraulic model assumes that all O’Connor TLMs are in place; and,

3. Future Conditions, Slater Fixed Weir - RCI diversion structure is located north within Confederation Park. A fixed weir dam, with a crest at elevation 52.7m, is implemented downstream of the Rideau Canal Regulator.

4. Future Conditions, Slater Bending Weir – RCI diversion structure is located north within Confederation Park. A 800mm high bending weir dam, with a crest at elevation 52.7m, is implemented downstream of the Rideau Canal Regulator.

5. Future Conditions, Laurier Fixed Weir - RCI diversion structure is located south of Laurier Street. A fixed weir dam, with a crest at elevation 53.7m, is implemented downstream of the Rideau Canal Regulator.

6. Future Conditions, Laurier Bending Weir – RCI diversion structure is located south of Laurier Street. A 800mm high bending weir dam, with a crest at elevation 53.7m, is implemented downstream of the Rideau Canal Regulator.

A summary of the results is provided in the following table. As can be observed, the future implementation of the Kent St. tunnel and Trunk Level Measures will provide much needed flood relief during large rainfall events. While the provision of a bending weir in the level control chamber downstream of the Rideau Canal Regulator helps control the increase in hydraulic grade line, there is still a marked increase in upstream surcharge level between the two potential locations for the Rideau Canal Interceptor (RCI) diversion chamber.

Table 4-3: Summary of Hydraulic Analysis Results

<table>
<thead>
<tr>
<th>Scenarios -&gt;</th>
<th>Existing</th>
<th>Interim</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diversion Location -&gt;</strong></td>
<td>N/A</td>
<td>Confed.</td>
<td>Confed.</td>
</tr>
<tr>
<td>Weir Crest Elev. (m)</td>
<td></td>
<td>52.70</td>
<td>52.70</td>
</tr>
<tr>
<td>Weir Type (5m long)</td>
<td>N/A</td>
<td>Bending</td>
<td>Fixed</td>
</tr>
<tr>
<td>Max HGL – Isabella @ Metcalfe (m)</td>
<td>67.59</td>
<td>67.08</td>
<td>63.59</td>
</tr>
<tr>
<td>Max HGL - Catherine @ Metcalfe (m)</td>
<td>66.92</td>
<td>62.62</td>
<td>63.41</td>
</tr>
<tr>
<td>Max HGL - RCI @ Lewis (m)</td>
<td>64.62</td>
<td>62.42</td>
<td>63.01</td>
</tr>
</tbody>
</table>

a – This configuration and anticipated performance is as documented in the O’Connor Flood Control Trunk Level Measures - Preliminary Design Report (Stantec 2012).

b – hydraulic grade line elevation

Since the diversion chamber for C3 is roughly 175m further south and 1m higher for this alignment (compared to C1 and C2), the dam proposed downstream of the Rideau Canal Regulator would need to be 1.0m higher in order for the EWT to perform as intended. When compared to Alternatives C1 and C2, Alternative C3 will increase the risk of basement flooding for up to 119 residences/buildings in the upstream sewershed (primarily located east of Bank Street and south of the Queensway) during extreme rainfall events. Compared to C1 and C2 with the southerly diversion chamber, it is estimated that 73% of these 119 residences will risk having their flood protection level of service decrease from a 100 year level of service (LOS) to a 50 year LOS, while the remaining 27% will risk having their LOS reduced to 25 years from an existing 50 year LOS.
The flooding risks/level of service for C3 can be made to be the same as C1 and C2 through operational modifications, but this would negatively impact CSO-control performance. The consequence in moving the diversion chamber 175 m further south is a reduced level of combined sewer capture in order to maintain a safe maximum flow level in the RCI. The risk of non-compliance with Council's zero overflow objective in the Design Year and MOE's two CSO events rule is compromised and Council/MOE would have to be consulted to ensure they are aware of, and accept the risk.

Evaluation of Economic Criteria

The evaluation of the three tunnel alignments with respect to the economic criteria was undertaken by comparing the south tunnel alignments (C2 and C3) which are considered to be more costly, with the north alignment (C1) which is considered to be the least expensive.

As described previously, the tunnel alignment with the least risk from a geotechnical perspective and overall system performance is the north alignment. Hence, the comparison focused on developing estimates for the mitigation measures that would be needed to reduce the risks associated with the two southern tunnel alignments. Table 4-4 provides a summary of additional construction costs anticipated with alignments C2 and C3. These are associated with a longer flow diversion pipe, special shoring and groundwater control for construction of the access shaft and adjacent tunnel, tunneling through poor rock conditions (shallow rock cover) and the possibility of having to construct from a constrained staging area. It should be noted that only those costs that can be quantified at this time are included in Table 4-4. In reality, additional costs will result from having to mitigate risks under alternatives and conditions with poor rock cover (i.e. in extent and quality of the rock).

It is expected that a stiff and watertight shoring system would be needed for the excavations for the access points along the southern alignments (C2 and C3). Additionally, an estimated 200m long section of the tunnel would also need to be made watertight by grouting both upstream and downstream of the access point. The cost of such a shoring system is estimated to be at least $1.5M.

The cost of the diversion sewer in Alignment C2 would be in the order of $3.0M ($20,000/m) compared to a cost in the order of $100,000 for a much shorter diversion sewer, as required by alignments C1 and C3. In a tunneling option, it is also likely that the size of the south access shaft would need to be increased in order to turn the tunnel boring machine, thus further increasing construction duration and costs.
Table 4-4: Added Implementation Costs for Alternatives C2 and C3

<table>
<thead>
<tr>
<th>Issue/Risk Item</th>
<th>Added Costs Compared to Alternative C1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longer Flow Diversion Pipe</td>
<td>Alternative C2</td>
</tr>
<tr>
<td></td>
<td>$3.0 M</td>
</tr>
<tr>
<td></td>
<td>Alternative C3</td>
</tr>
<tr>
<td></td>
<td>No added cost. Same as Alt. C1</td>
</tr>
<tr>
<td>Special Shoring and Groundwater Control for Access Shaft</td>
<td>Alternative C2</td>
</tr>
<tr>
<td>and Adjacent Tunnel</td>
<td>$1.5 M+</td>
</tr>
<tr>
<td></td>
<td>Alternative C3</td>
</tr>
<tr>
<td></td>
<td>$1.5 M+</td>
</tr>
<tr>
<td>Mitigation of Tunneling Risks under Poor Rock Cover</td>
<td>Alternative C2</td>
</tr>
<tr>
<td>Conditions</td>
<td>Added costs undefined at this time</td>
</tr>
<tr>
<td></td>
<td>Alternative C3</td>
</tr>
<tr>
<td></td>
<td>Added costs undefined at this time</td>
</tr>
<tr>
<td>Added Liability for public property damage</td>
<td>Alternative C2</td>
</tr>
<tr>
<td></td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Alternative C3</td>
</tr>
<tr>
<td></td>
<td>Added costs undefined at this time</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>at least $4.5 M</td>
</tr>
<tr>
<td></td>
<td>at least $1.5 M</td>
</tr>
</tbody>
</table>

4.3.2.5 Summary of Evaluation of EWT Alternative Alignments near the Rideau Canal Interceptor

Based on the information available, an evaluation of alternative alignments was undertaken. A summary of the evaluation is provided in Table 4-5.

A number of issues were identified in comparing the various alternatives. A few of the concerns that are raised are considered significant and inherently carry additional risks. From a purely engineering point of view (i.e. not considering land ownership), the northern EWT alignment (C1) in Confederation Park avoids the majority of the issues and risks identified herein.

From the general public’s point of view, Alternative C2 will impact on the largest amount of public land and Alternative C3 will impact on the least. Alternative C1 represents a greater impact on Confederation Park, but from a cumulative impact, represents an impact on 6% of the total public land space in Confederation Park and Festival Plaza. Comparatively, Alternative C2 represents an impact on 11% of the total public land.

Key risks with the southern EWT Alignment Alternatives (C2 and C3), include the potential impact on localized settlement in the surrounding shaft/tunnel area and the potential tunneling issues due to poor rock cover and rock/soil conditions. While available data is sufficient to conclude that there will be added risk, it is difficult to quantify the amount of risk that these issues carry with the historical geotechnical information at hand. Additional testing and investigations would need to be undertaken to better define the risks and identifying potential mitigation measures to reduce those risks as well as to confirm the viability of the construction along this alignment. These investigations will cause a significant delay in the implementation of the project. The delay to complete such a study could be expected to be in the range of one year, provided that the proposed approach proves feasible and even longer if the investigation indicates that an alternate alignment is necessary.

Alternative C3, represents the highest risk and least desirable option given not only the increased construction risks compared to Alternative C1, but also from a system operations perspective. If the hydraulic impacts of raising the downstream dam elevation by 1 m are not properly mitigated, Alternative C3 could lead to added risks from a public health and property damage perspective. That is, the frequency of sewage backups resulting in basement flooding.
would be doubled for close to 120 properties when compared to Alternatives C1 and C2. With proper mitigation measures in place to maintain the level of risk at the same acceptable level as in alternatives C1 and C2, a reduction in CSO capture performance would result. This is because the threshold level at which the downstream dam would attain the maximum operating limit would be more frequent and sooner under Alternative C3 than under Alternatives C1 and C2.

The aforementioned risks and related mitigation measures will increase implementation costs for C2 and C3 relative to C1. However, even those issues that do not necessarily increase risks, are also expected to increase implementation costs. As summarized in Table 4-4, some of the additional costs may be anticipated and estimated. The additional costs associated with further investigating and mitigating the risks of potentially challenging tunneling conditions and possible settlements with the alternate alignment are very difficult to estimate at this time. A more representative indication of cost increases relative to C2/C3 would only be possible with further geotechnical and hydrogeological investigations, which in themselves are costly and time consuming.
Table 4-5: Summary of Evaluation for EWT Alternative Alignments near the Rideau Canal Interceptor

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| C1           | • For the flow control strategy analyzed to date, this option has the lowest basement flooding risk; RCI Diversion chamber is located further north reducing the risk of basement flooding within the RCI sewershed.  
• Low risk of non-compliance with CSO control objectives.  
• No need to further encumber Confederation Park with an additional costly diversion sewer  
• Best geotechnical conditions and lowest construction risk (greater rock cover, less potential for dewatering induced impacts on adjacent buildings since supported on piles).  
• Potential for least constrained staging area.  
• Shortest construction duration.  
• Least cost alignment.                                                                                                                                 | • Loss of use of part (15%) of Confederation park for up to 18 months duration (if combined with midpoint staging area) and 10% of overall total public park space when considering both Confederation Park and Festival Plaza.  
• Total length of pipe encumbrance in public park spaces is 230 m. Since this piping is below/adjacent existing infrastructure, the effective new encumbrance on the park is roughly 100m (less than C2 but larger than C3).  
• Confederation Park is site of National Significance.                                                                                                                                 |
| C2           | • Similar to Alternative C-1, RCI Diversion chamber is located further north reducing the risk of basement flooding within the RCI sewershed.  
• Low risk of non-compliance with CSO control objectives.  
• Potential to minimize spatial extent and duration of disturbance in Confederation Park (~8 months).                                                                                                                                 | • Increased risk of unstable tunnel roof during tunneling. Inadequate and/or poor quality rock cover may impact the constructability.  
• Increased risk to adjacent buildings supported on raft footings due to dewatering induced settlements.  
• Potential need for structural/watertight shoring of south access shaft as well as grouting treatment of 200m of the tunnel at a premium of at least $1.5M.  
• Two surface Impacts, one for the diversion chamber and one for the tunnel construction.  
• Need for a significantly longer diversion sewer (between RCI and EWT) at a ~$3.0M premium.  
• Cumulative impact on public use of parks is greater given impacts to two sites of National Significance - Confederation Park and Festival Plaza (12% of public land for up to 18 months if combined with midpoint staging area).  
• Restrictive covenant on Festival Plaza which is considered a site of National Importance)  
• The diversion sewer encumbers the eastern side of Confederation Park over a length of 150m. Overall pipe encumbrances in public parks total 150 m to 225 m, depending on tunnel alignment west of Elgin.  
• Additional tight radius bends (increased tunneling costs) necessary with Slater alignment through Core.  
• Likely the longest construction duration due to added time for tunneling diversion sewer and larger access shaft (2-4 months longer).  
• Most expensive alignment.                                                                                                                                 |
Table 4-5: Summary of Evaluation for EWT Alternative Alignments near the Rideau Canal Interceptor

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| C3           | • Avoids disturbances in Confederation Park. Impact on public lands reduced to 5% of available space in Confederation Park and Festival Plaza.  
• Eliminates need for costly diversion sewer. | • Increased risk of unstable tunnel roof during tunnelling. Inadequate and/or poor quality rock cover may impact the constructability.  
• Increased risk to adjacent buildings supported on raft footings due to dewatering induced settlement.  
• Potential need for structural/watertight shoring as well as grouting treatment of 200m of the tunnel at a premium of at least $1.5M.  
• With Alternative C3, the RCI Diversion chamber is located further south, effectively doubling the risk of basement flooding for 119 residences when compared to Alternatives C1 and C2. Alternatively, if RCI dam is lowered to maintain level of service CSO control will be compromised.  
• Diversion structure would need to be on NCC and/or DND and/or Parks Canada land, shifting impact from one public entity to another  
• Festival Plaza is site of National Significance and has restrictive covenant. |

4.3.2.6 Preferred Alignment

Based on the above evaluation, Alternative C1 is identified as the preferred alignment as it provides a lower risk to existing structures and project duration, has lower cumulative impact to the public’s enjoyment of public spaces, and represents the lowest cost option.

