Centre Block Ventilation Towers Rehabilitation Project

Project R.008227
Solicitation Number EN463-101784/A

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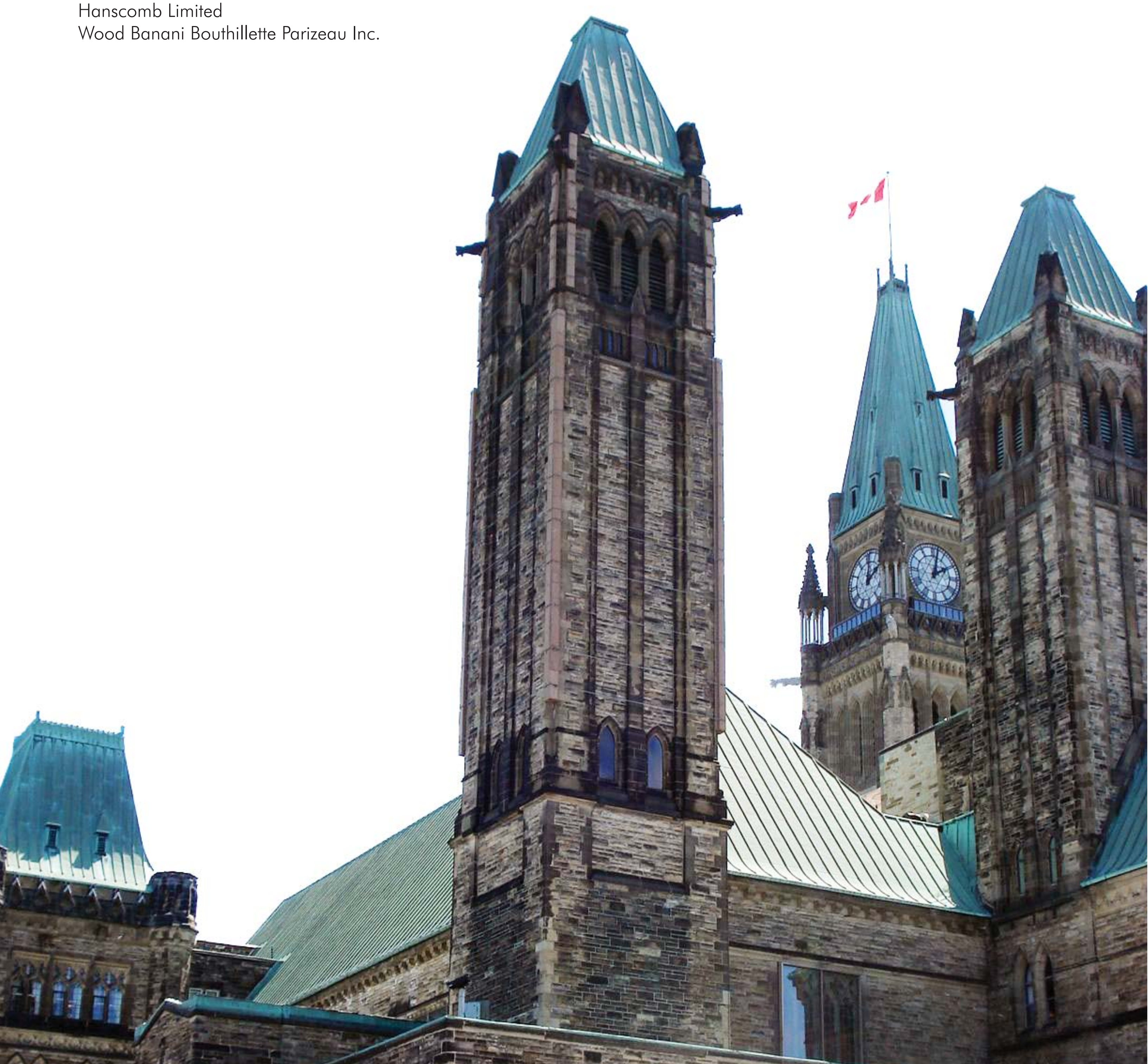

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Updated 21 June 2013

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1.0 Executive Summary

The following report is a compilation of the Pre-Design, Concept Design and Design Development Reports. The major objective of this report is to propose a well-considered and comprehensive approach to the conservation and structural and seismic reinforcement of the Centre Block Ventilation Towers on Parliament Hill.

The two Ventilation Towers, located at the north-east and north-west corners of the building, are an important element of the rebuilt Centre Block, and a key feature in tying this later building into the Gothic Revival character of the larger Parliament Hill ensemble. The exterior form, materials and detailing are the core Character Defining Elements of the Towers. While there have been localized repairs, these character-defining elements have remained relatively intact over the life of the building, as the repairs have been designed to preserve their essential character.

The interior of the Towers were designed as a service plenum intended to exhaust air from the building. The interior is lined with brick, whereas the exterior is sheathed with Nepean Sandstone and Ohio or Berea Sandstone at the corners. The Tower interiors contain a variety of access ladders, utility runs, and other intrusions -- some original and others added over the years. Neither the design nor the materials of these interiors are considered character-defining elements of the building.

The Towers are in poor condition. Many stones are cracked, in particular the Berea quoin stones. There is also severe diagonal and structural cracking of the Tower walls, which is evident both inside and outside. Extensive efflorescence is observed in the Tower interiors, as well as the exterior, which is causing both brick and stone to deteriorate.

An important conservation treatment is required to repair the masonry and provide both structural and seismic reinforcement so as to permit the continued, safe and long-term functional role of the Towers as ventilation shafts. In so doing, care must be taken to avoid any negative impact on the exterior form, materials or detailing.

Design Report Phases

The Pre-Design Report (RS2) established preliminary findings concerning the proposed conservation approach; regulatory requirements; a methodology for analysing the structure; existing conditions; and a budget for the conservation of the Ventilation Towers. The conservation approach was based on the gathering, review, and interpretation of existing documentation on the building, including archival material, and on the examination of the physical condition of the Towers.

The Concept Design Report (RS3) built upon the findings of the Pre-Design Report, and was developed with more data, including materials testing results, and additional consultations with PWGSC and others. The principal finding of the Concept Design phase was that vertical reinforcing of the Towers is required to resist lateral loads caused by seismic activity. The other major findings were that the box-like structural character of the Towers could be restored through the installation of horizontal grouted anchors. In addition, the masonry requires deep repointing and some replacements. Additional findings established that, while deteriorated, the windows and louvres could be treated through repairs (rather than replacement), whereas the roofs require full replacement. Also, the configuration of service platforms / ladders inside the Towers do not meet current workplace safety requirements and require alterations. Elsewhere, modifications will be required to the Senate Tower Water Closets, as a consequence of the seismic reinforcements. This requires removal of finishes and equipment, including Mechanical and Electrical equipment, which will require modifications and relocation. Finally, as scaffolding is required to implement the work, five (5) different configurations were analysed and considered.

The RS3 Report concluded with an analysis of Three Integrated Design Options, all of which incorporated treatment proposals for each of the constituent elements of the Towers. Scaffolding options for implementing the work were also presented. Each Integrated Design Option presents a comprehensive and fully coordinated possible solution to the conservation of the Ventilation Towers. Only one design approach presented itself as the most reasonable and viable option. This recommended option was carried forward to the RS4 stage. Refer to Section 3.11.

The present Design Development Report (RS4) consolidates the project scope and activities into a comprehensive statement that describes the recommended design approach to conservation of the Centre Block Ventilation Towers. The recommended approach reflects a critical analysis of existing conditions, extensive field and laboratory testing, and a thorough review and consultative process.

The Design Development Report represents current thinking, while the Pre-Design and Concept Design Reports provide background and context. This compilation represents the totality of design activity and research as it stands at the end of the RS4 phase.

Conservation Treatment

Despite the official name of the project, the conservation philosophy and primary treatment approach is identified as *Preservation*. As described in the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd ed.*, a *Preservation* approach seeks to stabilize the material integrity of an historic place, and is the most appropriate approach when heritage values relate primarily to the physical materials that make up a place (pp. 15-16). Therefore, Standards 1 through 9 have been applied to all aspects and thinking about the conservation of the Ventilation Towers.

All conservation activity seeks to manage change. The major distinction between the types of conservation treatment (*Preservation, Rehabilitation, Restoration*) relates to the extent of alteration or distinct change being proposed. The *Standards and Guidelines* (S&G) allow for a broad spectrum of conservation treatments under the banner of *Preservation*. These may include short term and interim actions, such as small repairs and maintenance; as well as long-term actions, such as extensive repointing and structural upgrades, that seek to stave off deterioration and prevent damage (p. 15). In all cases, the proposed treatments should allow for a continuing or new use, without extensively altering or adding to the historic place in such as way that its heritage value and character-defining elements would be adversely affected (p. 16).

The Heritage Character Statement (HCS) for the Centre Block building identifies the "*whole of its* *exterior, centred on the Peace Tower*" as a character-defining element of the building. While not specifically identified in the HCS, the Ventilation Towers are nonetheless an important element of the Centre Block building, and key features that tie this later building into the larger Parliament Hill ensemble. The symmetrical location of the Towers, combined with their exterior form, materials and detailing, are characteristics that reinforce Beaux Arts symmetry and Gothic Revival style — both features identified as character-defining elements of the Centre Block as a whole.

The interior of the Towers function as ventilation shafts. They are lined with inexpensive brick, and contain service platforms, ladders and utility runs. Neither the design nor the materials of the Tower interiors are considered significant character-defining elements of the building.

While the Towers are largely intact, they do exhibit extensive structural cracking, which is temporarily stabilized by exterior shoring. Permanent repairs to this condition require a long term intervention into the building. The proposed conservation approach at the Ventilation Towers aims simultaneously at stabilizing the structures while preserving their chief character-defining element — the exterior form, materials and detailing. The proposed preservation treatments — repairing and repointing masonry, reinforcing the structure, improving seismic performance, restoring the windows and louvres, and replacing the roof — seek to protect, maintain and stabilize the Towers against decay (p. 17). The focus is placed on limiting impact in areas related to the character-defining elements, retaining heritage fabric wherever possible, and accepting the patina of decay where there is still structural integrity.

This cautious and conservative approach emphasizes the long-term stability of the heritage fabric of the Towers, and the building as a whole. The interventions are planned to be minimally visible once complete. By retaining as much original material as possible, while minimizing intervention into the historic character-defining fabric, the proposed conservation treatment ensures the continued, safe and long-term use of the Towers as ventilation shafts, without compromising their heritage value. The conservation rationale was first developed in the RS2 phase, and further elaborated upon in RS3. The final conservation approach and treatment plan are presented in Section 4.3.

*

In their current condition the Towers have little capacity to resist lateral loads, and represent a significant health and safety risk. Given their extreme height and slenderness, they represent a much higher risk than the rest of the building in its un-conserved state. Within the overall conservation project, the recommended seismic and structural upgrades presented in this report are informed by the dynamic analysis of the structure. In sum, the finite element analysis of the Towers indicates that vertical reinforcing is required to resist lateral loads caused by seismic activity. The most appropriate method for implementing seismic reinforcing is the application of surface-mounted structural steel to the interior face of the Ventilation Towers. This will introduce ductility to the Towers and allow them to safely resist lateral loads to 60% of what current codes require, as per PWGSC policy.

The box-like structural character of the Towers can be restored by the installation of grouted anchors laid horizontally in the plane of the wall. Refer to Section 3.7 for a discussion of the structural options, and Section 4.5 for the final Structural and Seismic Analysis. The Dynamic Analysis report is included in Appendix E.

Field investigations revealed that the masonry exhibits severe efflorescence, which is contributing to stone and brick deterioration. Laboratory testing also demonstrated and confirmed that the mortars are heavily contaminated with salts, and that the surrounding masonry appears to be acting in a sacrificial manner, absorbing this material. Refer to Section 2.5 for presentation of the masonry conditions, and Appendix M for testing results. The most effective approach for removing salt contamination is through replacement of the Berea quoin stones at locations where salt contamination is observed. Cleaning alone will prove ineffective at repairing and ensuring long term durability of these stones; and therefore removal and replacement is preferred to ensure long-term integrity of the exterior masonry repairs. This approach also applies to the interior brick, where up to 75% of the brick will be replaced. Deep repointing of remaining masonry is also recommended as an effort to remove as much salt contamination as possible. Masonry testing results are discussed in Section 3.5. Analysis of mortar testing is presented in Section 4.3.5. The mortar testing results are included in Appendix M. Masonry treatment options were first developed in the RS3 phase. These recommendations remain unchanged and are presented in Section 3.8.2.1.

As part of the masonry repairs, it is recommended that the masonry be cleaned to a level that removes enough soiling to prevent detrimental changes in the masonry's hygrothermal characteristics, but stops short of removing all traces of patina. The Centre Block South Façade project will be used as a point of reference for the cleaning procedures, which will be guided by a visual evaluation, rather than the actual quantification of the amount of surface soiling to be removed. On the Centre Block in particular, comparison with existing conserved masonry is important, as the Ventilation Tower project should contribute to, rather than diminish, the overall aesthetic harmony of the building. It is assumed that microabrasive cleaning will be used, and therefore control of the level of cleaning will be achieved by adjusting dwell time. Establishing an acceptance standard will be done through a series of mock-ups.

The windows and architectural metals are in relatively good condition and it will be possible to restore these and give them an extended service life. The roof is recommended for replacement as it is exhibiting signs of deterioration. In addition, because the cost of scaffolding is extremely high — a cost which must be incurred in any case to undertake the masonry work — the time is appropriate to also replace the roofs. Refer to RS2 report for a conditions analysis of these building elements, Section 3.8.2 for treatment options, and Section 4.3.5 for the draft treatment report.

The recommended Integrated Design Option, carried forward from the Concept Design phase and presented in more detail in the present report, incorporates the following characteristics:

Structural:	Horizontal grouted anchors, laid in-plane, for structural reinforcement
Seismic:	Surface mounted vertical structural steel reinforcement
Masonry:	Replacement of Berea quoin stones and interior brick, as required, to remove salt contaminants; deep repointing of stone; repair and replacement of other masonry, as required; cleaning to remove soiling, as required but not all traces of aging.
Windows:	Conserve and restore existing
Louvres:	Conserve and restore existing
Roof:	Replace in-kind

In addition to the above-described treatments, the scope of work also includes redesign of service facilities inside the Towers, namely the service platforms and access ladders, so that these elements will be brought into line with current health and safety codes. Generally speaking, the redesign of the platforms allows the arrangement of permanent Electrical and Mechanical services to be reconfigured within the Towers so as to facilitate access for repairs and maintenance.

Finally, the water closets located in the Senate Tower will also be redesigned as universally accessible facilities. The opportunity to renovate these facilities is brought about by the primary need to install vertical seismic reinforcements on the interior walls of the Tower. The size and location of these elements require that the floor/ceilings and walls of both water closets be dismantled so to permit passage and installation of the vertical steel channels. Where feasible, interior finishes will be carefully removed and reinstated as part of the redesigned water closets.

Project Implementation

The scaffolding to implement the work is a major design challenge, and will have an impact on the construction schedule, the size and function of the worksites, as well as views from the occupied spaces of the Centre Block building. Five (5) options were put forward for consideration at the Concept Design stage (refer to Section 3.7.9). While most expensive, Option 4 was proposed as the preferred approach because its' fully-cantilevered frame meant that no loads would be imposed on the existing building and therefore the structure could be fully enclosed so as to permit year-round work to take place, without seasonal interruptions. However, it was determined that year-round work was not a critical factor, and that the cost savings of an open scaffold outweighed an accelerated work schedule. Therefore, Option 5 has been selected. This option features a Tower-supported scaffold wherein steel transfer beams are inserted through the Tower windows and louvre openings, and standard nose-and-clamp scaffolding is suspended from the beams. This scaffold configuration cannot be enclosed with a wind and waterproof enclosure, as wind loads imposed on the existing structure would be excessive; hence the construction period will be limited to approximately 6 months a year. The open scaffold method was used during the original construction of the Towers.

Cost Estimate

The substantive Class B construction cost estimate is $8,521,300, which includes escalation and contingency allowances, but not taxes. This cost is lower than the previous Class C Estimate, and accounts for a change in the scaffolding option from a fully-cantilevered and enclosed scaffold, to a tower-supported open scaffold system. The full cost report is included in Appendix C.

Report Preparation

This report was prepared by a team consisting of Watson MacEwen Teramura Architects in joint venture with KIB Consultants Inc. with additional support from Julian Smith, conservation architect; Trevor Gillingwater, masonry conservator; Craig Sims, window conservator; Ed Bowkett, metals conservator; Cleland Jardine Engineering, scaffolding engineer; Wood Banani Bouthillette Parizeau Inc, consulting engineers; and Hanscomb Limited, cost consultant.

This compilation of reports is assembled as a single document, whose sequencing moves from the general to the specific. The document begins with a Project Overview, which describes the findings to date. This summary is revised with each submission, and is intended to serve as a ‘road map’ for the document as a whole. Preliminary reports are included as background and context. Repetition is avoided by providing brief summaries of previous analyses, where appropriate, and referring readers to specific sections in previous reports, where more detailed information can be obtained.

The mandate of the report is to prepare the necessary information to allow the construction process to proceed on the basis of accurate information and an approved design approach. This compilation represents the RS4 phase of the project, which encompasses the totality of design activity and research to date. Completion of this report enables the subsequent phase of the project to begin; in particular, it enables PWGSC to consult FHBRO regarding a Review of Intervention; and it allows the design team to proceed towards preparing Construction Documents.

The findings of the study indicate that the project scope is accurately reflected in the Terms of Reference; that is, the project will consist of the seismic reinforcing of the masonry, restoration of the windows, and replacement of the copper roof. In other words, no new issues have been discovered to date.

1.1 Overall Summary

The following Design Development Report (RS4) consolidates the project scope and activities into a comprehensive statement that describes the recommended design approach to conservation of the Centre Block Ventilation Towers on Parliament Hill. The major objective is to present a well-considered, comprehensive and fully coordinated solution to the conservation and seismic reinforcement of the Ventilation Towers. This report represents the RS4 phase of the project, and completion of this report enables the subsequent phase of the project to proceed.

Treatment plans are presented for each of the constituent elements of the Towers; i.e. for vertical seismic reinforcing, horizontal structural reinforcing, masonry repair, windows, and metals. The construction worksite design is described, including construction of the scaffolding and the approach to ensuring life safety during the construction phase. Updated cost information is also presented.

The primary conservation approach is identified as *Preservation* with some elements of *Rehabilitation*. As defined in the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd ed.*, a *Preservation* approach seeks to stabilize the material integrity of an historic place, and is the most appropriate approach when heritage values relate primarily to the physical materials that make up a place (15-16). Standards 1 through 9 are applied to all aspects of the project, with Standards 1, 3, 4, 7 and 8 being the most applicable. Some elements of the work also warrant consideration under the *Rehabilitation* standards, namely Standard 11, such as the replacement glass in the Tower windows and the reconditioning of the Water Closets in the Senate Tower.

The findings of the dynamic analysis of the Towers confirmed that seismic and structural upgrades are required to ensure the continued, safe and long-term use of the Towers as ventilation shafts. In addition, the masonry (both interior and exterior) requires significant repair. Hence, the conservation of the Ventilation Towers is aimed at stabilizing the structures, while also taking great care to protect and enhance the chief character-defining elements of the Towers — the exterior form and detailing of the masonry. The aim of this project is that the work be cautiously and conservatively undertaken; with an emphasis placed on retaining as much original material as possible, while minimizing intervention into the historic fabric of the Towers. The final conservation rationale and draft treatment plan are presented in Section 4.3.

The findings of this study indicate that the project scope is accurately reflected in the Terms of Reference; that is, the project will consist of the seismic reinforcing of the masonry, restoration of the windows, and replacement of the copper roof. In other words, no new issues have been discovered to date.

This report was prepared by a team consisting of Watson MacEwen Teramura Architects in joint venture with KIB Consultants Inc. with additional support from Julian Smith, conservation architect; Trevor Gillingwater, masonry conservator; Craig Sims, window conservator; Ed Bowkett, metals conservator; Wood Banani Bouthillette Parizeau Inc, consulting engineers; and Hanscomb Limited, cost consultant.

1.1.1 Objectives

The overall project objectives include improving the Ventilation Towers' seismic performance; reinstating their box-like structural behaviour; the repair of structural cracking in the masonry enabling the removal of temporary shoring; the preservation of the building envelope; and the installation of improved safety and access infrastructure within the Towers. More generally, this project is an opportunity to gather more information on the construction of one component of the Centre Block building, which may help inform the planning of the proposed rehabilitation of the entire building. The project requirements as described in the Terms of Reference are: enhance health and safety by mitigating risks associated with the deterioration of the Towers; protect the heritage character of the building; utilize materials and methods commensurate with the quality of the building; identify and address the root causes of the building envelope deterioration; upgrade the seismic performance of the building in keeping with PWGSC policy for existing buildings; maintain continuity of operations within the building; and to ensure the goals of the Long Term Vision and Plan are met.

The specific objectives the Pre-Design Report were to gather, review, and interpret the existing documentation on the building; search through archival material for textual or visual records of the construction; establish a conservation approach; examine the physical condition of the building, including test openings; document applicable regulations; establish a methodology for analysing the structure; and establish a budget for the project.

The principal objective of the Concept Design Report was to prepare a comprehensive analysis of treatment options for each of the constituent elements of the Towers, and to employ these as the basis for a presenting a preferred Integrated Design Option for the conservation of the Ventilation Towers. The report intended to present a well-considered analysis of viable options, and recommendation of a preferred option.

The present Design Development Report seeks to develop the recommended design option in sufficient detail, upon which basis the project may proceed towards subsequent phases.

A parallel objective of the project is to utilize a consultative process whereby the body of knowledge developed within Canada's respective departments is fully utilized, so that the work of this project critically reviews, adds to, and builds upon existing knowledge.

1.1.2 Conservation Approach

The Ventilation Towers are important character-defining elements of the Centre Block building. Their exterior form, materials and detailing remain intact. While local repairs have been undertaken, the Towers retain a high level of material integrity.

Despite the official name of the project, the conservation philosophy and primary treatment approach is identified as *Preservation*. As described in the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd ed.*, a *Preservation* approach seeks to stabilize the material integrity of an historic place, and is the most appropriate approach when heritage values relate primarily to the physical materials that make up a place (pp. 15-16). No significant change in use is planned, and the Towers are virtually 100% original in material and form. A conservation approach is proposed that retains as much original material as possible, and minimizes intervention into the historic character-defining fabric of the Towers, and the building as a whole. Standards 1 through 9 have been applied to all aspects and thinking about the conservation of the Ventilation Towers.

While all conservation activity seeks to manage change, the major distinction between the types of conservation treatment (*Preservation, Rehabilitation, Restoration*) relates to the extent of alteration or distinct change being proposed. A *Preservation* treatment, as defined in the *Standards and Guidelines* (S&G), allows for a variety of conservation actions, including short term and interim actions such as small repairs and maintenance, as well as long-term actions such as extensive repointing and structural upgrades that seek to stave off deterioration and prevent damage (p. 15). In all cases, the proposed treatments should allow for the continuing or new use of an historic place, without extensively altering or adding to the historic place in such as way that its heritage value and character-defining elements would be adversely affected (p. 16).

The Heritage Character Statement (HCS) for the Centre Block building identifies the "*whole of its exterior, centred on the Peace Tower*" as a character-defining element of the building. While not specifically identified in the HCS, the Ventilation Towers are nonetheless an important element of the Centre Block building, and key features that tie this later building into the larger Parliament Hill ensemble. The symmetrical location of the Towers, combined with their exterior form, materials and detailing are characteristics that reinforce Beaux Arts symmetry and Gothic Revival style — both features identified as character-defining elements of the Centre Block as a whole.

The interior of the Towers function as ventilation shafts. They are lined with inexpensive brick, and contain service platforms, ladders and utility runs. Neither the design nor the materials of the Tower interiors are considered significant character-defining elements of the building.

While the Towers are largely intact, they do exhibit extensive structural cracking, which is temporarily stabilized by exterior shoring. Permanent repairs to this condition require a long term intervention stave off deterioration and prevent damage or collapse. The proposed conservation approach aims simultaneously at stabilizing the structures while preserving their chief character-defining element — the exterior form, materials and detailing. The proposed preservation treatments — repairing and repointing masonry, reinforcing the structure, improving seismic performance, restoring the windows and louvres, and replacing the roof — seek to protect, maintain and stabilize the Towers against decay (p. 17). The focus is placed on limiting impact in areas related to the character-defining elements, retaining heritage fabric wherever possible, and accepting the patina of decay where there is still structural integrity.

This cautious and conservative approach emphasizes the long-term stability of the heritage fabric of the Towers, and the building as a whole. By retaining as much original material as possible and minimizing intervention into the historic character-defining fabric, the proposed conservation treatment ensures the continued, safe and long-term use of the Towers as ventilation shafts, without compromising their heritage value. The conservation rationale was first developed in the RS2 phase. The final conservation rationale and treatment plan are presented in Section 4.3.

1.1.3 Assessment and Analysis

A visual and tactile survey was conducted on the building during the week of the Thanksgiving Parliamentary Recess in 2010. At that time the metals, window, and masonry conservators surveyed the building from a crane basket, as did the structural engineer and architect. Inspections of the interiors of the Towers were conducted at the same time.

While the Towers have a high level of material integrity, as indicated above, the stone exhibits weathering and decay at various locations, as well as some efflorescence. The mortar joints have been maintained more rigorously in recent years, therefore few if any open joints were found. The repointing, however also masks the structural cracking, and it is difficult to say if new cracks have developed during the period since the shoring has been in place.

The brick interiors of the Towers suffer from massive efflorescence, due to moisture infiltration from rain. The strong drying effect of having large volumes of dry, fan-driven exhaust air moving over the surface at all times creates an excellent environment for efflorescence to develop.

Subsequent laboratory testing demonstrates that the mortars are heavily contaminated with salts, and that the surrounding masonry appears to be acting in a sacrificial manner, absorbing this material. This is particularly true at the Berea quoin stones. The most effective approach for removing salt contamination is through replacement of the contaminated Berea quoin stones and up to 75% of the interior brick. Deep repointing of remaining masonry is also recommended as an effort to remove as much salt contamination as possible.

Replacement (rather than cleaning and repair) is the preferred approach at locations that are heavily contaminated by salts. The Berea quoin stones have been particularly susceptible to salt contamination, and are weakened by it, making these stones largely beyond repair. Cleaning procedures may remove salts to as deep as 50 mm, but they cannot be fully removed from the masonry by cleaning alone. While there will be a continuing presence of salts within the core of the walls, this is a tolerable risk in these locations. However, it would be inappropriate to retain the heavily damaged masonry units that have been contaminated by salts, when these should be replaced with units that will ensure long-term durability of the overall repair project.

Likewise, visual inspection and laboratory testing has confirmed that the interior bricks have been seriously affected by soluble salt crystallization. A replacement amount of 75% does not suggest complete dismantling of interior brick; rather, the affected areas are geometrically located such that replacement work can avoid sound areas while addressing affected areas. The brick interior is not considered a character defining element, so the need to replace is purely a technical concern, and not a cultural one. It is therefore both cautious and responsible stewardship to remove and replace affected masonry so as to prevent further weakening of the structure, and simultaneously reduce, if not eliminate, further spread of salt contamination from these points in the walls.

Seismic modelling of the Towers indicates that *in their current condition the Towers have little capacity to resist lateral loads, and represent a significant health and safety risk. Given their extreme height and slenderness, they represent a much higher risk than the rest of the building in its un-conserved state.* Vertical reinforcing is therefore required and recommended to resist lateral loads caused by seismic activity. The most appropriate method for implementing seismic reinforcing is the application of surface mounted structural steel to the interior face of the Ventilation Towers. Their box-like structural character can also be restored by installing grouted anchors laid horizontally in the plane of the wall.

The windows and louvres are found to be intact and in sound condition, and therefore easily candidates for restoration rather than replacement. The rolled steel sections exhibit some corrosion, however not so great as to cause perforation of the metals. The glass is cracked in places, likely due to oxide jacking. The copper louvres are original and are in good condition, with the exception of the flashing at the sill. The roof is recommended for replacement as it is exhibiting signs of deterioration.

Monitoring set in place by the Heritage Conservation Directorate indicates that the indoor air in the Towers is typically very dry, which is consistent with the fact that the air in both Towers is the exhaust air from the parliamentary Chambers, which are not humidified. Monitoring also indicates that the interior faces of the walls are typically dry, with periodic episodes of wetting which tends to follow rain events.

The Towers, situated on the north side of the Centre Block, are directly exposed to the prevailing winds and accompanying wind-driven rain. Observed conditions on the site during surveys of the upper portions of the Tower included wind velocities significantly higher than that experienced at grade. This, combined with the large surface areas of the Towers, suggests that these structures are subject to severe exposure to the weather.

In general, the condition of the Towers, their maintenance history, exposure, general configuration and monitoring data suggests that the walls have been subject to repeated and continuous wetting. However, their function as ventilation shafts provides excellent drying from within. While this has resulted in the movement of a great deal of salts to the interior of the building, it may also have protected the masonry from frost jacking, which would have resulted in potentially much more severe structural damage.

