FUNCTIONAL SERVICING REPORT
218 ORCHARD ROAD

December 1, 2023

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1 Background

Jewell Engineering Inc. (Jewell) was retained by Johnvince Foods to assist with an Official Plan Amendment for the proposed development of 218 Orchard Road in Colborne, Ontario. The development site is located immediately west of The Big Apple commercial site (Figure 1). This report is submitted to support the Official Plan Amendment.

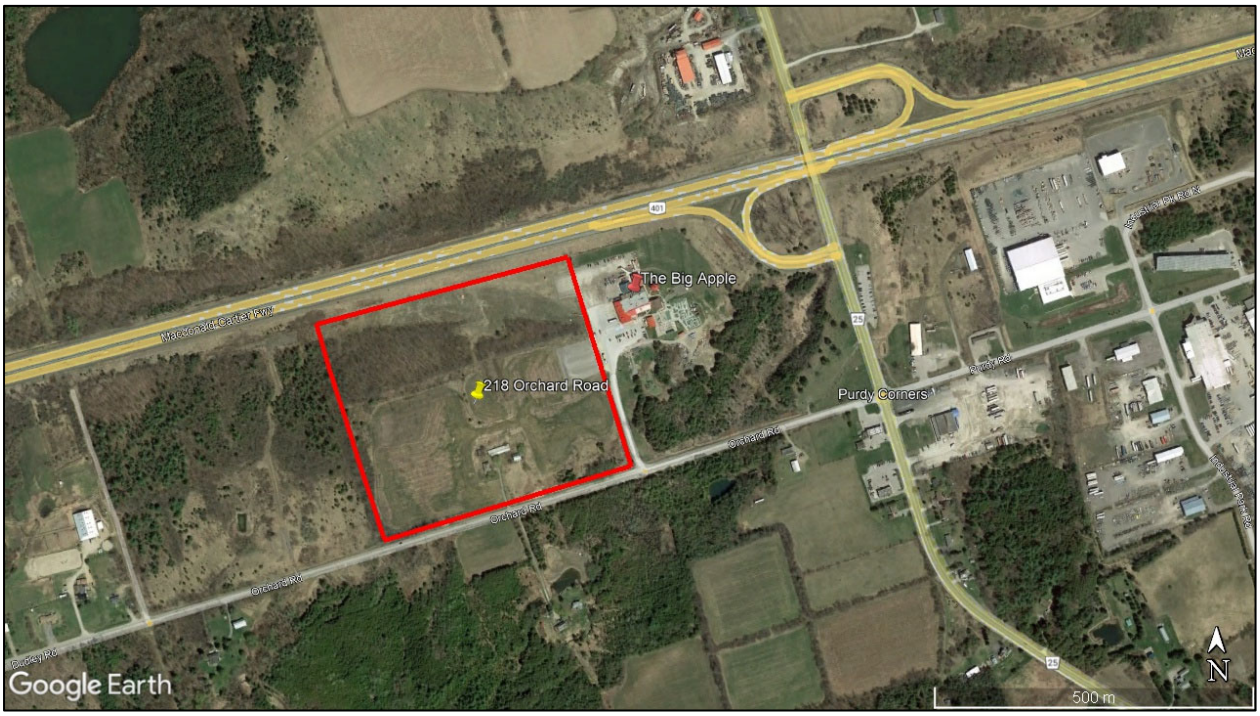


Figure 1: Site Location

The following services have been reviewed as part of this functional servicing report:

- Water Distribution
- Sanitary Septic (separate cover)

1.1 Site Description

The site is located immediately west of The Big Apple commercial site on Orchard Road in Colborne, Ontario. The property is currently undeveloped corn field and is approximately 13.23 ha. The site is zoned Rural in the Zoning By-law, June 2021, and designated Agricultural in the Cramahe Official Plan, December 2014.

The proposed development site fronts onto Orchard Road and abuts onto the 401 Highway to the north with a vacant lot to the west. The lands are gently graded and primarily drain south to the roadside ditches on Orchard Road.

1.2 Proposed Site Development

The proposed site plan includes the development of a 25,000 sq ft warehouse (Appendix A). The development has access from Orchard Road and The Big Apple entrance.

Municipal water service will be provided to the proposed warehouse. Two options for providing service exist:

1) connect to the existing service on The Big Apple commercial site; or
2) extend the municipal watermain on Orchard Road and provide a new separate service for the proposed warehouse development site.

The review of the available servicing was completed using the specifications outlined by the following:

- Ministry of Environment, Conservation, and Parks (MECP)
    - Design Guidelines for Drinking-Water Systems, 2008
- Ontario Building Code (OBC)
    - 2012 Building Code Compendium, April 29, 2022, update

2 Water Distribution System

2.1 Existing Conditions

A 200mm PVC municipal watermain is present on Orchard Road, terminating approximately 150m west of Percy St. at 309 Orchard Road. A private 200mm service extends from the municipal system through the woods north of Orchard Road to service the existing Big Apple commercial site. The proposed warehouse development site is located approximately 300m west of the termination of the municipal main. LHS Inc. completed hydrant testing on Orchard Road and The Big Apple site on September 14, 2023. A summary of the results is in Table 1, see Appendix B for the complete results.

Table 1: Hydrant Flow Tests, LHS Inc, September 14, 2023

Hydrant ID	Static Pressure (psi)	2 Port Projected Flow @ 20 psi (USGPM – L/min)
309 Orchard Road (last hydrant)	80	2,407 – 9,111
The Big Apple Site	70	1,909 – 7,226

2.2 Design Criteria

Jewell reviewed the proposed water demand using the MECP and OBC guidelines:

- Industrial per Hectare: 45 L/d*ha
- Population Factors:
  - Total Lot 34 Area: 13.23 ha
  - Proposed Warehouse Area: 2,323 sq. m
- Max Day Plus Fire Flow Demand Minimum Pressure: 140 kPa (20 psi)
- Peak Hour Demand Minimum Pressure: 280 kPa (40 psi)
- Peak Hour Demand Maximum Pressure: 700 kPa (100 psi)

2.3 Fire Flow Requirement

Jewell calculated the fire flow requirements using the OBC method, see Table 2. At the time of authoring of this report, detailed building plans were not available, therefore, the following assumptions were made about the proposed warehouse:

- Building Classification: F-2
- Building Height: 8 m
- Firewall Separation: No
- Sprinkler System: Yes
- Construction Type: Non-combustible (with rating)
- Exposure Distance: Min 10 m from other buildings

Table 2: Require Fire Flow and Supply per OBC Calculation

Fire Flow Requirements as per the Ontario Building Code (OBC)
*A-3.2.5.7. Water Supply for Fire-Fighting

Procedure				
1	Building to be Assessed		Warehouse	
2	Building Classification		F-2	A-3.1.2.1.(1)
3	Building Specific Details	1 - Single Floor Area	2323	sq.m
		2 - Number of Storeys	1	
		3 - Building Height	8	m
		4 - Firewall Separation?	No	
		5 - Sprinkler System?	Yes	
		6 - Construction Type	Non-combustible (rating)	
4	Minimum Supply of Water	K	17	Table 1
		V	18,581	cu.m
		S_{tot}	1.0	
		Q	316,000	L
5	**Minimum Fire Flow**	**Table 2**	**9000**	L/min
			150	L/s

As shown in Table 2, a fire flow of 150 L/s is required to service the proposed development in accordance with OBC. The Township should also confirm that the municipal reservoir has a minimum reserve of 316 cubic metres available for fire fighting water supply.

2.4 Water Demand

Average daily demands for the proposed building were calculated using the MECP's estimations for industrial use, see Table 3.

Table 3: Water Demand Calculation

Type	Industrial - Warehouse
Gross Floor Area (ha)	0.23
L/d per ha floor area	45
Average (L/d)	**10.35**
Average (L/s)	**0.07**
Peak Hour (L/s)	**0.26**
Max Day (L/s)	**0.18**

Peaking factors used were chosen from Table 3-1: Peaking Factors in the MECP guidelines based on the number of water meters connected to the network. Jewell obtained the number of water meters from the MOE Colborne Drinking Water System Inspection Report, dated February 8, 2019. The peaking factors per population are listed in Table 4.

Table 4: Peak Factors

Peak Factors	
Peak Hour	3.75
Max Day	2.50

A summary of the water demands under all conditions is shown below in Table 5.

Table 5: Water Demand Scenario Summary

Condition	Demand (L/s)
Average	0.07
Peak Hour	0.26
Max Day	0.18
Max Day + Fire Flow	150.18

2.5

2.6 Hydraulic Calculation

Calculations were completed assuming that the site will be serviced via an extension of the existing watermain on Orchard Road; therefore, a starting pressure of 80 psi was used in accordance with the hydrant test results completed, see Table 6. The results are strictly based on hydrant test results and do not account for influence of fire pumps within the municipal system. If fire pumps are present, it is expected that available fire flows are higher than calculated.

Table 6: Watermain Hydraulic Results

Exending 200mm Watermain on Orchard Road

Watermain Hydraulics Peak Hour			**Watermain Hydraulics Max Day + Fire Flow**		
Length (L)	500.0	m	Length (L)	500.0	m
Diameter (d)	200	mm	Diameter (d)	200	mm
Diameter (d)	0.20	m	Diameter (d)	0.20	m
Area (A)	0.03	m^2	Area (A)	0.03	m^2
Flow (Q)	0.002	m^3/s	Flow (Q)	0.107	m^3/s
Velocity (V)	0.08	m/s	Velocity (V)	3.41	m/s
Roughness (C)	110		Roughness (C)	110	
Friction Loss (H_f)	0.03	m	Friction Loss (H_f)	35.92	m
Start Elevation (EH_{START})	154.0	m	Start Elevation (EH_{START})	154.00	m
End Elevation (EH_{END})	158.0	m	End Elevation (EH_{END})	160.00	m
Start Pressure	80.0	psi	Start Pressure	80.0	psi
Start Pressure	551.5	kPa	Start Pressure	551.5	kPa
Start Pressure Head (PH_{START})	56.2	m	Start Pressure Head (PH_{START})	56.2	m
Gravity	9.8	kN/m^2	Gravity	9.8	kN/m^2
$HGL_{ENG} = PH_{START} + EH_{START} - H_f$	210.2	m	$HGL_{ENG} = PH_{START} + EH_{START} - H_f$	174.3	m
$PH_{END} = HGL_{END} - EH_{END}$	52.2	m	$PH_{END} = HGL_{END} - EH_{END}$	14.3	m
End Pressure	**512.0**	kPa	**End Pressure**	**140.3**	kPa
End Pressure	**74.3**	psi	**End Pressure**	**20.3**	psi

As shown in Table 7, under peak Hour conditions, the proposed warehouse will experience pressures within the acceptable operating range of 40 psi to 100 psi. Therefore, the municipal system is sufficient to supply the proposed development for typical daily use.

Table 7: Peak Hour Results Summary

Scenario	Min Pressure Permitted (psi)	Max Pressure Permitted (psi)	Pressure Calculated (psi)	Meets Requirements
Peak Hour	40	100	74.3	**Yes**

Under Max Day + Fire Flow conditions, a fire flow of 107 L/s at 20psi is anticipated to be available at the proposed warehouse (assuming no fire pump within the municipal system). As detailed in section 2.3, a minimum fire flow of 150 L/s is required per OBC. See summary of results in Table 8.