4.3.3 East-West Tunnel and Diversion Alternative Alignments near the East End

As part of the environmental assessment, the following alternative alignments were considered for the east end of the East-West tunnel and for the Rideau River Collector diversion infrastructure:

1. North Alignments

2. South Alignments
4.3.3.1 Functional Description

The eastern terminus of the proposed EWT is located at the boundary of Stanley and New Edinburgh Parks where it will discharge to the IOS. The EWT is intended to capture and store excess combined sewage originating from the Rideau River Collector (RRC) in the vicinity of the existing Keefer Regulator. The current overflow point for the RRC is located at the head of the John St. Sewer at River Lane and Keefer Street. Hence, a diversion chamber and sewer originating in the vicinity of the existing overflow point is desirable to ensure a reliable and effective solution.

The following describes the functional requirements for the capture of combined sewage from the Rideau River Collector (RRC) and the outflow control from the EWT.

Flow Control Structures for Interception and Capture of Overflows

RRC Diversion Sewer: A new overflow chamber and associated sewer is required to capture and convey excess combined sewage from the RRC to the EWT. As illustrated in Figure 4-8, two alternate locations for the diversion chamber and sewer were considered. Both alternatives are possible with either EWT alignments across the Rideau River.

4.3.3.2 Description of Alternative EWT and Diversion Sewer Alignments near the East End

North Alignments

EWT: The north alignment for the eastern end of the EWT heads north away from Cathcart St. across Bordeleau Park and is nearly parallel to the existing IOS across the Rideau River to New Edinburgh Park and the EWT outlet chamber. It may be possible to push the alignment further north to reduce encumbrances in Bordeleau Park.

Diversion Sewer: The north alignment for the Rideau River Collector diversion infrastructure involves the provision of a diversion chamber on the John St. Sewer downstream of the Keefer Regulator at Queen Victoria St. A diversion sewer would direct sewage south from the diversion chamber through Stanley Park, over the IOS to the EWT outlet chamber at the eastern terminus of the EWT.

South Alignments

EWT: The south alignment for the eastern end of the EWT runs east under Cathcart St. and then heads north under the Rideau River to New Edinburgh Park and the EWT outlet chamber.

Diversion Sewer: The south alignment for the Rideau River Collector diversion infrastructure involves the construction of a diversion chamber on the RRC at the east end of River Lane (near Dufferin Rd.) and a diversion sewer heading northwest to the end of the EWT. The use of a diversion chamber upstream of the Keefer Regulator would require some form of flow control adjustments (raising overflow weir elevation) downstream of the regulator and special flow controls in the diversion chamber (in the form of a bending weir) to ensure that flows are preferentially sent to the Keefer Regulator before being diverted to the EWT outlet chamber.
Operational Control and Support Facilities

The EWT outlet chamber is proposed to connect the RRC diversion to the EWT, and to connect the EWT to the IOS. The purpose of the EWT outlet chamber is to control the storage and subsequent release sequence into the EWT and also provide protection against hydraulic transients (or shock waves confined within the sewer pipes) within the EWT. The outlet chamber would be located immediately south of the IOS, in the northwest corner of New Edinburg Park (adjacent to Stanley Park). The chamber would have an internal diameter of 15m and would be equipped with an outflow modulation gate ahead of the outlet pipe to the IOS. The modulation gate would close when the water level in the IOS rises above the water level in the EWT and would re-open when the water level in the IOS drops below its obvert (i.e. when there is capacity in the IOS).

The control and power supply equipment for the EWT outlet chamber may be housed within the existing control building for the Rideau River Collector odour control facility located approximately 80m east of the EWT outlet chamber. A comprehensive review of the odour control facility and its performance is needed, for two reasons: 1) to assess current performance and suitability for its existing function and identify any necessary upgrades in that regard; and 2) to assess the need to upgrade the facility to handle potential odours from the EWT, which are not expected at this time but will be examined rigorously during the design of the EWT. Alternatively, a new kiosk may be necessary within the fenced in odour control facility compound.

4.3.3.3 Evaluation of Alternative Alignments near the East End

Evaluation of Technical Criteria

EWT: The bedrock surface near the existing IOS across the Rideau River is at about elevation 50m and based on limited geotechnical information, appears to slope down towards the south. This would indicate that approximately 6m of rock cover would be available over the proposed EWT along a north alignment and there may be less rock cover along a southern alignment. Bedrock tunnels typically require competent rock for two (2) tunnel diameters above the top of the tunnel to have adequate crown stability. Areas with less than two tunnel diameters of cover would require additional reinforcement into the crown or additional precautions prior to or during tunneling. Further geotechnical information is required to confirm the feasibility and/or establish if special measures are necessary to complete tunneling along the southern alignment.
Diversion Sewer: The northern alignment for the RRC diversion sewer provides a simpler, more reliable approach to CSO control since the diversion chamber is located downstream of a regulator and simply diverts excess sewage that could not be entirely captured by the Keefer regulator. In the case of the southern alignment, excess sewage would have to be backed-up within the RRC and diverted to the EWT. The use of a bending weir in the diversion chamber is recommended to optimize the amount of sewage that is captured by the regulator and minimize the occurrences of overflows. With this configuration however, there is an increased risk of overflows since sewage may be sent to the EWT prematurely filling the available storage. The provision of a bending weir would also necessitate additional monitoring equipment and involve increased maintenance.

Evaluation of Natural Environment Criteria

Soil contamination has been identified within Stanley and New Edinburgh Parks along both RRC diversion sewer alignments. The north diversion sewer and EWT outlet chamber intersect areas of Stanley Park that were recently restored (capped) whereas New Edinburgh Park was formerly a waste disposal site. It is expected that both alignments would have to deal with possible contaminants during construction.
Evaluation of Socio-Cultural Criteria

The northern alignments for the EWT and RRC diversion sewer would result in greater encumbrances to NCC managed lands as opposed to the southern alignments. These areas are parkland and floodplain and such underground encumbrances are compatible with the land use.

The RRC diversion sewer along the northern alignment borders a few more private residences (along Queen Victoria St.) than the southern alignment and therefore may result slightly greater temporary disruptions during construction. This however would be offset by the need to construct a new chamber to house a higher overflow weir north of Keefer St. The construction along either diversion sewer alignments will result in some temporary park disruption. Construction along the south alignment may disrupt the programming of the soccer pitch and ball diamond.

Evaluation of Economic Criteria

EWT: Based on the limited geotechnical information, it appears that the rock cover above the southern EWT alignment may be less than 2 tunnel diameters which may results in the need for additional reinforcement into the crown or additional precautions during construction. This alignment would therefore carry a risk for increased tunneling costs. More site specific geotechnical information is required to quantify the potential increased costs.

Diversion Sewer: The capital costs of both RRC diversion sewer alignments are expected to be comparable assuming traditional open cut construction methods are used. The implementation of the southern alignment would cost more due to the need for a bending weir within the diversion chamber and a new chamber to house a higher overflow weir. The operation and maintenance costs of the southern alignment are also expected to be slightly higher.

4.3.3.4 Summary of Evaluation of Alternative Alignments near the East End

Table 4-6: Summary of Evaluation for Alternative Alignments near the East End

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>EWT North</td>
<td>• Rock cover is approximately 6m.</td>
<td>• Greater encumbrance in Bordeleau Park (NCC property).</td>
</tr>
<tr>
<td>EWT South</td>
<td>• Reduced encumbrance in Bordeleau Park (NCC property)</td>
<td>• Rock cover may be less than 2 tunnel diameters with the need for additional precautions during implementation. Risk of slower production and increased costs.</td>
</tr>
<tr>
<td>North RRC Diversion</td>
<td>• Ideal location for diversion chamber resulting in more reliable and simpler operation</td>
<td>• Temporary disruption to Stanley Park</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Some contaminated soil in Stanley Park will have to be managed.</td>
</tr>
<tr>
<td>South RRC Diversion</td>
<td>• Limited construction disruptions to residents along Queen Victoria</td>
<td>• Need for 2 chambers - one upstream and one downstream of the Keefer Regulator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased risk of overflows and increased operation and maintenance costs (bending weir)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Temporary disruption to New Edinburg Park and possibly its programming.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Some contaminated soil in New Edinburg Park will have to be managed.</td>
</tr>
</tbody>
</table>
4.3.3.5 Preferred Alignments – East End

EWT: Based on the foregoing, the southerly alignment for the EWT is retained as the preferred alignment since it reduces the encumbrances in Bordeleau Park. It is recognized however that more detailed geotechnical investigations along the south alignment are necessary to confirm the feasibility of this alignment and that ultimately the northern alignment may be implemented to reduce construction risks.

Diversion Sewer: The northern alignment for the RRC diversion sewer is preferred as it offers a simpler more reliable system operation.

4.3.4 East-West Tunnel Alternative Intermediate Staging Areas

The following alternative East-West tunnel intermediate staging areas were considered as part of the environmental assessment:

1. Site CW-1: Confederation Park
2. Site CW-2: Festival Plaza (City Hall)
3. Site CW-3: Laurier Avenue Off-Ramp
4. Site CE-1: East of Rideau Canal
5. Site CE-2: East of Colonel By Dr.
6. Site CE-3: Tabaret Hall

An intermediate or mid-point staging area for the EWT construction is expected to provide significant benefits to the construction schedule for the EWT and subsequently construction costs. Without this staging area, the mined materials from the EWT would need to be removed from the main or east end staging area (New Edinburgh Park). As the tunnel boring machine moves further away from that main staging areas, it takes longer and longer to carry the mined rock inside the tunnel from the machine to its extraction point, thereby slowing progression. A mid-point staging area significantly shortens the distance that mined rock has to travel within the tunnel; without this mid-point staging area an estimated 40% cost premium on the tunneling related costs for the western half of the East-West tunnel are expected. This represents an additional project cost that is estimated at approximately $10M.

For practical purposes, the ideal staging area has a surface area of approximately 4,000 m² for site trailers, some parking, to allow safe working space for equipment and machinery and possibly some temporary excavated material storage area.
The minimum staging area has a surface area of approximately 1,000 m$^2$ and would not provide any temporary excavated material storage area impacting the productivity and ultimately implementation costs.

During discussions with the City and project stakeholders, the need to consider staging areas located on both sides of the Rideau Canal was identified and subsequently assessed. Six (6) sites were identified and are described below (Refer to Figures 4-9 to 4-11). It is important to note that not all of the alternative intermediate staging areas are compatible with the alternative East-West tunnel alignments. The following table provides a summary of the compatibility between intermediate staging areas and tunnel alignments.

<table>
<thead>
<tr>
<th>Table 4-7: Summary of compatibility between intermediate staging areas and EWT alignments</th>
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<tbody>
<tr>
<td>EWT Alignment</td>
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<td></td>
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<tr>
<td>C1</td>
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<td>C2</td>
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<td>C3</td>
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### 4.3.4.1 Sites West of Rideau Canal

**Site CW-1:** This site is located in the northeast corner of Confederation Park (west of Queen Elizabeth Dr. and south of the MacKenzie King Bridge). It is primarily a level grassed area which is traversed by an asphalt pathway running east-west. There is one tree near the south edge of the area. The total area available for staging is greater than 3,100 m$^2$.

