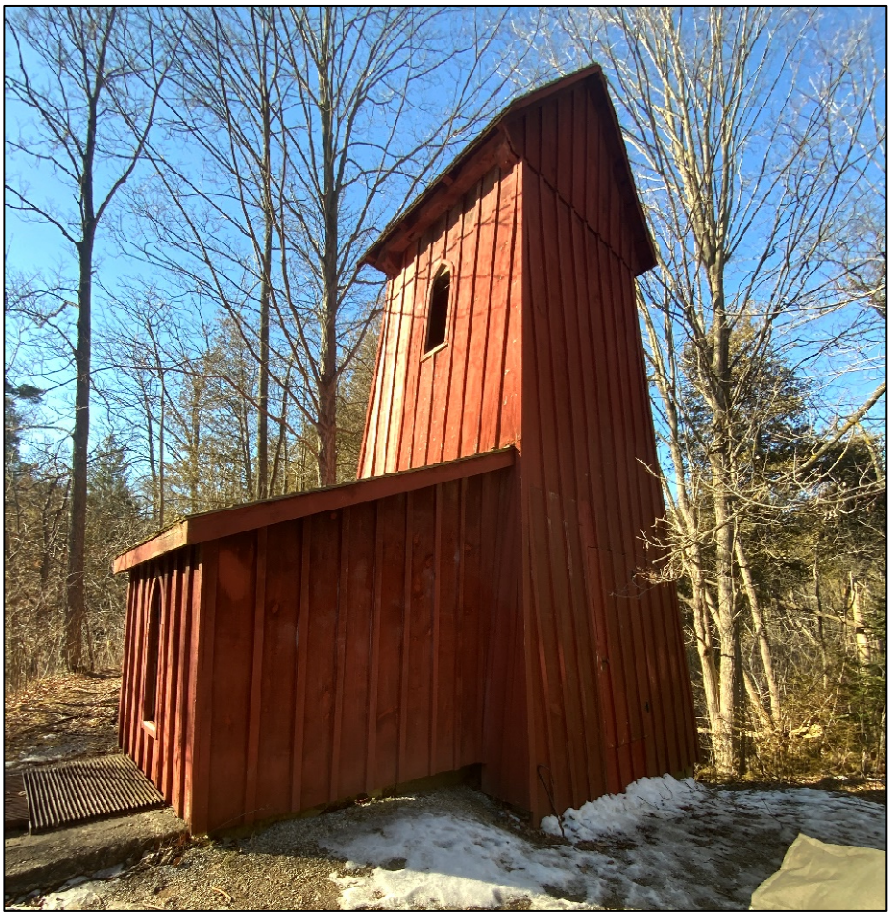
Sheave Tower
Structural Condition Assessment

90 Old Mill Road
Cambridge, Ontario



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March 25, 2024

Table of Contents

List of Photographs

List of Tables

1. Introduction

Tacoma Engineers has been retained by Robinson Heritage Consulting (RHC) to carry out a structural condition assessment of the Sheave Tower located at 90 Old Mill Road in Cambridge, in the historic Village of Blair. This assessment has been requested by the City of Cambridge as it undertakes planning to take over ownership of the property from the Cambridge and North Dumfries Branch of the Architectural Conservancy of Ontario (ACO).

Tacoma Engineers was retained by RHC on January 24th, 2024. The undersigned attended the site on February 6th and February 14th of 2024, accompanied by Tracie Seedhouse of RHC and Karen Scott Booth of the ACO.

This report includes a summary of the following items for the building:

- major structural systems;
- existing structural conditions and areas of potential concern;
- conceptual repair options for any areas that may require remedial work; and
- order-of-magnitude costing related to repair work expected within the next five (5) years.

2. Background

The ACO owns the building in question, and Tacoma Engineers is being retained as a Consultant directly by RHC on behalf of the City of Cambridge.

