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Project No.: 251.18271.00000

RE: CONSTRUCTION VIBRATION ASSESSMENT 535-551 BRANT STREET DEVELOPMENT, BURLINGTON, ONTARIO, ON

SLR Consulting Canada Ltd. (SLR) has completed a construction vibration control study for the planned proposed mixed use residential redevelopment, to be located at 535-551 Brant Street, in Burlington, Ontario.

A review of the proposed site plan, construction activities and shoring activities has been undertaken to establish the vibration Zone of Influence (ZOI). A summary of the analysis methodology and results from the assessment are provided below.

1.0 INTRODUCTION

The intent of this report is to address the requirements specified in the pre-consultation comments received from the City for the project which request that the impacts of construction on the properties to the south be assessed.

In the absence of specific Burlington policies on construction vibration impacts, those contained in the City of Toronto By-Law 514-2008 (Toronto Municipal Code 363-5) have been used in this assessment. These policies indicate that potential vibration impacts from construction activity must be reviewed by a Professional Engineer to establish requirements for control where impacts on neighboring structures (owned by others), are anticipated. The following report summarizes the results from the study.

2.0 PROJECT SITE AND LAND USES

The development site is located at 535-551 Brant Street, in Burlington, Ontario. The development will consist of four (4) levels of underground parking, and a mixed-use development containing ground level retail and a residential tower. A context plan of the proposed development can be found in **Figure 1**. The underground parking garage will extend to the property lines.

A context plan is provided in **Figure 2**:

- Immediately adjacent to the southern edge of the property is an existing 2-storey commercial building at 531 Brant Street containing JoeDog's Gasbar Grill. The Culaccino Bar + Kitchen is located further south at 527 Brant Street.
- The western edge of the property abuts Brant Street.
- The northern edge of the property is adjacent to the access driveway and parking lot for the No Frills commercial plaza.

- The eastern edge of the site abuts the John Street extension.

The closest Heritage property is the Edwin Thorpe Retirement House at 1454 Birch Avenue. The property is non-designated but is listed as being of interest. The structure is more than 90 m away from the development. As such, construction vibration impacts on this property are highly unlikely, and are not considered further.

3.0 PLANNED CONSTRUCTION ACTIVITIES

The focus of the current study is the vibration impact due to the excavation and shoring stage of construction. The activities anticipated to cause the highest ground vibration levels include the following:

- Installation of caissons; and,
- Drilling of tiebacks;

Planned equipment to be used for these works includes:

- Excavator;
- Backhoe;
- Loaded Trucks;
- Jackhammer; and
- Pneumatic drill

Given the proximity to nearby land uses and the nature of the above activities, there exists potential for these activities to generate ground vibrations that impact adjacent structures owned by others. The anticipated impacts from these activities have been quantified as part of this vibration control study.

4.0 CONSTRUCTION IMPACT ASSESSMENT

4.1 VIBRATION CRITERIA

The criteria used for the assessment are as specified in City of Toronto By-Law 514-2008. The By-Law specifies "Do-Not-Exceed" threshold limits as listed in **Table 1**.

Table 1 City of Toronto "Do-Not-Exceed" Threshold Limits

Frequency of Vibration (Hz)	Peak Particle Velocity (mm/s)
Less than 4	8
Between 4 and 10	15
Greater than 10	25

A 5 mm/s threshold is specified as an appropriate cautionary threshold for most structures and serves as the basis for defining the Zone of Influence, as described below.

4.2 ZONE OF INFLUENCE OF CONSTRUCTION VIBRATION

The City of Toronto By-Law requires determination of the vibration Zone of Influence (ZOI) associated with construction activities. Chapter 363 of The City of Toronto Municipal Code defines the ZOI as follows:

> *"The area of land within or adjacent to a construction site, including any buildings or structures, that potentially may be impacted by vibrations emanating from a construction activity where the peak particle velocity measured at the point of reception is equal to or greater than five (5) mm/sec at any frequency or such greater area where specific site conditions are identified by the professional engineer in a preliminary vibration study."*

For this study the model recommended by the Federal Transit Administration (FTA) in the United States has been applied for prediction of vibration impacts during construction and to establish the extent of the Zone of Influence. The source vibration levels associated with the equipment planned for shoring/excavation were specified based on data in the FTA document, as well as Novus' own measurement data from work conducted on other construction projects.