**Site CW-2:** This site is located in Festival Plaza (in front of City Hall), immediately south of Laurier Ave. It is a grassed area traversed by a pathway running northwest to southeast which is lined with flagpoles, a number of medium sized trees (10 to 15 cm diameter) to the north and the Rink of Dreams/underground parking to the south. Immediately to the northeast of the site is the recent firefighter’s memorial (inaugurated Sept. 2009). The total area available for staging is estimated at approximately 1,700 m$^2$.

**Site CW-3:** This site is located immediately south of Laurier Ave. and west of Queen Elizabeth Dr. The site is traversed by the Laurier Ave. off-ramp to Queen Elizabeth Dr. as well as a pathway and a sidewalk. The area is partially grassed and has a few planting beds with some mature trees and shrubs around its periphery. Its north portion slopes down toward the east. The total area available for staging is estimated at approximately 3,100 m$^2$.

### 4.3.4.2 Sites east of Rideau Canal

**Site CE-1:** This site is located immediately south of Laurier Ave. between the Rideau Canal and Colonel By Dr. It is a narrow (12 to 20m wide) grassed area with a pronounced slope toward the Canal. A paved pathway crosses the north end of the site and then borders the Canal. The total area available for staging is estimated at approximately 2,000 m$^2$.  

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4.40
Site CE-2: This site is located immediately south of Laurier Ave. between Nicholas St. and Colonel By Drive. The site is traversed by pathways heading east-west and north-south, it has a pronounced slope away from Laurier Av. and also toward Colonel by Dr. and has a significant amount of vegetation in the form of large, mature trees, shrubs and planting beds. The site is approximately 45 to 65 m wide and could accommodate an area of approximately 1,200 m². If we ignore the vegetation (assuming it can be replaced when done) the site could accommodate an area greater than 3,000 m².

Site CE-3: This site is located east of Tabaret Hall, immediately northeast of the Cumberland St. - Laurier Ave. intersection. The site is a grassed lawn bordered by a number of large, mature trees. The total available area for staging is estimated to be approximately 1,700 m².

4.3.4.3 Evaluation of EWT Alternative Intermediate Staging Areas

Prior to initiating a discussion or undertaking an evaluation of the various staging areas identified, it is important to emphasize that a number of pieces of infrastructure located near the mid-point of the EWT are vital to this project. They are:

1) Access shaft and Diversion structure to RCI - A diversion chamber and associated access is required to direct flows from the RCI to the proposed EWT (Refer to Section 4.3.2.1). The diversion chamber must be located as far north as possible along the RCI (which is located immediately to the west of the Queen Elizabeth Dr.). Because of existing infrastructure, the only feasible location is between the MacKenzie King Bridge and immediately south of the Laurier Ave.

2) A potential diversion sewer – depending on the location of the diversion structure and EWT alignment an additional diversion sewer may be required to connect the diversion structure and the EWT.
Figure 4-9: EWT Intermediate Staging Areas CW-1 to CW-3
Figure 4-10: EWT Intermediate Staging Areas CE-1 and CE-2

Figure 4-11: EWT Intermediate Staging Area CE-3
Evaluation of Technical Criteria

Dewatering Induced Settlement Impacts: A tunnel mucking shaft along the southern C2 and C3 tunnel alignments will extend into the shale or limestone bedrock at depth (i.e. to the invert of the tunnel) and will be open for many months. Given the rock and soil conditions at that location, dewatering of the shaft will result in drainage of the surrounding bedrock, which will then ‘under drain’ the surrounding area, and could lead to draw-down of the water level in the bottom of the overlying sediments. Where the bedrock is overlain by sensitive clay (such as in the vicinity of City Hall), there is a risk that this draw-down will stress the clay beyond its pre-consolidation pressure, particularly where heavy loads are already imposed on the clay (such as beneath buildings with heavily loaded raft slab foundations), and may result in settlement. Differential settlement may also occur between structures with deep foundations (such as pile-supported bridges or buildings) and the adjacent grade-supported structures (e.g. pavements, sidewalks, etc.).

The record structural drawings for City Hall indicate that, although the nearest part of the building’s underground parking garage is supported on piles, the main part of the building is supported on the clay with a raft foundation on a thick deposit of sensitive silty clay. Hence the combined effects of the raft loading and the under-drainage, causing potential overstress of the sensitive clay, leads to a risk of settlements in the area which may affect the structural integrity of City Hall.

The Rideau Canal structures (i.e. canal walls) are not likely vulnerable to settlements from dewatering as they do not place a significant enough stress on the clay due to their low weight (compared to a tall building such as the City Hall structure).

To the north, the National Arts Center (NAC) is supported by footings on rock while the MacKenzie King Bridge is supported on piles. Based on information available, it appears that the southernmost portions of the NAC underground parking structure are also supported on piles. Neither structure is therefore likely vulnerable to settlements from dewatering at site CW-1.

The Laurier Street bridge is supported on piles and rock-socketted caissons, while the east and west approach embankments are grade-supported. Differential settlement of the approaches relative to the bridge embankments is a potential concern.

At this time, it appears that CW-2 and CW-3, and to a lesser extent CE-1 and CE-2, present the greatest risk of impacts to adjacent structures from a dewatering standpoint. In order to quantify the potential impact on surrounding structures, information on the hydraulic conductivity of the bedrock is needed so that a hydrogeologic analysis can be carried out to determine the zone of influence of the dewatering. Geotechnical data on the compressibility of the clay deposit at depth would be needed to assess the potential settlements and impacts on the structure.

At CE-3, existing information indicates that the rock is overlain by stiff to very stiff clay and glacial till, which is at relatively low risk of dewatering induced settlement. No information was available on the foundations of adjacent structures.

It should be noted that the tunnel itself will also cause some surrounding groundwater level lowering. An assessment of the impacts of that dewatering will also need to be carried out at during the design.
**Shoring:** At CW-1, existing information indicates that the top of rock is expected to be between E.L 58 to 59 m, and that the rock is overlain by 7 to 8 m of fill and glacial till. Shoring of the overburden is expected to be carried out using conventional soldier pile and lagging.

A construction/access shaft at CW-2 and CW-3 will involve the highest shoring costs. Based on available data, the adjacent City Hall parking garage appears to be founded partly on piles and partly on a raft slab at about E.L 63.0m. The rock is much deeper, generally at about elevation E.L 51.0 to 55.0m. As such, a portion of the shaft excavation in the soil would extend several metres below founding level, and in close proximity to the parking garage. To avoid settlement or lateral movement of the parking garage foundations, a stiff and watertight shoring system would be needed for the excavation shaft. The cost of such a shoring system is estimated to be at least $1.5M. Additionally, a 200m long section of the tunnel would also need to be made watertight by grouting both upstream and downstream of the shaft which will also increase costs.

A construction shaft/access shaft at CE-1 and CE-2 will also involve higher shoring costs because of the thickness of overburden deposits (10 metres or more) and presence of firm clay. Preliminary information indicates that the top of rock is at about E.L 60m at CE-2 and deeper than E.L 56 at CE-1. Shafts placed in these locations will likely need to be constructed with internally braced sheet piles.

At CE-3, existing information indicates that the top of rock is expected to be at E.L 62 m, and that the rock is overlain by 8 m of stiff to very stiff clay and glacial till. Shoring in the overburden is expected to be carried out using conventional soldier pile and lagging.

**Evaluation of Natural Environment Criteria**

Sites CW-2, CW-3, CE-2 and CE-3 have a significant amount of vegetation including some very large trees in front of Tabaret Hall. Each site does have mature trees around its periphery which affects the ultimate size of staging area that can be accommodated without impacting trees. All sites with the exception of CE-1 and CW-1 require some significant tree removals.

CE-1, CE-2 and CW-3 are sloped and would require some regrading and/or would require some enhanced sediment controls to avoid potential off-site impacts (especially considering the proximity to the Rideau Canal).

**Evaluation of Socio-Cultural Criteria**

From a public impact perspective, the construction period will disrupt the use of public spaces for a period of up to 18 months with sites CW-1, CW-2 and CE-3 having the greatest impact. Site CW-1 will mostly impact Confederation Park, Site CW-2 may impact Confederation Park (8 mo. for diversion chamber) and will impact Festival Plaza (18 mo.), while Site CE-3 will impact activities at the University of Ottawa campus (18 mo.). Site CW3 could also impact CW1 if the diversion structure is located in Confederation Park.

Note that all three sites east of the canal and CW-2 will still require a lengthy (8 to 10 month), deep excavation in the vicinity of site CW-1 or CW-3 to provide a connection from the RCI to the EWT, depending on the tunnel route selected. These excavations and related staging areas would be smaller in footprint and shorter in duration than the main mid-point staging area.
Both CE-1 and CE-2 are part of a linear park system and the use of these sites would result in the disruption of the pathway and its users. It may be possible to temporarily re-align the pathways that cross CE-2. Site CE-1 is too narrow to maintain a pathway. Alternatively, it may be possible to temporarily close sections of pathways and direct users to alternate pathways.

From the perspective of cumulative impacts, Site CW-2 impacts on up to 11% of the total usable land area in both Confederation Park and Festival Plaza, while Site CW-1 impacts on 10% of this same total area over 18 months. Although Site CW-3 would only impact up to 5% of usable land surface (assuming the diversion chamber is located south of Laurier), it would have additional cumulative impacts on local traffic on Laurier and Queen Elizabeth and the route for the Changing of the Guard ceremony. Over 60% of Site CE-3 (small park in front of Tabaret Hall) would be impacted. This site is located within the Sandy Hill West Heritage Conservation District and therefore any permanent changes to the park would not be acceptable. Staging at sites CE-1 and CE-2 for 18 months would represent a significant impact for those general use open spaces, but would have the least cumulative impact on the general public and on sites considered to be of National Significance.

In consultation with Federal public agencies, it is clear that their preference is for selection of Sites CE-1 or CE-2 as staging areas in order to minimize the impact on programming and general public use at sites of National Significance (i.e. Confederation Park and/or Festival Plaza).

Surface Disruption: The need for a diversion chamber, diversion sewer and mid-point staging area as described above will all involve a surface construction site with a deep excavation to the EWT and/or the RCI. Such deep excavations will typically result in longer disruptions. As such, options which locate all three at the same site would be less obtrusive to the public and more cost-effective. Depending on the EWT alignment, Sites CW-1 and CW-3 have the potential of combining the Diversion chamber and EWT staging area. The other sites would require at a minimum two deep excavations and associated construction area.

- One for the construction of the diversion chamber somewhere along the RCI (west of the Rideau Canal), the likely prime candidate locations would be located within the CW-1 and CW-3 sites; and,
- One for the EWT construction staging.

Evaluation of Economic Criteria

As mentioned before, the provision of an intermediate or mid-point staging area has a significant impact on the projected capital cost of the project. Without this staging area, the mined materials from the EWT would need to be removed from the main or east end staging area (New Edinburgh Park) resulting in an estimated 40% cost premium on the tunneling related costs for the western half of the EWT. This represents an additional project cost that is estimated at approximately $10M.

The staging area options presented herein are equally effective in meeting the mid-point construction needs and in avoiding the $10M cost premium discussed above. The size of some of the staging areas identified will pose more constraints than others on the constructor and will result in an extended construction schedule and increased costs compared to more spacious...
options. This increase has been estimated at 10 to 20% increase on the costs of tunneling performed from this staging area (that is the tunneling from Queen Elizabeth Dr. to Lebreton Flats and the diversion structures required near Queen Elizabeth Dr.). For all sites other than CW-1 and CW-3 (and CE-2 provided that trees are removed and the site re-graded), the potential impact is a $2 to 4 Million increase. Only sites CW-1 and CW-3 provide the desired surface area (3,000 to 4,000 m²). Site CE-1 is additionally constrained since access to the tunnel is at the narrowest part of the site (i.e. tunnel alignment is immediately south of Laurier). Therefore the access to the tunnel will be significantly constrained.

Site CW-2 affects the surrounding public since it is bounded by Laurier Ave., the underground parking (load restrictions), Rink of Dreams and the Firefighter’s Memorial. It will also have an impact on the Changing of the Guard Ceremony.

4.3.4.4 Summary of Evaluation of EWT Alternative Intermediate Staging Area

An evaluation of alternative staging areas was undertaken. A summary of the review is provided in Table 4-7.

A number of issues were identified in comparing the various sites. A few of the concerns that are raised are considered significant and inherently carry additional risks. From a purely engineering point of view (i.e. not considering land ownership), the staging areas which are compatible with the northern EWT alignment can avoid the majority of the issues and risks identified herein.

