Pontem Group
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WHISTLER MUNICIPAL HALL

4325 Blackcomb Way, Whistler, BC

ALTERNATIVE SOLUTION REPORT

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SIGNATURES

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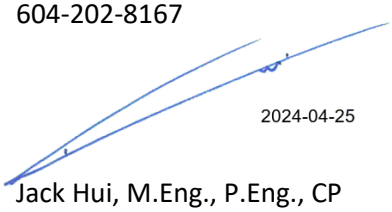

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1 EXECUTIVE SUMMARY

The Whistler Municipal Hall is an existing 3-level City Hall located at 4325 Blackcomb Way, Whistler, BC. To increase the level of fire and life safety in the building, 5 mitigating features are proposed.

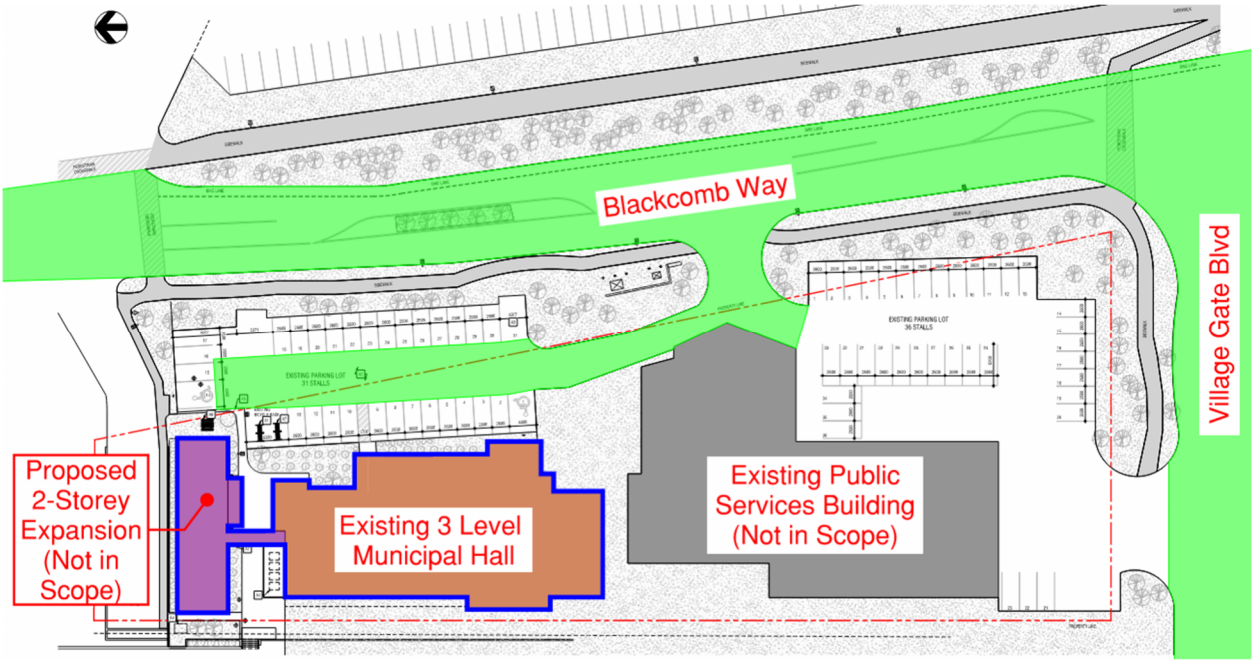


Figure 1: Site Plan

1.1 APPLICABLE CODE

The applicable Building Code for this project is 2018 British Columbia Building Code (BCBC).

1.2 SCOPE OF REPORT

Pontem Consulting Group Ltd. has been retained by the Resort Municipality of Whistler to provide an alternative solution for the project. This report is based on the information provided by S2 Architecture. It identifies the fire and life safety requirements with Division B, Part 3 of the BCBC. Any references indicated in the report are to the BCBC unless otherwise stated. Information related to the overall existing municipal hall mentioned in this report is based on record document forwarded to Pontem Group. It is not the scope of Pontem Group to assess every aspect of the entire existing municipal hall nor identify existing code deficiencies of the existing building. It is the building owner's responsibilities to follow the governing building code at the time of construction.

1.2.1 PREVIOUSLY ACCEPTED EQUIVALENCIES

There may be existing building code equivalencies that have been accepted by the City during previous construction of the municipal hall. The proposed expansion work will not involve extensive alterations to the existing building. Therefore, it is expected that the proposed municipal hall addition will not alter any previously accepted equivalencies and the existing standard of fire and life safety. All new work will be reviewed in conformance with the 2018 BCBC. Any new work which does not conform with the BCBC will be addressed by alternative solutions.

1.3 LIMITATION OF LIABILITY

This document is prepared by Pontem Consulting Group Ltd. (Pontem Group). The content contained in this document represents Pontem Group's best assessment based on the information available at the time of preparation. Pontem Group accepts no responsibility, if any, suffered by any third party as a result of the use of any content of this report without authorization from Pontem Group. Pontem Group shall not be held responsible for any content stated in this report without written acceptance by the applicable Authority Having Jurisdiction. As this document is not a design document, it is the responsibility of the registered professionals of record to incorporate building code measures described in this report, including alternative solutions, into the design, building permit and construction documents.

2 ALTERNATIVE SOLUTION: FIRE AND LIFE SAFETY UPGRADE

To improve the level of fire and life safety in the original municipal hall, several protective measures are proposed throughout the building, which include the following:

1. 45 Minute Floor Separation: Level 3 office glazing to be replaced with wired glass.

2. Sprinkler Protecting Levels 1, 2, and 3: Sprinklers will be installed on Levels 1, 2, and 3 of the original municipal hall to improve the existing roof rating and address the current exit arrangement on Level 3.

