2017-12-11 – Town of Lakeshore

FIRE UNDERWRITERS SURVEY

A Service to Insurers and Municipalities

Town of Lakeshore Fire Hall Location Study & Analysis

Notice of Confidentiality

This document contains confidential and proprietary information (the "Information") of SCM Opta Information Intelligence Inc. and has been prepared for the sole use of the Town of Lakeshore and stakeholders that provide fire protection related services.

The Information contained herein is disclosed on condition that it will be used solely in connection with its stated purpose. The Recipient shall not directly or indirectly disclose, allow access to, transmit or transfer the Information to any third party without SCM's prior written consent. Recipient may disclose the Information only to those of its employees who have a need to know the Information in connection with the stated purpose. This document cannot be reproduced in any form or by any mechanical or electronic means, including electronic archival systems, without the prior written approval of SCM provided, however, that the Recipient may make a reasonable number of copies for internal use in connection with the purpose. All copies of this document or portions thereof shall bear the proprietary notices of SCM.

If you have received this document by mistake, note that reading, reproduction or distribution of this document is strictly forbidden. You are hereby requested to inform us by telephone at 1-800-665-5661 and to return this document by certified mail.

Disclaimer

Our report is being submitted for your review and consideration. SCM makes no representation or warranty to Recipient with respect to the Information and shall not be liable for any errors or omissions in the Information or the use of thereof.

Readers of this report should read the report in its entirety as all parts of the report are interrelated and reading individual sections outside of the context of the report may result in misinterpretations of the intent of the writers.

Trademarks

SCM respectfully acknowledges that respective entities own all products and/or intellectual property identified in this report.

Table of Contents

Tables and Figures

1. Scope of Our Engagement

Town of Lakeshore contracted the services of Opta Intelligence Services Inc. (formerly IAO) – Fire Underwriters Survey to provide optimization analysis, considering specific options, for fire hall coverage within the Lakeshore Fire Protection Area.

1.1. Acknowledgement

Opta Information Intelligence wishes to thank Lakeshore Fire Department and Town of Lakeshore staff for their valuable assistance in the preparation of this report.

1.2. Distribution of Use

This report, along with the findings and conclusions, contained herein, is intended for the sole use of Town of Lakeshore to assist in the public fire protection planning needs of the community.

Judgements about the conclusions drawn, and opinions presented in this report should be made only after considering the report in its entirety. This report is Private and Confidential and is intended for the exclusive use of Town of Lakeshore.

1.3. Reliance and Limitation

We have relied on the general accuracy of information provided by stakeholders without independent verification. However we have reviewed this information for consistency and reasonableness. The accuracy of our conclusions is dependent upon the accuracy and completeness of this underlying data. Therefore, any discrepancies discovered in this data by the reader should be reported to us and this report amended accordingly, as warranted.

2. Executive Summary

The Town of Lakeshore currently has 5 fire halls located within the Lakeshore Fire Protection Area. Consideration is currently being given to replacing the fire halls, and as such, there is an opportunity to re-locate these response facilities. The following report looks at current coverage being provided, community growth over the next 10-15 years, and various optimization analysis developed using Geographical Information Systems (GIS) to aid decision making. The main purpose of the study was to design optimal station location options using various conditions of response.

A fire hazard and risk assessment was conducted in the Lakeshore Fire Protection Area to aid in determining the community's fire protection needs. A fire hazard and risk assessment, along with a response distance review, lays the groundwork for determining fire protection needs within a community. This assessment is important in ascertaining organizational structure, personnel requirements, training requirements, fire apparatus and fire equipment needs, response time requirements and adequacy of fire station locations. The fire hazard and risk assessment completed within the Lakeshore Fire Protection Area also included community growth projections and increases in building stock. A community tour and comprehensive risk assessment was completed to review the area and quantify the level of built risk within the community. Following this, a model was created to represent current community property risk levels. GIS tools were used to establish the current response coverage which can be seen in section 7.3 Current Coverage; coverage analysis was based on current and future risk levels, as well as current fire response facilities operating with the Lakeshore Fire Protection Area. Subsequently, four overall optimization options were developed to maximize coverage within the current Lakeshore Fire Protection Area; through the use of industry standards and best practices.

This study, as previously stated developed four optimizations of varying degrees based on applicable industry standards to determine an appropriate service model and fire hall alignment to serve the Town of Lakeshore for the next 30 - 40 years. Coverage analysis was first determined using current locations of fire halls, as it relates to Fire Underwriters Surveys' Table of Effective Response found in Table 3, and NFPA 1720 guidelines found in Table 5 - NFPA 1720 Staffing and Response Time Table. Secondarily, identifying whether current fire hall configurations could meet these standards of fire suppression response and coverage was completed. In an attempt to reduce the amount of needed fire hall response facilities for all optimizations completed; aiding neighbouring fire halls located in Essex and Tilbury were treated as fixed locations in each design to reduce the need for additional fire halls, as their response facilities can provide adequate rural response coverage. Essex and Tilbury fire halls are directly adjacent to Lakeshore administrative boundaries, which makes each fire hall a viable option to provide coverage within the Town of Lakeshore; specifically in rural areas of the community where it would be challenging to maintain fire halls.

The completion of Optimization No.1 – Table of Effective Response and Optimization No.2 – NFPA 1720 (9 New Fire Hall with 2 Aid Fire Halls) indicated the challenges associated with providing a consistent level of fire suppression response throughout the Lakeshore Fire Protection Area. Large areas used for agriculture, as well as numerous remote building locations allude to the difficulties of providing consistent response characteristics to all properties. These long distances and vast geographical areas create impractical fire protection needs, which if addressed, could cause a significant financial burden, and little enhancement to service levels. Each of the first two optimizations could be re-configured to determine what impact career staffing could have to reduce the number of fire halls required; however, the basis of these optimization designs was built to address current fire protection service models related to a fire suppression resources of a volunteer nature. NFPA 1720 guidelines indicate the standard can be used by volunteer or composite type departments, and may highlight the need to consider an enhanced service model including readily available on-duty staffing of a career nature. Likewise, career staffing of suppression staff was previously identified in the 2011 Master Fire Plan. Career staffing is also recommended through the NFPA 1720 guideline for areas of the community considered urban, which are identified mainly in the northwestern portion of the community; please see Figure 19 Town of Lakeshore – NFPA 1720 Demand Zones. This is also the area of Lakeshore which has experienced the most growth regarding residential and commercial buildings.

Optimization No.2 – NFPA 1720 (9 New Fire Hall with 2 Aid Fire Halls) aims to achieve a utilitarian approach to supplying as many properties as possible with a response within prescribed travel distances associated with Commercial and Personal Lines insurance. Commercially insured property within 5km by road of a fire hall, and Personal Lines insured property within 8km by road travel distance of a fire hall are required to decrease fire insurance premiums paid by business stakeholders and constituents within the Town of Lakeshore. This optimization improves the amount of demand points within 5km/8km by road travel distance from optimised fire hall locations, when compared to current locations of fire halls in Lakeshore. Consideration should be given to the design of one of the fire halls located in the Emeryville, Puce and Belle River corridor to include a fire hall that can incorporate and accommodate career staffing of suppression firefighters. As previously stated, this study aims to provide fire hall facilities for fire protection consideration for the next 30-40 years; incorporating population growth and increases in building stock, as well as increased risk levels.

The result of the fourth optimization illustrates a significant decrease in response coverage related to most criteria evaluated throughout this report. Additionally, another undesirable impact of this fire hall configuration is the inability of the model to address growth in the North Western portion of the community. Optimization No.4 – Maximising 8km Travel Distance Response reduces the amount of fire halls servicing the area of the community experiencing the most growth, densification of population and high value commercial property. Multiple commercial areas and properties are located beyond 5km by road travel distance of a fire hall and would likely result in significant increases of property insurance premiums associated with Commercial Lines insurance. Likewise, the configuration of fire halls would also impact currently updated fire insurance

classifications of the community, as the decrease in response capacity would lose substantial credit related to Public Fire Protection Classification (PFPC) grading schedule.

The recommended optimization from the developed options presented in this report is Optimization No.3 – Maximising Insurance Coverage Standards. This design clearly demonstrates and aligns with community growth experienced in the North Western portion of the Town of Lakeshore. Although Optimization No.1 and No.2 illustrate significant improvements in response coverage throughout the Town of Lakeshore, their design is restrictive due to the significant increase in finances necessary to accommodate such expenditures. Based on geographical challenges pertaining to the size, composition and unique make-up of the community which contains areas considered urban, suburban and rural; developing fire protection services primarily addressing response coverage only, is believed to be unsustainable for the Town of Lakeshore. A fire protection model that incorporates heightened proactive fire inspection and public education initiatives to reduce risk, with a reasonable capacity to respond to alarms safely and effectively would likely prove more suitable to the community's needs. Subsequently, Optimization No.3 improves coverage under categories of 5km and 8km response distances, maximising coverage, as it pertains to Commercial lines and Personal Lines insured property. Subsequently, Optimization No.3 also maintains the current number of fire halls at five, alleviating further potential increases in staffing, apparatus, equipment and facilities associated with designs requiring an increase in the number of fire halls to achieve ideal response coverage levels.

Conclusions drawn from the completion of the various optimization designs, indicate a definite need for the Lakeshore Fire Department to evolve beyond the volunteer service model currently in place. Current fire halls do not address areas of growth within the community, as their placement pre-dates the amalgamation of various communities which made their own fire protection decisions regarding the placement of fire halls. The Town of Lakeshore has utilised a fire suppression model of volunteer fire fighters effectively for many years. However, with recent community growth, as well as future planned growth, increased populations, and building stock, a need for more consistent response times throughout all hours of the day will continue to be prevalent as call volumes increase. It should also be noted, that the utilization of aiding neighbouring fire halls can limit the amount of fire halls servicing the Town of Lakeshore to a minimum of five local fire halls complimented by the two available fire halls adjacent to administrative boundaries in neighbouring communities. Should aiding fire halls no longer service areas of the Town of Lakeshore, consideration should be given to addressing gaps in service with the potential placement of additional fire halls.

Figure 1 Optimization No.3 - Response Coverage (5 New Fire Halls with 2 Aid Fire Halls)

N

LFD-1

LFD-3

CKFD-19

LFD-2

LFD-4

LFD-5

EFD-1

Legend

- Optimized Fire Hall 5km Urban
- Optimized Fire Hall 8km Rural
- Existing Fire Hall
- Road
- Fire Protection Boundary
- 5km Coverage Area
- 8km Coverage Area
- Unprotected

Fire Underwriters Survey
Est. 1883

Lakeshore, ON

Optimization No.3 – Maximising Coverage for 5km/8km Travel Distance (5 New Fire Halls with 2 Aid Fire Halls)

Scale = 1:34,000

0 1,050 2,100
Meters

Fire Underwriters Survey
A Service to Insurers and Municipalities

3. Terms of Reference

Term	Definition
Aerial Fire Apparatus.	A vehicle equipped with an aerial ladder, elevating platform, aerial ladder platform, or water tower that is designed and equipped to support fire fighting and rescue operations by positioning personnel, handling materials, providing continuous egress, or discharging water at positions elevated from the ground.
Aid - Automatic Aid	A plan developed between two or more fire departments for immediate joint response on first alarms. This process is accomplished through simultaneous dispatch, documented in writing, and included as part of a communication center's dispatch protocols.
Aid - Mutual Aid	Reciprocal assistance by emergency services under a prearranged plan. This is part of the written deployment criteria for response to alarms, as dispatched by the communications center.
Basic Fire Flow	The benchmark required fire flow for a community, typically the fifth highest calculated required fire flow of all areas within the community. The Basic Fire Flow is the benchmark against which all protective facilities are measured.
Building	Any structure used or intended for supporting or sheltering any use or occupancy.
Building area	The greatest horizontal area of a building above grade within the outside surface of exterior walls or within the outside surface of exterior walls and the centre line of firewalls.
Building height	The number of storeys contained between the roof and the floor of the first storey.
Built Environment	Buildings and structures: human-made buildings and structures, as opposed to natural features.
Combustible	A material fails to meet the acceptance criteria of CAN4-S114, “Determination of Non-Combustibility in Building Materials.”
Commercial Lines Insurance	A distinction marking property and liability coverage written for business or entrepreneurial interests (includes institutional, industrial, multi-family residential and all buildings other than detached dwellings that are designated single family residential or duplex) as opposed to Personal Lines.
Community - Major or Large	An incorporated or unincorporated community that has: • a populated area (or multiple areas) with a density of at least 400 people per square kilometre; AND • a total population of 100,000 or greater.
Community - Medium	An incorporated or unincorporated community that has: • a populated area (or multiple areas) with a density of at least 200 people per square kilometre; AND/OR • a total population of 1,000 or greater.

Community - Small	An incorporated or unincorporated community that has: • no populated areas with densities that exceed 200 people per square kilometre; AND • does not have a total population in excess of 1,000.
Company	A group of members that is (1) under the direct supervision of an officer or leader; (2) trained and equipped to perform assigned tasks; (3) usually organized and identified as engine companies, ladder companies, rescue companies, or squad companies; (4) usually operates with one piece of fire apparatus (pumper, ladder truck, elevating platform, rescue, squad, ambulance); and (5) arrives at the incident scene on fire apparatus or assembles at the scene prior to assignment. The term company is synonymous with company unit, response team, and response group.
Demand Zone Levels	An area used to define or limit the management of a risk situation. A demand zone can be a single building or a group of buildings. It is usually defined in terms of geographical boundaries, called fire management areas or fire management zones.
Detached Dwelling	Buildings containing not more than two dwelling units in which each dwelling unit is occupied by members of a single family with not more than three outsiders, if any, accommodated in rented rooms. Aka. One- and Two-Family Dwelling
Dwelling Protection Grade (DPG)	The fire insurance grade or grades utilized by Personal Lines Insurers in Canada. The DPG is a number between 1 and 5 that is calculated by comparing the fire risk in terms of require fire flows to available resources. Unlike the PFPC system, within the DPG system, the benchmark required fire flow is a constant, and is typical for a Detached Dwelling. The DPG for communities across Canada is determined from a basic survey of the available resources related to fire risk reduction and fire protection capacity.
Dwelling, Typical	Refers to One- and Two-Family Detached Dwellings: - with no structural exposures (buildings with an area exceeding 9.3 sq.m) within 3 m; - with no unusual fire risks (such as wood shake roofs); AND - with an effective area (all storeys excluding basements) not exceeding 334 sq.m (3,600 sq.ft).
Emergency Dispatch Protocol	A standard sequence of questions used by telecommunicators that provides post-dispatch or pre-arrival instructions to callers.
Emergency Incident	Any situation to which the emergency services organization responds to deliver emergency services, including rescue, fire suppression, emergency medical care, special operations, law enforcement, and other forms of hazard control and mitigation.
Emergency Response Facility (ERF)	A structure or a portion of a structure that houses emergency response agency equipment or personnel for response to alarms. Examples of ERFs include a fire station, a police station, an

	ambulance station, a rescue station, a ranger station, and similar facilities.
Emergency	A condition that is endangering or is believed to be endangering life or property; an event that requires the urgent response of an emergency response agency.
Engine	A fire department pumper having a rated capacity of 2840 L/min (625 Igpm) or more.
Exposing building face	That part of the exterior wall of a building which faces one direction and is located between ground level and the ceiling of its top storey or, where a building is divided into fire compartments, the exterior wall of a fire compartment which faces one direction.
Exposure	The heat effect from an external fire that might cause ignition of, or damage to, an exposed building or its contents.
Fire Apparatus	A fire department emergency vehicle used for rescue, fire suppression, or other specialized functions.
Fire Department Vehicle	Any vehicle, including fire apparatus, operated by a fire department.
Fire Department	A fire department is a group of persons formally organized as an authorized service of a municipal or other local government having a sustainable source of funding, which could include taxation, fees for services provided, contracts, permit fees or other reliable sources of revenue which will support the cost of services provided. A minimum number of trained persons able and equipped to respond with motorized fire fighting apparatus to extinguish fires or to respond to other classes of circumstances which may occur within a designated geographical area.
Fire Department. - Public Fire Department	A legally formed organization providing rescue, fire suppression, emergency medical services, and related activities to the public.
Fire Force, Available	A measure of the human resources that are available to participate in fire fighting operations on the fire ground or an equivalent measure.
Fire Force, Required	A measure of the human resources that are needed to participate in fire fighting operations on the fire ground (or an equivalent measure) for an ideal response based on the required fire flow, number of companies and average response time as specified in the Table of Effective Response.
Fire Flow	The flow rate of a water supply, measured at 20 psi (137.9 kPa) residual pressure that is available for fire fighting.
Fire Growth Potential	The potential size or intensity of a fire over a period of time based on the available fuel and the fire's configuration.
Fire Hall	An "emergency response facility" where fire department apparatus and equipment are housed, protected against harm, and made readily accessible for use in emergencies. The fire hall is normally the location where fire fighters respond from. Other primary purposes include training and administration of the fire department.

Fire Hydrant	A reliable connection to a water main for the purpose of supplying water efficiently and reliably to fire hose or other fire protection apparatus. To be recognized for fire insurance grading purposes, the device shall be designed and installed in accordance with CAN/ULC S520, UL 246 and/or AWWA C502/C503 and listed for use as a fire hydrant by UL and/or ULC.
Fire Hydrant – Public	A fire hydrant situated and maintained for public use on a public right-of-way (or easement) to provide water for use by the fire department in controlling and extinguishing fires. The location of a public fire hydrant is such that it is accessible for immediate and unrestricted use by the fire department at all times. Public fire hydrants are owned and maintained by the government entity (ex. city, village, etc.) which is responsible for maintaining the hydrants and water supply distribution system in operating condition at all times and is authorised to levy taxes to fund the operation and maintenance programs.
Fire Hydrant – Private	A fire hydrant located on privately owned property, or on streets not dedicated to public use. Although a private fire hydrant may be connected to a public water supply system, maintenance of the hydrant and access to the hydrant are the responsibility of the property owner. Private hydrants are normally required where buildings are so located on the property or are of such size and configuration that a normal hose lay from a public hydrant would not reach all points on the outside of the building.
Fire load	(as applying to an occupancy) The combustible contents of a room or floor area expressed in terms of the average weight of combustible materials per unit area, from which the potential heat liberation may be calculated based on the calorific value of the materials, and includes the furnishings, finished floor, wall and ceiling finishes, trim and temporary and movable partitions.
Fire Protection	Methods of providing fire detection, control, and extinguishment.
Fire Suppression	The activities involved in controlling and extinguishing fires. Fire suppression includes all activities performed at the scene of a fire or training exercise that expose fire department members to the dangers of heat, flame, smoke, and other products of combustion, explosion, or structural collapse.
First Responder (EMS)	Functional provision of initial assessment (airway, breathing, and circulatory systems) and basic first aid intervention, including CPR and automatic external defibrillator (AED) capability. A first responder assists higher level EMS providers.
First Storey	The uppermost storey having its floor level not more than 2 m above grade
Grade	(as applying to the determination of building height) The lowest of the average levels of finished ground adjoining each exterior wall of a building, except that localized depressions

	such as for vehicle or pedestrian entrances need not be considered in the determination of average levels of finished ground.
Hazard	The potential for harm or damage to people, property, or the environment. Hazards include the characteristics of facilities, equipment systems, property, hardware, or other objects, and the actions and inactions of people that create such hazards.
Hazardous Material	A substance (solid, liquid, or gas) that when released is capable of creating harm to people, the environment, and property.
Incident Commander.	The person who is responsible for all decisions relating to the management of the incident and is in charge of the incident site.
Incident Management System (IMS)	An organized system of roles, responsibilities, and standard operating procedures used to manage emergency operations. Such systems are also referred to as incident command systems (ICS).
Initial Attack	An aggressive suppression action consistent with fire fighter and public safety and values to be protected.
Initial Attack Apparatus	Fire apparatus with a permanently mounted fire pump of at least 250 USgpm (950 L/min) capacity, water tank, and hose body whose primary purpose is to initiate a fire suppression attack on structural, vehicular, or vegetation fires, and to support associated fire department operations.
Ladder Company	A fire department company that is provided with an aerial fire apparatus and is trained and equipped to support fire fighting and rescue operations by positioning personnel, handling materials, providing continuous egress, or discharging water at positions elevated from the ground.
Ladder Truck	An alternate name for Aerial Fire Apparatus.
Master Stream	A portable or fixed fire fighting appliance supplied by either hose lines or fixed piping and that has the capability of flowing in excess of 300 USgpm (1140 L/min) of water or water based extinguishing agent.
Member	A person involved in performing the duties and responsibilities of a fire department, under the auspices of the organization. A fire department member can be a full-time or part-time employee or a paid or unpaid volunteer, can occupy any position or rank within the fire department, and can engage in emergency operations.
Mobile Water Supply (Tanker)	A vehicle designed primarily for transporting (pickup, transporting, and delivery) water to fire emergency scenes to be applied by other vehicles or pumping equipment.
Non-combustible	A material that meets the acceptance criteria of CAN4-S114, “Determination of Non-Combustibility in Building Materials.”