From the general public’s point of view, Site CW-1 and CW-2 have the potential of impacting on the largest amount of public land whereas Sites CW-3, CE-1 and CE-2 will impact on the least. Site CW-1 represents a greater impact on Confederation Park, but from a cumulative impact, represents an impact on 10% of the total public land space in Confederation Park and Festival Plaza. Comparatively, Site CW-2 represents an impact on 11% of the total public land. With mid-point staging areas located east of the Rideau Canal, the cumulative impact on Confederation Park and Festival Plaza is reduced to 6% and the duration of the impacts is also greatly reduced.

From a construction perspective, Sites CW-1 and CE-2 (assuming some tree removal is acceptable) are the least constrained in terms of space. However, from an economic and technical perspective, sites east of the Rideau Canal are not ideal since pursuing these will result in the disruption of two areas (one east and one west of the canal) near the mid-point of the EWT and will result in greater construction costs as well as future operating and maintenance costs for an additional access shaft to the EWT.
Table 4-8: Summary of Evaluation of EWT Alternative Intermediate Staging Areas

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
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| CW-1         | • Fewer geotechnical concerns than staging areas associated with south tunnel routes (CW-2 & CW-3).  
               • No impact on Festival Plaza  
               • Low risk of dewatering induced settlement impacts.  
               • Single construction site for both diversion structure and staging area.  
               • Considered to be the most cost-effective alternative. | • Programming of larger events at Confederation Park will be affected for a duration of approximately 18 months. This site is deemed by NCC to have National Significance. |
| CW-2         | • Reduces and potentially eliminates impacts to programming of larger events at Confederation Park. | • Programming of larger events at Festival Plaza and possibly Confederation Park (if alignment C2 is retained) will be affected. Approx. 8 month duration at Confederation Park (assuming diversion chamber in the park) and approx. 18 month duration at Festival Plaza. Both are sites deemed of National Significance by NCC.  
               • Geotechnical concerns with risk of dewatering induced settlement impacts.  
               • May need hand-mined diversion sewer if diversion chamber is located in Confederation Park (alignment C2).  
               • Two staging areas required near mid-point (one for diversion chamber and one for the East-West tunnel).  
               • Constrained site.  
               • Most costly alternative. |
| CW-3         | • Potential for single construction site for both diversion structure and staging area if diversion structure is located south of Laurier (alignment C3).  
               • Minimizes impacts to programming of larger events at Festival Plaza and Confederation Park. | • Geotechnical concerns with risk of dewatering induced settlement impacts.  
               • 119 properties are at greater risk of flooding during extreme events if diversion chamber is located near staging area, south of Laurier (alignment C3). |
| CE-1         | • Shorten potential impacts to programming at Festival Plaza and/or Confederation Park (approx. 8 months may be required with an RCI diversion chamber in Confederation Park – alignments C1 or C2).  | • Large water infrastructure located at potential staging area.  
               • Very constrained (narrow) site adjacent to canal wall.  
               • Two construction sites required near mid-point (diversion chamber on west side of Rideau Canal and staging area) |
| CE-2         | • Shorten potential impacts to programming at Festival Plaza and/or Confederation Park (approx. 8 months may be required with an RCI diversion chamber in Confederation Park – alignments C1 or C2).  | • Some mature vegetation will be impacted (removed and replaced)  
               • Two construction sites required near mid-point (diversion chamber on west side of Rideau Canal and staging area) |
| CE-3         | • Shorten potential impacts to programming at Festival Plaza and/or Confederation Park (approx. 8 months may be required with an RCI diversion chamber in Confederation Park – alignments C1 or C2).  | • Two construction sites required near mid-point (diversion chamber on west side of Rideau Canal and staging area).  
               • Impacts to programming of events at Tabaret Hall, a well-used site of historical significance.  
               • Constrained site located on private property.  
               • May impact large mature trees. |
4.3.4.5 Preferred Staging Area

Given a preference for tunnel alignment alternative C1, the preferred staging areas are either CW-1 or CE-2. The primary disadvantage for CE-2 is economic related to having to construct two separate access shafts to the EWT within 300 m of one another. The primary disadvantage for CW-1 is a longer duration impact on event programming over a larger area within Confederation Park (additional 10 month impact over an additional area of 600 m²).

It is recognized that Confederation Park is a prime location and an integral component of a number of high profile NCC or third-party sponsored events (e.g. Winterlude, Jazz Festival, and the forthcoming 2017 Anniversary of Confederation Celebrations). Prolonged constraints on the use of portions of the park for construction related activities are considered to have the potential to significantly impact on programming for these activities and, consequently, the general public’s enjoyment of the City’s downtown core. The NCC has clearly indicated that an intermediate tunnel construction staging area should be located outside of Confederation Park, despite the additional costs to be incurred in doing so.

These issues are priority considerations for the public agencies that are the designated stewards of the affected public lands. Given these considerations, and given that a feasible alternative is available east of the Rideau Canal to mitigate these issues, the social impacts are deemed to outweigh the economic impacts. As such, staging area alternative CE-2 with tree removal is recommended as the preferred option.

4.3.5 Kent St. Tunnel Alternative Staging Areas near the North End

The following alternative Kent St. Tunnel staging areas were considered as part of the environmental assessment:

1. Supreme Court Lawn
2. East of Library and Archives

4.3.5.1 Functional Description

The Kent Street Tunnel (or North-South Tunnel, NST) consists of a north-south tunnel (3.0m diameter) located along Kent Street; this tunnel was initially identified as a required flood relief outlet for the O’Connor catchment area (Stantec, 2012). The O’Connor catchment area also represents a significant portion of the total drainage area that is tributary to the Rideau Canal Interceptor which is by far the largest CSO contributor to the Ottawa River.

With a connection to the proposed East-West tunnel (i.e. EWT) and a high level overflow to Ottawa River (via an existing Kent St. storm outfall to the Ottawa River), the north-south tunnel provides the dual functionality of CSO control and flood relief for the O’Connor catchment area. By combining these two functions in the same tunnel, it is estimated that the overall combined costs of CSO Control and flood relief can be reduced by $30M. The NST tunnel will flow south
to north and will connect to the EWT either at Laurier or Slater Streets (depending on the preferred EWT alignment at the Rideau Canal Interceptor). This interconnection to the EWT is required to make the NST available for combined sewage storage. From this connection point, the tunnel extends north and at an upward slope to the existing Kent St. storm outlet.

Originally, both Lyon and Kent Streets were considered as potential alignments for the north-south tunnel. Some of the factors that influenced the selection of Kent St. as the recommended alignment include:

- The avoidance of conflicts with the proposed LRT station at Albert St. near Lyon St.;
- Best alignment to connect to the existing Kent St. storm sewer outlet and possibly to the Kent St. combined sewer located along Kent St.; and,
- The south end of the tunnel would be located at the terminus of the proposed Catherine St. East Tunnel which will provide flood protection within the O’Connor area (Stantec, 2012). This location was favored for the west terminus of the proposed Catherine tunnel since it is located at the rock-clay interface. The NST will be entirely in rock since it is deeper than the proposed Catherine tunnel.

Interception and Capture of Overflows

The proposed configuration of the NST includes interconnections with the local combined sewer system at the south end of the NST. The intent is that dry weather flows would continue to drain toward the east to the RCI and combined sewage would only be directed to the NST in an effort to prevent surcharging of the local combined sewer system and flooding of basements with sewage. Interconnections to the local sewer system are recommended at Catherine, McLeod and Florence as described below.

**Catherine:** Located at the upstream end of the NST, this site conveys flow from the proposed Catherine East and West Trunk Level Measures (Stantec 2012) into the NST, where flow is then conveyed to the EWT during typical rainstorms, or to the River via the existing Kent Street Storm Outlet during major storms. Flow will be conveyed to the NST via 2 external vortex drop shafts located on either side of the NST.

**McLeod:** This site will convey flow from local combined sewers and proposed Trunk Level Measures (Stantec 2012) along McLeod to the NST via a vortex drop shaft.

**Florence:** This site will convey flow from local combined sewers along Florence to the NST. An inline gate will be used to store water in the upstream (south) portion of the NST for flushing of the NST following storage events.

**NST Outlet:** This site will provide a connection to the existing Kent Storm Tunnel and outlet to the Ottawa River. It will act as an emergency high-level overflow for the EWT and a tunnel outlet for flood relief within the O’Connor drainage area.

Although the NST outlet will need to connect the existing Kent Storm Tunnel on the east side of St. Laurent park (directly in front of the Supreme Court), the location of the construction access/tunnel staging area may be located either in St. Laurent Park or in the lawn area directly
west of St. Laurent Park. The alternative staging areas, and ultimately the NST outlet chamber, are discussed in Section 4.3.5.2.

**Operational Control and Support Facilities**

**NST Tunnel Flushing:** A sluice gate is proposed within the in-line flushing chamber. Side weirs are proposed on either side of the flushing gate to provide a passive bypass around the gate in the event of gate malfunction, blockage or failure. Level meters are proposed on the upstream and downstream sides of the modulation gate for control and monitoring of the flushing sequence.

**Supervisory Control Facilities:** Remote control and monitoring of the Florence site is proposed and would require that the site be connected to the central City of Ottawa wastewater SCADA system. An above grade control panel with a connection to SCADA via a radio antenna pole or fiber optic connection would be required near the Florence structure.

**Odour Control Facility:** For the purpose of the EA an odour control is assumed necessary at the south end of the NST to treat foul air that may be expelled during tunnel filling and emptying. A carbon adsorption system would treat air for most events and some air would be exhausted directly to the environment during large rainfall events. The size of the odour unit should be selected such that air is treated for a reasonable number of rainfall events and prevent oversizing the odour facility to handle large infrequent events. The required footprint of the odour control facility is estimated to be in the order of 8m x 8m.

Underground ductwork will connect the facility to the NST, where the distance from the facility to the NST would determine the required duct and fan sizes. Power, control and communication equipment for the odour control building will be required. The location of the facility may be required to be below grade due to lack of vacant land in the vicinity. Refer to Figure 4-12.

**4.3.5.2 NST Staging Area Options – North End**

A temporary construction staging area is required in order to build the NST, and would consist of materials storage, construction vehicle access, site trailers, a crane and an access shaft. The shaft allows the TBM to be launched and waste material to be extracted during tunneling.

Two locations identified as potential staging areas are illustrated on Figure 4-13. Both staging areas are located along Wellington near the Supreme Court on federally owned land. Public Works and Government Services Canada (PWGSC) is the acting authority over infrastructure and approvals for these areas. It should be noted that both staging areas may require construction to follow strict security and aesthetics standards dictated by PWGSC and the NCC due to the proximity to the Supreme Court and other federal government buildings. The expected duration of construction activity is approximately 18 months.
Staging Area 1

The first staging area is located on the front lawn of the Supreme Court of Canada. The site is bounded by Wellington St. to the south, Kent St., to the east, the Supreme Court building to the north and an access road to the west. Two rows of mature trees line both the east and west edges of the lawn whereas a single sparser row of trees lines its southern edge. An existing access chamber is located in the southeast corner of this property to access the head of the Kent St. Storm Tunnel Outfall.

This staging area could allow for a single site for the construction of both the tunnel and the overflow chamber including the connection to the Kent Street Storm Tunnel Outfall.

Staging Area 2

The second staging area is located along Wellington St. east of the Library and Archives Canada building and immediately west of Staging Area 1. It is also a tree-lined lawn which is slightly smaller that Staging Area 1.

This staging area could allow for the construction of the tunnel where the tunnel would be launched in an east direction on a radius that would allow a connection to the overflow chamber. With the use of this area for the main staging area, the overflow chamber and connection to the Kent Street Storm Tunnel Outfall would have to be constructed from a smaller construction staging area in front of the Supreme Court (Staging Area 1 above).
4.3.5.3 Evaluation of Staging Area Options – North End

Evaluation of Technical Criteria

A preliminary investigation indicates that there is no conflict with existing infrastructure for both staging areas. The existing DPW tunnels are north and/or east of the areas of interest.

One advantage with Staging Area 1 is that both the overflow chamber and NST connection to the existing storm sewer structure could be constructed concurrently within the same access shaft. This would reduce disturbances to the area when compared to Staging Area 2.

Staging Area 2 is bordered by an existing 1200mm high landscaped berm south, east and west sides of the area. If this vegetation and berm has to be maintained, it would require that the staging area be constrained to occupy the flat center of the area. This would result in a lower tunnel production rate and higher construction cost due to the inability to stockpile material on site.
Evaluation of Natural Environment Criteria

Staging Area 1 is bordered by rows of large mature trees. It is expected that these will not be impacted by the proposed construction staging area.