The substantive Class B construction cost estimate is $8,521,300, which includes escalation and contingency allowances, but not taxes. This cost is lower than the previously submitted Class C Estimate, and accounts for a change in the scaffolding option from a fully-cantilevered and enclosed scaffold, to a tower-supported open scaffold system. The full cost report is included in Appendix C.

1.1.4 Risk Analysis

Risks to the historic property will arise if the proposed interventions and repairs continue to be deferred. This risk, however, is mitigated by the fact that the project is proceeding. Similarly, risks to the public that result from exposure to deteriorated building assemblies are addressed by implementing the project.

The implementation of the project, of course, introduces other risks, all of which have come to fruition on other projects in the Precinct. Poor performance by contractors, delays in materials procurements, unanticipated conditions, and unseasonable weather can all contribute to cost escalations, delays, and claims. Rigorous and well coordinated construction documents can minimize certain of these risks, but others cannot realistically be avoided; for these, planning for financial and scheduling contingencies will minimize the consequences of these events.

Site security is a critical risk requiring careful management. Unauthorized access to scaffolding can lead to serious threats to the occupants of the Centre Block, or, at the least, embarrassment caused by hostile political actions as seen on the West Block recently. Secure hoarding, video surveillance, and regular monitoring require coordination with parliamentary security personnel. In addition, door locks should be changed on all doors that provide access to the worksites so as to limit access to the inside of the building. In the case of the fifth floor kitchen access (HoC Tower), an alarm activated door should be installed, since this door has been identified as a secondary fire escape route from the worksite.

Work stoppages due to parliamentarians complaining about noise, dust, or vibration can have a potentially crippling effect on the project. Scheduling noise-generating work for after-hour periods will mitigate this. A detailed and effective communications policy can assist in determining the hours of work; however the risk of work stoppage cannot be completely eliminated. A significant cost and time contingency will be required.

The continuing presence of salt in the walls, even following repairs, also represents a risk to the durability of the repairs. While it will not be possible to remove all of the salts within the Tower walls (without dismantling and rebuilding them), the risk of salts residing within the core of the wall is that, on occasion, water will penetrate through the new mortar into the old salt contaminated mortar. However, it is not practical to rake deeper than (50 mm), since the reach into repairing the masonry is limited without risking damage to the structure.

A draft Risk Management Plan is included in Appendix L. The Plan will continue to be discussed and updated at Project Meetings.

1.1.5 Shortfalls with respect to the desired target reliability levels

In the preliminary seismic analysis as per the NBC-10, an importance factor of 1.0 indicating a normal use was assumed. This assumption for the importance factor was previously used on similar structures on the Parliament Hill. Increasing the importance factor to High (1.3) or to post-disaster (1.5) could result in significant interventions to account for the increase in the predicted base shear values.

PWGSC has adopted a set of guidelines for the evaluation of existing buildings based on the National Research Council guidelines. These guidelines adopt a reduction factor of 0.6 applied to the NBC seismic loading criteria as a minimum for triggering seismic upgrading for any deficiency. If the Towers seismic capacity exceeds 60% of the NBC seismic loads, the Towers do not need to be seismically retrofitted. The reduction factor was calculated as a function of the consequences of the potential failure that are assessed on the base of redundancy and likelihood and number of people at risk. Assuming a medium redundancy and normal life-risk category, the NRC guidelines arrived at the 0.6 reduction factor.

The design of the vertical seismic retrofit reinforcement shall be evaluated at 100% of the NBCC 2010 seismic load along with minimum life-safety requirements at 60% of the NBCC-2010 seismic load. An importance factor of 1.0 indicating a normal use is assumed.

1.1.6 Required Immediate Actions and Recommendations

For timely development of the Construction Documents and accurate instruction in the Specifications, agreement on the masonry treatment is required. Input is also required from PWGSC-Construction Safety Branch on the rescue procedures from the Towers during the construction phase, and from PWGSC-PPB on the relocation of the lighting relays located in the Senate Tower.

Instructions for relocation of the Senate waste management services are also required, so that design of the construction sites can proceed.

Feedback is also requested on the Risk Management Plan.

1.2 Administrative Summary

1.2.1 Quality management process(es) for the Consultant Team

Scope Management

The structure of all documentation and deliverables are closely coordinated with the Terms of Reference (TOR). The major headings in this document, for example, are derived from the TOR. By following this format, it is a simple process to monitor the project activity relative to the intended scope of work. Should the project as it evolves require an activity that is not identified in the TOR, it will be quantified and a proposal submitted to the Project Manager prior to proceeding. This proposal will identify the impacts of undertaking, or failing to undertake, this new activity on the cost, schedule, and success of the project. At this point PWGSC can determine whether or not to proceed with the change. This methodology also provides PWGSC with a simple means of auditing the deliverables relative to the TOR.

Approvals

This project is subject to multiple, incremental approvals. These approvals may require considerable time and resources for the reviewing bodies, therefore this activity must be planned well in advance and scheduled. Therefore these review activities are included in the project schedule.

Schedule

A work breakdown structure and critical path method (CPM) schedule has been prepared in MS Project. The tasks in the schedule are coordinated with the major headings of the report as well as the required services in the TOR. The CPM schedule provides for the ability to monitor progress and report on delays on tasks that are on the critical path and therefore affecting the overall project schedule. By updating the application's reporting tools on a weekly basis it is possible to identify slippages before they become significant. Should these slippages be due to unavoidable causes such as weather or access restrictions, these will be noted and a change to the overall project schedule incorporated. Similarly, if a change in the project scope requires additional time, this will be included and the milestone dates adjusted. There should be no changes to the dates without concrete substantiation of the causes.

The schedule will be reviewed at bi-weekly project meetings and a new schedule issued at each meeting.

Cost

Due to the nature of conservation work construction costs will be driven mainly by the scope of damage to the existing structure. Concealed conditions may reveal additional damage once construction begins. To minimize the risk of cost increases during construction conservative estimates are being developed for the scope of required work. It is also recommended that various procurement strategies be considered to manage extras, such as unit pricing.

Addressing cost overruns in the design phase will not be as simple to address in preservation work as it can be in new construction, where savings can be achieved by simplifying the design, or reducing the quality of finishes, fittings and equipment. While there may be alternative means to implementing the required structural repairs, it will not be possible to implement them in a partial way. Similarly, it would not be good conservation practice to eliminate parts of the work that can only be done while the structure is fully scaffolded, such as the upper window restoration; this would imply leaving them to continue to corrode and possibly damage the newly repaired masonry. For these reasons careful management of the project scope will be the main tool for managing costs during the design development stage of the project.

Cost reports are being prepared at each major milestone. Options are provided for each of the treatments, to ensure that the project costs represent the result of a thorough consideration of all available options.

An important resource for the development of the cost estimates is the information provided by the South Façade restoration project.

Risk

The implementation of the project introduces risks, which rigorous and well coordinated construction documents can minimize but cannot fully and realistically avoid. For these, planning for financial and scheduling contingencies will minimize the consequences of these events.

The Risk Management Plan, which identifies major risk elements and proposed mitigating strategies, continues to be developed. A draft version is included in Appendix L. This document can continue to be discussed and updated at Project Meetings.

Health and Safety

Work on the Ventilation Towers presents a number of health and safety risks. It requires the use of elevated work platforms and crane baskets, but also, on the interior, entry to service spaces with limited access or means of escape.

All personnel on the consultant team have the training required by provincial labour legislation. In addition, Site Specific Safety Plans have been prepared for each of the activities. The training certification will be reviewed on an annual basis, and documentation will be provided to PWGSC for their records.

In terms of the construction phase, ongoing discussions with HRSDC, PWGSC and Labour Canada have determined that the scaffolding shall be considered a "permanent structure," which incorporates basic life safety systems such as fire alarms, smoke detectors, and exit signage. In addition, it has been determined that during the construction phase, egress from the tower interiors is best provided through the tower louvres, once these have been removed for treatment.

Consultations will continue through the duration of the project to evaluate health and safety issues as they arise. All work will be carried out in accordance with applicable labour regulations.

Quality

The work on the Ventilation Towers builds upon many years of ongoing analysis and study. The present project attempts to synthesize this existing body of work and produce viable options based on a highly informed position. Through ongoing consultation with professionals who have been involved in the previous studies it is expected that the knowledge base will be as comprehensive as possible.

Within the design team the major treatment proposals are discussed collectively and developed in an iterative fashion. In this way the collective experience of the entire team can be brought to bear on the project as a whole, which will in turn initiate a dialogue with PWGSC experts. Internal processes to ensure the quality of deliverables includes regular team meetings and/or conference calls, collective review of all documentation prior to issuing, and structuring all material to coordinate with the Terms of Reference to facilitate review for compliance and completeness. As the reports are the collective result of many contributors' work, all materials are edited and formatted by a single author prior to being issued, to ensure consistency in format, language, terminology and tone. This results in a more readable document.

The composition of the team itself is designed to ensure that high quality standards are maintained, and senior experts in their respective fields have been retained to advise and guide the team. Julian Smith, co-author of Canada's English-language doctrinal text for conservation, the Appleton Charter, is a leader in conservation. Similarly, Professor Donald Anderson of the University of British Columbia is an internationally recognized authority on seismic behaviour of structures, and he has provided guidance on this issue.

In the implementation phase, pre-qualification of contractors is recommended. To the extent that PWGSC contracting policy permits, bidding on the project should be limited to those contractors with a demonstrated record of quality preservation work.

Once construction is underway, the use of mock-ups will be critical in establishing benchmarks for the quality of the execution of various parts of the work. These will be used to determine a standard, and will serve as a reference point should disputes arise. In addition, the specification will call for specific operational procedures to ensure consistency in the final product; as an artisanal craft, traditional masonry is the product of individuals rather than an industrial process, so ensuring continuity in quality requires continuity in the personnel involved. Continuous site representation will be provided during the construction process, to ensure work is performed to the specified standard. Mixing of mortars will be observed on site, and temperatures monitored to ensure work is undertaken under appropriate conditions.

The sourcing of materials will be monitored and samples will be tested to ensure their compatibility with the project objectives. Where necessary, quarries will be visited to ensure they are capable of producing stone of the required quality and colour in sufficient quantities.

Design Development Report
Centre Block Ventilation Towers Rehabilitation

Project R.008227
Solicitation Number EN463-101784/A

KIB Consultants Inc. + Watson MacEwen Teramura Architects in Joint Venture

Julian Smith & Associates
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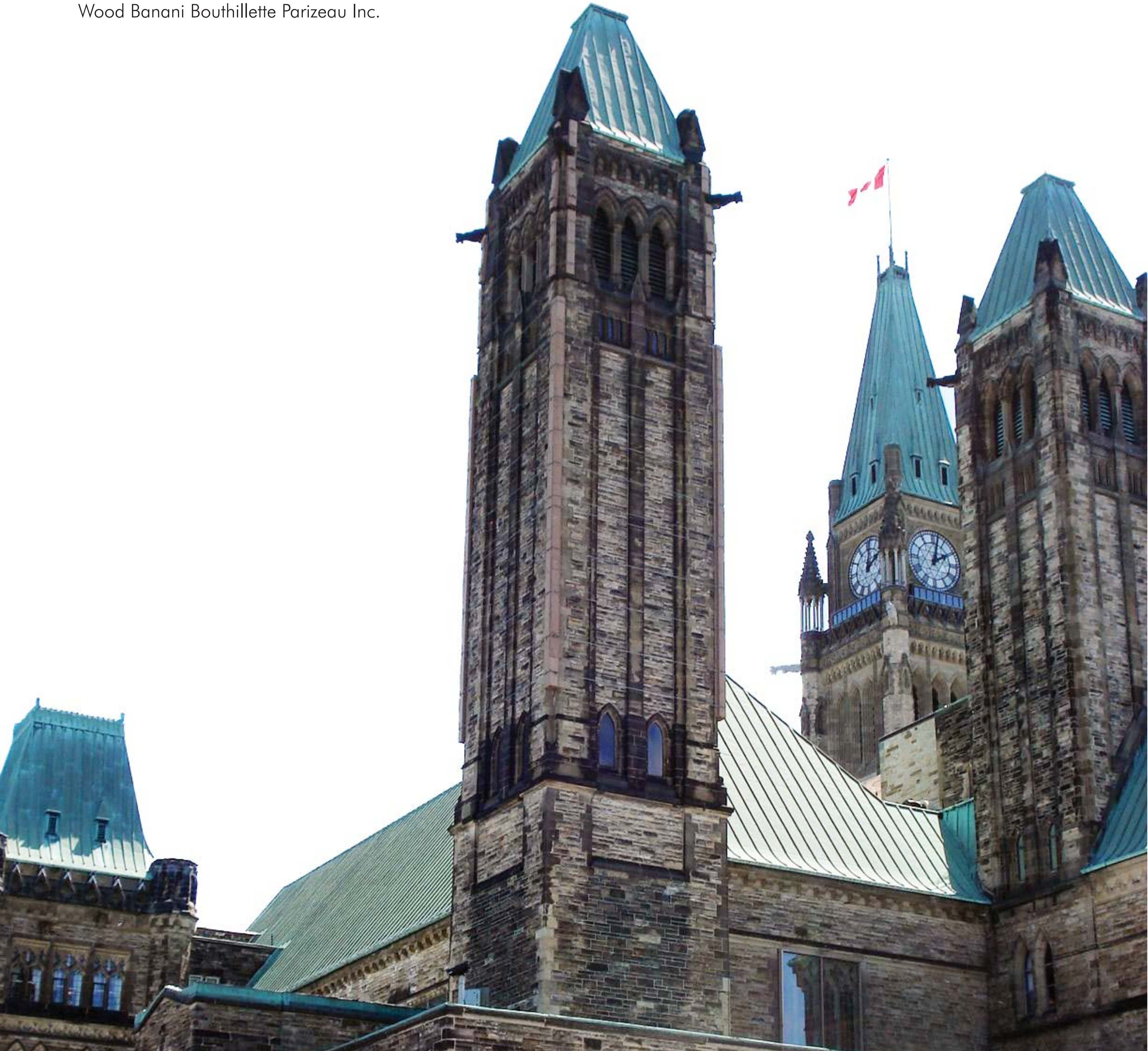

Centre Block Ventilation Towers Rehabilitation
Design Development Report (RS4)

FINAL

15 October 2012
50% Revisions 11 February 2013
90% Revisions 21 June 2013

Public Works and Government Services Canada

.../

4.0 Design Development Summary

The following Design Development Report builds on the findings and recommendations of the Pre-Design and Concept Design phases (RS2 and RS3), and consolidates the project scope and activities into a comprehensive statement that describes the recommended approach to conservation of the Centre Block Ventilation Towers on Parliament Hill. The major objective is to present a well-considered, comprehensive and fully coordinated solution to the preservation and seismic reinforcement of the Ventilation Towers. This represents the RS4 phase of the project. Completion of this report enables subsequent phases of the project to proceed.

This report was prepared by a team consisting of Watson MacEwen Teramura Architects in joint venture with KIB Consultants Inc. with additional support from Julian Smith, conservation architect; Trevor Gillingwater, masonry conservator; Craig Sims, window conservator; Ed Bowkett, metals conservator; Wood Banani Bouthillette Parizeau Inc, consulting engineers; and Hanscomb Limited, cost consultant.

The recommended approach put forward in this report is informed by a critical and expert analysis of existing conditions and is supported by the dynamic analysis of the structure. It is further supported by a thorough review and consultative process which has included ongoing discussions with PWGSC concerning the structural design parameters; consultation with Labour Canada and Construction Safety Branch of PWGSC concerning worker safety during the construction phase; and by extensive field, laboratory and materials review and testing. In this way, the approach reflects a consensus and the results of a consultative process that has drawn on the body of knowledge and expertise developed within Canada's respective departments. The work of this project critically reviews, adds to, and builds upon existing knowledge.

More generally, this project is an opportunity to gather more information on the construction of one component of the Centre Block building, which may help inform the planning of the proposed rehabilitation of the entire building.

Conservation Treatment

The primary treatment and overall conservation approach is *Preservation*. The Ventilation Towers are important character-defining features of the Centre Block building. Their form, materials and detailing remain intact, and, while local repairs have been undertaken, they retain a high level of material integrity. No significant change in use is planned, and the Towers are virtually 100% original; hence the goal of the project is to adopt a cautious and conservative approach, with an emphasis placed on retaining as much original material as possible, while minimizing intervention.

While the Towers are largely complete and intact, they do exhibit extensive structural cracking, which is temporarily stabilized by exterior shoring. The masonry — both interior brick and exterior stone — is damaged by severe efflorescence. Permanent repairs to these conditions require a significant intervention into the building. Where the Concept Design Report (RS3) presented an analysis of these and other conditions and put forward recommendations for treatment of each of the constituent elements of the Towers, the present report carries only one recommended Integrated Design Option forward for further development.

In sum, the recommended Integrated Design Option incorporates the following characteristics:

Structural:	Horizontal grouted anchors, installed in-plane, for structural reinforcement.
Seismic:	Surface mounted vertical structural steel reinforcement.
Masonry:	Replacement of Berea quoin stones and interior brick, as required, to remove salt contaminants; deep repointing of remaining stone using appropriate mortars; repair and replacement of other masonry, as required; and cleaning to remove soiling, as required, but not all traces of aging.
Windows:	Conserve and restore existing.
Louvres:	Conserve and restore existing.
Roof:	Replace in-kind.

Conservation treatment plans are summarized below for each of these constituent elements. These represent the most suitable options to achieve the overall conservation objectives, while also respecting the visual and material quality of these historic structures.

Structural / Seismic

The overall conservation project is reconfirmed by the findings of the seismic analysis, as outlined in the Dynamic Analysis Report (Appendix E), which indicates that vertical reinforcement is required to resist lateral loads caused by seismic activity. The most appropriate reinforcement method is the application of surface-mounted steel channels to the interior face of the Ventilation Towers. This will introduce ductility to the towers and allow them to safely resist lateral loads to 60% of what current codes require, as per PWGSC policy.

Structural reinforcement is also required to reinstate the box-like character of the Towers. This can be achieved through the installation of grouted anchors, laid horizontally in the plane of the wall.

Masonry

In general, the condition of the Towers, their maintenance history, exposure, general configuration and monitoring data suggests that the walls have been subject to repeated and continuous wetting. However, their function as ventilation towers provides excellent drying from within. Monitoring set in place by the Heritage Conservation Directorate confirms that the indoor air in the Towers is typically very dry and that the interior faces of the walls are also typically dry, with periodic episodes of wetting, which tends to follow rain events. While this has resulted in the movement of a great deal of salts to the interior of the building, the dry interior conditions may also have protected the masonry from frost jacking, which would have resulted in potentially much more severe structural damage.

Field investigations revealed that the masonry exhibits severe efflorescence, which has contributed to stone and brick deterioration. Laboratory testing — first of the masonry, and then of the mortars — further revealed that capillary action carries salts from the mortar through the wall assembly, where they are deposited on the interior brick. At the exterior surface, the Berea quoin stones have also acted in a sacrificial manner by absorbing salt contamination. This has weakened the stones and led to their premature deterioration. The most reasonable and viable approach for removing salt contamination is through replacement of damaged Berea quoin stones and up to 75% of the interior brick. In addition, deep repointing of remaining masonry will effectively remove most of the remaining salts.

Masonry repairs will also include cleaning to a level that removes enough soiling to prevent detrimental changes in the masonry's hygrothermal characteristics, but stops short of removing all traces of patina. The Centre Block South Façade project will be used as a point of reference for the cleaning procedures, which will be guided by a visual evaluation rather than the actual quantification of the amount of surface soiling to be removed. On the Centre Block in particular, comparison with existing conserved masonry is important, as the Ventilation Tower project should contribute to, rather than diminish, the overall aesthetic harmony of the building. It is assumed that micro-abrasive cleaning will be used, and therefore control of the level of cleaning will be achieved by adjusting dwell time. Establishing an acceptance standard will be done through a series of mock-ups.

Windows and Louvres

The windows and louvres are found to be in sound condition, and are easily capable of being restored rather than replaced. The rolled steel sections of the windows exhibit some corrosion, however not so great as to cause perforation of the metals. The glass is cracked in places, likely due to oxide jacking. The copper louvres are original and are in good condition, with the exception of the flashing at the sill, and some broken solder joints.

Roofs

While the roofs may retain some serviceable life, they are recommended for replacement since they exhibit signs of deterioration and the cost of scaffolding is extremely high.

Tower Interiors

Installation of the vertical seismic reinforcements requires gaining access to all interior wall surfaces of the Towers. The reinforcements will occupy a physical space inside the Towers. It is anticipated that the location and sizing of these steel elements will conflict with the location of several services, namely existing mechanical equipment and pipes, especially inside the House of Commons Tower. These services will need to be relocated to allow for installation of the vertical reinforcement. In consequence, opportunity will be taken to permanently reconfigure these M&E services such that they will run through the centre of the Towers, or the centre of the walls of the Towers, as opposed to being affixed near the exterior corners, as is the current situation. This reconfiguration will facilitate future access to both of the M&E elements as well as the interior masonry surfaces for maintenance and repairs. Refer to Section 4.8 for a description of the reconfigured M&E services, and Section 4.7 related to redesign of the service platforms and ladders.

In addition to re-routing the M&E services, a section of the chimney flue enclosures will also need to be dismantled in order to gain access to the interior corners of the Towers. As with the M&E services, the platforms are proposed to be reconfigured to allow for these flues to be reinstated at a future time.

Finally, two Water Closets are located within the Senate Tower, one superimposed above the other. Both WCs extend the full width of the Tower, and occupy approximately half of the floor plate area on the Tower. To allow for the installation of vertical reinforcement, these facilities will need to be largely dismantled. In particular, the walls will need to be removed, and the floor / ceilings dismantled. In consequence, all wall finishes, fittings and fixtures will be removed. The wall and floor finishes in WC 264N consist of Tennessee marble, a seldom-used, high quality material. This material was detailed and installed with care and skill, in particular in the cutting of panels, thresholds, ledges, and carved cove bases. The Specifications provide instruction for the careful removal and storage of these elements for the duration of the construction project. The finishes are to be reinstated when the WC is rebuilt. As with the M&E services, opportunity will be taken to redesign both Water Closets as universally accessible facilities. Again, refer to Section 4.7 for additional details and description.

Code Analysis

Building and other Codes have been reviewed and shall be fully complied with at the construction site, in particular as related to fire and life safety. The redesign of service facilities inside the Towers is also fully code compliant, in particular the design of ladders and platforms, as well as universally accessible Water Closets.

Scaffolding

Scaffolding is required to implement the conservation work. The selected option (Option 5) features an exterior Tower-supported scaffold wherein steel transfer beams are inserted through the Tower windows and louvre openings, and standard nose-and-clamp scaffolding is suspended from the beams on the exterior face of the Towers. This exterior scaffold configuration cannot be enclosed with a full wind and weatherproof enclosure, as wind loads imposed on the existing structure would be excessive. However, an 85% open safety mesh will be installed, which will protect the public from the risk of falling debris. As the construction period will be limited to approximately 6 months a year, mechanical systems to control the working environment will not be required. It is of note that the open scaffold method was used during the original construction of the Towers. The open scaffold results in minimal requirements for Mechanical and Electrical construction services. Power and water supply are proposed to be supplied to various connection points on the scaffold.

Standard scaffolding is to be erected inside the Towers. This will require removal / relocation of interior mechanical and electrical services, and existing service platforms and ladders. Fire detection and alarm systems, as well as power and water supply, and sufficient task lighting will all be required inside the Towers. Worker access to the Tower interiors will be gained through the louvre openings at the top of the Towers.

At ground level, Option 5 scaffolding occupies a small footprint. This has many advantages including minimal visual disruption for surrounding offices at occupied levels, and a more compact worksite. While the site design is relatively straight forward, it will require some relocation of services and functions, specifically relocation of the Senate waste management facilities. On the other hand, access to building services and entrances will not be compromised; and pedestrian paths will not be obstructed. Vehicular travel will also be unaffected, including access for fire and emergency vehicles. There will be no net change in the number of available parking spaces; existing spaces can be rearranged, as required. Views from Senate and House of Commons offices will be minimally obstructed by the scaffolding, and it should be anticipated that these offices will also experience some noise disruption. This can be mitigated by scheduling work to be performed after hours.

All of the scaffolding, mechanical and electrical systems are outlined as a performance specification.

Cost Estimate

The substantive Class B construction cost estimate is $8,521,300, which includes escalation and contingency allowances, but not taxes. This cost is lower than the previous Class C estimate, which reflects a change in the scaffolding option from a fully-cantilevered and enclosed scaffold, to a tower-supported open scaffold. The revised cost report is included in Appendix C.

Risk Management

A draft Risk Management Plan is included in Appendix L. The plan identifies risks associated with project delivery; site and building conditions; external factors; and internal context. The plan identifies the overall risk and proposes mitigation strategies. The plan will continue to be discussed and updated at Project Meetings.

It is recommended that specialty contractors be pre-qualified so as to ensure high quality workmanship.

4.1 Administrative

4.1.1 Update on Quality management process(es) for the Consultant Team

There has been no change to the Scope Management, Approvals, and Schedule since the RS3 phase. Updates to other management processes are provided below. Refer to Section 1.2 for a complete description of all management processes.

Cost

Cost reports have been prepared at each major milestone. Options were provided and reviewed for each of the treatments. In consequence, the project costs offered here represent the result of a thorough consideration of the recommended integrated design option.

Risk

The implementation of the project introduces risks, which rigorous and well coordinated construction documents can minimize but cannot fully and realistically avoid. For these, planning for financial and scheduling contingencies will minimize the consequences of these events. The Risk Management Plan, which identifies major risk elements and proposed mitigating strategies, continues to be developed and will be provided for discussion and update at Project Meetings.

Health and Safety

Work on the Ventilation Towers presents a number of health and safety risks. Ongoing discussions with HRSDC, PWGSC and Labour Canada have determined that the scaffolding shall be considered a “permanent structure,” which incorporates basic life safety systems such as fire alarms, smoke detectors, and exit signage. In addition, it has been determined that during the construction phase, egress from the tower interiors is best provided through the tower louvres.

Consultations will continue through the duration of the project to evaluate health and safety issues as they arise. All work will be carried out in accordance with applicable labour regulations.

Quality

The work on the Ventilation Towers builds upon many years of ongoing analysis and study. Through ongoing consultation and internal dialogue and analysis among the design team, the knowledge base for this project may be considered as comprehensive as possible. In this way, the collective experience of the entire team has been brought to bear on the project as a whole, and the present project can be said to present a viable option that is based on a highly informed position.

In the implementation phase, pre-qualification of contractors is recommended. To the extent that PWGSC contracting policy permits, bidding on the project should be limited to those contractors with a demonstrated record of quality preservation work. A detailed procurement strategy will be developed during the Construction Documents phase.

Once construction is underway, the use of mock-ups will be critical in establishing benchmarks for the quality of the execution of various parts of the work. In addition, specifications for each building component call for specific operational procedures to ensure consistency in the final product. Continuous site representation will also be provided during the construction process, to ensure work is performed to the specified standard.

4.2 Regulatory Analysis

The impact of compliance with codes is a critical challenge in defining a design approach that minimally affects the heritage value of the historic building, while also providing the necessary upgrades to permit its safe function. Conventional as well as alternative approaches have been used in analysing the structure of the Towers and to develop the optimum options to enhance their seismic performance with minimum impact on their heritage value. In this regard, while the proposed design observes provincial and national Codes, and all work will be carried out in accordance with applicable labour regulations, the project approach must also comply with the following:

- PWGSC policy and guidelines regarding seismic interventions;
- FHBRO review of design intervention, an approvals process that falls under the *Treasury Board Policy on Management of Real Property*; and
- Parks Canada *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd ed.*

For a list of building practices and codes that were applicable at the time of construction, a list of authorities having jurisdiction, and a complete list of current codes, regulations and standards applicable to this project, see Sections 2.2.3 through 2.2.8.

PWGSC policy on seismic interventions

PWGSC has adopted a set of guidelines for the evaluation of existing buildings based on the National Research Council guidelines. These guidelines adopt a reduction factor of 0.6 applied to the NBC seismic loading criteria as a minimum for triggering seismic upgrading for any deficiency.

If the Towers' seismic capacity exceeds 60% of the NBC seismic loads, the Towers do not need to be seismically retrofitted. The design of the vertical seismic retrofit reinforcement shall correspond to 100% of the NBCC 2010 seismic load along with minimum life-safety requirements at 60% of the NBCC-2010 seismic load. As requested by PWGSC, an importance factor of 1.0 indicating a normal use is assumed.

TBS Policy on Management of Real Property

The Treasury Board Secretariat *Policy on Management of Real Property* requires that custodian departments of federal heritage buildings seek the advice of the Federal Heritage Buildings Review Office (FHBRO) prior to undertaking (design) interventions to said buildings. A FHBRO response takes the form of a Review of Intervention.

The Parliamentary complex is a Classified Federal Heritage Building. Any proposed intervention, including the conservation of the Ventilation Towers, could affect the building's heritage character, which is defined in the Heritage Character Statement (included in Appendix J). In this case, a request for a Review of Intervention shall then be submitted to the FHBRO registrar for consideration.