Non-combustible construction	The type of construction in which a degree of fire safety is attained by the use of non-combustible materials for structural members and other building assemblies.
Non-combustible Material	A material, as defined in NFPA 220, Standard on Types of Building Construction, that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapours when subjected to fire or heat. Materials reported as non-combustible, when tested in accordance with ASTM E 136, Standard Test Method for Behaviour of Materials in a Vertical Tube Furnace at 750°C, are considered non-combustible materials.
Officer	
Officer - Company Officer	A supervisor of a crew/company of personnel. This person could be someone appointed in an acting capacity. The rank structure could be either sergeant, lieutenant, or captain.
Officer - Incident Safety Officer	An individual appointed to respond or assigned at an incident scene by the incident commander to perform the duties and responsibilities of that position as part of the command staff.
Officer - Supervisory Chief Officer	A member whose responsibility is above that of a company officer, who responds automatically and/or is dispatched to an alarm beyond the initial alarm capabilities, or other special calls. In some jurisdictions, this is the rank of battalion chief, district chief, deputy chief, assistant chief, or senior divisional officer (UK fire service). The purpose of their response is to assume command, through a formalized transfer-of-command process, and to allow company officers to directly supervise personnel assigned to them.
One- and Two-Family Dwelling	Buildings containing not more than two dwelling units in which each dwelling unit is occupied by members of a single family with not more than three outsiders, if any, accommodated in rented rooms.
Optimum Level of Fire Protection	The combination of fire fighting staff and apparatus that delivers a suppression effort commensurate with the fire demand faced, yet representing the most efficient use of resources in a safe and effective manner.
Peak Fire Flow	All buildings and building groups within a District or Municipality, the highest calculated required fire flow.
Personal Lines Insurance	Insurance covering the liability and property damage exposures of private individuals and their households as opposed to Commercial Lines. Typically includes all detached dwellings that are designated single family residential or duplex.
Personal Protective Clothing	The full complement of garments fire fighters are normally required to wear while on emergency scene, including turnout coat, protective trousers, fire-fighting boots, fire-fighting gloves, a protective hood, and a helmet with eye protection.

Personal Protective Equipment	Consists of full personal protective clothing, plus a self-contained breathing apparatus (SCBA) and a personal alert safety system (PASS) device.
Public Fire Department	An organization providing rescue, fire suppression, emergency medical services, and related activities to the public.
Public Fire Protection Classification	The fire insurance grade or grades utilized by Commercial Lines Insurers in Canada. The PFPC is a number between 1 and 10 that is calculated by comparing the fire risk in terms of require fire flows to available resources. The PFPC for communities across Canada is determined from an extensive survey and analysis of the fire risk in the built environment and the available resources related to fire risk reduction and fire protection capacity.
Public Fire Service Communications Center	The building or portion of the building used to house the central operating part of the fire alarm system; usually the place where the necessary testing, switching, receiving, transmitting, and power supply devices are located.
Public Safety Answering Point	A facility in which 9-1-1 calls are answered.
Pumper	Fire apparatus with a permanently mounted fire pump of at least 750 USgpm (2850 L/min or 625 Igpm) capacity, water tank, and hose body whose primary purpose is to combat structural and associated fires.
Quint	Fire apparatus with a permanently mounted fire pump, a water tank, a hose storage area, an aerial ladder or elevating platform with a permanently mounted waterway, and a complement of ground ladders. The primary purpose of this type of apparatus is to combat structural and associated fires and to support fire-fighting and rescue operations by positioning personnel-handling materials, providing continuous egress, or discharging water at positions elevated from the ground.
Required Fire Flow	The rate of water flow, at a residual pressure of 20 psi (138 kPa) and for a specified duration, that is necessary to confine and control a major fire in a specific building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure. This may include as much as a city block.
Storey	That portion of a building which is situated between the top of any floor and the top of the floor next above it, and if there is no floor above it, that portion between the top of such floor and the ceiling above it.
Wildland/Urban Interface	The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

4. Fire Underwriters Survey

Fire Underwriters Survey (FUS) is a national organization that represents more than 85 percent of the private sector property and casualty insurers in Canada. Fire Underwriters Survey provides data to program subscribers regarding public fire protection for fire insurance statistical and underwriting evaluation. It also advises municipalities if they desire to review the current levels of fire defence in the community and provide direction with recommendations where improvements will enable them to better deal with fire protection problems.

Fire Underwriters Survey offices maintain data from surveys on fire protection programs throughout all municipalities across Canada. The results of these surveys are used to establish the Public Fire Protection Classification (PFPC) and Dwelling Protection Grade (DPG) for each community. The PFPC and DPG is also used by underwriters to determine the amount of risk they are willing to assume in a given community or section of a community.

The overall intent of the grading systems is to provide a measure of the ability of the protective facilities within a community to prevent and control the major fires that may be expected to occur by evaluating in detail the adequacy, reliability, strength and efficiency of these protective facilities.

4.1. Fire Insurance Grading Classifications

Public Fire Protection Classification:

> The PFPC is a numerical grading system scaled from 1 to 10. Class 1 is the highest grading possible and Class 10 indicates that little or no fire protection is in place. The PFPC grading system evaluates the ability of a community's fire protection programs to prevent and control major fires that may occur in multifamily residential, commercial, industrial, and institutional buildings and course of construction developments.

Fire Underwriters Survey also assigns a second grade for community fire protection, referred to as the Dwelling Protection Grade (DPG), which assesses the protection available for small buildings such as single-family dwellings.

Dwelling Protection Grade:

> The DPG is a numerical grading system scaled from 1 to 5. One (1) is the highest grading possible and five (5) indicates little or no fire protection is provided. This grading reflects the ability of a community to handle fires in small buildings such as single family residences.

4.2. Public Fire Protection Classification System

The Public Fire Protection Classification grading system is a measure of a community's overall programs of fire protection. The ability of a community's fire defences are measured against recognized standards of fire protection relative to fire hazard and the fire/life safety risk present within the community. The following areas of fire protection are reviewed in the survey and have the following weights within the PFPC grading system:

- Fire Department 40%
- Water Supply 30%
- Fire Safety Control 20%
- Fire Service Communications 10%

The above classifications are conveyed to subscribing companies of Fire Underwriters Survey. FUS subscribers represent approximately 85-90% of the fire insurance underwriters in Canada. Subscribers use this information as a basis in their fire insurance underwriting programs to set limits in the amount of risk they are willing to assume within a given portion of a community, and to set fire insurance rates for commercial properties. Improved fire protection grades may result in increased competition for insurance underwriting companies to place their business within a community. Our analysis indicates that an improved fire protection grade has a positive effect on fire insurance rates.

In addition, PFPC classifications are a measure of the level of fire protection within a community. Many progressive communities use the classification system to assess the performance of their fire protection programs, and to plan the direction of fire protective services for the future of the community.

It should be noted that PFPC Grades do not apply beyond 5km road response distance from a recognized fire hall.

4.3. Dwelling Protection Grading System

Dwelling Protection Grades are based on a 1 to 5 grading system; DPG 5 indicates little or no fire protection being available. Most small and midsize communities that have a gradable emergency water supply are assigned a DPG 3A rating, which the insurance industry has termed fully protected. DPG 3B refers to communities, or portions of communities, that have a recognized fire department but are not protected with a recognized water supply. The insurance industry has termed this 'semi-protected'. Within the Fire Underwriters Survey grading, a grade of 3B indicates that the fire department is equipped, trained, prepared and adequately staffed to provide "Standard Shuttle Service" to a fire event within a reasonable response time (i.e. utilize a pumper, tender and various related equipment to deliver water to a fire site and provide structural fire fighting at the fire event).

The protected assignment refers to DPG 1 to DPG 3A. An unprotected designation refers to DPG 5. DPG 3B and 4 are given the semi-protected designation. The lower the DPG assignment

is, the larger the discount given in fire insurance rates. The discounts given for an identical property considered fully-protected over those considered unprotected can be approximately 60%. Where there is sufficient population and sufficient taxation base, the savings generated can more than offset the operating and capital costs of an effective fire service.

A summary of the requirements for the Dwelling Protection Grade system is provided in APPENDIX A Dwelling Protection Grade Summary of Basic Requirements.

Many insurers have simplified the Dwelling Protection Grading system to a simple three tier system. This is typical for setting insurance premium rates for detached single family residences only.

Different insurers utilize the Dwelling Protection Grades differently to set their own rates based on the marketplace and their own loss experiences. The three tier system that is typically used by many insurers is shown in Table 1 FUS Grades Correlation to Commonly used Insurance Terminology and Simplified Grades.

Table 1 FUS Grades Correlation to Commonly used Insurance Terminology and Simplified Grades

Fire Underwriters Survey Dwelling Protection Grades	System Used by Many Insurance Companies "3 tier" system	Insurance Companies typically refer to this grade as
1	Table I	Fully Protected, Career
2	Table I	Fully Protected, Composite
3A	Table I	Fully Protected, Volunteer
3B[1]	Table II	Semi–Protected, (Shuttle)
4	Table II or III	Limited–Protection, Volunteer
5	Table III	Unprotected

The fire insurance industry has minimum requirements that communities must meet in order for their fire protection program to receive recognition.

It should be noted that DPG Grades do not apply beyond 8km road response distance from a recognized fire hall.

Current fire insurance classifications attributed to the Town of Lakeshore can be found in Appendix B.

1 Note that communities qualifying for Dwelling Protection Grade of 3B may also be able to achieve an equivalency to 3A through Superior Tanker Shuttle Service Accreditation.

5. Project Scope and Methodology

5.1. Project Objectives

This fire hall location and optimization study looks at optimized locations for future fire hall placement located in the Lakeshore Fire Protection Area under various scenarios. The study provides coverage analytics and uses optimization analysis to provide a decision on optimal fire hall locations. The coverage parameters used are mainly based on the level of fire risk within the community.

The following is completed as part of the study:

- Conduct a site visit of the community
- Convert all mapping data into a useable format
- Calculate approximate Required Fire Flows, while improving the accuracy of higher Required Fire Flows, and generate GIS layer to represent buildings in the Fire Protection Area.
- Provide current coverage statistics and maps for the area.
- The following optimization scenarios will be completed with statistics and mapping:

Coverage & Optimization Analysis	Scenario
Coverage Analysis No.1 – Current Coverage	Maintaining the current location of Town of Lakeshore Fire Halls and neighbouring aiding stations, establish current coverage based on Geographical Information Systems analysis which include current and projected building stock based on growth areas identified from planning documents.
Optimization No.1 – Ideal Coverage Analysis	Optimize coverage within the Lakeshore Fire Protection Area with no fixed fire hall locations; and compare existing coverage with optimized coverage locations. Optimization includes aiding stations providing coverage in rural areas.
Coverage Analysis No.2 – NFPA 1720 Guidelines	Implement and develop current response coverage based on NFPA 1720 Guidelines. Establish a model of Lakeshore Fire Station Coverage areas based on NFPA 1720 coverage needs, to see if current fire hall alignments meets the requirements NFPA 1720.
Optimization No.2 – Optimize Fire Hall Locations using NFPA 1720 Guidelines	The location of Fire Halls was Optimized to meet the guiding requirements of NFPA 1720 for areas classified as Urban, Suburban, Rural and/or Remote, as defined by NFPA 1720.
Optimization No.3 – Optimize Fire Hall Locations using fire insurance coverage requirements	The location of Fire Halls was Optimized to ensure majority of built risk was within 2.5/5/8 km travel distance in association with fire insurance requirements.
Optimization No.4 – Optimize Fire Hall Locations based on 8 km by road travel related to Personal Lines insurance distances	Optimize fire hall locations at 90% coverage using GIS analysis with a maximum response distance of 8 km by road.

The following key contacts were made and provided information throughout the survey and development of the report:

- Don Williamson, Fire Chief
- Steve Salmons, Director of Community & Development Services
- Kim Darroch, Manager of Development Services
- Sue Johnston, GIS Technologist

6. Community Risk and Hazard Assessment

6.1. Background

A fire hazard and risk assessment was conducted in the Lakeshore Fire Protection Area to aid in determining the community's fire protection needs. A risk and hazard assessment, along with a response distance review, lays the groundwork for determining fire protection needs within a community. This assessment is important in ascertaining organizational structure, personnel requirements, training requirements, fire apparatus and fire equipment needs, response time requirements and adequacy of fire station locations. The fire hazard and risk assessment completed within the Lakeshore Fire Protection Area also included community growth projections and increases in building stock.

6.2. Measuring Fire Risk

Adequate response to a fire emergency is generally measured by the speed with which responding fire fighting crew(s) can arrive at the fire emergency with the correct type and amount of resources, to have a reasonable degree of opportunity to control or extinguish a fire. Simply put, the response provided by a fire fighting crew should equal the potential severity of the fire or fire emergency.

The potential severity of a fire event is generally associated with the fuel load present and exposures to the fire. Factors such as building construction materials; quality of construction; building renovation history; building size, height and age; occupancy and hazards associated with the occupancy, will all contribute to the potential severity of a fire. In addition, other buildings sufficiently exposed to a burning building can contribute to the magnitude of a fire and the resources necessary to be in place to control or extinguish a given fire. Alternatively, building controls and automatic fire protection systems (both active and passive) that limit fire spread will reduce the potential severity of a fire. For building controls to be considered effective, their design, installation and maintenance must also be reviewed as any weak link may result in the system being ineffectual.

Much of the research into fire protection requirements for individual buildings and communities and the corresponding number of pumper companies and response times has been conducted by Fire Underwriters Survey and the National Fire Protection Association (NFPA). Fire Underwriters Survey evaluates adequacy of response by comparing the potential severity of fires that may occur with a rating of the ability of fire crews and their resources responding within a specified time period relative to the fire and life safety risk potential that may be needed.

The base point for measuring fire risk and the resultant available and adequate response is the determination of Required Fire Flows.

6.3. Required Fire Flows

Required Fire Flows (RFF) may be described as the amount and rate of water application, and company response, required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposures.

Required Fire Flows were calculated for buildings in Lakeshore Fire Protection Area using the methodology described in the Fire Underwriters Survey 1999 Guideline "Water Supply for Public Fire Protection" (refer to APPENDIX C Fire Underwriters Survey – 1999 – Water Supply for Public Fire Protection). The calculation takes into account the construction type, occupancy, exposures, total effective area, and the fire protection systems in place for each risk. The Required Fire Flow calculation is based on the following formula:

$$F = 220C\sqrt{A^2}$$

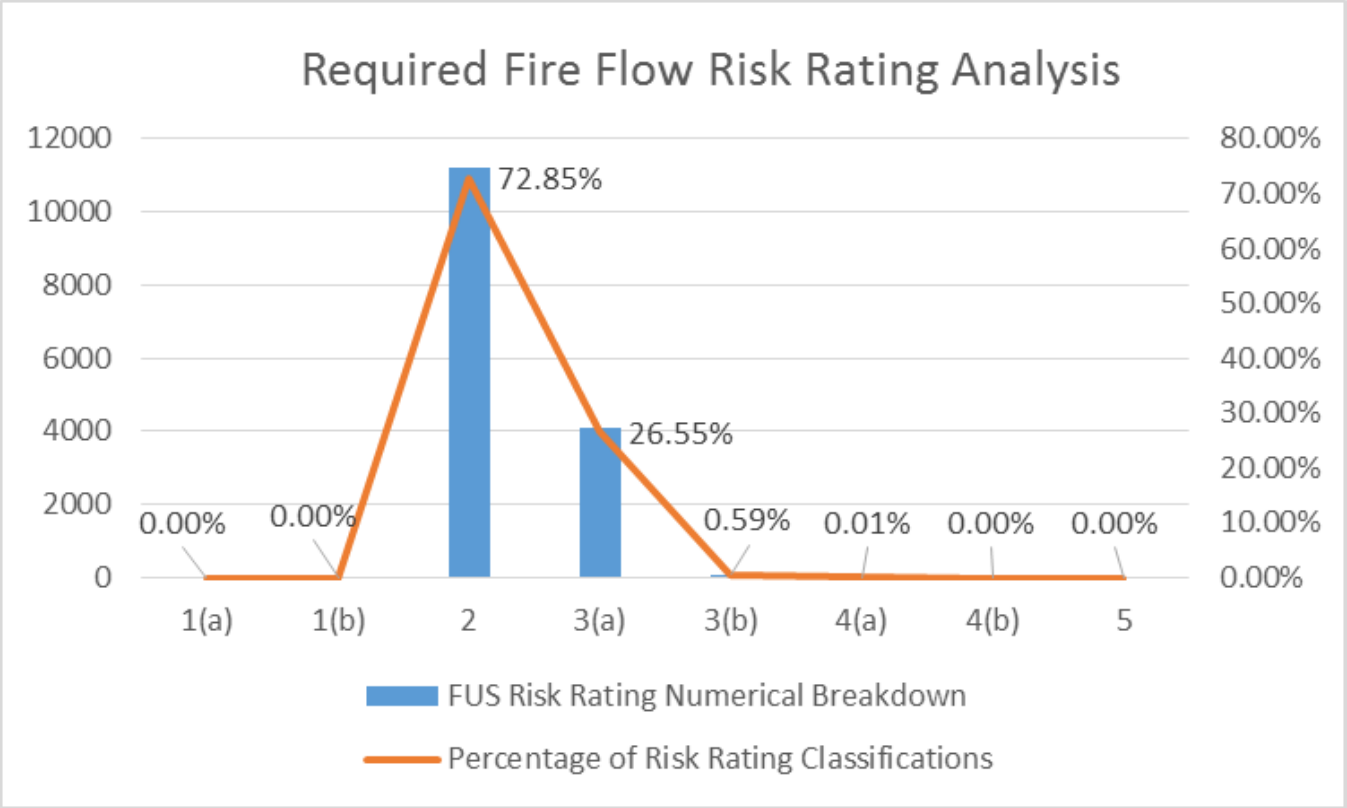
Where:

- C=coefficient related to the type of construction
- A=total effective building area

15,351 Required Fire Flows were specifically calculated for the Town of Lakeshore and included current building stock, as well as future development identified through planning and zoning documents. Table 2 provided below illustrates the demographics of Risk relevant to the Town of Lakeshore using Fire Underwriters Survey Risk Rating associated with the Table of Effective Response found in Table 3. The locations of these Required Fire Flows are shown in Figure 1. Additionally, subsequent risk assessment maps have been added to isolate the level of risk present in each of the communities in Lakeshore.

[2] Adjustments for occupancy, automatic fire protection systems, exposures are detailed in Fire Underwriters Survey 1999 Guideline "Water Supply for Public Fire Protection".

Table 2 Required Fire Flow Risk Rating Analysis



Risk Rating 2: Typical modern, 1-2 storey residential dwelling comprised of wood frame construction with exposures.

Risk Rating 3(a): Can include 3-4 storey residential and row housing, but specifically references small mercantile and industrial property in the Town of Lakeshore.

Risk Rating 3(b): Seriously exposed tenements, institutional, shopping centres and fairly large areas and fire loads with exposures.