Staging Area 2 is bordered by an existing 1200mm high landscaped berm south, east and west sides of this area. The use of this area would require removal and replacement of a portion of the mature trees and berms.

Evaluation of Socio-Cultural Criteria

Based on preliminary discussions with PWGSC, potential conflicts may exist between Staging Area Option 1 and adjacent construction staging activities for rehabilitation of the Supreme Court. PWGSC noted that this work is in the planning process and may take 5-20 years to complete, but it is unclear when this work will begin. There may be a significant amount of trades and subsequent traffic in and around this area.

There may be a potential for conflict with construction of a new east-west DPW tunnel in the general vicinity of Staging Area Option 1. The proposed DPW tunnel construction includes an access shaft in front of the Supreme Court. This construction is underway and is expected to be completed by the time the tunnel construction for this project is initiated.

The proposed access for construction traffic to Staging Area 1 may utilize the existing road between Staging Area 1 and 2 and may result in the temporary elimination of a few parking spaces along the access road. The staging area is lined with semi-mature trees on all four sides. If vehicle access is not granted from the lane in front of the courthouse, removal and replacement of trees may be required.

The proposed access for construction traffic to Staging Area 2 may be the existing road/parking access immediately west of Staging Area 2. This may require the elimination of a few parking spaces to provide construction traffic access to the staging area. The current entrance for the parking lot from Wellington may be shared or dedicated to construction traffic.

A construction site directly in front of or adjacent to the Supreme Court for an extended duration may have a negative aesthetic impact. These potential impacts could be reduced with the use of hoarding (to NCC standard or nicer).

Potential impacts to businesses are expected to be insignificant and comparable between alternatives.

Evaluation of Economic Criteria

The use of Staging Area 1 is expected to be least expensive due to a shorter length of tunnel and the ability to combine the construction of the north control chamber with the tunnel construction access shaft. With Staging Area 2, the increased cost for approximately 110m of tunnel on a 100m radius is estimated at $1,500,000 not including the additional costs to abandon this temporary section of tunnel following construction.
4.3.5.4 Summary of Evaluation of Staging Area – Kent St. Tunnel

Table 4-8 provides a summary of the detailed evaluation that was undertaken as part of this environmental assessment.

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Area 1       | • The NST overflow chamber and outlet connection to the existing storm sewer structure could be constructed concurrently with the access shaft, reducing disturbances to the area when compared to Staging Area 2.  
• Most cost effective. | • The proposed access for construction traffic may likely utilize the existing road between Staging Area 1 and 2. This may require the temporary elimination of a few parking spaces.  
• Temporary aesthetic impacts with presence of hoarding. |
| Area 2       | • Located further from Supreme Court thus reducing potential aesthetic impacts. | • Potential for constrained staging area or alternatively the removal and replacement of trees will be necessary.  
• Construction of connection to the existing storm tunnel will still require construction (6 to 8 months) northwest of the Wellington and Kent intersection.  
• Increased cost for additional 110m of tunnel on 100m radius is estimated at $1,500,000. |

4.3.5.5 Preferred Staging Area

With the information available, Staging Area Option 1 is the preferred location for the NST staging area. This option is more cost-effective with a shorter overall construction schedule. This alternative also causes fewer disturbances to the surrounding properties since using Staging Area 2 would require some significant disturbance at Staging Area 1 to complete a connection to the exiting storm sewer.

4.3.6 Operational Considerations

4.3.6.1 Tunnel Flushing after a Storage Event

As part of the functional design process, consideration was given to tunnel flushing systems to minimize the potential for accumulation of sediment and debris within the storage tunnels. Since the “first flush” of runoff is directed to the IOS and that the excess sewage will be decanted to the proposed storage tunnel, it is expected that the majority of the sediment and debris will be directed to the IOS and the treatment plant. However, some sediment and debris is still expected to be present in the stored sewage. A number of different approaches were considered including in- or off-line retention of post-storage flushing water, special operations and shaping of tunnel invert to minimize sedimentation.

To be effective, off-line flushing-water retention systems require large amounts of water and in the NST case such flushing facilities would be required at a number of locations along the tunnels. The stored flushing-water volumes are released in sequence in order to generate scour velocities along the storage tunnels.
Alternatively the use of in-line flushing water storage may also be considered. This may be achieved through the use of specialized gates (such as the HydroFlush® Canal Flush GS by Steinhardt) or regular modulation gates which hold back a portion of the stored sewage for rapid release. Note that such a system would require an emergency bypass in the case of a gate malfunction. This is especially true for the NST which also acts as a flood relief sewer for the O’Connor area.

Based on a review of the aforementioned methods, it is recommended that the NST be equipped with an in-line flushing system and that the East-West tunnel rely on operational measures, combination of rapid dewatering and dry weather flow bypass, for its flushing.

Three potential locations for an in-line flushing gate/chamber were considered for the NST:

- Within the Catherine St. East Tunnel - This alternative would utilize the available storage within the proposed Catharine St. East Tunnel with a flushing gate at the west end of the proposed tunnel and release it via the drop shaft to the lower NST following a storage event. The main advantage of this location is that it is significantly shallower. However, the Catherine St. Tunnel is smaller, and therefore will have less available volume, and it is not planned for construction in the near future;

- Within the NST at McLeod - This alternative would utilize the available storage within the proposed NST south of McLeod with a flushing gate near the McLeod intersection. The advantage with this location is that it may be built as part of the NST; and,

- Within the NST at Florence – This alternative would utilize the available storage within the proposed NST south of Florence with a flushing gate near the Florence intersection. The advantage with this location is that it offers the largest potential storage volume and that it may be built as part of the NST. This is the recommended location for the NST in-line flushing gate.

**Operation**

Flushing the proposed East-West tunnel may be done through special system operation. For example, the rapid dewatering to the IOS of the stored volume is expected produce velocities in excess of 0.5 m/sec in the eastern half of the East-West tunnel. This approach may be combined with a temporary dry weather flow by-pass from at the West End regulator to the East-West tunnel to achieve flushing velocities. The combined dry weather flows from the West Nepean Collector and Booth St. Sewer is approximately 950L/sec which would produce an average flushing velocity of 1.1m/sec with a depth of just over 50cm within the proposed 3.0m diameter tunnel. This dry weather flow by-pass would be performed routinely following storage events.

The NST in-line flushing gate would have the ability to detain (between Catherine and Florence) approximately 2,200m³ of combined sewage that would reach the tunnel. The control of the gate would be based on local water levels upstream and downstream of the proposed flushing gate. Control of the gate would be tied into SCADA. Following a storage event, once the East-West tunnel and downstream portion of the NST are dewatered, the flushing gate would be opened to a predetermined opening to allow the detained volume to flush the floor of the NST.
It is expected that a flushing velocity of 1.25m/sec or greater may be sustained for approximately 15 minutes.

### 4.3.6.2 Odour Control

The proposed storage facility is designed to capture and detain what may be characterized as a mixture of storm runoff and a bit of “fresh” sanitary sewage which is not particularly odourus. The implementation of the proposed storage tunnel and its interconnection with the existing collection system has the potential of changing the air dynamics of the system and thereby create new exhaust points which may be of concern for odours. A review of the proposed storage tunnel indicates that air entrained with the flowing sewage within the existing collectors may be expelled near the diversion chambers leading to the proposed tunnels. Furthermore, air will be displaced and expelled from the tunnels during the filling sequence. Any expelled air from the existing collectors or proposed tunnels has the potential to produce odours, which may lead to complaints from area residents and/or businesses.

As discussed previously, in order to mitigate potential odours from air expulsion from the tunnels, odour control facilities are recommended on the upper end of each tunnel (i.e. at Lebreton Flats and at Kent and Catherine). These would draw air from the tunnels as they fill, allowing exhausted air to be treated during events. The odour control facilities should be located as close as possible to the source of any expelled air. The final location for the odour control facilities has not yet been selected; however potential areas have been identified and are illustrated on Figures 4-3, 4-5 and 4-12.

Additional odour treatment may be warranted near the new RCI diversion chamber where entrained air from within the RCI runs the risk of being released adjacent to the Rideau Canal near Confederation Park during overflow events. An opportunity may exist to provide a dual purpose system to deal with existing odour issues noted by the NCC and Parks Canada along the lower portion of the RCI (from the existing Rideau Canal Regulator to the Ottawa River). The City, NCC and Parks Canada are currently investigating the existing odour problem and this information will help better define the existing odour problem and identify opportunities for future mitigation. This odour control facility may be located anywhere along the RCI between the National Arts Center and an area immediately south of Laurier Ave. (Refer to Figure 4-5). The City has had initial discussions with the NCC and Parks Canada, however, the final location is subject to further discussions.

Based on a review of odour control technologies, carbon adsorption is considered to be most appropriate treatment technology for intermittent odour sources as they are low maintenance and do not require chemicals for proper operation. Although biofilters and bioscrubbers have a high efficiency for odour removal, they must be supplied with a continuous food source for the micro-organisms. Furthermore, these technologies work best with a continuous air flow and are not appropriate for intermittent operation. Wet packed tower scrubber systems are not recommended for this project due to the intensive maintenance required and the large amount of chemicals necessary.

The odour control facilities may be housed within an above-grade building, constructed to fit into its respective surroundings. If necessary, these facilities may also be housed in below grade
vaults with minimal negative surface impact. A fan would be required as part of the treatment system to draw air from the sewer and direct it through the carbon unit for treatment.

Each odour control facility would be equipped with a bypass, such that air exceeding the capacity of the odour treatment system can be exhausted directly to the atmosphere. This would accommodate excess air being expelled during abnormally high inflow rates.

4.3.6.3 Tunnel Access at Intermediate Locations

In order to ensure that adequate access is provided for periodic maintenance, cleaning and inspection of the EWT and NST, access points will be provided to the proposed tunnels at all diversion and control structures. Additional access locations along the tunnels are proposed at the following locations:

- NST/EWT Junction (Slater/Kent); and,
- Midway between RCI and RRC on the EWT (near Cumberland and York).

The structures will provide intermediate access to the tunnels to reduce the distance between accesses to within about 500m. These structures are proposed to be of sufficient size to accommodate future inspection or repairs by maintenance personnel or motorized CCTV or pipe cleaning/repair equipment.

4.4 PHASE 3 PUBLIC AND AGENCY CONSULTATION

Consultation for phase 3 of the MCEA process also included meetings with the general public through one Public Open House.

4.4.1 First Nations and Aboriginal Consultation

Having received no response from the Algonquins of Ontario Consultation Office (AOO) during phase 2 of the Project and with the changes to design evolving into phase 3, the Project team decided to contact the Consultation Office with a Project update. Resulting from discussions, a Project brief was sent to the Consultation Office in time to be discussed at the next council meeting. No further inquiries about the project were made.

One meeting was requested by the Kitigan Zibi Anishinabeg community. Project Team members met with Chief Gilbert Whiteduck and selected members of the community on July 11, 2012 to discuss the Project. A hard copy of all consultation materials was provided to Chief Gilbert Whiteduck along with a copy of the same project brief that was sent to the AOO Consultation Office.

4.4.2 Notice of Public Open House

Notice of the third public open house was published twice in the Ottawa Citizen and LeDroit on June 8 and 25, 2012. The notice was also placed in Capital City News on June 8, 2012 and
posted on the Centertown Citizens Community Association Website, Central Park Community Website and the Lowertown Community Association Websites. Copies of all notices placed for phase 3 can be found in Appendix A.

Notification for the public open house was sent to the entire Project contact list.

4.4.3 Public Open House #3

The final public open house was held June 26, 2012 to present the evaluation of the alternative designs for the preferred solution the preferred functional design and potential impacts and proposed mitigation measures. All materials presented and distributed for this open house can be found in Appendix A.

The open house was held at City Hall and was attended by eleven members of the public.

The format of the public open house was the same as the ones held previously. Poster boards were displayed on easels around the room and consultants and City staff were present to provide additional information and answer any questions. A presentation at 7:00 pm gave the public an overview of public open houses purpose and current stage of the Project.

All consultation-related documents were provided in both English and French. The package was compiled from resource documents that were created by the Project team to assist with Project comprehension, to request further information and/or to allow members of the public to provide feedback on the Project. In addition to accepting verbal comments from the public, the Project Team representatives encouraged visitors to submit written comments regarding the information presented.