With completion of the present Design Development Report, PWGSC may now wish to submit a request for a Review of Intervention to the FHBRO, who will assess the impact of the proposed interventions against the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd. ed.* and, where appropriate, recommend mitigation measures. If the proposed intervention is deemed to be minor in nature, a formal Review may not be required. Alternatively, if in FHBRO's assessment, the intervention is likely to have a major impact on the heritage character of the Towers, and the Parliament Hill complex more generally, then FHBRO may choose to conduct a formal review and will advise PWGSC accordingly.

Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd. ed.

The project approach has been guided by Parks Canada's *Standards and Guidelines for the Conservation of Historic Places in Canada*, *2nd. ed.*, specifically the Standards pertaining to preservation; the Guidelines for Buildings, including guidelines related to roofs, windows, exterior walls and architectural metals; and the Guidelines for Materials, specifically masonry. The conservation approach is presented in more detail in Section 4.3.

4.2.1 Detailed building code analysis (code statement)

Refer to the drawings in Appendix B, where a Code Matrix is provided.

Occupancy
As discussed in the Pre-Design Report (Section 2.2), the Ventilation Towers may be considered vertical service spaces, which the *National Building Code* (Article 1.4.1.2, Division A) defines as: "*a shaft that is oriented essentially vertically and that is provided in a building to facilitate the installation of building services, including mechanical, electrical and plumbing installations and facilities such as elevators, refuse chutes and linen chutes*." As such, the design of the Towers, and interventions to them, is regulated by Section 3.6: Service Facilities, which relates to the nature and use of materials and equipment that may be located within these shafts. In this case, compliance with Section 3.6 is mainly limited to issues of continuity of fire separations, use of approved fire stopping materials, the use of various materials for ductwork, conduit, and sealants. As service spaces, the Towers are not considered to be occupancies, and therefore requirements for exits, occupant loads, or travel distances are not applicable. Instead, these issues are reviewed under the *Occupational Health and Safety Act*.

Architectural components within the Towers are limited to access ladders and rest platforms. The design of these components is also regulated by the *Occupational Health and Safety Act,* specifically Article 84, which addresses the requirements for fixed vertical access ladders. The design of the existing ladders is not compliant with current provincial workplace safety regulations. Solutions to this condition are proposed in the design drawings, and are discussed in more detail in Section 4.7 (below).

Egress / exit requirements
Egress and exit requirements, specifically related to the construction phase, are discussed in more detail in Section 4.2.2 (below). Following completion of the conservation work, the Towers will retain their current configuration of access and egress; that is, through the fifth floor kitchen at the HoC Tower, and the third floor access door at the Senate Tower. Improved access may be contemplated at a later date, when the Centre Block is renovated.

Fire resistance of building components, including firewalls and separations between occupancies
Consistent with Article 3.2.2.54 of the 2010 *National Building Code*, the building has been classified as a Part 3, Group D occupancy, which requires two hour fire separations for floors and sprinklers. All new walls and penetrations shall meet fire code and separation requirements, including new penetrations for fireplace flues. The Towers, in and of themselves, are separated from the rest of the building by their monolithic masonry walls.

In addition to the ladders and platforms within the Towers, other architectural elements include the renovation of two existing water closets contained within the Senate Tower. These are located at floors 1 and 2. The re-design of both water closets complies with accessibility requirements, as well as fire separation requirements. In particular, new walls of the W/Cs are to be rebuilt with two hour fire separation. Modifications will also be required to the mechanical and electrical services, including plumbing and ductwork, which will need to be re-worked, new lighting, door openers for barrier free access, and GFI outlets. Exhaust ventilation will be provided to ensure proper exhaust rates. This work shall conform to applicable codes and guidelines.

Fire protection
During the construction phase, the Tower interiors and its scaffolding will need to be equipped detectors, alarms, and pull stations. The fire alarm system shall comply with CAN/ULC-S524-2006, Installation of Fire Alarm Systems; CAN/ULC-S536-2004, Inspection and Testing of Fire Alarm Systems; and CAN/ULC-S537-2004, Verification of Fire Alarm Systems.

Following completion of the conservation work, the interior of the Towers will be equipped with basic fire protection elements.

Mechanical systems must also comply with requirements outlined in NBCC 2010, National Building Code of Canada; NPCC 2010, the National Plumbing Code of Canada; and NFCC 2010, National Fire Code of Canada. The natural gas system (for the tarp enclosure) shall comply with CSA-B-149, Natural Gas / Propane Code.

Refer to Section 4.8 - *Mechanical and Electrical Design*, below, for more details.

Structural requirements
Refer to Section 4.5 - *Structural and Seismic Design*, for more details.

4.2.2 Detailed fire and life safety strategy (fire and life safety statement)

Egress for workers
As discussed in the previous section, the Towers are not intended to be inhabited spaces. This poses a challenge for ensuring fire and life safety for workers during the implementation of the construction work. While workers will be inside the Towers for extended periods, the space does not provide a means to exit quickly nor easily evacuate an injured worker. The life safety measures required for these areas have been assessed through the *Occupational Health and Safety Act*.

Different scenarios were considered in assessing the feasibility of rescuing an injured worker and providing quick egress from the Towers in the event of emergency. In particular, consideration has been given to providing access/exit from the floors below the access doors; providing new doors from an occupied space or attic, which would require making new openings in the structural walls; and providing access / exit through adjacent service spaces.

While the Senate Tower is provided with a door to an adjacent roof at roughly the mid-height of the Tower, the House of Commons Tower has no such access point. Rescue could be contemplated through the service space adjacent to the fifth floor kitchen; however, restricted headroom due to deep structural members compromises the usability of this space for access or rescue. Refer to Appendix F: *Emergency 5th Floor Exit* for analysis of this exit path. Access to both Towers from the bottom is extremely problematic. Forming new openings in the vent Towers is not recommended, as these openings would need to be created at the beginning of the project, before the Towers are stabilized, which would seriously compromise the structure, as well as potentially interfere with the reinforcement work.

Consequently, priority has been given to elaborating a rescue methodology, rather than undertaking structural changes to the Towers. Following consultations with PWGSC-Construction Safety, (Construction Safety Meeting, 4 July 2012), it was determined that the most apparent and reasonable means of emergency egress would be through the louvre openings in each of the Ventilation Towers.

One louvre shall be removed from each Tower for the duration of the project, and should be designated as an emergency exit, to be accessible by scaffolding both within and outside the Towers. The louvres are at a higher elevation than a fire engine Tower ladder can achieve. Therefore, a rescue team would be required to manually remove a worker through the louvre and down scaffolding stairs to a lower level, where they would gain access to a Tower ladder. If tension cables are found to impede clear access through a louvre opening, these can be moved up or down slightly to provide clear access for a rescue crew, and unimpeded exit in the event of emergency. In addition, while locks should be changed on all doors that provide access the worksites (so as to limit access from roofs, for example), it is recommended that the fifth floor kitchen access in the HoC Tower be equipped with an alarm activated door for the duration of construction. While not a rescue route, this door will provide secondary escape from the worksite in the event of emergency.

It is recommended that the construction contract include provisions for rescuing workers. In particular, the construction of the scaffolding will in itself require means to extract workers in an emergency, such as a hoist and basket system. The sequence of work will require that the roadwork to accommodate the scaffolding be completed first, followed by assembly of the exterior scaffolding, then followed by the interior scaffolding, and finally execution of the masonry work itself.

The specifications include wording that begins to describe the requirements for rescue facilities. It is recommended that the contractor retain a high-angle rescue crew on site during the assembly of the interior scaffolding. Once the scaffolding is in place, the contractor shall then provide a hoist and basket for the duration of the construction phase. The contractor shall be made responsible for the design and approval of these systems and arrangements. The design of these systems is beyond the expertise of the design team.

Requirements resulting from this analysis have been included in the updated cost estimates.

Fire truck access
The site design and worksite areas provide for a minimum 6.7m drive aisle, which will allow fire and other emergency vehicle access. As mentioned above, a Tower ladder will not extend the full height of the Ventilation Towers; therefore, provision should be made in the scaffolding to permit an opening at the level to which a Tower ladder may reach for ease of movement of rescue crews onto the scaffolding platform.

Fire protection within the Towers and the scaffolding
As indicated above, during the construction phase, the interior scaffold and its stairwells shall be equipped with heat and smoke detectors, pull stations and alarm horns. Refer to Section 4.8 - *Mechanical and Electrical Design*, below, for additional discussion.

4.2.3 Detailed summary of preliminary meetings with authorities having jurisdiction

Discussions with HRSDC and Labour Canada (Construction Safety Meeting, 5 November 2010) suggested that the project scaffolding be constructed as though it is a "permanent structure," which is understood to mean that it should incorporate basic life safety systems such as fire alarms, smoke detectors, and exit signage.

Follow up discussions with PWGSC-Construction Safety (Construction Safety Meeting, 4 July 2012) confirmed that during the construction phase, egress is best provided through the Tower louvres.

Ongoing discussions with HRSDC and Labour Canada will continue through the duration of the project to evaluate health and safety issues as they arise.

4.3 Heritage Conservation

The Centre Block Ventilation Towers are part of the original design of the Centre Block and are important features of the building. The Heritage Character Statement (HCS) for the Centre Block identifies the conception of the building "*as a symbol of Canada*" and the "*whole of its exterior, centred on the Peace Tower*" as a among the key Character-defining elements of the building. While not specifically identified in the HCS, the Ventilation Towers are key features that tie the Centre Block into the Gothic Revival style of the larger Parliament Hill ensemble. The choice of a Gothic vocabulary to express the aspirations of Canada as a nation is symbolized in the various vertical elements of the Centre Block, including the Ventilation Towers. While not the primary element that embodies this symbolism, the Towers are contributing elements that reinforce the overall character and composition of the building as a Gothic Revival complex. Combined with the Peace Tower, the Water Towers and the chimneys, the Ventilation Towers act as strong signifiers of the vertical nature of the Gothic Revival style.

The character of the Centre Block also derives from the relationship between the Beaux Arts plan of the building, and the applied Gothic ornament. The symmetrical location of the Towers — anchoring the north-east and north-west corners of the building — reinforce the Beaux Arts principle of symmetry — an important character-defining element of the Centre Block. The Gothic ornament defines a clear hierarchy of spaces and building elements. The whole of the south façade including the Peace Tower and the Pavilions, as well as interior public and ceremonial spaces including the main corridors, the Senate and House Chambers and their foyers, are among the elements with the finest materials and attention to detailing. Following from this hierarchy, the Ventilation Towers fulfill a lesser symbolic function. The form and design of the Towers, including the stonework, the louvre design, and the choice of window design and materials, express their secondary position in the hierarchy of symbolic spaces within the Centre Block.

Altogether, the value of the Ventilation Towers resides in their exterior appearance (form, materials and detailing) and in their location and relationship relative to other key character-defining elements — namely the Peace Tower. Value also resides in their symmetrical arrangement, which reinforces the Beaux Arts emphasis on axis, composition and hierarchy.

In terms of condition, local repairs have been undertaken through the life of the Towers, and as a result they retain a high level of material integrity that contributes to the character and expression of the Centre Block. However, while their exterior form, materials and detailing remain largely intact, the Towers exhibit extensive structural cracking, which is temporarily stabilized by exterior shoring. Permanent repairs to this condition require a long-term intervention to stave off further deterioration and prevent damage or collapse.

The interior of the Towers function as ventilation shafts. They are lined with inexpensive brick, and contain service platforms, ladders and utility runs. Neither the design nor the materials of the Tower interiors are considered significant character-defining elements of the building. Refer to Section 2.3, *Pre-Design Report,* for a presentation of the heritage value of the Towers.

4.3.1 Final conservation approach and methodology

Despite the official name of this project, the conservation philosophy and primary treatment approach is identified as *Preservation*. As described in the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd ed.*, a *Preservation* approach seeks to stabilize the material integrity of an historic place, and is the most appropriate approach when heritage values relate primarily to the physical materials that make up a place (pp. 15-16). *Preservation* is also appropriate when a continuing or new use of an historic place does not require significant alteration of or addition to the character-defining elements of that place (p. 16).

As noted above, the chief character-defining elements of the Ventilation Towers are their exterior form, materials and detailing. These elements express and reinforce the Beaux Arts symmetry and Gothic Revival styling of the Centre Block building, in particular, and the Parliament Hill ensemble more generally. No significant change in use is planned for these Towers, which are virtually 100% original in material, form and function. Therefore, an approach is proposed that retains as much original material as possible, and minimizes intervention into the historic character-defining fabric of the Towers. Standards 1 through 9 have been applied to all aspects and thinking about the conservation of the Ventilation Towers. In the treatment of certain elements, *Rehabilitation* standards related to additions (11) are considered. These are discussed in Section 4.3.2, below.

Preservation can include short-term, interim and long-term actions to "*stave off deterioration or prevent damage*" (15). While the term 'action' is not defined in the *Standards & Guidelines*, it can be understood to be the same as 'intervention' — that is, "*any action, other than demolition or destruction, that results in a physical change to an element of a historic place*" (254). Action therefore implies change. *Preservation*, as with all other conservation approaches, seeks to manage change. The major distinction between the types of conservation treatment (specifically *Preservation* and *Rehabilitation*) relates to the extent of alteration or distinct change being proposed. A *Preservation* treatment allows for a variety of conservation actions, which can range from short term and interim measures, such as small repairs and maintenance, to long-term actions such as extensive repointing and structural upgrades. In all cases, the proposed treatments should allow for a continuing or new use, without extensively altering, changing or adding to the historic place in such as way that its character-defining elements might be adversely altered or affected (p. 16).

While the Towers are largely complete and intact, they do exhibit extensive structural cracking, which is temporarily stabilized by exterior shoring. A primary driver of this project is therefore to implement permanent repairs to restore the structural integrity and improve the seismic performance of the Towers. In ensuring the safe and continued functional role of the Towers as ventilation shafts, the conservation treatments also seek to protect and enhance the heritage value of the Towers and must thereby aim to be both visually and physically compatible with these historic building elements. Even though permanent structural repairs require significant intervention into the building, it is intended that there be minimal or no exterior evidence of the structural reinforcing, once it has been completed.

While the building's materials were intended to weather and acquire patina, it is also recognized that some materials are intrinsically sacrificial, and are intended to be replaced on a cyclical basis. For example, the copper roofing is a material with a predetermined lifespan and does require periodic renewal. The mortar is, and to a certain extent the interior bricks may also be, considered a sacrificial material. These are proposed to be replaced where the existing is in poor condition or inadequate in strength or other qualities.

On the other hand, the exterior stone is a permanent feature of the Towers, and requires careful consideration where replacement is proposed. The exterior stone is detailed with a distinct contrast between the rock-faced Nepean sandstone fieldstones and the dressed Berea quoin stones. Field and laboratory investigations confirm that the masonry suffers from severe efflorescence, which has contributed to both stone and brick deterioration. In particular, the Berea quoin stones have acted in a sacrificial manner by absorbing salt contamination. This has weakened the stones and led to their premature failure. Given their condition, the most reasonable and viable approach for removing salt contamination is through replacement of damaged Berea quoin stones. Deep repointing of remaining masonry will effectively remove most of the remaining salts. In attempt to preserve patina on the remaining stones, cleaning processes will involve the gentlest possible treatment.

The steel windows and copper louvres are original and intact, and their condition is reasonably good. Consistent with an overall *Preservation* approach, the windows and louvres will be retained and restored, rather than replaced.

The interior of the Towers are configured as a service plenum, designed to efficiently exhaust air from the Centre Block building. From a functional standpoint, this unobstructed space should be preserved. In contrast, the Heritage Character Statement for the Centre Block does not consider either the design or the materials of the Tower interiors as significant character-defining elements. Therefore, from a conservation standpoint the interiors would seem open to considerable change, as long as there is no negative impact on the exterior form, material or detailing — the chief character-defining elements of the Towers. The proposed interventions to the interiors will facilitate safer routine access inside the Towers, and will thereby contribute to the long-term preservation of the building. These interventions also require alterations to the interior elements, including the brick lining, the embedded utilities, and the various access ladders and platforms. Removal is also recommended for those miscellaneous pieces of mechanical and electrical equipment that penetrate the Tower walls and diminish the heritage character of the Towers and the Centre Block building as a whole.

This proposed conservation approach aims simultaneously at stabilizing the Towers while preserving their chief character-defining element — their exterior form, materials and detailing. The proposed preservation treatments — repairing and repointing masonry, reinforcing the structure, improving seismic performance, restoring the windows and louvres, and replacing the roof — seek to protect, maintain and stabilize the Towers against further deterioration and decay (p.. 17). This strategy ensures long-term performance, allowing the Towers to remain serviceable into the future through routine maintenance and repairs. The focus is therefore placed on limiting impact in areas related to the character-defining elements, retaining heritage fabric wherever possible, and accepting the patina of decay where there is still structural integrity. In this regard, the recommended treatment plan and conservation approach emphasizes retention of original material, and minimal intervention, wherever practicable — in other words, it is a *Preservation* project.

This cautious and conservative approach emphasizes the long-term stability of the heritage fabric of the Towers, and the building as a whole. By retaining as much original material as possible, while minimizing intervention into the historic character-defining fabric, the proposed conservation treatment ensures the continued, safe and long-term use of the Towers as ventilation shafts, without compromising their heritage value.

The conservation approach adopted at the Ventilation Towers is consistent with the Centre Block South Façade Project, which is a primary point of reference for the current project. In particular, it is important that the treatment of the Ventilation Towers — the extent of stone replacement and repair, the colour and detailing of the replacement mortars, the level of cleaning, the roof repair details — be consistent with the approach to other work on the Centre Block and the Parliament Hill complex more generally. Otherwise the cohesiveness of the entire complex will be undermined. Every effort will be made to emphasize the Gothic Revival character of the building within its larger Parliament Hill context.

4.3.2 Application of the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd. ed.*

This conservation project is considered primarily a *Preservation* project, with some elements of *Rehabilitation*. The overall conservation treatment approach has been guided by the fundamental principles of the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd. ed.* Standards 1 through 9 have been applied to all aspects of the project (with Standards 1, 3, 4, 7, 8 and 9 being the most applicable), and Standard 11 being applied to some specific interventions.

For the most part, compliance with these Standards is straightforward, as the building is intact and no changes in terms of use or form are contemplated. Standards 7 and 9 require judgement, however, as the proposed interventions include cleaning, repairs, and structural and seismic reinforcing. The nature of these interventions may not be considered gentle or reversible treatments.

The *Preservation* process is guided by the need to ensure the safe and continued functional role of the Towers as ventilation shafts, while also protecting and enhancing their heritage character. Consistent with Standard 7, the existing condition of the Towers and their pathologies were thoroughly analysed and evaluated. The root causes of problems were identified prior to treatment options being proposed. Underlying this analysis was an effort to gain a thorough understanding of the history, construction and character-defining elements that define and characterize the Towers. Gaining this insight ensures that the heritage value would be preserved (Standard 1), that the physical record of the Towers' ageing would not be obscured (Standard 4), that the proposed interventions are appropriate and protect the heritage value of the Towers (Standard 7), that character-defining elements would be protected and preserved (Standard 8) and that interventions into character-defining elements would be compatible with the historic place (Standard 9).

As both Towers exhibit structural cracking, a primary driver of this project is to implement permanent repairs to restore their structural integrity, and to improve their seismic performance in the event of an earthquake. Given the technically feasible approaches available to reinforce the Towers, reversibility of the structural reinforcement in particular, but also the seismic interventions, should not be considered achievable. In other words, while not likely to cause damage to the character-defining elements of the Towers, future removal of the reinforcements would require significant dismantling and intrusion into the fabric and services in the Towers.

The structural and seismic interventions have been considered under both *Preservation* and *Rehabilitation* standards, specifically Standards 7, 9 and 11. Although the structural work, in particular, requires a significant intervention into the building fabric, the work is consistent with an overall *Preservation* approach in that there will be minimal or no exterior evidence of the structural reinforcing, once it has been completed. Every effort has been made to ensure that the design and addition of the reinforcements is physically compatible with both the structural and seismic performance of the Towers (Standards 9 and 11). Since the structural anchors will not be visible once installed, their installation will be documented for future reference. Elsewhere, the seismic reinforcements will be visible on the interior faces of the Towers and will therefore be clearly distinguishable from the historic place, without being visible from the exterior. Consistent with Standard 7, the use and installation of the structural anchors and the vertical reinforcements is the most appropriate approach for achieving structural and seismic stability. In addition, the specified installation methods use the gentlest means possible for achieving these upgrades (Standard 7).

The proposal to replace a certain quantity of brick and stone masonry may appear to contradict Standards 1 and 3, which call for retaining original materials and adopting a minimal intervention approach. However, as indicated elsewhere, this recommendation is informed by evidence acquired through testing that indicates the mortars are heavily contaminated with salts, which is moving into the stone and brick. The removal and replacement-in-kind of these materials is therefore part of an attempt to meet the fundamental conservation objective of extending the life of the structure. In this way, it is consistent with Standard 7 in that the root causes have been clearly identified and the recommended treatment is the most appropriate means for addressing these issues. It is also consistent with Standard 8, which calls for repairing and reinforcing materials using recognized conservation methods, and replacing only deteriorated or missing parts.

Despite the above, the emphasis on minimal intervention remains (Standard 3). Wherever feasible, masonry treatments favour retaining original material and heritage fabric and accepting the patina of decay where there is still structural integrity (Standard 4). In this regard, cleaning processes are specified to use the gentlest possible treatment, and repair and re-pointing procedures using traditional techniques emphasize protecting character-defining elements from further decay — an approach that is also consistent with Standards 1 and 7. Where replacement of character-defining elements is proposed, the objective is to provide protection to the remaining elements — the exterior masonry — so as to conserve the essential exterior form, material and detailing of the Towers, thus meeting the intention of Standard 8 (to maintain and repair character-defining elements on an ongoing basis).

Retaining and repairing the louvres and windows is also consistent with Standard 8; as well as Standard 3, which calls for a minimal intervention approach. The proposal to install new laminated glass calls for consideration under *Rehabilitation* Standard 11, which requires that new work be physically compatible with, subordinate to and distinguishable from the historic element. Much of the original glass in the windows has already been replaced, and much of the remaining glass is broken. Upon close inspection, the replacement glass will be distinguishable as a new addition.

The copper roof is proposed to be replaced in-kind. This approach is appropriate given the age and deterioration of the existing roof, and is consistent with Standards 7 and 8 — it is the most appropriate intervention and deteriorated elements will be replaced in-kind.

4.3.3 Opportunities and strategies to minimize impact to the heritage fabric

As discussed at the beginning of this Section, the Ventilation Towers are important features of the Centre Block, and are key elements that reinforce the Gothic Revival style of this building and the larger Parliament Hill ensemble.

The focus of this project therefore lies in limiting the impact of interventions in areas that relate to the key character-defining elements of the Towers — namely, the form, material and detailing of the exterior masonry. Emphasis is placed on retaining original heritage fabric where possible, and accepting the patina of decay where there is still structural integrity. Interventions, including visible evidence of structural reinforcement, will be kept to a reasonable minimum, with the emphasis placed on the long-term stability of the heritage fabric of the Towers and the building as a whole.

The recommended approach to structural reinforcement best balances the project objectives with the protection of the heritage value of the Centre Block. Although reversibility of the horizontal grouted reinforcement may not be achievable, efforts will be made to ensure that the reinforcement intervention is minimal, and uses the gentlest means possible.

In a broader context, because of the major heritage value of the Centre Block building, all repair and conservation work must be executed with minimal disturbance to the existing building fabric. Protection of the surrounding fabric must be of the highest priority in the execution of the work. Specifications provide direction on implementing protective measures and procedures to ensure the protection of building fabric.

Elsewhere, care has been taken in the design of work that affects the finished interior of the building — namely, the Water Closets located inside the Senate Tower. To minimize impact on the heritage character of these spaces, careful consideration has been given to specifying the appropriate location, design, and selection of materials and finishes. In particular, the Tennessee marble finishes in WC 264N are to be carefully removed and stored, and reinstated at the end of works. Other finishes and fixtures are specified to be appropriate to the function and location of these facilities, while simultaneously meeting current accessibility standards.

4.3.4 Conservation objectives balanced with other project objectives and economic constraints

The recommended conservation approach remains compatible with the project objectives, and has not significantly changed since the previous phase (*RS3 – Design Concept*). A summary is provided below. In sum, the conservation objectives are well matched with economic constraints, whereby maximum material retention and minimal intervention both reduce the scope of work, and should also minimize the cost and the duration of site work.

Objective 1: Health and Safety
The recommended design option can be implemented in a manner that is compatible with the objective of enhancing health and safety by fully complying with applicable safety legislation, both for the construction phase, and after construction by eliminating the risks associated with the Tower's deterioration. This is discussed in more detail in Section 4.2 (above).

Objective 2: Protection of Heritage

The proposed approach strives to conserve as much historic material as possible, and in this sense can be described as a minimum intervention approach. In the implementation of removing the salt contaminated mortars and replacing the Berea stone, care must also be taken to replace these elements in-kind such that the essential character of the Towers is not altered.

Objective 3: Quality
The recommended approach strikes a balance between conservation and treatment of the salt contamination problem. Specifications call for the use of replacement materials and quality masonry techniques that are commensurate with the quality of the building.

In the implementation phase, a rigorous procurement strategy might ensure a quality delivery. To the extent that PWGSC contracting policy permits, bidding on the project should be limited to those contractors with a demonstrated record of quality preservation work. This is discussed in more detail in Sections 4.3.6 and 4.3.7, below.

Once construction is underway, the use of mock-ups will be critical in establishing benchmarks for the quality of the execution of various parts of the work. The sourcing of materials will be monitored and samples tested to ensure their compatibility with the project objectives.

Objective 4: Building Envelope
The recommended approach has taken account of the root causes of the building envelope deterioration. The masonry treatment plan strikes a balance between conservation and treatment of the salt contamination problem through removals. Retention and restoration of the windows and louvres, as well as replacement-in-kind of the copper roof, also contribute to ensuring a sound and continuous exterior envelope.

Objective 5: Seismic / Structural
As the principal driver behind the project, recommended upgrades seek to implement permanent repairs that will restore the structural integrity and improve the seismic performance of the Ventilation Towers, which is of course a life safety issue. However, in so doing, care must also be taken to ensure that the Tower's heritage value is protected and enhanced through an appropriate choice of design measures that will not detract from or damage the heritage fabric, namely the exterior masonry.

Objective 6: Continuity of Operation
The recommended approach seeks to confine the scope and duration of construction as much as possible, and also to minimize disruption to the functioning of Parliament.

Objective 7: Long Term Vision and Plan
The recommended approach remains compliant with the LTVP.

Conservation objectives balanced with the needs of the Parliamentary occupants
Another project objective is to implement the work without disrupting Parliamentary activities. Both Ventilation Towers are close to operationally sensitive areas, notably the quarters for the Speakers of both the House and the Senate. This proximity will require that some work be done after hours. In order to ensure quality work is possible, scaffolding will be provided with suitable task lighting.

It should be anticipated that the rooms immediately surrounding the Towers, particularly on the 1^{st} and 2^{nd} levels, will be affected by noise. In addition, views from these spaces will be restricted by the presence of the scaffolding.

At the Senate Tower, the interior office spaces at the 2nd and 3rd floor will be need to be accessed to allow for the installation of the vertical reinforcement inside the Tower. Wall finishes will need to be removed to allow access to the masonry walls. These surfaces will be reinstated after installation of the reinforcing.

The Water Closets located inside the Senate Tower (Rooms 166N and 264N) will be dismantled as part of the seismic intervention, and therefore these facilities will not be functional during construction. Architectural elements to be retained (such as doors and their hardware) will be protected during construction. The Water Closets are proposed to be redesigned and reinstated as barrier free facilities. (Refer to drawings A06.1 and A06.2 in Appendix B for design details).

4.3.5 Draft Analysis and Conservation Treatment Report for all conservation materials outlining replacement, repair, cleaning or refinishing techniques and processes

The Concept Design Report considered and presented three (3) integrated design options, which addressed all of the parameters studied in the Pre-Design Report. Treatment options were considered for each of the constituent elements of the Ventilation Towers. In most instances, only one option presented itself as realistic and viable for a preservation approach, and this was the option incorporated into the integrated options.

Within the overall conservation project, the recommended approach presented in this report is informed by the dynamic analysis of the structure, ongoing discussions with PWGSC and other departments concerning the structural and other design parameters, and the results of field investigations and materials testing.

The recommended approach to the conservation of the Centre Block Ventilation Towers incorporates the following characteristics:

Structural:	Horizontal grouted anchors, laid in-plane, for structural reinforcement.
Seismic:	Surface mounted vertical structural steel reinforcement.
Masonry:	Berea quoin stone replacement and interior brick replacement, as required, to remove salt contaminants; deep repointing of stone; repair and replacement of other masonry, as required; and cleaning to remove soiling, as required, but not all traces of aging.
Windows:	Conserve and restore existing.
Louvres:	Conserve and restore existing.
Roofs:	Replace.

The treatment of the masonry is the primary driver of conservation approach, which is appropriate since, along with the need for structural reinforcement, the masonry is the key character defining element of the Ventilation Towers. Work to the roof, louvres, and windows are ancillary to these main issues.