Table 8: Max Day + Fire Flow Results Summary

Scenario	Required Fire Flow OBC (L/min – L/s)	Available Fire Flow (L/min – L/s)	Meets Requirements	Additional Fire Flow Required (L/min – L/s)
Max Day + Fire Flow	9,000 – 150	6,420 – 107	**No**	2,580 – 43

As shown in Table 8, an additional fire flow of 43 L/s is required to meet OBC requirements. It is important to note that if a fire pump is present, the municipal system may already be able to provide this additional flow. If a fire pump is not present, additional on-site water supply could be required (at the Township's discretion, in accordance with OFM-TG-03-1999 – Problem #4, Option #3, see Appendix C).

If additional on-site water supply is deemed necessary, a volume of 77,400 L (77.4 cubic metres) is recommended based on the current assumptions regarding the proposed warehouse, see Table 9.

Table 9: On-site Water Supply Calculation

Total Flow Required	9,000 L/min (150 L/s)
Municipal Flow Available	6,420 L/min (107 L/s)
Additional Flow Needed	2,580 L/min (43 L/s)
Additional Volume Needed	77,400 L

It is recommended that this report be re-issued at the time of site plan approval, when more detailed building plans are available, in order to update calculations to reflect the actual proposed building construction (as building assumptions do impact the fire flow requirements).

3 Conclusion

Jewell studied the existing site and reviewed the feasibility of servicing the proposed development with municipal water service:

- Two options exist to service the proposed development site:
  1) Via connection to the existing service on the Big Apple commercial development site; or
  2) By extending the 200 mm watermain along Orchard Road to the proposed development site frontage.

- Calculations completed in this report are based on extension of the municipal watermain on Orchard Rd to service the site as this is understood to be the desired servicing option;

- Under peak Hour conditions, the proposed warehouse will experience pressures within the acceptable operating range of 40 psi to 100 psi.

- Under Max Day + Fire Flow conditions, a fire flow of 107 L/s is anticipated to be available at the proposed warehouse (assuming no fire pump within the municipal system).

- At the time of authoring of this report, detailed building plans were not available; therefore, calculation of OBC fire flows required were based on assumptions of the building height and construction. Assumptions should be confirmed once building plans are available at the time of site plan application. In accordance with OBC, a minimum fire flow of 150 L/s is required.

- An additional fire flow of 43 L/s may be required to meet OBC requirements. It is important to note that if a fire pump is present, the municipal system may already be able to provide this additional flow. If a fire pump is not present, additional on-site water supply could be required (at the Township's discretion). If additional on-site water supply is deemed necessary, a volume of 77,400 L (77.4 cubic metres) is recommended.

- It is recommended that this report be re-issued at the time of site plan approval, when more detailed building plans are available, in order to update calculations to reflect the actual proposed building construction (as building assumptions do impact the fire flow requirements).

In summary, the proposed development site is serviceable via the municipal water system on Orchard Road.

Prepared by:

Julie Humphries

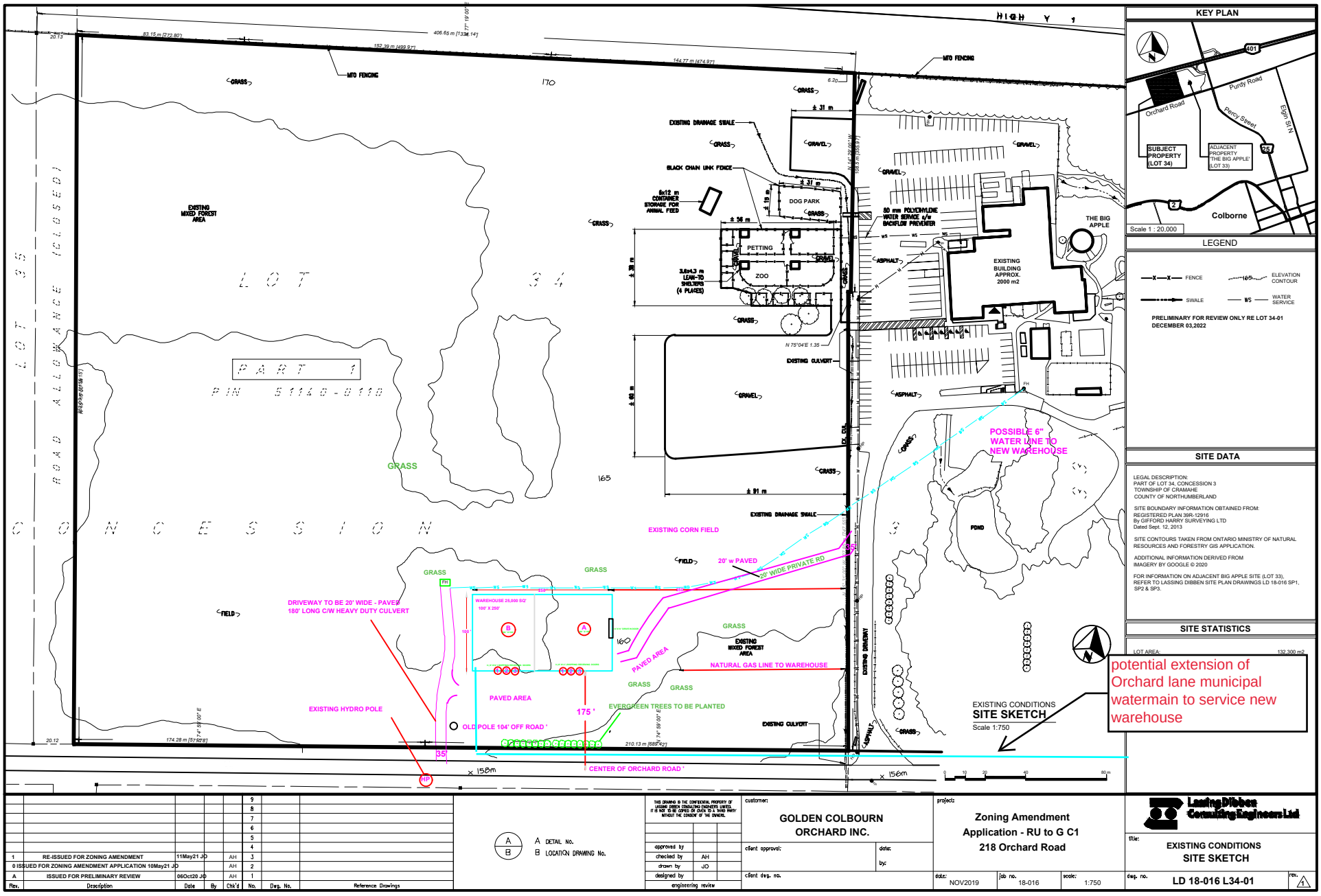
Julie Humphries, C.E.T.
Jewell Engineering Inc.

Approved by:

Amanda Redden, P. Eng
Jewell Engineering Inc.

FSR - JOHNVINCE FOODS - BIG APPLE LOT 34 - OCTOBER 2023.DOCX

APPENDIX A:
CONCEPT PLAN



KEY PLAN

LEGEND

FENCE
ELEVATION CONTOUR
SWALE
WS WATER SERVICE

PRELIMINARY FOR REVIEW ONLY RE LOT 34-01
DECEMBER 03,2022

SITE DATA

LEGAL DESCRIPTION:
PART OF LOT 34, CONCESSION 3
TOWNSHIP OF CRAMAHE
COUNTY OF NORTHUMBERLAND

SITE BOUNDARY INFORMATION OBTAINED FROM:
REGISTERED PLAN 39R-12916
By GIFFORD HARRY SURVEYING LTD
Dated Sept. 12, 2013

SITE CONTOURS TAKEN FROM ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY GIS APPLICATION.

ADDITIONAL INFORMATION DERIVED FROM IMAGERY BY GOOGLE © 2020

FOR INFORMATION ON ADJACENT BIG APPLE SITE (LOT 33), REFER TO LASSING DIBBEN SITE PLAN DRAWINGS LD 18-016 SP1, SP2 & SP3.

SITE STATISTICS

LOT AREA: 132,300 m2

Rev.	Description	Date	By	Chk'd	No.	Dwg. No.	Reference Drawings
1	RE-ISSUED FOR ZONING AMENDMENT	11May21	JO	AH	3		
0	ISSUED FOR ZONING AMENDMENT APPLICATION	10May21	JO	AH	2		
A	ISSUED FOR PRELIMINARY REVIEW	06Oct20	JO	AH	1		

A DETAIL No.
B LOCATION DRAWING No.

approved by
checked by AH
drawn by JO
designed by
engineering review

customer: GOLDEN COLBOURN ORCHARD INC.

client approval: date: by:

client dwg. no.

project: Zoning Amendment Application - RU to G C1 218 Orchard Road

date: NOV2019 | job no. 18-016 | scale: 1:750

Lassing Dibben Consulting Engineers Ltd

title: EXISTING CONDITIONS SITE SKETCH

dwg. no. LD 18-016 L34-01 | rev. 1

APPENDIX B:
HYDRANT TEST RESULTS

LHS INC.

P.O. Box 712 Cobourg ON K9A 4R5
905-377-0715 / 1-866-622-4022
Email: info@lhsinc.com

Client	Jewell Engineering (Test#1) 1-71 Millennium Parkway Belleville, On	**Site**	Big Apple Colborne, On
		Site Contact Phone	Utility

FIRE FLOW TEST

Fire Flow Date **September 14, 2023 - 9:07 am**
Site **Big Apple Colborne, On**
Static Hydrant **Last hydrant on Orchard Rd.**
Flow Hydrant **First Private hydrant on big Apple site**

Hydrant Colours

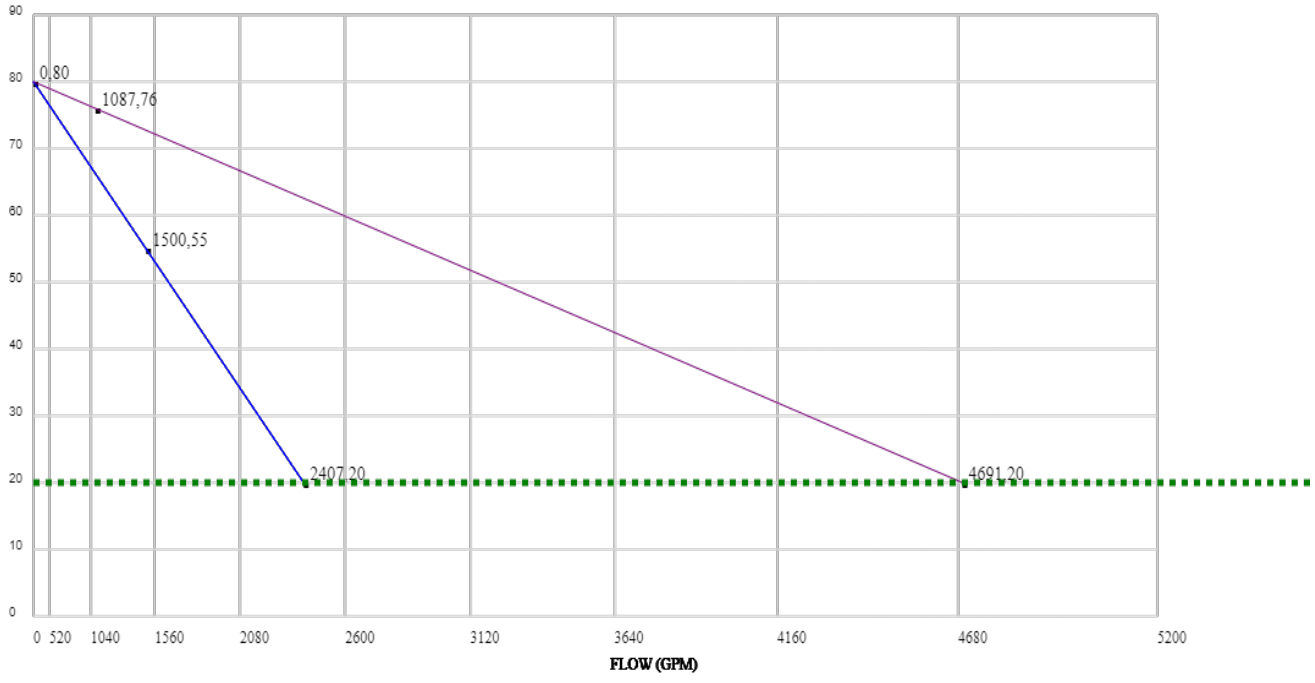
RED - C	0-500
ORANGE - B	500-1000
GREEN - A	1000-1500
BLUE - AA	>1500

Single Port

Static	80 psi
Residual 1	76 psi
Flow	42 psi
Observed	**1087 US GPM** 905 IMP GPM 4115 L / MIN
Projected @ 20psi	**4691 US GPM** 3906 IMP GPM 17757 l/min.