Figure 2 Lakeshore Fire Protection Area – Specific RFF Locations

Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Figure 3 Community of Emeryville – Specific RFF Locations

Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:5,000 0 155 310 Meters

Fire Underwriters Survey

Figure 4 Community of Emeryville – Specific RFF Locations

Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:5,500 0 162.5 325 Meters

Fire Underwriters Survey

Figure 5 Community of Belle River – Specific RFF Locations

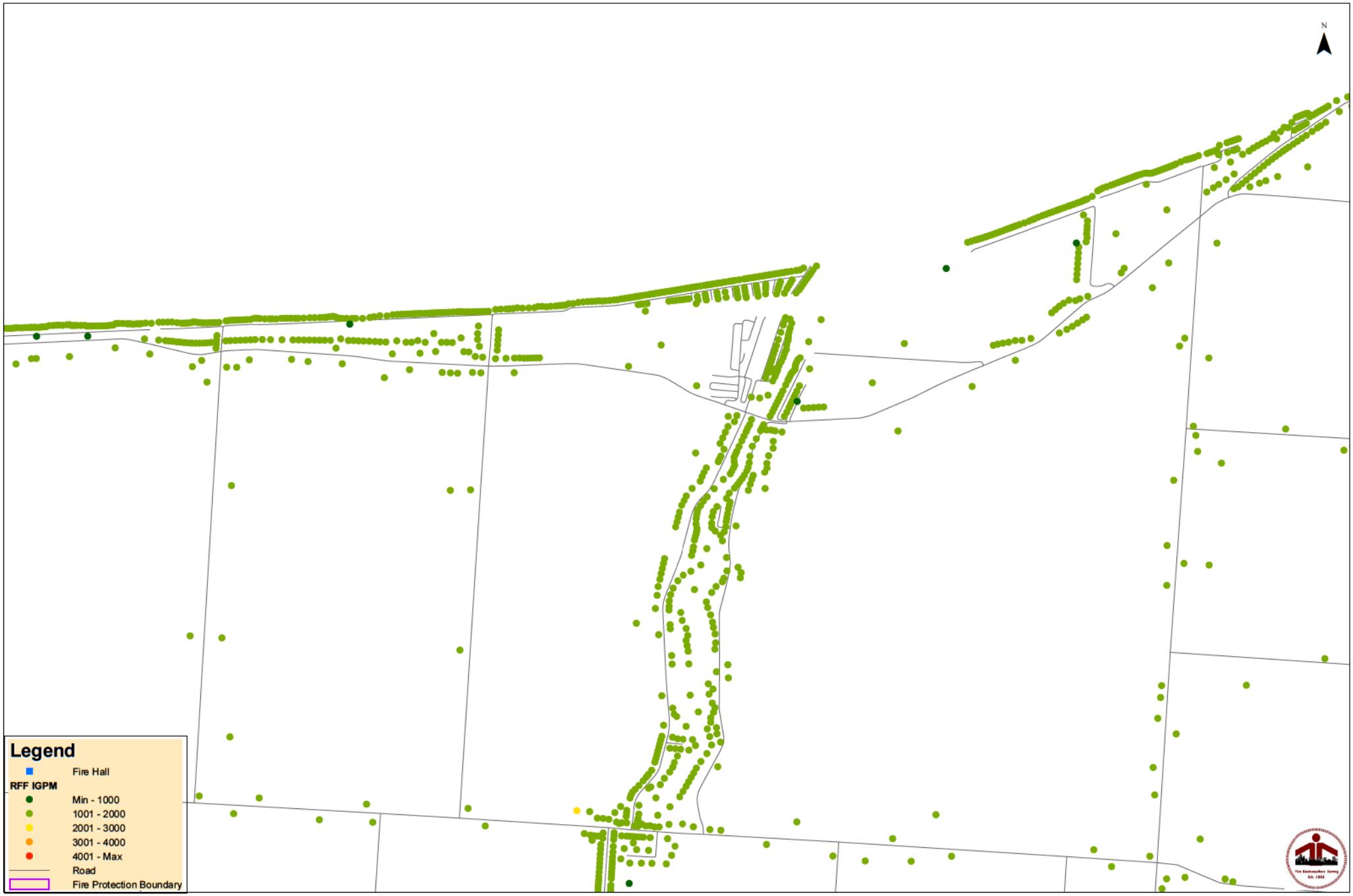
Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:5,000 0 155 310 Meters

Fire Underwriters Survey

Figure 6 Community of Saint Joachim – Specific RFF Locations



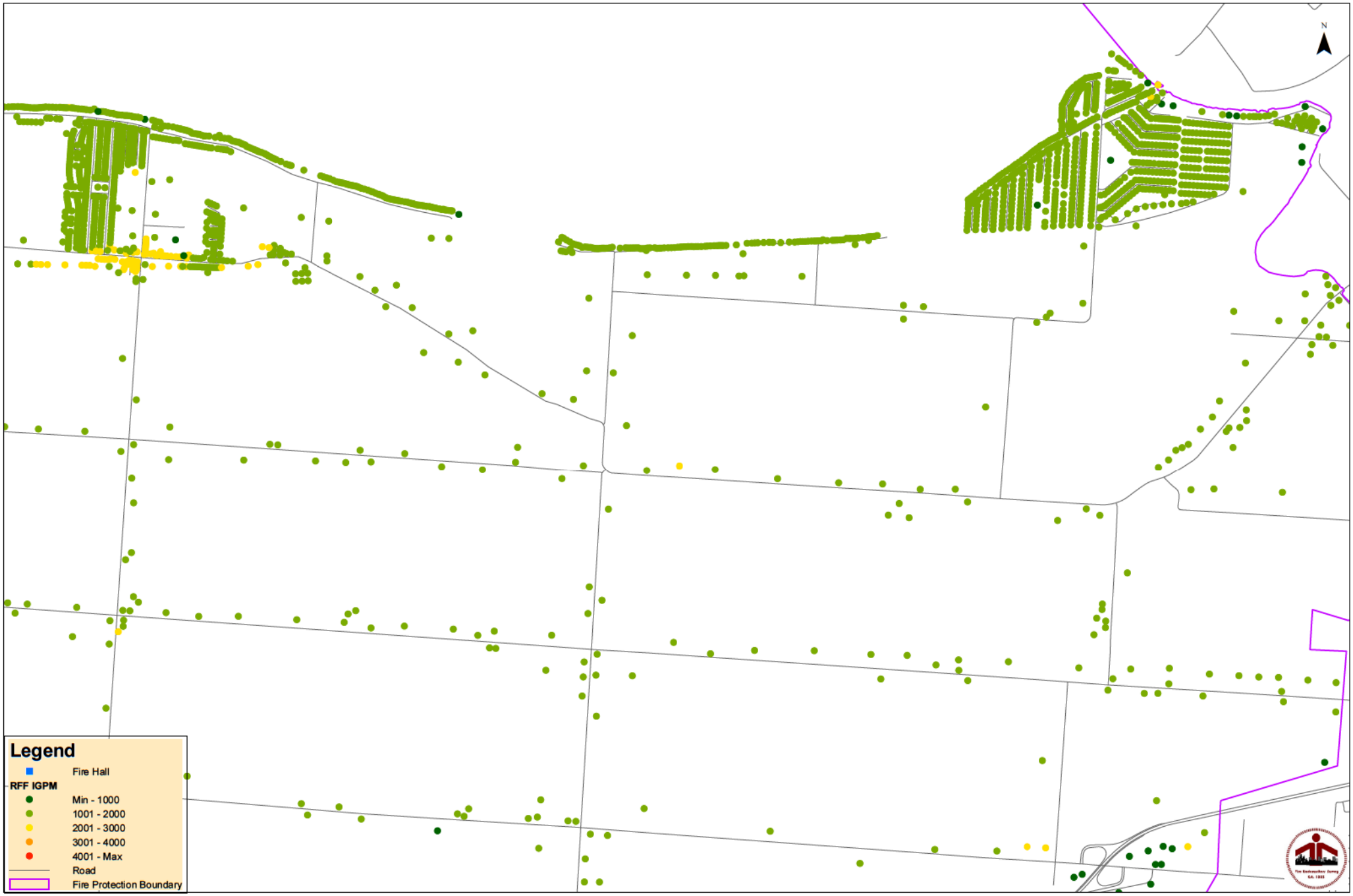
Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:7,000 0 215 430 Meters

Fire Underwriters Survey

Figure 7 Community of Point Aux Roches – Specific RFF Locations



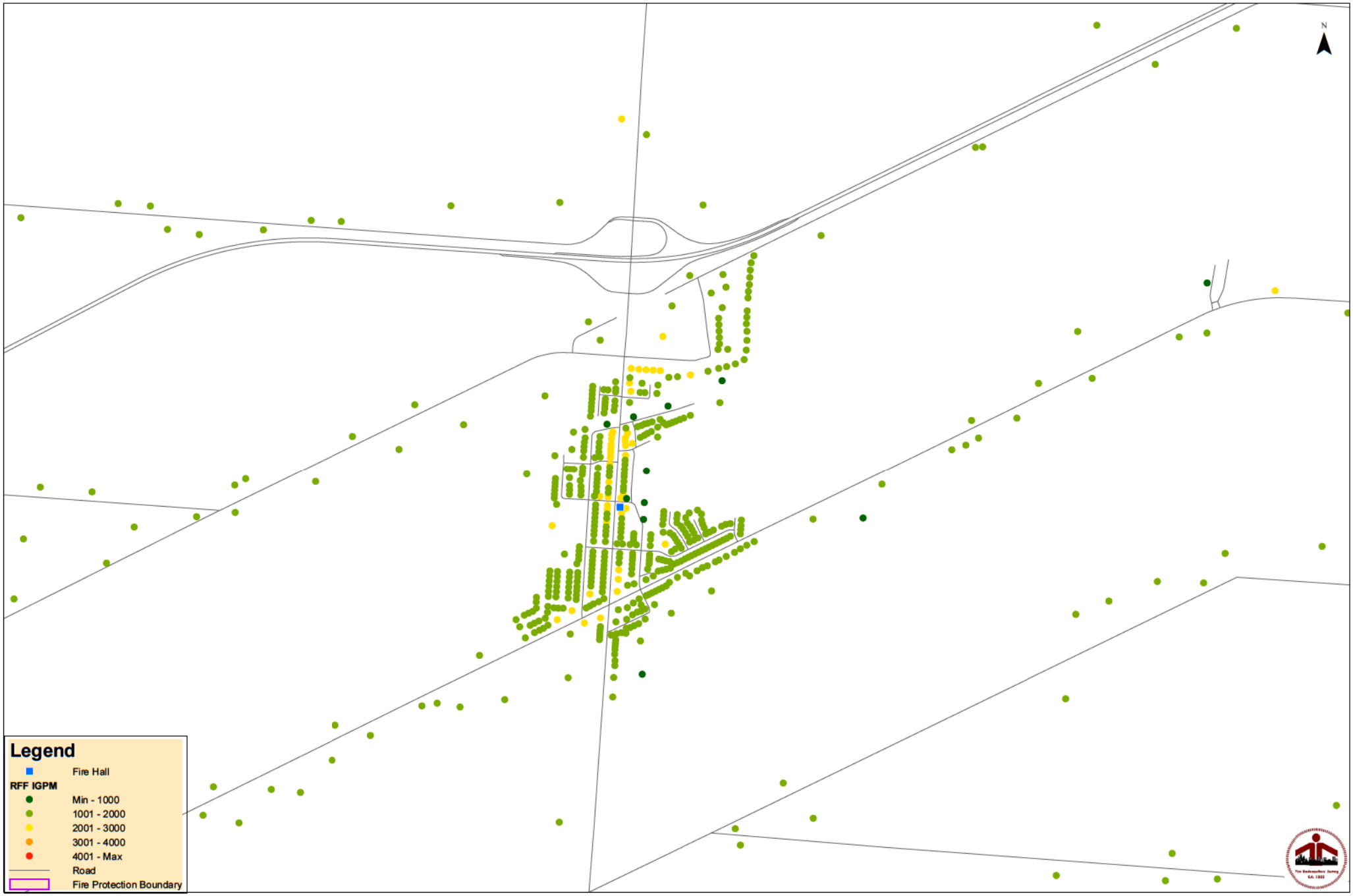
Town of Lakeshore

Risk Assessment (2017-07-10)

Scale = 1:9,000 0 265 530 Meters

Fire Underwriters Survey

Figure 8 Community of Comber – Specific RFF Locations



Town of Lakeshore

Risk Assessment (2017-07-10)

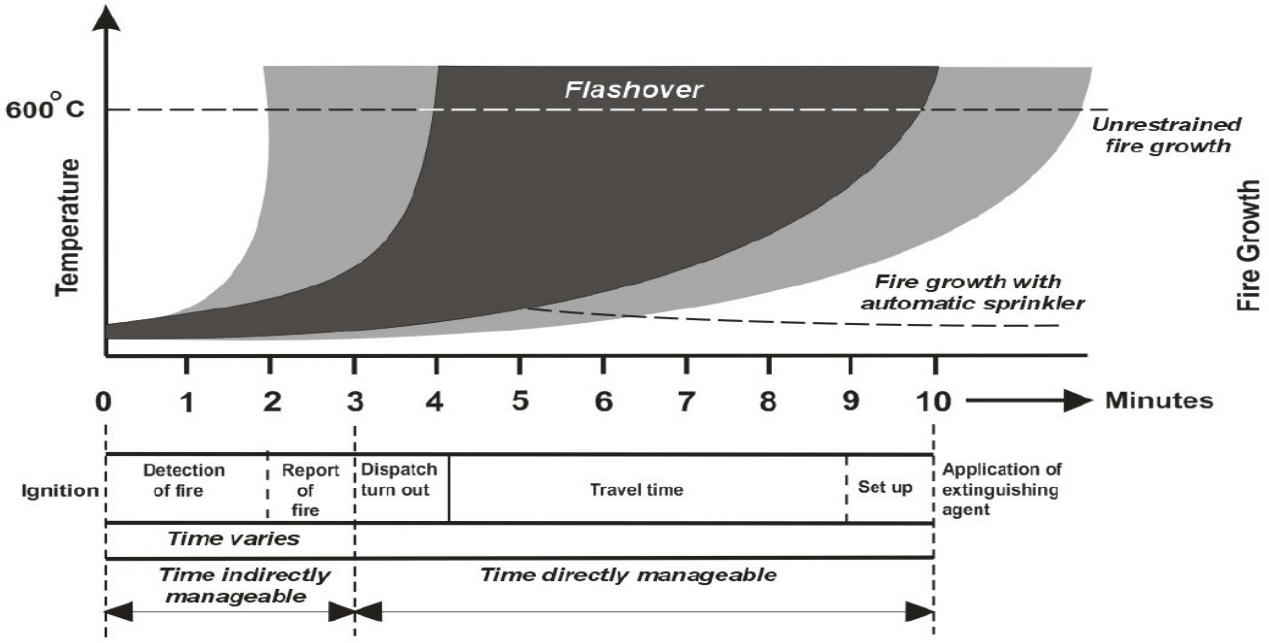
Scale = 1:5,500 0 170 340 Meters

Fire Underwriters Survey

6.4. Response Assessment

There is no standardized system to measure the level of response required, although various exist with some more widely accepted than others. However, while non-standardized systems exist, the intent of all systems is to arrive at a fire scene with the necessary resources before the point of flashover, see Figure 9. Beyond the point of flashover, it can become very difficult to combat a fire as fire growth increases exponentially as can be seen.

Figure 9 Fire Propagation Curve



6.4.1. Response Assessment – Fire Underwriters Survey

For response assessment, the Table of Effective Response is used as the benchmark; see Table 3 Fire Underwriters Survey - Table of Effective Response. The following is provided as an example to illustrate how the Table of Effective Response is interpreted:

- A sample building has a Required Fire Flow of 2200 IGPM
- The requirements for Pumper and Ladder companies is read from the Table of Effect Response as follows:
    - Initial response to alarms for Pumper companies is 2, i.e. 1 Pumper company in a first due response time of 3.5 minutes and 1 Pumper company in a second due response time of 5 minutes.
    - The total number of Pumper companies required is 3 in 6 minutes.
    - In the case of 2200 IGPM a Ladder company is required only if the building is 3 stories or greater. The total number of Ladder companies that would be required in this case (3 storeys) would be 1 in 4 minutes.

- The response times are then converted into distance using the following formula:

$$D = \frac{T - 0.65}{1.065}$$

Where

- D=distance in kilometres
- T=time in minutes

The ability of a community to achieve these benchmark levels of response is quite rare and vary dependent on the tax base available for fire department resource funding. Even in large municipalities it can be uncommon to achieve these levels of response for the majority of buildings. The strength of fire defence within a community depends largely on the will and financial ability of the community to support this emergency service. Fire Underwriters Survey and the National Fire Protection Association statistics indicate that the larger the population of a community, the higher the level of fire protection when measured against the risk of fires within the community. The best scenario for the level of fire protection occurs when expectations of fire suppression and prevention match the community's willingness to pay for this expectation.

Community growth resulting from capital developments increases the level of fire risk: however, the development of fire protective services often falls behind the development of the community, particularly in communities where growth happens quickly. If the fire protection services provided to the community remain unchanged as the fire risk levels increases, the expectation for a reasonable level of fire protection for the community may no longer be met.

The optimum level of fire protection, generally, is defined by the combination of fire fighting staff and apparatus that delivers a suppression effort commensurate with the fire demand faced, yet representing the most efficient use of resources in a safe and effective manner.

Table 3 Fire Underwriters Survey - Table of Effective Response

The following Table aids in the determination of Pumper and Ladder Company distribution and total members needed. It is based on availability within specified response travel times in accordance with the fire potential as determined by calculation of required fire flows, but requiring increases in availability for severe life hazard.

RISK RATING	BUILDING DISTRICT EXAMPLES	FIRE FLOW L/min X1000	FIRE FLOW Approx. Igpm Range	INITIAL RESPONSE TO ALARMS Pumper Companies	INITIAL RESPONSE TO ALARMS Ladder Companies	1st DUE Engine Company, Minutes	2nd DUE Pumper Company, Minutes	1st DUE Ladder Company, Minutes	TOTAL Pumper Companies. No.	TOTAL Pumper Companies. Min.	TOTAL Ladder Companies No.	TOTAL Ladder Companies Min.
1 (a)	Very small buildings, widely detached buildings.	2	400	1	0	7.5	-	*9	1	7.5	*1	9
(b)	Scattered development (except where wood roof coverings).	3	600	1	0	6	-	*7.5	1	6	*1	7.5
2	Typical modern, 1 - 2 storey residential subdivision 3 - 6 m 10 - 20 ft. detached).	4-5	800-1,000	2	0	4	6	*6	2	6	*1	6
3 (a)	Close 3 - 4 storey residential and row housing, small mercantile and industrial.	6-9 10-13	1,200-2,000 2,200-2,800	2 2	1(if required by Hazards)	3.5 3.5	5 5	*4 *4	2 3	5 6	*1 *1	4 4
3 (b)	Seriously exposed tenements. Institutional. Shopping Centres Fairly large areas, fire loads, and exposures.	14-16 17-19	3,000-3,600 3,800-4,200	2 2	1 1	3.5 3.5	5 5	4 4	4 5	7 7	1 **1	4 4
4 (a)	Large combustible institutions, commercial buildings, multi-storey and with exposures.	20-23 24-27	4,400-5,000 5,200-60,00	2	1	2.5 2.5	4 4	3.5 3.5	6 7	7.5 7.5	2 2	5 5
4 (b)	High fire load warehouses and buildings like 4(a).	28-31 32-35	6200-6800 7000-7600	3	1	2.5 2.5	3.5 3.5	3.5 3.5	8 9	8 8	3 3	7 7
5	Severe hazards in large area buildings usually with major exposures. Large congested frame districts.	36-38 39-42 43-46	7,800-8,400 86,00-9,200 9,400-10,000	3	3	2 2 2	3.5 3.5 3.5	2.5 2.5 2.5	10 12 14	8 9 9	4 5 6	7.5 8 9

Notes to Table of Effective Response

* A ladder company is required here only when exceptional conditions apply, such as 3 storey heights, significant life hazards.

** For numerous or large single buildings over three stories use two ladder companies in 5 minutes.

When unsprinklered buildings over six stories have fire flow requirements less than Group 4, the number of Pumper and Ladder Companies under “Total Availability Needed” should be increased at least to the next group to provide the additional manpower required except where this additional manpower regularly responds in the time allotted, as occurs in some volunteer or composite fire departments.

The table gives travel times for apparatus AFTER dispatch and turn-out. Under very exceptional conditions affecting total response time, these nominal figures should be modified.

7. Fire Hall Locations and Distribution Analysis

7.1. Required Fire Flow (demand) Points

As already identified in section 6.3, Required Fire Flows were specifically calculated for 15,351 buildings in the Lakeshore Fire Protection Area. In order to analyze fire hall alignment within a community it is necessary to create a risk assessment model to represent building locations. Cadastral data, GIS data and planning documents provided by the Town of Lakeshore were used to create demand points, i.e. a point was used to represent property lots and individual buildings. The data attributes were then used to group and identify building and occupancy types based on their designation and actual use codes. Where close packed mobile home parks were identified additional points were added to represent property structures. Overall the risk assessment layer provides a reasonable model of the level and distribution of risk in the Lakeshore Fire Protection Area.

7.2. Response Distances

Fire Underwriters Survey recommends that underwriters use the following response distances when applying fire insurance grades.

Table 4 Benchmark Distances when Applying Grades

Grouping	Dwelling Protection Grade (DPG)	Public Fire Protection Classification (PFPC)
Maximum for Coverage	8km	5km

Coverage statistics are provided for each of these distances as well as at 1km intervals. Additionally coverage statistics are provided for the first due response needs of each property based on its Required Fire Flow value, see Table 3. It should be noted that coverage analysis only considers the roads shown and does not consider private driveway access, i.e. the assumption is that the property is at the road. Optimization analysis is completed for 8km response distances in order to maximize the number of residential properties receiving the benefits of the fire insurance grades. Furthermore considering the expectation that the majority of properties in the Lakeshore Fire Protection Area are residential the overall financial benefit to the community of the fire insurance grades would come from ensuring residential coverage, i.e. 8km for all properties. While various optimization scenarios can be considered, this study is based on maximum fire insurance grade application for residential properties, as well as NFPA 1720 Guidelines which will be discussed later in this report.