Members of the public that were unable to attend a public open house and did not have access to the internet could request that a hard copy resource information package be mailed to them. An online version of the questionnaire was also made available by request on the City of Ottawa’s website. Additional comments could also be received via either of the emails or fax numbers contained on several resources, the presentation, poster boards or website. A duration of 30 days was available to receive public comment on materials presented. A total of four completed questionnaires were received, no additional comments were received after the 30 day time period.

4.5 PUBLIC AND AGENCY CONSULTATION RESULTS

Consultation during phase 2 of the MCEA process has affected the outcome of the Project Meetings that were held during phase 3 are listed below:

External Consultation
- 4 meetings with Federal Agencies;
- 4 meetings with the DOTT team
- 1 meeting with City Traffic/Transitway Representatives; and,
- 1 meeting with the University of Ottawa.

**Public Consultation**
- recorded notes from comments made during Q & A at the public open house; and,
- questionnaires (4) submitted from the public open house.
- All additional comments received from anyone by any other form of communication (i.e. email).

Consultation during phase 3 of the Project involved discussions focusing on scheduling of Project construction and continued refinement of locating Project infrastructure.

Continued discussions with the LRT office identified potential opportunities to coordinate construction of the two projects in the west end. Continued discussions with City traffic/Transitway groups investigated options for limiting roadway disturbance from Project construction and placement of permanent Project infrastructure.

Multiple meetings with the NCC raised issues particularly related to proposed Project infrastructure near Confederation Park. Project team members worked to find ways to move a majority of temporary and permanent infrastructure out of Confederation Park, avoid the timing of planned major events and explore opportunities to house Project infrastructure but provide utility for the NCC’s programming in the park.

Public comments again, were generally supportive of the Project. Expediting the Project was expressed by members of the public during the public open house.
5.0 Description of Project Undertaking

5.1 DESCRIPTION OF PREFERRED UNDERTAKING

The recommended preferred solution, as illustrated in Figure 4-1, consists of a 4,400m long 3.0m diameter storage tunnel through the City core interconnected with a 1,600 m long 3.0m diameter north-south tunnel along Kent St. The East-West tunnel extends between Booth St. at Albert St. and New Edinburg Park where it connects to the existing Interceptor Outfall Sewer. The Kent St. tunnel extends between Catherine St. and roughly Wellington St. where it connects to the existing Kent St. Storm Tunnel Outlet. The two storage tunnels provide a combined storage volume of approximately 43,600m³ and would prevent combined sewer overflows from the events from the Design Year including a 15% allowance for climate change uncertainty.

New diversion chambers and associated diversion sewers are necessary to intercept and direct excess sewage to the proposed tunnels. New diversion chambers/sewers would be provided on the Cave Creek and Rideau River Collectors, the Rideau Canal Interceptor and the Booth St., Catherine St., McLeod St. and Florence St. Sewers.

New dour control facilities are recommended at the western terminus of the East-West tunnel, at the southern terminus of the Kent St. tunnel and near the new diversion chamber on the Rideau Canal Interceptor. The exact location and character (above or below grade) of the odour control facilities has not yet been finalized. Upgrading of the existing facility at Stanley Park may be required and needs further investigations.

A flushing gate and flow by-pass chamber is recommended on the Kent St. tunnel at Florence St. Maintenance access points will be provided at all diversion and flow control chambers as well as at the interconnection of the two tunnels at Kent and Slater, and at an intermediate point in the eastern half of the East-West tunnel along Cumberland Street.

Note that the functional design of the recommended preferred solution presented herein is based primarily on existing geotechnical information. Fairly extensive geotechnical investigations will be completed as part of the subsequent preliminary and detailed design phase of the project to confirm and refine the proposed alignments and construction methods. Findings from these detailed investigations may warrant adjustments to the proposed alignments especially in areas with low rock cover including the east end, across the Rideau River, and the west end, west of Bronson Ave.

5.2 OPINION OF PROBABLE COST

An opinion of probable capital cost was developed as part of the functional design of this project. The Class ‘D’ opinion of probable cost can be estimated to be roughly within +35% and -20% of the actual project cost.
Changes during preliminary/detailed design, tendering and construction will impact the cost presented as will any changes to the market condition such as material and labour prices.

Perhaps the most critical factor that impacts the capital costs is the price of tunneling which accounts for approximately 65% of the overall project cost. The cost per meter for tunneling is known to vary based on geographical area, geotechnical conditions and market demand. To develop a cost estimate for the rock tunnels, three tunneling Contractors in Ontario were approached and were provided with the conceptual design details and geotechnical information available at the time. The Contractors provided costs per meter for rock tunneling based on various tunnel lengths and finished sewer diameters, which excluded the costs of TBM entry/exit shafts, access shafts and associated infrastructure (i.e. new diversion chambers, etc.). These were reviewed to develop cost estimates for the proposed tunnels.

The cost of odour control was separated out of the overall project cost for clarity as the necessity of odour control on the tunnels will need confirmation during the preliminary design.

The total capital project cost includes a construction contingency of 30% and a project delivery allowance of 29% (Engineering design, City project management, etc.). The opinion of probable cost does not include any allowance for land or easements acquisition. The opinion of probable cost for the works is summarized in Table 5-1. A detailed breakdown of the opinion of probable cost and cost allowance can be found in Appendix G.
### Table 5-1: Opinion of Probable Cost

<table>
<thead>
<tr>
<th>Site</th>
<th>Capital Cost</th>
<th>Project Cost Allowance (28.6%)</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>East-West Tunnel (EWT)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunneling - EWT</td>
<td>$62,918,700</td>
<td>$17,994,000</td>
<td>$80,912,700</td>
</tr>
<tr>
<td>Site 1 - West End</td>
<td>$6,630,000</td>
<td>$1,896,000</td>
<td>$8,526,000</td>
</tr>
<tr>
<td>Site 1 - Odour Control</td>
<td>$3,250,000</td>
<td>$929,000</td>
<td>$4,179,000</td>
</tr>
<tr>
<td>Site 2 - Kent Access</td>
<td>$587,600</td>
<td>$168,000</td>
<td>$755,600</td>
</tr>
<tr>
<td>Site 3 - Rideau Canal</td>
<td>$2,895,100</td>
<td>$828,000</td>
<td>$3,723,100</td>
</tr>
<tr>
<td>Site 3 - Odour Control</td>
<td>$1,950,000</td>
<td>$558,000</td>
<td>$2,508,000</td>
</tr>
<tr>
<td>Site 4 - Cumberland</td>
<td>$7,291,700</td>
<td>$2,085,000</td>
<td>$9,376,700</td>
</tr>
<tr>
<td>Site 5 - RRC/Keefer</td>
<td>$2,223,000</td>
<td>$636,000</td>
<td>$2,859,000</td>
</tr>
<tr>
<td><strong>Subtotal EWT</strong></td>
<td>$86,026,200</td>
<td>$24,602,000</td>
<td>$110,628,200</td>
</tr>
<tr>
<td><strong>North-South Tunnel (NST)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunneling - NST</td>
<td>$30,898,400</td>
<td>$8,837,000</td>
<td>$39,735,400</td>
</tr>
<tr>
<td>Site 6 - NST Outlet</td>
<td>$2,223,000</td>
<td>$636,000</td>
<td>$2,859,000</td>
</tr>
<tr>
<td>Site 7 - Florence</td>
<td>$1,610,700</td>
<td>$461,000</td>
<td>$2,071,700</td>
</tr>
<tr>
<td>Site 8 - McLeod</td>
<td>$712,400</td>
<td>$204,000</td>
<td>$916,400</td>
</tr>
<tr>
<td>Site 9 - Catherine</td>
<td>$1,864,200</td>
<td>$533,000</td>
<td>$2,397,200</td>
</tr>
<tr>
<td>Site 9 - Odour Control</td>
<td>$1,950,000</td>
<td>$558,000</td>
<td>$2,508,000</td>
</tr>
<tr>
<td><strong>Subtotal NST</strong></td>
<td>$39,258,700</td>
<td>$11,229,000</td>
<td>$50,487,700</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>$125,284,900</td>
<td>$35,831,000</td>
<td>$161,115,900</td>
</tr>
</tbody>
</table>

Notes:  
- a – Includes 30% contingency.  
- b – Breakdown of project cost allowances is provided with the full cost breakdown (Appendix G).  
- c – Total project cost includes capital costs and cost allowances.

### 5.3 COORDINATION WITH OTHER PROJECTS

Other projects and activities have been identified for inclusion in the Municipal Class EA that could overlap spatially and temporally with this project:

- Proposed development at Lebreton Flats
- Refacing Rideau Canal walls
- Road alignment changes on Sussex Street
- Light-rail Transit development
- West Block renovation 5-10 years to complete
- Centre Block renovation to start 2020
- Victoria Way Road construction
- Landscaping and stabilization of Parliament hill (slopes on north and east sides)
- 417 widening
- Stanley Park remediation
Description of Project Undertaking
January 10, 2013

- Somerset sewer upgrades
- City of Ottawa Outfalls rehabilitation
- RCI Odour control
- PWGSC tunnel on Wellington Street

Best practices serve to alleviate any concerns with overlap of projects and include coordination of construction activities for those projects that will overlap temporally with this project.

5.4 IMPACTS AND MITIGATION

The impacts and their associated mitigation measures have been identified for the Project during all phases i.e. site preparation, construction and operation. The Table 5-2 describes these impacts and provides measures to mitigate the impacts.

Most potential environmental effects resulting from the Project following implementation of mitigation measures will be small in size and temporary in nature. Numerous mitigation measures have been proposed to reduce or eliminate effects on listed Valued Environmental Components (VECs) through all phases of the Project (i.e. site preparation, construction and operation). Positive environmental effects were also considered.

VECs were determined based on consultation, standard EA scoping methods and derived from the criteria developed for evaluating alternatives. The project, in conjunction with other ORAP projects, will significantly reduce the frequency and volume of CSOs to the Ottawa River. This will lead to improvements to the quality and health of the River, to the ultimate benefit of natural environment and all communities that enjoy and depend on it.

Despite implementation of best practices and mitigation through good design, some residual environmental effects will remain. For those cases additional monitoring and follow-up programs have been recommended and are detailed in the following sections.
<table>
<thead>
<tr>
<th>VALUED ENVIRONMENTAL COMPONENT (VEC)</th>
<th>PROJECT COMPONENT OR PHASE</th>
<th>POTENTIAL ENVIRONMENTAL EFFECTS</th>
<th>PROPOSED MITIGATION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site preparation</td>
<td></td>
<td>Increased vehicle emissions</td>
<td>Stocks of excavated material and/or infill material will be properly shaped and covered or stabilized to avoid dust generation.</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>Dust and mud generation</td>
<td>Activities with potential to generate dust will be restricted during windy conditions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased odours at the NAC Café</td>
<td>Unnecessary idling of vehicles will be avoided. Heavy equipment used during the Project will be in good operating condition.</td>
</tr>
<tr>
<td>Air Quality/ Odour/Dust</td>
<td></td>
<td>Potential failure of the odour control equipment</td>
<td>Existing odours in Stanley Park will be mitigated by upgrading existing facilities with newer technologies.</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td>Increased odours at public spaces if odour control facilities are not designed properly</td>
<td>Mitigation through best design of facilities. Odour treatment systems will be provided for the treatment of air expelled from the proposed tunnels and locally within existing collector sewers during and immediately following a rainfall event.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased odours during events at Confederation Park</td>
<td>Potential odours will also be mitigated through proper maintenance (draining and flushing of the tunnels following an event).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels that coincide with events at Confederation Park</td>
<td>Development and adherence to proper monitoring, operating and maintenance protocols.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from construction activities in nearby communities such as New Edinburgh area</td>
<td>Odour control facilities will be designed with the opportunity for expansion if required to adequately control odours.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased odours at community parks such as the NAC Café</td>
<td>During operation it is anticipated that air quality with respect to odours will improve due to the reduced number of CSOs, an overall positive impact.</td>
</tr>
<tr>
<td>Ambient Noise</td>
<td></td>
<td>Increased noise levels that coincide with events at Confederation Park</td>
<td>All equipment used during the Project will meet applicable standards and regulations regarding noise emissions where noise may cause potential disruptions (e.g., Occupational Health and Safety Act, local By-laws).</td>
</tr>
<tr>
<td>Site preparation</td>
<td></td>
<td>Increased noise levels from construction activities in nearby communities such as New Edinburgh area</td>
<td>In order to limit the effects of noise during construction, when possible, work will be restricted to hours that adhere to applicable City of Ottawa by-laws (No. 2004-253).</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Rock blasting activities are anticipated for construction access shafts. Blasting programs will be designed and monitored by qualified experts to ensure procedures and potential vibrations are maintained within legislated and recommended limits so that no damage to private property occurs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>The blasting programs will be designed and monitored by qualified experts to ensure procedures and potential vibrations are maintained within legislated and recommended limits so that no damage to private property occurs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Use of controlled blasting designed by a 3rd party with expertise in blasting patterns. Time delays in the blast patterns would be established to minimize the “big shock” wave phenomena. Use blast mats to control noise and dust. City could require the use of a shaft boring machine instead of shaft blasting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Pre and post blasting surveys of individual properties will be conducted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Staging of equipment and materials to take place, to the extent possible, at a staging area away from noise sensitive sites.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Requiring some equipment to be electric driven, but it must be noted that not all equipment can meet this requirement. For example, the contractor could also be forced to use an electric hoisting crane to limit noise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Construction staging areas will be placed away from sensitive receptors to the extent possible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Lining trucks with wood or rubber – but liners wear out fast or get damaged and may not get replaced in a timely fashion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Muffling engine exhausts, shrouding engine fans, moving tunnel vent fans underground, and providing vent line silencers are all useful measures to attenuate construction noise from an active site. Set a maximum decibel level for construction activities (noise ordinance limitations are not uncommon).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Hoardings and shrouding of engines and tunnel vents will be used to limit noise spread.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Hoardings with textured finishes and extra height have been used in some cases to limit noise spread. In a few cases the construction shafts have been enclosed in a light duty building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased noise levels from community parks such as the NAC Café</td>
<td>Consult with the New Edinburgh Community organization prior to Project commencement.</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Increased noise created by odour control facilities disrupting events or moored boats on the Rideau Canal</td>
<td>Timing of routine maintenance will be scheduled to limit disruption to nearby communities/businesses, etc.</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Operational maintenance may be disruptive to events at Confederation Park</td>
<td></td>
</tr>
</tbody>
</table>
### Table 5-2: Potential Impacts & Mitigation Measures (continued)

