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Cai, Zhen; Fathi-Fazl, Reza; Fazileh, Farrokh; Cortés-Puentes, Leonardo

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Level 1 – Preliminary Seismic Risk Screening Tool (PST) for Existing Wood Light Frame Buildings under Part 9 of the NBC

Part 1: User's Guide

Prepared for

National Research Council Canada

by

Zhen Cai, Reza Fathi-Fazl, Farrokh Fazileh, Leonardo Cortés-Puentes

Seismic Resilience Team

Asset Performance Assessment Group

Sustainable Resilient Infrastructures and Communities Unit

Construction Research Centre

March 2022

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LEVEL 1 – PRELIMINARY SEISMIC RISK SCREENING TOOL (PST) FOR EXISTING WOOD LIGHT FRAME BUILDINGS UNDER PART 9 OF THE NBC

Part 1: User's Guide

Prepared by:

Zhen Cai, Reza Fathi-Fazl, Farrokh Fazileh, Leonardo Cortés-Puentes

Seismic Resilience Team
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Funded by:

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BACKGROUND TO THIS DOCUMENT

Historically, wood light frame buildings under Part 9 of the National Building Code of Canada (*WLF-P9*) have performed well in earthquakes from the perspective of life safety. It is therefore permissible to detail and construct *WLF-P9* buildings using conventional rules that are a combination of calculated designs and solutions based on historic performance (Doudak and Viau 2020). While *WLF-P9* buildings have shown good performance with low fatality rates, severe damages and collapses were reported in previous major earthquakes such as the 1971 San Fernando earthquake, the 1989 Loma Prieta earthquake, and the 1994 Northridge earthquake (FEMA P-807 2012). There is a clear need to develop cost-effective and risk-informed seismic risk assessment tools to assist the owners of existing *WLF-P9* buildings, especially those located in high seismicity areas, in assessing and mitigating the seismic risks in their buildings.

The National Research Council Canada (NRC) recently developed *Level 1 – Preliminary Seismic Risk Screening Tool (PST)* (Fathi-Fazl et al. 2020a; Fathi-Fazl et al. 2020b) and *Level 2 – Semi-Quantitative Seismic Risk Screening Tool (SQST)* (Fathi-Fazl et al. 2020c; Fathi-Fazl et al. 2020d) for existing buildings under Part 4 of the National Building Code of Canada (NBC) (also known as Part 4 buildings). It is reasonable and cost-effective to extend these two seismic risk screening tools to cover existing *WLF-P9* buildings. To this end, the Seismic Resilience Team (SRT) in the Sustainable Resilient Infrastructures and Communities (SRIC) unit at the Construction Research Centre initiated an internal R&D project in 2019 pertaining to the extension of *Level 1 – PST* and *Level 2 – SQST* to cover existing *WLF-P9* buildings. This project consists of three phases: (1) extension of *Level 1 – PST* to cover existing *WLF-P9* buildings; (2) extension of *Level 2 – SQST* to cover existing *WLF-P9* buildings, and (3) development of user's guides and supporting documentation and completion of a pilot study. That project was successfully completed in March 2022.

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FOREWORD TO *LEVEL 1 – PST (WLF-P9)*

The *Level 1 – Preliminary Seismic Risk Screening Tool (PST)* for existing wood light frame buildings under Part 9 of the NBC (*WLF-P9*) aims to quickly identify and exempt existing *WLF-P9* buildings with acceptable seismic risks from further seismic risk assessment. The methodology in *Level 1 – PST (WLF-P9)* is based on *Level 1 – PST* (Fathi-Fazl et al. 2020a; Fathi-Fazl et al. 2020b) originally developed for existing Part 4 buildings. *Level 1 – PST (WLF-P9)* is designed to be completed by trained screeners using *Level 1 – PST (WLF-P9)* screening forms. A site visit is not required as the building information for completing the form can be collected in office. Major changes made to the original *Level 1 – PST* for existing Part 4 buildings are summarized as follows:

1. The benchmark NBC edition for existing *WLF-P9* buildings have been identified by tracking the evolution of design provisions in Part 9 of the NBC.
2. Consequences of failure have been determined for existing *WLF-P9* buildings.
3. The seismic risk acceptance criteria have been updated to suit the characteristics and seismic behaviour of existing *WLF-P9* buildings.
4. The *Level 1 – PST* screening form has been modified to reflect the changes.

Supporting technical documentation for *Level 1 – PST (WLF-P9)* is provided in a separate document (Cai et al. 2022a).

The authors of *Level 1 – PST (WLF-P9)* would appreciate specific suggestions for further improvement.

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1 Intent and scope

The *Level 1 – Preliminary Seismic Risk Screening Tool (PST)* for existing wood light frame *buildings* with light construction under Part 9 of the NBC (*WLF-P9*) aims to quickly identify and exempt existing *WLF-P9 buildings* with acceptable *seismic risks* from further seismic risk assessment. It is designed on the basis of a number of seismic risk acceptance criteria, which include: (1) seismicity, (2) *building* design period, (3) *remaining occupancy time*, and (4) consequences of failure. *WLF-P9 buildings* with heavy construction are not within the scope of this tool and are recommended to be evaluated using *Level 3 – Seismic Evaluation Guidelines (SEG)* (Fathi-Fazl et al. 2022). "Heavy construction" refers to *buildings* with tile roofs, stucco walls or floors with concrete topping, or that are clad with directly-applied heavyweight materials (NRC 2015). Assemblies should be considered as heavyweight where their average dead weight is as follows (an additional partition weight of 0.5 kPa per floor is assumed): 0.5 to 1.5 kPa for floor, 0.5 to 1.0 kPa for roof, and 0.32 to 1.2 kPa for wall (vertical area). *WLF-P9 buildings* that do not meet the seismic risk acceptance criteria are flagged for *Level 2 – Semi-Quantitative Seismic Risk Screening Tool (SQST)* for existing *WLF-P9 buildings* (Cai et al. 2022b; Cai et al. 2022c). *Level 1 – PST (WLF-P9)* also provides a list of conditions that, if present, will directly trigger *Level 3 –SEG*.

Level 1 – PST (WLF-P9) deals with life safety, consistent with Part 9 of the NBC 2015, and does not address other objectives more stringent than life safety. A *building* expected to achieve objectives more stringent than life safety (e.g., a *building* with a *federal heritage designation*) is still eligible for screening with this tool, but only to determine if its life safety risk due to seismic hazards exceeds the acceptable *seismic risk*.

Level 1 – PST (WLF-P9) was developed and written for *trained screeners* who are civil or structural engineering professionals, architects, or graduate students with a minimum knowledge in seismic design of *buildings*. To ensure consistency in data collection and uniformity in making judgement and decisions, it is essential to have the completed *Level 1 – PST (WLF-P9)* screening form reviewed by a licensed structural engineer.

Level 1 – PST (WLF-P9) assumes that existing *WLF-P9 buildings* have been constructed in accordance with applicable NBC editions. Verification of such compliance is not within the scope of this tool.

2 Notice

Level 1 – PST (WLF-P9) described herein is intended to assist building owners in quickly identifying existing *WLF-P9 buildings* with potentially unacceptable *seismic risks* that require *Level 2 – SQST (WLF-P9)* or *Level 3 – SEG*. Written permission from the National Research Council Canada (NRC) is required to use *Level 1 – PST (WLF-P9)*.

3 Supporting technical documentation

Further guidance on the development and use of *Level 1 – PST (WLF-P9)* can be found in the companion Part 2: Supporting Technical Documentation.

4 Definitions and notations

4.1 Definitions

Words and terms used in *Level 1 – PST (WLF-P9)* that are not included in the following list of definitions shall have the meanings that are commonly assigned to them in the context in which they are used, including the specialized use of terms by the various trades and professions to which the terminology applies.

The words and terms in italics used throughout *Level 1 – PST (WLF-P9)* have the following meanings:

Building means any structure used or intended to support or shelter any use or *occupancy*.

Building collapse means failure of a structure or component that leads to the loss of structural integrity.

Building damage refers to adverse effects on *buildings* due to various types of hazards (e.g., non-engineered modifications to *buildings' seismic-force-resisting systems*, earthquakes, blasts, fire, and floods).

Building deterioration refers to adverse effects of environmental factors on buildings such as weathering, chemical attacks, and other conditions that lead to loss of material strength.

Collapse factor means the expected value of collapsed area given that the *building* is in a complete damage state.