Note that the Cumulative Distribution Function (CDF) is shown on each of the coverage graphs below. Each point on the curve shows the total fractional coverage at the distance interval. For

example looking at Figure 10 below it can be seen that at 5km (>4-5km) 0.62 of all points are covered or 62% of all points are covered. Based on this, the steeper the curve in the lower distance intervals, the larger the number of property points located closer to a fire hall and the more ideal the location.

7.3. Current Coverage

In order to design a response model suitable for the Town of Lakeshore within Lakeshores Fire Protection Area, it is first important to analyze the current response capabilities and response characteristics provided at present within the community. Maintaining the current location of Town of Lakeshore Fire Halls and neighbouring aiding fire halls in Essex and Tilbury, and using GIS converted data, we established current coverage based on Geographical Information Systems analysis. The data set of buildings include current and projected building stock; including growth areas identified from planning documents, as well as mapping documents. The distribution of response distances is shown in Figure 10 Lakeshore - Travel Distance from Closest Fire Hall (5 Existing Fire Hall with 2 Aid Fire Halls). It can be seen that the highest percentage of responses lie in the 1-2km range. The cumulative distribution function shows a larger overall spread of response with 81% (0.81) lying within 8km of a fire hall, and should be considered beneficial as it relates to fire insurance coverage standards, but can be improved. Fire insurance response coverage standards are shown in Table 4 Benchmark Distances when Applying Grades. It can be seen in Figure 11 Lakeshore - Standard Distances Analysis (5 Existing Fire Hall with 2 Aid Fire Halls), that 62.15% of RFF points are within 5km; and once again 80.89% are within 8km by road travel distance of a fire hall.

Fire Underwriters Survey utilises the Table of Effective Response shown above to determine the strength of a communities response locations. The measurement involves analysing the distribution of Risk throughout the community, and determining the percentage of property within prescriptive travel distances associated with fire insurance credit points and the Table of Effective Response. As can be seen in Figure 12 Lakeshore – Distribution of Pumper Response (5 Existing Fire Halls with 2 Aid Fire Halls), of the 15,351 RFF points calculated only 6213 (40%) met the criteria for First Due Pumper Response. This is largely due to the size of the community and numerous Risks that are considered rural and remote, mostly defined as residential property. Likewise, of the 15,306 RFF points requiring a second due pumper, it was determined that only 2,650 (17%) were within the prescribed distance outlined in the Table of Effective Response. Lastly, under the classification of Total Concentration, 72 of the 457 (15%) risks requiring multiple unit responses identified in the risk assessment, were within the prescriptive travel distance defined in the Table of Effective Response.

These numbers are common for communities with similar land area use and composition, as the Table of Effective Response is used for both urban cities having more densely populated areas, as well as smaller communities with larger geographical areas and significant land area not is use or considered agricultural lands. Designing a model related to initial response coverage when utilising the Table of Effective Response is completed in the first Optimization of this study and will be discussed later in this report.

One final analysis was completed to identify how many RFF points are covered by aiding fire stations providing initial response within the Lakeshore Fire Protection Area. Although the data suggests that the majority of RFF points are provided an initial response from Lakeshore Fire Halls, aiding fire halls provide significant coverage of the land area beyond reasonable response distances of a Lakeshore Fire Hall and should be considered valuable in aiding remote and rural areas. Figure 13 Lakeshore – Distribution of Response Summery with Aid vs Without Aid, demonstrate the increase in coverage provided by neighbouring fire stations located in Chatham-Kent and Essex. Removing aiding stations is not recommended and will used in further designs and analysis in an attempt to reduce the amount of fire halls needed.

Figure 10 Lakeshore - Travel Distance from Closest Fire Hall (5 Existing Fire Hall with 2 Aid Fire Halls)

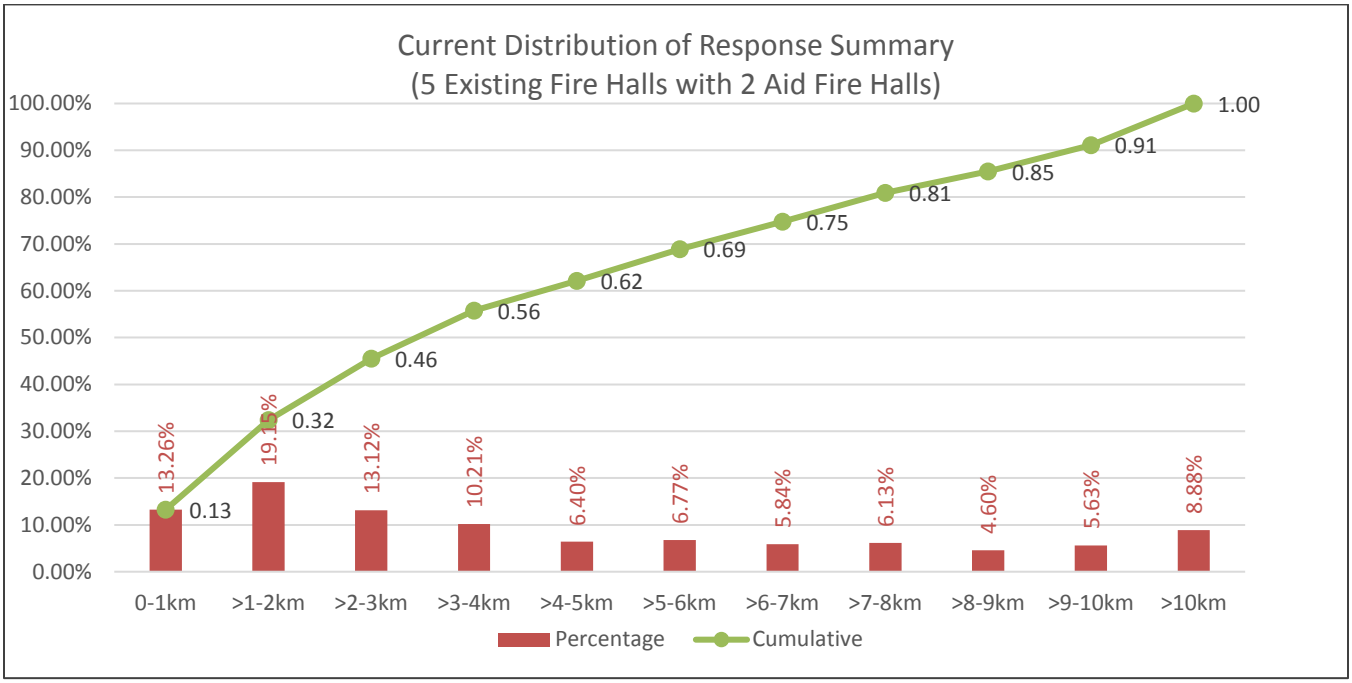


Figure 11 Lakeshore - Standard Distances Analysis (5 Existing Fire Hall with 2 Aid Fire Halls)

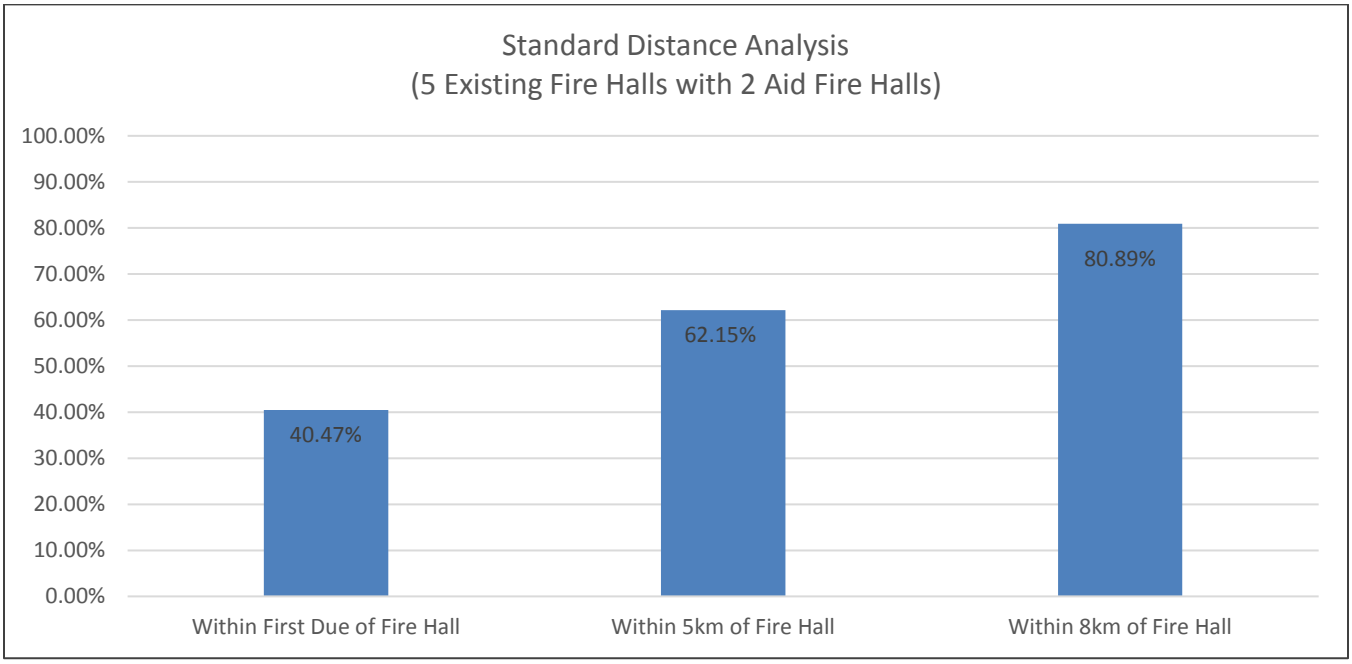


Figure 12 Lakeshore – Distribution of Pumper Response (5 Existing Fire Halls with 2 Aid Fire Halls)

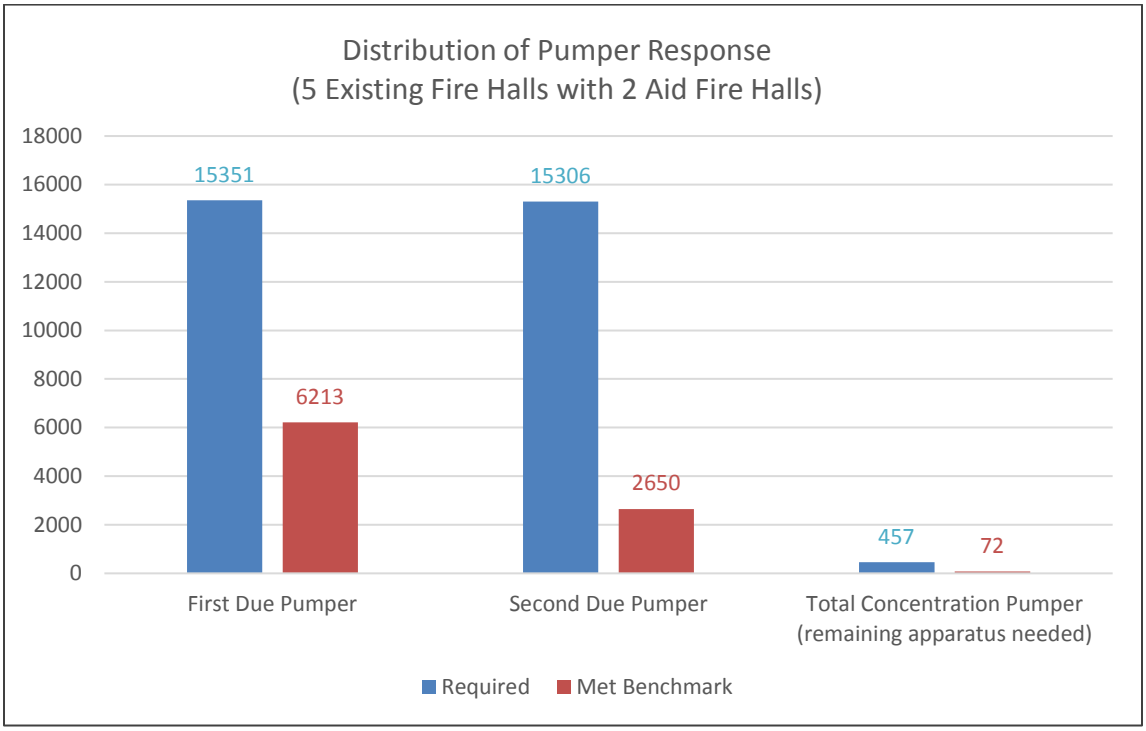


Figure 13 Lakeshore – Distribution of Response Summery with Aid vs Without Aid

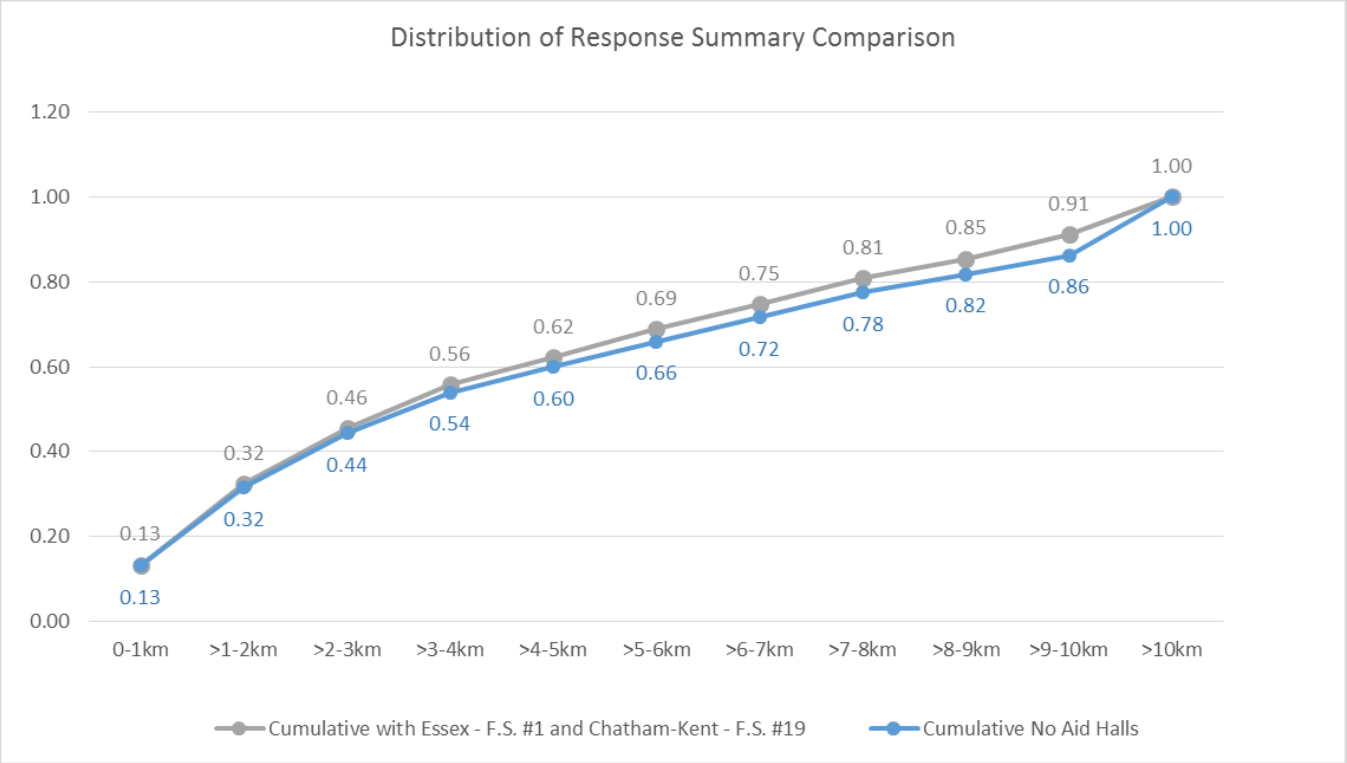


Figure 14 - Current Coverage Map (5 Existing Fire Halls with 2 Aid Fire Halls)

Lakeshore, ON

Current Coverage Map – 5km & 8km Travel Distance

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

7.4. Fire Hall Optimizations

7.4.1. Optimization No.1 – Table of Effective Response

The first optimization completed within the Lakeshore Fire Protection Area involved designing the ideal coverage of response facilities for initial response with fixed fire hall locations provided from Essex and Chatham-Kent. The completed Risk Assessment allows Fire Underwriters Survey to determine the needed response capacity (amount and type of apparatus) necessary to have a reasonable chance of property loss mitigation and an increase to life safety of occupants through fire suppression response. As already identified in Section 6.3, Required Fire Flows were specifically calculated for 15,351 Risks (buildings) in the Lakeshore Fire Protection Area. Building and zoning data provided by the Town of Lakeshore was used to create demand points, i.e. a point was used to represent each building and/or property lots and were classified using Table 3 Fire Underwriters Survey - Table of Effective Response. Each points represents a needed fire suppression response associated with the fire potential of each building it represents.

The results of Optimizing response to all points indicated the need for 13 fire halls with 2 fixed fire halls located in Essex and Chatham-Kent. The location of fire halls considered optimal can be seen in Figure 16 Optimization No.1 – 13 Fire Halls with 2 Aid Fire Halls.

A complete coverage analysis indicated that the orientation of optimized fire halls achieved the prescribed travel distance and response time for initial response or First Due Company for 86% buildings within Lakeshore Fire Protection Area. Insurance coverage standards of 5km for Commercial Lines and 8km for Personal Lines insurance, were also analysed to determine the total coverage of points. As can be seen in Figure 17, 92.20% of points were optimized to be within 5km by road travel distance of a fire hall, while our analysis also showed that 98.13% of the building stock was within 8km by road travel distance of a fire hall. Statistically, the optimization provides the ideal response capacity for the Town of Lakeshore, as it pertains to fire insurance classification grading, but does not provide a fiscally responsible or logical level of fire protection when considering all variables associated with providing services to constituents and business stakeholders. For numerous reasons, designing a model of response based on the Table of Effective Response for the Town of Lakeshore may prove financially challenging and may not be suitable for the purpose of the community. It should be noted, the design model completed was used to identify the “Ideal” level of fire suppression capacity that could be provided within the Lakeshore Fire Protection Area. The results of this analysis are generally considered effective in determining the number and amount of fire halls necessary in urban centres representative of metropolitan cities, and are generally related to the improvement of fire insurance classifications, as well as achieving response capacities associated with recognised industry standards.