This assessment is being undertaken by the City of Cambridge and is intended to provide guidance to the City as it considers taking over ownership of the property. This report is not being prepared as a response to an Order, recommendations, or request by any regulatory body outside of those listed above.

This report is based on a visual inspection only and does not include any destructive testing. Where no concerns were noted, the structure is assumed to be performing adequately. The structure is assumed to have been constructed in accordance with best building practices common at the time of construction. No further structural analysis or building code analysis has been carried out as part of this report unless specifically noted.

No previous work has been completed by Tacoma Engineers on this building for this or any other owner. No sub-consultants have been retained by Tacoma Engineers to participate in this assessment.

3. Building History

The Sheave Tower was constructed in 1876 to provide power to the neighbouring mill by means of a pulley and cable turning a wheel (the sheave) near the top of the tower. The tower provided power until early in the twentieth century when it is likely that a fire at the mill in 1928 terminated the tower's original utility. It is not clear exactly when the building was abandoned, but it has been confirmed that by 1954 the tower was no longer in use. A reconstruction project is reported to have been carried out in 1962, the scope of which appears to have been relatively limited given the available cost estimates from the work. A further restoration program was completed in 1999-2000, including wood framing, wood cladding, and concrete repairs.

4. Scope and Methods

The following documents were provided to the undersigned prior to the preparation of this report:

- Foundation Investigation, Dillon Consulting Engineers, September 1988
- Progress Report, Nicholas Hill – Heritage Architect, December 2000

The assessment of the building is based on a visual assessment from grade. During the initial site visit of February 6th access to the interior could not be coordinated. The follow-up site visit on the 14th of February allowed for a visual review of the interior of the tower.

5. Definitions

The following is a summary of definitions of terms used in this report describing the condition of the structure as well as recommended remedial actions. Detailed material condition definitions are included in Appendix A of this report.

- **Condition States**[1]:
    1. Excellent – Element(s) in "new" condition. No visible deterioration type defects present, and remedial action is not required.
    2. Good – Element(s) where the first signs of minor defects are visible. These types of defects would not normally trigger remedial action since the overall performance is not affected.
    3. Fair – Element(s) where medium defects are visible. These types of defects may trigger a "preventative maintenance" type of remedial action where it is economical to do so.
    4. Poor – Element(s) where severe or very severe defects are visible. These types of defects would normally trigger rehabilitation or replacement if the extent and location affect the overall performance of that element.
- **Immediate remedial action**[1]**:** these are items that present an immediate structural and/or safety hazards (falling objects, tripping hazards, full or partial collapse, etc.). The remedial recommendations will need to be implemented immediately and may include restricting access, temporary shoring/supports or removing the hazard.

- **Priority remedial action**[1]**:** these are items that do not present an immediate hazard but still require action in an expedited manner. The postponement of these items will likely result in the further degradation of the structural systems and finishes. This may include interim repairs, further investigations, etc. and are broken down into timelines as follows:
    1. **Short-term**: it is recommended that items listed as short-term remedial action are acted on within the next 6 months (**before the onset of the next winter season**).
    2. **Medium-term:** it is recommended that items listed as medium-term remedial action are acted on within the next 24 months.
    3. **Long-term:** it is recommended that items listed as long-term remedial action are acted on within the next 5-10 years. Many of these items include recommendations of further review/investigation.

- **Routine maintenance**[1]: these are items that can be performed as part of a regularly scheduled maintenance program.

[1] Adapted from "Structural Condition Assessment", 2005, American Society of Civil Engineers/Structural Engineering Institute

In addition to the definitions listed above, it should be noted that the exterior of the building is designated under Part IV of the Ontario Heritage Act under By-Law 59-88 as amended. The building is also located with the Blair Village Heritage Conservation District and as such is subject to Part V of the Ontario Heritage Act through designation By-Law 205-01. Refer to RHC report for additional clarification as required.