For a detailed description of the current condition of the Towers and their component parts, refer to the Pre-Design Report, Section 2.5.2.2 - *Observations from detailed visual and tactile inspection*.

Structural / Seismic

A detailed presentation of the structural and seismic upgrades is included in Section 4.5 - *Structural and Seismic Design*. Briefly, the Dynamic Analysis of the structure confirmed that in their current condition the Towers have little capacity to resist lateral loads, and represent a significant health and safety risk. Given their extreme height and slenderness, they represent a much higher risk than the rest of the building in its un-conserved state.

Within the overall conservation project, the recommended seismic and structural upgrades are required to resist lateral loads caused by seismic activity, and to restore the box-like structural capacity of the Towers. The most appropriate method for implementing seismic reinforcing is the application of surface-mounted vertical structural steel to the interior face of the Ventilation Towers. This will introduce ductility to the Towers and allow them to safely resist lateral loads to 60% of what current codes require, as per PWGSC policy. The box-like structural character of the Towers can be restored by the installation of grouted anchors laid horizontally in the plane of the walls.

The design of the vertical reinforcement shall correspond to 100% of the NBCC 2010 seismic load along with minimum life-safety requirements at 60% of the NBCC-2010 seismic load. As requested by PWGSC, an importance factor of 1.0 indicating a normal use is assumed. The detailed design stage (RS5 - Construction Documents) will reveal whether the seismic upgrade will work for detailing and capacity-related issues. In consequence, the seismic reinforcement will be designed to cause critical sections of the Towers to exhibit ductile behaviour with reinforcement yielding at maximum loads to allow for maximum energy dissipation. At the upper section of the Towers, the vertical reinforcement will be reduced in response to the reduced overturning moment. The vertical steel reinforcement can be applied to the interior surface of the Tower walls and does not require any dismantling of the masonry.

The design of the structural reinforcements will allow the Towers to behave collectively as a box-like structure. Grouted anchors, laid horizontally in the plane of the walls, will extend from one face of the Tower to the opposite face. Extending the length of the grouted anchors is recommended because there is no distinct keying between the inner brick wythe and the outer Nepean sandstone. The purpose of the in-plane reinforcement then, is to bridge any cracks that may develop in the vertical or the diagonal directions and provide confinement for the cracked masonry. This reinforcement would increase the capacity and the ductility of the masonry walls, but will only be effective once the masonry starts cracking under progressive loading. The removal of a limited number of stone quoins is required for this procedure, which can be carried out from the exterior surfaces and scaffold. Where these are removed, it allows for the inspection of the masonry condition and the anchoring locations.

As the principal driver behind the project, these recommended upgrades seek to implement permanent repairs that will restore the structural integrity and improve the seismic performance of the Ventilation Towers, which is of course a life safety issue. While the recommended intervention options are the most suitable to achieve the conservation objectives, they also seek to observe the relevant guidelines for the conservation of historic structures by being designed to ensure that the

Tower's heritage value is protected and enhanced through appropriate design measures that will not detract from or damage the heritage fabric, namely the exterior masonry.

Section 3.7 provides a discussion of the structural options, and Section 4.5 presents the final Structural and Seismic Analysis. The Dynamic Analysis report is included in Appendix E.

Masonry

Water infiltration has resulted in significant efflorescence on the interior faces of the Tower walls, thus contributing to deterioration of the interior wythe. The presence of salts is also precipitating deterioration of the Berea quoin stones (refer to drawings in the A03 series, Appendix B, for a survey of damaged masonry). The recommended treatment plan is to deeply repoint and repair the masonry, and replace as required. This approach reaches further than standard intervention procedures and therefore attempts to significantly slow, if not arrest, the deterioration processes related to the salt contamination. The success of this procedure relies on a committed maintenance program throughout future time.

All bedding (horizontal) joints are proposed to be cut out to a maximum depth of 50 mm and re-pointed using a mortar formulated to have excellent bond, vapour transmission, frost resistance, and low saturation coefficient rating (the technical Specifications include details on the mortar composition). The perpendicular ("head" or vertical) joints are to be fully cut and raked out and re-pointed with the same improved mortar formula. This intervention aims at removing the effects of water readily contacting and dissolving the soluble salts of the original mortar.

All deteriorated Berea sandstone will be removed and replaced. In addition, as much as is safe to do, the contaminated deep core shall be removed and rebuilt/repacked with new mortar and stones of low porosity, such as the St. Canut sandstone. The entire surface of the masonry walls will be poulticed with diatomaceous earth clays in order to reduce the salts present in the stone surfaces.

This procedure will not remove but rather seeks to isolate the salts, while removing contamination in the remaining stones and bricks wherever possible. Some salt contamination will remain in the core of the walls. Testing has shown that the salts are mostly concentrated toward the surface of the stone masonry units, so that poulticing would provide the benefits of removing surface salts within the outer 50 mm surface area.

At the interior, the brick affected by efflorescence and spalling shall be removed to a depth of two wythes, and replaced with new. It is expected that this will affect 75% of the wall surface. This replacement amount does not require complete dismantling of interior brick; rather, it represents an allowance that covers the surface area of the wall that has been confirmed by visual inspection to be seriously affected by soluble salt crystallization. The affected areas are geometrically located such that replacement work can avoid sound areas while addressing affected areas. The brick interior is not considered a character defining element, so the need to replace is purely a technical concern, and not a cultural one. Refer to Section 4.6.2 for discussion of replacement quantities.

Replacement (rather than cleaning and repair) is the preferred approach at locations that are heavily contaminated by salts. The Berea quoin stones have been particularly susceptible to salt contamination, and are weakened by it, making them largely beyond repair. Likewise, the interior bricks have been seriously affected by soluble salts. It is therefore both cautious and responsible stewardship to remove and replace affected masonry so as to prevent further weakening of the structure, and simultaneously reduce, if not eliminate, further spread of salt contamination from these points in the walls.

It can be anticipated that some water, in the form of condensation, will continue to infiltrate the wall even after complete repointing and repair. The proposed intervention therefore takes into account the requirement to permit this moisture to dry properly, so that the effect is not exacerbated and further damage can be arrested, if not prevented. Unless severe saturation takes place by some unforeseen circumstance, it is assumed that average environmental conditions of both precipitation and drying cycles will only affect the outer reaches of the masonry. For the most part, it is assumed that the remedied zone of 50 mm will provide the buffer required between normal and extreme wetting conditions of the masonry. In other words, with the barrier provided by the improved repointing mortar, it would only be under extreme wetting conditions that water would occasionally reach the deep positioned contaminated original mortar. It is not practical to rake deeper than 50 mm, since the reach into repairing the masonry is limited without risking damage to the structure.

The mortar design is intended to follow the 1:2:8 mortar mix, as designed for the Centre Block South Façade work carried out in the latter half of the 1990s. This remains a standard and serviceable mortar that has a track record for performing well for the Centre Block masonry walls of the early 20th century. The draft Specifications provide additional information on mortar, including environmental condition requirements.

As part of the repairs, the masonry should be cleaned to a level that removes enough soiling to prevent detrimental changes in the masonry's hygrothermal characteristics, but stops short of removing all traces of patina. The Centre Block South Facade project will be used as a point of reference for the cleaning procedures, which will be guided by a visual evaluation, rather than the actual quantification of the amount of surface soiling to be removed.

On the Centre Block in particular, comparison with existing conserved masonry is important, as the Ventilation Tower project should contribute to, rather than diminish, the overall aesthetic harmony of the building. The south facade is the main reference; however, the Library and the upcoming Pavilion project should also be considered.

It is assumed that micro-abrasive cleaning will be used, and therefore control of the level of cleaning will be achieved by adjusting dwell time. Establishing an acceptance standard will be done through a series of mock-ups.

Very recently, laser cleaning technology has evolved into a system that may have both practical and cost effective merits for use in cleaning masonry on Parliament Hill. This technology and its application to cleaning is still under review by both HCD and consultants. Therefore, it is not possible to include this form of cleaning technology at the present time.

Working on open scaffolding presents challenges for controlling environmental conditions and thereby ensuring consistent results are achieved in the masonry work. It will be necessary to ensure that optimum conditions are provided during all masonry repair procedures. Undertaking work only under specific and acceptable ranges of environmental conditions will avoid the need to remove and redo masonry repairs, and will ensure the safety of workers and the public. The Specifications describe the required environmental conditions needed to ensure quality masonry work, including monitoring humidity levels, providing temporary heated enclosures, ensuring protection from direct sunlight and wind, and avoiding work when ambient temperatures are too high or too low. The Specifications also describe acceptable methods for handling, storing and using hazardous materials and protecting workers, the public and adjacent building surfaces from damage related to use of these materials.

*

This treatment plan conserves existing material while removing a limited number of stone quoins. It also provides thorough treatment of the salt contamination without dismantling the structure. Removal of the quoins shall allow for simultaneous inspection of the masonry condition, as well as the structural anchoring locations.

The desired results of the masonry intervention are part and parcel of the broader conservation task being performed. The proposed procedures are based on internationally-recognized conservation treatments for these specific conditions -- whether mechanical consolidation of detaching portions of stone, poulticing to lessen salt contamination, replacement in-kind to remove a deteriorated portion of stone (i.e. a Dutchman), or a full stone replacement. As such, the proposed forms of intervention for remediating deteriorating conditions are the result of a conservation-driven approach and standard procedures recognized by the international conservation community.

Refer to Section 3.8.2 *Masonry Treatment – Option 1*, for a detailed description of the pathologies in the masonry and recommended treatment option.

Windows and Louvres

The existing windows and louvres are proposed to be conserved through repair rather than replacement. The condition of these elements is reasonably good, given their age, exposure and the lack of informed maintenance. The windows and louvres are described in detail in the Pre-Design Report, Section 2.5.2.2 - *Observations from detailed visual and tactile inspection*, which also outlines the current condition, and describes the specific deficiencies that should be addressed through restoration.

Windows

The recommended treatment plan begins with removal of all windows to the shop for handling, including thorough removal of paint and corrosion products through a process of electrolytic reduction; replacement of all glazing with a laminated glass, which would mitigate health and safety issues in the event of future breakage; straightening of deformed elements; and re-painting.

The original colour of the Tower windows is a light brown, matching that used on the restored original windows in the south façade of the Centre Block. This colour is proposed to be reinstated for consistency. After electrolytic reduction, all surfaces shall be painted with a zinc-rich primer, and then covered with an epoxy base coat and polyurethane top coat to protect the epoxy.

Louvres

The recommended treatment plan for the louvres involves restoration of the existing fabric and improvement of the fasteners connecting the steel grilles to the masonry. The treatment plan begins with removal to the shop for handling, where the louvres and their screens will be disassembled. The copper grilles will receive a gentle cleaning, broken joints will be re-soldered, and copper repairs will receive an artificial green patina using a copper nitrate solution.

All interior steel components are to be sandblasted and epoxy primed and painted, as described above.

It is also proposed that an alternate detail be considered for the stone sill-to-copper interface along the bottom of each grille, so as to better shed water. The overlap height behind the lowest louvre shall be increased, and the ends of the bottom strip be terminated in existing mortar joints or reglets.

The copper grilles are to be re-installed with no protective finishes, as these grilles should be left to age and weather in the same way as do copper roofs.

*

The proposed treatment plan for the windows and louvres has the advantage of conserving existing material, while ensuring thorough treatment of all corrosion. As a minimal intervention approach, it also has the benefit of being the most cost effective method of preserving the maximum amount of existing material and maintaining character defining elements.

Roofs

The terms of reference for this project require the full replacement of the roofs. Given that the roofs are approaching 100 years of age, this is not an unreasonable approach. This project requires very costly scaffolding; therefore it is logical to coordinate the roof replacement with the masonry and structural work. Furthermore, it provides an opportunity to inspect the condition of the substrate of the copper roofing, and make necessary repairs to it, as required. It is recommended that the copper roof be replaced in-kind, which is consistent with a preservation approach.

The new roofing assembly will consist of the existing concrete structure, a 3-ply spun bonded polypropylene underlayment, and new copper roofing with battens, as per the existing detail.

Refer to Section 3.8.2.2 for analysis of roof treatment options. Refer to Appendix H for specifications.

4.3.6 Recommendations for pre-qualification of specialty contractors

The most significant risk element to this project may be the type of contractor that PWGSC hires to complete the conservation work. Recent contracts have been awarded in the Precinct where a culture of bidding low and generating multiple claims and requests for changes has emerged. This has for effect to reduce the overall quality of work and also threatens the integrity of the Precinct as a whole.

The nature of this conservation project requires the highest quality contractors. To the extent that PWGSC contracting policy permits, bidding on the project should be limited to those contractors with a demonstrated record of quality preservation work. It is therefore recommended that alternatives be examined, utilizing a quality-based selection process.

4.3.7 Preliminary procurement strategy, with PWGSC

The best means for obtaining quality service is to set aside standard procurement strategies, which are based on lowest cost, in favour pre-qualifying both general and specialty contractors. It is recommended that a "two-envelope" procurement strategy be employed, whereby the overall score reflects a balance between meeting competencies and cost-effectiveness. Factors may be included in the award criteria that ensure only contractors with demonstrated abilities are selected, such as adherence to conservation standards, and demonstrated familiarity with conservation legislation and guidelines (exemplified by specialty contractors with training in the conservation trades), for example.

This type of procurement strategy would support the achievement of project objectives — in particular the protection of heritage and procuring materials and methods that are commensurate with the quality of the building — by ensuring that bidders demonstrate competency related to masonry conservation.

Further discussion and understanding of procurement of construction services for historic properties is required. In addition, design team members, including Julian Smith, would be available to meet with the management team and RPCD to discuss alternatives and experiences on other projects, especially in Europe. After which, possible alternatives and scenarios can be proposed.

4.4 Site Design

4.4.1 Narrative

The design of the worksite areas is driven in large part by the design of the scaffolding. The scaffolding option that has been retained (Option 5, described and illustrated in the Concept Design Report, Section 3.7.9) now occupies a significantly smaller footprint than the options would have required. This refinement allows for the worksites to be limited in area, which in turn reduces the impact on adjacent functions.

The worksites are contained to an area roughly contiguous with the existing alignment of sidewalks adjacent to the HoC service entrance and the Senate loading facility. While the worksite areas extend onto the paved roadway, they do not alter or impede the current alignment and function of this roadway, which retains a minimum 6.7m road allowance for the passage of emergency and service vehicles.

The design of the scaffolding and the worksite layouts take into account the requirement to maintain access to service entrances and loading facilities. Therefore, pedestrian paths of travel will not be disrupted and vehicle access to these entrances will be maintained throughout the construction phase.

The House of Commons worksite is contained between the Speakers' Entrance on the west and the service entrance and loading dock on the north side of Centre Block. Currently, this area accommodates five parking spaces (four designated for use by the disabled, and one non-disabled). However, the construction worksite will overlap with these spaces. Therefore, it is proposed that three of the disabled parking spots be relocated further east, adjacent to the Library, where they will remain within reasonable distance of the service entrance. In consequence, the two additional spaces (one disabled, and one not) will be eliminated during the construction phase. Additional parking could be provided to the north of the Senate loading facility, if required.

The Senate worksite extends between the pedestrian entrance on the east side of Centre Block, and the Senate loading facility on the north. The scaffolding structure will be constructed independent of the existing Senate loading facility, and therefore most day-to-day operations should not be impeded. However, the waste management function will be impacted; in particular the garbage container will need to be relocated in order to make room for the scaffolding and worksite. An alternate location will need to be identified where the container can be stored and where a truck can safely load and unload the container.

While no masonry or structural work is required on the exterior of the building at occupied levels, a portion of the scaffolding structure will extend to the ground and therefore will have an impact on daylight and views. This will be minimized by the fact that the scaffolding will not be enclosed, and therefore daylight will be allowed to pass through to occupied spaces; and views will be maintained (albeit somewhat obstructed) from the Senate and HoC quarters.

Within the worksite areas, storage facilities will be limited. All stones and materials are to be trucked off-site for storage and eventual treatment. Each worksite will contain a Site Office, and a Security Booth, as well as portable toilets, for the convenience of work crews. In addition, on site contractor parking will not be offered. All worker and contractor vehicles will be required to be parked off site.

Refer to the proposed site plans (Drawing A01.1, in Appendix B) for details. These plans include a proposed layout for the worksites, road alignment, and parking relocation, as well as indicating the footprint of the scaffolding and the temporary Senate structures. These drawings are laid out as preliminary working drawings, and should not be interpreted as final construction documents.

4.4.2 Site features and restrictions

No new issues related to site features and restrictions have been identified since the previous report. Refer to Sections 2.4 and 3.6 for details. In sum, the Towers are surrounded by multiple functions, including shipping and receiving, access points for deliveries, service entrances and parking. These require full-time vehicle and pedestrian access, which will be preserved during the construction phase. In addition, the drive aisle to the east, north and west of the Towers is required as an emergency vehicle access route; therefore this area must also be kept clear during the construction phase.

The north side of Centre Block is highly exposed to prevailing winds from the northwest, particularly at higher elevations. These wind loads have been taken into account in the design of the scaffolding, and is the reason the selected scaffolding option will not be enclosed -- because the wind loads imposed on the existing structure would be excessive and cannot be supported by the Towers in their unconserved condition.

The area around the Towers is mainly flat, such that topographical features have minimal effect on the design of either the worksites or the scaffolding.

The Towers are surrounded by occupied offices on both the Senate and House of Commons side. While it is anticipated that masonry, structural and seismic work can be performed from inside the Towers, and therefore access to these office spaces will not be required, it remains that noise, dust and vibration will be highly sensitive issues, particularly during office hours. The scheduling of work may require adjustment and re-assessment if and when conflicts arise. That said, it should be noted that ongoing work on the East Block Northwest Tower is in continuous operation during office hours.

Similarly, security is also an important issue, particularly due to the proximity of critical parliamentary functions. This is addressed in more detail in Section 4.4 below.

Elsewhere, close to fifty significant construction projects are planned in the Parliamentary Precinct between now and 2023. While there do not appear to be any projects in direct conflict with the Ventilation Tower Rehabilitation, construction activity related to the East Block North West Tower may have an impact in the form of construction traffic. Coordination with this and other projects will be required as the Ventilation Towers project approaches the implementation phase.

In earlier site and scaffold design iterations, it was likely that one of the sculptural monuments located adjacent to the HoC worksite would require temporary relocation during project implementation.

However, it has been determined that this statue will not be affected by construction activities, and therefore can remain in its current location.

The revised scaffolding option (Option 5, Tower-supported frame) occupies a small footprint at grade, and requires no foundation. Therefore, since no excavation work will be required, archaeological disturbances are unlikely to be a factor in the implementation of this project. Likewise, the services of the CBUS structure (below grade) will not be affected.

4.4.3 Infrastructure, subsurface and above-grade services, including capacities and limitations

No new issues related to infrastructure and site services have emerged since the previous report. Refer to Sections 2.4 and 3.6 for details. As the design evolves, instructions for relocation of the Senate waste management services will need to be provided to the consultant team.

Refer to Section 4.8 – *Mechanical and Electrical Design* for discussion of temporary services to be provided at the construction sites.

4.4.4 Construction yard including scaffold and temporary enclosures requirements / restrictions

The construction worksites will be fully protected by hoarding, and all pedestrian and vehicular entrances to the building will be separated from the construction area in accordance with applicable legislation. The type of fencing shall be similar to that used on current projects on Parliament Hill, consisting of a pre-manufactured system of powder-coated tubular steel pickets, complete with gates (refer to image 1-58 in the Concept Design Report for illustration, and Drawing A01.1 in Appendix B for details related to hoarding and fencing.).

The open scaffold presents some risk to public safety due to the possibility of falling debris. Where overhead work may potentially threaten pedestrian paths, overhead protection will be provided. Catchment safety nets with a minimal wind surface will also be required at all scaffolding work levels.

Site security is also an important site management issue; in particular preventing unauthorized access to scaffolding, which can lead to threats to the safety of the occupants of the Centre Block, or, at the least, embarrassment caused by hostile political actions, as seen on the West Block recently.

It is recommended that the scaffolding be treated as part of the perimeter of the main building, such that access to the scaffolding -- both from the worksite and from within the building (at the upper floor levels) -- would be controlled. Details will need to be confirmed by and coordinated with the RCMP, and can be worked out once a more detailed scaffolding layout has been developed (as part of the RS5 phase).

Elsewhere, in addition to secure hoarding, and the presence of a security office on each of the worksites, it is recommended that daytime access to the sites be restricted to a single entry gate. A secondary exit door will be provided on each worksite, but this will remain locked, and shall only be used in the need of emergency exit from the worksite.

In addition, door locks should be changed on all doors that provide access the worksites so as to limit access from roofs (for example) to the inside of the building. In the case of the fifth floor kitchen access (HoC Tower), it is recommended that an alarm activated door be installed in this location for the duration of construction. While this exit door is not part of the rescue route, it should remain operational so that it may serve as a secondary escape route from the work-site in the event of emergency.

Finally, it is recommended that minimal worksite illumination be provided at night, and that video surveillance be implemented. This should be supplemented by regular monitoring of the worksite, an activity that would need to be coordinated with parliamentary security personnel. Additional direction on security issues is included in the Specifications.

4.4.4 Other Impacts (including on occupants and on building operations)

The scaffolding option allows the structure of the scaffold to be fully supported on the Towers and the walls of the Centre Block, and therefore will not penetrate the interior of the occupied spaces of the building. Similarly, the exterior footprint of the scaffolding is minimized since the majority of the scaffold load is transferred into the load-bearing walls and foundation of the existing Towers, which also minimizes impact on parking areas and visual obstruction to building occupants.

The impact on the public will be minimized with the smaller footprint of the scaffolding.

The principal disadvantage will be an extended construction schedule (seasonal work taking place over multiple years, rather than continuous work). As well, because of the open scaffolding, the worksite will be visible and may appear unsightly to some occupants and visitors.

4.5 Structural and Seismic Design

In upgrading the Towers, the intent is not to alter their overall behaviour as they are constructed from massive load bearing masonry walls. The prime objectives for the structural upgrade of the Towers are:

- To correct the noticed structural deficiencies (such as the lack of in-plane keying that causes the wall to act as a set of independent vertical bands);
- To improve the ductility of the masonry elements in order to increase their ability to dissipate energy; and
- To improve the capacity of the Tower against overturning that could be caused by the applied seismic loads.

The variations in stiffness and stress levels between the Tower and the Centre Block building walls may cause them to respond differently to any seismic event. Therefore, some cracking at the interface areas is expected. This issue is further discussed in the seismic analysis report (Appendix E – Dynamic Analysis).

4.5.1 Final structural and seismic analysis

A three-dimensional (3D) finite element model was developed to determine the seismic response of the Centre Block Ventilation Towers using time-history analysis. The finite element method is a numerical tool with which structural and non-structural elements of the building can be modelled, where various changes in geometry, physical properties and connectivity can be represented.

Two modeling approaches were considered. The first approach uses two stick models that were developed to determine the effect of modelling only the section of the Towers above the 3rd floor versus modelling the entire Towers from the foundation level including the stiffness of the Centre Block Building. Results were obtained from carrying out a dynamic spectral analysis with a spectral record representing the Ottawa area. Two modulus of elasticity values (3,000 MPa and 6,300 MPa) were used to evaluate this effect. The second approach uses a three dimensional finite element model of the section of the Towers above the 3rd floor. Changes in geometry and Tower details were obtained from the available drawings of the Centre Block building. The base of the Centre Block building was assumed to be resting on bedrock. 3D brick elements (8-20 node isoparametric solid elements) were used to model the masonry walls and 3D shell elements were used to model the roof of the Towers.

For the three-dimensional (3D) finite element analysis, seven simulated ground motion time histories, (developed by Atkinson and Beresnev (revised 2009)) with a return period of 1/2500 p.a. (2% in 50 years) and scaled to be compatible with the NBCC 2010 hazard spectra for Ottawa, were utilized to study the seismic response of the Towers. These ground motion histories are compatible with the uniform hazard spectra provided by the Geological Survey of Canada. Each record, simulating an earthquake event, was applied to the Tower and the maximum displacement at top of the Tower was calculated. Then, the maximum base shear, overturning moment, normal and shear stresses were calculated at the base of the Tower.

In the 3D analysis, it was assumed that the Tower model behaves mainly as a cantilever extending up from the third floor with a fixed boundary condition at its base. The ground-motion time-history record was applied at the third floor. The effect of the building on the Tower was assessed by the stick models where a comparison in response between a model of the building including the Tower and a model of the section of the Tower above the 3rd floor was carried out. Based on this assessment, the response of the 3D model did not require any scaling to account for the fact that the simulated records are not applied at the ground level.

The findings from the seismic analysis confirm the need for the vertical reinforcement, as discussed in detail in Section 3.7 - *Structural and Seismic Analysis*. The forces and stresses from the seismic load significantly exceeded the capacity of the Towers. Under the simulated earthquake records, the Towers can fail by overturning. This poses significant life safety risks to the occupants and the public. The displacement values at the 3rd floor were found to be small to cause a premature failure of the nearby elements in the form of potential slippage at the support points. Some masonry cracks may develop. However, this should be expected once the building is subjected to a significant seismic event.

Details of the seismic study are documented in a report titled *Dynamic Analysis of the Centre Block Ventilation Towers* by KIB Consultants Inc. dated May 2012 which is included in Appendix E.

4.5.1.1 Wall In-plane Horizontal Reinforcement: Grouted Anchors through exterior masonry

To cause the masonry walls of the Towers to behave collectively as a box-like structure, wall in-plane reinforcement shall be introduced. The purpose of this proposed in-plane reinforcement is to bridge any cracks that may develop in the vertical or the diagonal directions and provide confinement for the cracked masonry. This reinforcement shall increase the capacity and the ductility of the masonry walls. This reinforcement shall only be effective once the masonry starts cracking under progressive loading.

As illustrated in the drawings in Appendix B, horizontal reinforcement shall be implemented through the installation of grouted anchors to be installed in the horizontal direction, extending from one face of the Tower to the opposite face, and spaced about 1.8 m (6 ft.) vertically. To install a single in-plane reinforcement anchor, removal of two quoin stone units shall be required. Then, a core in the in-plane direction of the wall shall be drilled until it reaches the opposite corner of the Tower to allow for the installation of the anchor. The anchor is then placed in the core and the core space is fully filled with grout. The reinforcement effect is accomplished through bond action of the anchor with the surrounding masonry and through the end dowels that shall be installed in the quoins

The removal of a limited number of stone quoins is required for this procedure, which can be carried out from the exterior surfaces and scaffold. Where these are removed, it allows for the inspection of the masonry condition and the anchoring locations.

4.5.1.2 Vertical Reinforcement: Interior Surface-mount Reinforcement

The prime objectives of the vertical reinforcement seismic upgrade at the lower section of the Towers are to improve the ductility of the masonry elements in order to increase their ability to dissipate energy, and to improve the capacity of the Towers against overturning that could have resulted from the applied seismic loads.

Vertical reinforcement steel members will be mounted on the interior surface of the Towers in the areas with the maximum bending tensile stresses (locations of maximum bending moments). This is illustrated in the drawings in Appendix B. These areas are most likely to be around the 3rd floor level, where the Towers are connected to the building. The new steel members will be made from steel sections that will be mounted using proper horizontal mounting anchors.

The installation of vertical reinforcement requires access to all interior wall surfaces, which will require that the existing brick chimney flue enclosures be dismantled in both Towers. In the House of Commons Tower, the installation of the steel elements may conflict with the location of the existing mechanical equipment and pipes, which will have to be rerouted. For the Senate Tower, the water closets on the 1st and 2nd levels will need to be dismantled, and the office spaces at the 2nd and 3rd floor may also need to be accessed to allow for the installation of the vertical reinforcement. Wall finishes would then need to be removed to allow access to the masonry walls, and would be repaired after the reinforcement work is completed.

4.5.1.3 Compatibility of Materials

The grouted anchors shall be made of stainless steel, which is corrosion resistant. Therefore, the risk of damage of masonry due to corrosion is eliminated.

In the published literature, values for the coefficient of thermal expansion were reported between (16-18 x10-6) for stainless steel, (12-15 x10-6) for sandstone, and (11-13 x10-6) for mortar, respectively. As can be seen, stainless steel, sandstone and mortar have very comparable values for the coefficient of thermal expansion. Considering the above values, the differential movement between the grouted anchor and the surrounding masonry (of an anchor of about 1 m in length with temperature differential of 40°C) is estimated to be 0.08 mm. This differential movement may result in a tensile stress value in masonry of about 0.08 MPa which can be considered negligible.

The notion that the presence of the steel anchors could cause condensation on the steel surfaces that may cause damage to the masonry has to be viewed in regard to the experience we have with the use of steel (normal and stainless) in concrete and masonry. Since the introduction of grouted anchors in masonry (about 20 years ago), no cases were reported where the moisture condensation on the stainless steel anchor surface was the cause of masonry damage. This micro-mechanism at the interface between the steel bar and the surrounded grout may need to be further studied. However, it cannot constitute a base to reject the use of similar types of anchors.