Two Port

Static	80 psi
Residual 2	55 psi
Flow 2 (x2)	20 psi
Observed	**1500 US GPM** 1249IMP GPM 5679 L / MIN
Projected @ 20psi	**2407 US GPM** 2004 IMP GPM 9111 l/min.



LHS INC.

P.O. Box 712 Cobourg ON K9A 4R5
905-377-0715 / 1-866-622-4022
Email: info@lhsinc.com

Client	Jewell Engineering (Test#2) 1-71 Millennium Parkway Belleville, On	**Site**	Big Apple Colborne, On
		Site Contact Phone	Utility

FIRE FLOW TEST

Fire Flow Date **September 14, 2023 - 9:08 am**
Site **Big Apple Colborne, On**
Static Hydrant **1st private hydrant at Big Apple site**
Flow Hydrant **2nd private hydrant at the Big Apple site**

Hydrant Colours

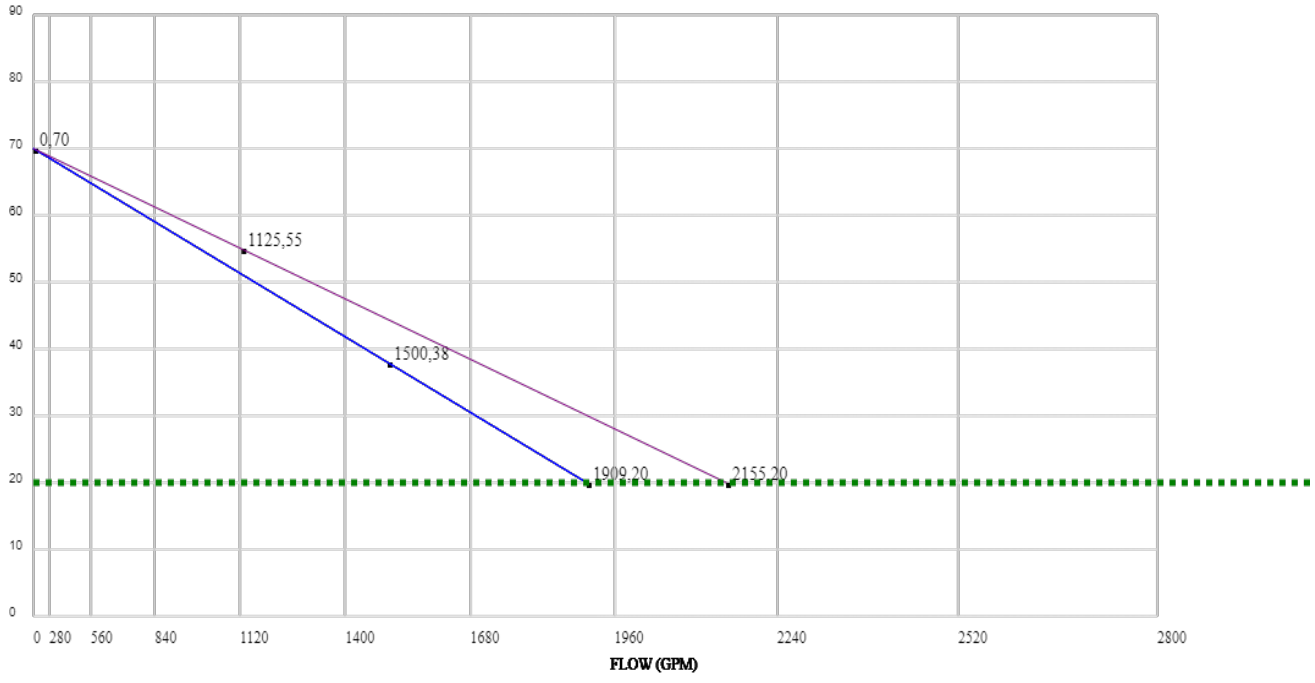
RED - C	0-500
ORANGE - B	500-1000
GREEN - A	1000-1500
BLUE - AA	>1500

Single Port

Static	70 psi
Residual 1	55 psi
Flow	45 psi
Observed	**1125 US GPM** 937 IMP GPM 4259 L / MIN
Projected @ 20psi	**2155 US GPM** 1794 IMP GPM 8158 l/min.

Two Port

Static	70 psi
Residual 2	38 psi
Flow 2 (x2)	20 psi
Observed	**1500 US GPM** 1249IMP GPM 5679 L / MIN
Projected @ 20psi	**1909 US GPM** 1590 IMP GPM 7226 l/min.



APPENDIX C:
OFM-TG-03-1999, FIRE PROTECTION WATER SUPPLY GUIDELINE FOR PART 3 IN THE ONTARIO BUILDING CODE

OFM Guideline

Office of the Fire Marshal

OFM-TG-03-1999
FIRE PROTECTION WATER SUPPLY GUIDELINE FOR PART 3 IN THE ONTARIO BUILDING CODE

October 1999

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SECTION

WATER SUPPLY ADEQUACY COMMITTEE

The Office of the Fire Marshal would like to acknowledge the contribution of the following individuals and organizations in the development of this guideline.

Kim Bailey	Office of the Fire Marshal
John Braam	American Water Works Association
Roy Chalk	Ontario Municipal Fire Prevention Officers Association
Ed Coe	Insurers Advisory Organization
Tom Eyre	Ontario Municipal Water Association
Don Livingston	Ministry of Housing, Building Branch
Steve Penna	Ontario Building Officials Association
Chief Tom Powell	Ontario Association of Fire Chiefs
David Shantz	Municipal Engineers Association

October 1999
OFM Section: Fire Safety Standards at (416) 325-3100

ABSTRACT

This guideline will assist those trying to establish an adequate fire protection water supply for new and renovated Part 3 buildings as required by Article 3.2.5.7. or Part 11 of the Building Code. The criteria for "adequate water supply" will be detailed and the limitations of these criteria explained. Several other factors will be explained as they relate to the fire protection water supply, such as fire department response, environmental impact and cost.

The guideline provides a method of simple calculation of an on-site water supply, taking into account building occupancy, size, construction and exposures, as well as minimum water duration requirements. Other conditions that may affect the need for an on-site water supply or design considerations are discussed as well. Sample problems are included to assist the user.

1.0 INTRODUCTION

The Office of the Fire Marshal, in cooperation with the Ministry of Municipal Affairs and Housing and the Water Supply Adequacy Committee has developed this guideline to help building owners, consultants and others involved in life safety design of buildings, meet the requirements for "adequate water supply for fire fighting" as found in Part 3 of the Building Code. This guideline is not intended for farm buildings or buildings that fall within Part 9 of the Building Code.

This guideline has been developed in conjunction with the Appendix Note A-3.2.5.7. on Adequate Water Supply in the 1997 Building Code.

The primary purpose of this guideline is to provide an adequate fire protection water supply to support evacuation and fire department search and rescue operations during a fire, and prevent fire spread to other buildings.

The secondary purpose of this guideline is to provide a fire protection water supply that can be used to provide a good measure of property protection during the early stages of a fire.

With the exception of sprinklered buildings, this guideline does not intend to provide the optimum for property protection. However with a timely response by a well trained fire department, the water supply designated in this guideline should be sufficient to allow the fire department to extinguish building fires where adverse circumstances are not encountered.

It should be noted that where "property protection" is a primary expectation of the building owner, or where significant environmental contamination from a fire is a concern, other recognized fire protection guidelines should be referenced (such as the Fire Underwriters Survey) to ensure adequate water supplies for manual fire suppression by available fire fighting means, or the building should be sprinklered.

***NOTE**: Building owners should be made aware of the limitations of the fire protection water supply as required in this guideline, prior to the design and construction of their building and/or the design of an on-site water supply.*

It should be noted that other guidelines, such as the Fire Underwriters Survey, should be used when designing water supply systems for newly developed municipal areas, as this fire protection water supply guideline is not intended to address domestic service water needs.

2.0 OVERVIEW OF THE BUILDING CODE REQUIREMENTS

Article 3.2.5.7.of the Building Code states: "an adequate water supply for fire fighting shall be provided for every building".

2.1 What does this mean for unsprinklered buildings?

As interpreted in this guideline, an adequate fire protection water supply for unsprinklered buildings means an immediately available and accessible water supply, with sufficient volume and/or flow to enable the fire department to use their fire hoses to control fire growth until the building is safely evacuated and search and rescue operations have been completed. The fire protection water supply is also intended to prevent the fire from spreading to adjacent buildings. This water supply should also be sufficient to provide a limited measure of both property protection and protection against fire growth in buildings with contents that could result in a significant environmental impact.

2.2 What does this mean for sprinklered buildings?

For sprinklered buildings, an adequate fire protection water supply means a reliable water supply providing sufficient water flow for the sprinkler systems in terms of pressure, volume, and duration to limit fire growth until the fire department arrives to suppress the fire. This automatic protection is expected to provide time for the evacuation of buildings, assist the fire department in preventing fire spread to adjacent buildings, limit the environmental impact of fires, and provide significant property protection.

***NOTE**: A properly designed sprinkler system, and especially those using modern technology sprinkler heads, will often extinguish a fire even without additional manual fire fighting intervention.*

3.0 FIRE DEPARTMENT RESPONSE

Determining an adequate water supply for manual fire protection is not dependent solely on building characteristics. A major factor will be the response time and intervention provided by the local fire department. This guideline assumes a prompt response by a well-equipped fire department using modern fire fighting techniques, and assumes that buildings will be evacuated in accordance with established building fire safety plans and fire department pre-fire plans. Where there is no fire department, please refer to Section 9.3 of this guideline.

An immediately available fire protection water supply permits the fire department, at their discretion, to enter a burning building with hose lines to conduct search and rescue operations. The duration of this water supply should, as a minimum, be sufficient to allow complete the search and rescue. Once the search and rescue operations are complete, additional water may be required for exposure protection or for fire suppression to limit property damage. Exposure protection and fire suppression to limit property damage go beyond the minimum for life safety as established by water supply requirements set out in this guideline.