The Standards and Guidelines for the Conservation of Historic Places in Canada provide direction when a structural system is identified as a character-defining element of an historic place. They also provide direction on maintaining, repairing, and replacing structural components or systems[2]. Refer to the General Guidelines for Preservation, Rehabilitation, and Restoration to further inform the development of more detailed remedial actions.

6. General Structural Conditions

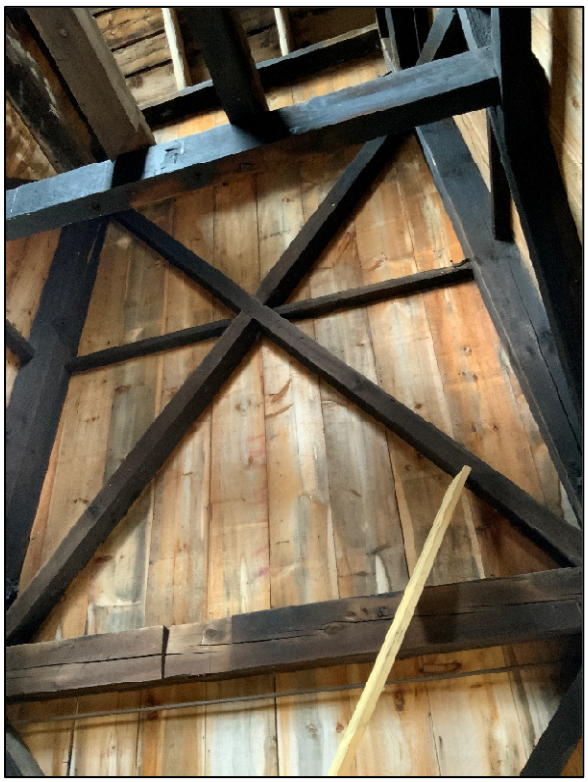
The building is constructed as a timber wood-framed structure clad with vertical wood siding. The tower stands approximately 31'-0 tall and is located downstream of the mill building located on Old Mill Road. The main building is approximately 12'-0" square at the base, tapering to an estimated 8'-0" square at the eaves. A small wood-framed lean-to extends from the south elevation towards the mill pond. The upper structure appears to be supported on an older cast-in-place concrete foundation.

6.1. Upper Structure

Construction

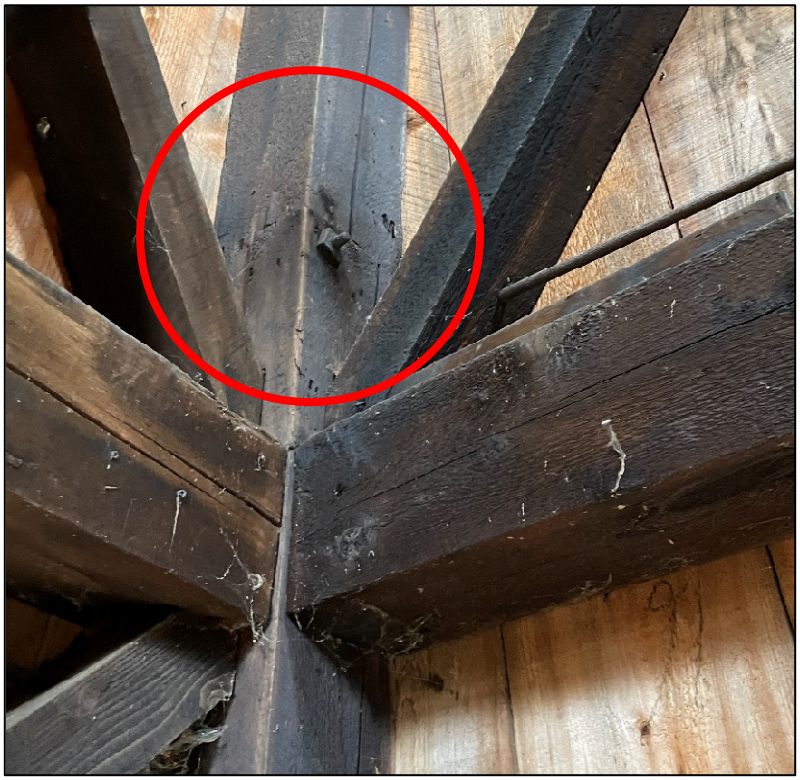
The primary section of the tower is constructed with heavy timber frames arranged in a double vertical braced bay. Refer to the following photograph.