4.5.2 Compatibility of design with the conservation approach and compliance with the *Standards and Guidelines for the Conservation of Historic Places in Canada, 2nd. ed.*

Even though permanent structural and seismic repairs require significant intervention into the building, it is intended that there be minimal or no exterior evidence of this reinforcing, once it has been completed. As such, the proposed reinforcement conforms well to Standard 3, the concept of minimum intervention. In addition, these procedures comply well with the health and safety requirements in that character defining elements are preserved and heritage value is maintained.

The proposed interventions also conform to Standard 7, which recommends evaluating the existing condition of the character defining elements to determine the appropriate interventions needed by using the gentlest means possible for each intervention, and by respecting the heritage value when undertaking an intervention.

Standard 8 recommends maintaining character defining elements on an on-going basis, and repairing character-defining elements by reinforcing their material using recognized conservation methods, which is the approach being taken here.

Finally, the proposed interventions are needed to preserve character-defining elements, both physically and visually, and shall be compatible with the historic Towers of the Centre Block. These shall be identifiable on close inspection, as per Standard 9, and are recommended for documentation for future reference.

Reversibility
The horizontal anchors shall run in about the mid-width of the wall and can only be installed from the exterior of the Tower. At the end of the anchor, the corner quoins are removed to allow for the anchor installation without coring through the stone quoins.

The installation of a single anchor can be viewed as a reversible intervention because the anchor can be completely removed from the masonry without causing significant damage to the masonry. However, considering the length of each anchor, the effort and cost to install them, and the considerable effort and accuracy to remove all of them, therefore, the implementation of this intervention should be considered irreversible.

The proposed vertical reinforcement to be mounted on the interior surface of the Towers is distinctive and fully reversible. The steel structure shall be installed without any impact on the historic masonry of the Towers.

4.5.3 Special construction and demolition, including of heritage fabric

4.5.3.1 Wall in-plane horizontal reinforcement
The wall in-plane horizontal reinforcement is a sophisticated intervention that requires special skills in drilling and anchor installation. This would typically reflect a higher cost resulting from the narrow pool of contractors and suppliers. In recent years, experience has been gained from the installation of these anchors on several Towers on the East Block and West Block of the Parliamentary Precinct, in both the in-plane and out-of-plane directions.

The following sequence of work is proposed for the areas of the wall where anchors will be installed:

- The restoration of the interior brick masonry will be restored by replacing all of the delaminated and deteriorated brick units.
- The removal of two quoins at each end of the Tower elevation will be carried out to allow for coring for the grouted anchors.
- The removal of the quoins shall allow for the inspection of the masonry condition at the anchoring locations. If required, the proper conservation masonry to the core and

surrounding masonry can proceed.
- The masonry at the coring location, including the nearby restored interior brick masonry, will need to cure for at least 28 days before the coring process starts. The reason for the delay is to allow the masonry to gain proper strength so that it is not affected by the vibration caused by the coring process.
- The anchor will be inserted in the core and inflated with grout.
- The quoins can then be placed with new proper anchoring plates and dowels that connect the quoins to the grouted anchor.

4.5.3.2 Vertical reinforcement

The installation of the vertical steel reinforcement on the interior surface of the Tower is simple to implement, and should reflect a relatively reasonable cost. No masonry removal is required, which will reflect less debris, noise, and dust.

The work for installation of the vertical reinforcement starts with preparation activities that will grant access to the Towers' interior surfaces where the steel reinforcement will be mounted. These activities include:
- Removal of mechanical and electrical equipment that restrict access to the masonry interior surfaces in the installation locations (mainly at the corners of the Towers);
- Removal of the corner brick fireplace flue enclosures;
- Demolition of the wall surfaces inside the water closets within the Senate Tower;
- Create access openings in the floor slabs to allow for the installation of the vertical reinforcement.

Interruption to these spaces is expected to last only a portion of the construction duration. After which, these spaces can re-gain their functions. The design of architectural components is addressed in Section 4.7, below. Once the mounting surfaces for the steel elements are accessible, the location of the mounting anchors can be marked and the anchors installed. The installation of these anchors will be followed by the installation of the vertical steel components. The steel reinforcement will be installed in sections that will be spliced together.

4.5.4 Sustainable design opportunities and strategies

None identified.

4.5.5 Scaffold and enclosure systems, temporary support requirements

The scaffold structure on the exterior of the Towers utilizes structural steel transfer beams, inserted through the window and louvre openings, combined with standard nose-and-clamp scaffolding. Two transfer beams would be installed in both the north-south and east-west directions, as shown on drawings S101 and S102. The transfer beams would be located through the existing window and louvre openings of the Towers, which will require removal in any case for restoration. Two levels of transfer beams would be required in the House of Commons Tower in order to accommodate the varying roof elevations surrounding the Tower. This simplified design offers benefits in terms of minimizing the scaffold set-up and take-down time, and allowing the use of re-usable prefabricated components.

The purpose of the steel beams is to transfer the load from the section of scaffolding above the beams into the load-bearing masonry walls of the existing Tower. The scaffolding section below the transfer beams would be hung and partially supported by the transfer beams, as well as supported at grade. In other words, this option utilizes the structure of the existing Towers to support the temporary scaffolding. In so doing, the size of the scaffolding can be minimized and therefore reduce the visual impact on the public and building occupant spaces.

On the other hand, the north side of Centre Block is highly exposed to prevailing winds from the northwest, particularly at higher elevations. Because this scaffold option imposes additional stress onto the existing masonry before the conservation process is undertaken, it cannot be enclosed with a wind and waterproof enclosure. Wind loads imposed on the existing structure would be too excessive. An 85% open safety mesh would be installed to protect the public from falling debris. The construction period will be limited to approximately 6 months a year. Additional constraints may therefore arise from adverse weather, requiring the use of burlap and misting in hot weather, and insulated blankets in cold weather. However, it should be noted that these are normal masonry procedures and that fully weather-protected enclosures are not necessarily the norm outside of the Parliamentary Precinct.

While it may be possible to enclose a portion of the scaffold to permit winter heating, numerous challenges to this approach exist and therefore it is not recommended. Notwithstanding this recommendation, the contractor may be permitted to propose this approach at their own risk, should they find it advantageous. The Specifications would then need to include provision for expected performance.

Work inside the Towers requires standard scaffold construction, which will be independent of the exterior scaffold system. Installation of the interior scaffold will require removal and relocation of existing interior mechanical and electrical services. The re-arrangement of these services will be worked out in detail at the RS5 stage, however initial configurations are provided in Section 4.8 - *Mechanical & Electrical Systems*. Fire detection and alarm systems, as well as power and water supply, and sufficient task lighting will be required inside the Towers. Worker access to the Tower interiors will be gained through the louvre openings at the top of the Towers. Worker safety and egress requirements are discussed in more detail in Section 4.2.1, *Egress/Exit Requirements*.

4.5.6 Specifications

Refer to Appendix H for updated Outline Specifications.

4.6 Building Envelope Design

The building envelope of the Towers consists of few components. The walls are solid unreinforced masonry consisting of an outer wythe of stone bonded to a clay brick backup, which is several wythes thick. The windows are rolled steel frames set into stone rebates. The louvres are formed sheet copper, paired with an iron screen mounted inside the copper grille. The roofs are copper over cast-in-place concrete. Refer to Section 2.5.2 of the *Pre-Design Report* for assessment and analysis of the condition of the masonry, roof, windows and louvres.

In sum, the condition of the envelope is good in the sense that it is intact and complete. Localized repointing has closed most open joints; however, structural cracking and neglect has historically allowed water to enter the wall assembly. This water infiltration has resulted in significant efflorescence on the interior faces of the walls, thus contributing to deterioration of the interior wythe, which is the evaporation plane. Salt damage is also noted on the exterior surface. The deterioration of the wall assembly can be traced to the movement of relatively warm, dry air in the Towers, which draws moisture from the outside and carries salts through the wall assembly, resulting in the formation of efflorescence. Despite the risk of continued capillary action drawing water and salts towards the interior plane of the walls, it is not recommended to alter the performance and function of the monolithic masonry. Deep repointing seeks to isolate remaining salts inside the wall, which water and condensation may only reach under extreme wetting conditions.

There is no evidence of moisture penetration through the roof assembly. The concrete, from the underside, appears to be sound and in good condition. The copper roofing is intact, however the roofing does exhibit some movement in joints, and some fasteners appear to be backing themselves out. The steeply sloping roofs shed water directly without gutters or downspouts, and copper staining along the wall indicates that runoff from the roof and/or louvres is travelling down the face of the Tower.

4.6.1 Refinement and development of drawings including masonry walls, roofing, windows, louvres, doors

Refer to drawings in Appendix B, which illustrate the design and treatment of the building envelope components. In particular, drawings A03.1, A03.2 and A3 & A4 illustrate the pathologies present on the masonry, and provide details on the type of repairs and replacements that are required. Drawing A05.3 provides details related to the window and louvre treatment plans.

Elsewhere, while the flat roof areas adjacent to the Towers are adequately surfaced, these are likely to be damaged during the construction phase. Instructions are provided in the Site Plans to replace / repair these roofs at the completion of the project.

4.6.2 Compatibility analysis of stone replacement, estimated quantities of replacement stone, stone procurement strategy, terms of reference for stone procurement

Replacement stones have now been mapped on the façade drawings of the Towers (see drawings

A03.1 and A03.2), and provide an accurate estimate of the quantity of stone that is required. The Berea sandstone quoins have experienced the most salt-related deterioration, and therefore comparatively less St. Canut stone is required than Berea stone.

The supply of both materials is generally good. In particular, the replacement stone for the Nepean sandstone on Parliament Hill has recently been St. Canut sandstone, which is available in sufficient quantity at Plouffe Park. It is therefore recommended that an amount be reserved and set aside for the Ventilation Towers project.

The Berea sandstone is quarried in Ohio, where the supply is plentiful and is not expected to cause procurement or delivery problems. Amounts can now be secured based on the quantities analysis.

Replacement of the interior brick will require additional research. Notably, the compatibility of brick replacement relates mostly to the sizing, as opposed to the structural qualities, which are essentially comparable. Provided the coursing and other physical properties of the brick can be matched, the replacement need not be a visual match, since the interior of the Towers is not a character-defining element. However, if an unusual size needs to be specified, a longer lead time may be required. This issue will continue to be researched, and presented for discussion and review in Project Meetings.

4.6.3 Project specific conservation design approach / philosophy

As discussed, the primary treatment and overall conservation approach for the Ventilation Towers is Preservation, which emphasizes cautious and conservative interventions, and the retention of as much original material as possible. Even though the structural upgrades require significant intervention into the building, the presence of significant salt contamination requires removal and repointing of the stone exterior and brick interior. In this regard, the design of the building envelope components emphasizes retention of original material, and minimal intervention, wherever practicable.

4.6.4 Special construction and demolition, including heritage fabric, hazardous materials abatement

The recommended treatment plan to deeply repoint and repair the masonry reaches further than standard intervention procedures and will require the expertise and skill of accomplished trades' people.

Several Berea quoin stones will have to be removed in order to allow insertion of structural reinforcing. Some overlap will occur between damaged stones needing to be replaced and those stones that need to be removed for reinforcing.

Restoration of the window and louvre components requires the employ of skilled artisans and conservators to implement the work.

A *Designated Substance Report* (DSR) was completed for the East and West ventilation Towers in November 2007. Chrysotile asbestos pipe insulation was found in the West Ventilation Tower and in caulking material. No additional investigations are needed at this time. Plans and specifications for the implementation of this project will comply with Ontario Ministry of Labour Regulations, and include direction on asbestos abatement, and other hazardous materials abatement if required, as provided by PWGSC.

4.6.5 Sustainable design opportunities and strategies

The Towers are open shafts, intended to extract air. As such, it would be difficult to assess the performance of the envelope using a sustainability target, nor to attain any level of certification through a credit-based system such LEED. However, it is possible to aim for project-specific sustainability targets derived from LEED or similar programs.

Refer to Section 2.7.1.4 in the *Pre-Design Report* for discussion of LEED-specific targets that might be considered for this project.

4.6.6 Commissioning strategy

A draft Commissioning Plan is included in Appendix K. A more detailed Commissioning Plan will be developed in accordance with PWGSC Commissioning Guidelines. In general, the commissioning plan will set out procedures for the submittal of shop drawings or product information prior to construction, which will be reviewed for compliance with the specifications. Processes, such as cleaning and repair techniques, will be discussed with the operatives to ensure a common understanding of the intended outcome exists prior to any work beginning. At this time there may be an opportunity for the contractor to propose alternate methods for consideration.

As each component of the building envelope is installed, the work will be reviewed by the appropriate member of the design team. New work will be checked for compliance, to ensure that the building envelope assembly functions together correctly. The sequence of their installation will be reviewed to ensure new work is not placed at risk of damage by subsequent work.

The work will be recorded and fully documented to provide a complete record of the project at close-out. Product data, warranties, and maintenance information will be provided in a project manual.

4.6.7 Specifications

Refer to Appendix H for updated Outline Specifications, and Division 1 specifications, as well as draft technical specifications specifically addressing Windows and Louvres.

4.7 Architectural Component Design

4.7.1 Refinement and development of drawings (plans, sections, details)

Architectural components within the Towers are limited to access ladders and rest platforms, which provide access for maintenance. These are generally in good condition, and exhibit minimal corrosion. However, their configuration does not comply with current *Occupational Health and Safety Act* requirements.

Proposed designs for new access ladders are included in Appendix B. These ladders are to be protected by a safety cage, and be interrupted by rest platforms that are located maximum 3.5 metres apart (vertical distance). While the rest platforms provide an opportunity to create working areas for future inspections and maintenance, they must also facilitate materials movement vertically through the space, and will therefore be equipped with openings protected by a guardrail.

In addition to being safely designed, the building components introduced into the Towers must not inhibit the flow of exhaust air. The rest platforms will therefore be constructed of structural grilles, similar to the existing detail. Existing platforms — at landings 4 and 7 in both Towers — are proposed to be retained and reinstalled with new supports.

Installation of the vertical seismic reinforcements requires gaining access to all interior wall surfaces of both Towers. The reinforcements will occupy a physical space inside the Towers. It is anticipated that the location and sizing of these steel elements will conflict with the location of several services, namely existing mechanical and electrical equipment, pipes, and the brick fireplace flue enclosures. These services will need to be relocated to allow for installation of the vertical reinforcement. As discussed in Section 4.8 below, M&E services will be permanently reconfigured such that they will run through the centre of the Towers, affixed to the new service platforms. This reconfiguration will facilitate future access to both of the M&E elements as well as the interior masonry surfaces for maintenance and repairs.

In addition to re-routing the M&E services, the brick chimney flue enclosures will also need to be dismantled in order to gain access to the interior corners of the Towers. It is desirable to be able to reinstate the function of the fireplace flues in the future. It is proposed that, as with the M&E services, the platforms be reconfigured to allow for the flues to be reinstated at a future time. Stainless steel flues, for example, may replace the masonry ones, which are to be removed.

Even though the brick flue enclosures are not considered character-defining elements of the Towers, and their reinstatement is not critical to protecting the heritage value of the latter, it would be possible to reinstate the brick enclosures, including their clay tile lining. However, the integration of the brick flues with the surface-mounted vertical reinforcements would require careful detailing. The location of the reinforcements would take precedence over the reinstatement of the brick flue enclosures, and therefore may necessitate a reconfiguration of the latter.

At this time, it is recommended that the brick enclosures be permanently dismantled and that the new service platforms be equipped with a square notch in the location of the existing brick flues. A removable steel plate or grille shall cover the notch. In the future, stainless steel flues could be reinstated in the location of the former brick flue; that is, through the notches in the rest platforms. The notch in the grates will have to be sized to accommodate both the vertical reinforcements, as well the stainless steel flues. The notches would also allow for the eventual reconstruction of the brick flues, should it be desired to restore the configuration of the shaft interior.

It is not clear exactly which fireplaces are currently functioning. Designs for the flue notch plates will be developed further to enable this functionality. Elsewhere, the design of the interior masonry repairs adjacent to the fireplaces will provide for allowances to make future connections to a stainless steel flue, so as to enable the fireplaces to be made functional in the future. See Appendix B for drawing details.

The Senate Tower also includes two existing Water Closets, at Levels 1 and 2 (rooms 166N and 264N, respectively). To allow for the installation of vertical reinforcement, these facilities will need to be largely dismantled. In particular, the walls will need to be removed, and the floor / ceilings dismantled. In consequence, all wall finishes, fittings and fixtures will be removed. The wall and floor finishes in WC 264N consist of Tennessee marble, a seldom-used, high quality material. This material was detailed and installed with care and skill, in particular in the cutting of panels, thresholds, ledges, and carved cove bases. The Specifications provide instruction for the careful removal and storage of these elements for the duration of the construction project. The finishes are to be reinstated when the WC is rebuilt. As with the M&E services, opportunity will be taken to redesign both Water Closets as universally accessible facilities. Refer to drawings A06.1 and A06.2 for details.

4.7.2 Project specific conservation design approach /philosophy

From a conservation standpoint, neither the design nor the materials of the Tower interiors are considered significant character-defining elements. These elements would seem open to considerable change, as long as there is no negative impact on the exterior form, material or detailing of the Towers. Therefore, alterations to the interior elements of the Towers are planned so as to contribute to the long-term preservation of the building and facilitate safer access inside the Towers, without altering the exterior form and detailing of the Towers. In addition, miscellaneous pieces of mechanical and electrical equipment that diminish the heritage value of the building shall be removed.

As regards the water closets, it is not clear when these facilities were inserted into the Senate Tower. It is possible that these spaces were originally intended as utility closets. In any case, it is fair to assume that they are not original features of the Tower, and their interior finishes are not considered character-defining elements of the Towers, or of the Centre Block. Nonetheless, as noted above, the interior finishes in WC 264N are proposed to be retained. As well, the existing doors and their hardware will be removed, stored and protected during construction, and reinstated at the end of works.

4.7.3 Special construction and demolition, including heritage fabric, hazardous materials abatement

The interiors of the Vent Towers consist of exposed structural bricks. No architectural finishes are applied to the Tower interiors, as they were not intended to be visible.

At the lowest levels of the Towers, the surrounding spaces in the Centre Block are offices. The walls of the Towers are finished in plaster. At the corridors and in the Chambers, the Towers are clad in Tyndall stone. At present, it is not anticipated that interventions will be required at these levels or in these areas.

The existing washrooms in the Senate Tower will be completely dismantled and reconstructed, including all interior finishes and partition walls. The floors, however, will be retained. New walls will be constructed to comply with fire separation requirements. Architectural elements (in particular the doors and their hardware) will be retained and protected.

Per Section 4.6.4, all specified procedures are to comply with Ontario Ministry of Labour Regulations, including handling lead, asbestos and other Designated Substances, as identified in the PWGSC *Designated Substances Report* of November 2007.

4.7.4 Sustainable design opportunities and strategies

As with the building envelope, it is difficult to assess the design of architectural components through a credit-based system such as LEED, since these programmes are largely intended for new construction or comprehensive renovation.

Nonetheless, it is possible to aim for project-specific sustainability targets derived from LEED or similar programs. These could be dealt with in the NMS Specifications, and documented during the construction phase. These targets might include reusing building elements, diverting construction waste and using regionally-sourced materials.

4.7.5 Commissioning strategy

A draft Commissioning Plan is included in Appendix K. A more detailed Commissioning Plan will be developed in accordance with PWGSC Commissioning Guidelines. In general, the commissioning of architectural elements shall include quality assurance processes throughout the construction phase by the consulting team.

4.7.6 Specifications

Refer to Appendix H for Division 1 specifications, as well as updated Outline Specifications.

4.8 Mechanical & Electrical Design

The Ventilation Towers currently have multiple existing mechanical and electrical services, which supply equipment in the Centre Block building. Both Towers have existing lightning protection that forms part of the overall building as well as roof lightning protection system. Each Tower includes roof-mounted air terminals and copper down conductors, which are installed on the exterior of the building and connect to existing ground rods. On site observations revealed that these down conductors have been damaged. Rooftop heat tracing systems located in the area of the Ventilation Towers will need to be removed for the construction period. All equipment is to be reinstated at the completion of construction.

In the House of Commons Ventilation Tower, numerous electrical conduits pass through the space, which will interfere with structural and masonry repairs and the vertical reinforcing to be installed at the corners of the Towers. Similarly, ductwork and piping for multiple mechanical systems line a large portion of the Tower interior. These systems will need to be relocated to allow for structural modifications to take place. For example, a fan uses a window as an air intake. The ductwork for this fan will be reworked, and a new intake location identified. The window will be restored to its original state. A stand pipe, vacuum line, Natural Gas line, and sanitary drain will also need to be relocated away from the corners of the Tower to an available area, preferably the centre of the Tower walls.

The interior of the Senate Tower is mostly empty of mechanical equipment; however there is ductwork, domestic water piping, natural gas piping, and a sanitary riser located at the bottom of the Tower that will need to be removed in order to facilitate structural modifications. The Senate Tower is located above a mechanical room in the basement and has been modified to allow for more floor area in this mechanical room. The services in the mechanical room will require modifications in order to allow access to the Senate Tower walls. As noted elsewhere, the Water Closets in the Senate Tower will be dismantled, including the ventilation and plumbing systems. In terms of electrical services, the Senate Tower contains a series of lighting relay panels, which control the Senate lighting system. It also contains electrical distribution equipment and a rooftop antenna. All of these lighting panels will need to be removed and relocated during construction.

4.8.1 Scaffold / Site Systems

During construction temporary lightning protection will need to be installed on the construction enclosure and scaffold. All lightning protection work must be installed in accordance with CAN/CSA B72. It is recommended that the existing building lightning protection system be interconnected with the temporary construction lightning protection and grounding. This should include bonding the steel structure of the construction scaffold to the lightning protection grounding.

All electrical equipment and systems in the construction scaffold shall be properly bonded and grounded in accordance with the Canadian Electrical Code and CSA C22.2 No. 41-07: Grounding and Bonding Equipment. Sketches SKE-E3 and SKE-E4 show the proposed lightning rods, grounding wires and grounding rod configuration to protect the scaffolding. These sketches are an indicative design only. The actual installation will be at the contractor's discretion, as per the performance-based construction specification document.

Lighting and Controls

The scaffold Contractor will be required to provide construction lighting. Fixture selection and layouts should be designed to provide minimum illumination, in accordance with NBCC and Department of Labour requirements and to meet minimum construction requirements. All fixtures should be controlled by timers and/or photocells and arranged to suit construction requirements. All fixtures required for life safety (minimum code illumination of exit route and stairs) or security should remain un-switched.

The scaffold contractor will also be required to provide emergency lighting battery units on each level so as to illuminate exit routes and stairs. It will be required that these be provided in sufficient quantity to provide minimum code illumination levels. In addition, exit signs or red exit lighting should clearly indicate exact routes.

Sketches SKE-E3 and SKE-E4 indicate the proposed exterior scaffolding lighting provisions. These sketches are an indicative design only. The actual installation will be at the contractor's discretion, as per the performance-based construction specification document.

Scaffold Mechanical Services

The exterior scaffolding will be open and will not require a controlled environment. There will be no weather enclosure to offer protection against exterior conditions. It has been agreed that the contractor will no longer require natural gas to heat areas of work. Any additional heating requirements should be provided through electrical equipment.

Scaffolding Security Provisions

Electrical security systems were outside of the scope of work of this review. If security provisions are required, RCMP/PWGSC should identify who is responsible for the installation.

4.8.2 Temporary Mechanical & Electrical Construction Services

The following describes requirements for temporary construction services. The design of the temporary services will be performance-based, as outlined in the draft Specifications, included in Appendix H. Mechanical and electrical sketches are included in Appendix B - *Drawings*.

Mechanical Services

The mechanical design documents will provide for two domestic water connections (one at each Tower). These NPS 1 water connections will be shown equipped with a back flow preventer of low risk protection, a water meter, and an isolation valve. The water meter will serve to monitor the water use of the contractor.

Once the water connections have been installed, the contractor will be responsible for any additional equipment required for the use of water during construction. Our design documents will include specification sections and construction drawings detailing the requirements of the domestic water connections.

The provision and specification of any fuel-driven equipment will be the contractor's responsibility. However, the contractor will be responsible to follow all labour and environmental laws for the use and storage of fuel.

The mechanical systems located in the Senate Tower needs to be temporarily removed for the installation of the interior scaffolding. Critical systems can be relocated to a permanent location once the scaffolding layout has been determined.

Electrical Services

The contractor will be required to provide a complete temporary power service, connected to a designated power source located in the Centre Block building. At a minimum, the temporary power service should include the following:

- Connection to an existing 225A – 3P breaker located in a basement electrical room. The existing spare breaker located in a 600 volt panel IRP-3-1, which is part of switchboard #1.
- Construction of a temporary plywood enclosure to house all electrical equipment, and located on centrally on the flat roof between the two Ventilation Towers. Two additional enclosures should be provided at each Tower. The enclosures should be sufficiently large to house all equipment, be weatherproof, ventilated and lockable. In addition, they should be secured to the building.
- The central enclosure should be sized and equipped to receive a feeder from the basement (3 conductor #3/0-CU-TECK Cable – PVC jacket + ground cable, sized to Canadian Electrical Code); a 600 volt – 3 phase, 3 wire splitter box – 225A; and two x 100A – 3 pole, 3 wire fused switches.

From the central rooftop enclosure, a 100A, 600 volt, 3-phase, 3-wire feeder and ground should supply each Tower, where an additional power kiosk will be required. Each power kiosk will then include: an isolation disconnect switch (100A, 600 V, 3 phase); a 100A splitter & fused switches, sized to suit loads; and a step-door transformer for lighting & power panel board.

The contractor is to provide lighting and power circuits, as required, for each Ventilation Tower. Wiring and equipment is to be installed temporarily and should be weather resistant. In addition, the system should be flexible so as to meet the requirements of masonry as well as work by other divisions.

Sketches SKE-E1 to SKE-E4 indicate the proposed temporary power configuration for the exterior scaffolding. These sketches are an indicative design only. The actual installation will be at the contractor's discretion, as per the performance-based construction specification document.

4.8.3 Permanent Mechanical & Electrical Services

The following describes requirements for permanent Mechanical & Electrical services, which are to be reinstated or re-designed.

Permanent Mechanical Systems

The House of Commons Tower is filled with many mechanical services, including supply, return, and exhaust systems ductwork. At this time, it is assumed that these systems will need to remain operational during construction. The structural work requires access to the corners of the Tower.

To facilitate this work, the mechanical services need be to be relocated from the walls to the centre of the Tower. Relocating the ductwork in this way will allow for the structural modifications, while maintaining air distribution. New supports will be required to brace the ductwork. These may be integrated with the new service platforms. This is a detail that will be worked out in the RS5 phase. Once the structural modifications to the Tower are complete, the ductwork can remain in its new location. In effect, it will only need to be moved once.

All plumbing services located in the House of Commons Ventilation Tower also need to be relocated. They are currently installed along the south wall of the Tower and will interfere with the modifications to the structure as well as the scaffolding required to perform the construction. Like the ductwork modifications, it is recommended that the piping be relocated to the centre of the Ventilation Tower. The piping systems currently installed in the Tower are: chilled water, steam and condensate, sanitary, standpipe, gas, and vacuum. Once relocated, the systems can be in operation while structural modifications are being performed and do not need to be returned to their original location.

Additional sprinklers will be installed in both Ventilation Towers to respect NFPA13 requirements. Two additional sprinklers need to be installed; one near the bottom of the Towers and one at the tops. In order to prevent freezing of the new sprinkler risers, a dry-pipe sprinkler system is recommended to be installed in the basement of the Centre Block for both Towers.

A window located on the fifth floor of the House of Commons Ventilation Tower is currently used as a fresh air intake. The duct work is to be modified to return the window to its original design. A location for the new fresh air intake will be identified in the RS5 phase. The ductwork will be re-routed to the new air intake.

Water Closets located in rooms 166N and 264N in the Senate Ventilation Tower are to be remodeled, and will be largely demolished for the structural work of the Tower. New plumbing fixtures are to be selected and installed. Slight modifications to the mechanical services will be required. The plumbing and ductwork will need to be re-worked, and new exhaust ventilation will be provided to ensure proper exhaust rates. The construction on the Water Closets will be staged, since the demolition work will begin prior to the structural modifications. New work will only be completed once the Towers are structurally sound.

Brick chimney stacks are located in the north-west and south-east corners of both Towers. These chimneys are located where the structural modifications are required. The existing chimneys are to be removed and replaced with newer double-wall type stainless steel chimneys.

Permanent Electrical Systems

The existing lightning protection system on both Towers, including roof mounted air terminals and copper down conductors, will be removed during the construction phase, and temporary services supplied. At the completion of the masonry and structural repairs new air terminals and down conductors will be installed on each Tower and reconnected to the existing ground rod. All lightning protection work will be required to be installed in accordance with CAN/CSA B72.

The electrical conduits inside the House of Commons Tower will interfere with structural and masonry repairs. In preparation for the masonry and structural work, it is recommended that these conduits and the associated wiring be permanently relocated to the centre of the walls or to the centre of the Ventilation Tower, running adjacent to the ductwork. These elements may remain in their new location at the completion of work. Sketches SKE-E5 to SKE-E10 indicate the modifications to the interior of the tower and show the required conduit relocations.