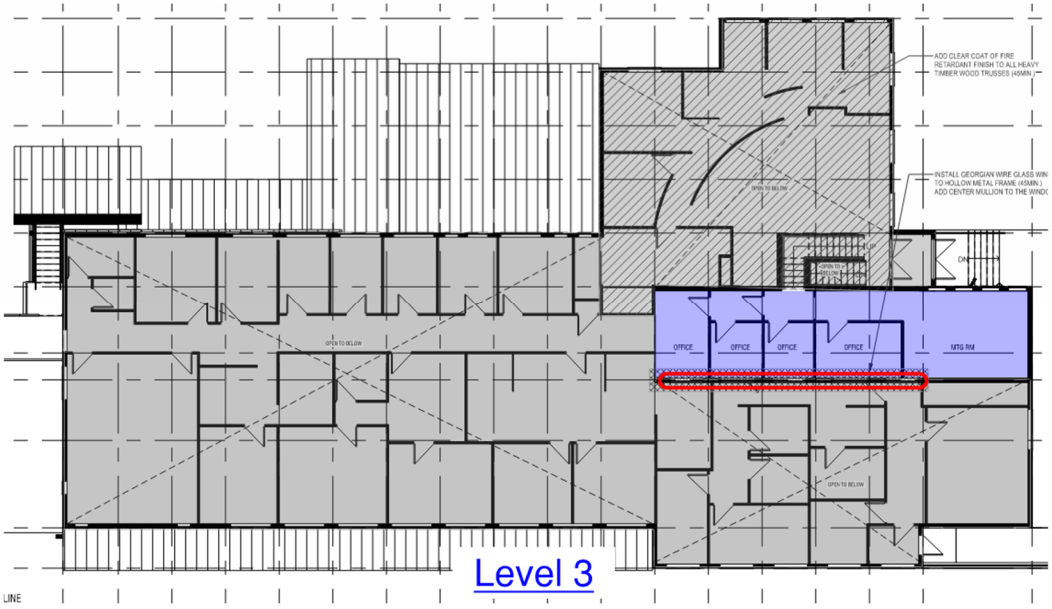
3. Spatial Separation: A water curtain will be installed along the interior of the west exterior wall, supplemented by the addition of non-combustible cladding to improved fire protection.

4. Protection of Exit Facilities: A water curtain will be installed on the interior side of the unprotected opening, which exposes the north external stairway and south accessible entrance ramp.

2.1 MITIGATING FEATURE: 45 MINUTE FIRE SEPARATION

2.1.1 CODE REQUIREMENTS

There is existing glazing that connect Level 3 offices to the space below on Level 2. As such, the required 45 min floor separation between Levels 2 and 3 is currently incomplete. Wired glass, which is permitted in a fire separation with up to 1 h fire-resistance rating, is proposed to replace the existing glazing to meet code compliance.



Legend	Note
	Existing glazing to be replaced by wired glass
	Level 3 office area
	Area open to Level 2 below

Figure 2: Level 3 Proposed Wired Glass Location

3.1.8.16.(1) Wired Glass and Glass Block

Except as permitted by Articles 3.1.8.18. and 3.1.8.19. for the separation of exits, an opening in a fire separation having a fire-resistance rating not more than 1 h is permitted to be protected with fixed wired glass assemblies or glass blocks installed in conformance with NFPA 80, “Fire Doors and Other Opening Protectives.”

2.1.2 MAINTENANCE REQUIREMENTS

Field reviews will be conducted to confirm that the alternative solution will be implemented during construction. The protection measure is passive protection and there are no specific maintenance requirements, but it will be part of the general building maintenance arrangement.

2.2 MITIGATING FEATURE: SPRINKLER PROTECTING LEVELS 1, 2, AND 3 OF THE ORIGINAL MUNCIPAL HALL

2.2.1 CODE REQUIREMENTS

According to the code, the expanded municipal hall can remain under Construction Article 3.2.2.60. and may remain without sprinklers; however, the roof must have a 45-minute fire resistance rating. This alternative solution is provided to enhance the fire safety of the original municipal hall's roof and further safeguard the current exit arrangement on Level 3.

2.2.2 OBJECTIVES AND FUNCTIONAL STATEMENTS

Clause 3.2.2.60.(2)(c) establishes the roof construction of the building. Since it is proposed to enhance the fire safety of the original municipal hall's roof to further safeguard the current exit arrangement on Level 3, the objectives and functional statements outlined in Clause 3.2.2.60.(2)(c) will be addressed. The objective and functional statements are as follows:

[F04-OS1.3]
[F04-OP1.3]

OS1	Objectives
Fire Safety	An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to fire. The risks of injury due to fire addressed in this Code are those caused by:
OS1.3	Collapse of physical elements due to a fire or explosion

OP1	Objectives
Fire Protection of the Building	An objective of this Code is to limit the probability that, as a result of its design or construction, the building will be exposed to an unacceptable risk of damage due to fire. The risks of damage due to fire addressed in this Code are those caused by:
OP1.3	Collapse of physical elements due to a fire or explosion

	Functional Statements
F04	To retard failure or collapse due to the effects of fire.

2.2.3 INTENT STATEMENTS

The intent statements are as follows:

3.2.2.60.(2)	Intent Statements
[F04-OS1.3] Fire Safety	**Intent 1:** To limit the probability that loadbearing walls, columns and arches exposed to fire will prematurely fail or collapse, which could lead to the failure or collapse of a supported combustible roof assembly during the time required to achieve occupant safety and for emergency responders to perform their duties, which could lead to harm to persons. **Intent 2:** To limit the probability that a combustible roof assembly exposed to fire will prematurely fail or collapse during the time required to achieve occupant safety and for emergency responders to perform their duties, which could lead to harm to persons.
[F04-OP1.3] Fire Protection of the Building	**Intent 1:** To limit the probability that loadbearing walls, columns and arches exposed to fire will prematurely fail or collapse, which could lead to the failure or collapse of a supported combustible roof assembly during the time required to achieve occupant safety and for emergency responders to perform their duties, which could lead to damage to the building. **Intent 2:** To limit the probability that a combustible roof assembly exposed to fire will prematurely fail or collapse during the time required to achieve occupant safety and for emergency responders to perform their duties, which could lead to damage to the building.

2.2.4 MITIGATING FEATURES

To address the objectives and functional statements, the following mitigating features are provided.

Alternative	Mitigating Features
Fire Protection	Levels 1, 2, and 3 of the original municipal hall will be sprinkler protected and the sprinkler system is to comply with NFPA 13 - 2013
Smoke Detection in Hallway	All hallways will have smoke detectors.
Fire Alarm System	The existing fire alarm system must be revised accordingly to incorporate the new municipal hall addition and the new sprinkler system. The fire alarm system is to comply with CAN/ULC-S524-14 and be monitored by a monitoring station in conformance with CAN/ULC-S561-13. Notification of the fire department must be provided in conformance with CAN/ULC-S561-13, "Installation and Services for Fire Signal Receiving Centres and Systems."

Areas in the original municipal hall where sprinkler protection will be installed are highlighted in the figures below.