[2] "Standards and Guidelines for the Conservation of Historic Places in Canada", 2nd Edition, 2010, www.historicplaces.ca



Photograph 1: Partial interior elevation

Corner columns and the primary crossing members were measured onsite as 8x8. Lapped diagonal braces were measured as 4x6, and the intermediate siding support members are 2x4. Several scarf joints were noted connecting upper and lower sections of the corner columns. The joints are connected with through-bolts and square headed nuts.



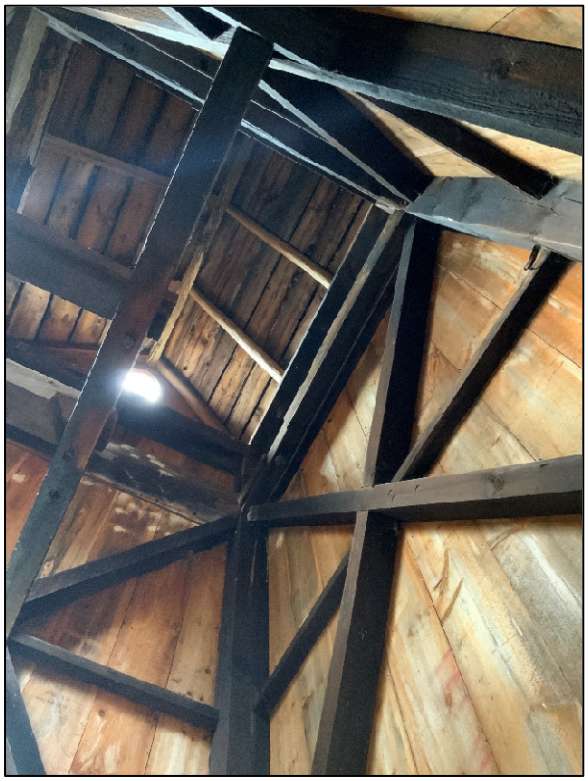
Photograph 2: Connection between upper and lower column sections

In addition to the primary timber framing, several tension rods were noted to cross the exterior walls at each of the horizontal crossing members. These rods do not appear to be an integral part of the primary structure as it currently stands, and they are assumed to be either a remnant of the original structure (likely related to the forces resulting from the mechanics of power generation) or to have played a role in the 1962 or 1999 restoration projects. The ends of the tension rods are not visible on the exterior of the structure.

Diagonal braces were found in some locations to be secured to the vertical columns using round-headed galvanized nails, specifically where the diagonal braces come down in the middle of the height of the column. It is likely that these braces were altered or added as part of the lean-to addition work, although it cannot be confirmed that these nails were not added as part of some other maintenance or repair work. The specifics of the connections at the primary corners could not be determined at the time of the review.

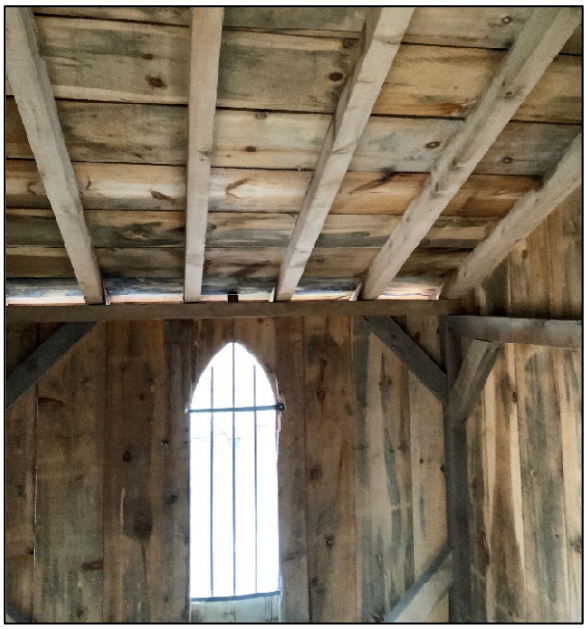
Photograph 3: Connection of diagonal brace to column (south elevation)