Figure 15 Optimization No.1 - 13 Optimized Fire Halls with 2 Aid Fire Halls (Response Summary)

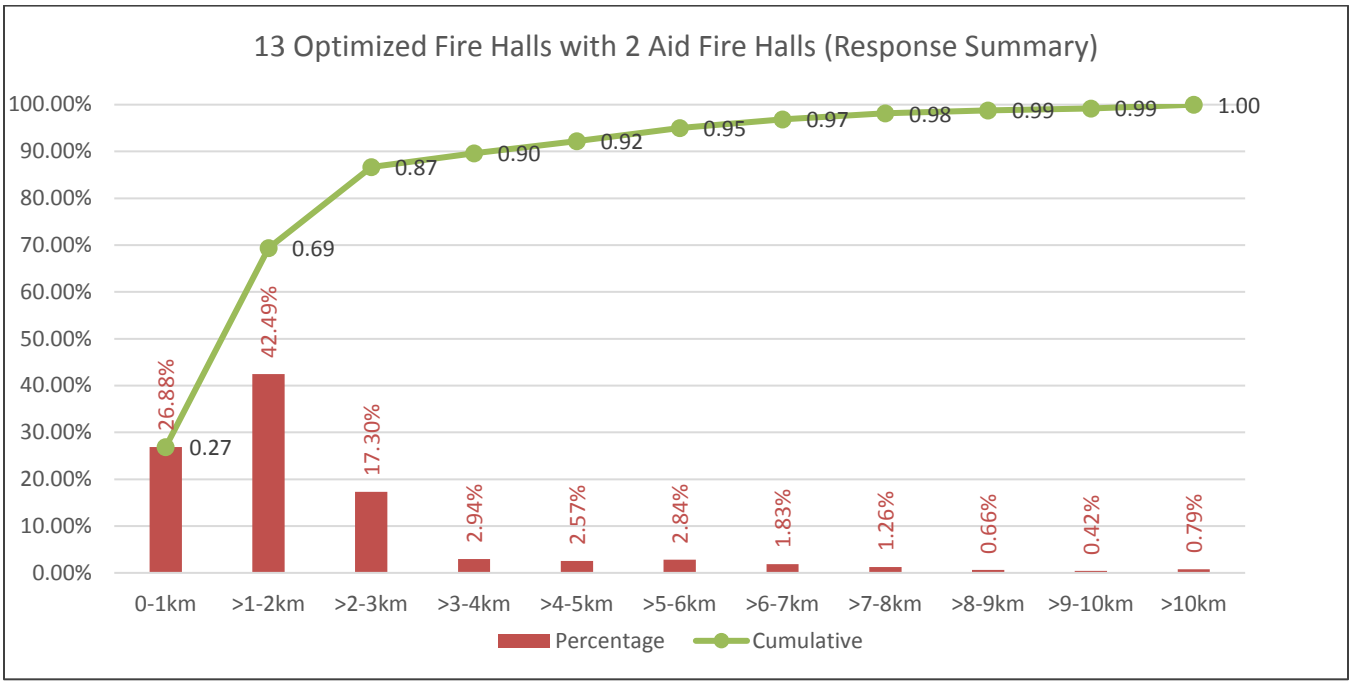


Figure 16 Optimization No.1 – 13 Fire Halls with 2 Aid Fire Halls

Lakeshore, ON

Optimization No.1 – 13 Fire Halls with 2 Aid Fire Halls

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Figure 17 Optimization No.1 – Standard Distance Analysis (13 Fire Halls with 2 Aid Fire Halls)

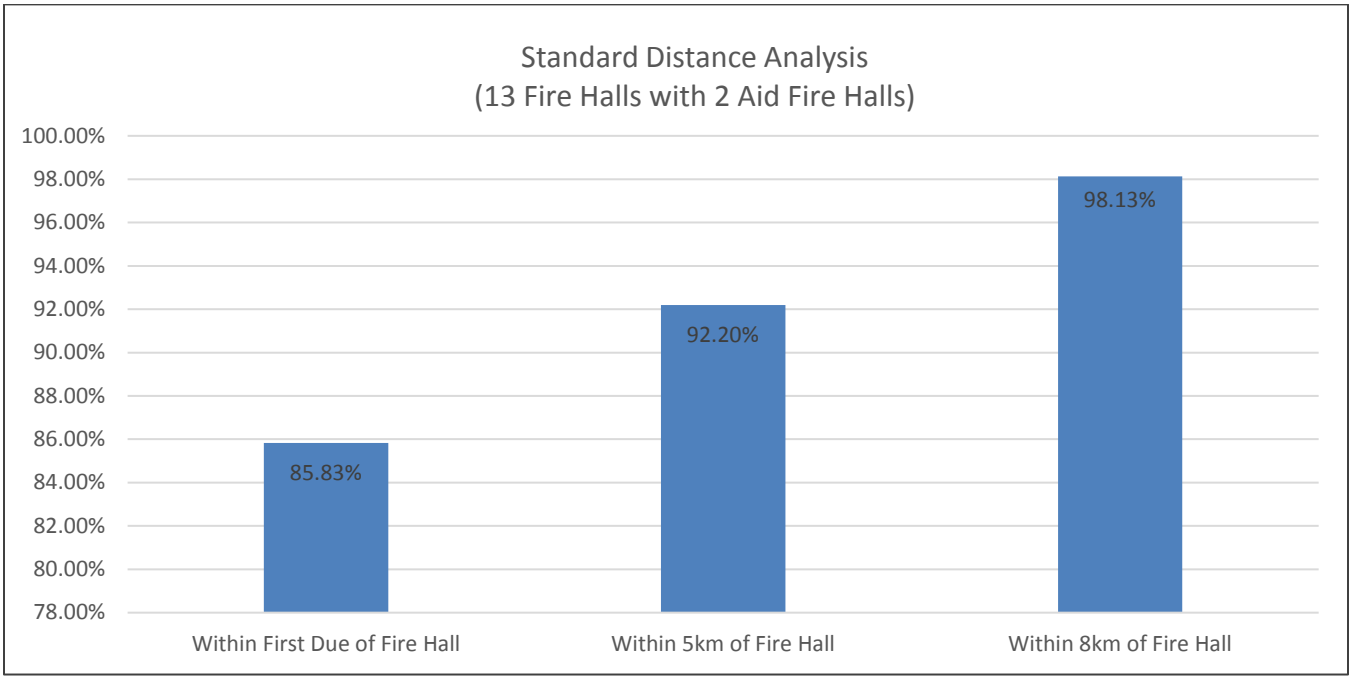
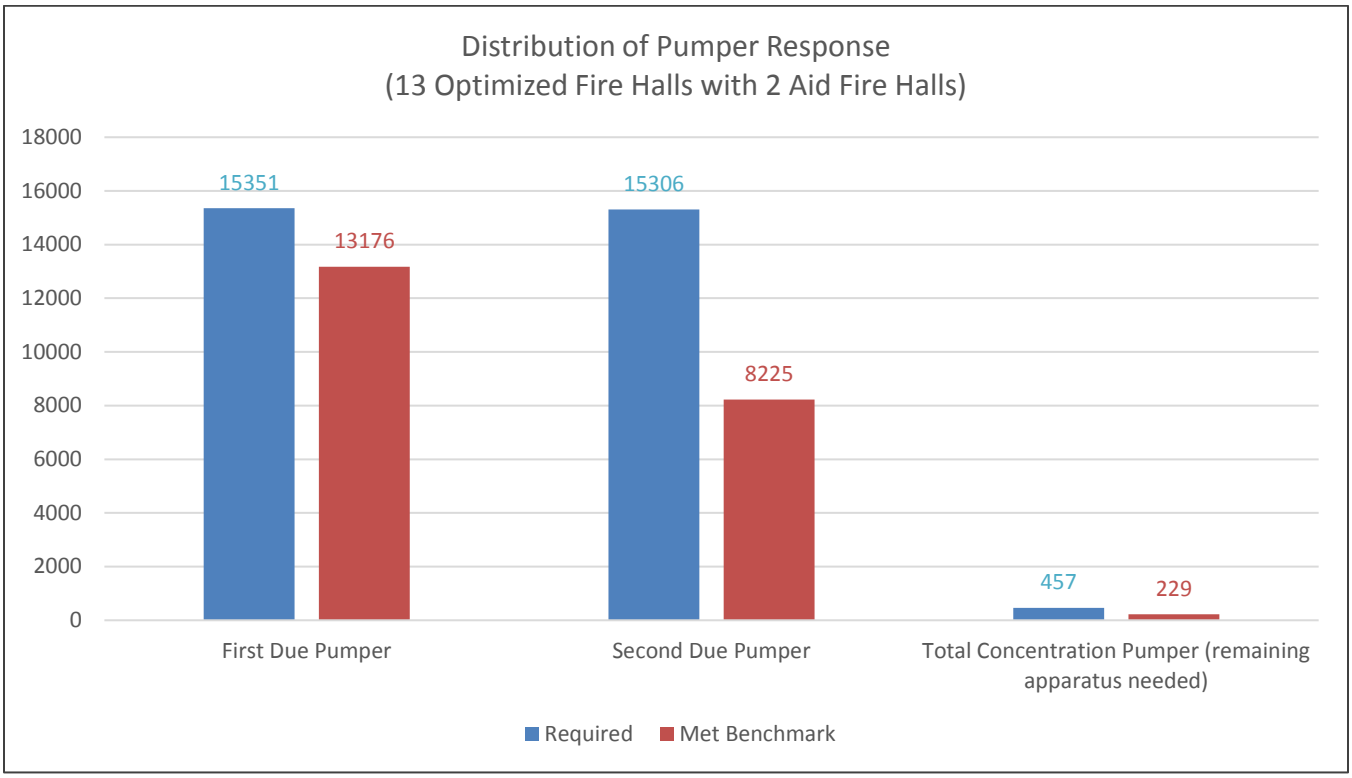


Figure 18 - Distribution of Pumper Response (13 Fire Halls with 2 Aid Fire Halls)



7.4.2. NFPA 1720 Coverage Analysis – Current Fire Halls with Aid Fire Halls

At the request of the Town of Lakeshore, a Fire Hall deployment design was completed to the specifications found in National Fire Protection Association (NFPA) 1720: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical and Special Operations to the Public by Volunteer Fire Departments. This standard provides recognised requirements for the effective and efficient organization and deployment of fire suppression operations for communities providing response to the public utilising volunteer and composite fire departments. The analysis was developed with current response characteristics to observe whether the guideline could be considered a reasonable level of service in which to develop in the Town of Lakeshore. This standard is used to determine staffing and response time objectives for structural firefighting, based on a low-hazard occupancy such as a 2000 ft2 (186 m2), two-story, single-family home without a basement and exposures. The standard aims to achieve performance measures that can be evaluated at regular intervals by administration.

The NFPA 1720 guideline requires a community to identify demand zones found throughout the community. These demand zones are based on the population density and demographics associated with NFPA: 1720s Table 4.3.2 Staffing and Response Times, which can be found within the guideline, as well as provided below in Table 5 of this report. As can be seen in the Table below, demand zones are prescriptive and related to the density of population for specific areas within the community. It should be noted, the category defined as “Special Risks” was not assigned within the Town of Lakeshore because the “Special Risk” classification must be determined by the Authority Having Jurisdiction (AHJ).

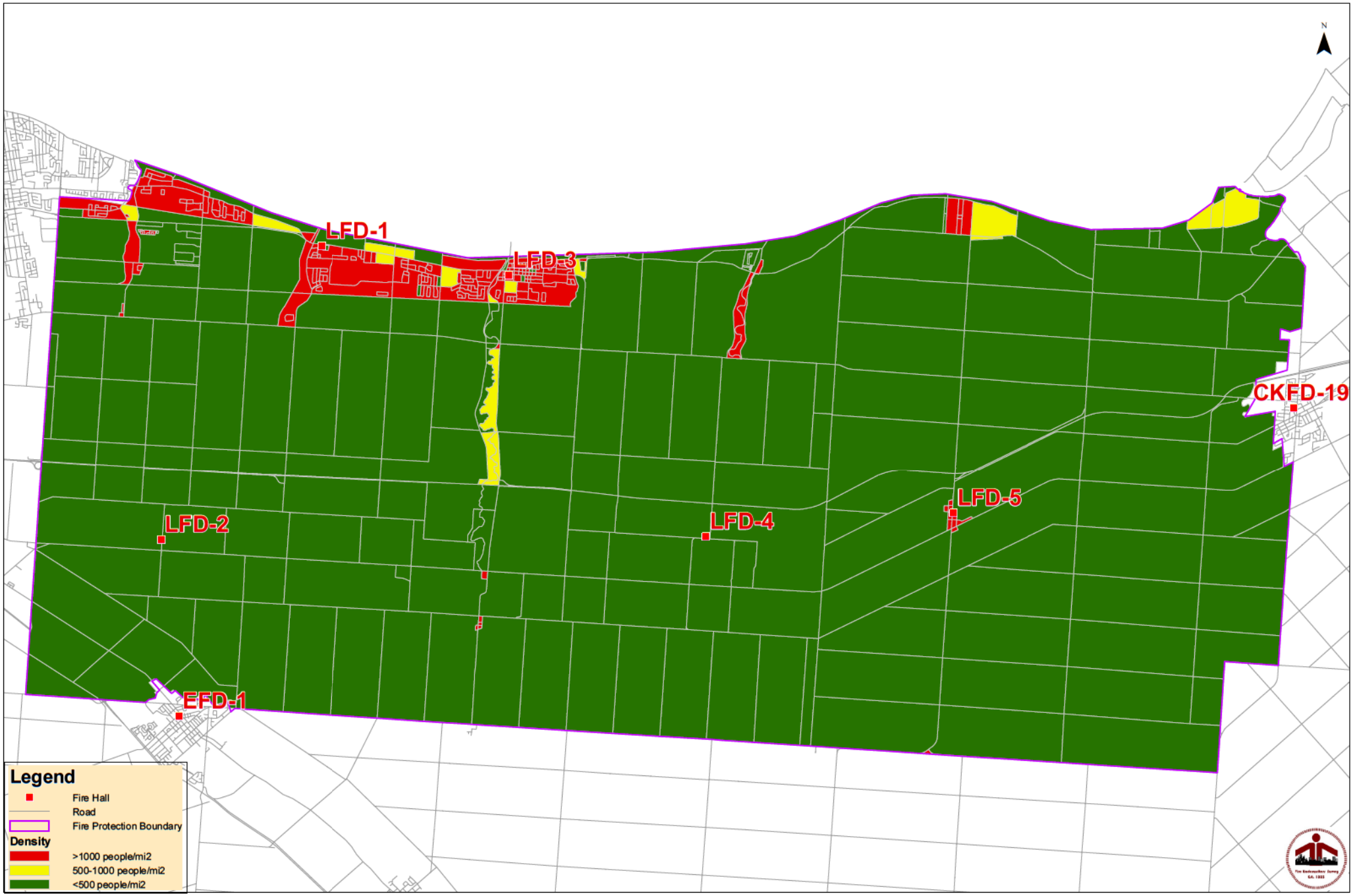
Table 5 NFPA 1720 Staffing and Response Time Table

Table 4.3.2 Staffing and Response Time

Demand Zone[a]	Demographics	Minimum Staff to Respond[b]	Response Time (minutes)[c]	Meets Objective (%)
Urban area	>1000 people/mi^2	15	9	90
Suburban area	500–1000 people/mi^2	10	10	80
Rural area	<500 people/mi^2	6	14	80
Remote area	Travel distance ≥ 8 mi	4	Directly dependent on travel distance	90
Special risks	Determined by AHJ	Determined by AHJ based on risk	Determined by AHJ	90

[a] A jurisdiction can have more than one demand zone.

Figure 19 Town of Lakeshore – NFPA 1720 Demand Zones



Lakeshore, ON

Town of Lakeshore - NFPA 1720 Demand Zones

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Census data mapping from Statistics Canada provided through Fire Underwriters Survey was used to determine the demand zones for Urban, Suburban, Rural, and Remote areas; as defined by NFPA 1720. The Town of Lakeshore demand zones can be found in Figure 19. Mapping of Demand Zones clearly illustrates that the majority of land found within the Town of Lakeshore falls within the rural classification. However; the Town is also comprised of areas considered to be urban, and suburban. The diversity of demand zones found in the community illustrates the challenge of providing consistent response services throughout the Town.

There are a number of variables that need to be considered when using NFPA 1720 as a guideline in which to analyse and develop Fire Station Models within any community. Once the demand zones are identified, the next step is to evaluate the needed response time, minimum staff to respond, as well as whether the objective level of response expressed in a percentage can be achieved. As stated in the guideline, the response time begins upon the completion of the emergency dispatch. Therefore; the measurement of response times also includes the time it takes for Lakeshore Fire Department members to respond to their respective fire stations after receiving notification of an emergency. The time in which it takes to assemble at fire stations is generally called “Turn Out Time” and/or “Assembly Time”; the latter used administratively by Lakeshore Fire Department. The fire department has collected assembly times for each fire hall since 2006. These assembly times are displayed in Table 6 Lakeshore Fire Department Historic Assembly Times.

Table 6 Lakeshore Fire Department Historic Assembly Times

Assembly Time Year	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Annual Average
2006	4:20	4:44	3:37	6:12	4:02	4:35
2007	4:28	5:15	4:03	6:26	4:22	4:54
2008	4:30	5:39	4:34	6:46	4:16	5:09
2009	4:51	5:27	4:49	7:08	6:01	5:39
2012	4:50	6:43	5:49	7:10	5:32	6:00
2013	5:16	5:59	7:10	7:59	5:47	6:26
2014	5:25	6:47	6:36	7:57	7:03	6:45
2015	5:41	7:11	6:31	7:34	7:32	6:53
2016	5:51	6:12	6:47	7:55	6:27	6:38

The assembly times above, were then subtracted from the desired response times associated with the various Demand Zones in relation to Table 5 NFPA 1720 Staffing and Response Time Table. For the purpose of this analysis, 2016 Assembly Times were used. The results of subtracting 2016 Assembly Times from Response Times prescribed from Table 5 NFPA 1720 Staffing and Response Time Table, provides the remaining Residual Response Time to be mapped. The final result allows for the display of NFPA 1720 coverage found within the Town of Lakeshore. Residual response times were converted to travel distances in kilometers to allow for mapping and coverage analysis, as can be seen below.

The response times are then converted into distance using the following formula:

D= (T-0.65)/1.065

Where:

D=distance in kilometres T=time in minutes

Table 7 NFPA 1720 Residual Response Time Determination

	Assembly Time (2016)	NFPA 1720 Demand Zone	NFPA 1720 Response Time	Residual Response Time	Response Distance (km)
STN 1	5:51	Urban	9:00	3:09	2.29
STN 2	6:12	Rural	14:00	7:48	6.41
STN 3	6:47	Urban	9:00	2:13	1.39
STN 4	7:55	Rural	14:00	6:05	5.07
STN 5	6:27	Urban	9:00	2:33	1.58

Provided in Table 7 NFPA 1720 Residual Response Time Determination are Residual Times/Distances and comprise the mapping distance of coverage area associated with each Demand Zone classification. Currently, Fire Stations 1, 3 and 5 are located in Urban Demand Zones and require a 9 minute response, while Fire Stations 2 and 4 are located in Rural Demand Zones and require a 14 minute response.

Figure 20 NFPA 1720 Response Coverage Map illustrates how current Fire Station locations responding in Lakeshore Fire Protection Area contribute to meeting the requirements of NFPA 1720.

Coupled with Aiding Fire Stations in Essex and Chatham-Kent, current coverage appears to provide a reasonable level of response coverage, but clearly indicates that there are areas where fire suppression response coverage can be improved. The mapping alludes to areas of population densification in Emeryville, Puce and Belle River where a focused effort could be made to improve coverage and response times. Emeryville, Puce and Belle River are also identified as locations where majority of commercial property and community employers are located. Emeryville is home to a significant industrial park wherein severity of fires can be expected to be high, requiring reduced response times, and an increase in fire fighting resources to mitigate large loss fires safely. The areas described, constitute the largest percentage of built environment found throughout the community, with the majority of population also living in this concentrated corridor. Improving response times in this general area would represent a significant improvement of service to the majority of constituents within the Town of Lakeshore. Reducing assembly times may provide a level of improvement to response times; however, assembly times have continually increased over the last number of years and are consistent with other volunteer departments. Likewise, retaining and training new fire fighters can be difficult as well as costly, subsequently the availability of volunteer fire fighters is inconsistent and will continue to fluctuate based on time of day amongst other factors.

Meeting NFPA 1720 guidelines may require the Fire Department to evolve into a composite structure employing some level of career on-duty response to improve response times and response coverage.

Figure 20 NFPA 1720 Response Coverage Map – 5 Existing Fire Halls with 2 Aid Fire Halls

Lakeshore, ON

NFPA 1720 Response Coverage Map – 5 Existing Fire Halls with 2 Aid Fire Halls

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

7.4.3. Optimization No.2 – NFPA 1720 (9 New Fire Hall with 2 Aid Fire Halls)

A location-allocation tool was used to find the amount along with the optimal location of fire halls, maximizing the cover of all properties with a 9 and 14 minute response times. The design was completed in conjunction with NFPA 1720 guidelines and Town of Lakeshore demand zones. The objective is to determine the amount and location of Fire Halls necessary to satisfy NFPA 1720 guidelines; using the Town of Lakeshores' population demographics, as well as NFPA Classifications of Urban, Suburban, Rural and Remote areas. Aiding neighbouring fire halls located in Essex and Chatham-Kent were used as fixed fire halls and provide coverage in a portion of the rural areas of Town of Lakeshore. NFPA 1720 demand zones can be found in Figure 19 Town of Lakeshore – NFPA 1720 Demand Zones.

This model, which is based on National Fire Protection Associations guidelines referring to standard response requirements for volunteer and composite fire departments, resulted in a prescriptive need for 9 Lakeshore Fire Halls, augmented by aiding neighbouring fire halls located in Essex and Chatham-Kent through existing agreements. The optimal location of fire halls can be seen Figure 21 Optimization No.2 - NFPA 1720 (9 Fire Halls with 2 Aid Fire Halls).