For this study, the ZOI was determined based on the following numerical model:

$$\mathrm{PPV}_{equip} = \mathrm{PPV}_{ref} \times (25/D)^{\gamma} \quad (1)$$

Where:

- PPV_{equip} is the estimated peak particle (ground) velocity at distance *D* from the equipment;
- PPV_{ref} is the peak particle (ground) velocity due to operation of the source equipment at an offset distance of 25 ft (7.6 m); and,
- γ is the ground vibration decay factor (γ = 1.25 for the project site).

The ground vibration decay factor was selected for this site based on information from the geotechnical investigation prepared for the project, and published values. Estimation of the ZOI requires solving equation (1) for *D* when PPV_{ref} = 5 mm/sec. This calculation is completed for each anticipated equipment type to establish the maximum (worst-case) offset of the ZOI from the extent of the shoring activity.

The source level for the equipment used in this study (PPV_{ref}), and associated ZOI offset distances are summarized in **Table 2**.

The extent of the ZOI for the site during shoring activities is shown in **Figure 3**.

Table 4 Summary of ZOI offset associated with construction activities

Equipment/Activity	Peak Particle Velocity – PPV @ 1m Setback (mm/s)	ZOI[1] Setback Distance (m)
Caisson Installation	48	6
Excavator	9	2
Backhoe	7	1
Loaded Trucks	41	5
Jackhammer	19	3
Tieback Drilling	6	2

Note: [1] The Zone of Influence is the offset distance from the equipment/source at which ground vibration levels are estimated to be 5mm/s.

[2] The Zone of Influence offset distance for properties designated under the Ontario Heritage Act uses a vibration threshold of 3mm/s.

5.0 RECOMMENDATIONS

As indicated in **Figure 3**, the ZOI associated with shoring and excavation activity extends beyond the boundaries of the site and encroaches upon the 531 Brant Street property and surrounding roadway rights-of-way.

Due to the encroachment of the ZOI on adjacent properties, the following are necessary:

1. Pre-construction survey consultation;
2. Pre-construction measurement of background vibrations;

3. Pre-construction inspection of adjacent buildings and structures within the zone of influence;
4. Identification of mitigation measures (if required); and,
5. A vibration monitoring program during construction.

5.1 PRE-CONSTRUCTION CONSULTATION

A pre-construction consultation will need to be completed. Any utilities within 6 m of the property line, along Brant Street, the John Street Extension and the No Frills driveway should be identified. The owners of 531 Brant Street (JoeDog's Gasbar Grill) will need to be consulted regarding the proposed construction and monitoring.

5.2 PRE-CONSTRUCTION MEASUREMENT OF BACKGROUND VIBRATIONS

Measurements of existing background vibration levels at/within 531 Brant Street will need to be completed.

5.3 PRE-CONSTRUCTION INSPECTION OF ADJACENT BUILDINGS AND STRUCTURES

A pre-construction survey of 531 Brant Street will need to be completed, to identify any existing cracks in walls, floors and exterior cladding of the structure and interior finishes of all storeys below grade in sufficient detail to facilitate comparison of preconstruction and post-construction condition.

5.4 VIBRATION MITIGATION MEASURES AND MONITORING PROGRAM

A monitoring program is required at 531 Brant Street. The vibration monitoring program serves several purposes:

1. It provides the Developer and their construction contractors with real-time alerts if vibration levels at the foundations approach damage thresholds;
2. It provides assurance to stakeholders that they are being protected from potential damage to their property; and;
3. It provides assurance to the owners of 531 Brant Street and the City of Burlington that appropriate controls are in place to protect all stakeholders.

The use of real-time alerts is intended to instigate corrective actions, such as the use of alternate equipment, to reduce vibration impacts. It has been our experience that less vibration complaints arise, and less chance of damage claims results, when vibration monitoring is conducted.

Vibration monitoring is recommended throughout construction.