The upper roof is framed with a combination of round and milled timber rafters supported on an undressed log ridge beam and eave beams that appear to have been salvaged from another structure.



Photograph 4: Upper roof framing

The south elevation lean-to is constructed with light braced frame walls and 3x4 wood rafters spaced at 16-18" on centre, all of which appear to have been part of the 1999 restoration program. It has been reported that this lean-to was added prior to 1962 to house a more modern means of electrical generation.



Photograph 5: Lean-to framing (typical)

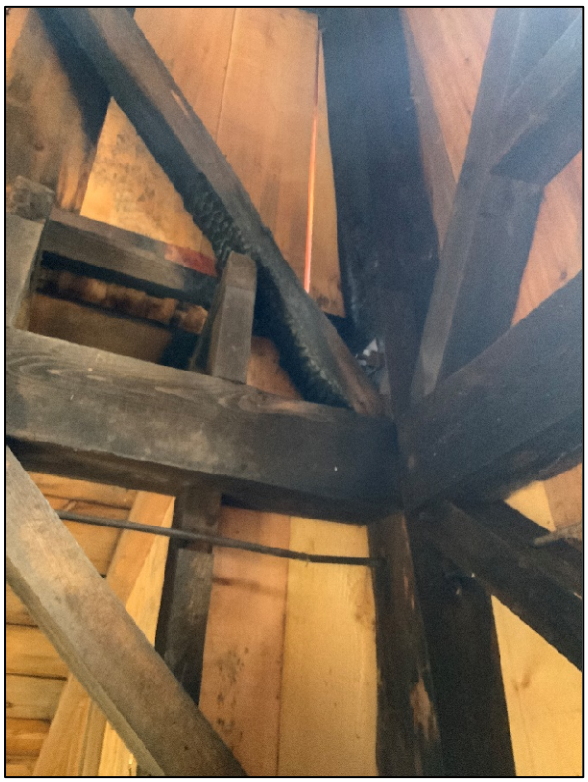
Visible in all previous photographs are the vertical wood siding boards that are reported to have been replaced in the most recent restoration project.

Conditions

The primary upper structural framing was found to be primarily in excellent condition. It is likely that portions of the primary framing have been replaced at some time in the building's history, although the application of creosote coatings has unified the appearance of the materials and does not allow for an exact determination of the chronology and extent of repairs and replacements. While the reapplication of creosote as part of future maintenance is not recommended, the current state of the materials is stable and will serve to protect the structural members well into the future.

Some mention is made of deteriorated sill beams in the Dillon report of 1988. During the course of the review of 2024 the sill beams were largely hidden from view behind the wood siding; however, the ends of the sill beams were found to be in fair condition where exposed. It is likely that they were replaced after the issuance of the Dillon report.

Localized charring damage was noted at the southwest corner approximately 9'-0" above the interior finished floor.



Photograph 6: Charring damage

This damage is reported to be the result of a minor fire within the last 24 months. The damage is limited to the base of a diagonal 4x6 brace and less substantial damage to the column above the horizontal crossing member. This damage has not significantly compromised the structural framing.