<table>
<thead>
<tr>
<th>VALUED ENVIRONMENTAL COMPONENT (VEC)</th>
<th>PROJECT COMPONENT OR PHASE</th>
<th>POTENTIAL ENVIRONMENTAL EFFECTS</th>
<th>PROPOSED MITIGATION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water</td>
<td>Site preparation/Construction</td>
<td>• Construction will require excavation and possibility the temporary stock piling of fill material, both of which may cause sediments to wash off-site during storm events. • Release of deleterious substances</td>
<td>• Sediment erosion control measures will be implemented and monitored to prevent runoff of sediment-laden stormwater. • All equipment or associated materials will be operated, stored and maintained (e.g., re-fuel, lubricate) in a manner that prevents the entry of any deleterious substances into nearby waterways. • Nearby stormwater catchbasins will be sealed within project construction areas. • Contaminated soils or other contaminated materials will be securely contained and removed off-site to a licensed disposal facility. • Measures will be in place to minimize impacts of spills; all measures and procedures will adhere to provincial and federal regulations. • Chemicals and cleaning agents will not be discharged into nearby waterways. • Measures will be implemented to prevent concrete, timber waste, aggregate, or other debris from entering the water.</td>
</tr>
<tr>
<td></td>
<td>Site preparation/Construction</td>
<td>• Release of deleterious substances</td>
<td>• Deceased in ground water</td>
</tr>
<tr>
<td>Groundwater Quality</td>
<td>Site preparation/Construction</td>
<td>• Spread of contaminated soils</td>
<td>• Environmental Site Assessments Phase I and II will be completed to identify contaminated soils prior to work. • Any identified contaminated soils will be handled and sent to a licensed disposal facility in accordance with federal and provincial regulations. • The contractor will ensure that a suitable split kit is kept and maintained at all staging areas and within the immediate construction areas.</td>
</tr>
<tr>
<td>Soil Quality</td>
<td>Site preparation/Construction</td>
<td>• As much vegetation as possible will be retained. • Trees will be impacted by a qualified arborist prior to removal for pests or disease and disposed of accordingly. • Trees that will be preserved will be demarcated to protect them from construction. • Trees removed will be replaced in greater numbers. • Native non-invasive species will be used for replacement plantings.</td>
<td>• Introduction of invasive species • Loss of vegetation • Loss of trees on Supreme Court lawn • Transfer of pests/diseases • Disturbance • Avoidance of construction areas • Sediary wildlife occurring at construction areas will be humanely trapped and relocated. • Targeted surveys to identify potential for Species at Risk or their habitat prior to work and development of appropriate mitigation measures following surveys.</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Site preparation/Construction</td>
<td>• Introduction of invasive species • Loss of vegetation • Loss of trees on Supreme Court lawn • Transfer of pests/diseases</td>
<td>• Clearing of trees and shrubs will be scheduled to occur outside of the nesting season (April – July). If trees or shrubs must be cleared during the breeding season, a nesting survey will be conducted by a qualified biologist prior to disturbances. If migratory birds or species at risk are identified actively nesting in the Project area, additional mitigation will need to be applied in consultation with the Ministry of Natural Resources.</td>
</tr>
<tr>
<td>Terrestrial Animals</td>
<td>Site preparation/Construction</td>
<td>• Disturbance • Avoidance of construction areas</td>
<td>• Clearing of trees and shrubs will be scheduled to occur outside of the nesting season (April – July). If trees or shrubs must be cleared during the breeding season, a nesting survey will be conducted by a qualified biologist prior to disturbances. If migratory birds or species at risk are identified actively nesting in the Project area, additional mitigation will need to be applied in consultation with the Ministry of Natural Resources.</td>
</tr>
<tr>
<td>Avifauna</td>
<td>Site preparation/Construction</td>
<td>• Disturbance • Avoidance of construction areas</td>
<td>• Clearing of trees and shrubs will be scheduled to occur outside of the nesting season (April – July). If trees or shrubs must be cleared during the breeding season, a nesting survey will be conducted by a qualified biologist prior to disturbances. If migratory birds or species at risk are identified actively nesting in the Project area, additional mitigation will need to be applied in consultation with the Ministry of Natural Resources.</td>
</tr>
<tr>
<td>Aquatic Environment</td>
<td>Site preparation/Construction</td>
<td>• Alteration of fish habitat</td>
<td>• There are no anticipated impacts to fish and fish habitat during site preparation or construction.</td>
</tr>
<tr>
<td>Fish and Fish Habitat</td>
<td>Site preparation/Construction</td>
<td>• Improvement to fish habitat</td>
<td>• Potential impacts as they relate to fish and fish habitat are anticipated to improve during operation of the project as the reduced number of CSOs to the Ottawa River will reduce pollution.</td>
</tr>
<tr>
<td>VALUED ENVIRONMENTAL COMPONENT (VEC)</td>
<td>PROJECT COMPONENT OR PHASE</td>
<td>POTENTIAL ENVIRONMENTAL EFFECTS</td>
<td>PROPOSED MITIGATION MEASURES</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>Socio-Economic Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heritage/Historical</strong></td>
<td>Site preparation</td>
<td><em>Damage due to nearby vibrations</em></td>
<td><em>Mitigation through design, surface disturbance is expected to be low because tunneling will occur at depth.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Damage from construction vibrations to University of Ottawa historic/heritage buildings</em></td>
<td><em>Consultation with Parks Canada to ensure design and implementation of project components do not have a negative impact on the Rideau Canal World Heritage Site’s Outstanding Universal Value.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Damage from construction vibrations on heritage houses on Séraphin Marion and Wilbrod Streets</em></td>
<td><em>Consultation with Federal Heritage Buildings Review Office.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Change in heritage character/viewscapes at the Rideau Canal</em></td>
<td><em>Blasting programs will be designed and monitored by qualified experts to ensure vibrations and procedures are maintained to limit potential effects to private property.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Compromising a place of recognized symbolic importance</em></td>
<td><em>This and post-blasting surveys specific to heritage buildings will be conducted as necessary.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Change in heritage character/viewscapes of the Supreme Court (including lawn)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Pre and post-blasting surveys specific to heritage buildings will be conducted as necessary.</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Compromising a place of recognized symbolic importance</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Disruption to tourism facilities</em></td>
<td><em>Measures will be put in place to ensure that every home and business has emergency access to the street.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>All lane closures will occur in compliance with all local by-laws and appropriate signage or other safety devices as required by law will be implemented and maintained.</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td><em>Disruption to Transitway during peak hours.</em></td>
<td><em>Schedule project activities and future maintenance to minimize conflict with commercial use of nearby area.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Increased truck traffic from several projects in close proximity</em></td>
<td><em>Temporary driveway or local road access will be provided for local traffic during construction.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Parking space loss or constraints at the Supreme Court</em></td>
<td><em>Measures will be put in place to ensure that every home and business has emergency access to the street.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Disruption of pedestrian/cycling movements between adjacent uses</em></td>
<td><em>Limiting disruptions to nearby communities as best as possible special consideration to those communities that have previously had intensive construction (e.g. Stanley Park and Somerset neighbourhoods).</em></td>
</tr>
<tr>
<td><strong>Archaeology</strong></td>
<td>Site preparation</td>
<td><em>Permanent disruption to an area’s aesthetics</em></td>
<td><em>Schedule project activities off-peak hours and during the summertime wherever possible.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Changing the character/viewscapes of important recognized places within the National Capital Region</em></td>
<td><em>Measures will be put in place to ensure that every home and business has emergency access to the street.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Change in security requirements of Supreme Court</em></td>
<td><em>Avoiding any development that might compromise areas with “Open Space Plans” where possible.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Compromising future development in areas with “Open Space Plans”</em></td>
<td></td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>Site preparation</td>
<td><em>Disruption to recreational use</em></td>
<td><em>Schedule construction and maintenance activities to minimize conflicts with recreational use and planned uses of recreational spaces.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Limiting of greenspaces use for 150th Anniversary celebrations</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Change in security requirements of Supreme Court</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td><em>Minimizing visitor impact to cultural resources</em></td>
<td></td>
</tr>
<tr>
<td><strong>Aesthetics</strong></td>
<td>Site preparation</td>
<td><em>Permanent disruption to an area’s aesthetics</em></td>
<td><em>Schedule project activities and future maintenance to minimize conflict with commercial use of nearby area.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Changing the character/viewscapes of important recognized places within the National Capital Region</em></td>
<td><em>Measures will be put in place to ensure that every home and business has emergency access to the street.</em></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td><em>Disruption to commercial use of nearby area</em></td>
<td><em>Schedule project activities and future maintenance to minimize conflict with commercial use of nearby area.</em></td>
</tr>
<tr>
<td><strong>Economy</strong></td>
<td>Site preparation</td>
<td><em>Disruption to commercial use of nearby area</em></td>
<td><em>Schedule project activities off-peak hours and during the summertime wherever possible.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Minimizing visitor impact to cultural resources</em></td>
<td><em>Measures will be put in place to ensure that every home and business has emergency access to the street.</em></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td><em>Minimizing visitor impact to cultural resources</em></td>
<td><em>Schedule project activities and future maintenance to minimize conflict with commercial use of nearby area.</em></td>
</tr>
<tr>
<td><strong>Land Use</strong></td>
<td>Construction</td>
<td><em>Compromised security for Supreme Court</em></td>
<td><em>Securing construction area must meet requirements of Supreme Court as well as all other PMGSC construction standards set for the Supreme Court of Canada/RCMP.</em></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td><em>Change in security requirements of Supreme Court</em></td>
<td><em>Follow NCC hoarding guidelines.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Effect on potential future site development and “loss of opportunity costs”</em></td>
<td><em>Avoiding any development that might compromise areas with “Open Space Plans” where possible.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Compromising future development in areas with “Open Space Plans”</em></td>
<td></td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Site preparation</td>
<td><em>Construction traffic could be a safety issue for nearby communities during construction</em></td>
<td><em>Installation of proper signage.</em></td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td><em>Safety concerns with respect to cyclist and pedestrians on nearby pathways.</em></td>
<td><em>Limiting access to construction areas.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Safety risk to public and users of areas near construction</em></td>
<td><em>Fencing and barriers to keep non-construction workers out of hazardous areas.</em></td>
</tr>
</tbody>
</table>
5.5 OPERATION, MAINTENANCE AND MONITORING

The operation of the proposed CSST is described in Sections 4.1.2 to 4.1.4. While every effort has been made to simplify the operation and maintenance of the proposed CSST, some automated mechanical sluice gates and associated controls are necessary to initiate a storage event, to protect the system in the case of a large runoff event, to protect City staff during inspections and to automate some of the routine maintenance activities (sediment and debris flushing).