The fire department has discretion as to how they will use hose streams on any given fire. Where a limited amount of fire protection water is available on site, decisions will be made on how much water will be used in the initial "search and rescue" stage, the suppression stage and for exposure protection.

For example, the fire department may elect to concentrate all fire department resources to suppress a fire in its early growth stage, thereby drawing-down the limited water supply quickly. Alternatively, the fire department may "nurse" the limited water supply until the search and rescue procedure is completed and then concentrate on exposure protection until supplemental water supplies arrive.

Fire departments serving remote or rural areas often have to respond to a fire with a transportable water supply having a duration of approximately five to ten minutes when using one or two 38 mm hose lines. This provides minimal hose streams allowing immediate search and rescue and fire suppression in small buildings with simple layouts. However, where a fire has had a significant head start, this transported water supply is unlikely to be sufficient to save the building.

For larger, more complex buildings, an on-site fire protection water supply is needed to provide an extended duration of hose stream use by the fire department to allow search and rescue of the building, exposure protection and fire suppression. The volume of this on-site fire protection water supply is dependent on the building size, construction, occupancy, exposure and environmental impact potential, and should be sufficient to allow at least 30 minutes of fire department hose stream use.

4.0 COST IMPACT

Cost impact on buildings constructed in rural or remote areas is typically greater than for buildings constructed within areas where municipal water mains are available. The great majority of existing municipal water systems will be able to satisfy the requirements of this guideline for new building construction. This would not preclude situations where new large "high fire demand" type buildings are being proposed in areas where the municipal water supply is not adequate. In these cases the building owner may need to provide supplemental fire protection water to meet the requirements of this guideline. The building owner may alternatively make design modifications to the building to reduce the water supply requirements. These modifications could include providing firewalls, using noncombustible construction in lieu of combustible construction, sprinklering the building, reducing the amount of window openings exposing a property line, etc.

Buildings constructed in rural or remote areas without a municipal water supply or an adjacent accessible body of water (i.e. river or large pond) may require on-site water storage tanks or a water reservoir for the fire protection water supply required by this guideline. Hydrants, suction connections for fire department "drafting", or underground dry mains may also be needed to provide appropriate building coverage. For additional information, please refer to Section 9.7 of this guideline.

5.0 SIGNIFICANT ADVERSE ENVIRONMENTAL IMPACT

5.1 What types of building fires could result in a significant adverse environmental impact and thus require additional fire protection water supplies?

Any building used for the storage or processing of chemicals or materials should be deemed to have the potential for significant adverse environmental impact, if a fully developed fire would result in significant contamination of ground or surface water through direct runoff or atmospheric dispersion.

5.2 What fire protection criteria should be used for these buildings?

Properly designed sprinkler protection should be provided in these buildings to prevent fully developed fires. Sprinklered buildings typically require reduced amounts of water for control or suppression of a fire, thus reducing the potential for environmental impact from contaminated water run-off.

Where sprinkler protection is not provided, other recognized fire protection guidelines (e.g. Fire Underwriters Survey) may be used to determine the manual fire fighting water supply needs for these buildings. The Chief Building Official or Chief Fire Official should evaluate these special cases on an individual basis.

5.3 Why do unsprinklered buildings with occupancies that constitute an adverse environmental impact typically require an increased water supply for manual fire fighting?

An increased water supply gives the fire department the option of conducting an all out fire hose suppression attack in the early stages of a fire. A successful hose deluge attack at this time may achieve extinguishment before significant amounts of environmentally hazardous chemicals and materials are involved.

***NOTE**: Unsprinklered buildings require careful preplanning by fire departments to ensure judicious application of this greater amount of fire fighting water to prevent significant adverse environmental impact due to water run-off.*

6.0 WATER SUPPLY REQUIREMENTS

To simplify this guideline, requirements have been placed into four categories. It is best to use a process of elimination to determine the correct category of water supply requirements. This guideline is not intended to be used for farm buildings or buildings that fall under Part 9 of the Building Code (see also Section 9.8 of this guideline).

The four categories for evaluating the water supply are:

- buildings not requiring on-site fire protection water supply,
- sprinklered buildings,
- buildings requiring on-site fire protection water supply,
- additions to existing buildings.

6.1 Buildings Not Requiring On-Site Fire Protection Water Supply

(a) A building does not require an on-site water supply for fire fighting if the building satisfies the criteria set out in Section 6.1 (b) or Section 6.1 (c), provided that:

(i) the building is serviced by a municipal water supply system that satisfies Section 6.3 (b) of this guideline, or

(ii) the fire department can respond with a transportable water supply of sufficient quantity to allow them to conduct an effective search and rescue of the building, determined on the basis of other guidelines or standards such as NFPA 1231, "*Standard on Water Supplies for Suburban and Rural Fire Fighting*" (please refer also to Sections 9.1 to 9.3 of this guideline).

(b) A building does not require an on-site water supply for fire fighting where all the following criteria are met:

(i) the building area is 200 m² or less,

(ii) the building height is 2 storeys or less,

(iii) the building does not have a Group B occupancy (care or detention),

(iv) the building does not require a sprinkler system or a standpipe and hose system,

(v) the limiting distance from the property line is at least 13 m if the building has an F-1 (high hazard industrial) occupancy, and

(vi) the building constitutes no significant environmental contamination potential under fire conditions.

(c) A building that exceeds 200 m² in building area or 2 storeys in building height may not require an on-site water supply for fire fighting where it has an F-3 occupancy with an insignificant combustible loading (such as found in cement plants, steel stock storage sheds, etc.), as determined by the Chief Building Official.

6.2 Sprinklered Buildings

For sprinklered buildings, NFPA 13, "*Standard for the Installation of Sprinkler Systems*", as referenced by Article 3.2.5.13. of the Building Code, shall be used to obtain sprinkler and hose stream water requirements (see also Section 8.1 of this guideline).

6.3 Buildings Requiring On-Site Fire Protection Water Supply

(a) Except for sprinklered buildings and as required by Sections 6.3 (c) and 6.3 (d), new buildings shall be provided with a supply of water available for fire fighting purposes not less than the quantity derived from the following formula:

$$\mathbf{Q = KVS_{Tot}}$$

where

Q = minimum supply of water in litres (L)
K = water supply coefficient from Table 1
V = total building volume in cubic metres
S_{Tot} = total of spatial coefficient values from property line exposures on all sides, as obtained from the formula:

$$\mathbf{S_{Tot} = 1.0 + [(S_{Side1}) + (S_{Side2}) + (S_{Side3}) + \ldots \text{etc.}]}$$

where

$\mathbf{S_{Side}}$ values are obtained from Figure 1, as modified by Sections 6.3 (e) and 6.3 (f) of this guideline, and
$\mathbf{S_{Tot}}$ need not exceed 2.0
(see also Section 7.0 of this guideline)

(b) Except as provided in Section 6.3 (d), water supply flow rates shall not be less than that specified in Table 2. Where the water supply is from a municipal or industrial water supply system, then the required flow rate shall be available at a minimum pressure of 140 kPa.

(c) Except as provided in Section 6.3 (d), the minimum fire protection water supply "Q" required in Section 6.3 (a) shall not be less than what is needed to provide the minimum flow rate specified in Table 2 for a duration of 30 minutes.

(d) In elementary and secondary schools, the water supply determined in accordance with Sections 6.3 (a) and 6.3 (b) may be reduced. The level of reduction to be applied should be at the discretion of the local jurisdictional authority and should not exceed 30%. Factors to consider should include fire department response time, fire department resources and the size and complexity of the school building
(see Section 9.10 of this guideline for additional information).

Table 1:
Water Supply Coefficient - K

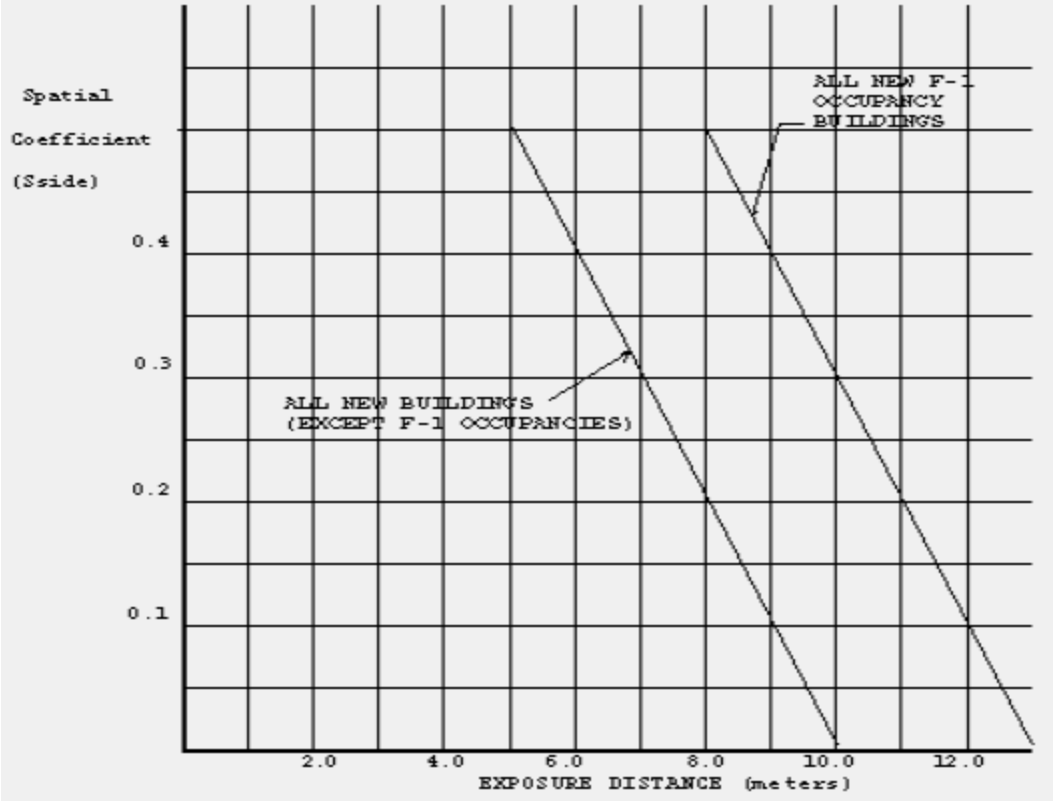
TYPE OF CONSTRUCTION	**Classification by Group or Division in Accordance with Table 3.1.2.1 of the Ontario Building Code**				
	A-2 B-1 B-2 B-3 C D	**A-4 F-3**	**A-1 A-3<**	**E F-2**	**F-1**
Building is of noncombustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2. of the OBC, including loadbearing walls, columns and arches.	10	12	14	17	23
Building is of noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6. of the OBC. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	16	19	22	27	37
Building is of combustible construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2. of the OBC, including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire-resistance rating where permitted in Subsection 3.2.2. of the OBC.	18	22	25	31	41
Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.	23	28	32	39	53
Column 1	2	3	4	5	6

Table 2: **Minimum Water Supply Flow Rates**	
Building Code, **Part 3 Buildings**	**Required Minimum Water Supply Flow Rate (L/min.)**
One-storey building with building area not exceeding **600m² (excluding F-1 occupancies)**	1800
All other buildings	2700 (If **Q** ≤ 108,000L)(1) 3600 (If **Q** > 108,000L **and** ≤ 135,000L)(1) 4500 (If **Q** > 135,000L **and** ≤ 162,000L)(1) 5400 (If **Q** > 162,000L **and** ≤ 190,000L)(1) 6300 (If **Q** > 190,000L **and** ≤ 270,000L)(1) 9000 (If **Q** > 270,000L)(1)

Note: (1) **$Q=KVS_{Tot}$** as referenced in Section 3(a)

FIGURE 1

SPATIAL COEFFICIENT VS EXPOSURE DISTANCE



(e) Where a masonry wall with a minimum fire-resistance rating of 2 hours and no unprotected openings is provided as an exterior wall, the spatial coefficient "S_{Side}" for this side of the new building may be considered equal to 0. This exterior masonry wall shall be provided with a minimum 150 mm parapet.
Firewalls that divide a structure into two or more buildings may be given similar consideration when evaluating the exposure of the buildings to each other.