Recommended Actions

The following **routine maintenance** actions are recommended for the upper structure:

- Continue to monitor the property regularly and limit access to the interior. Maintenance should include the control and pruning of surrounding vegetation to ensure that the risk of damage due to falling limbs or trees is minimized.
- Review the conditions of the roofing and flashing, and ensure that roofing maintenance and replacement is completed prior to a significant failure of the roof.
- Repair the door hardware to ensure easy and reliable access to the interior for maintenance staff.
- Remove and replace deteriorated exterior cladding prior to complete failure of the material.
- Consider the provision of lighting and/or other security measures to mitigate risk of vandalism and arson.

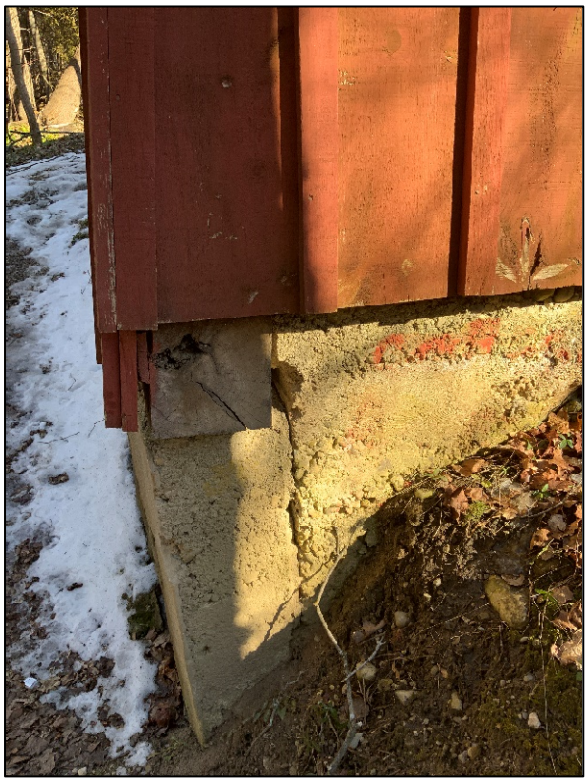
6.2. Foundations

Construction

The tower foundations and associated raceways appear to be constructed with cast-in-place concrete. A raised wood floor prevents a direct observation of the interior face of the foundations below the main building. The raceway walls at the intake are visible from both the interior and exterior of the building. It appears that portions of these walls have been repaired or replaced at some point with relatively new concrete.

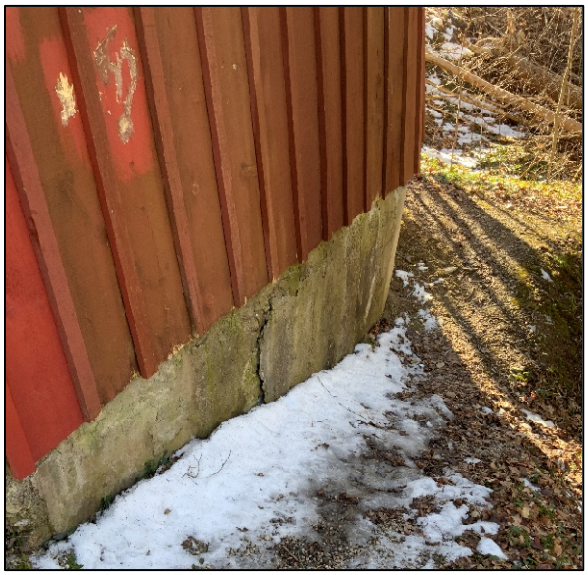
Conditions

The foundation walls below the main building are in fair condition. The majority of the foundations are below grade and below the main floor structure, and as such were not visible for a detailed review. Where exposed at the northwest corner, at the lower grade, the concrete is honeycombed and an open vertical joint is visible at the corner.