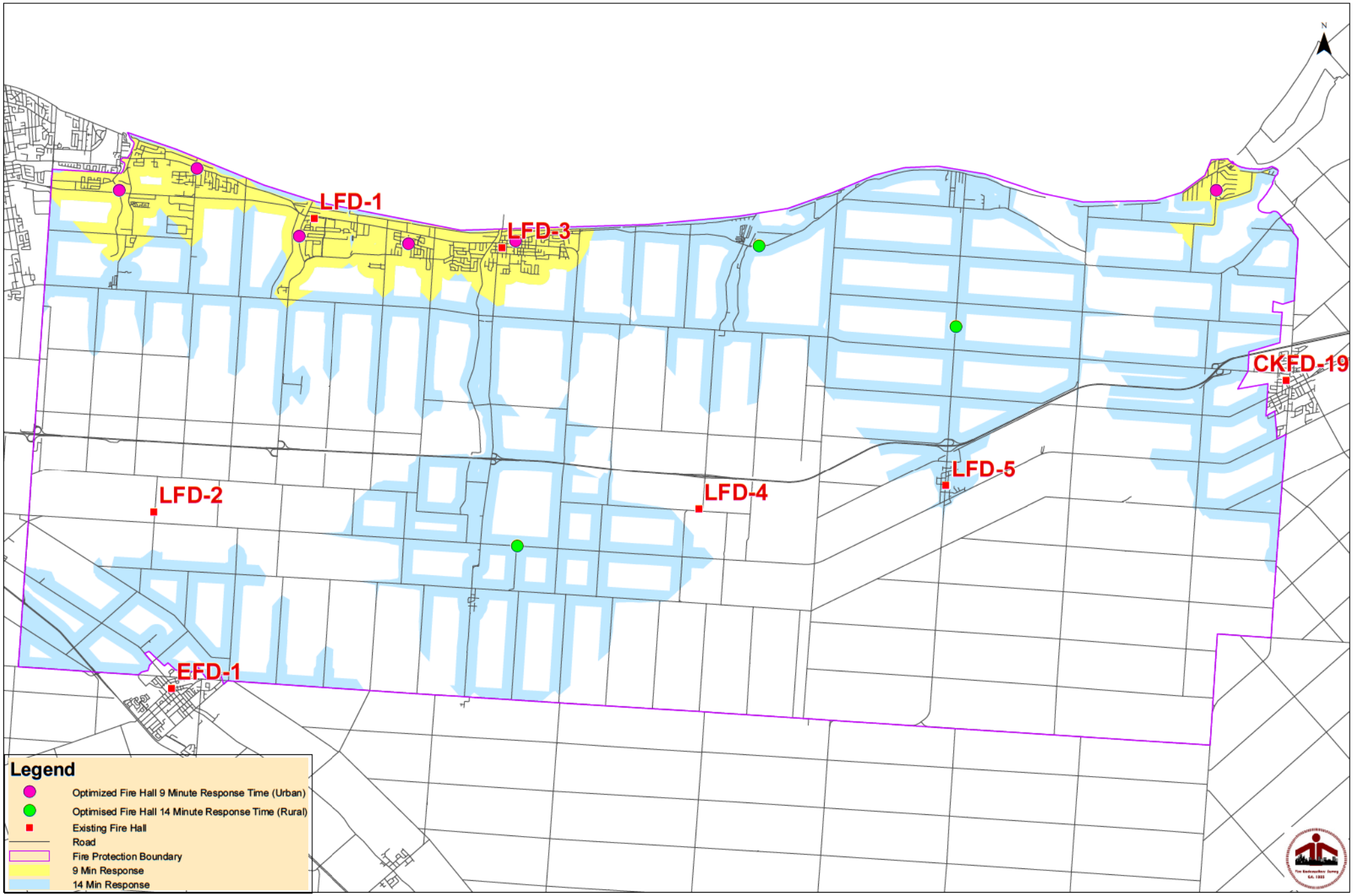
The limiting factor in reducing the amount of fire halls required to achieve the response objectives designed in NFPA 1720, was related to Lakeshore Fire Department assembly times; provided in Table 6 Lakeshore Fire Department Historic Assembly Times. Generally, improving assembly times could improve the coverage requirements designed in NFPA 1720. However, current assembly times have increased year over year. Assembly times experienced for the Lakeshore Fire Department are representative of other volunteer fire services in Ontario, and across the country. In addition, minor improvements experienced in assembly times would likely be negligible as it relates to extended coverage based on NFPA 1720 models. Likewise, significant assembly time reduction in the magnitude of shaving a number of minutes off the time it takes volunteers to assemble at a fire hall before responding, may prove overtly challenging and/or near impossible. Therefore, it would appear moving to a composite fire service model would be considered more effective at reducing response times and improving effective response coverage of the community. Likewise, based on the need for 9 Fire Halls, evolving towards a composite service model would prove more cost effective than staffing 9 new fire halls with additional volunteers and response resources i.e. apparatus, equipment, training, wages etc.

Although the suggested response times of 9 minutes in Urban areas and 14 minutes in Rural areas may seem suitable for the Town of Lakeshore, achieving these objectives using a volunteer service and requiring 9 fire halls is not likely a manageable service model and requires significant increases in response facilities, response apparatus and volunteer fire fighters. It is suggested that improvements in response times can likely be achieved through an on-duty response (eliminating long assembly times), while also reducing the financial burden incurred by the community associated with 9 fire hall locations. Furthermore, improvements to fire insurance classifications would also likely be impacted in a positive manor. This model only looked at achieving the desired objective through employing a volunteer fire service model and would require a minimum of 135 volunteer with 9 pumper and 1 ladder to support the response facilities with adequate equipment and resources. Current volunteer staffing numbers for the entire community include 80 volunteer firefighters, their availability fluctuates in addition to the

years of service they may be prepared to provide to the community. Retaining and adding additional volunteers would likely be considered even more challenging than it is currently.

This model does substantiate a significant improvement in First Due Cover, as well as improving the amount of risks within 5 and 8 km coverage of all properties within the Town of Lakeshore in comparison to current coverage found in Figure 11 Lakeshore - Standard Distances Analysis (5 Existing Fire Hall with 2 Aid Fire Halls), and should be compared to Figure 24 Optimization 2 - Standard Distance Analysis (9 Fire Halls with 2 Aid Fire Halls) based on NFPA 1720 mapping.

Figure 21 Optimization No.2 - NFPA 1720 (9 Fire Halls with 2 Aid Fire Halls)



Lakeshore, ON

Optimization No.2 – NFPA 1720 (9 Fire Halls with 2 Aid Fire Halls)

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Figure 22 Optimization No.2 - 5km & 8km Travel Distances (9 New Fire Halls with 2 Aid Fire Halls)

Lakeshore, ON

Optimization No.2 – 5km/8km Travel Distance

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Figure 23 Distribution of Pumper Response (9 Fire Halls with 2 Aid Fire Halls)

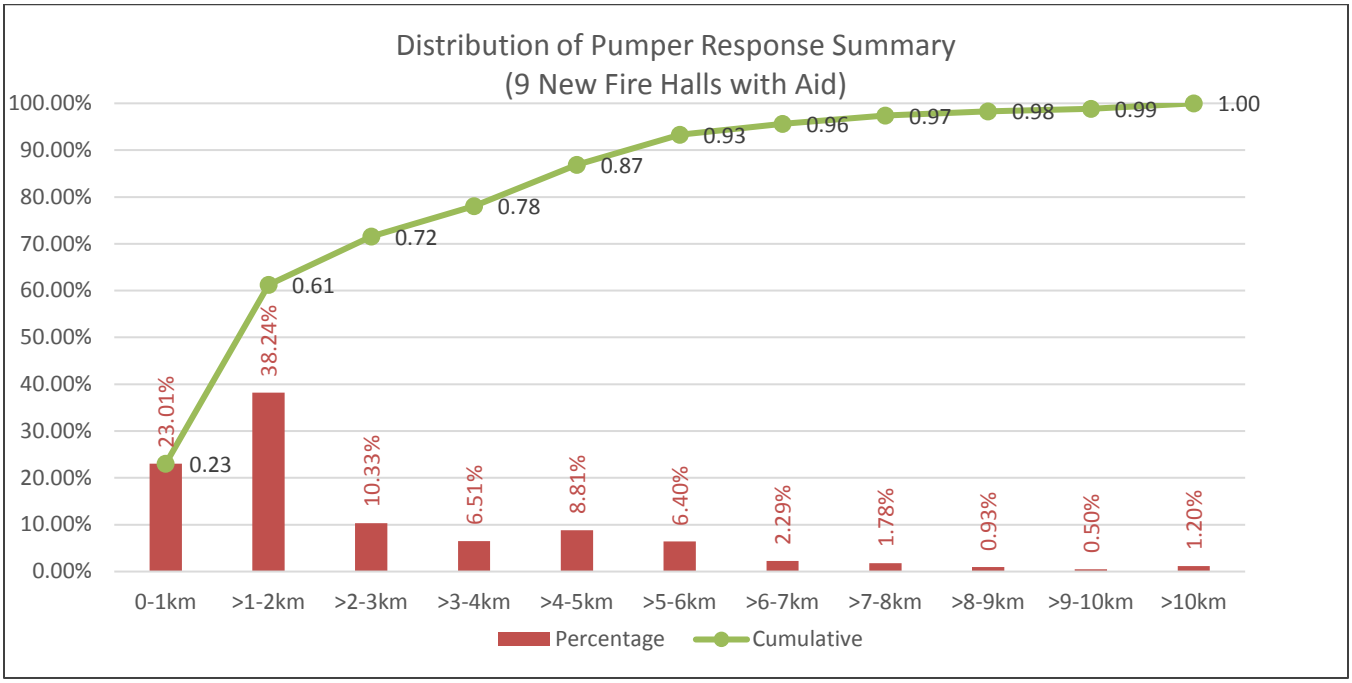


Figure 24 Optimization 2 - Standard Distance Analysis (9 Fire Halls with 2 Aid Fire Halls)

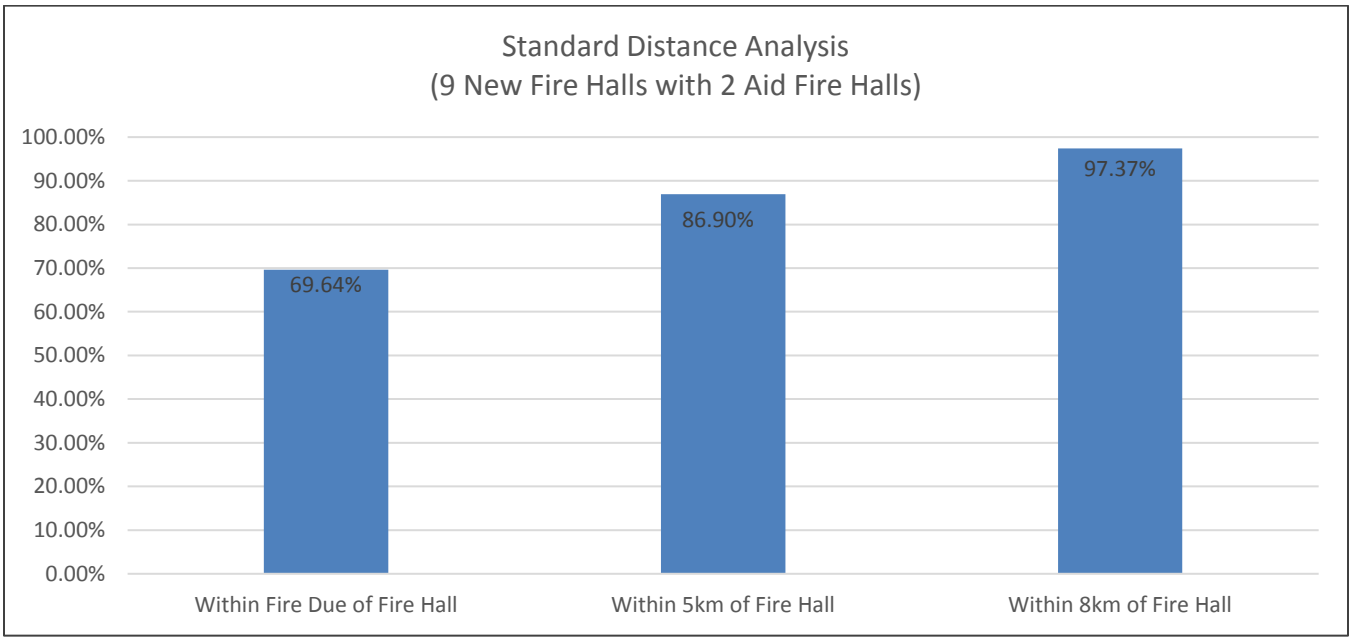
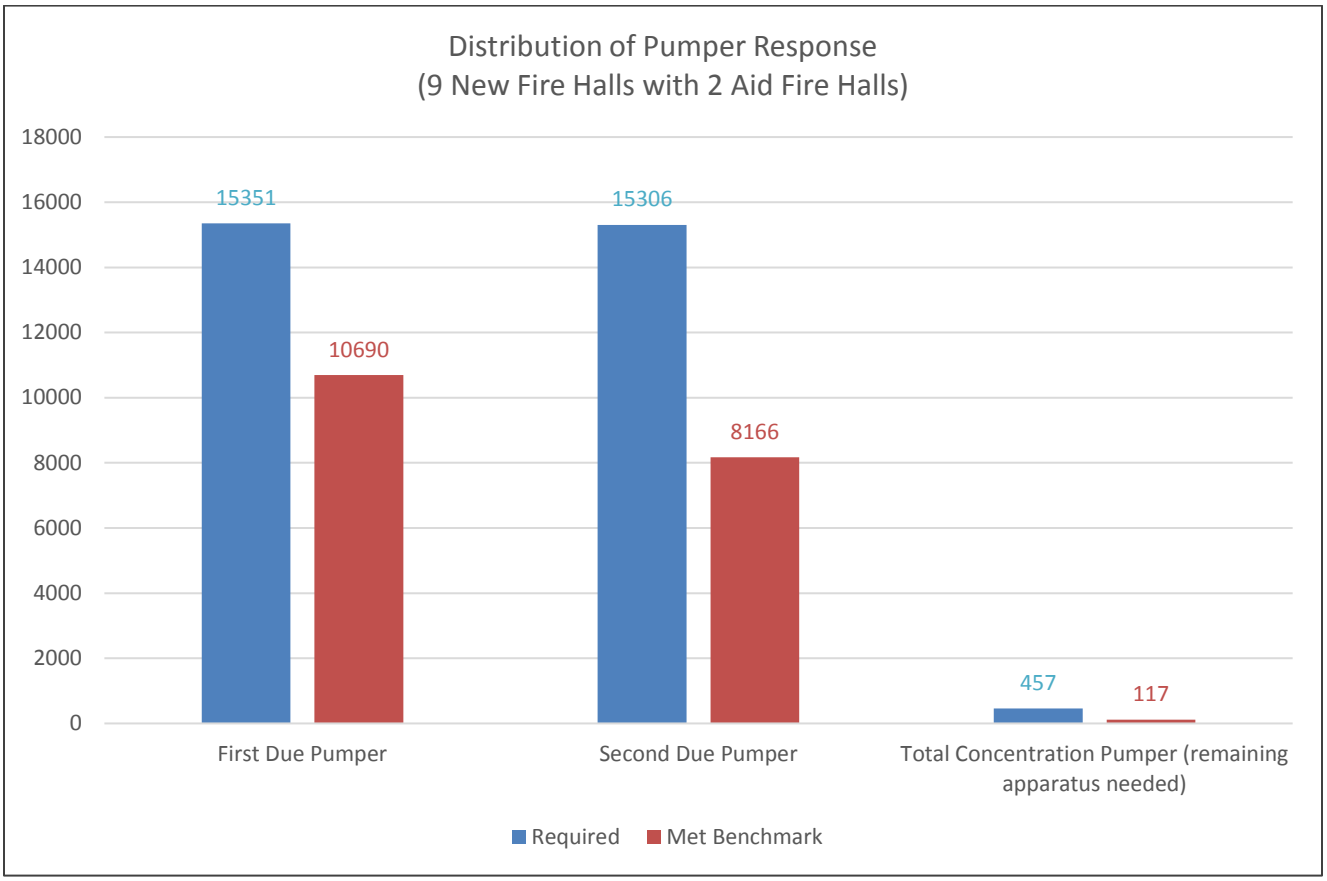


Figure 25 Distribution of Pumper Response (9 Fire Halls with 2 Aid Fire Halls)



7.4.4. Optimization No.3 – Maximising Insurance Coverage Standards

The third optimization completed within the Lakeshore Fire Protection Area involved designing fire hall coverage using a location-allocation tool that would ensure the majority of property within the Town of Lakeshore would fall within the prescribed 5 km by road travel distance requirements of fire insurance classifications for Commercial Lines insurance. The 5km response coverage design was limited to areas in Emeryville, Puce and Belle River, where commercial property is primarily concentrated. The second objective of optimization three, was to ensure that the majority of property in the Town of Lakeshore would fall within the prescribed fire insurance response coverage recognition of 8 km by road travel distance from a Fire Hall; for Personal lines insurance purposes. Lastly, a coverage analysis was completed to determine the response characteristics of the optimization, analyzing similar coverage objectives found throughout this report.

This optimization resulted in the configuration of 5 new fire hall locations with existing aiding fire halls in Essex and Tilbury, acting as fixed locations contributing to response coverage of risks within 8km their reach. The optimization focused on 5 km and 8 km travel distances within this specific design. The result, when compared to current fire hall locations and their coverage analysis found in Figure 11 Lakeshore - Standard Distances Analysis (5 Existing Fire Hall with 2 Aid Fire Halls) shows an 8% decrease in coverage for first due company credit. However, this optimization shows coverage improvements for both the 5km and 8km travel distances from current fire hall locations.

In summary, currently 62.15% of risk points are located within 5km of a fire hall, meeting Commercial Lines insurance needs. Optimization 3 improves coverage within 5km by road travel distance by 10.03% with an optimization of 72.19%. Lastly, the biggest improvement achieved with this third optimization model is the 8km by road travel distance associated with Personal Lines insurance. As suggested in the Risk Assessment, the majority of risks within the Town of Lakeshore fall within the consideration of residential dwellings. The analysis completed showed an improvement of 14.66% additional demand points are located within the 8km by road travel distance requirement for personal lines insurance with this placement of fire halls. Current coverage established that 80.89% of Risks are within 8km by road travel distance; Optimization 3 places 95.55% of risks located within 8km travel distance of a fire hall. Figure 26 Optimization No.3 – Insurance Coverage Standards (5 New Fire Halls with 2 Aid Fire Halls) illustrates the configuration of fire halls associated with Optimization No.3.

One of the major short falls of this fire hall realignment plan based on 5km/8km travel distances is that the optimised fire hall locations do not achieve an improvement in First Due coverage. Although the optimization provides a utilitarian application of coverage as it pertains to insurance coverage and maximising the number of properties that will receive fire insurance discounts for applicable fire protection response, it does not improve response times on its own. Increasing the number of stations to include shorter distances using more volunteer response facilities, may also not have the desired effect of reducing response times significantly either. Therefore, consideration to include on-duty staffing centrally located in the Emeryville, Puce and Belle River corridor, in combination with this alignment of fire halls, may prove the best option at improving and reducing response times in the community to the majority of constituents and properties in

Lakeshore. Industry standards related to on-duty staffing and turn out times/assembly times are measured at 60 seconds. Therefore, an immediate improvement can be achieved in comparison to the current 5 minute and 53 second average assembly time being provided by the current volunteer service model.

Providing a career response would enhance service levels, reduce the number of fire halls needed and improve the fire insurance classifications of the community; while it can also be anticipated to reduce capital costs related to building more than 5 fire halls. Likewise, operational budgets would fluctuate minimally as the amount of apparatus and equipment along with training cost would likely be comparable to the costs incurred by the service currently, with the exception of providing costs associated with career staffing.