Existing building means an already completed *building* that was designed as per the code edition that is one cycle or more behind the latest NBC edition.

Federal heritage designation means a *building* that is included in the Directory of *federal heritage designations* and meets any one of the following conditions: (1) *buildings* of any age, designated as recognized or classified federal heritage at the time of screening; and (2)

buildings of age not less than 40 years that have not been evaluated by the Federal Heritage Buildings Review Office at the time of screening.

Floor area means the space on any *storey* of a *building* between exterior walls, excluding parking area.

Full seismic upgrading NBC refers to an applicable NBC edition to which an *existing building* was upgraded, to fully comply with seismic requirements.

Geologic hazard means a condition present at or near the building site that has the potential to significantly increase the *building's* seismic vulnerability, including *liquefaction*, *landslide potential*, and *surface fault rupture*.

High Importance buildings are *buildings* that are likely to be used as post-disaster shelters, including *buildings* whose primary use is as:

- an elementary, middle or secondary school;
- a community centre.

Manufacturing and storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.

Landslide potential refers to potential life safety threats due to the landslide at or near the building site.

Level 1 – PST (WLF-P9) refers to a preliminary seismic risk screening tool that aims to exempt *WLF-P9 buildings* from *Level 2 – SQST (WLF-P9)* or flag *WLF-P9* buildings for *Level 3 – SEG,* based on a number of key criteria and conditions.

Level 2 – SQST (WLF-P9) refers to a detailed seismic risk screening tool that aims to exempt *buildings* from *Level 3 – SEG* and prioritize *buildings* with potentially unacceptable *seismic risk* for *Level 3 – SEG* by implementing quantitative structural *seismic risk* scoring and qualitative non-structural component *seismic risk* scoring.

Level 3 – SEG refers to seismic evaluation guidelines intended to identify building deficiencies that may pose unacceptable risk to human life or of injury as a result of component failure or *building collapse*.

Liquefaction means a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness under seismic loading.

Model building type means a classification of *buildings* defined in terms of the type of *seismic-force-resisting system* and construction materials.

New building means an already completed *building*, designed as per the latest edition of the NBC.

Number of storeys means the number of *storeys* of a *building,* counted from the lowest finished grade around the *building*.

Occupancy means the intended use of a *building* or part thereof for the shelter or support of persons, animals or property.

Occupants mean the persons for which a *building* or part thereof is designed.

Original design NBC means the applicable NBC edition to which the *building* was originally designed. If a provincial or municipal *building* code was used to design the *building*, the

original design NBC corresponds to the NBC edition on which the provincial or municipal *building* code was based.

Post-benchmark building means a *building* that was originally designed to the applicable *benchmark NBC edition* or newer. An *existing building* that had *seismic upgrading* is considered a *post-benchmark building* only if the *building* was upgraded to fully comply with the seismic requirements of an applicable *benchmark NBC edition* or newer.

Post-disaster building means a *building* that is essential to the provision of services in the event of a disaster, and includes:

- hospitals, emergency treatment facilities and blood banks;
- telephone exchanges;
- power generating stations and electrical substations;
- control centres for air, land and marine transportation;
- public water treatment and storage facilities, and pumping stations;
- sewage treatment facilities and *buildings* having critical national defence functions; and
- *buildings* of the following types, unless exempted from this designation by the authority having jurisdiction:
  - emergency response facilities;
  - fire, rescue and police stations, and housing for vehicles, aircraft or boats used for such purposes; and
  - communication facilities, including radio and television stations.

Remaining occupancy time means the number of years of intended *occupancy* of an *existing building* until the lease of the *building* is terminated or until the *building* is decommissioned.

Seismic-force-resisting system refers to the elements of the structure that provide its basic strength and stiffness to resist seismic forces.

Seismic risk means the risk to human life and injury due to any of the following earthquake-induced conditions: (1) collapse of the entire *building*, (2) collapse of portions of the *building*, (3) fail and fall of non-structural components that can pose life safety hazards in the *building*, and (4) blockage of exit and entry routes.

Seismicity means the occurrence or frequency of earthquakes in an area of interest.

Site class refers to a classification assigned to a site based on the engineering properties of the soil profiles present.

Site class F means a site category including the following soil types: (1) liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils, and other soils susceptible to failure or collapse under seismic loading, (2) peat and/or highly organic clays greater than 3 metres in thickness, (3) highly plastic clays (Plasticity Index greater than 75) more than 8 metres thick, and (4) soft to medium stiff clays more than 30 metres thick.

Site seismic category refers to a geographic area defined by threshold values of spectral response acceleration parameters for design ground motions.

Storey means the portion of a *building* that is situated between the top of any floor and the top of the next floor above it, and if there is no floor above it, that portion between the top of such floor and the ceiling above it.

Structural upgrading means the process of increasing the structural resistance of a *building*.

Surface fault rupture means a displacement along a fault that reaches the earth's surface during slip.

Total floor area is the sum of the *floor area* of all *storeys* counted from the lowest finished grade around the building.

Trained screener means a person who is properly trained to conduct the seismic risk screening using *Level 1 – SQST (WLF-P9)*.

Year built means the year when the construction of a *building* was completed.

4.2 Notations

F(T)	Site coefficients
HC	High consequences
LC	Low consequences
MC	Medium consequences
n	Remaining occupancy time
n_s	Number of storeys
PGA	Peak ground acceleration
PGA_{ref}	Reference peak ground acceleration
SSC	Site seismic category
S_a(T)	5% damped spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T.
S(T)	Design spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T
T	Period in seconds
VLC	Very low consequences
VHC	Very high consequences
WLF-P9	Wood light frame *buildings* under Part 9 of the NBC

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5 Instructions for completing *Level 1 – PST (WLF-P9)* screening forms

The *Level 1 – PST (WLF-P9)* screening forms provided in Appendix A shall be completed by *trained screeners* based on the key building information collected in the office. Each form is divided into the following parts:

1. Part A: Data collection;
2. Part B: Seismic risk acceptance criteria;
3. Part C: Decision support.

The screening form has been designed to be completed in a smooth progressive manner, with a minimum amount of writing. Appendix B presents an example of seismic risk screening for an *existing building*.

Prior to reviewing the form, the *trained screener* needs to determine whether the *building* to be screened is classified as a *WLF-P9 building* with light construction covered by Part 9 (Division B of Volume 2) of the NBC, and therefore within the scope of this tool. This information can be determined by contacting the building owner or property manager or by checking the criteria for *WLF-P9 buildings* with light construction covered by Part 9 of the NBC.

Buildings may have additions built after the original construction. If that is the case, consider the original *building* and addition(s) as a single *building* if the addition(s) is (are) connected to the original *building*, and consider the original *building* and addition(s) as separate *buildings* if there are any gaps or expansion joints between them.

The first step in completing *Level 1 – PST (WLF-P9)* is to select the appropriate *Level 1 – PST (WLF-P9)* screening form, which is described as follows.

5.1 Selecting *Level 1 – PST (WLF-P9)* screening forms

Select the *Level 1 – PST (WLF-P9)* screening form based on the *original design NBC* of the *building* under screening. The *original design NBC* corresponds to the applicable NBC edition to which the *building* was originally designed. If a provincial or municipal *building* code was used in the original design, the *original design NBC* corresponds to the NBC edition on which the provincial or municipal *building* code was based. The *original design NBC* is best determined based on well-documented sources such as original drawings. If this information is unavailable, the *original design NBC* can be estimated based on the *year built*. The *year built* corresponds to

the year when the construction of the *building* under screening was completed. If there is more than one *year built*, use the very first year to estimate the *original design NBC*. In order to consider the time that typically elapses between design date and *year built*, the *trained screener* may choose to deduct a few years (e.g., five years) from the *year built* to estimate the *original design NBC*.

Select the *Level 1 – PST (WLF-P9)* screening form for post-benchmark *WLF-P9 buildings* if the *original design NBC* corresponds the NBC 2010 or newer. Otherwise, select the *Level 1 – PST (WLF-P9)* screening form for non-benchmark *WLF-P9 buildings*.

Instructions for completing the *Level 1 – PST (WLF-P9)* screening form are provided in the sections hereunder.