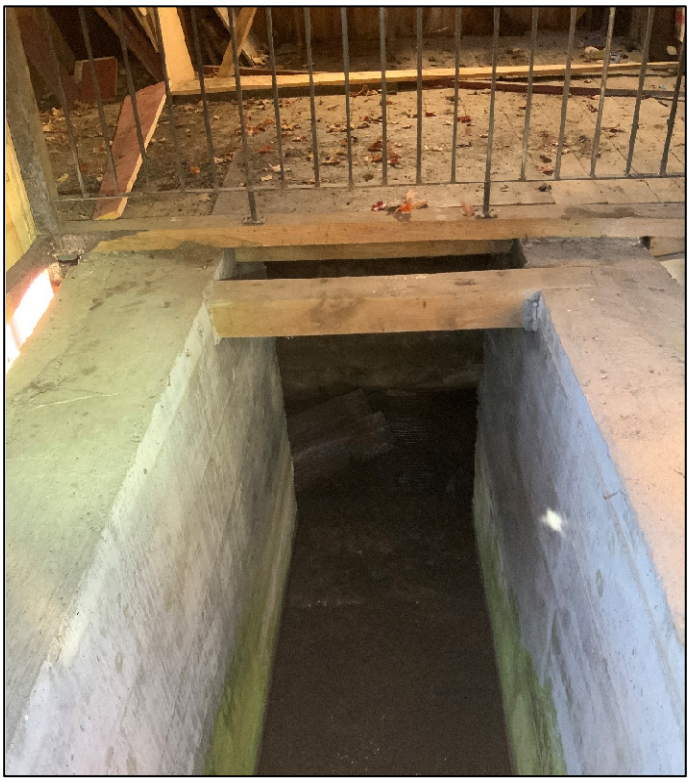
Photograph 7: Exposed foundation wall at northwest corner

The exposed north elevation is in fair condition and showing signs of spalling. This spalling material appears to be a thin parge not part of the original construction.



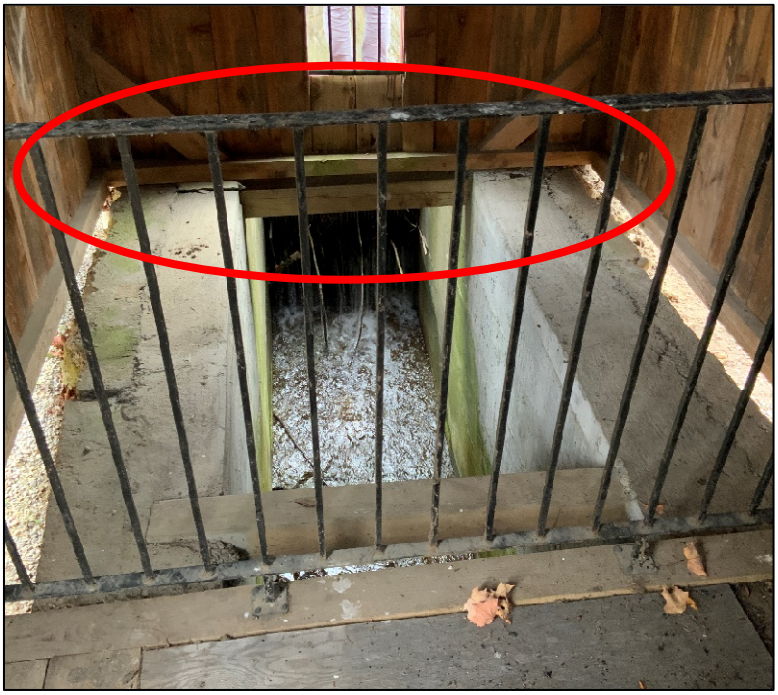
Photograph 8: North foundation wall

The foundation walls at the water intake are in good condition. The surface profile of the exposed concrete differs from that visible on the exterior of the building; it is likely that new concrete was added at some point in the life of the structure.



Photograph 9: Water intake foundation walls

Wood crossing member have been cast into the tops of the wall, likely when the walls were repaired. The member below the endwall of the lean-to has contributed to cracking and spalling of the top of the wall. A cold joint is also visible from the interior of the building (refer to following photograph).