(f) The spatial coefficient "S_{Side}" may be considered equal to 0 when the exposed building is on the same property and is less than 10 m² in building area.

6.4 Additions to Existing Buildings

(a) Except as permitted in Sections 6.4 (b) and 6.4 (c), additions to existing buildings shall be provided with a fire protection water supply as required in Sections 6.3 (a) to 6.3 (f) (see Section 8.2 of this guideline for additional information).

(b) Buildings with new additions falling into any one of the following criteria do not require an additional water supply for fire fighting:

(i) the expanded building complies with all the requirements of Section 6.1 (a),

(ii) the new addition does not exceed 100 m² in building area, or

(iii) the new addition exceeds 100 m² but does not exceed 400 m² in building area, contains an assembly, business and personal services, mercantile or low hazard industrial occupancy, is of noncombustible construction, does not result in a significant increase in exposure to other existing buildings, has no combustible storage or process, and is separated from the existing building by a minimum 1 hr fire-rated separation.

(c) Where a firewall is provided between the new addition and the existing building, the fire protection water supply may be determined in accordance with Sections 6.1 (a) and 6.3 (a), using only the building volume of the new addition.

NOTE*: Consideration should be given to designing the water supply to the more stringent requirements of the two separated buildings.*

7.0 EXPLAINING THE CALCULATIONS

7.1 What is the "K" factor and how were these values developed?

The K factor, also known as water supply coefficient, is a value that takes into account typical compartmentalization of buildings, combustibility of construction, combustible loading of the building occupancy and evacuation responses by the building occupants.

These factors were developed using the "occupancy hazard classification numbers" and "construction classification numbers" in NFPA 1231, adjusting them to fall within the occupancy classifications of buildings within the Building Code, and then modifying them so that the final units of the equation are in litres. Table 1 of this guideline lists K values according to the type of construction and occupancy classification.

7.2 What volume is included in "V"?

All spaces below and above grade within a building, measured to the underside of the roof deck, should be included in the volume (cubic metres) for the fire protection water supply formula. An exception may be made to exclude a non-combustible crawl space (with no combustible services) below a non-combustible floor, located under the lowest building floor area, if it will not be developed in the future or used as a storage area.

7.3 How are "exposures" measured?

Exposure distances from a new building are measured from the exterior building faces to the property lines of the building. The distance from the face of the building to the property line shall be determined in accordance with Sentence 3.2.3.1.(3) of the Building Code. When facing a street, the property line shall be deemed to be the centre of the street.

When facing an existing building (exceeding 10 m² in building area) on the same property, the exposure distance (for use in Figure 1) shall be the greater of either the "limiting distance" of the new building face as obtained from Sentence 3.2.3.1.(1) of the Building Code, or the mid-point between the two buildings.

7.4 How are spatial coefficient values obtained from Figure 1?

Once the exposure distance for each building face has been determined, these values can be located along the horizontal arm at the bottom of Figure 1. By following straight up from these points, the graph line may be intersected providing a spatial coefficient value (S_{Side}) along the left vertical arm of Figure 1. Exposure distance values of at least 10 m (except F-1 occupancies, which require a minimum of 13.0 m) result in a spatial coefficient value of 0.

7.5 How are multiple exposures calculated?

Where a new building has exposures on more than one side, the percentage increase in the fire protection water supply due to the exposures on each side should be totaled to reflect all exposure protection requirements. For example, if exposure to one side results in a 50% increase in water volume (i.e. $S_{Side}1 = 0.50$), and exposure to another side results in a 25% increase in water volume (i.e. $S_{Side}\ 2 = 0.25$), then the total increase in water volume for exposure protection is 75%. The spatial coefficient S_{Tot} is then 1.0 + 0.50 + 0.25 = 1.75. It should be noted that S_{Tot} need not exceed 2.0.

7.6 What is the rationale for the minimum 30 minute water supply duration and what new buildings will be most affected by this requirement?

The minimum 30 minute fire protection water supply duration requirements as stated in Section 6.3 (b) recognizes life safety concerns by providing a dependable and immediately available fire protection water supply for fire department use. It is intended that the duration be long enough to allow complete search and rescue of any building by the fire department. This minimum fire protection water supply should also give the fire department a reasonable opportunity to control and/or extinguish a small fire upon their arrival, thereby preventing its growth and spread to adjacent

buildings and limit any negative environmental impact. This minimum 30 minute duration requirement also allows a reasonable time for the fire department to arrange for supplementary water supplies using a water shuttle system for most buildings.

Concerns for minimum fire protection water supply volumes are mostly relevant for building sites not serviced by municipal water supply systems, where an on-site fire protection water supply has to be provided. Building sites serviced by municipal water supply systems are usually provided with sufficient water volumes for their fire protection needs. This guideline focuses on water supply flow rates at minimum pressures for these buildings. It should be noted however that some municipalities have fairly limited water supply storage capacities and should therefore be evaluated when a new "high demand" building is to be constructed.

7.7 How do exterior 2hour rated masonry walls with parapets and no unprotected openings and interior firewalls influence exposure, and thus water supply calculations?

Interior firewalls and exterior masonry walls fire rated for 2 hours, with parapets and no unprotected openings, are expected to remain in place during the period that fire exposure is greatest. Exposure to adjacent buildings is reduced to a point where additional exposure protection water may not be needed.

Judgment by the Chief Building Official should be used in determining the design of exterior 2 hour fire-rated masonry walls and interior firewalls with regard to exposures. The usual 150 mm (6 inch) parapet may not be considered adequate exposure protection where a new building exposes a much higher existing building in close proximity. Rather than having to increase the water supply due to exposure, a higher parapet may be sufficient protection. In situations where parapet design or other methods do not provide adequate exposure protection for the existing building, then additional exposure fire protection water may be required.

Where firewalls divide a new facility into separate buildings, the fire protection water supply should be sized to the building with the greatest water supply demand.

7.8 What would be the impact on fire protection water supply requirements for a new building if an existing exposed property has its own on-site fire protection water supply?

Where a new building exposes an existing property provided with its own independent on-site fire protection water supply, the Chief Fire Official may deduct this water supply from the quantity needed by the new building due to this exposure. This neighbouring water supply should be accessible to the fire department to protect exposed buildings.

The Chief Fire Official should be satisfied that the two property owners will properly maintain their respective fire protection water supplies for the life of their buildings. This agreement may require approval from the municipality and may be subject to criteria provided by the Building Code Commission.

8.0 FURTHER EXPLANATIONS

8.1 Regarding sprinklered buildings, where in NFPA 13 are hose stream requirements specified?

NFPA 13 contains the hose stream requirement for sprinklered buildings in the "Occupancy Hazard Fire Control Approach" section (in Chapter 5 of 1992 to 1998 NFPA 13 editions). Within, is a table entitled "Hose Stream Demand and Water Supply Duration Requirements". This table provides total inside and outside hose stream requirements and duration for each hazard classification of sprinkler system design.

A sprinkler contractor designing a sprinkler system for a building will determine the minimum water supply requirements for the sprinkler system. Using the duration period obtained from the above referenced table, the contractor will add the sprinkler and hose stream requirements and calculate the total fire protection water supply required for the building.

8.2 Where new additions are added to existing buildings that do not have an on-site water supply, what volumes of water are considered adequate for life safety and exposure?

Whereas Part 11 of the Building Code indicates that only the addition to an existing building is required to conform to Part 3 of the code, this might in reality not be adequate to deal with life safety and exposure where fire protection water supply needs are concerned.

When an addition is added to an existing building and water supply calculations are based only on the volume of the addition, the fire protection water supply provided on-site might not be adequate to allow full search and rescue throughout the entire building. As well, exposure to neighbouring buildings from the new addition may not be reflective of the nature and size of a potential fire in the enlarged building. Calculations using the entire volume of an expanded building therefore are the only accurate indication of fire protection water supply needs.

8.3 Does this guideline apply to buildings that are being renovated under Part 11 of the Building Code?

Part 11 of the Building Code should be reviewed to determine the conditions under which Article 3.2.5.7. applies. This is found in the Compliance Alternative tables in Part 11.

Where Article 3.2.5.7. does apply, the existing water supply should be evaluated to determine if it is sufficient for the renovated building. Some discretion may be used by the building official if the water supply for the renovated building is not significantly greater than the existing water supply.

9.0 SPECIAL CASES

9.1 Can water transported by the fire department be satisfactory to protect small buildings?

Smaller buildings (2 storeys or less in building height and with a building area of 200 m² or less) may be adequately protected by the fire department using proper pre-planning methods and transported fire protection water supplies. NFPA 1231 "*Standard on Water Supplies for Suburban and Rural Fire Fighting*" provides methods to assist the fire department with this pre-planning. Where the fire department does not have the equipment necessary for proper water shuttle system to adequately protect these smaller buildings as per NFPA 1231, an on-site fire protection water supply should be considered.

9.2 What extra precautions, if any, should be taken for institutional occupancies?

Buildings with Group B, Division 1, 2 and 3 occupancies should be treated in a special manner with respect to fire protection water supplies. The occupants of these buildings require direct supervisory assistance for phased evacuation during a fire. This could result in a prolonged search and rescue by

the fire department. If this type of building is located in areas not serviced by municipal water mains, the fire protection water supply that the fire department is capable of transporting to the site may not be adequate for the duration of this search and rescue period. Only a properly sized on-site fire protection water supply will provide the hose stream duration that the fire department needs. Alternatively, sprinkler protection could be provided.

9.3 What provisions should be made where fire department response is slow or nonexistent?

For new buildings constructed in areas where fire department response is not expected in a reasonable time, sprinklers should be installed to help ensure safe evacuation. In locations where a fire department pumper truck is not available, consideration should be given to installing a private water supply. The water supply should be capable of providing a minimum 700 kPa (100 psi) water pressure at the required flow rate to permit fire fighters or other persons trained in the use of fire hoses, to effectively use a "fog-nozzle" hose spray on the fire. This type of hose spray is most effective at controlling fires. Alternatively, sprinkler protection could be provided.

9.4 How should an outdoor reservoir be designed to take ice formation into account?

When designing an open, unheated reservoir to provide a fire protection water supply as required in this guideline, a 600 mm ice depth allowance should be included in the water volume calculations. Where local winter temperature conditions result in a greater ice depth (as typically found on local lakes or ponds), this should be factored into the volume calculations.

9.5 What provisions should be made to ensure that water reservoir supplies do not drop to unsafe levels as a result of evaporation or leakage?