MONITORING EQUIPMENT

Seismographs shall be installed at 531 Brant Street. The monitors will be capable of recording continuous time traces of peak particle velocity (PPV) using a minimum sample frequency of 1024 Hz. Histograms of the maximum PPV value in 15-minute intervals (or less) so that a continuous record of levels is generated. A minimum 5-second duration time trace of vibrations shall be recorded for further review/analysis for any events triggering the specified alarms levels.

The seismographs shall be armed with alarms that provide notification to all relevant stakeholders in the event the "Do Not Exceed" thresholds specified by the By-Law are exceeded. The seismographs shall be configured to have continuous power throughout the monitoring period. A detailed description of the monitoring protocol is provided below.

MONITORING PROTOCOL

Vibration levels are reviewed and monitored in accordance will thresholds published in City of Toronto's By-Law 514-2008 in **Table 1**.

A cautionary limit of 5 mm/s is specified as a trigger level for download and review the data. Should any vibration triggers exceed the threshold limits provided in **Table 1**, onsite staff shall be notified to review and adjust their construction operational parameters or to cease operations. **Table 3** is a summary of the required Vibration Exceedance Protocol.

Table 3: Vibration Monitoring Protocol

Measured PPV (mm/s)	Notification	SLR Action	Required or Recommended Action for Contractor
<5 mm/s	None[1]	No action required	No action required
5 mm/s – 8 mm/s	SLR	SLR to review vibration event to determine vibration frequency (Hz) and duration. If appropriate, send notification email to stakeholders advising that vibration levels on site are approaching established limits	Communication from Novus may be provided as a cautionary notice if vibration levels are established limits
8 mm/s to 25 mm/s	SLR	SLR to review vibration event to determine if it has exceeded the limit. SLR will contact selected stakeholders and site supervisor to advise whether limits are exceeded and if construction activities need to be stopped / changed. A summary of all events exceeding 8 mm/s will be included in the monthly monitoring report	Communication from Novus will be provided to alert stakeholders and site that the 8 mm/s PPV level has been exceeded. If levels exceed the limits at the frequencies specified in **Table 1** changes to work methodology to reduce impacts will be required. If levels do not exceed limits construction activity may continue but changes may be recommended to limit disruptions and potential complaints.
> 25 mm/s	SLR Site Supervisor Selected Stakeholders	SLR will contact selected stakeholders and site supervisor to advise on required changes to construction activities A summary of all events exceeding 8 mm/s will be included in the monthly monitoring report	Contractor to stop all construction operation **immediately** at boundary of site adjacent residences. Contact Novus directly via number provided in notification to confirm vibration level and discuss required changes to work methodology to reduce impacts at adjacent site.

Note: Although vibrations may be below the applicable compliance thresholds, they may be perceptible to building occupants.

REPORTING

Reports summarizing monitored vibration levels should be submitted on a monthly basis and distributed to relevant stakeholders. The reports shall include maximum measured vibrations in each monitoring interval, and a discussion on compliance with the threshold limits. A summary discussion of events that exceed the limits shall be included, together with a description of corrective measures taken to reduce vibrations to compliant levels.

6.0 CONCLUSION

Should you have any questions or wish to discuss the recommendations outlined in this report, please contact us at your earliest convenience.

