10 Duke Steet West
Kitchener, Ontario

Existing Façade Retention
Vibration Monitoring Plan

Project No. 24012

Draft report issued December 15th, 2023

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Report Prepared by:

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CONSULTING ENGINEERS

1. INTRODUCTION

John G. Cooke & Associates Ltd. (JCAL) was retained by VanMar Developments Inc. (VanMar) to provide consulting structural engineering services as it relates to the retention of portions of the primary façades of the existing building at 10 Duke Street West, in Kitchener, Ontario, for incorporation of these facades with a planned redevelopment on the site. The redevelopment will include the construction of a new tower that occupies much of the footprint of the existing building presently on the site.

VanMar received conditional approval of their Site Plan Application - SP22/104/D/AP. The draft version of this approval, dated June 23, 2023 and provided to JCAL, included Heritage Planning Conditions which require

> *[t]hat the Owner submits a Risk Management Plan, including a Vibration Monitoring Plan commenting on the means and methods that shall be used to minimize vibration to 10 Duke Street West during grading, construction, servicing or other site development works to the satisfaction of the Manager of Development Review and the City's Heritage Planner.*

This report is intended to satisfy the requirement for a Vibration Monitoring Plan.

Further to other conditions in the Site Plan Application approval, JCAL has already completed an investigation of the subject site, including destructive exploratory openings, and prepared a Structural Assessment Report, dated December 4th, 2023.

Design progress drawings for the new tower have been completed and reviewed by JCAL, to 75% progress at the time of this writing. A geotechnical report (File no. G21270, Chung & Vander Doelen Engineering Ltd.) has been prepared and also reviewed by JCAL.

2. TERMS OF REFERENCE

The scope of work for John G. Cooke & Associates Ltd. is based on JCAL proposal P23208, dated September 18, 2023.

3. EXISTING CONDITIONS

JCAL completed an investigation of existing conditions at the subject site. Observations made during that investigation are more comprehensively described in our Structural Assessment Report. A summary of the relevant facts are included in the discussion below.

The existing building is constructed predominantly of one-way concrete slabs, supported by steel beams, which are supported by interior steel columns and, at the building perimeter, load-bearing multi-wythe brick masonry exterior walls. The exiting building is a 3-storey building plus a full-height basement level.

The existing exterior walls are in good condition where visible on the exterior, and where exposed during investigatory openings made at the interior. The walls consist of an exterior wythe of clay brick with two backup wythes of concrete brick at the interior. These are bonded together with regular header bricks. Mortar joints remain generally intact, except for localized areas. and openings at the interior revealed a well-constructed wall assembly with solid mortar present in the head and collar joints. Stone masonry is included at details such as bands, sills, and surrounding the main entrance.

Localized repointing and other conservation work will be required as part of the preservation and retention of the relevant portions of the existing facades, including at stone details and throughout the masonry. No bulging, significantly displaced stones, or excessively deteriorated or unstable

masonry was noted that would cause us to consider this building to be especially vulnerable to vibrations. Masonry conservation work is not expected to be required in advance of construction.

One caveat is at the parapet which extends above the roof level. The interior face of the parapet is fully covered with metal flashing. While it was not possible to assess the masonry at arms-length from the exterior, and mortar joints here do appear to be generally intact, there is some efflorescence at the exterior of the parapet. This is an indication of high moisture content and migration, suggesting a higher likelihood of deterioration of masonry within the core of the wall. There is nothing to suggest a deviation from the course of action proposed herein, but the condition of this parapet will be monitored and assessed further, as work is ongoing on this project.

4. PLANNED CONSTRUCTION

As noted in the Introduction section, above, the project includes the planned retention of a portion of the primary facades of the existing building at 10 Duke St W, for integration with a new tower to be constructed on the site. The project's intent is to retain the existing facades by primarily making use of the steel frame of the existing load-bearing masonry and steel-framed building, supplemented by temporary bracing and supports as necessary, until the façade may be secured to the new permanent structure (designed by other consultants), floor by floor, as construction progresses.

The interior finishes in the building are typically applied to a terra cotta tile backup placed with an approximately 25 mm gap to the interior wythe of backup brick. As part of the work to stabilize the façade and to integrate it with new wall assemblies, it is proposed to remove this terra cotta tile and all finishes. As such, impact to plaster or other finishes are not a consideration in determining the vibration susceptibility of the building.

The new tower will be constructed with a raft foundation, the base of which will be set close to the basement level of the current building. The raft will occupy much of the height of the current lower level of the building, and, aside from elevator pits, the occupiable space of the building will generally extend from approximately grade level and above. The geotechnical report indicates that native soil on the site consists generally of fine granular deposits and silty clay till. It is clear that rock will not be encountered for the proposed depth of excavation.