Photograph 10: Spalling concrete at cast-in wood

Recommended Actions

The following **routine maintenance** actions are recommended for the foundation:

- Continue to monitor the property regularly and limit access to the interior.
- Carry out regular reviews of the exterior exposed concrete foundation walls, specifically at the northwest corner where the rougher exterior surface can result in accelerated freeze-thaw deterioration. These reviews can be completed at the same time as the regular monitoring of the property.

7. Summary of Recommendations

The following provides a summary of the recommendations for the existing structure.

Items requiring routine maintenance:

1. Continue to monitor the property regularly and limit access to the interior. Maintenance should include the control and pruning of surrounding vegetation to ensure that the risk of damage due to falling limbs or trees is minimized.
2. Review the conditions of the roofing and flashing, and ensure that roofing maintenance and replacement is completed prior to a significant failure of the roof.
3. Repair the door hardware to ensure easy and reliable access to the interior for maintenance staff.
4. Remove and replace deteriorated exterior cladding prior to complete failure of the material.
5. Consider the provision of lighting and/or other security measures to mitigate risk of vandalism and arson.
6. Carry out regular reviews of the exterior exposed concrete foundation walls, specifically at the northwest corner where the rougher exterior surface can result in accelerated freeze-thaw deterioration. These reviews can be completed at the same time as the regular monitoring of the property. Table 1 (below) includes a budget allowance for surficial concrete repairs to be completed in 2029, if required.
7. While it is expected that the conditions of the tower will be acceptable over the next 5 years, it may be advantageous to engage the services of a structural engineer experienced with heritage structures every 5 years. This review would include an investigation of the existing conditions and recommendations for remedial work that may fall outside of the items listed above. The expected cost of this assessment is included as item 7 in Table 1 in the next section of this report.

There is no recommended *structural repair* or *structural remedial work* anticipated within the next five (5) years. Regular and routine maintenance items should be expected and are summarized in the following section.

8. Estimated Maintenance Costs

The following provides an estimate of the costs related to the maintenance items in section 7 above. For the purposes of providing cost estimates to monitoring actions, reviews have been assumed to be quarterly at a cost of approximately $375-450.00 per review, carried out by City staff, with additional costs every two (2) years related to tree maintenance. Note also that a roof replacement has been assumed in the calendar year of 2029, since the existing roof conditions could not be confirmed at the time of the review.

Table 1: Estimated Maintenance Costs

		Year Ending					
		2024	2025	2026	2027	2028	2029
Recommended Remedial Action	1	$ 1,500.00	$ 1,500.00	$ 1,500.00	$ 1,750.00	$ 1,750.00	$ 1,750.00
	2	$ -	$ -	$ 500.00	$ -	$ -	$ 5,000.00
	3	$ 500.00	$ -	$ -	$ -	$ -	$ -
	4	$ -	$ -	$ 1,000.00	$ -	$ -	$ 1,000.00
	5	$ 3,500.00	$ -	$ -	$ -	$ -	$ -
	6	$ -	$ -	$ -	$ -	$ -	$ 5,000.00
	7	$ -	$ -	$ -	$ -	$ -	$ 5,000.00
		$ 5,500.00	**$ 1,500.00**	**$ 3,000.00**	**$ 1,750.00**	**$ 1,750.00**	**$ 17,750.00**

9. Conclusions

The Sheave Tower structure is in good condition. Restoration projects in the 1960s and in 1999 have replaced many of the primary structural elements, which for the most part remain in excellent condition. Minor fire damage was noted at a single diagonal brace, and localized concrete spalling is visible at the top of the intake below the lean-to and on the exterior of the north concrete foundation wall.

Remedial work is expected to include securing and maintaining the site, maintaining the exterior envelope and roof, and carrying out regular reviews of visible structural elements. Order-of-magnitude estimates of these costs are provided in the costing section of the report and should be used for budgetary planning purposes only.

Per

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