The interior of the Senate Ventilation Tower contains a series of lighting control dimmer panels, which serve the Senate lighting system. These are located on the fourth floor of the Tower. In order to facilitate structural and masonry repairs, all of these lighting panels will need to be removed. A new permanent location for these panels will need to be proposed and a design will be developed for their relocation. Relocation for six (6) panels and the relocation of associated electrical and controls wiring may require a construction period of up to ten (10) days, during which time the lighting control system will not be available. This work can be scheduled to correspond with a time period where the Senate is out of session. Refer to sketch SKE-E9 for the existing location of the relay panels.

The third floor of the Senate Ventilation Tower contains electrical distribution equipment including two panels, two disconnect switches, and a transformer. This equipment powers the lighting control dimmer panels located on the fourth floor. This electrical equipment will be relocated prior to construction and will need to find a new permanent location. If the lighting control system must remain fully operational, new electrical provisions may have to be made. Sketch SKE-E8 shows the location of this equipment.

Rooftop antenna equipment located in the Senate Ventilation Tower on the fifth floor is to be removed or relocated for the construction period by the owner of the equipment (RCMP). If the equipment is to remain operational then it may need to be relocated or protected. Relocated or removed equipment is to be reinstated at the completion of construction, if required. Refer to sketch SKE-E10 for equipment location.

Permanent duplex receptacles will need to be installed on alternating floors inside both Ventilation Towers. These will provide power for construction equipment during and after completion of work. Refer to sketches SKE-E5 to SKE-E9 for interior electrical power modifications. Power connections will extend to the top of the Towers with a total of at least 5 connection points throughout. The electrical design specification sections cover the anticipated system design modifications.

Lighting and Controls

600 mm fluorescent strip fixtures with guards should be mounted on every level on the interior of the Ventilation Towers. These lights are to be connected to a building emergency circuit and equipped with motion sensors to turn them on and off after a time delay.

Inside of the Ventilation Towers, self-illuminated exit signs are to be added at all exit locations. Refer to sketches SKE-E5 to SKE-E10 for interior Ventilation Tower lighting provisions. Lighting will extend to the top of the Towers, as required to meet lighting level targets. The electrical design specification sections cover the anticipated system design modifications.

Fire Alarm and Life Safety

Inside of the Ventilation Towers, the following fire alarm devices are to be installed:

- Combination rate of rise and fixed temperature heat detectors to be installed at the top of the Ventilation shaft;

- Smoke detectors to be installed in the Senate Tower water closets;
- Alarm horn signals and visual strobe alarm signals located throughout in sufficient quantity to meet minimum alarm signal level;
- Manual pull stations located at each exit point from the ventilation shaft; and
- Upon alarm activation, automatic fan shut down of ventilation and heating fans.

Refer to sketches SKE-E5 to SKE-E10 for interior Ventilation Tower fire alarm layouts. Fire alarm and life safety equipment will extend to the top of the Towers, as required. The electrical design specification sections cover the anticipated system design modifications.

New Water Closet Layouts
Water Closets located in the rooms 166N and 264N in the Senate Ventilation Tower are being remodeled. New pendant lighting fixtures are to be selected and installed. The doors are to be equipped with automatic door openers to allow for barrier-free access. GFI equipped duplex plugs will be added at counter height by the sinks. Sketches SKE-E6 and SKE-E7 show the new washroom electrical layouts.

4.8.4 Quality Control, Codes & Standards

Mechanical
All mechanical work will need to comply with requirements outlined in NBCC 2010 (National Building Code of Canada), the NPCC 2010 (National Plumbing Code of Canada), the NFCC 2010 (National Fire Code of Canada). Natural gas systems will need to comply with CSA-B-149, Natural Gas / Propane Code.

Electrical
All work is to be carried out by qualified, licensed electricians, or apprentices in accordance with the conditions of the Provincial Act. Field testing will include: temporary power distribution system including phasing, voltage, grounding and load balancing; motors, heaters and associated control equipment including sequenced operation of systems where applicable; a systems performance verification of the fire alarm system; and insulation resistance testing.

Enforceable Codes and Standards will include installation in accordance with latest edition of CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations. In addition, all electrical work will be required to be compliant with requirements outlined in NBCC 2010, National Building Code of Canada.

The fire alarm system must be compliant with CAN/ULC-S524-2006, Installation of Fire Alarm Systems; CAN/ULC-S536-2004, Inspection and Testing of Fire Alarm Systems; CAN/ULC-S537-2004, Verification of Fire Alarm Systems.

Mounting Heights for all equipment and devices is shown from finished floor to centre line of equipment. Local switches are shown at 1200 mm; wall receptacles are generally shown at 450 mm; and fire alarm pull stations are shown at 1200 mm.

4.8.5 Project specific conservation design approach / philosophy

The mechanical and electrical systems are not character defining elements of the Ventilation Towers. Therefore, alterations or relocation have only been considered from a functional standpoint. That said, care will need to be taken not to (re)-install equipment or services in a way that diminishes the heritage value of the structures. In addition, where miscellaneous pieces of mechanical and electrical equipment do diminish the heritage value of the building, these shall be removed or relocated.

4.8.6 Special construction and demolition, including heritage fabric, hazardous materials abatement

Per Section 4.6.4, all specified procedures are to comply with Ontario Ministry of Labour Regulations, including handling lead, asbestos and other Designated Substances, as identified in the PWGSC Designated Substances Report of November 2007.

4.8.7 Sustainable design opportunities and strategies

None identified.

4.8.8 Commissioning strategy

A detailed Commissioning Plan will be developed in accordance with PWGSC Commissioning Guidelines. In general, all mechanical and electrical work shall be carried out by qualified, licensed professionals, or apprentices, in accordance with the conditions of provincial Acts. Field testing shall be reviewed by the design team, and may include:

- Temporary power distribution system including phasing, voltage, grounding and load balancing;
- Motors, heaters and associated control equipment including sequenced operation of systems where applicable;
- Systems performance verification: fire alarm system; and
- Insulation resistance testing.

4.8.9 Specifications

Refer to Appendix H for updated Specifications.

4.9 Budget, Project Planning, Monitoring and Control (PPMC), and Risk Analysis

4.9.1 Substantive Class B estimate

A substantive Class B Estimate is included in Appendix C.

4.9.2 Updated Risk Management Plan

The Risk Management Plan, included in Appendix L, identifies major risk elements and proposes mitigating strategies. The detailed plan will continue to be developed through discussion and updates at Project Meetings.

In general, the Plan begins to address issues related to Project Delivery; Site Conditions; External Constraints; and Internal Context.

4.9.3 Updated monthly progress report

1.11.3.1 Executive Summary, August, 2011.

1.11.3.2 Narrative Report

1.11.3.2 Variances Report

4.9.4 List of minutes

Project meeting 1	7 September 2010
Project meeting 2	21 September 2010
Project meeting 3	5 October 2010
Project meeting 4	19 October 2010
Project meeting 5	2 November 2010
Project meeting 6	30 November 2010
Project meeting 7	14 December 2010
Project meeting 8	11 January 2011
Project meeting 9	25 January 2011
Project meeting 10	8 February 2011
Project meeting 11	22 February 2011
Project meeting 12	8 March 2011
Project meeting 13	22 March 2011
Project meeting 14	6 April 2011
Project meeting 15	19 April 2011

Project meeting 16	3 May 2011
Project meeting 17	17 May 2011
Project meeting 18	31 May 2011
Project meeting 19	14 June 2011
Project meeting 20	28 June 2011
Project meeting 21	12 July 2011
Project meeting 22	26 July 2011
Project meeting 23	23 August 2011
Project meeting 24	9 September 2011
Project meeting 25	20 September 2011
Project meeting 26	4 October 2011
Project meeting 27	18 October 2011
Project meeting 28	15 November 2011
Project meeting 29	13 December 2011
Project meeting 30	10 January 2012
Project meeting 31	24 January 2012
Project meeting 32	7 February 2012
Project meeting 33	21 February 2012
Project meeting 34	20 March 2012
Project meeting 35	3 April 2012
Project meeting 36	17 April 2012
Project meeting 37	1 May 2012
Project meeting 38	15 May 2012
Project meeting 39	29 May 2012
Project meeting 40	26 June 2012
Project meeting 41	10 July 2012
Project meeting 42	24 July 2012
Project meeting 43	21 August 2012
Project meeting 44	4 September 2012
Project meeting 45	18 September 2012
Project Meeting 46	2 October 2012

4.10 Presentations

4.11 Rebuttal to PWGSC Quality Assurance Review

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Appendix C: Cost Estimate

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CENTRE BLOCK
VENTILATION TOWERS - OPTION 5
OTTAWA, ONTARIO

REVISED CLASS 'B' ESTIMATE

November 23, 2012
Revised: May 28, 2013

CENTRE BLOCK
VENTILATION TOWERS - OPTION 5
OTTAWA, ONTARIO

REVISED CLASS 'B' ESTIMATE

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November 23, 2012
Revised: May 28, 2013
PROJECT NUMBER: Ott-4710

TABLE OF CONTENTS

Appendices

1. INTRODUCTION

1.1 Purpose: This Revised Class 'B' Estimate is intended to provide a realistic allocation of direct and indirect construction costs for the Centre Block, Ventilation Towers - Option 5, located in Ottawa, Ontario, with exceptions of items listed in 1.5 below.

1.2 Description: This project is rehabilitation of the Centre Block Ventilation Towers. This report will include the work detailed as Integrated Option 1 (recommended):

- Structural Option 1, grouted anchors
- Seismic Option 1, surface mounted reinforcement
- Windows Option 1, conserve existing
- Roof Option 1, replacement
- Louvres Option 1, conserve existing
- Scaffolding Option 5
- Masonry Option 1, deep re-pointing, stone and replacement as required
- Access ladders, new with safety cage and rest stops

1.3 Methodology: From the documentation and information provided, quantities of all major elements were assessed or measured where possible and priced at rates considered competitive for a project of this type under a stipulated lump sum form of contract in Ottawa, Ontario.

Pricing shown reflects probable construction costs obtainable in the Ottawa, Ontario area on the effective date of this report. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the work.

1.4 Specifications: For building components and systems where specifications and design details are not available, quality standards have been established based on discussions with the design team.

1. INTRODUCTION

1.5 Exclusions: This Revised Class 'B' Estimate does not provide for the following, if required:

- Legal fees and expenses
- Right of way charges
- Easement costs
- Financing or fund raising costs
- Owner’s staff and associated management
- Professional fees and expenses
- Cost of contaminated material removal, if required
- Maintenance equipment
- Overtime and restrictive working hours allowance
- Cash allowances
- Phased construction premiums
- Construction contingency
- Preventative maintenance contracts
- Building permit
- Harmonized Sales Tax

2. DOCUMENTATION

This Revised Class 'B' Estimate has been prepared from the following documentation:

Received October 20, 2012:

- House Tower Elevations
- Senate Tower Elevations
- Masonry Treatment List
- A01.1 Existing/New Site Plan
- A02.1 HOC Ladders & WC Plans
- A02.3 Senate New Ladders and Landing Plans
- A04.01 HOC Sections
- A04.2 Senate Sections
- A05.3 Louvres & Windows
- A06.1 Senate WC Elevations & Details
- A06.2 Senate WC Elevations & Details
- A07.1 Senate WC Reflected Ceiling Plans
- S100 Key Plan & Tower Plans
- S101 Senate Tower Sections
- S102 HOC Sections
- SKE-M1 HOC Heating Layout
- SKE-M2 Heating Layout
- SKE-E1 Electrical Layout Demolition & New
- SKE-E2 Electrical Layout Demolition & New
- SKE-E3 Electrical Layout Demolition & New
- SKE-E4 Electrical Layout Demolition & New
- SKE-E5 Electrical Layout Demolition & New
- SKE-E6 Electrical Layout Demolition & New
- Anchors notes and sketches
- Specification
- Comments from QADR dated March 21, 2013

All of the above documentation was received from Watson MacEwen Teramura Architects and was supplemented with information gathered in meeting(s) and telephone conversations with the design team, as applicable.

Design changes and/or additions made subsequent to this issuance of the documentation noted above have not been incorporated in this report.

3. COST CONSIDERATIONS

3.1 Cost Base:

All costs are estimated on the basis of competitive bids (a minimum of six (6) general contractor bids and at least four (4) sub-contractor bids for each trade) being received in October 2012 from general contractors and all major sub-contractors and suppliers based on a stipulated lump sum form of contract.

If the minimum contractor/sub-contractor conditions are not met, the bids received could exceed the estimate.

3.2 Escalation:

A contingency of 3.0% has been included for construction cost escalation that may occur between October 2012 and the anticipated bid date of July 2013 for the project. Escalation during the construction period is included in the unit rates used in the estimate.

3.3 Contingencies:

A contingency of 3.0% has been included to cover design and pricing unknowns. This contingency is not intended to cover any program space modifications but rather to provide some flexibility for the designers and cost planners during the remaining contract document stages.

No contingency has been included to cover construction (post contract) unknowns. It is recommended that a provision for this item be included in the overall program budget.

3.4 Unit Rates:

The unit rates in the preparation of this Revised Class 'B' Estimate include labour and material, equipment, subcontractor's overheads and profits.

3.5 Taxes:

No provision has been made for the Harmonized Sales Tax. It is recommended that the owner make separate provision for HST in the project budget.

3.6 Statement of Probable Costs:

Hanscomb has no control over the cost of labour and materials, the contractor's method of determining prices, or competitive bidding and market conditions. This opinion of probable cost of construction is made on the basis of experience, qualifications and best judgment of the professional consultant familiar with the construction industry. Hanscomb cannot and does not guarantee that proposals, bids or actual construction costs will not vary from this or subsequent cost estimates.

Hanscomb has prepared this estimate in accordance with generally accepted principles and practices. Hanscomb's staff is available to discuss its contents with any interested party.

3.7 Ongoing Cost Control:

Hanscomb recommends that the Owner and design team carefully review this document, including line item description, unit prices, clarifications, exclusions, inclusions and assumptions, contingencies, escalation and mark-ups. If the project is over budget, or if there are unresolved budgeting issues, alternative systems/schemes should be evaluated before proceeding into the next design phase.

Requests for modifications of any apparent errors or omissions to this document must be made to Hanscomb within ten (10) days of receipt of this estimate. Otherwise, it will be understood that the contents have been concurred with and accepted.

It is recommended that a final update estimate be produced by Hanscomb using Bid Documents to determine overall cost changes which may have occurred since the preparation of this estimate. The final updated estimate will address changes and additions to the documents, as well as addenda issued during the bidding process. Hanscomb cannot reconcile bid results to any estimate not produced from bid documents including all addenda.

4. CONSTRUCTION COST ESTIMATE SUMMARY

COST SUMMARY:

-	New Construction	$2,656,600
-	Site Development	$207,100
-	Temporary Enclosures	$3,511,000
	Total- Including Site	**$6,374,700**
-	General Requirements	$1,274,900
-	Fee	$382,500
	Total- Excluding Contingencies	**$8,032,100**
-	Design and Pricing Allowance	$241,000
-	Escalation Allowance	$248,200
-	Construction Allowance	$0
	Total- Including Contingencies	**$8,521,300**
-	Harmonized Sales Tax	$0
	Total Construction Estimate	**$8,521,300**

Appendix
A - Elemental Cost Comparison

Project : Centre Block
: Ventilation Towers
Location : Ottawa, Ontario
Owner : PWGSC
Client : Watson MacEwen Teramura Architects

COMPARISON COST SUMMARY

Report Date: May 28, 2013

Element	Class C Estimate Centre Block Vent Tower Option 4 September 28, 2012 Elemental Amount Sub-total	Total	Class B Estimate Centre Block Vent Tower Option 5 May 28, 2013 Elemental Amount Sub-total	Total	Variance Sub-total	Total
A SHELL		1,869,600		2,340,100		470,500
A1 SUBSTRUCTURE		0		0		0
A11 Foundations	0		0		0	
A12 Basement Excavations	0		0		0	
A13 Special Conditions	0		0		0	
A2 STRUCTURE		0		0		0
A21 Lowest Floor Construction	0		0		0	
A22 Upper Floor Construction	0		0		0	
A23 Roof Construction	0		0		0	
A3 EXTERIOR CLADDING		1,869,600		2,340,100		470,500
A31 Walls Below Grade	0		0		0	
A32 Walls Above Grade	1,333,400		1,739,200		405,800	
A33 Windows and Entrances	270,200		282,200		12,000	
A34 Roof Coverings	234,000		286,700		52,700	
A35 Projections	32,000		32,000		0	
B INTERIORS		135,000		157,000		22,000
B1 PARTITIONS & DOORS		5,000		8,700		3,700
B11 Partitions	5,000		8,700		3,700	
B12 Doors	0		0		0	
B2 FINISHES		88,000		95,000		7,000
B21 Floor Finishes	2,000		3,900		1,900	
B22 Ceiling Finishes	2,000		2,500		500	
B23 Wall finishes	84,000		88,600		4,600	
B3 FITTINGS & EQUIPMENT		42,000		53,300		11,300
B31 Fittings & Fixtures	42,000		53,300		11,300	
B32 Equipment	0		0		0	
B33 Elevators	0		0		0	
B34 Escalators	0		0		0	
C SERVICES		159,500		159,500		-
C1 MECHANICAL		89,500		89,500		0
C11 Plumbing & Drainage	9,500		9,500		0	
C12 Fire Protection	0		0		0	
C13 HVAC	80,000		80,000		0	
C14 Controls	0		0		0	
C2 ELECTRICAL		70,000		70,000		0
C21 Service & Distribution	70,000		70,000		0	
C22 Lighting & Power	0		0		0	
C23 Systems & Ancillaries	0		0		0	
NET BUILDING COST - EXCLUDING SITE		$ 2,164,100		$ 2,656,600		$ 492,500
D1 SITE WORK		70,000		207,100		137,100
D11 Site Development	50,000		187,100		137,100	
D12 Mechanical Site Services	0				0	
D13 Electrical Site Services	20,000		20,000		0	
D2 ANCILLARY WORK		6,925,600		3,511,000		-3,414,600
D21 Demolition	0				0	
D22 Temporary Enclosures	6,925,600		3,511,000		-3,414,600	
NET BUILDING COST - INCLUDING SITE		$ 9,159,700		$ 6,374,700		$ (2,785,000)
Z1 GENERAL REQUIREMENTS & FEE		1,465,600		1,657,400		191,800
Z11 General Requirements	1,465,600		1,274,900		-190,700	
Z12 Fee			382,500		382,500	
TOTAL EXCLUDING CONTINGENCIES		$ 10,625,300		$ 8,032,100		$ (2,593,200)
Z2 ALLOWANCES		1,477,500		489,200		-988,300
Z21 Design contingency	956,300		241,000		-715,300	
Z22 Escalation contingency	521,200		248,200		-273,000	
Z23 Construction contingency	0				0	
TOTAL INCLUDING CONTIGENCIES		$ 12,102,800		$ 8,521,300		$ (3,581,500)
__ HARMONIZED SALES TAX EXCLUDED		0		0		0
__ Harmonized Sales Tax	0		0		0	
TOTAL CONSTRUCTION ESTIMATE		$ 12,102,800		$ 8,521,300		$ (3,581,500)

Gross Floor Area	881 m2	881 m2	- m2
Rate Per m2	$ 13,737.57 m2	$ 9,672.30 m2	$ (4,065.27) m2

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Appendix
B - Detailed Elemental Cost Estimate

Project : **Centre Block**
: **Ventilation Towers - Option 5**
Location : **Ottawa, Ontario**
Owner : **PWGSC**
Consultant : **Watson MacEwen Teramura Architects**

ELEMENTAL COST SUMMARY

Report date : 28 May 2013
Page No. : 1
Bldg Type : 312
C.T. Index : 0.0
GFA : 881 m2

Element	Ratio to GFA	Elemental Cost Quantity	Elemental Cost Unit rate	Elemental Amount Sub-Total	Elemental Amount Total	Rate per m2 Sub-Total	Rate per m2 Total	%
A SHELL		881 m2			2,340,100		2,656.19	29.1
A1 SUBSTRUCTURE					0		0.00	0.0
A11 Foundations				0		0.00		
A12 Basement Excavation				0		0.00		
A13 Special Conditions				0		0.00		
A2 STRUCTURE					0		0.00	0.0
A21 Lowest Floor Construction				0		0.00		
A22 Upper Floor Construction				0		0.00		
A23 Roof Construction				0		0.00		
A3 EXTERIOR ENCLOSURE					2,340,100		2,656.19	29.1
A31 Walls Below Grade				0		0.00		
A32 Walls Above Grade	0.590	518 m2	3,358.00	1,739,200		1,974.12		
A33 Windows & Entrances	0.060	55 m2	5,131.00	282,200		320.32		
A34 Roof Coverings	0.160	144 m2	1,991.00	286,700		325.43		
A35 Projections	0.000	1 Sum	32,000.00	32,000		36.32		
B INTERIORS		881 m2			157,000		178.21	2.0
B1 PARTITIONS & DOORS					8,700		9.88	0.1
B11 Partitions	0.000	1 Sum	8,700.00	8,700		9.88		
B12 Doors				0		0.00		
B2 FINISHES					95,000		107.83	1.2
B21 Floor Finishes	0.020	14 m2	279.00	3,900		4.43		
B22 Ceiling Finishes	0.020	14 m2	179.00	2,500		2.84		
B23 Wall Finishes	1.310	1,156 m2	77.00	88,600		100.57		
B3 FITTINGS & EQUIPMENT					53,300		60.50	0.7
B31 Fittings & Fixtures	1.000	881 m2	60.00	53,300		60.50		
B32 Equipment				0		0.00		
B33 Elevators				0		0.00		
B34 Escalators				0		0.00		
C SERVICES		881 m2			159,500		181.04	2.0
C1 MECHANICAL					89,500		101.59	1.1
C11 Plumbing & Drainage	0.000	1 Sum	9,500.00	9,500		10.78		
C12 Fire Protection				0		0.00		
C13 HVAC	0.000	1 Sum	80,000.00	80,000		90.81		
C14 Controls				0		0.00		
C2 ELECTRICAL					70,000		79.46	0.9
C21 Service & Distribution	0.000	1 Sum	70,000.00	70,000		79.46		
C22 Lighting, Devices & Heating				0		0.00		
C23 Systems & Ancillaries				0		0.00		
NET BUILDING COST - EXCLUDING SITE				**$**	**2,656,600**		3,015.44	33.1
D SITE & ANCILLARY WORK		881 m2			3,718,100		4,220.32	46.3
D1 SITE WORK					207,100		235.07	2.6
D11 Site Development	0.000	1 Sum	187,100.00	187,100		212.37		
D12 Mechanical Site Services				0		0.00		
D13 Electrical Site Services	0.000	1 Sum	20,000.00	20,000		22.70		
D2 ANCILLARY WORK					3,511,000		3,985.24	43.7
D21 Demolitions				0		0.00		
D22 Temporary Enclosures	1.100	973 m2	3,608.00	3,511,000		3,985.24		
NET BUILDING COST - INCLUDING SITE				**$**	**6,374,700**		7,235.75	79.4
Z1 GENERAL REQUIREMENTS & FEE					1,657,400		1,881.27	20.6
Z11 General Requirements		20.0 %		1,274,900		1,447.11		
Z12 Fee		5.0 %		382,500		434.17		
TOTAL CONSTRUCTION ESTIMATE - EXCLUDING ALLOWANCES				**$**	**8,032,100**		9,117.03	100.0
Z2 ALLOWANCES					489,200		555.28	
Z21 Design & Pricing Allowance		3.0 %		241,000		273.55		
Z22 Escalation Allowance		3.0 %		248,200		281.73		
Z23 Construction Allowance		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE - INCLUDING ALLOWANCES				**$**	**8,521,300**		9,672.30	
_ HARMONIZED SALES TAX					0		0.00	
__ Harmonized Sales Tax		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE				**$**	**8,521,300**	**$**	**9,672.30**	

A3 EXTERIOR ENCLOSURE		Quantity	Unit rate	Amount	Trade
A32	Walls Above Grade				
	House of Commons Tower				
1	Structural	419 m2	286.40	120,000	
	- Horizontal grouted anchors, 100mm diameter, supply & install	48 no.	2,500.00	120,000	
	- Removal and replacement of quoin stones, measured below		nil		
2	Seismic	419 m2	564.20	236,400	
	- Vertical reinforcement channels	16,915 kg	10.00	169,200	
	- 40mm dia grouted anchors 500mm long	448 no.	150.00	67,200	
3	Masonry Repairs	419 m2	948.70	397,500	
	- Remove and replace quoin stone units required for horizontal anchors	48 no.	400.00	19,200	
	- Repointing	419 m2	250.00	104,800	
	- Sandstone replacement supply	62 m2	250.00	15,500	
	- Nepean limestone replacement supply	24 m2	250.00	6,000	
	- Interior brick replacement c/w access allowance	314 m2	500.00	157,000	
	- Aveolar decay	3 m2	450.00	1,400	
	- Removal of efforescence	23 m2	150.00	3,500	
	- Gypsum crust removed	1 m2	250.00	300	
	- Remove pigeon dirt	2 m2	150.00	300	
	- Replace sedimenary bedding (50%)	5 m2	650.00	3,300	
	- Dutchman repair - medium	63 no.	1,200.00	75,600	
	- Replace stone due to stone damaged beyond repair	6 m2	850.00	5,100	
	- Repair crack -250mm	4 m	350.00	1,400	
	- Repair crack +250mm	5 m	750.00	3,800	
	- Repair exisitng parging	1 m2	250.00	300	
4	Allowance for dismantle and rebuild roof stacks with vertical reinforcement		allow	30,000	
5	Removal of existing chimney flue	52 m	350.00	18,200	
	Senate Tower				
6	Structural	499 m2	240.50	120,000	
	- Horizontal grouted anchors, 100mm diameter, supply & install	48 no.	2,500.00	120,000	
	- Removal and replacement of quoin stones, measured below		nil		
			Carried Forward :	922,100	

A3 EXTERIOR ENCLOSURE	Quantity	Unit rate	Amount	Trade
A32 Walls Above Grade (Continued)		**Brought Forward :**	922,100	
7 Seismic	499 m2	473.70	236,400	
- Vertical reinforcement channels	16,915 kg	10.00	169,200	
- 40mm dia grouted anchors 500mm long	448 no.	150.00	67,200	
8 Masonry Repairs	499 m2	866.70	432,500	
- Remove and replace quoin stone units required for horizontal anchors	48 no.	400.00	19,200	
- Repointing	413 m2	250.00	103,300	
- Sandstone replacement - supply	62 m2	250.00	15,500	
- Nepean limestone replacement - supply	24 m2	250.00	6,000	
- Interior brick replacement c/w access alllowance	300 m2	500.00	150,000	
- Aveolar decay	2 m2	450.00	900	
- Remove copper staining	1 m2	150.00	200	
- Removal of efflorescence	69 m2	150.00	10,400	
- Gypsum crust removed	1 m2	250.00	300	
- Remove pigeon dirt	1 m2	150.00	200	
- Replace sedimenary bedding (50%)	2 m2	650.00	1,300	
- Dutchman repair - medium	45 no.	1,200.00	54,000	
- Replace stone due to stone damaged beyond repair	80 m2	850.00	68,000	
- Repair crack -250mm	4 m	350.00	1,400	
- Repair crack +250mm	2 m	750.00	1,500	
- Repair exisitng parging	1 m2	250.00	300	
9 Allowance for dismantle and rebuild roof stacks with vertical reinforcement		allow	30,000	
10 Removal of existing chimney flue	52 m	350.00	18,200	
11 Allowance for Masonry Conservator	1 sum	100,000.00	100,000	
A32 Walls Above Grade **TOTAL : $**	518 m2	3,357.53	1,739,200	

A3 EXTERIOR ENCLOSURE	Quantity	Unit rate	Amount	Trade
A33 Windows & Entrances				
House of Commons Tower				
1 Louvres	19 m2	4,078.90	77,500	
- Iron screens: remove, electrolytic reduction, epoxy prime & paint, reinstal with ss anchor	20 m2	1,500.00	30,000	
- Copper louvres: wash & brush clean, solder damaged sections, repatina as required	19 m2	2,500.00	47,500	
2 Windows	6 m2	8,933.30	53,600	
- W5, remove, repair, paint & prime, reinstall glazing, reinstall with stainless steel anchors	4 no.	5,000.00	20,000	
- W8, remove, repair, paint & prime, reinstall glazing, reinstall with stainless steel anchors	24 no.	1,400.00	33,600	
Senate Tower				
3 Louvres	19 m2	4,078.90	77,500	
- Iron screens: remove, electrolytic reduction, epoxy prime & paint, reinstall with ss anchors	20 m2	1,500.00	30,000	
- Copper louvres: wash & brush clean, solder damaged sections, repatina as required	19 m2	2,500.00	47,500	
4 Windows	9 m2	8,177.80	73,600	
- W5, remove, repair, paint & prime, reinstall glazing, reinstall with stainless steel anchors	8 no.	5,000.00	40,000	
- W8, remove, repair, paint & prime, reinstall glazing, reinstall with stainless steel anchors	24 no.	1,400.00	33,600	
5 Exist door at grade, no work measured		nil		
A33 Windows & Entrances **TOTAL : $**	55 m2	5,130.91	282,200	