5.2 Part A: Data collection

Collect the key *building* information, including *building* identification (i.e., building name, *federal heritage designation*, and building address), seismic data, *year built*, *original design NBC*, *full seismic upgrading NBC*, *benchmark NBC edition*, *number of storeys*, *total floor area*, building *occupancy,* consequences of failure, *remaining occupancy time*, record of *building deterioration/damage*, *site class*, *site seismic category*, and *geologic hazards*. Any unknown or uncertain *building* conditions should be documented in the comments section of Part C of the screening form.

In the sections hereunder, instructions for completing Part A are provided in detail.

5.2.1 Building name, use, and federal heritage designation

Building name may be recorded because it is very useful for quick identification. Building use may be recorded because it is useful for determining the occupancy type of the *building*.

Select "Yes" in the *federal heritage designation* section if the *building* is in the Directory of Federal Heritage Designations and meets any one of the following conditions:

1. A *building* of any age, designated as recognized or classified federal heritage at the time of screening; and
2. A *building* of age not less than 40 years that has not been evaluated by the Federal Heritage Buildings Review Office (FHBRO) at the time of screening.

Parks Canada provides the Directory of Federal Heritage Designations (https://www.pc.gc.ca/apps/dfhd/search-recherche_eng.aspx). The information can be obtained by contacting Heritage Conservation Services (e-mail: dcp.hcd@tpsgc-pwgsc.gc.ca). If there is any

doubt about the *federal heritage designation,* a written letter from the *building* owner or manager is required to determine if the *building* under screening has a *federal heritage designation*.

5.2.2 Building address

Enter the street address, city, province, and postal code into the building address section.

5.2.3 Seismic data

Seismic data can be obtained either from Appendix C of the NBC 2015 or from the Natural Resources Canada earthquake hazard online calculator at the following website: http://www.earthquakescanada.nrcan.gc.ca/hazard/interpolator/index_2015-en.php.

Enter the values of $S_a(0.2)$, $S_a(0.5)$, $S_a(1.0)$, PGA into this section. The value of reference peak ground acceleration (PGA_{ref}) should be recorded since it is a key parameter in determining site coefficients in Part A of the form. PGA_{ref} is calculated as follows:

- PGA_{ref} = 0.8 PGA (peak ground acceleration), for $S_a(0.2)/PGA<2$, or
- PGA_{ref} = PGA, otherwise.

5.2.4 Year built

Record the *year built* determined in Section 5.1 There may not be a single *year built* designation. Certain portions of the structure may have been designed and constructed before others. If that is the case, document that in the comments section of Part C of the screening form. If this information is unavailable, leave this section blank.

5.2.5 Original design NBC

Enter the *original design NBC* determined in Section 5.1. Enter pre-1965 if the *building* was constructed prior to the release of the 1965 edition of the NBC. If a provincial or municipal building code was used in the original design, the *original design NBC* corresponds to the NBC edition on which the provincial or municipal building code was based. The *original design NBC* is best determined based on well-documented sources such as original structural drawings or existing seismic assessment reports. If this information is unavailable, the *original design NBC* may be estimated based on the year built. In order to consider the lapse in time that typically occurs between design date and year built, the screener may choose to deduct a few years from the year built to estimate the *original design NBC*.

5.2.6 Full seismic upgrading NBC

Enter the applicable *full seismic upgrading NBC* if the *building* was upgraded to fully comply with the seismic requirements of an applicable NBC edition. If a provincial or municipal building code

was used in the original design, the *full seismic upgrading NBC* corresponds to the NBC edition on which the provincial or municipal building code was based. Enter N/A if a full seismic upgrading has never been performed.

5.2.7 Heavy construction

Check "Yes" if the type of construction is heavy construction. Refer to Section 1 for the definition of heavy construction.

5.2.8 Post-benchmark building

Select "Yes" if the *original design NBC* or *full seismic upgrading NBC* corresponds to the NBC 2010 or newer. Select "No" if that is not the case.

5.2.9 Screener information

Identify the *trained screener*'s name, initials, or some other type of code. Check "P. Eng./ing." if the *trained screener* is a licensed professional engineer in Canada. The screening date should also be recorded.

5.2.10 Number of storeys

Enter the *number of storeys* above the lowest finished grade elevation around the *building* under screening. For *buildings* constructed on a hill or with different roof levels, use the largest *number of storeys* counted from the lowest finished grade elevation around the *building* to the corresponding roof.

5.2.11 Total floor area (m^2)

Enter the *total floor area* for the *building* under screening as the sum of the *floor areas* (in m^2) for each *storey* above the lowest finished grade elevation around the *building*. The *floor area* can be determined based on the dimensions of each floor from the construction drawings. If one or more new floors were added and occupied, these *floor areas* should also be taken into consideration. Use an asterisk or a note to indicate when the *total floor area* is estimated.

5.2.12 Occupancy

According to the NBC 2005 and its later editions, Part 9 provisions apply to *buildings* that are mainly used for major *occupancies* classified as follows: residential (Group C), business and personal service (Group D), mercantile (Group E), and medium- and low-hazard industrial (F2 and F3). Nonetheless, some existing *WLF-P9* buildings may have been used for other *occupancies* such as schools, community centres, police stations, hospitals, etc. To account for various occupancies, the following ten common occupancy types are considered and listed as follows:

1. office *buildings*
2. public *buildings*
3. commercial *buildings*
4. industrial *buildings*
5. educational *buildings*
6. residential *buildings*
7. care/treatment *buildings*
8. parking *buildings*
9. public assembly *buildings*
10. passenger stations

Public *buildings* refer to *buildings*, for single or multiple *occupancies*, to which the public is admitted and/or where a wide range of government services and benefits can be provided to the public (e.g., service centres, passport offices, etc.).

Determine the *occupancy* type of the *building* based on the ten *occupancy* types above. If the *building* is not classified as any of the listed *occupancy* types, specify the *occupancy* under "Other" in the *occupancy* section.

If the *building* has more than one *occupancy* type, such as commercial and residential, select all applicable *occupancy* classes. If only a small portion of the *building* is occupied by a specific *occupancy* type, the *trained screener* can choose to circle the main *occupancy* type only. The decision should be made based on the judgement of an experienced structural engineer and consultation with the *building* owner or property manager.

Record the original *occupancy* type in the original *occupancy* section, based on available *building* information. If this information is unavailable, select "DNK" and assume that the original *occupancy* type is the same as the *occupancy* type identified in the *occupancy* section.

Select "Yes" if the *occupancy* change increases structural loads other than seismic. The structural load information can be found in construction drawings. If this information is unavailable, the structural loads from Section 4.1 of Part 4 of Division B of the NBC 2015 can be used.

5.2.13 Consequences of failure

Five levels of consequences of failure, namely Very Low Consequences (VLC), Low Consequences (LC), Medium Consequences (MC), High Consequences (HC), and Very High Consequences (VHC), are defined to describe *buildings'* lowest to highest consequences of failure. HC and VHC do not apply to *buildings* designed in accordance with the NBC 2005 and newer.

Select "Very Low (VLC)" if the *building* is classified as one of the following *occupancy* types: residential, office, public, commercial, and parking. Select the appropriate box for consequences of failure according to Table 5.1. Definitions for Group A through Group F are presented in Appendix C. Note that *WLF-P9 buildings* designed in accordance with the NBC 2005 or newer are not used for public assembly, passenger station, educational, and care/treatment *occupancy* types.

Table 5.1: Consequences of failure for ten occupancy types in *WLF-P9* buildings

Occupancy type	**Consequences of failure**
Residential, office, public, commercial, parking	Very Low Consequences (VLC)
Public assembly, passenger station	Medium Consequences (MC)
Industrial	Low Consequences (LC) • Group F-3; • Do not serve as public utility; and • Do not serve as an emergency facility. Medium Consequences (MC) • Group F-2; • Do not serve as public utility; and • Do not serve as an emergency facility.
Educational	Medium Consequences (MC) • One storey High Consequences (HC) • Exceed one storey.
Care/Treatment	Medium Consequences (MC) • Accommodate no more than 50 *occupants* and have no surgery or emergency facilities. High Consequences (HC) • Accommodate more than 50 *occupants* and have no surgery or emergency facilities. Very High Consequences (VHC) • Have surgery or emergency facilities.

If the *occupancy* type is identified as "Other" in the *occupancy* section, determine the consequences of failure as follows:

- Select "Very Low Consequences (VLC)" if the *building* under screening is an agricultural *building*.
- Select "Very High Consequences (VHC)" if the *building* under screening is intended to be a *post-disaster* facility. Note that *WLF-P9 buildings* designed in accordance with the NBC 2005 or newer are not used as *post-disaster* facilities.
- Select "Very Low Consequences (VLC)" if the *building* is not identified as any of the above conditions.