Performance monitoring is a key component of the proposed CSST as it will enable to City to gauge the performance of the proposed facility, to ensure its proper operation and make any necessary adjustments in its operation. The current performance monitoring being undertaken by the City to measure the efficiency of the key regulators may also be used to monitor the performance of the CSST. Some of the existing flow and level monitoring equipment will have to be relocated as part of the CSST implementation and will be used in conjunction with new level monitoring equipment within the tunnels. The performance of the CSST will be documented in the annual report being submitted to the MOE.

5.5.1 EWT / NST Inspection

Access to the EWT is proposed to be provided at the following locations:

- West End EWT structure;
- NST/EWT intersection (intersection of Slater/Kent);
- RCI EWT structure;
- Cumberland access structure (intersection of Cumberland and York); and
- RRC EWT structure. This site also provides a new access location to the IOS.

Access to the NST is proposed to be provided at the following locations:

- Catherine NST Structure;
- McLeod NST Structure;
- Florence NST Flushing Structure;
- NST/EWT intersection (intersection of Slater/Kent); and
- NST Outlet Structure (intersection of Kent/Wellington);

These access locations will allow for periodic inspection and maintenance of the EWT and NST.
These access locations do not require lock-out of inflows for machine inspection (i.e. CCTV) but would for person entry. Lock-out of the EWT inflow would require closure and lock-out of the inlet gates.

The recommended inspection periods for the tunnels will vary throughout the life cycle of tunnels and may vary pending the actual operational condition. Table 5-3 provides a recommended inspection schedule for the tunnels.

<table>
<thead>
<tr>
<th>Inspection/Maintenance Task</th>
<th>EWT</th>
<th>NST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection for sedimentation and debris accumulation.</td>
<td>Year 1 (First winter following implementation)</td>
<td>Year 1 (First winter following implementation)</td>
</tr>
<tr>
<td>Structural inspection for concrete shrinkage and structural integrity. Inspection for sedimentation and debris accumulation.</td>
<td>Year 2</td>
<td>Year 2</td>
</tr>
<tr>
<td>Sediment/debris removal and detailed structural inspection.</td>
<td>Year 5</td>
<td>Year 5</td>
</tr>
<tr>
<td>Sediment/debris removal and detailed structural inspection.</td>
<td>Year 10</td>
<td>Year 10</td>
</tr>
<tr>
<td>Sediment/debris removal and detailed structural inspection combined with concrete repairs as required.</td>
<td>Year 20</td>
<td>Year 20</td>
</tr>
</tbody>
</table>

5.6 FUTURE APPROVALS

A number of approvals will be required prior to implementation of the CSST. These approvals will be obtained as part of the preliminary and detailed design stage of the CSST project. A listing of the anticipated approvals is provided below.

5.6.1 City of Ottawa Utility Circulations

Utility circulation through the City of Ottawa will be completed following the preliminary design submission to ensure that the works are not in conflict with existing utilities and infrastructure. Key utilities impacted by the proposed works and requiring relocation have been identified as part of the CSST Functional Design Report (Stantec 2012).

A service layout request will be completed during the preliminary/detailed design to determine if Hydro Ottawa can supply the electrical service required at each TBM staging area to power the TBM and site equipment for the duration of construction.

5.6.2 Ministry of the Environment
5.6.2.1 Environmental Compliance Approval

A new Environmental Compliance Approval (ECA) for wastewater collection system will be required for the proposed works in addition to amendment to the existing Certificate of Approvals (CoFA) for the key regulators being affected by the project (see list below). A pre-consultation meeting with the regional MOE office should be held during the preliminary design to determine the Ministry’s requirements for this project.

Approval for use of a backup or duty generator may be required for the TBM staging sites during construction. The successful Contractor would be responsible for obtaining the necessary approval(s) from the MOE and City of Ottawa.

The following CoFA exist for the key regulators whose operation will be modified/affected by the proposed project:

1. CoFA Sewage: Booth/Booth-Wellington Regulators (CoFA Reference # 1784-7RCSF7, issued June 10, 2009)
2. CoFA Sewage: Lloyd-Preston Regulators (CoFA Reference # 3276-7NQSYM, issued June 10, 2009)
3. CoFA Sewage: Rideau Canal Regulator (CoFA Reference #9816-7AKSU, Issued December 24, 2007)

5.6.2.2 Permit to Take Water

It is anticipated that dewatering will be required during construction of the EWT, NST and associated access shafts. A Permit to Take Water will be required to carry out the dewatering exercises and will be obtained by the successful Contractor.

5.6.3 National Capital Commission (NCC)

Three (3) of the EWT sites, Lebreton Flats, Confederation Park, and Stanley Park may require the use of National Capital Commission (NCC) lands for temporary construction facilities and for permanent below ground infrastructure. Land Use Permits and property agreements will be required at some locations pending negotiations between the City and the NCC.

Lebreton Flats

The NCC is currently working on the redevelopment strategy for the Lebreton Flats area, which includes proposed uses of the parcels of land bordered by Booth, Albert, Old Wellington and the Transitway. Negotiations are currently ongoing between the City and NCC regarding land transfers in this area.
Confederation Park

Coordination with the NCC regarding the use of the park is ongoing, with a general agreement on preferred EWT alignment and diversion chamber staging area within the park (refer to Sections 4.3.2 and 4.3.4).

Stanley Park

The RRC diversion sewer traverses Stanley Park, land owned by the NCC, while the outlet control chamber and surge tank is primarily located on City property adjacent to Stanley Park. Temporary construction access and underground easements will be necessary for implementation of the project.

5.6.4 Public Works and Government Service Canada

Discussion between Public Works and Government Service Canada (PWGSC) and the City are ongoing for the temporary use of St. Laurent Square in front of the Supreme Court for the duration of NST construction. Approvals from the PWGSC will be required for installation of any permanent infrastructure within the limits of the Judicial Precinct. Coordination is also currently ongoing with respect to upcoming PWGSC construction in the area which may conflict with the proposed works.

FHBRO/PWGSC informed the City that an application by the owner (PWGSC) will be required for works in front of the Supreme Court. FHBRO/PWGSC noted that construction of the new chamber on the existing Rideau Canal Outfall, on the west side of the Canal Locks, could also require FHBRO involvement if the escarpment is affected. The City assists in the preparation but it is the owner that submits.

5.6.5 Property Acquisitions / Easements

Generally the EWT and NST will be routed within City owned Right-of-Way (ROW) road allowances. There are some areas where underground easements will be required to accommodate the EWT/NST route as described in the following sections.

5.6.5.1 National Capital Commission

The proposed alignment for the EWT and diversion sewers will necessitate easements for Confederation Park, Stanley Park, land parcel south of Laurier Ave. and east of Colonel By Dr. and possibly in Lebreton Flats.

5.6.5.2 Public Works / Parliamentary Precinct

Underground easements may be required at the NST outlet below the St. Laurent Square in front of the Supreme Court.
5.6.5.3 University of Ottawa

The proposed alignment for the EWT requires crossing below University of Ottawa property in front of Tabaret Hall. Initial discussions have taken place with the University staff with respect to the need for an underground strata easement will be necessary.

5.6.5.4 Parks Canada

Parks Canada property will be impacted by the proposed undertaking including the property west of the Rideau Canal locks due to the construction of a new underground chamber to house a dam and the Rideau Canal near Laurier Ave by the underground alignment of the EWT. Initial discussions have taken place with Parks Canada staff with respect to the need for this infrastructure.

5.6.5.5 Province of Ontario

The Rideau River will be impacted by the underground alignment of the EWT. A Work Permit will be required from the Ontario Ministry of Natural Resources and an underground strata easement may be necessary.

5.6.5.6 Private Property

A number of private properties located near the intersection of Cumberland and Cathcart Streets will be impacted by the underground alignment of the EWT where a long radius bend is required. Underground strata easements will be necessary for these properties.

5.7 IMPLEMENTATION

An implementation schedule for design, construction and commissioning of the CSST and NST is presented in Figure 5-1. Construction of the tunnels and associated infrastructure is anticipated to take 36 months to complete, assuming all approvals and permits are in order prior to mobilization. This schedule assumes that one Tunnel Boring Machine (TBM) is used to complete both the NST and the EWT and that a intermediate staging area is provided in the vicinity of the Rideau Canal.

Due to the size and complexity of the NST and EWT construction, there are numerous ways for sequencing the tunnel construction, where each option would have an impact on the schedule and possibly on capital cost. The options are based solely on the sequencing of the tunneling, assuming there would be no impact to the schedule for completing the associated infrastructure (i.e. new diversion chambers, odour control, access shafts, etc.). Three (3) general construction sequencing options are as follows:

Option 1 (Single TBM to construct EWT and NST): The schedule shown in Figure 5-1 is based on this option.
Generally the EWT would be constructed from the RRC to the mid-point staging area (RCI), then from the RCI to West End. The NST would be constructed from Catherine to the Kent outlet following completion of the EWT.

**Option 2** (NST built independently, single TBM to construct EWT): The NST would be constructed separately prior to the EWT. A single TBM would be used to construct the EWT with an intermediate staging area. Specialized work may be required for the connection to the NST.

**Option 3** (Construct EWT without intermediate staging area): A single TBM would be used to construct the EWT without an intermediate staging area. The cost of this option would be higher than Option 1 with increased tunneling duration. Following completion of the EWT, the TBM would be used for NST construction.

<table>
<thead>
<tr>
<th>Description</th>
<th>Duration</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary &amp; Detailed Design</td>
<td>20 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tender &amp; Contract Award</td>
<td>6 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>36 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East End Staging Area Shaft</td>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East End Diversion Chamber &amp; Sewer</td>
<td>6 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EWT Tunneling - East Half</td>
<td>13 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rideau Canal Diversion Chamber</td>
<td>8 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EWT Intermediate Staging Area Shaft</td>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EWT Tunneling - West Half</td>
<td>13 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West End Chambers</td>
<td>12 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NST Staging Area Shaft (North)</td>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NST Tunneling</td>
<td>10 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NST Drop Shafts (South)</td>
<td>3 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NST Overflow Structure (North)</td>
<td>2 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning</td>
<td>4 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5-1: Implementation Schedule

### 5.8 NOTICE OF COMPLETION AND 30-DAY REVIEW PERIOD

A Notice of Completion was published in the LeDroit and Sun newspapers on January 25, 2013, and was also distributed to all individuals and stakeholders on the Project contact list indicating an interest in the study. This report has been made available to the public at the following branches of the Ottawa Public Library: Hazeldean (50 Castlefrank Road), Ruth E. Dickinson (100 Malvern Drive), Main (120 Metcalfe Street) and Orléans (1705 Orléans Boulevard). This report will be available for review for 30-days.

During the 30-day review period, the public has an opportunity to review this Environmental Study Report and provide additional comments and input. If concerns cannot be addressed through discussions with the City of Ottawa, a person/party may request the Minister of the Environment to order the project to comply with Part II of the EA Act. If Part II Order requests are received, the proponent and the concerned parties can work together to help resolve conflicts. If conflicts cannot be resolved, the Minister of the Environment will make a decision as
to whether or not the Part II Order should be granted and an Individual Environmental Assessment completed. If there are no Part II Order requests during the 30-day review period, the proponent may proceed with the project.

Requests for a Part II Order must be received by the Ministry by February 25, 2013 and can be submitted by a written request to the Minister at the following address:

The Honourable Jim Bradley  
Minister of the Environment  
77 Wellesley Street West  
11th Floor, Ferguson Block  
Toronto ON  
M7A 2T5  

Email: minister.moe@ontario.ca  
Telephone: (416) 314-6790  
Fax: (416) 314-6748  

Copies of the Part II Order request should also be sent to:  
Tracy Manolakakis, Public Consultation Coordinator  
Public Consultation Unit  
Metro Hall, 55 John Street  
Toronto, Ontario  
M5V 3C6
6.0 References


City of Ottawa. Date City of Ottawa Consolidated Official Plan.


Muncaster and Brunton. 2005 City of Ottawa Urban Natural Areas Environmental Evaluation Study. Final Report. Prepared for the Environmental Management Division, Planning & Growth Management Department, City of Ottawa