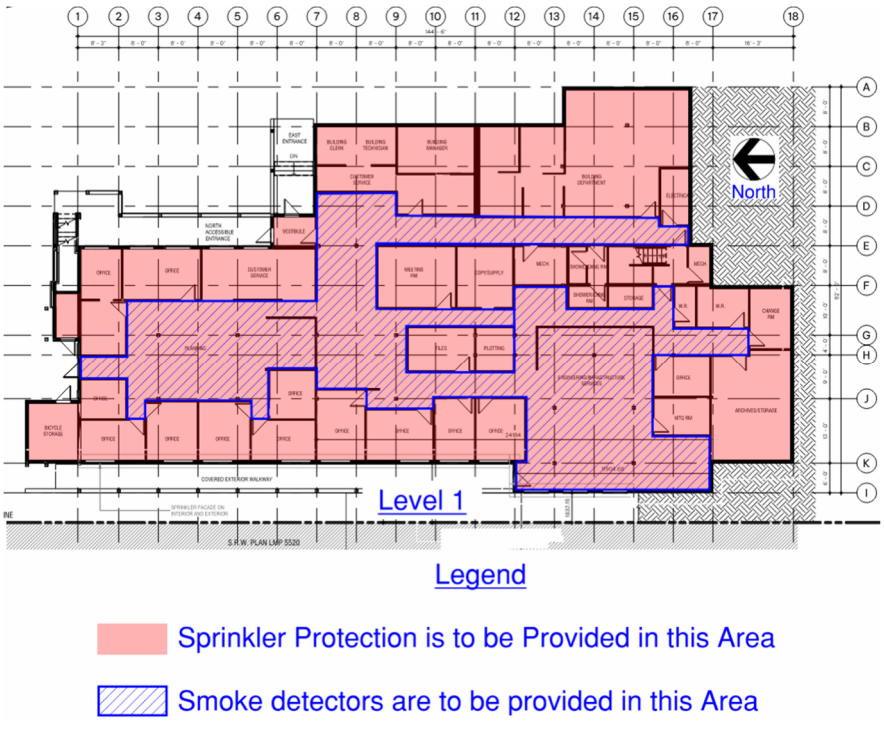


Figure 3: Proposed Areas with Sprinkler Protection and Smoke Detectors

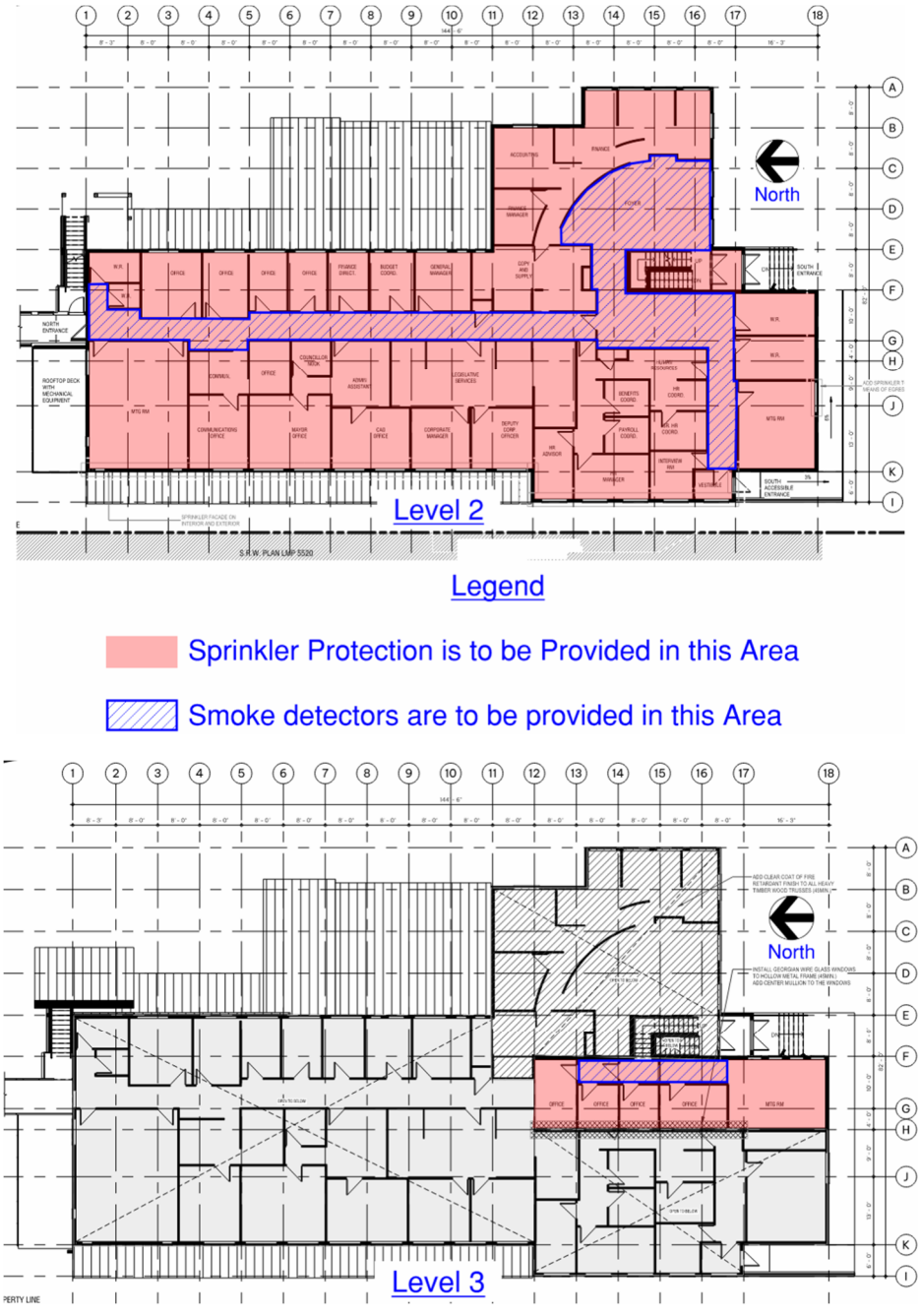


Figure 4: Proposed Areas with Sprinkler Protection and Smoke Detectors

2.2.5 DISCUSSION

The proposed alternative solution addresses the objectives and functional requirements of Sentence 3.2.2.60.(2). The approach and rationale for providing the mitigating features listed in this alternative solution are provided in Table 1.