If there is more than one *occupancy* circled in the *occupancy* section, identify the consequences of failure for each applicable *occupancy* type.

Record the original consequences of failure based on the original *occupancy*, *number of storeys*, *total floor area*, and number of *occupants* (if applicable). For *buildings* with addition(s), the *number of storeys* and *total floor area* should be determined based on the original *building* configuration.

Check "Yes" if the current consequences of failure are higher than the original consequences of failure.

5.2.14 Remaining occupancy time

Check the *remaining occupancy time* box based on the following conditions:

- If the *remaining occupancy time* is less than or equal to 5 years, check the "≤5" box.
- If the *remaining occupancy time* is greater than 5 years, but less than or equal to 10 years, check the ">5 and ≤10" box.
- If the *remaining occupancy time* is greater than 10 years or unknown, check ">10."

If "≤5" or ">5 and ≤10" is checked, a written letter from the *building* owner is required to verify the *remaining occupancy time*.

5.2.15 Building deterioration/damage

Select "Yes" if there is record of *building deterioration/damage* that has not been repaired under the supervision of a licensed structural engineer. The *building deterioration/damage* information can be determined based on well-documented sources such as past performance reports.

5.2.16 Site class

Select the *site class* as designated by the letters A through F in the NBC 2015, as stipulated in Table 5.2, or "DNK" (Do Not Know) if the *site class* cannot be identified. If "DNK" is selected, assume *site class* E for screening purposes.

Table 5.2: Site classification for seismic site response (reproduced from the NBC 2015)

Site class	Ground profile name	Average properties in top 30 m		
		Average shear wave velocity, V_{s30}, m/s	**Average standard penetration resistance, N_{60}**	**Soil undrained shear strength, s_u**
A	Hard rock	$V_{s30} > 1500$	n/a	n/a
B	Rock	$760 < V_{s30} \leq 1500$	n/a	n/a
C	Very dense soil and soft rock	$360 < V_{s30} \leq 760$	$N_{60} > 50$	$s_u > 100$ kPa
D	Stiff soil	$180 < V_{s30} \leq 360$	$15 \leq N_{60} \leq 50$	50 kPa $< s_u \leq 100$ kPa
E	Soft soil	$V_{s30} \leq 180$	$N_{60} < 15$	$s_u < 50$ kPa
		Any profile with more than 3 m of soil with the following characteristics: • plasticity index: PI > 20 • moisture content: w ≥ 40%, and • undrained shear strength: $s_u < 25$ kPa		
F	Other soils[(1)]	Site-specific evaluation required		

[(1)] Other soils include:

- liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils, and other soils susceptible to failure or collapse under seismic loading;
- peat and/or highly organic clays greater than 3 m in thickness;
- highly plastic clays (PI > 75) more than 8 m thick;
- soft to medium stiff clays more than 30 m thick.

If the *site class* was defined based on previous soil types used in the NBC 1975 through NBC 1995, the *site class* can be determined from the mapping shown in Table 5.3. [Note that soil types were first introduced in the NBC 1975 and replaced by *site classes* in the NBC 2005.] In the screening process, soil types 1 to 3 are conservatively mapped to *site classes* D to F, respectively.

Table 5.3: Mapping between previous soil types and site classes in the NBC 2015

Soil type (NBC 1975 to NBC 1995)		*Site class* (NBC 2005 & newer)
1	Rock, dense and very dense coarse-grained soils, very stiff and hard fine-grained soils; compact coarse-grained soils and firm and stiff fine-grained soils from 0 to 15 m deep	A, B, C, and D
2	Compact coarse-grained soils, firm and stiff fine-grained soils with a depth greater than 15 m; very loose and loose coarse-grained soils and very soft and soft fine-grained soils from 0 to 15 m deep	D and E
3	Very loose and loose coarse-grained soils, and very soft and soft fine-grained soils with depths greater than 15 m	E and F

There are various sources of data for the *site class*, including geotechnical reports. Geotechnical reports may be unavailable at the time of screening. If that is the case, available site classification maps can be used to determine the *site class*. Several maps have been developed for different cities in Canada (e.g., Montreal, Ottawa, and Vancouver) based on the average shear wave velocity in the top 30 metres of soil, V_{s30}. Some of these maps, however, may be unavailable to the public and should be requested from the City or an academic or public institution. Such maps should be used with some caution, and in case of any doubt about the *site class*, the *trained screener* should select "DNK."

5.2.17 Site coefficients

The site coefficients $F(0.2)$, $F(0.5)$, and $F(1.0)$ shall be obtained from Article 4.1.8.9 of Part 4 of the NBC 2015.

5.2.18 Site seismic category

Table 5.4 presents the *site seismic categories* defined by the thresholds of $S(0.2)$ [maximum of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$] and $S(1.0)$ [i.e. $F(1.0)S_a(1.0)$], respectively.

Table 5.4: Site seismic categories and corresponding spectral acceleration thresholds

Site seismic category (SSC)	*S*(0.2)		*S*(1.0)	
	>	≤	>	≤
Very Low		0.10 g		0.05g
Low	0.10 g	0.20 g	0.05g	0.10 g
Moderate	0.20 g	0.35 g	0.10 g	0.15 g
Moderately High	0.35 g	0.75 g	0.15 g	0.30 g
High	0.75 g	1.15 g	0.30 g	0.50 g
Very High	1.15 g		0.50 g	

Calculate the values of *S*(0.2) and *S*(1.0). Compare them with the corresponding thresholds to determine the *site seismic category*. The *site seismic category* based on the *S*(0.2) may be different from the *site seismic category* based on the *S*(1.0). If that is the case, select the higher as the *site seismic category.*

5.2.19 Geologic hazard

Identify *geologic hazards* based on available geotechnical reports and other relevant documents. For each type of *geologic hazard*, select "Yes" if the hazard is present at or near the *building* site, and select "DNK" (Do Not Know) if the presence of the hazard cannot be identified. If "DNK" is selected, assume "No" for screening purposes.

Landslide potential can be identified based on street views or aerial maps from public online sources. As a rule of thumb, if the height of the slope is greater than the distance from the nearest side of the *building* to the slope, *landslide potential* should be circled on the form (Figure 5.1).

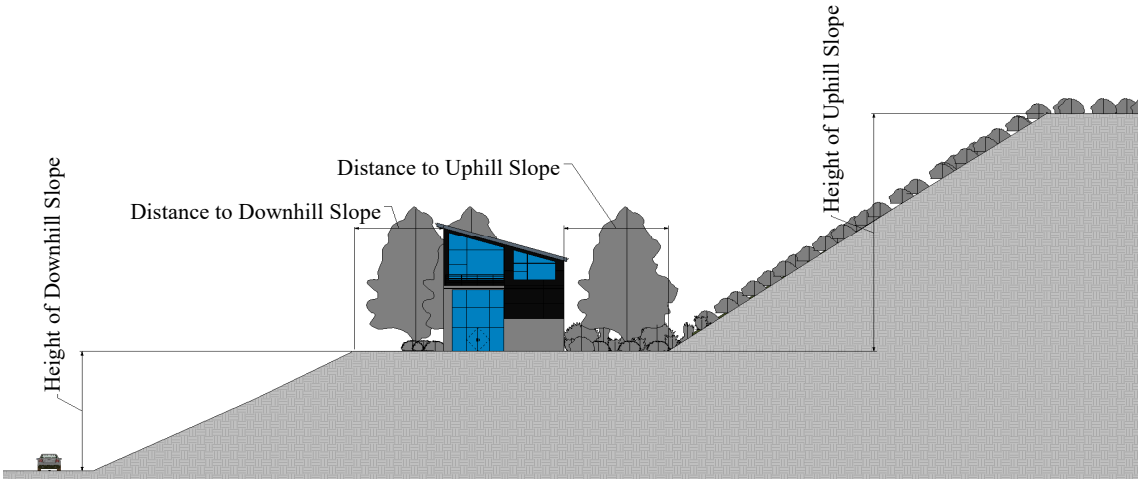

Figure 5.1: Building with landslide potential

5.2.20 Extent of review

Document whether drawings were reviewed for the *building*'s seismic screening. If "Yes," the *trained screener* should document the types of drawings reviewed, authors, and dates of issue in the comments section of Part C of the screening form. Document the *site class* and *geologic hazard* sources. In addition, document the applicable authors and dates of issue.