A make-up water supply should be provided to maintain the design volume of fire protection water supply reservoirs. Storage tanks should be provided with limit switches, pressure gauges or water level gauges to monitor volume.

If make-up water supply for open water supply reservoirs is provided by natural refill methods (i.e. water table seepage) and periods of drought are common, the reservoir capacity should be increased to take into account the reduced water table levels expected from the evaporation of water.

9.6 What standards should be used to provide an acceptable water supply design?

Tanks should conform to NFPA 22 "*Water Tanks for Private Fire Protection*" and the local fire department should be consulted to determine appropriate connections for their pumping equipment.

Fire main installations should conform to NFPA 24 "*Private Fire Service Mains and Their Appurtenances*".

On-site fire pump installations should conform to NFPA 20 "*Standard for the Installation of Centrifugal Fire Pumps*".

Standards such as NFPA 13D "*Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*" and NFPA 13R "*Installation of Sprinkler Systems in Residential Occupancies Up To and Including Four Stories*" may be used where appropriate for the type of building covered by these standards. These other standards should be acceptable to the local jurisdictional authority in addition to NFPA 13 "*Standard for the Installation of Sprinkler Systems*".

For new buildings that present a special hazard to a community as a result of their size, occupancy or economic importance, the Fire Underwriters Survey Guide should be used to determine suitable water supply and hydrant siting.

9.7 For evaluation of the fire protection water supply and associated fire hydrants, are there other considerations in addition to those set out in the Building Code?

Impounded fire protection water supply for a remote building shall be accessible to the fire department to allow the use of suction lines for drafting either directly from the impounded water source, or from a dry hydrant supplied from the impounded water source. This water source or hydrant shall be located to comply with Sentence 3.2.5.7.(2) of the Building Code.

Where at least two widely separated private fire hydrants are required to protect a building and water is to be supplied from a single on-site fire protection water supply (e.g. reservoir), it is acceptable to provide a fire department pumper connection adjacent to the water supply to allow a pumper truck to pump into an underground "dry" main feeding the two remote hydrants. This arrangement permits fire fighters to attach hoses directly to the hydrants or to use a second pumper truck to draw boosted water from these hydrants.

Existing water flow test information being used to determine the adequacy of the municipal or private water supply for fire protection of a new building should be evaluated with regard to the age of the test. Consideration should also be given to whether the flow test was conducted during high or low demand periods and whether the possibility that future development in the area will significantly affect the supply. A current hydrant flow test at the proposed construction site will provide the most accurate information.

When dealing with new buildings serviced by municipal or industrial pressurized fire protection water systems, this guideline specifies a minimum water flow rate at 140 kPa pressure. This pressure is the accepted minimum that most fire departments will allow service mains to be drawn down to. Water main and/or booster pump damage could occur from cavitation at pressures below this level.

9.8 Can this guideline be used for Part 9 of the Building Code?

The Building Code does not currently require that Part 9 buildings be provided with an adequate water supply for fire fighting. However, this guideline may be used on a voluntary basis to provide a suitable fire protection water supply for these buildings.

The Water Supply Adequacy Committee recommends that an on-site fire protection water supply as required by this guideline be provided for multi-unit residential (Group C) type buildings (i.e. hotels, motels, apartments, townhouse complexes, etc.) that fall within Part 9 of the Building Code. These buildings inherently have delayed building evacuation, resulting in more extensive search and rescue operations, and will likely benefit from an on-site fire protection water supply.

9.9 How are standpipes and hose systems affected by these requirements?

Where a building requires a standpipe and hose system under the Building Code, the standpipe system should continue to be designed to Article 3.2.9.2. The standpipe will draw from the required water supply specified in this guideline, still leaving a significant fire protection water supply for exterior hose stream use.

9.10 Can the water supply requirements of this guideline be reduced in buildings with an established fire safety plan that can ensure a rapid building evacuation?

Elementary and secondary schools have a record of well-established and practiced fire safety plans, which allow complete school evacuations within 4 minutes. Because of this and the inherent high level of supervision in these types of facilities, a reduction of up to 30% in the fire protection water supply requirements as set out for unsprinklered buildings in this guideline, may be given. However, caution should be used if the duration of water supply is reduced to less than 30 minutes, unless other compensating features are also provided.

Another factor that should be considered is accessibility for disabled students and teachers within the general school population. A delayed evacuation may be expected for these occupants of the building. This could result in prolonged search and rescue operations by the fire department and should be considered when determining water supply reductions.

9.11 Can the water supply requirements of this guideline be reduced if alternate fire suppression methods are proposed?

Alternate fire suppression methods may result in reduced water supply requirements when compared to design parameters set out in this guideline. Questions should be directed to the local authority that has jurisdiction over these matters.

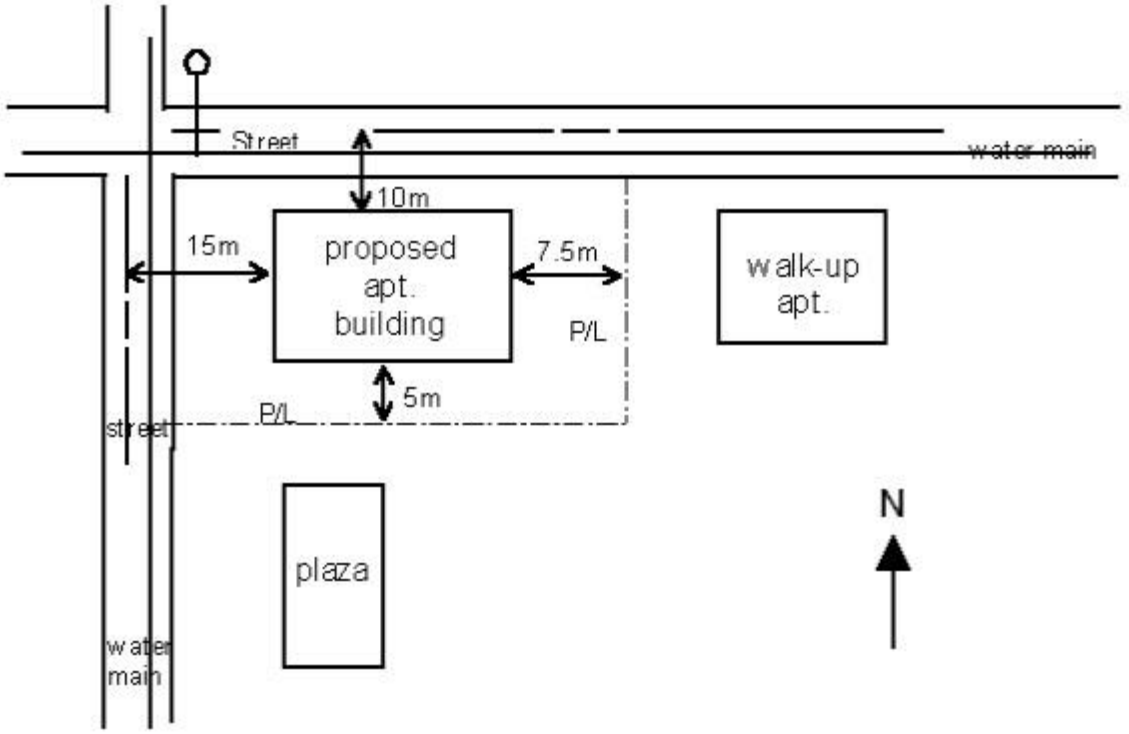
Alternative fire suppression methods being considered for allowing a reduction in the water supply requirements of this guideline are, foam/water extinguishing systems, carbon dioxide extinguishing systems or dry chemical extinguishing systems. Exterior water curtain (deluge) systems may be considered in lieu of fire protection water supply requirements for exposure purposes.

APPENDIX
SAMPLE CALCULATIONS

PROBLEM #1

A new apartment building is to be constructed in your municipality. The building will measure 30 m by 25 m, with 3 m between floors, and consists of 3 storeys plus a basement used for storage and laundry facilities. Parking will be outside. The building is to be of combustible construction and is to conform to Article 3.2.2.47. of the Building Code (1997 edition). An attic space is also provided in this building with a 750 m^3 volume. A 30 minute fire separation is provided between the third floor and the attic space. The building is not to be sprinklered nor provided with a standpipe system.

The building is located on a corner lot and faces 2 streets (see diagram). Property lines are located 5 m to the south and 7.5 m to the east of the proposed building. All of the buildings are serviced by municipal water mains and hydrants. What is the required minimum flow rate of the municipal main for an adequate fire protection water supply?



SOLUTION - PROBLEM #1

1. **Determine building classification:**
   Residential apartment is Group C.

2. **Check parameters of Section 6.1 to determine whether the building requires an on-site water supply:**
   Building exceeds 200 m², is two storeys in building height with significant combustibles and is not a Part 9 building under the Building Code, therefore needs a water supply evaluation.

3. **Calculate $Q=KVS_{Tot}$:**

   (i) Determine K from Table 1.
   Based on building construction and classification, the water supply coefficient K=18.

   (ii) Calculate the building volume, V= L × W × H
   Use total height of building, 3 storeys plus basement, and attic space (750 m³) (3 m between floors × 4 floors =12 m).
   V= (30m × 25m × 12m) + 750 m³ = 9750 m³

   (iii) Determine S_{Tot} from Figure 1.
   Consider each side of the building.
   The north and west sides of the building each face a street and the distance to the centre of the streets exceed 10 m, therefore S_{Side} will be equal to 0.0 on both sides.
   The property line is 5 m to the south of the building. From Figure 1, S_{Side} is equal to 0.5, meaning that a 50% increase in the volume of water will be required to protect this side.

The property line to the east of the building is 7.5 m. From Figure 1, S_{Side} is equal to 0.25, meaning that a 25% increase in the volume of water will be required to protect this side. Therefore, because of the exposure on the south and east sides of the building, it will be necessary to increase the total volume of the water by 75% (the sum of all the spatial coefficients from each side).

i.e. S_{Tot} = 1 + (total of spatial coefficients)
= 1+ (0.5 + 0.25)
= 1.75 (Note: S_{Tot} need not exceed 2.0)

therefore, $Q = KVS_{Tot}$
$= 18 \times 9750 \times 1.75$
= 307,125 L

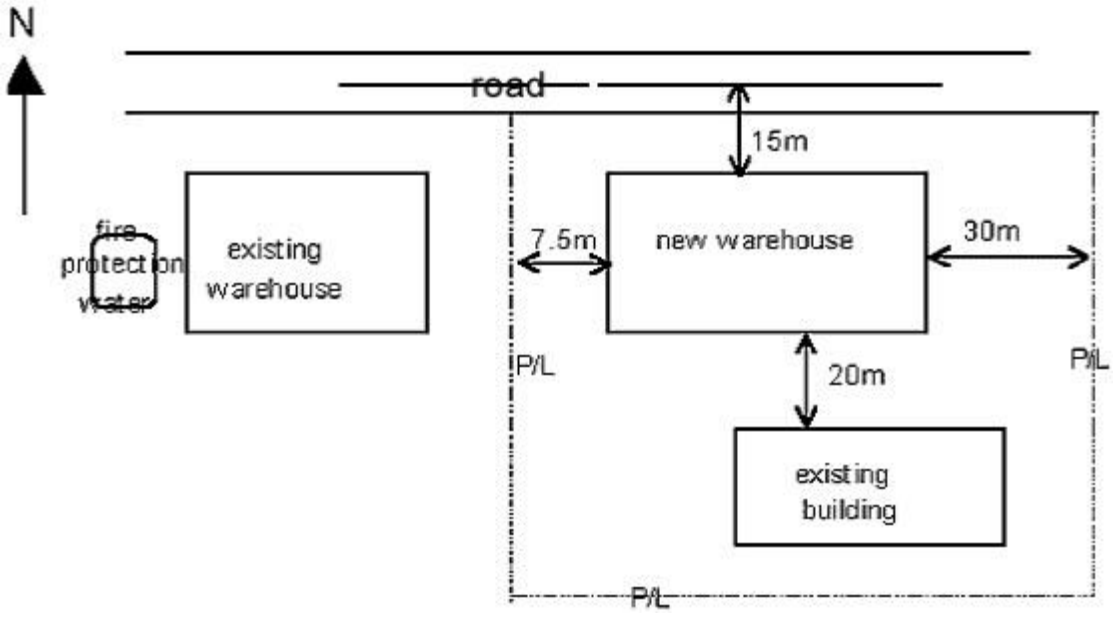
4. **Determine the water supply flow rate:**
From Table 2, (since the building either exceeds 1 storey or its area is greater than 600 m², and the calculated Q is greater than 270,000 L) the required minimum water supply flow rate from the municipal system would be 9000 L/min. This flow rate is required at 140 kPa in accordance with Section 6.3 (b).