Table 1: Overall Mitigating Features of Proposed Construction

Overall Construction				
Building Elements	**Code Requirement**	**Proposed Features**	**Justification**	**Increase Fire Protection**
Code Reference	3.2.2.60. permits the expanded municipal hall to remain unsprinklered and the roof of the building is required to have a 45 minute fire resistance rating.	The alternative solution includes providing active fire protection such as a • sprinkler system and • smoke detection. In general, the alternative solution increases the fire protection aspects of the building.	The proposed sprinkler system will be installed in accordance with NFPA 13. With an NFPA 13 sprinkler system in place, the following will be present. • Early Suppression: The sprinkler system can detect and suppress the fire at its early stages, preventing it from growing. • Life Safety: Sprinkler protection will provide occupants with more time to evacuate safety by controlling the fire's growth and spread, thereby, reducing the risk of injury. • Property Protection: The sprinkler system can help minimize property damage by containing fires to their area of origin, limiting the extend of damage to the building and its contents. Based on the above, it is expected that the growth of fire will be slowed by the proposed sprinkler system, thereby reducing the effects of the fire on areas beyond its point of origin. With this in mind, • a fire originating on the floor area of the original municipal hall will be controlled, • the roof of the original municipal hall will be preserved, and • additional time will be provided for occupants on Level 3 to exit the building. Smoke detectors in all hallways of the building will provide early warning to occupants. Smoke detectors will typically activate sooner than sprinklers as smoke spreads earlier and more quickly than heat. Therefore, the smoke detectors can provide earlier warning to occupants in a fire event.	Sprinkler protecting Levels 1, 2, and 3 of the original municipal halls will increase fire protection level. This feature addresses the functional statement: [F04] To retard failure or collapse due to the effects of fire.

2.2.6 MAINTENANCE

Pontem Group will conduct a field review to confirm the construction is in substantial compliance with all of the mitigating features indicated in this alternative solution.

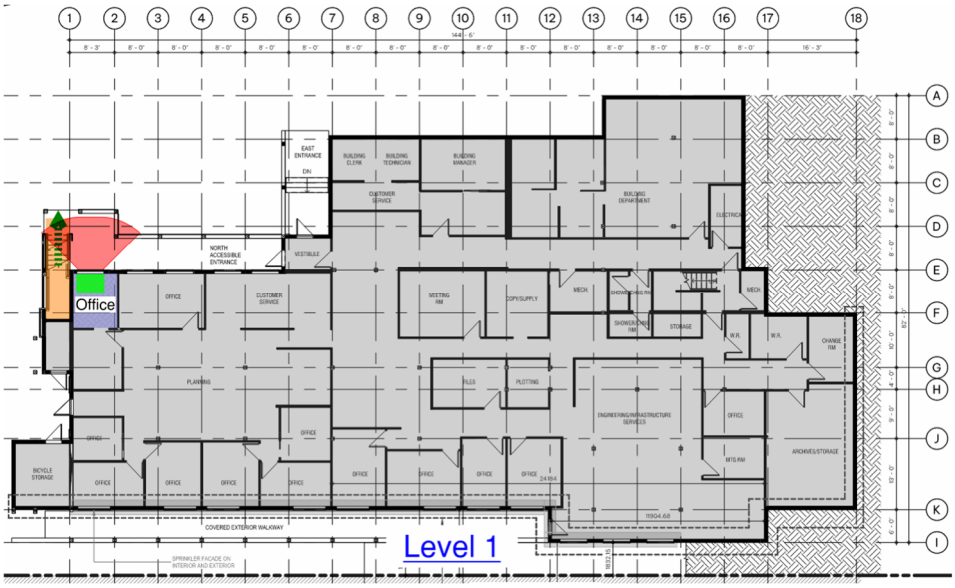
The sprinkler system must be maintained in accordance with NFPA 25 and is the responsibility of the owner.

With the reliance on active fire protection measures, the fire alarm and sprinkler system must be tested annually in accordance with the British Columbia Fire Code (BCFC), CAN/ULC-S537 and NFPA 25.

2.3 MITIGATING FEATURE: PROTECTION OF EXIT FACILITIES – WATER CURTAIN

2.3.1 CODE REQUIREMENTS

Two exterior discharge pathways from exits are exposed by openings in the adjacent fire compartment as shown the figures below.



Legend	Note
	Proposed exit path
	Proposed water curtain

Figure 5: Level 1 Proposed Water Curtain Location

These exit exposure conditions are not being protected through Sentence 3.2.3.13.(4), which states:

3.2.3.13.(4)	**Exit Protection from Fire Exposure**

The opening protection referred to in Sentences (1), (2) and (3) shall consist of

- glass block conforming to the requirements of Article 3.1.8.16.,
- a wired glass assembly conforming to D-2.3.15. in Appendix D, or
- a closure conforming to the requirements of Subsection 3.1.8. and Articles 3.2.3.1. and 3.2.3.14.

The exit exposure conditions will not be provided with wired glass, glass block or listed closures, and will instead be addressed by the water curtain proposed in this alternative solution.

2.3.2 OBJECTIVES AND FUNCTIONAL STATEMENTS

Objectives and Functional Statements of Sentence 3.2.3.13.(4) are as follows:

[F06-OS1.2][F05-OS1.5] and [F06-OP1.2]

OS1	**Objectives**
Fire Safety	An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to fire. The risks of injury due to fire addressed in this Code are those caused by
OS1.2	Fire or explosion impacting areas beyond its point of origin
OS1.5	Persons being delayed in or impeded from moving to a safe place during a fire emergency

OP1	**Objectives**
Fire Protection of the Building	An objective of this Code is to limit the probability that, as a result of its design or construction, the building will be exposed to an unacceptable risk of damage due to fire. The risks of damage due to fire addressed in this Code are those caused by
OP1.2	Fire or explosion impacting areas beyond its point of origin

	Functional Statements
F05	To retard the effects of fire on emergency egress facilities.
F06	To retard the effects of fire on facilities for notification, suppression and emergency response.

2.3.3 INTENT STATEMENTS

The intent statements are as follows:

3.2.3.13.(4)	Intent Statement
[F06-OS1.2] **[F05-OS1.5]** **Fire Safety**	**Intent 1:** To limit the probability of the spread of fire from exterior walls or openings of a building to exit facilities, which could lead to: • delays in evacuating or moving to a safe place, which could lead to harm to persons, and • delays in access to the building by emergency responders, which could lead to fire emergency response operations being delayed or ineffective, which could lead to the spread of fire, which could lead to harm to persons, including emergency responders.
[F06-OP1.2] **Fire Protection of the Building**	**Intent 1:** To limit the probability of the spread of fire from exterior walls or openings of a building to exit facilities, which could lead to delays in access to the building by emergency responders, which could lead to fire emergency response operations being delayed or ineffective, which could lead to the spread of fire, which could lead to damage to the building.

2.3.4 MITIGATING FEATURES

To address the objectives and functional statements, the following mitigating features are provided.

Alternative	Mitigating Features
Water Curtain	The proposed water curtain design criteria are indicated in Figure 6.