A3 EXTERIOR ENCLOSURE		Quantity	Unit rate	Amount	Trade
A34	Roof Coverings				
	House of Commons Tower				
1	Remove and install new copper roofing	72 m2	1,500.00	108,000	
2	Allowance for repairs to decking	72 m2	125.00	9,000	
3	Replacement of existing mod bit roofing membrane	145 m2	180.00	26,100	
	Senate Tower				
4	Remove and install new copper roofing	72 m2	1,500.00	108,000	
5	Allowance for repairs to decking	72 m2	125.00	9,000	
6	Replacement of existing mod bit roofing membrane	148 m2	180.00	26,600	
A34 Roof Coverings	TOTAL : $	144 m2	1,990.97	286,700	

A3 EXTERIOR ENCLOSURE	Quantity	Unit rate	Amount	Trade
A35 Projections				
House of Commons Tower				
1 Allowance for reinforcement of upper stone short stacks, allowance	4 no.	4,000.00	16,000	
Senate Tower				
2 Allowance for reinforcement of upper stone short stacks, allowance	4 no.	4,000.00	16,000	
A35 Projections **TOTAL : $**	1 Sum	32,000.00	32,000	

B1 PARTITIONS & DOORS	Quantity	Unit rate	Amount	Trade
B11 Partitions				
House of Commons Tower				
1 Assume no partition restoration required		nil		
Senate Tower				
2 Removal of existing partitions	28 m2	25.00	700	
3 New partitions to washrooms	84 m2	95.00	8,000	
B11 Partitions **TOTAL : $**	1 Sum	8,700.00	8,700	

B2 FINISHES		Quantity	Unit rate	Amount	Trade
B21	Floor Finishes				
	House of Commons Tower				
1	Assume no work required		nil		
	Senate Tower				
2	Removal of existing flooring	14 m2	100.00	1,400	
3	New floor ceramic tile	14 m2	175.00	2,500	
B21 Floor Finishes	**TOTAL : $**	14 m2	278.57	3,900	

B2 FINISHES		Quantity	Unit rate	Amount	Trade
B22	Ceiling Finishes				
	House of Commons Tower				
1	Assume no work required		nil		
	Senate Tower				
2	Removal of existing ceiling	14 m2	75.00	1,100	
3	New acoustic ceiling tile	7 m2	75.00	500	
4	Painted suspended gypsum board	7 m2	125.00	900	
B22 Ceiling Finishes	**TOTAL : $**	14 m2	178.57	2,500	

B2 FINISHES		Quantity	Unit rate	Amount	Trade
B23	Wall Finishes				
	House of Commons Tower				
1	Removal of efflorescence to interior walls	260 m2	150.00	39,000	
2	Replace interior brick, measured elsewhere	252 m2	0.00	0	
3	Allowance for restoration as required		allow	2,000	
	Senate Tower				
4	Removal of efflorescence to interior walls (50%)	260 m2	150.00	39,000	
5	Replace interior brick, measured elsewhere	300 m2	0.00	0	
6	Allowance for restoration of washrooms on first and second floor and other areas affected		allow	4,000	
7	Paint to walls	63 m2	15.00	900	
8	Ceramic wall tile	21 m2	175.00	3,700	
B23 Wall Finishes	TOTAL : $	1,156 m2	76.64	88,600	

B3 FITTINGS & EQUIPMENT		Quantity	Unit rate	Amount	Trade
B31	Fittings & Fixtures				
	House of Commons Tower				
1	Assume new washroom accessories not required		nil		
2	Remove and install new ladder c/w guard	7 no.	2,500.00	17,500	
3	New hatch within existing grating	1 no.	1,500.00	1,500	
4	Infill existing grating c/w anchors	2 no.	750.00	1,500	
5	Infill existing opening with concrete c/w anchors	2 no.	1,500.00	3,000	
	Senate Tower				
6	Remove and install new ladder c/w guard	7 no.	2,500.00	17,500	
7	Allowance for new washroom accessories, as required	2 no.	3,150.00	6,300	
	- Remove existing accessories	2 sets	500.00	1,000	
	- New vanity	4 m	750.00	3,000	
	- Grab bars	2 sets	450.00	900	
	- Toilet paper dispenser	2 no.	125.00	300	
	- Soap dispenser	2 no.	50.00	100	
	- Mirror	2 no.	150.00	300	
	- Paper towel/waste disposal combo unit	2 no.	350.00	700	
8	New hatch within existing grating	1 no.	1,500.00	1,500	
9	Infill existing grating c/w anchors	2 no.	750.00	1,500	
10	Infill existing opening with concrete c/w anchors	2 no.	1,500.00	3,000	
B31 Fittings & Fixtures	TOTAL : $	881 m2	60.50	53,300	

C1 MECHANICAL	Quantity	Unit rate	Amount	Trade
C11 Plumbing & Drainage				
1 Dismantle existing WC in Senate tower and rebuild after masonry works completed	1 sum	9,500.00	9,500	
- Disconnect and carefully remove existing plumbing fixture, protect and reinstall in the same location	4 no.	1,000.00	4,000	
- Cap and protect existing DCW/DHW & SAN pipes during the construction work	1 sum	2,000.00	2,000	
- Testing, verification etc.	1 sum	2,000.00	2,000	
- Miscellaneous such as mobilization , start up & cleaning etc.	1 sum	1,500.00	1,500	
C11 Plumbing & Drainage **TOTAL : $**	1 Sum	9,500.00	9,500	

C1 MECHANICAL	Quantity	Unit rate	Amount	Trade
C13 HVAC				
1 Temporary relocation of existing mechanical services to provide access to masonry (allow $40000 per tower)	1 sum	80,000.00	80,000	
C13 HVAC **TOTAL : $**	1 Sum	80,000.00	80,000	

C2 ELECTRICAL	Quantity	Unit rate	Amount	Trade
C21 Service & Distribution				
1 Temporary relocation of existing electrical services to provide access to masonry work (allow $25000 per tower)	1 sum	50,000.00	50,000	
2 Final remedial works for lightning protection system in ventilation towers (allow $10000 per tower)	1 sum	20,000.00	20,000	
C21 Service & Distribution **TOTAL : $**	1 Sum	70,000.00	70,000	

D1 SITE WORK		Quantity	Unit rate	Amount	Trade
D11	Site Development				
	House of Commons Tower				
1	Remove granite pavers and store for reinstallation	38 m2	100.00	3,800	
2	Remove concrete sidewalk	27 m2	75.00	2,000	
3	Remove asphalt paving	79 m2	35.00	2,800	
4	Remove existing sod	231 m2	10.00	2,300	
5	Gravel working base 300mm thick	124 m3	65.00	8,100	
6	Decorative steel fence on prefabricated jersey barrier	66 m	750.00	49,500	
7	Double gate for vehicle access	1 pr.	6,500.00	6,500	
8	Man gate	2 no.	750.00	1,500	
9	Remove existing fencing	66 m	250.00	16,500	
10	Remove vehicle gates	1 pr,	1,500.00	1,500	
11	Remove man gates	2 no.	200.00	400	
12	Reinstall granit pavers	38 m2	75.00	2,900	
13	New concrete sidewalk	27 m2	95.00	2,600	
14	New asphalt paving	79 m2	75.00	5,900	
15	New sod and top soil	231 m2	10.00	2,300	
	Senate Tower				
16	Remove granite pavers and store for reinstallation	17 m2	100.00	1,700	
17	Remove concrete sidewalk	16 m2	75.00	1,200	
18	Remove asphalt paving	172 m2	35.00	6,000	
19	Remove existing sod	62 m2	10.00	600	
			Carried Forward :	118,100	

D1 SITE WORK		Quantity	Unit rate	Amount	Trade
D11	Site Development (Continued)		**Brought Forward :**	118,100	
20	Gravel working base 300mm thick	104 m3	65.00	6,800	
21	Decorative steel fence on prefabricated jersey barrier	36 m	750.00	27,000	
22	Double gate for vehicle access	1 pr.	6,500.00	6,500	
23	Man gate	2 no.	750.00	1,500	
24	Remove existing fencing	36 m	250.00	9,000	
25	Remove vehicle gates	1 pr,	1,500.00	1,500	
26	Remove man gates	2 no.	200.00	400	
27	Reinstall granit pavers	17 m2	75.00	1,300	
28	New concrete sidewalk	16 m2	95.00	1,500	
29	New asphalt paving	172 m2	75.00	12,900	
30	New sod and top soil	62 m2	10.00	600	
D11	Site Development **TOTAL : $**	1 Sum	187,100.00	187,100	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services				
1 Allowance for relocation of lighting standards		allow	20,000	
D13 Electrical Site Services **TOTAL : $**	1 Sum	20,000.00	20,000	

D2 ANCILLARY WORK		Quantity	Unit rate	Amount	Trade
D22	Temporary Enclosures				
1	Building Supported - House of Commons Tower	414 m2	3,064.70	1,268,800	
	- Tube & clamp scaffolding c/w dismantling	1 sum	673,000.00	673,000	
	- Tarping - screen	1 sum	107,800.00	107,800	
	- Structural steel transfer beams	1 sum	400,000.00	400,000	
	- Transfer beam opening in tower	1 sum	80,000.00	80,000	
	- Roof membrane to scaffolding	1 sum	8,000.00	8,000	
2	Building Supported - Senate Tower	529 m2	2,398.50	1,268,800	
	- Tube & clamp scaffolding c/w dismantling	1 sum	673,000.00	673,000	
	- Tarping - screen	1 sum	107,800.00	107,800	
	- Structural steel transfer beams	1 sum	400,000.00	400,000	
	- Transfer beam opening in tower	1 sum	80,000.00	80,000	
	- Roof membrane to scaffolding	1 sum	8,000.00	8,000	
	Note: The above costs were developed by Cleland Jardine Engineering Ltd., dated May 24, 2012, Option 1				
3	Allowance for interior support within the chambers		allow	500,000	
4	Interior scaffolding allowance, House of Commons Tower	419 m2	250.00	104,800	
5	Interior scaffolding allowance, Senate Tower	499 m2	250.00	124,800	
6	Temporary domestic water supply for tower rehabilitation work	1 sum	25,000.00	25,000	
	- Insulated risers in enclosure	100 m	140.00	14,000	
	- Hose bib connections, allow	6 no.	400.00	2,400	
	- Connect new risers to existing 8" DCW main in Centre Block basement	1 sum	5,000.00	5,000	
	- Allow for booster pump	1 no.	3,600.00	3,600	
7	Temporary fire protection to construction during the rehabilitation works	1 sum	24,000.00	24,000	
	- 100mm sch. 40 dry standpipe riser in each stair well (2x50m)	100 m	125.00	12,500	
	- Siamese connection at bottom of en closure to connect to fire truck	2 no.	1,500.00	3,000	
	(Continued)				
			Carried Forward :	3,316,200	

D2 ANCILLARY WORK	Quantity	Unit rate	Amount	Trade
D22 Temporary Enclosures (Continued)		**Brought Forward :**	3,316,200	
7 Temporary fire protection to construction during the rehabilitation works (Continued)				
- 64mm hose connections at main landings (2x17)	34 no.	250.00	8,500	
8 Temporary power service during tower renovation works	1 sum	83,800.00	83,800	
- 225A service from existing 225A-3P spare breaker in 600V panel IBR-3- 1, part of switchboard #1		note		
- Plywood construct equipment enclosure on existing roof	3 no.	1,500.00	4,500	
- 3 conductor #3/0-CU-TECK cable in PVC jacket from basement existing 600V panel, allow	80 m	95.00	7,600	
- 100A, 600V, 3p, 3w feeder from enclosure to temp. construction power kiosks in each tower, allow	260 m	70.00	18,200	
- 225A, 600V, 3ph, 3w splitter box	1 no.	500.00	500	
- 100A, 3p, 3w fused switch	2 no.	500.00	1,000	
- Kiosk c/w 100A,600V, 3ph disconnet switch, 100A splitter & fused switches, TX for panelboard	2 sum	6,000.00	12,000	
- Allow for grounding and lightning protection c/w ground rods	2 sum	20,000.00	40,000	
9 Temporary lighting	1 sum	36,000.00	36,000	
- Allow for fixtures c/w wiring, control switches etc.	2 sum	8,000.00	16,000	
- Emergency lighting battery units to illuminate exit route & stair	2 sum	6,000.00	12,000	
- Exit signs to indicate exact route	2 sum	4,000.00	8,000	
10 Temporary fire alarm system	1 sum	50,000.00	50,000	
- FA control panels, devices, connections, conduit & wiring	2 sum	25,000.00	50,000	
11 Remove all temorary mechanical & electrical survices after rehabilitation works and reverify the systems, allow	1 sum	25,000.00	25,000	
D22 Temporary Enclosures **TOTAL : $**	973 m2	3,608.43	3,511,000	

Appendix H: Outline Specification

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No of Pages

TITLE PAGE

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 2 - SITEWORK

DIVISION 3 – CONCRETE

DIVISION 04 - MASONRY

DIVISION 05 - METALS

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

DIVISION 08 - OPENINGS

DIVISION 09 - FINISHES

DIVISION 21 – FIRE SUPPRESSION

DIVISION 22 – PLUMBING

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

DIVISION 26 - ELECTRICAL

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

END OF LIST OF CONTENTS

Appendix J: Heritage Character Statement

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Ottawa, Ontario
Centre Block
Parliament Hill

HERITAGE CHARACTER STATEMENT

The Centre Block was built during the period 1916-1927 to the designs of John A. Pearson, architect and J.O. Marchand, associate architect. It replaced the original Centre Block (1859-1865 Thomas Fuller and Chilion Jones) destroyed by fire in 1916. It is under the care of Public Works Canada. See FHBRO Building Report 86-52.

Reason for Designation

On January 16, 1986, the Centre Block was designated Classified because of its exceptional significance as a national landmark. It has come to symbolize Canada's nationhood, not only because of its historical associations as the site since 1922 of both the House of Commons and the Senate, but also because of the ceremonial and iconographic design and detailing of the building itself.

Character Defining Elements

The Centre Block was consciously designed as a symbol of Canada. The whole of its exterior, centred on the Peace Tower, its many public interiors and its ceremonial circulation spaces are inextricably entwined with its symbolic and practical functions as the seat of government, and thus embody its heritage character.

The Centre Block is an example of the design methodology of the Ecole des Beaux Arts applied to a Gothic design vocabulary. Its character derives from the relationship between Beaux Arts and Gothic. The Beaux Art method gave the building its symmetry of plan and composition and its clear functional layout reinforced by a carefully considered hierarchy of space. Beaux Arts regularity infuses the building; it is essential to the order and formality that form a large part of its heritage character.

The Gothic ornament of the building has an important symbolic value. This is a very regularized Gothic; it does not aspire to a 19th century picturesqueness. The ornamental scheme is carefully worked out to reinforce the clear reading of the building and its hierarchy of space. A thorough understanding of this ornamental system is fundamental to the appropriate care of the building.

The on-going carving program in the building has become a small part of its heritage character. In this and other decorative work -- and a distinction must be drawn between ornament and decoration -- some stylistic evolution is to be expected. The original

.../2

design of the building made ample provision for continuing decoration, which has generally to date taken the form of commemorative devices. It is important that decoration not be allowed to obscure the architectural clarity of the building.

The Centre Block was reglazed some years ago. This work is noticeably badly detailed.

1987.02.04

Appendix K: Commissioning Plan

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Commissioning Plan

Project: **Centre Block Ventilation Towers Rehabilitation**
Project number: **R.008227.002**
Revision no: **01 – 10/12/2012**

1. Importance and purpose of the Commissioning Plan

The Commissioning Plan is the master **planning tool** relating to commissioning, setting out scope, standards, roles and responsibilities, expectations, deliverables, etc. It provides an overview of commissioning, a general description of all elements that make up the Commissioning Plan, and sets out the process and the methodology for successful commissioning of the above-mentioned project.

The Commissioning Plan functions as a **management tool**, setting out the scope standards of commissioning, roles and responsibilities of each member of the Project Commissioning Team and deliverables

The Commissioning Plan also functions as a **communications tool**, addressed to all members of the Project Design, Design Quality Review, Construction, Commissioning and Property Management Teams and informing each member of each team, in general terms, of their own roles and responsibilities and those of all the other members of the teams.

2. Production of the Commissioning Plan

The Designer will produce the Commissioning Plan using input from the Project Commissioning Team.

3. Revisions to this Commissioning Plan

The Commissioning Plan will be reviewed, revised, refined and updated as detailed design and production of the working documents proceeds and, if required, every 6 months during construction.

Each time it is revised, the revision number and date will also be revised. The revised Commissioning Plan shall be submitted to the PWGSC Project Manager and PWGSC Commissioning Manager for review and approval.

4. Composition, roles and responsibilities

The Commissioning Plan is intended to be used by the:

.1 **PWGSC Project Manager:** who has the overall responsibility for the project and is the sole point of contact between the Client, the Designer, the Commissioning Manager and all other members of the project team.

.2 **PWGSC Design Quality Review Team:** who conducts detailed reviews from the functional perspective during all stages of the design to ensure appropriate design criteria, design intents, design solutions, that designs are well-developed, commissioning specifications are appropriate to this project, transmits technical design information to the Designer via the Project Manager. During construction, may conduct periodic site reviews to observe general progress.

.3 **PWGSC QA Commissioning Manager:** who ensures that all commissioning activities are carried out so as to ensure the delivery of a fully operational project complete in every respect.. This includes reviews of all commissioning documentation from the operational perspective, reviews for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under all conditions of operation, protection of health, welfare, safety and comfort of occupants and O&M personnel. The PWGSC Commissioning Manager works closely with all other members of the Commissioning Team. The PWGSC Commissioning Manager is also responsible for monitoring all commissioning activities, training and development of commissioning documentation.

.4 **Designer (i.e. Consultant):** who designs the facility to meet the Client's functional and operational requirements and budget, prepares all working documents, including incorporation of commissioning specifications in to construction specifications, organizing commissioning, monitoring commissioning activities, witnessing and certifying the accuracy of reported results, witnessing and certifying TAB and other tests, develops Building Management Manual, ensures the implementation of this Commissioning Plan, performing verification of performance of all installed systems, implementation of Training Plan.

.5 **Construction Team:** which consists of Contractor, sub-contractors, suppliers and other support disciplines, The Contractor is responsible for construction/installation in accordance with the contract documents, including testing, performance of commissioning activities, delivery of training and all commissioning documentation.. For administrative and co-ordination purposes, the Contractor assigns one person as the point of contact with the Designer and the PWGSC Commissioning Manager.

.6 **Contractor's Commissioning Agent:** who implements all commissioning activities required by the specifications, including demonstrations, training, testing, preparation and submission of test reports. This is a responsibility that is distinct from that of the Contractor's site supervisor.

.7 **Property Manager**: Has responsibility for receiving the renovated facility and is responsible for day-to-day operation and maintenance of the facility and represents the lead role in the Operation Phase and onwards.

5. Commissioning participants

.1 The following commissioning participants are employed in the following situations to verify performance of all equipment and systems (all as specified in greater detail in the commissioning specifications).

.1 **The installing contractor or installing subcontractor:** All equipment and systems except as noted herein.

.2 **Equipment manufacturer:** Equipment specified to be installed and started up by the manufacturer (e.g. elevators, emergency generators). These will also require performance verification**.**

.3 **Specialist subcontractor:** Equipment and systems supplied and installed by a specialist subcontractor (e.g. EMCS, fire alarm systems).

.4 **Specialist commissioning agency:** possessing specialist qualifications eg, environmental space conditions, indoor air quality (IAQ) and other installations providing environments which are essential to the Client's program but are outside the scope or expertise of other commissioning specialists on this project. If not specified in the commissioning specifications, the identity of this specialist will be provided at a later date.

.5 **Contractor's TAB agency:** Equipment and systems involving the measurement and adjusting of flow rates and pressures to meet indicated or specified values (e.g. Includes, but not necessarily limited to, ducted air and hydronic systems, fans, pumps).

NOTE : TAB is a construction contractor's activity which permits the Designer to certify the results of the performance verification tests of the installed design to the satisfaction of the Commissioning Manager.

.6 **PWGSC Commissioning Manager:** Some conditions or situations which fall outside the scope of this contract (eg. emergency evacuation).

.7 **Client:** Intrusion and access security systems.

.2 Each commissioning participant will:

.1 have a work force large enough to complete the work (including all necessary remedial work) within the scheduled time frame,

.2 be available for emergency and troubleshooting service during the first year of occupancy by the User for adjustments and modifications outside the responsibility of the O&M personnel. These include changes to ventilation rates to meet changes in off-gassing, changes to heating or cooling loads beyond the ranges of the EMCS, and changes to EMCS control strategies beyond the level of training provided to the O&M personnel, re-balancing of electrical distribution services, changes to fire alarm systems as may become apparent, modifications to PA and voice communications systems, etc.

.3 The names of all commissioning personnel, details of instruments which will be used and commissioning procedures which will be followed will be provided at least [3] months prior to the scheduled starting date of commissioning so as to permit proper review and approvals.

6. Risk assessment

To follow

7. Objective of commissioning

Commissioning will provide a fully functional facility:

.1 whose systems, equipment and components have been proven to meet all User's functional requirements before the date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under all normal loads

.2 in which the *[facility User and]* O&M personnel will have been fully trained in all aspects of all installed systems

.3 having optimized life cycle costs

.4 having complete documentation relating to all installed equipment and systems

8. Extent of commissioning

.1 General:

This preliminary Commissioning Plan is based upon the RFP and has been prepared prior to the development of the Conceptual Design. It is possible, therefore, at this time to refer to systems only in very general terms. Systems to be commissioned shall include:

.2 Architectural and structural:

.1 Masonry
.2 Structural Reinforcing
.3 Roof
.4 Windows and Louvers

.3 Mechanical

.1 HVAC systems
.2 Exhaust systems and related make-up systems
.3 Indoor space conditions
.4 Plumbing and other building services
.5 Wet and dry pipe sprinkler systems
.6 Standpipe & hose systems

.7 Environmental control systems
.8 Noise and vibration control systems
.9 Seismic restraint and control measures

.4 Electrical

.1 High voltage switch gear and transformation equipment and high voltage distribution systems
.2 Low voltage (below 750 V) distribution systems
.3 Emergency power generation
.4 Lighting equipment and distribution systems
.5 Fire exit emergency signage
.6 Transfer switches and controllers, annunciators
.7 Fire alarm systems, control panels
.8 Fire alarm batteries
.9 Fire alarm systems
.10 Electronic data and communications information systems
.11 Intrusion and access security and safety systems
.12 Emergency lighting systems
.13 Lightning protection systems

9. Deliverables relating to O&M perspectives

.1 General requirements:

.1 The following list of deliverables may not be complete – others may have been added as detailed design develops.
.2 The following is a brief overview of the deliverables. A more detailed description of requirements will be provided as required.
.3 The Designer shall utilize a computer-based data management system. This will include the cost of all labour, material and EDP equipment to deliver the program (e.g. "as-built" drawings and specifications, PV and commissioning documentation, Building Management Manual, and Training Plan).
.4 Separate manuals shall be compiled - one inn English and one in French.
.5 Deliverable will include duplicate discs and two (2) hard copies.
.6 All documentation shall be transferred to the Property Manager in a computer-compatible format that can be readily inputted for data management.

.2 Building Management Manual

This shall be produced by the Designer with input from the PWGSC Commissioning Manager and Property Manager in a format to be approved by the PWGSC Project Manager. The Commissioning Manager will monitor its development, content, etc. at all stages of production, with the PWGSC Design Quality Review Team involved in all reviews. This manual will be organized so that keeping it up-to-date will require minimum time and resources. Electronic media will be used for data storage and retrieval to the fullest extent possible. Depending upon RFP requirements, separate manuals may be compiled – one in French, one in English. Deliverables will include duplicate discs and [two] hard copies. It will be organized as described in *CP.4 - Guide to the development of Building Management Manuals*. Among many other items, this document includes:

.1 **Design criteria, design intents, operating parameters**: These are described in Part 2 - Design criteria, design intent, design philosophy. And will be identified in the "As Designed" columns of the PV report forms.

.2 **Standard Operating Procedures (SOP) Manual:** fully described in Part 3: System operation and maintenance.

.3 **Operating and Maintenance (O&M) Manual**: fully described in Part 3: System Operation and Maintenance.

.4 **Life Safety Compliance (LSC) Manual:** Fully described in Part 4: Building Management.

.5 **WHMIS information:**. Fully described in Part 5: Supporting Appendices.

.6 **Electrical panel inventory** indicating detailed inventory of electrical circuitry, per panel board, installed or modified as part of this project. Manual is to be in conformance with details outlined in the PWGSC Electrical Panel Work Authorization (PEPWA). Manual format to be approved by the Commissioning Manager. Samples of existing electrical panel inventories for PPD buildings are available from the Commissioning Manager

.3 **Operation and maintenance budget**

A preliminary O&M budget will be established by the Designer with input from the PWGSC Design Quality Review Team, the Commissioning Manager, and Property Manager [and User] during the Conceptual Design Report stage. It will include the number of O&M personnel, security staff, janitorial staff, O&M spatial requirements, organization relating to flow of materials into and out of the facility, etc, As the design develops, it will be updated to include breakdowns to show the various elements of operation and maintenance (e.g. cleaning, service contracts), etc.

.4 **Design energy budget**

Requirement for this budget will depend upon client requirements. This will be prepared by the Designer with input from the PWGSC Commissioning Manager and PWGSC Design Quality Review Team, and presented with the Conceptual Design Report. This budget shall be updated at the completion of the Working Documents.

.5 **Warranties**
A complete inventory will be provided by the Contractor to the Designer who will review same before submission to the Commissioning Manager who, in turn, recommends acceptance by the PWGSC Project Manager.

.6 **"As-built" drawings and specifications**
These will be produced by the Designer from the project record documents maintained on the site and kept up-to-date with all changes as they occur and marked thereon by the Contractor. Accuracy will be verified by the Designer before preparation of the "As-builts" and by the PWGSC Commissioning Manager after submission by the Designer. They shall be completed in time to be used during pre-start-up inspections. They will be refined and revised as required during commissioning.

.7 **Inventory of spare parts, special tools, maintenance materials** Inventory will be identified as a requirement during the design stage by the Designer with input from the PWGSC Commissioning Manager and the Property Manager, based upon consideration of the complexity of the project and immediacy of availability; specified by the Designer; checked by the Contractor immediately upon delivery to ensure each is complete with instructions for use; inventoried, packaged and identified by the Contractor; and stored by the Contractor in facilities to be designated by the PWGSC Project Manager and the PWGSC Commissioning Manager.

.9 **Identification**
The PWGSC MMS (Maintenance Management System) identification system will be incorporated into the working documents and implemented on all systems, equipment and components.

11. Deliverables relating to the commissioning process

.1 **General**
Start-up, testing and commissioning requirements, conditions for acceptance and specifications will be included in the Contract Documents

.2 **Definitions**
All references in this document to commissioning shall include commissioning of components, equipment, subsystems, systems and integrated systems.

.3 **Performance verification tests and inspections conducted at factory** These will be witnessed by the PWGSC Design Quality Review Team and witnessed and certified by the Designer and reports of all results provided to the Project Manager. The Commissioning Manager may wish to participate.

.4 **Start-up, pre-commissioning activities and related documentation**

For every item, the extent of involvement of the members of the Commissioning Team will be determined (e.g. who reviews, performs, monitors, certifies). This schedule will be prepared by the Designer with input from the Commissioning Manager and will include, nut not necessarily be limited to:

.1 **Pre-start-up tests:** These will include pressure, static, flushing, cleaning, "bumping", etc., conducted during construction and will be specified by the Designer to be performed by the Contractor and witnessed and certified by the Designer. Depending upon the size and complexity of the project the Commissioning Manager may monitor some or all of these inspections and tests. The completed documentation will be included in the Commissioning Report.

.2 **Pre-start-up inspections** conducted by the Designer prior to permission to start up and rectification of all deficiencies to the satisfaction of the Designer and Commissioning Manager. The Designer will use approved installation check lists (see below). Depending upon the size and complexity of the project the Commissioning Manager will monitor some or all of these inspections. The completed documentation will be included with the Commissioning Report.

.3 **Start-up:** This will be by the Contractor (may also include equipment manufacturer, supplier and/or installing specialist subcontractor) under the direction of the Designer. Depending upon the size and complexity of the project the Commissioning Manager may wish to monitor some or all of these activities. It will also include rectification of all start-up deficiencies by the Contractor to the satisfaction of the Designer and Commissioning Manager.

.4 **Performance verification (PV)** will be performed by the approved Commissioning Agent, repeated where necessary until results are acceptable to the Designer. Procedures will be as per generic procedures but modified to suit project requirements. Reported results will be witnessed and certified by the Designer using approved PI and PV forms (see below). The completed TAB and PV Reports will be approved by the Designer and provided to the PWGSC Commissioning Manager who reserves the right to verify up to [30]% of all reported results. Any failure of randomly selected item shall result in the rejection of the TAB report or the report of system startup and testing. All activities will be monitored by the PWGSC Commissioning Manager

.5 **Pre-commissioning activities - ARCHITECTURAL**

.1 Masonry: regularly through the construction process the extent of repointing will be reviewed and documented. Replacement of stone will be reviewed and documented. Extent and nature of cleaning processes will be reviewed on site. These activities will be carried out in consultation with the Masonry Conservator.