PROBLEM #2

A single storey warehouse and distribution centre, classified as a low industrial hazard occupancy, is to be built in an area not serviced by a municipal water supply. The building is to be 1500 m² in area, 4 m high and of noncombustible construction conforming to Subsection 3.1.5. of the Building Code. This building falls within Article 3.2.2.80. of the Building Code. Storage commodities vary, but in general are farm implements in wood crates.

The warehouse faces one street to the north, with property lines 30 m to the east and 7.5 m to the west. An existing building is located on the same property and will be 20 m to the south of the proposed new warehouse. The new warehouse building will have 10% unprotected openings in its south face.

There is a similar type warehouse that has its own 20,000 litre on-site fire protection water supply located to the west. This water supply is determined by the fire department to be reliable and accessible. How much water will be required on site for fire protection of the proposed building?



SOLUTION - PROBLEM #2

1. **Determine building classification:**
   Proposed low hazard warehouse building is Group F-3.
2. **Check parameters of Section 6.1 to determine whether the building requires an on-site water supply:**
   Building is a Part 3 building (under the Building Code) as it exceeds 600 m²in area and has a significant combustible loading, therefore it needs an on-site water supply.
3. **Calculate $Q=KVS_{Tot}$:**

   (i) Determine K.
   From Table 1, based on building construction and classification, the water supply coefficient K=19.

   (ii) Calculate the building volume, V= Area × H = (1500 × 4) = 6000 m³

   (iii) Determine STot from Figure 1 by considering each side of the building.

   On the east side of the proposed building the distance to the property line exceeds 10 m so no increase in water volume is necessary.

   The proposed building faces a street on the north side with distance to the centre of the street 10 m away. No increase in the water volume will be required due to lack of exposure on this side.

   The proposed building faces an existing building on the same property, 20 m to the south. The 10% unprotected openings in the south building face of the proposed building results in a "limiting distance" of 2.5 m using Table 3.2.3.1.A. of the Building Code. Since the mid-point between the two buildings on the same property (10 m) is greater than the limiting distance of the south face of the new building, the 10m is deemed the exposure distance. No increase in water volume will therefore be needed from exposure on this side.

The property line to the west is 7.5 m from the exterior wall, which means a 25% increase in the volume of water to protect the property on that side. However, the neighbour's warehouse has its own reliable 20,000 litre fire protection water supply, so this can be used to reduce the exposure needs. Exposure calculations should be completed to evaluate the neighbouring water supply, therefore:

STot = 1 + total of spatial coefficients

= 1 + (0.25) = 1.25

and, Q = KVSTot

= 19 × 6000 × 1.25 = 142,500 L

Of this amount, 28,500 L (142,500 - 114,000 = 28,500) is required for exposure, of which 20,000 L is already provided on the exposed property. Therefore, an additional 8,500 L should be added to the on-site water supply to make up the shortfall in exposure protection. Therefore, Q= 122,500 L (114,000 + 8,500 = 122,500).

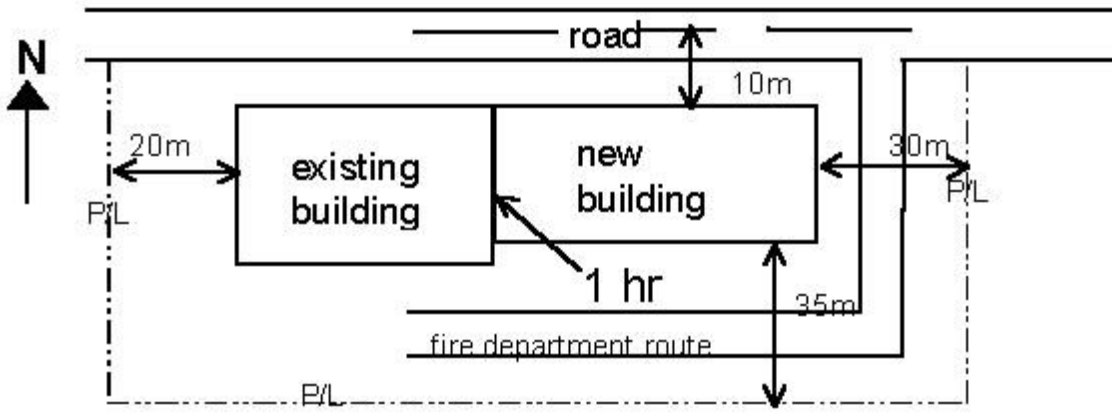
4. **Determine the water supply flow rate:**
   From Table 2, since the building area exceeds 600 m² and the calculated Q is greater than 108,000 L but less than 135,000 L, the required minimum water supply flow is 3600 L/min. However, in accordance with Section 6.3 (b) it must also be confirmed that 3600 L/min. can be delivered for a minimum of 30 minutes. Since a 34 minute duration is achieved (122,500 ÷ 3600 = 34 minutes), this is satisfactory.

PROBLEM #3

An existing 400 m² single storey (with basement) school is being provided with a 400 m² addition of noncombustible construction. The existing building is of combustible construction with a 45 minute rated roof and basement ceiling (structural supports rated as well), while the new addition is of noncombustible construction as well and meets the requirements of Article 3.2.2.25. of the Building Code. Both the new and existing buildings are provided with full basements, 2.5 m in height. The ground floor has a ceiling height of 3.0 m. An attic space is provided in both buildings, each with a volume of 800 m². A 1 hour fire rated separation is to be provided between the new and existing structures.

No water mains or hydrants are located in the area. A hose standpipe is voluntarily being provided throughout the entire building, with a booster pump. Distances to the property lines are as indicated on the accompanying sketch. An all volunteer fire department with limited equipment is located within 20 minute response of the building site.

What size pond is needed on site (assuming no freezing temperatures), to ensure minimum life safety requirements?



SOLUTION - PROBLEM #3

1. **Determine building classification:**
School building is Group A-2.

2. Go to Section 6.4 (a) (iii) of this guideline. This section indicates that a single storey, noncombustible addition with an assembly occupancy, up to 400 m² in building area, with no combustible storage or process and separated from the existing building by a minimum 1 hour fire separation does not require additional water supplies for fire fighting purposes.

3. The municipal jurisdictional authority however, may also wish to take into consideration the ability of the local fire department to provide an effective water supply shuttle system to this school by using NFPA 1231 as a reference. If equipment is not available to provide effective amounts of water supply, then an on-site water supply may be the best choice. Please refer also to Section 6.1 (a) (ii) of this guideline.

4. **If an on-site water supply is chosen, it may be sized by calculating Q = KVS_{Tot}:**

(i) Although Part 11 of the Building Code would only size the on-site water supply based on the addition, the fire department should determine if this is sufficient for their search and rescue needs.

(ii) Assuming the entire building volume is selected to determine Q, determine K.
From Table 1, based on building construction and classification, the water supply coefficient for the existing building is K=18 and for the new addition K=16.

(iii) Calculate the building volume, V = L × W × H

$V_{Existing}$ = (400 × 3) + (400 × 2.5) + 800 = 3000 m³

$V_{Addition}$ = (400 × 3) + (400 × 2.5) + 800 = 3000 m³

(iv) Determine S_{Tot}.

From Figure 1, since no property lines are less than 10 m away, all S_{Side} = 0.0, no additional water volume is needed for exposures and therefore S_{Tot}=1.0

$Q = KVS_{Tot}$
$= (KVS_{Tot})_{Existing} + (KVS_{Tot})_{Addition}$
$= (3000 \times 18 \times 1.0) + (3000 \times 16 \times 1.0)$
= 102,000 L

This is the required pond size, assuming a means to maintain the water level and no freezing concerns. Note that Section 6.3 (d) also allows a reduction in the water supply and flow rate for schools. This reduction may not be considered due to the volunteer fire department with limited equipment.

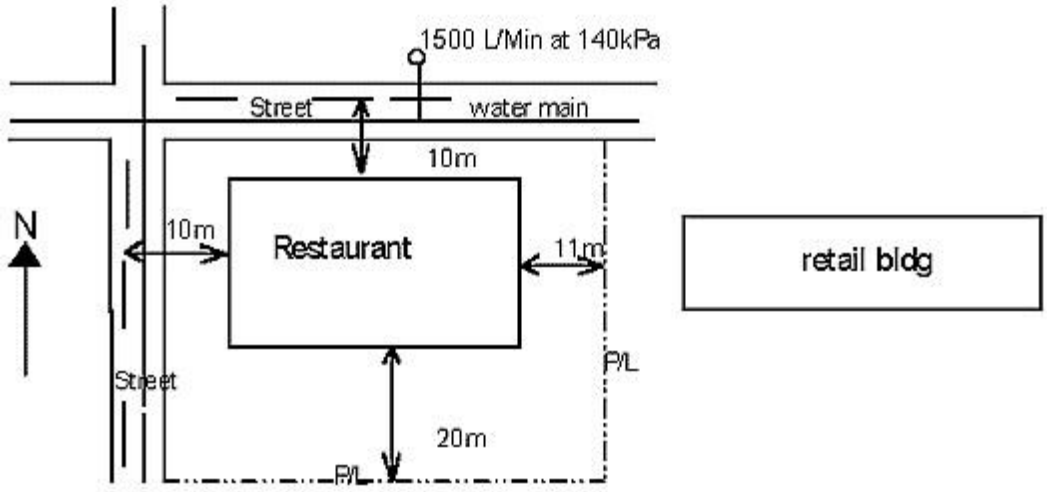
5. **Determine the water flow rate:**
From Table 2, since the building area exceeds 600 m² and the calculated Q is less than 108,000 L, the required minimum water supply flow is 2700 L/min. However, in accordance with Section 6.3 (b) it must also be confirmed that 2700 L/min. can be delivered for a minimum of 30 minutes. Since a 38 minute duration is achieved (102,000 ÷ 2700 = 38), this is satisfactory. Note if the water supply was sized only to the addition, then a 54,000 litre pond, allowing a 30 minute duration at a flow rate of 1800 L/min. would be required. However, at 2700 L/min., which is a reasonable flow rate for the entire structure, this provides only 20 minute duration.