5.3 Part B: Seismic risk acceptance criteria

In this section, the *trained screener* needs to check the *seismic risk* acceptance criteria based on the building information collected in Part A, including the *post-benchmark building*, *site seismic category*, *remaining occupancy time*, and consequences of failure.

5.4 Part C: Decision support

This section provides the actions resulting from *Level 1 – PST (WLF-P9)*, specifically whether the *building* requires *Level 2 – SQST (WLF-P9)* or *Level 3 – SEG*.

5.4.1 Comments

This section is for documenting any comments that the *trained screener* may wish to make regarding the collecting of *building* information in Part A and the required action(s) in Part C. In addition, the *trained screener* should report unknown or uncertain *building* conditions.

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6 References

Cai, Z., Fathi-Fazl, R., Fazileh, F., and Cortés-Puentes, W.L., 2022a. Level 1 – Preliminary Seismic Risk Screening Tool (PST) for existing wood light frame buildings under Part 9 of the NBC, Part 2: supporting technical documentation (available upon request). National Research Council Canada, Ottawa, Ontario, Canada.

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Doudak, G. and Viau, C., 2020. Comparison between the seismic provisions of the 2018 International Residential Code and Part 9 of the 2015 edition of the National Building Code of Canada for wood light-frame construction (available upon request). Prepared for National Research Council Canada. Department of Civil Engineering, University of Ottawa, Ottawa, Ontario, Canada.

Fathi-Fazl, R., Cai, Z., Jacques, E., and Kadhom, B., 2020a. Level 1 – Preliminary Seismic Risk Screening Tool (PST) for existing buildings, Part 1: user's guide. National Research Council Canada, Ottawa, Ontario. https://doi.org/10.4224/40001929.

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NRC, 2015. National Building Code of Canada. National Research Council Canada, Ottawa, Ontario, Canada.

Appendix A *Level 1 – PST (WLF-P9)* screening forms

This appendix provides blank *Level 1 – PST (WLF-P9)* screening forms. Each form consists of a front page and a back page. The front page includes Part A: Data collection, Part B: Seismic risk acceptance criteria, and Part C: Decision support. The back page provides the intent and scope of *Level 1 – PST (WLF-P9)* and explanations of the superscripts on the front page.

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Level 1 – PST (WLF-P9) Screening Form for Post-benchmark WLF-NE Buildings†

PART A: DATA COLLECTION

Building name:		**Use:**	**Federal heritage designation[1]:** ☐ Yes* ☐ No	
Street address:			**City/Province:**	**Postal code:**
Seismic data[2] : $S_a(0.2)$=	$S_a(0.5)$=	$S_a(1.0)$=	PGA=	PGA_{ref}=
Year built[3]:	**Original design NBC[4]:**		**Full seismic upgrading NBC (if applicable)[5]:**	
Heavy construction: ☐ Yes* ☐ No			**Post-benchmark building:** ☐ Yes ☐ No	
Screener:	P.Eng./ing.: ☐ Yes ☐ No		**Date:**	

No. of storeys[7]: **Total floor area (m^2)[8]:**	**Site Class:** ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F* ☐ DNK (assume E for screening)
Occupancy[9]: Office, Public, Commercial, Industrial, Educational, Residential, Care/Treatment, Parking, Public Assembly, Passenger Stations, Other_____	**Site coefficient s[14] :** $F(0.2)$= $F(0.5)$= $F(1.0)$=
Original occupancy:_____	***S* (*T*) :** $F(0.2)S_a(0.2)$= $F(0.5)S_a(0.5)$= $F(1.0)S_a(1.0)$=
Increase in structural loads due to a change of occupancy: ☐ Yes* ☐ No	**Site seismic category[15]:** ☐ Very Low (SSC-0) ☐ Low (SSC-1) ☐ Moderate (SSC-2) ☐ Moderately High (SSC-3) ☐ High (SSC-4) ☐ Very High (SSC-5)
Consequences of failure (COF)[10]: ☐ Very Low (VLC) ☐ Low (LC) ☐ Medium (MC) ☐ High (HC) ☐ Very High (VHC)	**Geologic Hazards[16]:** **Liquefaction:** ☐ Yes* ☐ No ☐ DNK; **Landslide potential:** ☐ Yes* ☐ No ☐ DNK; **Surface rupture fault:** ☐ Yes* ☐ No ☐ DNK
Original COF[11]:_____	**EXTENT OF REVIEW**
COF higher than original COF: ☐ Yes* ☐ No	**Drawings reviewed[17]:** ☐ Yes ☐ No
Remaining occupancy time, *n* (Year)[12]: ☐ ≤5 ☐ >5 and ≤10 ☐ > 10	**Site Class source:**_____
Record of building deterioration/damage[13]: ☐ Yes ☐ No	**Geologic hazards source:**_____

PART B: SEISMIC RISK ACCEPTANCE CRITERIA

Site seismic category (SSC)	**Post-benchmark building**		
	Structure	**Non-structural components**	
	Consequences of failure (COF)	**Consequences of failure (COF)**	
	VLC & LC & MC	VLC	LC & MC
SSC-0 & SSC-1	☐ Met	☐ Met	☐ Met
SSC-2			☐ Not Met
SSC-3		☐ Not Met	
SSC-4			
SSC-5			

Note: HC & VHC do not apply to post-benchmark *WLF-P9* buildings. The remaining occupancy time does not apply to post-benchmark *WLF-P9* buildings.

PART C: DECISION SUPPORT

Level 3 – Seismic evaluation required without conducting Level 2 – Semi-quantitative screening[18]?

☐ Yes, any of the following conditions apply
- ☐ Heavy construction
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☐ No, none of the conditions above apply. Proceed to below.

Level 2 – Semi-quantitative screening of the structure required?

☐ Yes, there is record of building deterioration/damage. Structural seismic risk may exceed the acceptable seismic risk.

☐ No, there is NO record of building deterioration/damage. Structural seismic risk does NOT exceed the acceptable seismic risk.

Level 2 – Semi-quantitative screening of the non-structural components required?

☐ Yes, any of the following conditions apply. Seismic risk of the non-structural components may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the non-structural components does NOT exceed the acceptable seismic risk.

Comments:

☐ Additional comments on separate page(s)

† Review the back page for the intent and scope of the tool and explanations of the superscripts on this page. * If circled or selected, skip Part B and proceed to Part C.

Intent and Scope

***Level 1 – PST (WLF-P9)* is intended to cover existing wood light frame buildings under Part 9 of the National Building Code of Canada (NBC)**. WLF-NE buildings with heavy construction are not within the scope of this tool. "Heavy construction" refers to buildings with tile roofs, stucco walls or floors with concrete topping, or that are clad with directly applied heavyweight materials (NRC 2015). It is not intended for existing buildings covered by Part 4 of the NBC.

***Level 1 – PST (WLF-P9)* deals with life safety objectives, consistent with the NBC 2015 and does not address other objectives more stringent than life safety.** A building expected to achieve objectives more stringent than life safety (e.g., a building with a federal heritage designation) is still eligible for screening with this tool, but only to determine if its life safety risk exposed to seismic hazards exceeds the acceptable seismic risk.

The *Level 1 – PST (WLF-P9)* screening forms for existing *WLF-P9* buildings should be used in conjunction with Part 1: User's Guide.

Explanation of Superscripts

1. Federal heritage designation refers to a building in the Directory of Federal Heritage Designations and meets any one of the following conditions: (1) buildings of any age, designated as recognized or classified federal heritage at the time of screening; and (2) buildings of age not less than 40 years that have not yet been evaluated by the Federal Heritage Buildings Review Office (FHBRO) at the time of screening. Parks Canada provides the Directory of Federal Heritage Designations (https://www.pc.gc.ca/apps/dfhd/search-recherche_eng.aspx). The information can be obtained by contacting Heritage Conservation Services (e-mail: dcp.hcd@tpsgc-pwgsc.gc.ca).

2. Seismic data: Natural Resources Canada provides the seismic data for all locations across Canada (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php). An alternative to obtaining the seismic data is reviewing Appendix C of Division B of the latest editions of the NBC.

PGA_{ref} is the reference peak ground acceleration and is calculated as follows:

- PGA_{ref} = 0.8 PGA, if $S_a(0.2)/PGA < 2.0$;
- PGA_{ref} = PGA, otherwise.