As a result of the foundation and soil conditions, excavation is anticipated to be relatively minimal. It is further understood, as communicated by VanMar, that the limited excavation that will be required will proceed using sloped excavations. Certainly, no blasting or hoe ramming of rock is anticipated to be required.

Currently, there is a basement mechanical/boiler room within the existing building that extends further below grade than typical conditions, approximately an additional floor level below grade. This room is located against the North (rear) wall of the building and extends for approximately 10m in each direction (about 1½ structural bays). The brick chimney which extends up beyond the roof is quite visible and is located at the northeast of this room. It will be necessary to fill and level the subgrade prior to construction of the raft slab, and the geotechnical report provides two potential options for infilling at this room, to bring it flush with the remaining basement. The first is to place lean mix concrete for the height required, and the second is to place heavily compacted granular fill. VanMar have indicated that they will place lean mix concrete to fill this void, which would not result in significant vibrations being induced, as the costs are quite comparable between the options.

Overall, vibration from excavation is expected to be relatively minimal. General vibration from other construction is expected to stem from miscellaneous construction equipment and activities, such truck traffic adjacent to the facades retained in-situ, and no special circumstances are anticipated to apply.

Localized vibration may be induced from demolition and construction activity near the masonry to be retained. The bracing and construction sequencing and the design of temporary lateral support for the existing masonry facades to remain in-situ are also being prepared by JCAL. Provisions for saw or torch cutting of masonry, concrete, and steel elements connecting to the masonry to be retained will be included. Specifically,

- saw cuts will be introduced in masonry walls at the interface with masonry to be retained before demolition is to occur on portions that are not to be retained,
- saw cuts will be introduced in the concrete slabs along the masonry walls to be retained, before those slabs are removed,
- steel beams that are connected with elements to remain will be torch cut prior to removal, and
- the use of chippers on elements that remain connected to the masonry to be retained will be limited to 12 lb. electric models, unless a mock-up demonstrates that alternatives do not risk damaging masonry.

5. VIBRATION LIMITS

Vibration limits are not stipulated in the City's conditions, nor is there a municipal bylaw in effect to limit vibrations. The nearby City of Toronto has placed limits on construction vibrations, in their bylaw No. 514-2008, and those limits are indicated in Figure 1, below.

Table 1.0 "Prohibited Construction Vibrations"	
Frequency of Vibration (hertz)	Vibration Peak Particle Velocity (mm/sec)
Less than 4	8
4 to 10	15
More than 10	25

Fig 1: City of Toronto construction vibration limits

The above-noted vibrations, while a good benchmark, are limits for any construction activity and are not necessarily applicable or appropriate to all projects. For historic buildings we typically recommend following the limits established in the DIN 4150-3 Standard, per line 3 of Table 1, included at Figure 2, below. The limits are

- **3 mm/s for vibrations less than 10 Hz,**
- **3 to 8 mm/s for vibrations between 10 to 50 Hz, to be interpolated linearly,**
- **8 to 10 mm/s for vibrations between 50 to 100 Hz, to be interpolated linearly, and**
- **10 mm/s for vibrations above 100 Hz.**

We recommend proceeding with the limits indicated above in this case.

These limits are quite low, and are intended to mitigate effects of vibration on historic buildings that might include deteriorated materials or sensitive finishes. The masonry facades to be retained on this building can be expected to be more resilient than many more delicate built historic structures.

Though we do not anticipate exceedances even of these values given the understood nature of the adjacent construction, these limits could be re-evaluated should these limits be found to have significant impact on construction.

Table 1: Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on structures

Line	Type of structure	Guideline values for velocity, v_i, in mm/s			
		Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz *)	at all frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

*) At frequencies above 100 Hz, the values given in this column may be used as minimum values.

Fig 2: DIN 4150-3 guideline on vibration limits for various structure types

6. VIBRATION MONITORING AND MONITOR PLACEMENT

We recommend that vibration monitoring be implemented with the placement of two tri-directional digital seismographs to be securely affixed to the façade. See Figure 3.

- The first monitor is to be affixed to the interior face of the concrete foundation wall below the façade, just above the level of the raft slab, within the central third of the South (front) elevation wall. See red star in Fig 3.
- The second monitor is to be affixed to the interior face of the façade, immediately above the first monitor, within 600 mm of the underside of the roof level. See blue star in Fig 3.

Existing interior finishes and terra cotta tile are to be removed from the wall prior to installation, such that the monitors can be affixed to the underlying concrete or backup brick masonry.

The monitors and associated reporting are to continue through the course of construction on the project, or until such time as major vibration inducing construction activities have been completed, there are no regular vibration exceedances, any potential for damage from vibration is not anticipated, and the Consultant advises that they may be removed.

The vibration monitors are to be supplied and installed by a specialized firm that has experience providing such monitors for the duration of construction projects.