PROBLEM #4

A 300 m² single storey restaurant is to be constructed of noncombustible construction in a town with a marginal water supply due to old mains and poor grid system. The municipal water reservoir is sized for 4,546,000 L (1.0 million Imperial gallons). The building will have a 3.5 m high ceiling. No hose standpipe or sprinklers are planned. Is the existing street supply adequate?

Property lines are located 11 m to the east and 20 m to the south. Street centreline distances are 10 m to the north and west.

The fire department routinely arrives at a fire scene in this part of town with a tanker/pumper truck carrying enough water (4500 L) for two 38 mm hoses adequate for 5 minutes of discharge. The hydrant at the street can provide 1500 L/min. at 140kPa.



SOLUTION - PROBLEM #4

1. **Determine building classification:**
Restaurant building is Group A-2 occupancy.

2. **Check parameters of Section 6.1 to determine whether building requires an on-site water supply:**
The building falls within Part 3 of the Building Code.
The building area is more than 200 m² and is not an F-3 occupancy.

3. **Compare existing water supply with required water supply:**
As the building does not exceed 600 m², the required water supply flow rate from Table 2 for this size building is 1800 L/min.
Provided public water supply from hydrant at street is 1500 L/min at 140 kPa (adequate volume of supply).
Transported water supply by fire department is 4500 L.
The required water supply shortfall from the public supply is (1800 − 1500) = 300 L/min. The transported water supply by the fire department will last 15 minutes if used at a flow rate of 300 L/min (4500 ÷ 300 = 15 minutes) to make up the shortfall from the public supply.

4. **Solutions to make up water supply shortfall:**

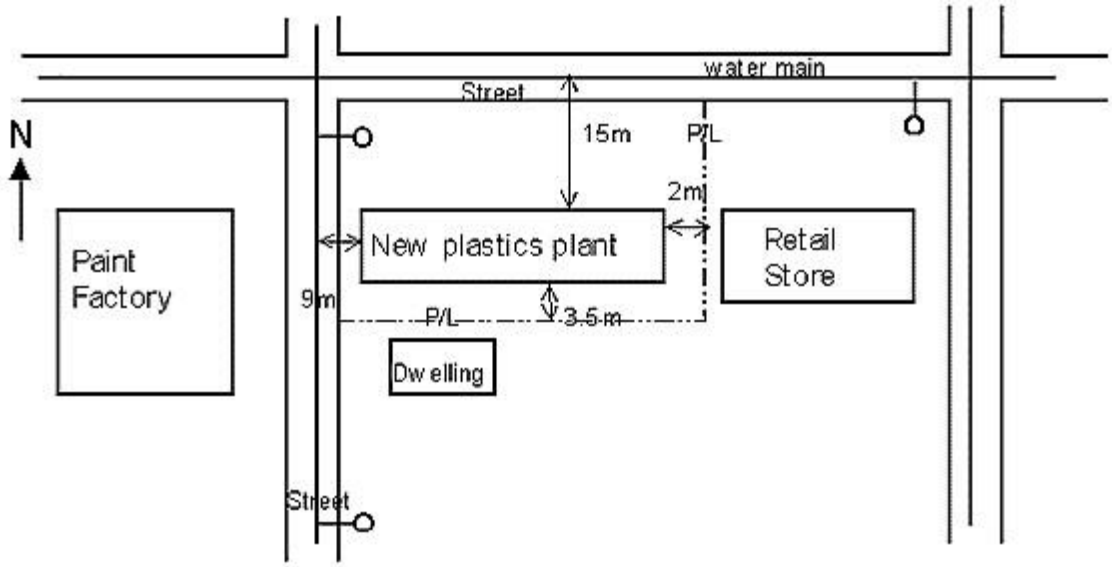
Option #1 - As the total water supply that is deemed adequate for this new building is 1800L/min x 30 minutes = 54000 L, and the provided water supply is (1500 × 30) + 4500 = 49500 L, then an additional on-site water supply of 4500 L could be provided.

Option #2 - Provide an additional transportable water supply source (i.e. tanker truck) of 4500 L.

Option #3 - The municipal authority may determine that 1650 L/min is satisfactory based on building occupancy and layout, and the restaurant's fire safety plan. The municipal authority may also determine that "life safety" is no longer a significant concern after 15 minutes in this type of occupancy and the remaining public water supply is satisfactory for exposure concerns.

PROBLEM #5

A new 4 storey plastics extrusion plant (F-2 occupancy) is being constructed in a town with a marginal water supply. The flat-roofed building will cover a 500 m² area and be 12.0 m in overall height. Construction is to be combustible and in conformance with Article 3.2.2.70. of the Building Code. The roof and floor separations have a fire-resistance rating of 45 minutes. Exposure includes property lines 2 m and 3.5 m away and street centrelines 9 m and 15 m away to the west and north. What is the required water supply from the street mains for this new building?



SOLUTION - PROBLEM #5

1. **Determine building classification:**
Group F-2 occupancy.

2. **Check parameters of Section 6.1 to determine whether building requires an on-site water supply:**
The building is a Part 3 building (under the Building Code) as it meets dimensional parameters (i.e. more than 3 storeys).

3. **Calculate $Q = KVS_{Tot}$:**

(i) Determine K.
From Table 1, based on building construction and classification, the water supply coefficient K=31.

(ii) Calculate the building volume, $V = L \times W \times H = 500 \times 12 = 6000\ m^3$

(iii) Determine S_{Tot} from Figure 1 (consider each side of the building).

The street centreline to the north is more than 10 m away thereby providing no exposure concerns.

The street centreline to the west is 9 m away thereby resulting in an S_{Side} of 0.1.

The P/L to the east is 2 m away resulting in an S_{Side} of 0.5.

The P/L to the south is 3.5 m away, resulting in an S_{Side} of 0.5.

Therefore the resulting total of spatial coefficient values is:

$S_{Tot} = 1 + (0.1 + 0.5 + 0.5)$
$= 1 + (1.1)$
$= 2.1$

However as S_{Tot} need not exceed 2.0, assume $S_{Tot} = 2.0$.

(iv) Therefore, $Q = KVS_{Tot} = 31 \times 6000 \times 2.0 = 372{,}000$ L.
It should be confirmed that the municipal reservoir has this reserve fire fighting water supply capacity.

4. **Determine the water supply flow rate:**
From Table 2, this type of building requires a minimum fire protection water supply flow rate of 9000 L/min at 140 kPa. Water flow tests on street hydrants at the building site should confirm this minimum flow.

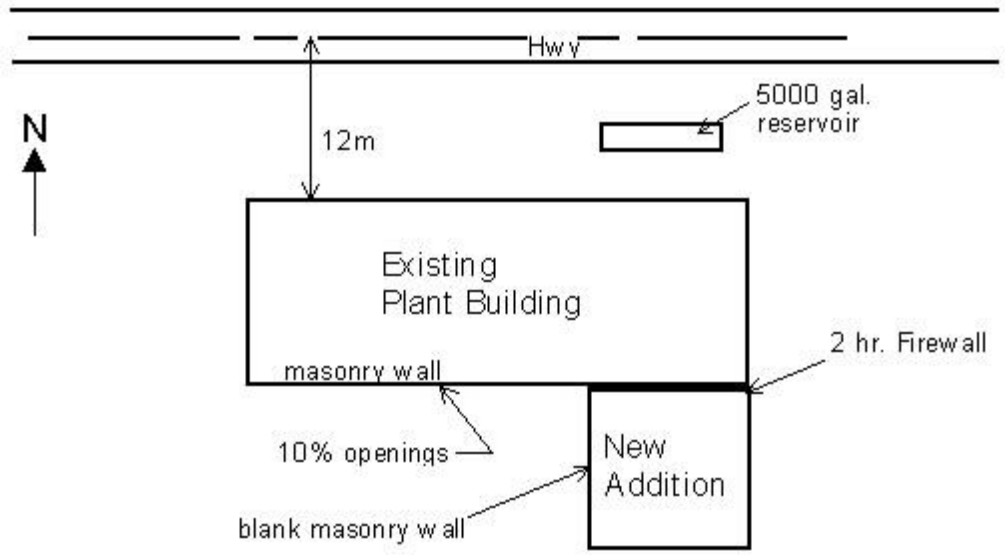
PROBLEM #6

A 200 m² single storey flammable liquids storage and paint mixing room is being constructed on the southwest corner of this existing remote 600 m², single storey metal parts fabricating and treating plant. The property line is no closer than 60 m from the building in the south, east and west directions. The centreline of the highway to the north is 12 m. An existing 22,730 L (5,000 Imperial gallons) fire protection water supply is currently provided on-site, with a dry hydrant to provide fire department draft from this reservoir.

The building is located in an area surrounded by agricultural lands used for growing cash crops, and lakes used to provide potable water for the local communities.

The existing building has interior hoses but no sprinklers. The new addition is to be separated from the existing building by a 2 hour firewall, but is not to be sprinklered. The addition is to be 4 m in height and of noncombustible, non-rated construction. The walls of the addition at right-angles to the

existing building are blank masonry, while the masonry walls of the existing building at right-angles to the addition have 10% openings. Is the existing water supply sufficient for the addition or the existing building.



SOLUTION - PROBLEM #6:

1. **Determine new building classification:**
Group F-1 occupancy.

2. **Check parameters of Section 6.4 for this addition:**
Section 6.4 (c) deals with firewalls separating additions from existing buildings. Check parameters of Section 6.1 to determine whether the addition requires an on-site water supply. The addition has an F-1 occupancy and is therefore a Part 3 (Building Code) building. Because the chemical occupancy of the addition may result in a significant adverse environmental potential to the local aquifer, the addition does not fall within Section 6.1. Therefore check Sections 6.2 and 6.3.

3. **Addition is not to be sprinklered so Section 6.2 does not apply.**

4. **From Section 6.3, calculate Q for the addition using $Q=KVS_{Tot}$:**

(i) Determine K.
From Table 1, based on building construction and classification, the water supply coefficient K=37.

(ii) Calculate the building volume, $V = L \times W \times H = 200 \times 4 = 800\ m^3$.

(iii) Determine S_{Tot} from Figure 1 (consider each side of the building).

The P/L to the east, west and south exceeds 13 m resulting in S_{Side} values of 0 in each direction.

To the north, the limiting distance to the south exposed wall of the existing building from the blank west wall of the addition is determined from Sentence 3.2.3.1.(1). of the Building Code. Because of the blank masonry wall, the limiting distance is 0.

Therefore the resulting total of spatial coefficient values is:

$S_{Tot} = 1 + (0 + 0 + 0 + 0) = 1.0$

(iv) Therefore, $Q = KVS_{Tot}$

$= 37 \times 800 \times 1.0$

$= 29{,}600$ L

5. **Determine the water supply flow rate:**
From Table 2, F-1 occupancy buildings require a minimum fire protection water supply flow rate of 2,700 L/min. The existing on-site fire protection water supply of 22,730 L (5,000 Imperial gallons) can provide this flow rate for 8 minutes.
Since a minimum 30 minute duration in water supply is needed, an additional 58,250 L of on-site water supply is needed for the addition to make up the shortfall (81,000-22,750 L).
The existing building may also be evaluated to determine if water supply requirements for that portion would be higher. The owner may decide to provide additional water to meet the higher demand.
Under the Building Code the existing building also has to be evaluated to determine that exposure has not increased due to the location of the addition.