Figure 26 Optimization No.3 – Insurance Coverage Standards (5 New Fire Halls with 2 Aid Fire Halls)

Lakeshore, ON

Optimization No.3 – Maximising Coverage for 5km/8km Travel Distance (5 New Fire Halls with 2 Aid Fire Halls)

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

Figure 27 Distribution of Pumper Response (5 New Fire Halls with 2 Aid Fire Halls)

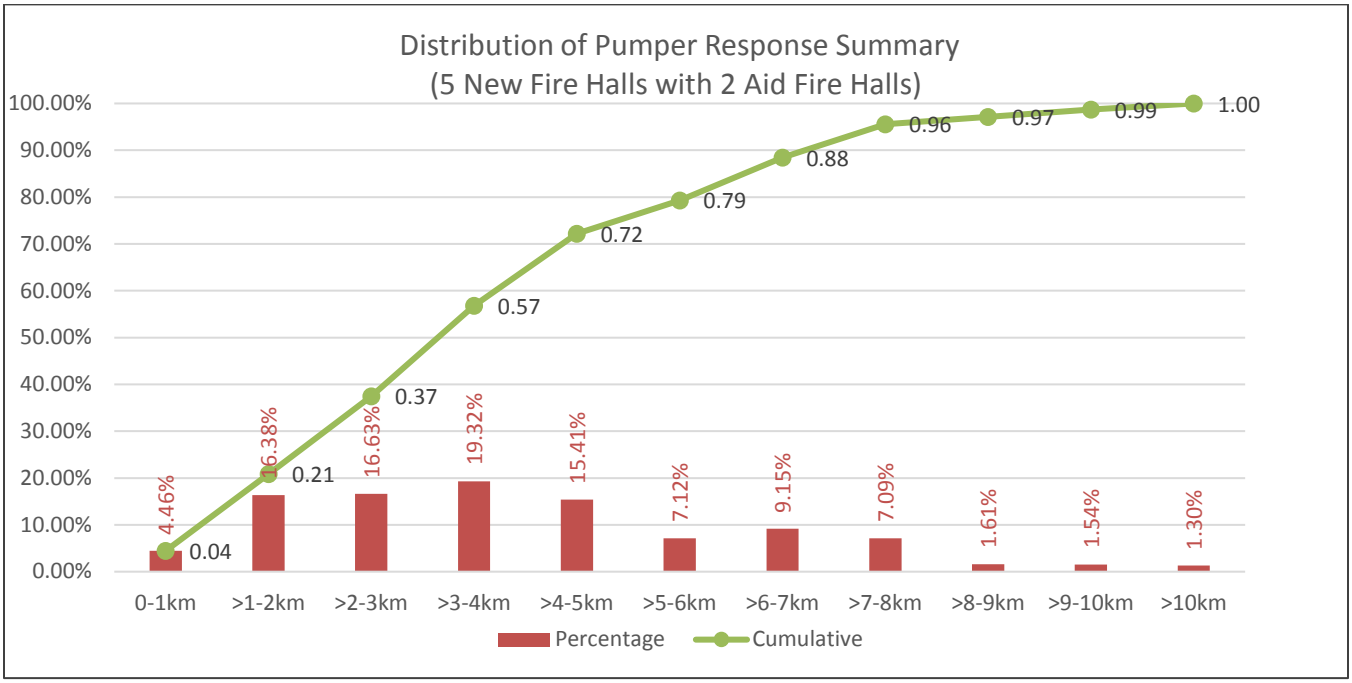


Figure 28 Optimization 3 - Standard Distance Analysis (5 New Fire Halls with 2 Aid Fire Halls)

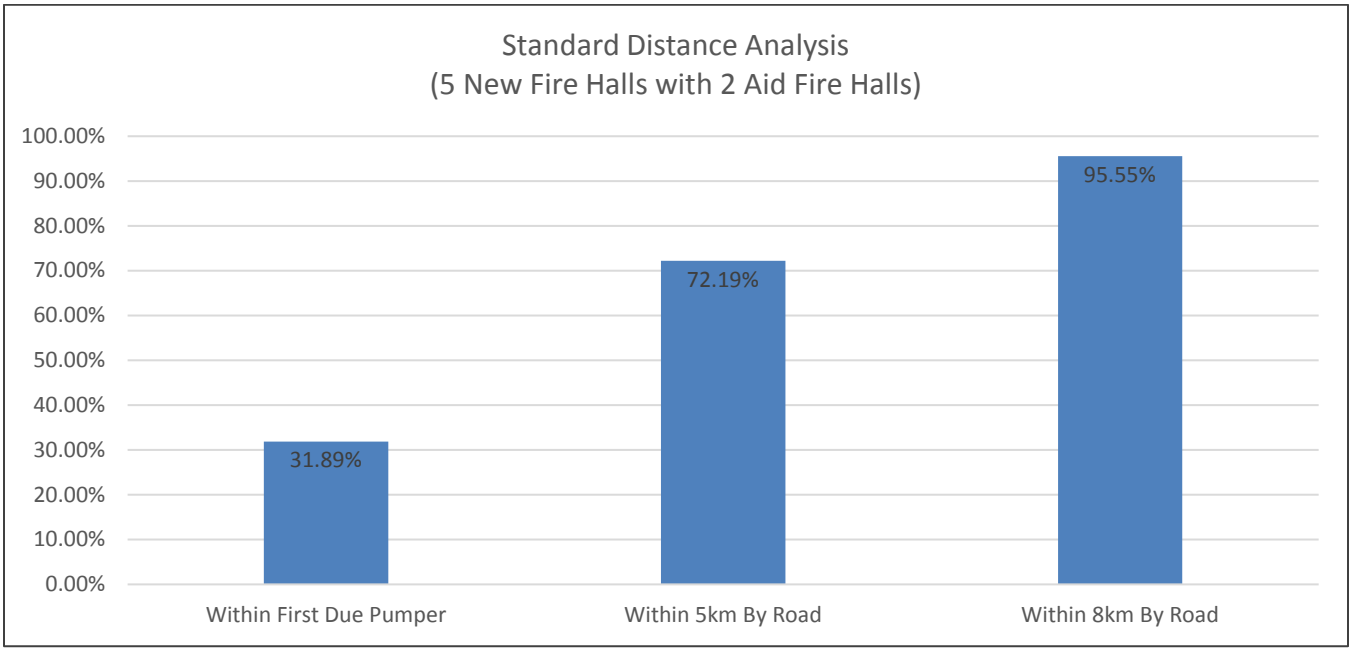
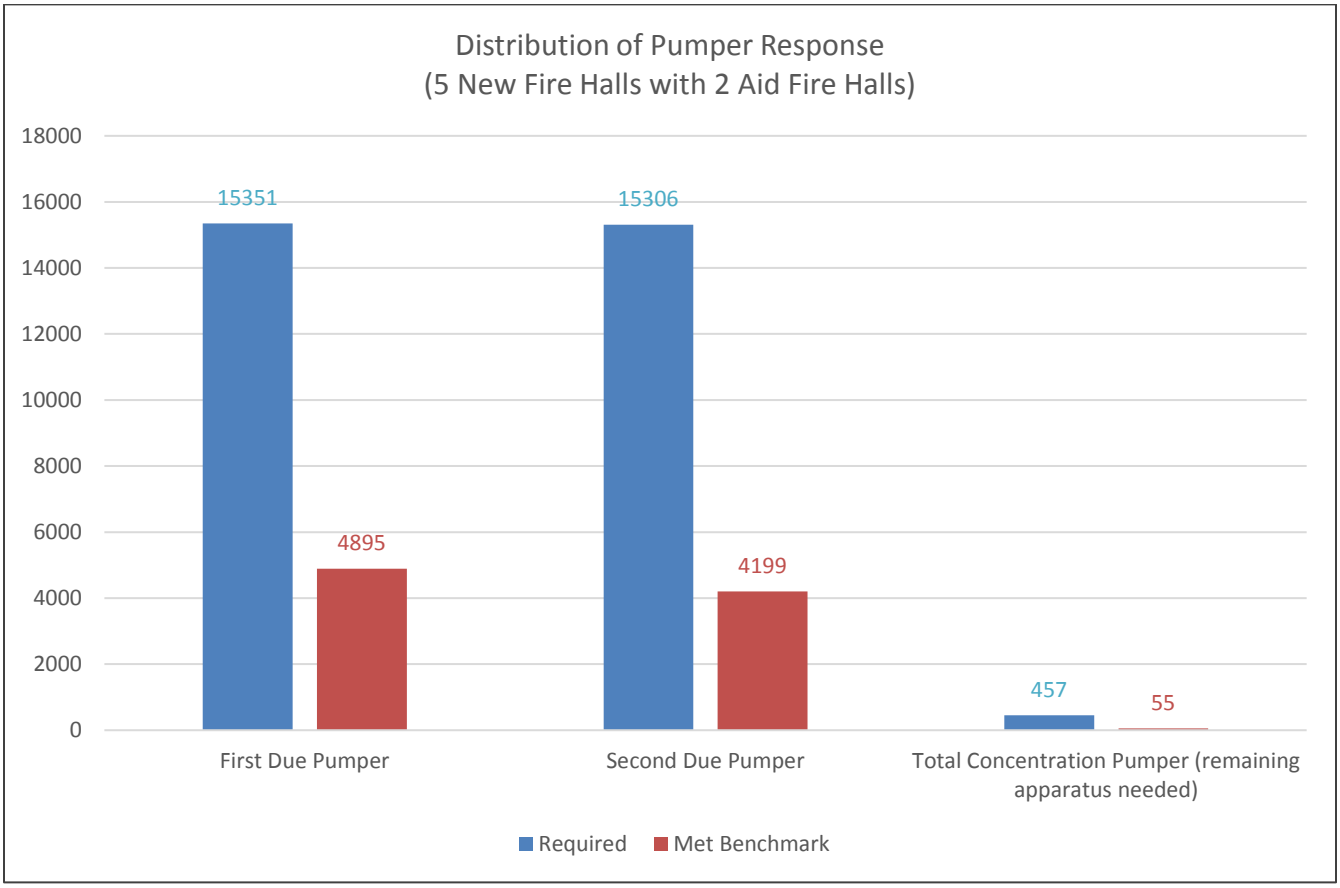


Figure 29 Distribution of Pumper Response (5 New Fire Halls with 2 Aid Fire Halls)



7.4.5. Optimization No.4 – Maximising 8km Travel Distance Response

The fourth optimization completed within the Lakeshore Fire Protection Area involved designing fire hall coverage using a location-allocation tool that would ensure the majority of property within the Town of Lakeshore would fall within 8 km by road travel distance requirements of Personal Lines property insurance. The 8km response coverage model was designed to achieve a coverage of 8km by road travel distance for 90% of risk points found within the Town of Lakeshore. The second objective of optimization four, was to investigate whether a decrease in the number of fire hall locations could be achieved, while maintaining suitable coverage throughout the community. Lastly, a coverage analysis was completed to determine the response characteristics of the optimization, analyzing similar coverage objectives found throughout this report.

This optimization resulted in the configuration of 4 new fire hall locations with existing aiding fire halls in Essex and Tilbury, acting as fixed locations contributing to response coverage of risks within 8km travel distances. The result, when compared to current fire hall locations and their coverage analysis indicated a significant decrease in achieving first due response, and reductions in the amount of demand points within 5 km by road of fire hall; however, the model improved response to demand points within 8 km by road of a fire hall.

Analysing coverage under the category of first due pumper response, this optimization performs the worst of all configurations considered. Only 17.89% of demand points associated with Optimization 4 are within the prescribed distances for an initial response pumper company. This represents a significant impact on potential response distances and would certainly result in continued increases in response times compared to current fire suppression response capacities found throughout the Town of Lakeshore.

When evaluating the criteria of 5km response coverage for Commercial Lines purposes, currently 62.15% of risk points are located within 5km of a fire hall. Optimization 4 diminishes coverage within 5km by road travel distance by 16.45% with coverage achieving 45.70% of demand points. Lastly, the only improvement that was achieved with this fourth optimization model included the 8km by road travel distance associated with Personal Lines insurance.

The coverage analysis completed also showed an improvement of 12.13% additional demand points are located within the 8km by road travel distance requirement for personal lines insurance compared to current coverage. Current coverage established that 80.89% of Risks are within 8km by road travel distance; Optimization 4 places 93.02% of risks located within 8km travel distance of a fire hall. Figure 30 Optimization No.4 - Maximising 8km Travel Distance (4 New Fire Halls with 2 Aid Fire Halls) shows the configuration of fire halls associated with Optimization No.4.

Figure 30 Optimization No.4 - Maximising 8km Travel Distance (4 New Fire Halls with 2 Aid Fire Halls)

Lakeshore, ON

Optimization No.4 – Maximising Coverage for 8km Travel Distance (4 New Fire Halls with 2 Aid Fire Halls)

Scale = 1:34,000 0 1,050 2,100 Meters

Fire Underwriters Survey

The results of the fourth optimization illustrate a significant decrease in response coverage related to most criteria evaluated throughout this report. Additionally, another undesirable impact of this fire hall configuration is the inability of the model to address growth in the North Western portion of the community. Optimization 4 reduces the amount of fire halls servicing the area of the community experiencing the most growth, densification of population and high value commercial property found within the community. Multiple commercial areas and properties are located beyond 5km by road travel distance of a fire hall and would likely result in significant increases of property insurance premiums associated with Commercial Lines insurance. Likewise, the configuration of fire halls would also impact current fire insurance classifications as the decrease in response capacity would lose substantial points related to the Public Fire Protection Classification (PFPC) grading schedule.

Figure 31 Optimization No.4 Distribution of Pumper Response (4 New Fire Halls with 2 Aid Fire Halls)

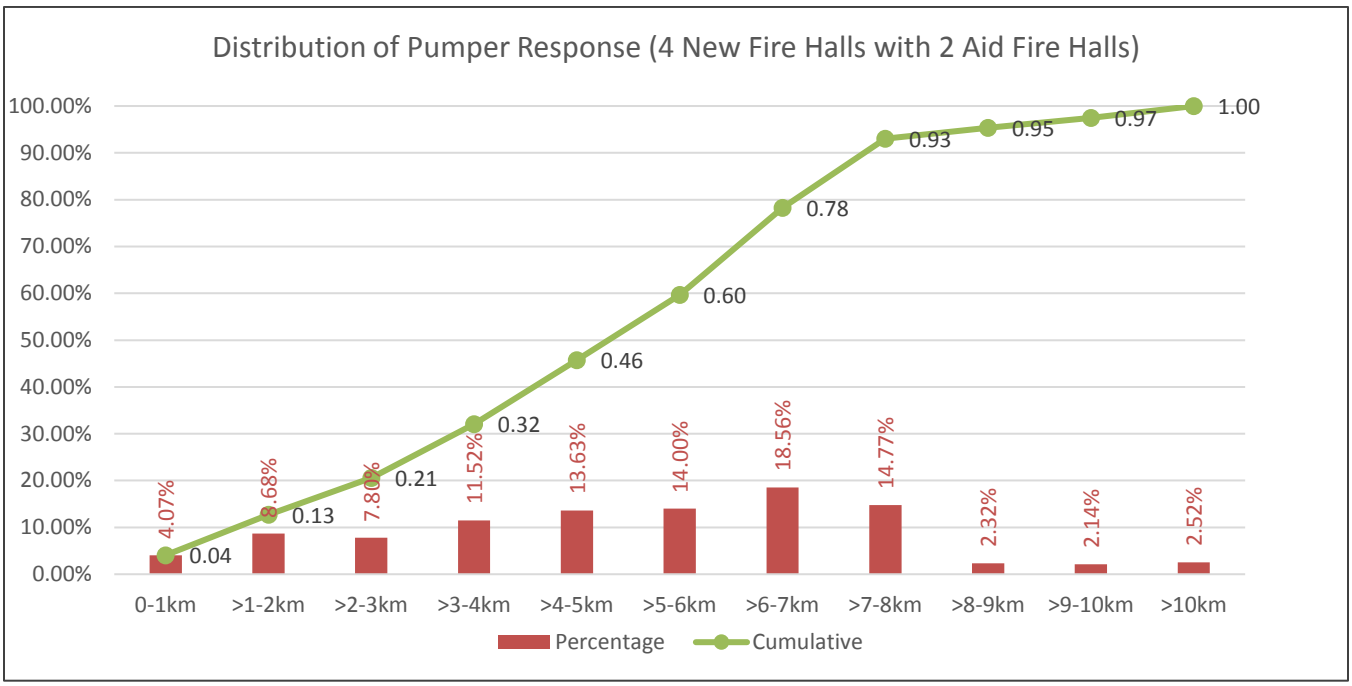


Figure 32 Optimization No.4 Standard Distance Analysis (4 New Fire Halls with 2 Aid Fire Halls)

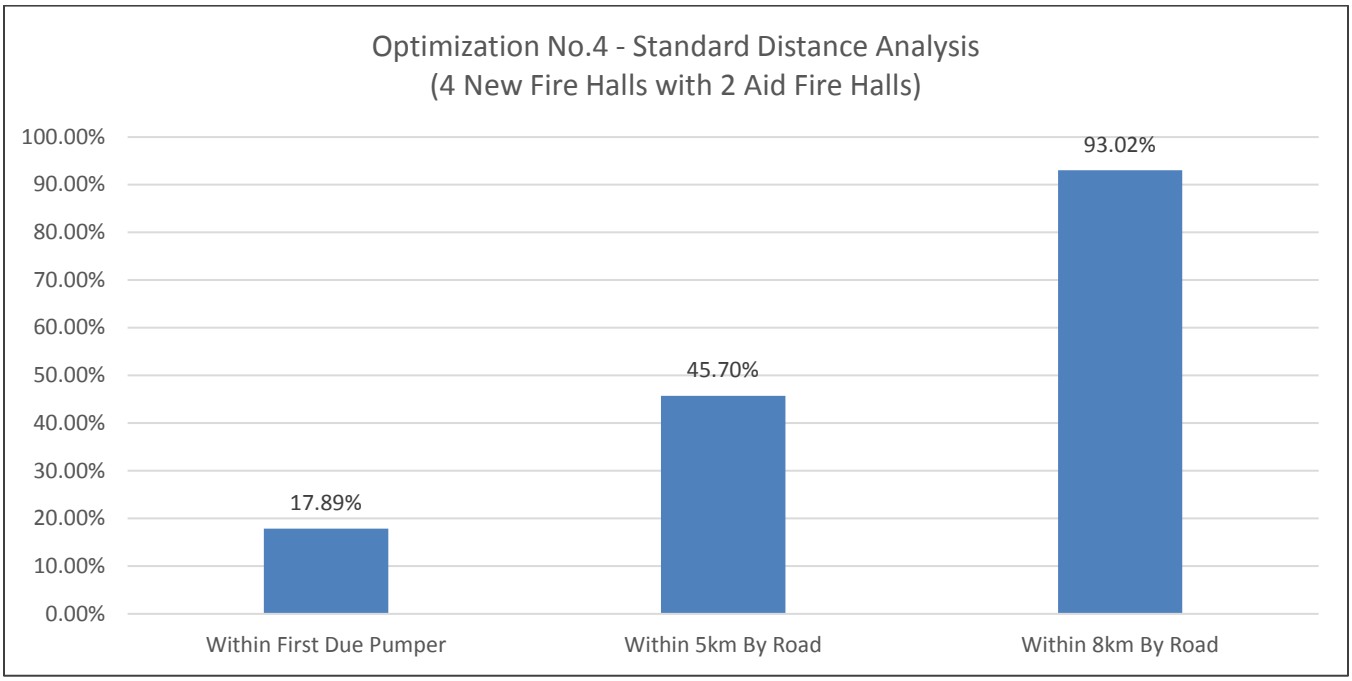
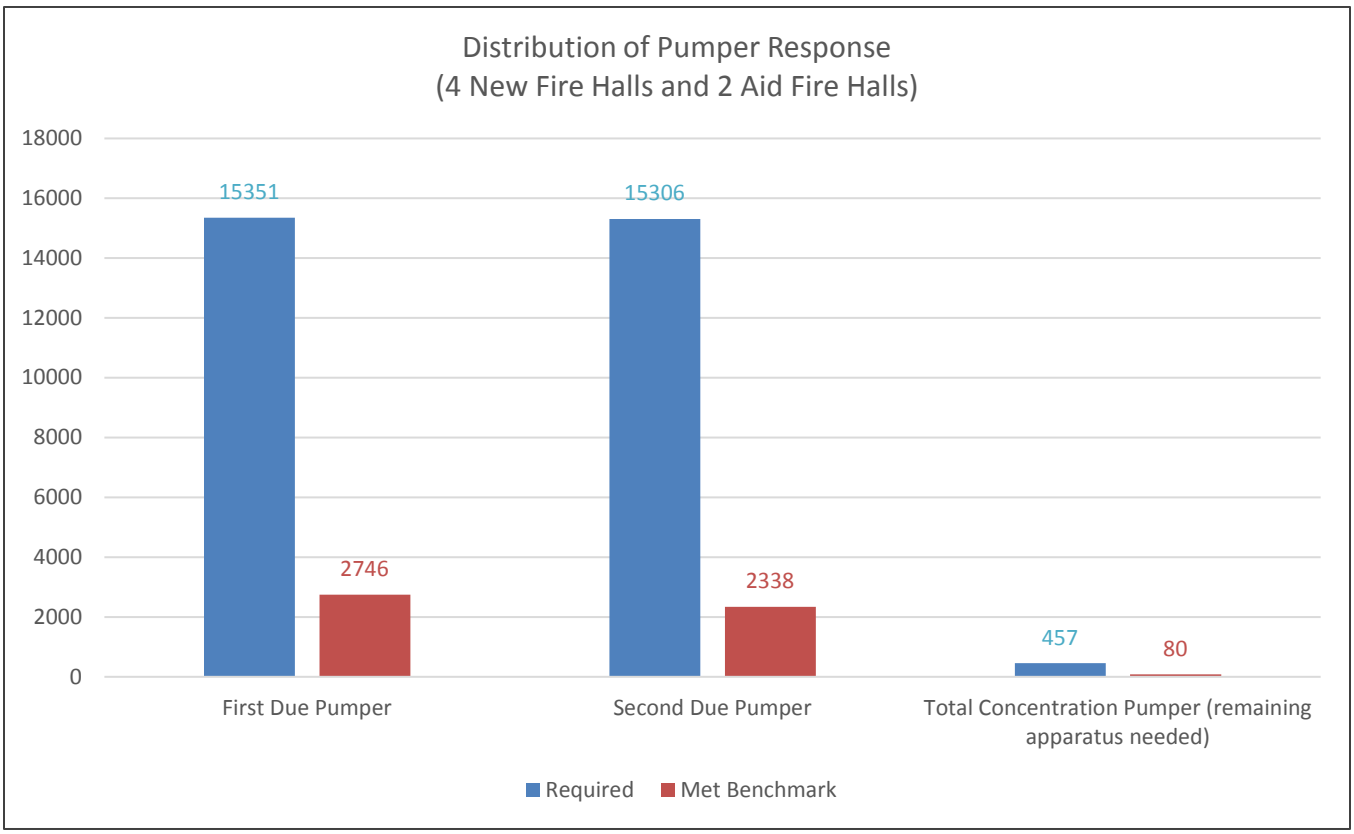


Figure 33 Distribution of Pumper Response (4 New Fire Halls and 2 Aid Fire Halls)



8. Conclusion

This study developed four optimizations of varying degrees based on applicable industry standards to determine an appropriate service model and fire hall alignment to serve the Town of Lakeshore for the next 20 to 40 years. A risk assessment was developed to identify community growth and ascertain benchmark levels risk to assign a level of fire protection commensurate with risk levels that would need to be provided to the community; as it out grows in population and building stock. Coverage analysis was first determined using current locations of fire halls, as it relates Fire Underwriters Surveys' Table of Effective Response found in Table 3, and NFPA 1720 guidelines. Secondarily, identifying whether current fire hall configurations could meet these standards of fire protection response and coverage was completed. In an attempt to reduce the amount of needed fire suppression facilities and resources throughout the community, aiding neighbouring fire halls located in Essex and Tilbury were maintained in each design to reduce the need for additional fire halls, as their coverage provides value.