3. Year built means the year when the construction of the building was completed.

4. Original design NBC means the applicable NBC edition to which the building was originally designed. If a provincial or municipal building code was used to design the building, the original design NBC corresponds to the NBC edition on which the provincial or municipal building code was based. The original design NBC can be estimated by deducting a few years from the year built.

5. Full seismic upgrading NBC refers to an applicable NBC edition to which an existing building was upgraded, to fully comply with seismic requirements.

6. Benchmark NBC edition refers to an applicable NBC edition in which significantly improved seismic requirements were adopted and enforced. The NBC 2010 is the benchmark NBC edition for existing *WLF-P9* buildings

7. No. of storeys refers to the number of storeys counted from the lowest finished grade elevation around the building (excluding the penthouse).

8. Total floor area refers to the sum of the floor area of all storeys above the grade (excluding parking areas). The floor area of each storey can be estimated based on the dimensions of each floor.

9. Occupancy: Refer to Part 1: User's Guide for definitions and guidance on how to identify occupancy.

10. Consequences of failure: Refer to Part 1: User's Guide for guidance on how to identify the consequences of failure.

11. Original consequences of failure refers to the consequences of failure of the building when it was originally built. The original consequences of failure may change due to the occupancy change or building addition(s). Refer to Part 1: User's Guide for guidance on how to determine the original consequences of failure.

11. Building foundation deficiency: Refer to Part 1: User's Guide for guidance on how to identify the foundation deficiency.

12. Remaining occupancy time means the number of years of intended occupancy of an existing building until the lease of the building is terminated or until the building is decommissioned. If the remaining occupancy time is less than or equal to 10 years, a written letter from the building owner or property manager is required to verify the remaining occupancy time. The remaining occupancy time should not be considered if the building's consequences of failure is Very High.

13. Building deterioration refers to adverse effects of environmental factors on buildings, such as weathering, chemical attacks and other conditions that lead to loss of material strength. Refer to the User's Guide for guidance on how to identify building deterioration. **Building damage** refers to adverse effects on buildings due to various types of hazards (e.g., non-engineered modifications to buildings' seismic-force-resisting systems, earthquakes, blasts, fire, and floods).

14. Site coefficients: Site coefficients can be obtained from Article 4.1.8.4 of the NBC 2015.

15. Site seismic category: The site seismic category should be determined according to Table 1. The site seismic category based on the maximum of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$ may be different from the site seismic category based on $F(1.0)S_a(1.0)$. If that is the case, select the higher as the site seismic category.

Table 1: Site seismic categories and corresponding spectral acceleration thresholds

Site seismic category	Max[$F(0.2)S_a(0.2)$, $F(0.5)S_a(0.5)$]		$F(1.0)S_a(1.0)$	
	>	≤	>	≤
Very Low (SSC-0)		0.1		0.05
Low (SSC-1)	0.1	0.2	0.05	0.1
Moderate (SSC-2)	0.2	0.35	0.1	0.15
Moderately High (SSC-3)	0.35	0.75	0.15	0.3
High (SSC-4)	0.75	1.15	0.3	0.5
Very High (SSC-5)	1.15		0.5	

16. Geologic hazards: This information can be found in available geotechnical reports and other relevant documents. If geologic hazards are unknown, select DNK (i.e., do not know) but assume No for screening purposes.

17. Drawings reviewed: If drawings are reviewed, record their type, authors and dates of issue in the comments section of Part C of the screening form.

18. Level 3 – Seismic Evaluation: If the building is exempt from Level 3 – Seismic Evaluation, non-existence of Site Class F and geologic hazards shall be verified by a certified geotechnical engineer.

Level 1 – PST (WLF-P9) Screening Form for Non-benchmark *WLF-P9* Buildings[†]

PART A: DATA COLLECTION

Building name:	**Use:**	**Federal heritage designation[1]:** ☐ Yes[*] ☐ No
Street address:		**Street address:**
Seismic data[2] : $S_a(0.2)$=	$S_a(0.5)$=	$S_a(1.0)$= PGA= PGA_{ref}=
Year built[3]:	**Original design NBC[4]:**	**Full seismic upgrading NBC (if applicable)[5]:**
Heavy construction: ☐ Yes[*] ☐ No		**Post-benchmark building:** ☐ Yes ☐ No
Screener:	P.Eng./ing.: ☐ Yes ☐ No	**Date:**

No. of storeys[7]: **Total floor area (m^2)[8]:**	**Site Class:** ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F[*] ☐ DNK (assume E for screening)
Occupancy[9]: Office Public Commercial Industrial Educational Residential Care/Treatment Parking Public Assembly Passenger Stations Other_____	**Site coefficient s[14] :** $F(0.2)$= $F(0.5)$= $F(1.0)$= ***S* (*T*) :** $F(0.2)S_a(0.2)$= $F(0.5)S_a(0.5)$= $F(1.0)S_a(1.0)$=
Original occupancy:_____	**Site seismic category[15]:** ☐ Very Low (SSC-0) ☐ Low (SSC-1) ☐ Moderate (SSC-2) ☐ Moderately High (SSC-3) ☐ High (SSC-4) ☐ Very High (SSC-5)
Increase in structural loads due to a change of occupancy: ☐ Yes[*] ☐ No	**Geologic Hazards[16]:** **Liquefaction:** ☐ Yes[*] ☐ No ☐ DNK; **Landslide potential:** ☐ Yes[*] ☐ No ☐ DNK; **Surface rupture fault:** ☐ Yes[*] ☐ No ☐ DNK
Consequences of failure (COF)[10]: ☐ Very Low (VLC) ☐ Low (LC) ☐ Medium (MC) ☐ High (HC) ☐ Very High (VHC)	**EXTENT OF REVIEW**
Original COF[11]:_____	**Drawings reviewed[17]:** ☐ Yes ☐ No
COF higher than original COF: ☐ Yes[*] ☐ No	**Site Class source:**_____
Remaining occupancy time, *n* (Year)[12]: ☐ ≤5 ☐ >5 and ≤10 ☐ > 10	**Geologic hazards source:**_____
Record of building deterioration/damage[13]: ☐ Yes ☐ No	

PART B: SEISMIC RISK ACCEPTANCE CRITERIA

Site seismic category (SSC)	**Non-benchmark building**					
	Structure			**Non-structural components**		
	Consequences of failure (COF)			**Consequences of failure (COF)**		
	VLC & LC & MC	HC	VHC	VLC	LC & MC & HC	VHC
SSC-0 & SSC-1	☐ Met	☐ Met		☐ Met	☐ Met	☐ Met
SSC-2					☐ Met if $n \le 10$ ☐ Not Met if $n > 10$	☐ Not Met
SSC-3		☐ Met if $n \le 10$ ☐ Not Met if $n > 10$	☐ Not Met	☐ Met[‡] if $n \le 10$ ☐ Not Met if $n > 10$	☐ Met if $n \le 5$ ☐ Not Met if $n > 5$	
SSC-4	☐ Met if $n \le 10$ ☐ Not Met if $n > 10$	☐ Met if $n \le 5$ ☐ Not Met if $n > 5$		☐ Met[‡] if $n \le 5$ ☐ Not Met if $n > 5$	☐ Not Met	
SSC-5	☐ Not Met			☐ Not Met		

Note: HC & VHC do not apply to existing *WLF-P9* buildings designed as per the NBC 2005 or newer. [‡] This only applies to existing *WLF-P9* buildings designed as per the NBC 1965 or newer.

PART C: DECISION SUPPORT

Level 3 – Seismic evaluation required without conducting Level 2 – Semi-quantitative screening[18]?

☐ Yes, any of the following conditions apply
- ☐ Heavy construction
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☐ No, none of the conditions above apply. Proceed to below.

Level 2 – Semi-quantitative screening of the structure required?

☐ Yes, any of the following conditions apply. Seismic risk of the structure may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the structure does NOT exceed the acceptable seismic risk.

Level 2 – Semi-quantitative screening of the non-structural components required?

☐ Yes, any of the following conditions apply. Seismic risk of the non-structural components may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the non-structural components does NOT exceed the acceptable seismic risk.

Comments:

☐ Additional comments on separate page(s)

[†] Review the back page for the intent and scope of the tool and explanations of the superscripts on this page. [*] If circled or selected, skip Part B and proceed to Part C.