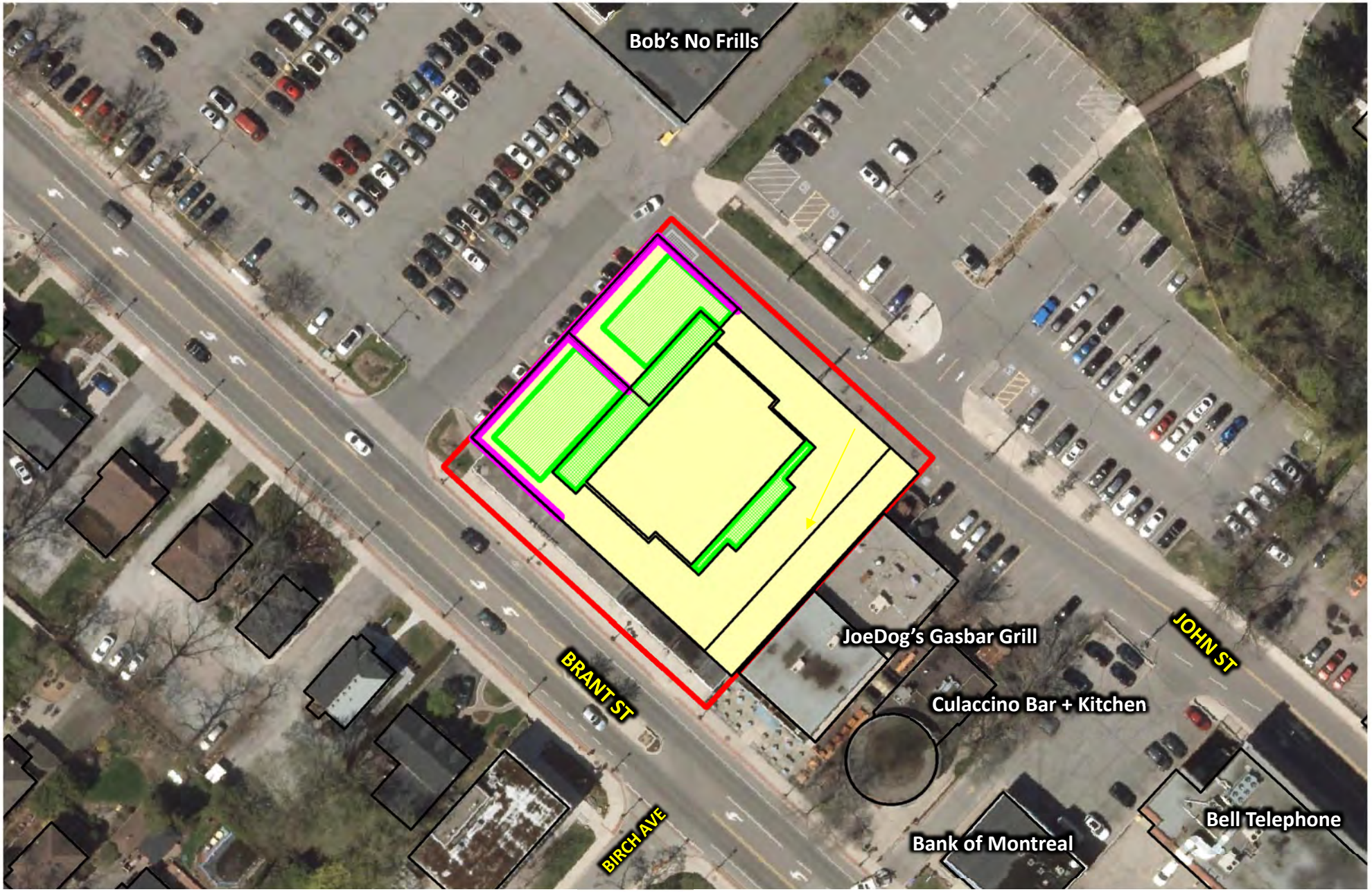
Yours sincerely,
SLR Consulting (Canada) Ltd.