Tag	Items	Description
A	System:	Water curtain must be a wet system.
B	Zone:	Water curtain may be part of the floor area zone.
C	Sprinkler Type:	Quick response sprinkler with a nominal K-factor of 5.6 and ordinary temperature classification (without ceiling: upright, with ceiling: pendent).
D	Location: (Not Shown)	Water curtain must be spaced at 1,830 mm on center and not more than 910 mm away from the edge of opening.
E	Position:	Water curtain must be mounted not more than 305 mm horizontally from the interior plane of opening.
F	Baffles: (Not Shown)	Sprinkler must be protected from cold solder effects caused by sprinkler discharge at a proximate distance by means of baffles in conformance with NFPA 13.
G	Opening:	Glazed opening may be openable.
H	Obstruction:	Drapes, curtains and blinds are permitted to be installed between the water curtain and the opening.
I	Discharge:	Minimum 4.5 gpm/ft, but not less than 27 USgpm per sprinkler.
J	Hydraulic Design:	Hydraulic calculation must include the water curtain and adjacent floor area sprinklers and hose demand in conformance with NFPA 13.
K	Coverage:	The alternative solution sprinkler head can provide floor coverage subjected to the following: • The discharge must be meet both NFPA 13 and the alternative solution discharge criteria, and • The selected sprinkler must be one that meets the type of sprinkler required for the protected area as per NFPA 13.

Section View

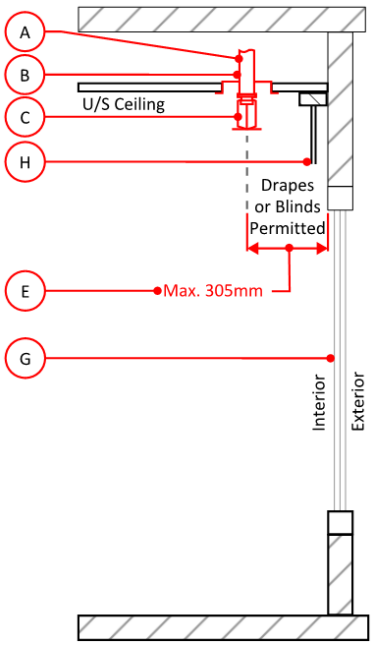


Figure 6: Water Curtain Arrangement

2.3.5 DISCUSSION

The proposed alternative solution addresses the objectives and functional requirements of Sentence 3.2.3.13.(4). The discussions are as follows:

Water Curtain Discussion

The water curtain works to provide opening protection by saturating fire gases in the vicinity of the opening and by absorbing and scattering radiation.

Saturation of Fire Gases

In his research, Leonard Cooper[(1)] from the Center for Fire Research demonstrates that water curtains are an effective means of restricting the flow of heated gases through an opening. The results of his research indicate that water curtain discharge from standard spray sprinklers with a nominal K factor of 5.6 and a minimum flow of 4.5 USgpm/ft is capable of saturating hot gases such that the temperature of the gas does not exceed 100°C. Such cooling of the gases decreases their buoyancy, reducing the potential risk that a fire will spread through the opening.

In Cooper's study, the water curtain was evaluated around the opening of an open stairwell, demonstrating that the effectiveness of the water curtain is not dependent on the use of physical barriers. Glazed openings are therefore permitted to be openable. Furthermore, since the proposed water curtain does not rely on maintaining the integrity of the glazing, drapes, curtains, or blinds installed between glazed openings and water curtain sprinklers are not expected to reduce the level of safety provided by the water curtain. Tempered or laminated safety glass is specified at the protected openings to reduce the risk of injury if the glass fails during a fire emergency.

Radiation Absorption and Scattering

Research by Heselden and Hinkley [(2)] of the British Joint Fire Research Organization shows that sprinkler water spray is effective in reducing radiant heat transfer by scattering and absorbing radiant heat. The proposed water curtain is required to have a minimum flow of 4.5 USgpm/ft, which is expected to absorb more than 50% of the incident radiation (Typically, wired glass is able to provide 50%). This level of performance offers a higher level of protection than a wired glass assembly permitted as an acceptable solution in Sentence 3.2.3.13.(4).

(1) Cooper, L. Y. The Design of Effective Water Spray Cooling in Stairwell-Sprinkler System, National Bureau of Standards, Gaithersburg, Maryland.

(2) Heselden, J. M. and Hinkley, P. L. Measurements of the Transmission of Radiation Through Water Sprays, British Joint Fire Research Organization.

2.3.6 MAINTENANCE REQUIREMENTS

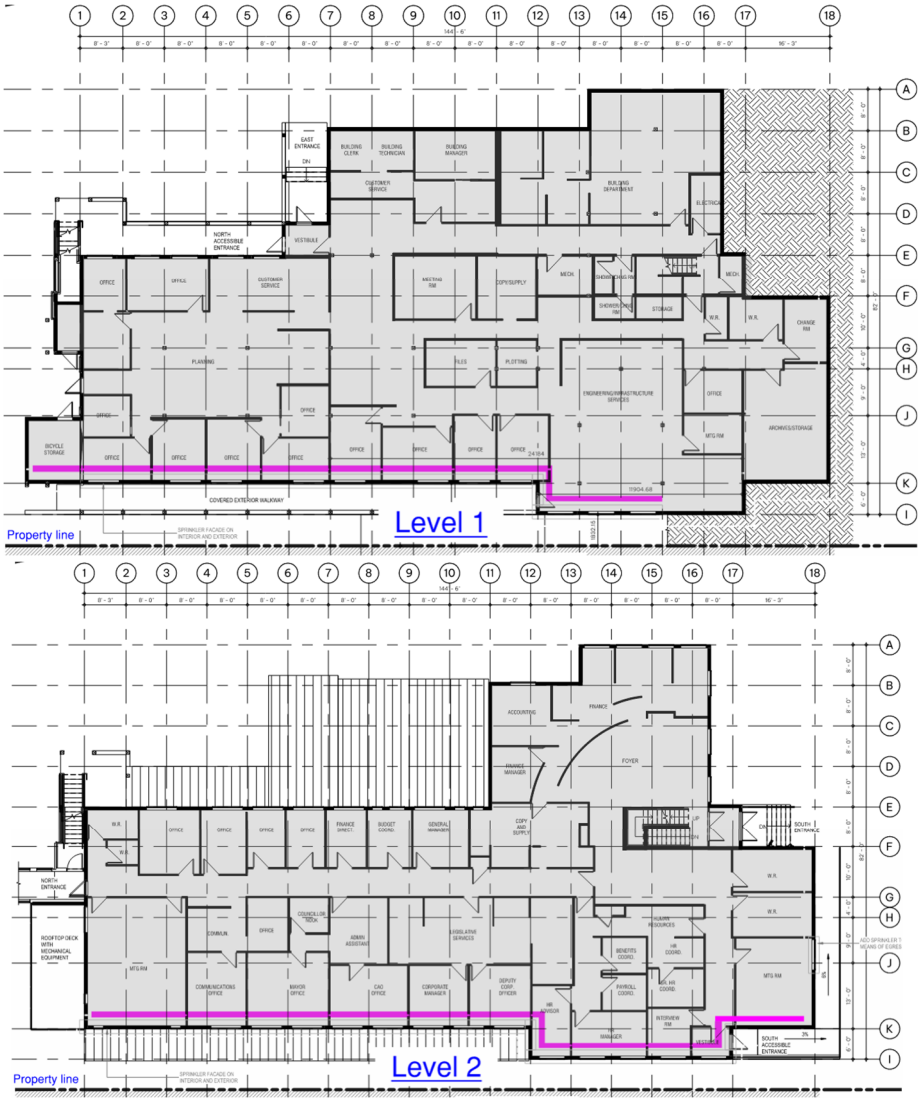
Pontem Group will conduct shop drawing reviews and field reviews to confirm the construction is in substantial compliance with the proposed alternative solution. The water curtain system is expected to be inspected and tested annually in conformance with NFPA 25.