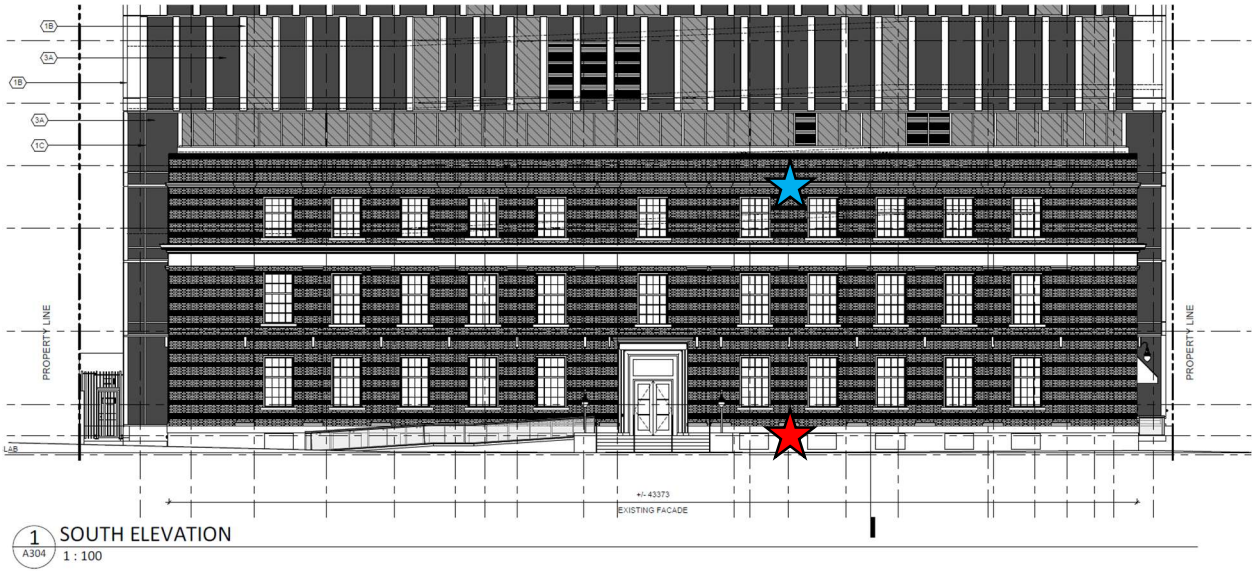

Fig 3: Part South Elevation, indicating proposed locations of vibration monitors.

7. NOTIFICATION AND EXCEEDENCE PROCEDURE

The vibration monitors must be connected for continual reporting of vibration events that result in exceedances of the vibration limits stipulated above. Exceedance events shall be reported by automated email to the Contractor, Owner, and appropriate Consultant(s).

In the event of an exceedance the Consultant is to be contacted. If the exceedance is not the result of disturbing the vibration monitoring equipment or very localized activity around it (both of which are common causes of exceedances), and the Consultant considers the exceedance to be significant, the Consultant shall review on site for any damage that may have resulted from the exceedance.

Future construction activity shall be modified to avoid further exceedances. In cases where this is not possible, and the exceedance was not observed to have had any impact to the structure, the Consultant may advise with respect to increased vibration limits. Note that this approach is intended to be generally consistent with the DIN 4150 standard, which states that "Exceeding the values in table 1 does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary." As noted above, it is our view that this building would likely tolerate vibration limits above those stipulated.

8. DISCLAIMER & LIMITATIONS

This report is based on and limited to information supplied to John G. Cooke & Associates Ltd. by VanMar Developments Inc. personnel and representatives, and by observations made during walk-through inspections of the subject property. Only those items that are capable of being observed and are reasonably obvious to John G. Cooke & Associates Ltd. or have been otherwise identified by other parties and detailed during this investigation can be reported.

The work reflects the Consultant’s best judgment in light of the information reviewed by them at the time of preparation. There is no warranty expressed or implied by John G. Cooke & Associates Ltd. that this investigation will uncover all potential deficiencies and risks of liabilities associated with the subject property. John G. Cooke & Associates Ltd. believes, however, that the level of detail carried out in this investigation is appropriate to meet the objectives as outlined in the request. We cannot guarantee the completeness or accuracy of information supplied by any third party.

John G. Cooke & Associates Ltd. is not investigating or providing advice about pollutants, contaminants, or hazardous materials.

This report has been produced for the sole use of VanMar Developments Inc. and cannot be reproduced or otherwise used by any third party unless approval is obtained from John G. Cooke & Associates Ltd. No portion of this report may be used as a separate entity; it is written to be read in its entirety.

We trust this report covers the scope of work as outlined in our Terms of Reference. Should there be any questions regarding this report, or if we can be of any further assistance to you, please contact us.

JOHN G. COOKE & ASSOCIATES LTD.

Jonathan Dee, P. Eng., ing., CAHP
Principal

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24012/10 Duke – Vibration Monitoring Plan