.2 Structural reinforcing: Placing of core drill locations will be reviewed with the designer, as well as the grouting operations.

.2 Roof: following stripping of the existing roof the substrate will be examined and any repairs required undertaken. Each layer of new construction will be reviewed prior to installation of subsequent layers.

.3 Windows and Louvers: Components will be reviewed at each stage of their restoration, ie, prior to removal, after stripping and sandblasting, during metal repairs, finishing, and re-installation.

.6 Pre-commissioning activities - MECHANICAL

.1. **HVAC equipment and systems:** each item of equipment will be "bumped" in its "stand-alone" mode (i.e. without completion of controls, fire alarm, etc. interfaces). At this time, pre-start-up checks will be completed and relevant documentation completed. Emphasis at this time is on those items which might have a detrimental effect on the operation of the equipment (e.g. noise and vibration) and the safety of the operating personnel. It is recognized that TAB may affect some parameters. After equipment has been started, the related systems will be tested in conjunction with the control systems on a system-by-system basis.

.2 **Plumbing systems**: Each item of equipment will be "bumped" in its "stand-alone" mode (e.g. without completion of controls, interfaces), pre-start-up checks completed and relevant documentation completed. Emphasis at this time is on those items that might have a detrimental effect on the operation of the equipment and the safety of the operating personnel. It is recognized that TAB may affect some parameters. After equipment has been started, the related systems will be tested in conjunction with the control systems on a system-by-system basis.

.7 Pre-commissioning activities - EMCS

.1. It is planned that point-by-point testing will be performed in parallel with start-up. This will not be witnessed.

,2. Point-by-point verification will be carried out as part of system verification and will be witnessed and certified by the Designer.

.3 Demonstration of the performance of each system will be witnessed by the Designer and Commissioning Manager prior to the start of the 30-day Final Acceptance Test period.

.4. Final commissioning and operational tests will be performed during the demonstration period and the 30-day test period.

5. The only additional testing after the foregoing have been successfully completed are the "Off- Seasonal Tests".

.8 Pre-commissioning activities - LIFE SAFETY SYSTEMS

These will include all of equipment and systems identified above and reports of test results witnessed and certified by the Designer before verification:

.9 Pre-commissioning activities - ELECTRICAL

.1 **Distribution system:** This includes high voltage systems over 750 volts and low voltage systems under 750 volts. It requires an independent testing agency to perform pre- energization and post-energization tests.

.2 **Lighting systems:** *to follow*

,3 **Low voltage systems:** These include clock, communications, low voltage lighting control systems and data communications systems.

.4 **Emergency lighting systems:** Tests will include verification of lighting levels and coverage, initially by disrupting normal power.

.5 **Transfer switches:** These will be tested by simulating loss of power. Availability of power at all equipment requiring same (e.g. emergency lighting, elevators, fire pumps) will be verified.

.6 **Fire alarm systems:** These will be tested after all other aspects of life safety and security systems are completed. Contractor testing will include a complete verification in accordance with CAN/ULC requirements. After the Designer has witnessed and certified the report, all devices and zones will be demonstrated to the PWGSC Project Manager and the PWGSC Commissioning Manager.

.7 **Security, surveillance and intrusion alarm systems:** *to follow*

.10 Commissioning activities and related documentation

.1 Commissioning will be performed by the specified commissioning agent using procedures developed by the Designer and approved by the Commissioning Manager.

.2 Commissioning activities will be witnessed by, and results certified by, the Designer

.3 Reported results will be witnessed and certified by the Designer using approved PV forms.

.4 Upon satisfactory completion, the commissioning agency performing the tests will prepare the required Commissioning Report which will be certified by the Designer and forwarded to the Commissioning Manager who reserves the right to verify a percentage of all reported results at no cost to the contract (percentages to be prescribed in the commissioning specifications).

.5 The Commissioning Manager will monitor all commissioning activities.

.11 Commissioning of integrated systems and related documentation

Commissioning will be performed by the specified commissioning specialist, using procedures developed by the Designer and approved by the PWGSC Commissioning Manager. They will be witnessed by, and results certified by, the Designer and documented on approved report forms. Upon satisfactory completion, the commissioning specialist will prepare a Commissioning Report which will be certified by the Designer and submitted to the PWGSC Commissioning Manager for review. The PWGSC Commissioning Manager reserves the right to verify a percentage of reported results.

The schedule of integrated systems will be prepared conjointly by the Designer and the PWGSC Commissioning Manager and will identify integrated systems to be commissioned over and above those listed herein:

.1 HVAC and associated systems forming part of integrated HVAC systems,
.2 Environmental space conditions,
.3 Fire alarm systems,
.4 Fire pumps and controllers,
.5 Voice communications systems,
.6 Transfer switch and controllers,
.7 Emergency lighting systems,
.8 Life safety systems identified above.

.12 Identification

The Commissioning Manager, in co-operation with the Property Manager, will establish, during the design stage, an identification system for all systems and equipment which will reflect final MMS (Maintenance Management System) identification requirements, to be provided to the Contractor. This will be reflected in the identification system used in the Working Documents by the Designer. During the later stages of commissioning and before hand-over and acceptance, the Designer, Contractor, Property Manager and Commissioning Manager will cooperate to complete inventory data sheets and provide assistance to PWGSC forces in the full implementation of the MMS identification system.

.13 Commissioning specifications

Preliminary commissioning specifications will be developed and submitted at the same time as the Design Development Report for review by the Commissioning Manager and approval of the Project Manager. Final versions will be prepared by the Designer and submitted for review at each submission during the working document stage, using generic commissioning specifications provided by the Commissioning Manager and edited by the Designer so as to become project-specific. They will be supplemented by project-specific commissioning specifications prepared by the Designer, reviewed by the Commissioning Manager and approved by the Project Manager. They will also include samples of PI and PV report forms. Commissioning specifications will be incorporated into the construction specifications by the Designer.

.14 Installation Check Lists (ICL)

These are required to inform the Commissioning Manager of those systems which are ready for commissioning. A generic list is provided by the Commissioning Manager to the Designer, who will tailor them to meet the requirements of the project. Where these are not available, they will be developed by the Designer and approved by the Commissioning Manager. Where modifications are necessary, these will be completed no later than [10] weeks after approval of shop drawings.

.15 Product Information (PI) report forms

All product information relating to equipment and components supplied and installed on this project will be reported on approved PI report forms similar to the samples attached to the commissioning specifications. Some PI report forms already exist. Others will be prepared by the Designer, reviewed by the discipline specialists and approved by the Commissioning Manager no later than [10] weeks after approval of shop drawings for the equipment concerned. Instructions for use will be included in the commissioning specifications. All completed PI report forms will be certified by the Designer. After review and verification by the Commissioning Manager, these report forms will be included in the Building Management Manual.

.16 Performance Verification (PV) report forms

All results of commissioning will be entered on PV report forms. These will include the results of all commissioning tests and similar activities using approved PV report forms similar to the samples attached to the commissioning specifications. Some PV report forms already exist. Others will be prepared by the Designer, reviewed by the discipline specialists and approved by the Commissioning Manager no later than [10] weeks after approval of shop drawings for the equipment concerned. Instructions for use will be included in the commissioning specifications. All completed PV report forms will be certified by the Designer. After review and verification by the Commissioning Manager, these report forms will be included in the relevant Commissioning Reports.

.17 Commissioning reports

The completed PV report forms will be certified by the Designer and included in properly formatted Commissioning Reports. Before any reports are accepted, all reported results will be subject to verification by the Commissioning Manager.

.18 Activities during the Warranty Period

While all commissioning activities must be completed before the issuance of the Interim Certificate, it is anticipated that certain commissioning activities will be necessary during the Warranty Period, including:

.1 fine tuning of HVAC systems,

.2 adjustment of ventilation rates to promote good indoor air quality and reduce the deleterious effects of VOCs generated by off-gassing from construction materials and furnishings, etc,

.3 full-scale emergency evacuation exercises

.19 Tests to be performed by the Owner/Use: *to follow*

.20 Training Plans

.1 General

The preliminary Training Plans will be developed in greater detail as design progresses and as the working documents are developed. These will be produced by the Designer and approved by the PWGSC Commissioning Manager to meet project-specific requirements and will include details provided by the Property Manager relating to numbers and prerequisite qualifications and skills of trainees, type of training (i.e. observation, hands-on, classroom), etc

.2 Development

The Training Plans shall be completed [within 3 months after award of Contract] [before construction contract is 50% complete].

.3 Commissioning training schedule

Will be prepared by the Contractor and will indicate in detail how training will be implemented, the duration of each training session, the trainers, trainees, etc.

.4 Duration of training

Duration of training for each system, instruction aids, etc. will depend on complexity and PFM needs.

The minimum number of hours for training sessions will be identified in the commissioning specifications - particularly in Section 01815 -

.5 Responsibilities

Training will be under the direction of the Designer and monitored by the Commissioning Manager. The Designer will also monitor all training activities including:

1. Preparation of agenda and outlines,
2. Videotaping of all sessions as may be required, to be carried out by the Commissioning Manager

.6 Instructors

Instructors and trainers will include the Designer, Contractor, specialist subcontractors, equipment manufacturers, suppliers and installers, factory-trained and certified equipment suppliers and manufacturers, factory-trained and certified maintenance specialist personnel and the service contractors holding service contracts for the following:

.1 EMCS,
.2 fire alarm systems,
.3 security systems,
.4 broadcast systems,
.5 lighting control systems,
.6 elevators,

and any other service contracts that may be implemented during this project.

.7 Trainees

These will include the Property Manager, building operators, maintenance staff, security staff, technical specialists as necessary and facility occupants as necessary. The PWGSC Commissioning Manager will co-ordinate their attendance at agreed-upon times.

The following is a list of O&M personnel, property management staff and others requiring requisite training:

		Number
Facility Property Manager (already in place)	.	*?*
Operating staff:	*Building operators (already in place)*	*?*
Maintenance staff:	*Plouffe Park shops*	*?*
	Building Maintenance (already in place)	*?*
Service contractors (e.g. Cleaning)		*?*
Security staff:	*[- identify building area -] (already in place)*	*?*
	[_- identify building area -] (already in place)	*?*

.8 Prerequisite skills and qualifications

Trainees will meet all identified qualification requirements of installed equipment and systems: *to follow*

.9 Details of training:

Training will include:

..1 **Training sessions relating to the design philosophy:** will be organized around the Building Management Manual and will include:

.1 an overview of how each system is intended to operate,

.2 a description of design parameters and operating requirements,
.3 a description of operating strategies,
.4 information to assist in troubleshooting system operating problems.

These sessions are to be given by the Designer and shall be presented within three months after award of contract. This will permit all involved in the construction and future operation of this facility to become familiar with all aspects of the design philosophy. If the O&M personnel have not been identified or are not available at this time, these sessions will be repeated during the Contractor-led training sessions.

2 **All aspects of operation under all normal, emergency and "what-if" modes,** over the full range of operating ranges.

.3 **Detailed maintenance, troubleshooting, regular, preventive and emergency maintenance.**

.10 **Organization of training:**
Training will consist of the following elements, to be completed, with demonstration of completeness, before date of acceptance:

.1 **Random on-site familiarization and observations during construction,** installation, layout of equipment, systems and components, start-up and testing of the work, access to approved shop drawings, equipment operating and maintenance data. On- site observations will include still-photo records as deemed necessary by the O&M personnel – particularly of concealed elements.

.2 **Hands-on instruction** relating to start-up; shut-down; emergency procedures; features of controls; monitoring; servicing; maintenance; performance verification and commissioning; reasons for, results of and implications on associated systems of adjustment of setpoints of control, limit and safety devices; interaction among systems during integrated operation; and troubleshooting diagnostics. Other elements will include system operating sequences, step-by-step directions for operation of valves, dampers, switches, adjustment of control settings and other specialized training relating to installed systems.

.3 **Formal classroom sessions** relating to functional and operational requirements, system philosophy, limitations of each system, and operation and use of Building Management Manual. Duration of these sessions will be as specified in the commissioning specifications, using space to be identified.

.11 Timing of training:

Training shall be conducted only after commissioning and performance verification tests of all components, equipment, sub-systems, systems and integrated systems have been completed.

Training to be completed, with demonstration of completeness, before date of acceptance:

.12 Implementation of training:

The Contractor will be responsible for implementation of training activities, quality of instruction and training materials and for coordination among the instructors.

.13 Training materials

Training materials will be in a form permitting future training procedures to be in the same degree of detail and will include at least the following:

.1 "As-built" contract documents,
.2 Building Management Manual,
.3 TAB and PV reports,
.4 Transparencies for overhead projectors and 35 mm slides,
.5 Manufacturers' training videos (after prior screening for suitability),
.7 Equipment models.

.14 Completion of training

All training will be completed prior to issuance of the Interim Certificate.

.15 Videotaping

Hands-on and classroom sessions will be videotaped for future reference and retraining but will be held only after all systems have been fully commissioned.

Production will be of professional quality and organized into several short modules to permit incorporation of changes.

The Video may recorded on a CD ROM to permit visualization on a PC by operations staff at a later date.

.16 Standard of training

Training will be in sufficient detail and of sufficient duration to ensure:

.1 Safe, reliable, cost-effective, energy-efficient operation of all systems in normal and emergency modes and under all conditions,

.2 Effective ongoing inspection, measurements of system performance,
.3 Proper preventive maintenance diagnosis, troubleshooting,
.4 Ability to update documentation,
.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

.17 Limitations
Long-term ongoing training will not be included. However, the training courses and training materials including video-taping will permit further ongoing training as well as training of new personnel.

.18 Demonstrations
Training will include demonstrations by the trained personnel to show their confidence in, and depth of understanding of, all installed systems and equipment and to demonstrate completeness of their training.

.19 Manufacturers' video-based training
Video will be used as training tool after Engineer's review of videos and written approval at least three months prior to static completion. To be included in Construction and Completion Schedule.

.21 Evaluation Report
.The final Commissioning (ie. Evaluation) Report will be produced, assessing the overall quality of the commissioning process and results obtained. It will include recommendations for any additional commissioning activities as well as feedback information for use in future similar projects

.22 Data management requirements
In delivering the Commissioning Program, the Designer shall utilize a computer-based data management system. This will include the cost of all labour, materials, and electronic data processing (EDP) equipment to deliver the program (e.g. "as-built" drawings and specifications, PV and Commissioning documentation, Building Management Manual, Training Plan).

12. Deliverables relating to the administration of commissioning

.1 General

.1 As detailed design develops, the Commissioning Plan will be revised to include provisions for testing all parameters to the full range of operating conditions and to check responses of all such equipment and systems under all conditions. This is necessary because the proper installation and operation of all systems are of paramount importance to health, safety, comfort and welfare of occupants and users.
.2 The completion of the renovations within the stipulated time frame is essential to the continuance of the overall Parliamentary Precinct

renovation program..

.3 Since access into secure or sensitive areas will be very difficult after take-over, it is planned to complete commissioning of occupancy-, weather- and seasonal-sensitive equipment and systems in these areas before the building is occupied by the User. Six months is included in the completion schedule for verification of performance in opposite seasons and weather conditions.

.4 Detailed requirements relating to the timing of the various commissioning activities relative to the commissioning of other systems will be included in the commissioning specifications.

.2 Commissioning Schedule

A detailed Commissioning Schedule will be prepared by the Contractor's Commissioning Agent and submitted to the Commissioning Manager and Project Manager for review and approval at the same time as the Construction and Completion Schedule. It will include all necessary time-points and milestones, testing, documentation, training and commissioning activities. After approval, it will be incorporated into the Contractor's Construction and Completion Schedule.

The Designer, the Contractor and his commissioning agent, and the Commissioning Manager will monitor progress of commissioning against this schedule. A separate detailed schedule in day-by-day format will be provided by the Contractor for commissioning of all components, equipment, subsystems, systems and integrated systems. This schedule will include a detailed training schedule so as to demonstrate that there will be no conflicts with testing. The commissioning schedule will include the following milestones (as appropriate):

.1 Design criteria, design intents to Contractor: 14 days after contract award

.2 Pre-TAB review: 28 days after contract award, before construction starts

,3 Commissioning agents' credentials: more than 60 days before start of commissioning.

.4 Commissioning procedures (if different from specs or TAB standards): less than 3 months after award of contract.

.5 Commissioning Report format: less than 3 months after contract award.

.6 Discussion of heating/cooling loads for commissioning: more than 3 months before start-up.

.7 Submission of list of instrumentation with relevant certificates: more than 21 days before start of commissioning.

.8 Notification of intention to start TAB: at least 21 days before start of TAB.

.9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.10 Notification of intention to start commissioning: at least 14 days before start of commissioning.

.11 Notification of intention to start commissioning of integrated systems: after commissioning of related systems is completed and at least 14 days before start of integrated system commissioning.

.12 Identification of deferred commissioning.
.13 Implementation of training plans.
.16 Commissioning Reports: immediately upon successful completion of commissioning.

.3 Commissioning schedule for mechanical systems

.1 The schedule of commissioning activities will be produced in a bar chart format to a scale that will ensure legibility. This bar chart will show sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods. It will also show commissioning resources which will be committed to this project to ensure completion by prescribed dates, the Training Plan and the commissioning Documentation Plan.

.2 **Water/fire mains and related site fire hydrants:** These will be commissioned **as soon as installation is complete**, using procedures described in NFPA reference standards. This will also provide protection for the exterior envelope of the new building during construction.

.3 **Fire and hose standpipe systems:** (temporary fire hose cabinets will be by the Contractor). These systems will be installed so as to provide fire protection during construction but will not be commissioned until after the building has been closed in.

.4 **New incoming water mains:** These will be commissioned as soon as temporary heat is available.

.5 **High pressure steam and condensate mains from central heating and cooling plant (CHCP):** These will be commissioned as soon as the modifications to same have been completed and as soon as the new addition has been closed in and the use of temporary heat is possible. Commissioning will be under the direction of the CHCP staff. This will permit the use of CHCP steam for temporary heat. All steam condensate will be returned to the CHCP.

.6 **Energy meters on steam, chilled water and electrical services:** These devices will be commissioned after all other energy-consuming systems have been commissioned so as to permit changes to ranges and other adjustments as necessary to reflect actual requirements.

.7 **HVAC systems**:
.1. Sections of ductwork, piping and conduit systems to be concealed will be tested and certified to be to specified standards before being concealed.

.2. HVAC systems will be initially started up, "bumped" in a stand-alone mode (i.e. without controls, fire alarms or smoke detectors) and pre-start-up inspections completed.
.3. They will be started only after all dust-producing construction procedures have been completed and all areas are dust-free.
.4. At this point, they may be started to replace temporary heating systems.
.5. They will be operated so as to permit TAB and to ensure full compliance with the contract documents when weatherstripping, caulking and sealing of the exterior envelope has been completed, partitions and doors are installed and ceiling return plenums are in place.

.8 **Clean-steam humidification systems:** These will be commissioned after the relevant water treatment systems have been commissioned.

.9 **Hydronic systems:**
.1 These will be filled, pumps "bumped" in a stand-alone mode and pre-start-up inspections completed. Thereafter, cleaning and flushing processes will take place.
.2 They will be commissioned after the exterior envelope has been completed and all exterior caulking is finished, but only after the relevant water treatment systems have been commissioned.
.3 They will be commissioned at the same time as the HVAC systems are being TAB'd.

.10 **HVAC and related hydronic systems:** These systems will be tested in conjunction with EMCS, and fire and smoke detection systems.

.11 **Plumbing systems**:
.1 These will be filled, pressure booster pumps "bumped" in a stand-alone mode and pre-start-up inspections completed. Thereafter flushing, cleaning and disinfection processes will take place.
.2 Plumbing and other piping systems will be tested in conjunction with related control systems.

.12 Items which may have a detrimental effect on operation and maintenance (e.g. noise, vibration) will receive preliminary attention at this point. Further attention to these items will occur as commissioning proceeds.

.13 **Integrated systems:** Performance of all HVAC systems, fire protection systems, EMCS and other systems forming part of integrated systems will be verified after all systems have been TAB'd to ensure full compliance with prescribed requirements.

.14 **Vibration isolation and seismic control measures:** These measures will be tested at the same time as the connected system.

.15 **Equipment and systems subject to specified codes and standards or subject to the approval of an authority having jurisdiction:** All equipment and systems will be commissioned in accordance with those requirements.

.16 **EMCS**: Testing and commissioning will be outlined in the EMCS specifications and conditions for acceptance will be clearly defined therein. Point-by-point and end-to-end testing will be carried out by the installing Contractor, monitored by the Designer and verified as part of the system verification. Demonstration of operation of all systems under all operating conditions and over the full operating range will take place prior to the 30-day test period and will be witnessed by the Designer, Commissioning Agent (or Commissioning Manager) and the Project Manager. This will include simulated opposite-season tests. EMCS programming and operation will be verified after HVAC systems have been TAB'd and will include the specified 30-day test period.

.17 **Standpipe and hose systems**:: Standpipe risers will be installed as construction progresses and may be used for fire protection purposes during construction. Fire hoses to be provided by the Contractor. Completed system will be tested in accordance with requirements of NFPA 14.

.18 **Sprinkler systems**: These will be tested in accordance with requirements of NFPA 13.

.19 **Fire pumps, transfer switch and controllers**: These will be tested in accordance with NFPA 20. It is anticipated that the jockey pump will have sufficient capacity to prevent repeated starts of the fire pumps.

.20 **Integrated fire protection systems**:

.1. Upon completion of individual system tests, tests of the integrated systems will be performed to verify that all components work together.

.2. After fire alarm connections are completed and the jockey pump has been commissioned, flow tests of the sprinkler system will be conducted.

.21 **Full-scale emergency evacuation tests of entire facility:** These will be carried out during the early stages of the Warranty Period using procedures and protocols developed during the commissioning phase.

.22 **Indoor air quality (IAQ):** Tests will be carried out only if and when the need arises.

.23 **Space environmental conditions:** Tests will be carried out only if and when the need arises.

.24 **To reduce VOC concentrations to acceptable levels:** Flow rates of outside air into HVAC systems will be adjusted as required during commissioning, after occupancy and for as long as necessary after occupancy.

.25 **Final commissioning activities**: Upon completion of commissioning to the satisfaction of the Commissioning Manager, all control devices will be locked in their final positions, settings will be indelibly marked and included in TAB and PV Reports.

.26 **Thermal and electrical power and energy required for commissioning in the form of electrical load banks, CHCP steam and CHCP chilled water:** These will be provided free of cost to the Contractor who will be responsible for equipment and system operation and maintenance. Disposal of unwanted energy in an environmentally safe manner will be discussed during the development of the commissioning schedule.

.4 Commissioning schedule for electrical systems

.1 A schedule of commissioning activities will be produced in a bar chart format to a scale that will ensure legibility. This bar chart will show sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods. It will also show commissioning resources which will be committed to this project to ensure completion by prescribed dates, the Training Plan and the commissioning Documentation Plan.

.2 **Main distribution system:** Testing and commissioning will be defined in the construction specifications. The Contractor will conduct "megger" tests of feeders. Commissioning will require the services of an independent testing agency to perform a series of pre-energization and post-energization tests.

.3 **Low voltage systems:** These include clock, PA communications, low voltage lighting and data communications systems.

.4 **Emergency power systems**: Testing and commissioning of emergency generator, transfer switch and controllers will be included in the construction specification. Transfer switches will be tested by simulating loss of normal power. Power availability will be verified at all equipment requiring emergency power (e.g. emergency lighting, certain defined elevators, fire pumps, certain defined fans).

.5 **Emergency lighting systems:** Tests will be performed by interrupting normal power. Thereafter adequacy of coverage will be verified.

.6 **Fire alarm systems**: These systems will be verified only after all aspects of the life safety and security systems are complete. Testing by the Contractor will be monitored by the Designer and include complete verification in accordance with ULC/CAN requirements. After receipt by the Commissioning Manager of the Commissioning Report, the commissioning specialist will demonstrate all devices and zones to the Commissioning Manager, Project Manager and Property Manager.

.9 Lightning protection systems: *to follow.*

.10 Commissioning requirements will be included in the construction specifications.

.11 Reports of these tests, witnessed and certified by the Designer, will be submitted to the Commissioning Manager who will verify reported results.

.12 Upon completion of commissioning to the satisfaction of the Commissioning Manager, all control devices will be locked in their final positions, settings will be indelibly marked and included in Commissioning Reports.

.5 Payments for commissioning

.1 *to follow*

Appendix L: Risk Management Plan

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Appendix M: Chemical Analysis - Mortars

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CHEMICAL ANALYSIS REPORT

Client:	Watson MacEwen Teramura Architects	**Client ID:**	WATS001
Project:	Centre Block, Vent Towers, Parliament Hill	**Report #:**	SL0542-01
Location:	Ottawa, Ontario	**Date Received:**	05/01/13
Sample Types:	Brick and mortar fragment and masonry cores	**Report Date:**	05/09/13
Delivered by:	Client's representative (T. Gillingwater)	**Chemist:**	H. Hartshorn
		Supervisor:	J. Walsh
		Page 1 of 2	

1. Introduction

On May 1st, 2011, Highbridge received one brick and mortar fragment labeled "T6 Backing" as well as a sample bag with six masonry core fragments. The fragments were labeled 1, 2, 3, 3, 5, and 8. At the client's request, one sample from each group are tested to determine water-soluble chloride, water-soluble sulfate, and acid-soluble sulfate content. The choice of samples was left to the discretion of Highbridge. One core fragment labeled "3" was randomly chosen from the bag to be tested along with "T6 Backing".

2. Methods of Examination

One piece of mortar was removed from each of the two samples chosen for analysis. Each mortar piece was then ground to pass a No. 50 sieve and fully homogenized to be used for chemical analysis. Water-soluble chloride content was determined using the digestion and potentiometric titration methods of ASTM C1218. Rather than determining a single sulfate content for each sample, the analysis was split into water-soluble and remaining acid-soluble analyses. Water-soluble determination was performed first using a similar water digestion as used for chloride determination. The filtrate was reserved and the residue treated with a hot acid digestion using methods adopted from ASTM C114. Both filtrates were analyzed for sulfate content using gravimetric methods specified in ASTM C114.

3. Chemical Analysis of Masonry Mortar

Table 3.1: Chloride and sulfate content determinations

Sample ID	Chloride Content (%)	Water-soluble sulfate SO_4 (%)	Acid-soluble sulfate SO_4 (%)	Total sulfate SO_4 (%)
3	0.005	0.87	1.58	2.44
T6	0.013	0.04	0.71	0.75

4. Sulfate Normalization

The following table recalculates the sulfate values presented above and presents them as equivalent weights of thenardite (or water-soluble sodium sulfate) and gypsum (or acid-soluble calcium sulfate dihydrate). These are arbitrary choices and should not be taken as an identification of these particular salts within the masonry.

Table 4.1: Normalization of sulfate content

Sample ID	Thenardite equivalent wgt. %	Gypsum equivalent wgt. %
3	1.28	2.82
T6	0.07	1.27

Respectfully submitted,

John J. Walsh
President / Senior Petrographer

AF

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28 May 2013

ATTN. HEATHER
WMT ARCH.

Re: Center Block, **Vent Towers**: comments on additional salts testing to mortar.

Hi Allan,

Taking this opportunity to comment on the additional testing recently completed by John Walsh of Highbridge Materials Consulting Inc (Report # SL0542-01). The testing was requested by HCD as an addition to the original report completed on various masonry stone and brick materials composing the Vent Towers by Highbridge in 2011, report no. SL029802. Our brief on that report with respect to salt identification followed in May 2012. As the mortar had not been specifically targeted for qualitative/quantitative analysis, but was rather picked up incidentally where the samples cores of the various masonry materials happened to include it, HCD's request was certainly a valid one.

The data collected by Highbridge suggested that the sulphate salts affecting the masonry would have originated from the masonry mortar used in the original construction. We went further in our May 2012 report and concluded that the mortars were the source for the soluble salts affecting the masonry of the towers given the correlation that was found between salt (sulphate) presence and increased quantification data wherever mortar was an incidental part of the masonry segment being tested. This present letter is to confirm that the mortar has now been tested, and the results do illustrate that the mortar is indeed the source of the salts.

The samples were taken from miscellaneous cored and wall core brick halves taken during our wall openings in 2011. Two samples from this miscellaneous supply were used in the testing (reference names are *3* and *T6*).

Briefly described, the recent results on the mortars alone confirm the same salt identification of sulphate salts. Taking the C4 T1 brick series testing from the earlier SL0542-01 Report, we see that similar quantities are present in those samples as we find in the most recent, mortar only, *T6* sample. It is peculiar that relatively higher figures are found for the Sample *3*, but this is presently assumed to be a result of a higher portion of Portland cement likely in that particular location of the wall from which the sample was taken.

Sincerely,

Trevor Gillingwater