Intent and Scope

***Level 1 – PST (WLF-P9)* is intended to cover existing wood light frame buildings under Part 9 of the National Building Code of Canada (NBC)**. *WLF-P9* buildings with heavy construction are not within the scope of this tool. "Heavy construction" refers to buildings with tile roofs, stucco walls or floors with concrete topping, or that are clad with directly applied heavyweight materials (NRC 2015). It is not intended for existing buildings covered by Part 4 of the NBC.

***Level 1 – PST (WLF-P9)* deals with life safety objectives, consistent with the NBC 2015 and does not address other objectives more stringent than life safety.** A building expected to achieve objectives more stringent than life safety (e.g., a building with a federal heritage designation) is still eligible for screening with this tool, but only to determine if its life safety risk exposed to seismic hazards exceeds the acceptable seismic risk.

The *Level 1 – PST (WLF-P9)* screening forms for existing *WLF-P9* buildings should be used in conjunction with Part 1: User's Guide.

Explanation of Superscripts

1. Federal heritage designation refers to a building in the Directory of Federal Heritage Designations and meets any one of the following conditions: (1) buildings of any age, designated as recognized or classified federal heritage at the time of screening; and (2) buildings of age not less than 40 years that have not yet been evaluated by the Federal Heritage Buildings Review Office (FHBRO) at the time of screening. Parks Canada provides the Directory of Federal Heritage Designations (https://www.pc.gc.ca/apps/dfhd/search-recherche_eng.aspx). The information can be obtained by contacting Heritage Conservation Services (e-mail: dcp.hcd@tpsgc-pwgsc.gc.ca).

2. Seismic data: Natural Resources Canada provides the seismic data for all locations across Canada (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php). An alternative to obtaining the seismic data is reviewing Appendix C of Division B of the latest editions of the NBC.

PGA_{ref} is the reference peak ground acceleration and is calculated as follows:

- PGA_{ref} = 0.8 PGA, if $S_a(0.2)/PGA < 2.0$;
- PGA_{ref} = PGA, otherwise.

3. Year built means the year when the construction of the building was completed.

4. Original design NBC means the applicable NBC edition to which the building was originally designed. If a provincial or municipal building code was used to design the building, the original design NBC corresponds to the NBC edition on which the provincial or municipal building code was based. The original design NBC can be estimated by deducting a few years from the year built.

5. Full seismic upgrading NBC refers to an applicable NBC edition to which an existing building was upgraded, to fully comply with seismic requirements.

6. Benchmark NBC edition refers to an applicable NBC edition in which significantly improved seismic requirements were adopted and enforced. The NBC 2010 is the benchmark NBC edition for existing *WLF-P9* buildings

7. No. of storeys refers to the number of storeys counted from the lowest finished grade elevation around the building (excluding the penthouse).

8. Total floor area refers to the sum of the floor area of all storeys above the grade (excluding parking areas). The floor area of each storey can be estimated based on the dimensions of each floor.

9. Occupancy: Refer to Part 1: User's Guide for definitions and guidance on how to identify occupancy.

10. Consequences of failure: Refer to Part 1: User's Guide for guidance on how to identify the consequences of failure.

11. Original consequences of failure refers to the consequences of failure of the building when it was originally built. The original consequences of failure may change due to the occupancy change or building addition(s). Refer to Part 1: User's Guide for guidance on how to determine the original consequences of failure.

11. Building foundation deficiency: Refer to Part 1: User's Guide for guidance on how to identify the foundation deficiency.

12. Remaining occupancy time means the number of years of intended occupancy of an existing building until the lease of the building is terminated or until the building is decommissioned. If the remaining occupancy time is less than or equal to 10 years, a written letter from the building owner or property manager is required to verify the remaining occupancy time. The remaining occupancy time should not be considered if the building's consequences of failure is Very High.

13. Building deterioration refers to adverse effects of environmental factors on buildings, such as weathering, chemical attacks and other conditions that lead to loss of material strength. Refer to the User's Guide for guidance on how to identify building deterioration. **Building damage** refers to adverse effects on buildings due to various types of hazards (e.g., non-engineered modifications to buildings' seismic-force-resisting systems, earthquakes, blasts, fire, and floods).

14. Site coefficients: Site coefficients can be obtained from Article 4.1.8.4 of the NBC 2015.

15. Site seismic category: The site seismic category should be determined according to Table 1. The site seismic category based on the maximum of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$ may be different from the site seismic category based on $F(1.0)S_a(1.0)$. If that is the case, select the higher as the site seismic category.

Table 1: Site seismic categories and corresponding spectral acceleration thresholds

Site seismic category	Max[$F(0.2)S_a(0.2)$, $F(0.5)S_a(0.5)$]		$F(1.0)S_a(1.0)$	
	>	≤	>	≤
Very Low (SSC-0)		0.1		0.05
Low (SSC-1)	0.1	0.2	0.05	0.1
Moderate (SSC-2)	0.2	0.35	0.1	0.15
Moderately High (SSC-3)	0.35	0.75	0.15	0.3
High (SSC-4)	0.75	1.15	0.3	0.5
Very High (SSC-5)	1.15		0.5	

16. Geologic hazards: This information can be found in available geotechnical reports and other relevant documents. If geologic hazards are unknown, select DNK (i.e., do not know) but assume No for screening purposes.

17. Drawings reviewed: If drawings are reviewed, record their type, authors and dates of issue in the comments section of Part C of the screening form.

18. Level 3 – Seismic Evaluation: If the building is exempt from Level 3 – Seismic Evaluation, non-existence of Site Class F and geologic hazards shall be verified by a certified geotechnical engineer.

Appendix B An example of *Level 1 – PST (WLF-P9)* performed on an existing *WLF-P9* building

This appendix illustrates *Level 1 – PST (WLF-P9)* screening of an existing *WLF-P9 building* in Pohénégamook, Quebec. The objective of this example is to assist the *trained screener* in completing the *Level 1 – PST (WLF-P9)* screening forms. *The example is provided for illustrative purposes and is not necessarily representative of the actual building condition*.

Appendix B.1 Building description

Building XYZ is a one-storey *WLF-P9 building* located in Pohénégamook, Quebec with public *occupancy*. The *building* was built in 1950.

Appendix B.2 Selection of the *Level 1 – PST (WLF-P9)* screening form

Since the *year built* is prior to the *benchmark NBC edition* (i.e., NBC 2010), the *building* is not a *post-benchmark building*. Therefore, the *Level 1 – PST (WLF-P9)* screening form for non-benchmark *WLF-P9 buildings* should be selected.

Appendix B.3 Data collection

Building XYZ is not listed in the Directory of Federal Heritage Designations; therefore, it is not identified as *federal heritage designation*.

Building XYZ is located on a site with spectral accelerations of $S_a(0.2)$ = 0.431 g, $S_a(0.5)$ = 0.261 g, $S_a(1.0)$ = 0.140 g at 0.2-, 0.5-, and 1.0-second periods, respectively, and peak ground acceleration (PGA) of 0.275 g. [The seismic data of the *building* was obtained from the NRCan earthquake hazard calculator.] The PGA_{ref} corresponds to 80% of PGA (i.e. 0.22 g) given that the ratio of $S_a(0.2)$ to PGA was smaller than 2.

The original structural drawings and other available documents were reviewed in the office. Key information collected is summarized as follows:

- The *building* has one *storey* above grade.
- An approximate *total floor area* of 65 m^2 was calculated based on the dimensions of the floor plan.
- The *building* was constructed of wood light frame in accordance with Part 9 of the NBC.

- The *occupancy* was identified as "Public" and no *occupancy* change was made.
- Given the *occupancy* of the *building*, the consequences of failure were determined as Very Low Consequences (VLC).
- *Remaining occupancy time* of the *building* is greater than 10 years.
- No record of *building deterioration/damage*.
- *Site class* is unknown due to lack of geotechnical information. *Site class* E is assumed in the screening.
- Site coefficients for *site class* E are obtained from the NBC 2015: $F(0.2)=1.20$, $F(0.5)=1.74$, and $F(1.0)=2.01$. Linear interpolation was conducted to calculate the values.
- The *site seismic category* is Moderately High (SSC-3) based on the maximum value of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$; the *site seismic category* is Moderately High (SSC-3) based on the value of $F(1.0)$ $S_a(1.0)$. Therefore, the *site seismic category* is Moderately High (SSC-3).
- Due to lack of geotechnical information, *liquefaction* potential and *surface fault rupture* are unknown. No *landslide potential* is present based on the review of aerial maps of the building.