If any changes are proposed in the future, a qualified fire protection consultant will be required to review the proposed work and confirm that the work will not affect the level of fire and life safety assumed in this alternative solution.

2.4 MITIGATING FEATURE: SPATIAL SEPARATION

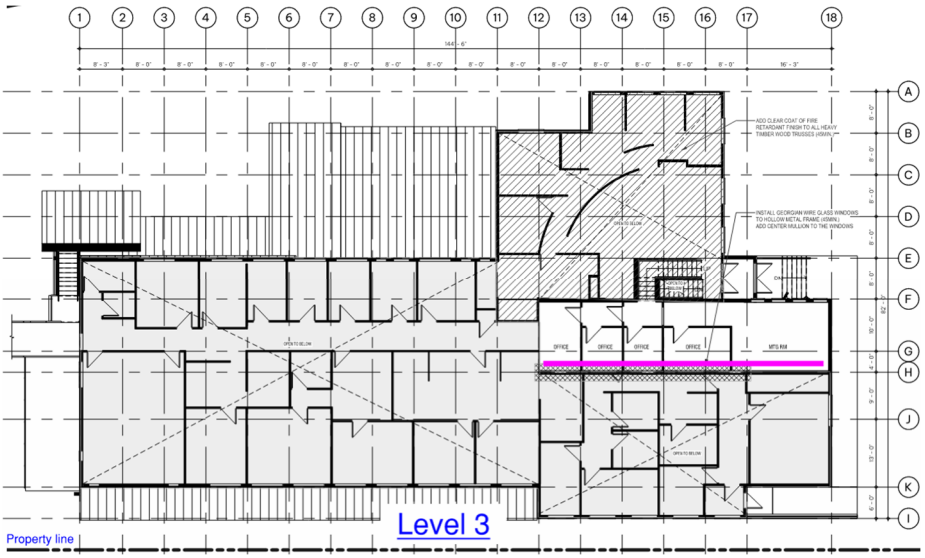
2.4.1 CODE REQUIREMENTS

Due to its proximity to the western property line, the existing exterior wall on the west side of the original municipal hall is to be enhanced. This alternative solution is being proposed to improve the fire safety of the existing west exterior wall of the municipal hall. Closely-spaced sprinklers will be installed along the interior of the west exterior wall, supplemented by the addition of non-combustible cladding to improved fire protection (See Figure 7, Figure 8, and Figure 9).



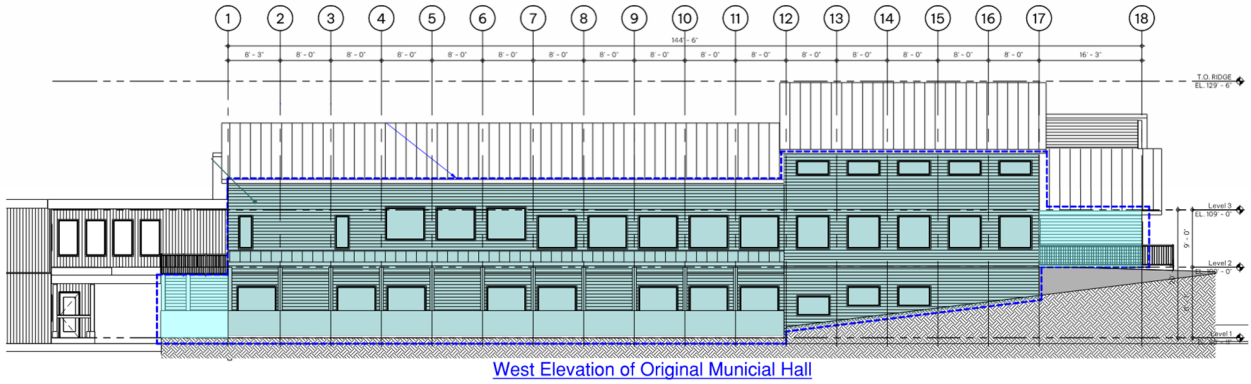
Legend	Note
	Interior closely-spaced sprinklers

Figure 7: Proposed Closely Spaced Sprinklers on Levels 1 and 2 to Enhance the West Exterior Walls



Legend	Note
	Interior closely-spaced sprinklers

Figure 8: Proposed Closely Spaced Sprinklers on Level 3 to Enhance the West Exterior Walls



Legend	Note
	Wall Area to be protected by the proposed Interior closely-spaced sprinklers

Figure 9: Proposed Closely Spaced Sprinklers on Level 1, 2, and 3 to Enhance the West Exterior Walls

3.2.3.1.(1)	Limiting Distance and Area of Unprotected Openings

The area of unprotected openings in an exposing building face for the applicable limiting distance shall be not more than the value determined in accordance with:

- Table 3.2.3.1.-D or 3.2.3.1.-E for an exposing building face conforming to Article 3.2.3.2. of a sprinklered fire compartment that is part of a building which is sprinklered in conformance with Section 3.2.

3.2.3.2.(1)	Area of Exposing Building Face

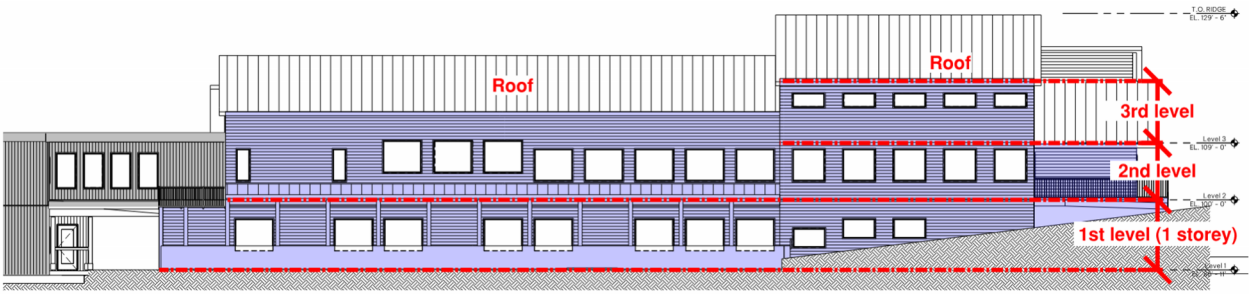
The area of an exposing building face shall be calculated as the total area of an exterior wall facing in one direction on any side of a building measured from the finished ground level to the uppermost ceiling.