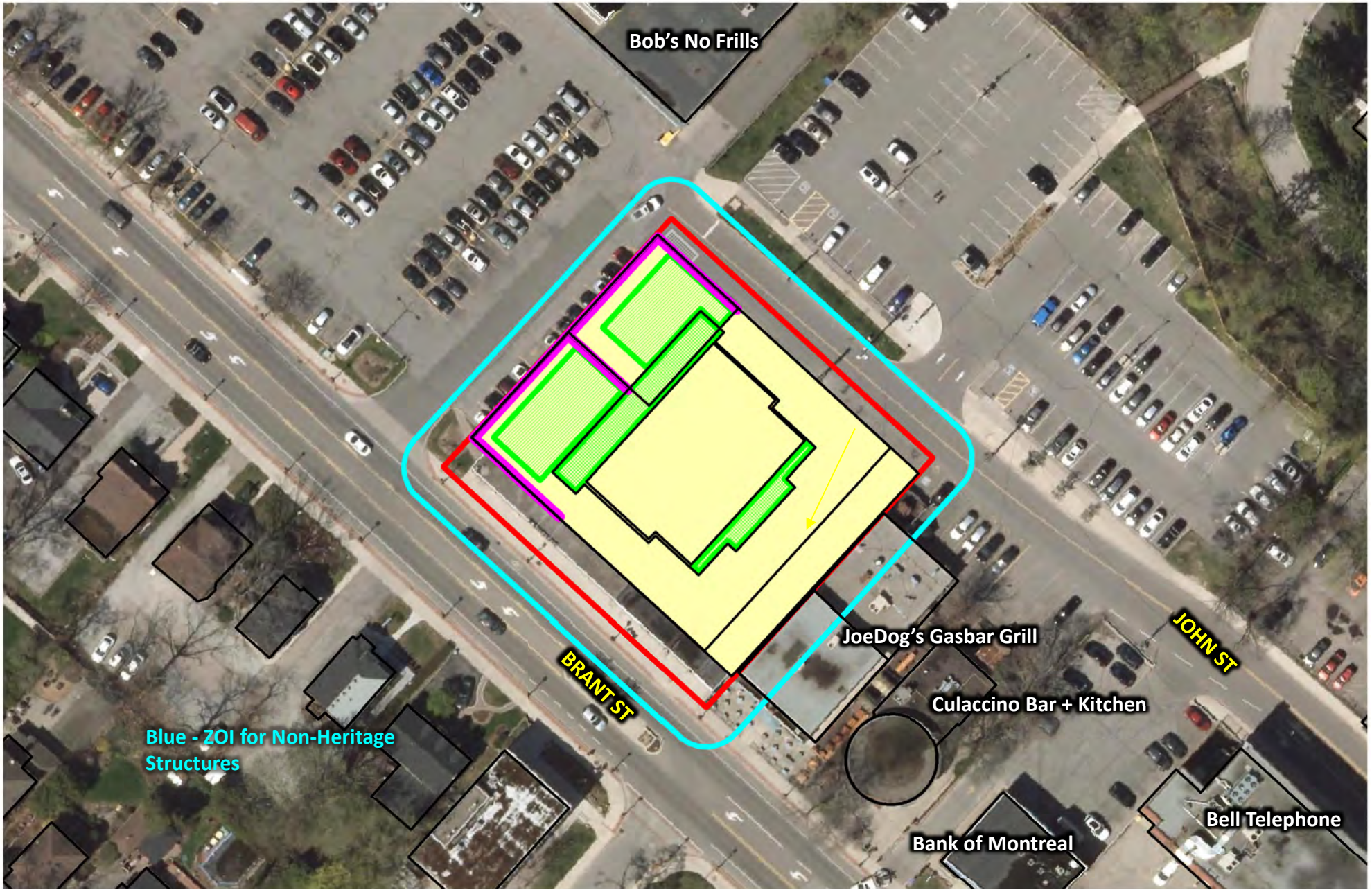
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RENIMMOB PROPERTIES LIMITED	True North	Scale: NTS	METRES	SLR global environmental solutions
535-551 BRANT STREET DEVELOPMENT		Date: Nov 12, 2020 Rev 0.0	Figure No. **1**	
EXCERPTS FROM SITE PLAN (ORIGINAL FROM TURNER-FLEISCHER)		Project No. 241.18271.00000		



RENIMMOB PROPERTIES LIMITED	True North	Scale: 1:800	METRES	SLR global environmental solutions
535-551 BRANT STREET DEVELOPMENT		Date: Nov 12, 2020 Rev 0.0	Figure No. 2	
SURROUNDING PROPERTIES		Project No. 241.18271.00000		



RENIMMOB PROPERTIES LIMITED	True North	Scale: 1:800	METRES	SLR global environmental solutions
535-551 BRANT STREET DEVELOPMENT		Date: Nov 12, 2020 Rev 0.0	Figure No. 3	
ZONES OF INFLUENCE		Project No. 241.18271.00000		