Appendix B.4 Completion of the *Level 1 – PST (WLF-P9)* screening form

Based on the data collected, the *Level 1 – PST (WLF-P9)* screening form for non-benchmark *WLF-P9 buildings* was completed as shown below. Building XYZ is flagged for *Level 2 – Semi-Quantitative Seismic Risk Screening (SQST)* for *WLF-P9 buildings* because "Not Met" is checked for non-structural components in the *building*.

Level 1 – PST (WLF-P9) Screening Form for Non-benchmark WLF-P9 Buildings†

PART A: DATA COLLECTION

Building name: Building XYZ		**Use:** Public	**Federal heritage designation[1]:** ☐ Yes* ☒ No	
Street address:			**City/Province:**	**Postal code:**
Seismic data[2]: $S_a(0.2)$= 0.431	$S_a(0.5)$= 0.261	$S_a(1.0)$= 0.140	PGA= 0.275	PGA_{ref}= 0.220
Year built[3]: 1950	**Original design NBC[4]:** Pre-NBC 1965		**Full seismic upgrading NBC (if applicable)[5]:** N/A	
Heavy construction: ☐ Yes* ☒ No			**Post-benchmark building:** ☐ Yes ☒ No	
Screener: B.B.	P.Eng./ing.: ☒ Yes ☐ No		**Date:** 2021.10.05	

No. of storeys[7]: 1 **Total floor area (m^2)[8]:** 64

Occupancy[9]: Office (Public) Commercial Industrial Educational Residential Care/Treatment Parking Public Assembly Passenger Stations Other_____

Original occupancy: Public

Increase in structural loads due to a change of occupancy: ☐ Yes* ☒ No

Consequences of failure (COF)[10]: ☒ Very Low (VLC) ☐ Low (LC) ☐ Medium (MC) ☐ High (HC) ☐ Very High (VHC)

Original COF[11]: Very Low (VLC)

COF higher than original COF: ☐ Yes* ☒ No

Remaining occupancy time, *n* (Year)[12]: ☐ ≤5 ☐ >5 and ≤10 ☒ > 10

Record of building deterioration/damage[13]: ☐ Yes ☒ No

Site Class: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F* ☒ DNK (assume E for screening)

Site coefficient s[14]: $F(0.2)$= 1.20 $F(0.5)$= 1.74 $F(1.0)$= 2.01

***S* (*T*):** $F(0.2)S_a(0.2)$= 0.52 $F(0.5)S_a(0.5)$= 0.45 $F(1.0)S_a(1.0)$= 0.28

Site seismic category[15]: ☐ Very Low (SSC-0) ☐ Low (SSC-1) ☐ Moderate (SSC-2) ☒ Moderately High (SSC-3) ☐ High (SSC-4) ☐ Very High (SSC-5)

Geologic Hazards[16]:
- **Liquefaction:** ☐ Yes* ☐ No ☒ DNK
- **Landslide potential:** ☐ Yes* ☒ No ☐ DNK
- **Surface rupture fault:** ☐ Yes* ☐ No ☒ DNK

EXTENT OF REVIEW

Drawings reviewed[17]: ☒ Yes ☐ No

Site Class source: N/A

Geologic hazards source: N/A

PART B: SEISMIC RISK ACCEPTANCE CRITERIA

Site seismic category (SSC)	Non-benchmark building					
	Structure			Non-structural components		
	Consequences of failure (COF)			Consequences of failure (COF)		
	VLC & LC & MC	HC	VHC	VLC	LC & MC & HC	VHC
SSC-0 & SSC-1	☒ Met	☐ Met		☐ Met	☐ Met	☐ Met
SSC-2					☐ Met if $n \le 10$ ☐ Not Met if $n >10$	☐ Not Met
SSC-3		☐ Met if $n \le 10$ ☐ Not Met if $n >10$	☐ Not Met	☐ Met‡ if $n \le 10$ ☒ Not Met if $n >10$	☐ Met if $n \le 5$ ☐ Not Met if $n >5$	
SSC-4	☐ Met if $n \le 10$ ☐ Not Met if $n >10$	☐ Met if $n \le 5$ ☐ Not Met if $n >5$		☐ Met‡ if $n \le 5$ ☐ Not Met if $n >5$	☐ Not Met	
SSC-5	☐ Not Met			☐ Not Met		

Note: HC & VHC do not apply to existing *WLF-P9* buildings designed as per the NBC 2005 or newer. ‡ This only applies to existing *WLF-P9* buildings designed as per the NBC 1965 or newer.

PART C: DECISION SUPPORT

Level 3 – Seismic evaluation required without conducting Level 2 – Semi-quantitative screening[18]?

☐ Yes, any of the following conditions apply
- ☐ Heavy construction
- ☐ Federal heritage designation
- ☐ Change of occupancy increases structural loads
- ☐ Consequences of failure higher than original consequences of failure
- ☐ Site Class F
- ☐ Presence of any geologic hazards

☒ No, none of the conditions above apply. Proceed to below.

Level 2 – Semi-quantitative screening of the structure required?

☐ Yes, any of the following conditions apply. Seismic risk of the structure may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☐ Seismic risk acceptance criteria "Not Met" in Part B

☒ No, none of the conditions above apply. Seismic risk of the structure does NOT exceed the acceptable seismic risk.

Level 2 – Semi-quantitative screening of the non-structural components required?

☒ Yes, any of the following conditions apply. Seismic risk of the non-structural components may exceed the acceptable seismic risk.
- ☐ Record of building deterioration/damage
- ☒ Seismic risk acceptance criteria "Not Met" in Part B

☐ No, none of the conditions above apply. Seismic risk of the non-structural components does NOT exceed the acceptable seismic risk.

Comments:

Geotechnical study is not available.

Structural seismic risk is acceptable.

The seismic risk of the non-structural components needs to be further assessed by Level 2 – SQST (WLF-NE).

☐ Additional comments on separate page(s)

† Review the back page for the intent and scope of the tool and explanations of the superscripts on this page. * If circled or selected, skip Part B and proceed to Part C.

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Appendix C NBC's major occupancies

Table 6.1: Major occupancies in the NBC 2015

Group	Division	Description of major occupancies
A (Assembly occupancies)	1	Assembly occupancies intended for the production and viewing of the performing arts (e.g., theatres, opera houses, etc.)
	2	Assembly occupancies not elsewhere classified in Group A (e.g., museums, art galleries, schools and colleges, etc.)
	3	Assembly occupancies of the arena types (e.g., indoor swimming pools, rinks, etc.)
	4	Assembly occupancies in which the *occupants* are gathered in the open air (e.g., grandstands, stadia, etc.)
B (Detention, treatment, and care occupancies)	1	Detention occupancies where people are restrained from or are incapable of evacuating to a safe location without the assistance of another person because of security measures not under their control (e.g., jails, prisons, etc.)
	2	Treatment occupancies where overnight accommodation is available to facilitate the treatment (e.g., hospitals, healthcare facilities, etc.)
	3	Occupancies where care is provided to residents (e.g., assisted/supportive living facilities, children's custodial homes, etc.)
C (Residential occupancies)	-	Residential occupancies for whom sleeping accommodations are provided but who are not harboured for the purpose of receiving care or treatment and are not involuntarily detained (e.g., apartments, hotels, motels, etc.)
D (Business and personal services occupancies)	-	Business and personal services occupancies for the transaction of business or the rendering or receiving of professional or personal services (e.g., banks, offices, medical offices, dental offices, etc.)
E (Mercantile occupancies)	-	Mercantile occupancies for the displaying or selling of retail goods, wares or merchandise (e.g., shops, department stores, supermarkets, etc.)
F (Industrial occupancies)	1	High-hazard industrial occupancy containing sufficient quantities of highly combustible and flammable or explosive materials that, because of their inherent characteristics, constitute a special fire hazard (e.g., laboratories, factories, creameries, etc.)
	2	Medium-hazard industrial occupancy in which the combustible content is more than 50 kg/m^2 or 1 200 MJ/m^2 of floor area and not classified as a high-hazard industrial occupancy (e.g., aircraft hangars, box factories, printing plants, etc.)
	3	Low-hazard industrial occupancy in which the combustible content is not more than 50 kg/m^2 or 1 200 MJ/m^2 of floor area (e.g., feed mills, flour mills, mattress factories, etc.)

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