The west exterior wall has existing combustible cladding. Due to its proximity to the adjacent properties, the existing west exterior wall will be upgraded, and non-combustible cladding will replace the existing combustible cladding as part of the alternative solution (See Figure 10 and Figure 11).

Legend	Note
	Non-combustible cladding to replace existing combustible cladding

North

Figure 10: Proposed Non-combustible Cladding Locations



West Elevation of Original Municial Hall

Legend	Note
	Non-combustible cladding to replace existing combustible cladding

Figure 11: Proposed Non-combustible Cladding Locations

3.2.3.7.(1) Construction of Exposing Building Face

Except as provided in Sentences (3) and (4), and Articles 3.2.3.10. and 3.2.3.11., the fire-resistance rating, construction and cladding for exposing building faces of buildings or fire compartments of Group A, B, C, D or Group F-3 occupancy classification must comply with .

Table 2: Minimum Construction Requirements for Exposing Building Faces

Occupancy Classification of Building or Fire Compartment	Maximum Area of Unprotected Openings, % of Exposing Building Face Area	Minimum Required Fire-Resistance Rating	Type of Construction Required	Type of Cladding Required
Group A, B, C, D, or Group F, Division 3	0 to 10	1 h	Noncombustible	Noncombustible
	> 10 to 25	1 h	Combustible, Encapsulated mass timber, or Noncombustible	Noncombustible
	> 25 to 50	45 min	Combustible, Encapsulated mass timber, or Noncombustible	Noncombustible
	> 50 to < 100	45 min	Combustible, Encapsulated mass timber, or Noncombustible	Combustible or Noncombustible

2.4.2 OBJECTIVES AND FUNCTIONAL STATEMENTS

The objectives and functional statements of Sentences 3.2.3.1.(1), 3.2.3.2.(1), and 3.2.3.7.(1) are as follows:

[F03-OP3.1]

[F03,F02-OP3.1]

OP3	Objectives
Protection of Adjacent Buildings from Fire	An objective of this code is to limit the probability that, as a result of the design or construction of the building, adjacent buildings will be exposed to an unacceptable risk of damage due to fire. The risks of damage to adjacent buildings due to dire addressed in this code are those caused by -
OP3.1	Fire or explosion impacting areas beyond the building of origin

	Functional Statements
F02	To limit the severity and effects of fire or explosions
F03	To retard the effects of fire on areas beyond its point of origin

2.4.3 INTENT STATEMENTS

The intent statements are as follows:

3.2.3.1.(1)	Intent Statement
Protection of Adjacent Buildings from Fire [F03-OP3.1]	**Intent 1:** To limit the probability of the spread of fire from the building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings. **Intent 2:** To direct code users to Article 3.2.3.2. for the calculation of the maximum area of unprotected openings in an exposing building face

3.2.3.2.(1)	Intent Statement
	Intent 1: To state how to calculate the area of an exposing building face.

3.2.3.7.(1)	Intent Statement
Protection of Adjacent Buildings from Fire [F02,F03-OP3.1]	**Intent 1:** To limit the probability that an exposing building face will have insufficient fire resistance, which could lead to the spread of fire from the building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings. **Intent 2:** To limit the probability that an exposing building face will be ignited and contribute to a fire, which could lead to the spread of fire from the building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings.

2.4.4 MITIGATING FEATURES

To address the objectives and functional statements, the following mitigating features are provided.

Alternative	Mitigating Features
Non-combustible Cladding	The existing combustible cladding on the west exterior wall will be replaced with cement board cladding.
Water Curtain	The proposed water curtain design criteria are indicated in Figure 12.

Tag	Items	Description
A	System:	Sprinkler system must be a wet system.
B	Zone:	Water curtain may be part of the floor area zone.
C	Sprinkler Type:	Quick response sprinkler with a nominal K-factor of 5.6 and ordinary temperature classification (without ceiling: upright, with ceiling: pendent).
D	Location: (Not Shown)	Water curtain must be spaced at 1,830 mm on center and not more than 910 mm away from interior walls.
E	Position:	Water curtain must be mounted not more than 305 mm horizontally from the interior plane of west exterior wall.
F	Baffles: (Not Shown)	Sprinkler must be protected from cold solder effects caused by sprinkler discharge at a proximate distance by means of baffles in conformance with NFPA 13.
G	Opening:	Glazed opening may be openable.
H	Obstruction:	Drapes, curtains and blinds installed between water curtain and opening is permitted.
I	Discharge:	Minimum 4.5 gpm/ft, but not less than 27 USgpm per sprinkler.
J	Hydraulic Design:	Hydraulic calculation must include the following: • Water curtain, • Adjacent floor area sprinklers based on NFPA 13 requirements, and • Hose demand.
K	Coverage:	The alternative solution sprinkler head can provide floor coverage subjected to the following: • The discharge must be meet both NFPA 13 and the alternative solution discharge criteria, and • The selected sprinkler must be one that meets the type of sprinkler required for the protected area as per NFPA 13.

Section View

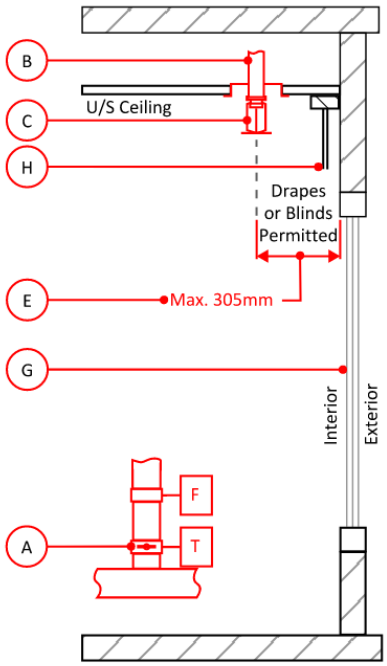


Figure 12: Interior and Exterior Sprinkler Arrangement

2.4.5 DISCUSSION

The proposed alternative solution addresses the objectives and functional requirements of Sentence 3.2.3.1.(1), 3.2.3.2.(1), and 3.2.3.7.(1). The discussions are as follows:

Mitigating Feature	Discussion
Overall	The functional statement of the applicable code references is intended: • To limit the severity and effects of fire or explosions • To retard the effects of fire on areas beyond its point of origin. This alternative solution provides mitigating features that meet the functional statement above. The following are discussed: • Spatial separation construction requirements • Effectiveness of the closely spaced sprinkler protection • Spatial separation reduction
Closely Spaced Sprinklers	The water curtain works to provide opening protection by saturating fire gases in the vicinity of the opening and by absorbing and scattering radiation. The following discusses the effectiveness of closely-spaced pendent sprinklers in suppressing fire. **Saturation of Fire Gases** In his research, Leonard Cooper[(1)] from the Center for Fire Research demonstrates that water curtains are an effective means of restricting the flow of heated gases through an opening. The results of his research indicate that water curtain discharge from standard spray sprinklers with a nominal K factor of 5.6 and a minimum flow of 4.5 USgpm/ft is capable of saturating hot gases such that the temperature of the gas does not exceed 100°C. Such cooling of the gases decreases their buoyancy, reducing the likelihood that a fire will spread through the opening. Since the proposed water curtain follows Cooper's sprinkler criteria, it is expected to fully saturate heated gases and therefore reduce the likelihood of fire spread through the opening. In Cooper's study, the water curtain was evaluated around the opening of an open stairwell, demonstrating that the effectiveness of the water curtain is not dependent on the use of physical barriers. Glazed openings are therefore permitted to be openable. Furthermore, since the proposed water curtain does not rely on maintaining the integrity of the glazing, drapes, curtains, or blinds installed between glazed openings and water curtain sprinklers are not expected to reduce the level of safety provided by the water curtain. Safety glass is specified at the protected openings to reduce the risk of injury if the glass fails during a fire emergency.

Mitigating Feature	Discussion
	Radiation Absorption and Scattering Research by Heselden and Hinkley [(2)] of the British Joint Fire Research Organization shows that sprinkler water spray is effective in reducing radiant heat transfer by scattering and absorbing radiant heat, where heat transmission through the spray from a pendent head installed at 2.75 m above the floor was measured. Experimental results show that for any sprinkler head and water pressure, radiation transmission from sources at 800°C to 1000°C (comparable with that from large fires) is reduced as water flow rate in the radiation path increases, due to heat absorption by evaporation of water droplets from the sprinkler head. The proposed water curtain is required to have a minimum flow of 4.5 USgpm/ft, which is expected to absorb more than 50% of the incident radiation. This allows the sprinkler droplets, which absorb the radiation, to effectively reduce radiation transmission through the proposed glazing and decrease exposure to adjacent properties.
Spatial Separation	**Requirement:** The area of unprotected openings in an exposing building face of an unsprinklered fire compartment shall be no greater than the value determined in accordance with Table 3.2.3.1.-B. **Commentary:** Closely spaced sprinklers installed along the interior portion of the West facing wall are expected to limit the spread of fire from the existing building to the adjacent property. **Proposed Arrangement:** Closely spaced sprinklers are proposed along the interior of the entire North, West facing wall on Levels 1, 2, and 3, including both the wall assembly and openings. Since these sprinklers can effectively reduce radiant heat transfer through the openings near their locations of installation, walls and glazing located within the extent of coverage of sprinklers can be considered as sufficiently protected and are unlikely to expose an adjacent property. The west exterior wall has existing combustible cladding, and they will be replaced with non-combustible cladding. This action aims to improve the existing building performance by demolish sections of the current structure and replace them with non-combustible building material that adhere to the 2018 BCBC regulations. Providing non-combustible cladding will increase fire protection level. This feature addresses both intent statements:

Mitigating Feature	Discussion
	• **Intent 1:** To limit the probability that an exposing building face will have insufficient fire resistance, which could lead to the spread of fire from the building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings. • **Intent 2:** To limit the probability that an exposing building face will be ignited and contribute to a fire, which could lead to the spread of fire from the building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings.

(1) Cooper, L. Y. The Design of Effective Water Spray Cooling in Stairwell-Sprinkler System, National Bureau of Standards, Gaithersburg, Maryland.

(2) Heselden, J. M. and Hinkley, P. L. Measurements of the Transmission of Radiation Through Water Sprays, British Joint Fire Research Organization.

(3) Babrauskas, V. Ignition of wood: a review of the state of the art, Journal of Fire Protection Engineering.

2.4.6 MAINTENANCE REQUIREMENTS

Pontem Group will conduct a field review to confirm the construction is in substantial compliance with all mitigating features.

The sprinkler system must be tested annually in accordance with the British Columbia Fire Code (BCFC), CAN/ULC-S537 and NFPA 25. If any changes are proposed in the future, a qualified fire protection consultant will be required to review the proposed work and confirm that the work will not affect the level of fire and life safety assumed in this alternative solution.

The protection measures for upgrading the fire-resistance rating and cladding of the wall are passive protection and there are no specific maintenance requirements, but it will be part of the general building maintenance arrangement.

2.5 CONCLUSION

Based on the discussions in this report, the mitigating features listed in this report:

- limit the severity and effects of fire or explosions (F02),
- retard the effects of fire on areas beyond its point of origin (F03),
- retard failure or collapse due to the effects of fire (F04),
- minimize the effects of fire on emergency egress facilities, and (F05), and
- minimize effects of fire on facilities for notification, suppression and emergency response (F06).

It is reasonable to conclude that the proposed alternative solution will provide at least the level of performance intended by the applicable acceptable solutions of the BCBC.

LICENCE

Engineers and Geoscientists BC has authorized

Justin Wing Hung Lau, P.L.Eng.
Professional Licensee Engineering

Registration/Licence Number: 211939
Granted: December 17, 2019

to engage in the practice of professional engineering in the Province of British Columbia within the Authorized Area of Reserved Practice specified hereunder:

Discipline: **Civil**

Field of Practice: **Building Code Consulting**

Limited to:

1. Building code analysis, consulting, design, and field review of alternative solutions, where the alternative solution area is limited to: applying active fire protection (fire suppression systems and fire detection systems) to replacing or adding to passive fire protection (fire-resistance rating of fire separation or wall and floor assemblies).
2. Reviewing and reporting on building construction for compliance with fire protection, occupant safety, and accessibility requirements of Building Codes and Fire Codes.
3. Providing consulting services on Division A, Division B Parts 1, 2, 3, 8, and 9 (and Part 11of the Vancouver Building By-law representing the upgrade requirements of existing buildings) and Division C of the British Columbia Fire Code, National Fire Code of Canada, and the Vancouver Fire By-law (including associated appendices).

Exclusions:

a. Detailed design of fire protection and fire suppression systems.

b. Fire, explosion, life safety, risk assessment and quantitative analysis.

c. Development of alternative solutions related to smoke control and management, human behaviour and/or using the principles of fire dynamics and fire modelling

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