The completion of Optimization No.1 – Table of Effective Response and Optimization No.2 – NFPA 1720 (9 New Fire Hall with 2 Aid Fire Halls), indicated the challenges associated with providing a heightened level of fire suppression response throughout the Lakeshore Fire Protection Area. Large areas used for agriculture and remote building locations highlight the difficulties of providing consistent response characteristics to all properties. These long distances and vast geographical areas create impractical fire protection needs, which if addressed, could cause a significant financial burden, and little enhancement to service levels. Each of the first two optimizations could be re-configured to determine what impact career staffing would have to reduce the number of fire halls required; however, the basis of these optimization designs was built to address current fire protection service models related to volunteer departments. NFPA 1720, does indicate the standard can be used by volunteer or composite type departments, and may highlight the need to consider an enhanced service model including readily available on-duty staffing of a career nature, as identified in the 2011 Master Fire Plan.

Optimization No.3 – Maximising Insurance Coverage Standards aims to achieve a utilitarian approach to supplying as many properties as possible with a response within prescribed travel distances associated with Commercial and Personal Lines insurance. Commercially insured property within 5km by road of a fire hall, and Personal Lines insured property within 8km by road travel distance are required to decrease fire insurance premiums paid by business stakeholders and constituents within the Town of Lakeshore. This optimization improves the amount of demand points within 5/8km by road travel distance from optimised fire hall locations, and should be facilitated with career on-duty staffing centrally located within the Emeryville, Puce and Belle River corridor. Enhancing fire fighting resources with career on-duty staffing can limit the number of fire halls required, while at the same time improving response times and allow for a consistent initial response compliment of resources. Comparable analysis related to similar communities and demographics are provided below in Table 9 Dwelling Protection Grades (DPG) with Similar Population(s), and illustrates the evolution of community growth necessitating enhanced fire protection needs by way of career staffing. These communities have evolved their fire protection resources over time to include an on-duty compliment to augment volunteer

staffing and provide a higher level of service commensurate with growth.The results of the fourth optimization illustrate a significant decrease in response coverage related to most criteria evaluated throughout this report. Additionally, another undesirable impact of this fire hall configuration is the inability of the model to address growth in the North Western portion of the community. Optimization No.4 reduces the amount of fire halls servicing the area of the community experiencing the most growth, densification of population and high value commercial property. Multiple commercial areas and properties are located beyond 5km by road travel distance of a fire hall and would likely result in significant increases of property insurance premiums associated with Commercial Lines insurance. Likewise, the configuration of fire halls would also impact currently updated fire insurance classifications of the community, as the decrease in response capacity would lose substantial points related to Public Fire Protection Classification(s) (PFPC) of the Town of Lakeshore.

The recommended optimization from the four developed options presented in this report is Optimization No.3 – Maximising Insurance Coverage Standards. This design clearly demonstrates and aligns with community growth experienced in the North Western portion of the Town of Lakeshore. Although Optimization No.1 and No.2 illustrate significant improvements in response coverage throughout the Town of Lakeshore; their design is restrictive due to the significant increase in finances necessary to accommodate such expenditures. Based on geographical challenges pertaining to the size, composition and unique make-up of the community, which contains areas considered urban, suburban and rural; developing fire protection services primarily addressing response coverage only, is believed to be unsustainable for the Town of Lakeshore. A fire protection model that incorporates heightened proactive fire inspection and public education initiatives to reduce risk, with a reasonable capacity respond to alarms would likely prove more suitable to the community's needs. Subsequently, Optimization No.3 improves coverage under categories of 5km and 8km response distances, maximising coverage, as it pertains to Commercial lines and Personal Lines insured property. Subsequently, Optimization No.3 also maintains the current number of fire halls at five, alleviating further potential increases in staffing, apparatus, equipment and facilities associated with designs requiring an increase in the number of fire halls to achieve ideal response coverage levels.

Table 8 Comparable Communities with On-Duty Staffing

Community	Population	Number Of Fire Halls	Land Area (sq. km)	Number of Career Fire Fighters (On-Duty)
Town of Georgina	45,418	3	287.5	7
Town of East Gwillimbury	23,991	3	245.04	2
Town of Whitchurch-Stouffville	45,837	2	206.22	4
Town of Midland	16,864	1	35.34	4
City of Thorold	18,801	4	82.99	4
City of Brockville	21,346	2	20.85	4
Town of LaSalle	30,180	1	65.35	5
City of Orillia	31,166	2	28.58	7
Town of Lakeshore	36,611	5	530.33	0

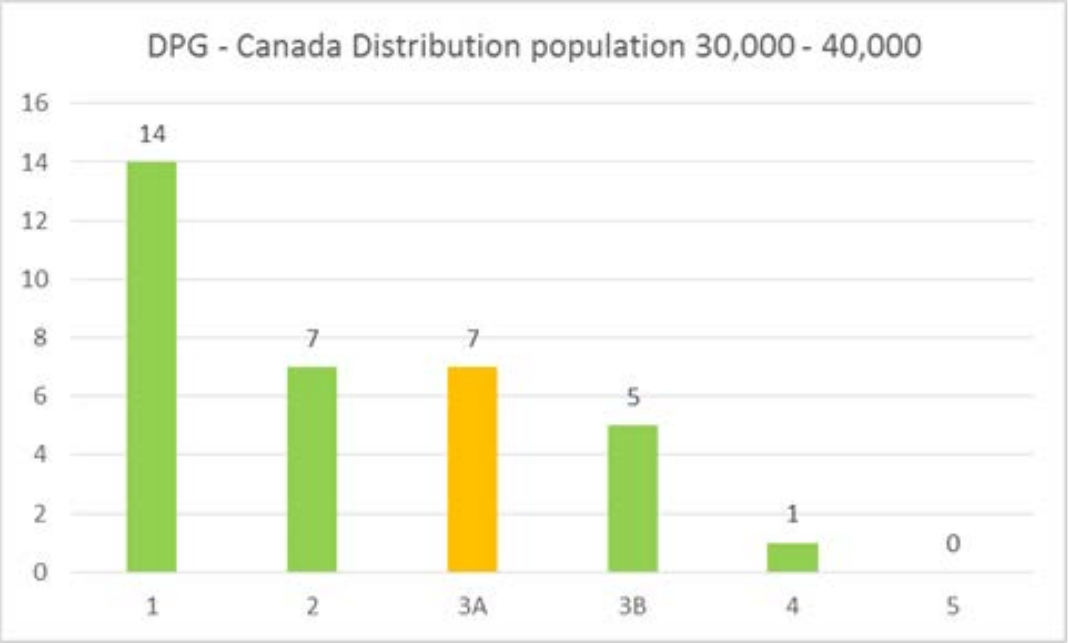
A subsequent investigation was conducted to retrieve data from the Canadian Fire Insurance Grading Index and determine what level of service is common in Canada with relation to staffing composition for communities supporting a population between 30,000 – 40,000 residents. The data provided below, illustrates that majority of communities with similar population demographics have some level of on-duty career firefighting response. Dwelling Protection Grade (DPG) classifications of DPG 1 and DPG 2, are representative of career and/or composite staffing levels.

The Town of Lakeshore currently falls within Dwelling Protection Grade (DPG) 3A; commensurate with the volunteer nature of response associated with the service model currently provided. The data suggests that 61.7% of fire halls in communities with similar population demographics provide some level of on-duty career response, while 20.5% of fire halls only provide a volunteer suppression response. We are unable to determine whether the remaining fire halls with DPG 3B and DPG 4, support fire halls with on-duty staffing, as those Dwelling Protection Grades are designed to address rural property and are not defined by staffing levels, but rather the equipment available at the fire halls. Those classifications can include both career of volunteer department staffing.

Dwelling Protection Grade (DPG) Staffing Requirement per Fire Hall:

DPG 1 – 3 Career Fire Fighters + 1 Officer/Captain
DPG 2 – 1 Career Fire Fighter + 15 Auxilliary/Volunteer Fire Fighters
DPG 3A – 15 Auxilliary/Volunteer Fire Fighters

Table 9 Dwelling Protection Grades (DPG) with Similar Population(s)



Please see Appendix A for a complete breakdown of Dwelling Protection Grade (DPG) requirements per fire hall.

APPENDIX A Dwelling Protection Grade Summary of Basic Requirements

Dwelling Protection Grade Summary of Basic Requirements per Fire Station[i]

DWELLING PROTECTION GRADE	WATER WORKS SYSTEM	FIRE DEPARTMENT		CORRELATION WITH PFPC[ii] Public Fire Protection Classification
		EQUIPMENT	FIREFIGHTERS[iii]	
1	Water supply system designed in accordance with Fire Underwriters Survey standard "Water Supply for Public Fire Protection" with a relative classification of 5 or better	Response from within 8 km by road of a triple combination pumper	Minimum Response: - On-duty: 3 career fire fighters, plus - Off-duty: fire chief or other officer	Water Supply and Fire Department must grade PFPC Relative Class 5 or better
2	Water supply system designed in accordance with Fire Underwriters Survey standard "Water Supply for Public Fire Protection" with a relative classification of 6 or better	Response from within 8 km by road of a triple combination pumper	Minimum Response: - On-duty: 1 career fire fighters, plus - On-call: 15 auxiliary fire fighters	Water Supply and Fire Department must grade PFPC Relative Class 6 or better
3A	Water supply system designed in accordance with, and meeting the minimum requirements of, Fire Underwriters Survey standard "Water Supply for Public Fire Protection"	Response from within 8 km by road of a triple combination pumper	15 auxiliary fire fighters	No Public Fire Protection Classification required
3B	Not required – however fire department must have adequate equipment, training and access to approved water supplies to deliver standard shuttle service in accordance with NFPA 1142, Standard on Water Supplies for Suburban and Rural Fire Fighting	2 units required. Triple combination pumper plus a mobile water supply with a combined water carrying capacity of not less than 6,820 L (1,500 IG)	15 auxiliary fire fighters	No Public Fire Protection Classification required
4[3]	Not required – however fire department must have adequate equipment, training and access to approved water supplies to deliver shuttle service in accordance with NFPA 1142, Standard on Water Supplies for Suburban and Rural Fire Fighting	2 units required. Triple combination pumper plus a mobile water supply with a combined water carrying capacity of not less than 6,820 L (1,500 IG)	15 auxiliary fire fighters	No Public Fire Protection Classification required
5	Unprotected communities or communities not qualifying for Grades 1, 2, 3A, 3B, or 4 above	Unprotected communities or communities not qualifying for Grades 1, 2, 3A, 3B, or 4 above	Unprotected communities or communities not qualifying for Grades 1, 2, 3A, 3B, or 4 above	No Public Fire Protection Classification required

[i] Refer to additional notes and requirements for interpretation

[ii] The P.F.P.C. is a sophisticated municipal fire protection grading system utilized for Commercial Lines insurance. PFPC fire insurance grades are scaled from 1 to 10. One (1) represents a high level of fire protection and 10 indicates little or no recognized fire protection. This system evaluates the ability of a community's fire defences to prevent and control major fires that may occur in commercial, industrial and institutional buildings and/or districts.

[iii] Requirements for Dwelling Protection Grade 4 are the same as for Dwelling Protection Grade 3B, however in some cases, an allowance may be considered for Dwelling Protection Grade 4 where all of the criteria for Dwelling Protection Grade 3B have been met with one exception. If more than one criteria has not been met (ex. less than 15 auxiliary fire fighters and a single pumper apparatus) Dwelling Protection Grade 5 is applied.

Where Dwelling Protection Grade 4 is applied, a signed letter of intent from the community is to be sent to Fire Underwriters Survey indicating that improvements will be made, within an agreed timeframe, to meet the criteria of Dwelling Protection Grade 3B.

It is important to note that the absolute minimum number of auxiliary fire fighters considered within the fire insurance grading is 10 and that maximum age of apparatus that can be considered is 30.

APPENDIX B Town of Lakeshore Current Fire Insurance Classifications

October 18, 2017

Lakeshore Fire Department
592 St. Charles Street
Belle River, ON
N0R 1A0

Attention: Don Williamson, CMM III Fire Service Executive, EMP / Fire Chief / CFO / CEMC / CFI

Fire Underwriters Survey – Town of Lakeshore

Fire Underwriters Survey is a national organization that represents approximately 90 percent of the private sector and casualty insurers operating in Canada. Fire Underwriters Survey (FUS) provides data to program subscribers regarding public fire protection for fire insurance statistical and underwriting evaluation.

Fire Underwriters Survey conducted an assessment of the Town of Lakeshore's fire defenses for the primary purpose of fire insurance grading and classification. The following letter provides a brief description of the grading process and the results of our fire insurance classification review.

The Public Fire Protection Classification (PFPC) is a numerical grading system scaled from 1 to 10 that is used by Commercial Lines[1] insurers. Class 1 represents the highest grading possible, alternatively Class 10 represents an unrecognized level of fire protection, or fire protection beyond 5 km by road travel distance from the nearest responding fire station. The PFPC grading system evaluates the ability of a community's fire protection programs to prevent and control major fires that may occur in multi-family residential, commercial, industrial, institutional buildings, and course of construction developments.

Fire Underwriters Survey also assigns a second grade for fire protection. The second grading system, entitled Dwelling Protection Grade (DPG), assesses the protection available for small buildings, such as single-family dwellings, and is used by Personal Lines[2] insurers. The DPG is a numerical grading system scaled from 1 to 5. Class 1 is the highest grading possible, Class 5 indicates little or no fire protection is present; Class 5 also represents fire protection beyond 8 km by road travel distance of a responding fire station. This grading reflects the ability of a community to handle fires in small buildings such as single family dwellings and semi-detached dwellings.

We are pleased to inform that our analysis of Lakeshore's fire insurance classification assessment is complete. The following two tables outline past and present Public Fire Protection Classifications and the Dwelling Protection Grades attributed to the Town of Lakeshore.

---

1 Commercial Lines: A distinction marking property and liability coverage written for business or entrepreneurial interests (includes institutional, industrial, multi-family residential and all buildings other than detached dwellings that are designated single-family residential or duplex) as opposed to Personal Lines.
2 Personal Lines: Insurance covering the liability and property damage exposures of private individuals and their households as opposed to Commercial Lines. Typically includes all detached dwellings that are designated single family residential or duplex

Table 1 – Public Fire Protection Classification (PFPC) Updates for the Town of Lakeshore

SUB DISTRICT(S) and (contract protection areas)	PFPC Previous	PFPC 2017	COMMENTS
Lakeshore – F.S. #1 (H.P.A)	5	**5**	Hydrant Protected Area – Commercial Lines insured properties within 5 km of a fire hall, and within 150 m of a fire hydrant.
Lakeshore – F.S. #2 (H.P.A)	6	**5**	Hydrant Protected Area – Commercial Lines insured properties within 5 km of a fire hall, and within 150 m of a fire hydrant.
Lakeshore – F.S. #3 (H.P.A)	5	**5**	Hydrant Protected Area – Commercial Lines insured properties within 5 km of a fire hall, and within 150 m of a fire hydrant.
Lakeshore – F.S. #4 (H.P.A)	6	**5**	Hydrant Protected Area – Commercial Lines insured properties within 5 km of a fire hall, and within 150 m of a fire hydrant.
Lakeshore – F.S. #5 (H.P.A)	6	**5**	Hydrant Protected Area – Commercial Lines insured properties within 5 km of a fire hall, and within 150 m of a fire hydrant.
Chatham-Kent – F.S. #19 (Automatic Aid Agreement)	-	**5**	Contract Aid Area – Commercial Lines insured properties within 5km by road of a fire station, and within 150m of a fire hydrant.
Lakeshore – F.P.A	9	**9**	Fire Hall Protected Area – Commercial Lines insured properties within 5 km by road of a fire station, but not within 150 m of a fire hydrant.
Lakeshore – Rest	10	**10**	Unprotected – Commercial Lines insured properties further than 5 km by road of a fire hall.

Table 2 – Dwelling Protection Grade (DPG) Updates for the Town of Lakeshore

SUB DISTRICT(S) and (contract protection areas)	DPG Previous	DPG 2017	COMMENTS
Lakeshore – F.S. #1 (H.P.A)	3A	**3A**	Hydrant Protected Area – Personal Lines insured properties within 8 km of a fire hall, and within 300 m of a fire hydrant.
Lakeshore – F.S. #1 (F.P.A)	4	**4**	Fire Hall Protected Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300 m of a fire hydrant.
Lakeshore – F.S. #2 (H.P.A)	3A	**3A**	Hydrant Protected Area – Personal Lines insured properties within 8 km of a fire hall, and within 300 m of a fire hydrant.
Lakeshore – F.S. #2 (F.P.A)	3B-S	**3B-S**	Fire Hall Protected Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300 m of a fire hydrant.
Lakeshore – F.S. #3 (H.P.A)	3A	**3A**	Hydrant Protected Area – Personal Lines insured properties within 8 km of a fire hall, and within 300 m of a fire hydrant.
Lakeshore – F.S. #3 (F.P.A)	4	**4**	Fire Hall Protected Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300 m of a fire hydrant.

Lakeshore – F.S. #4 (H.P.A)	3A	**3A**	Hydrant Protected Area – Personal Lines insured properties within 8 km of a fire hall, and within 300 m of a fire hydrant.
Lakeshore – F.S. #4 (F.P.A)	3B-S	**3B-S**	Fire Hall Protected Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300 m of a fire hydrant.
Lakeshore – F.S. #5 (H.P.A)	3A	**3A**	Hydrant Protected Area – Personal Lines insured properties within 8 km of a fire hall, and within 300 m of a fire hydrant.
Lakeshore – F.S. #5 (F.P.A)	3B-S	**3B-S**	Fire Hall Protected Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300 m of a fire hydrant.
Chatham-Kent – F.S. #19 (Automatic Aid Agreement)	-	**2**	Contract Aid Area – Personal Lines insured properties within 8 km of a fire hall, and within 300m of a hydrant.
Chatham-Kent – F.S. #19 (Automatic Aid Agreement)	-	**4**	Contract Aid Area – Personal Lines insured properties within 8 km of a fire hall, but not within 300m of a hydrant.
Lakeshore – Rest	5	**5**	Unprotected – Personal Lines insured properties further than 8 km by road of a fire hall.

Fire Underwriters Survey measures the ability of the Fire Department, Water Supply, Emergency Communication, and Fire Safety Control (Fire Prevention and Public Education) against the level of built risk within the community. The measurement is not usually determined by the most significant risk, but is generally the value which is representative of the fire potential of most large properties in the municipality. The risk evaluation may exclude several of the largest properties since they may not be considered typical or representative to the municipality.

Provided below is a description of each of the four (4) categories evaluated during the recent fire insurance classification assessment; Fire Department, Water Supply, Emergency Communication, and Fire Safety Control (Fire Prevention and Public Education). Also included are corresponding Grading Credit Charts to assist the Town of Lakeshore and Lakeshore Fire Department in determining areas where credit points are available. Their inclusion in this letter is intended to allow for future improvements to be developed regarding the Town's fire insurance grades.

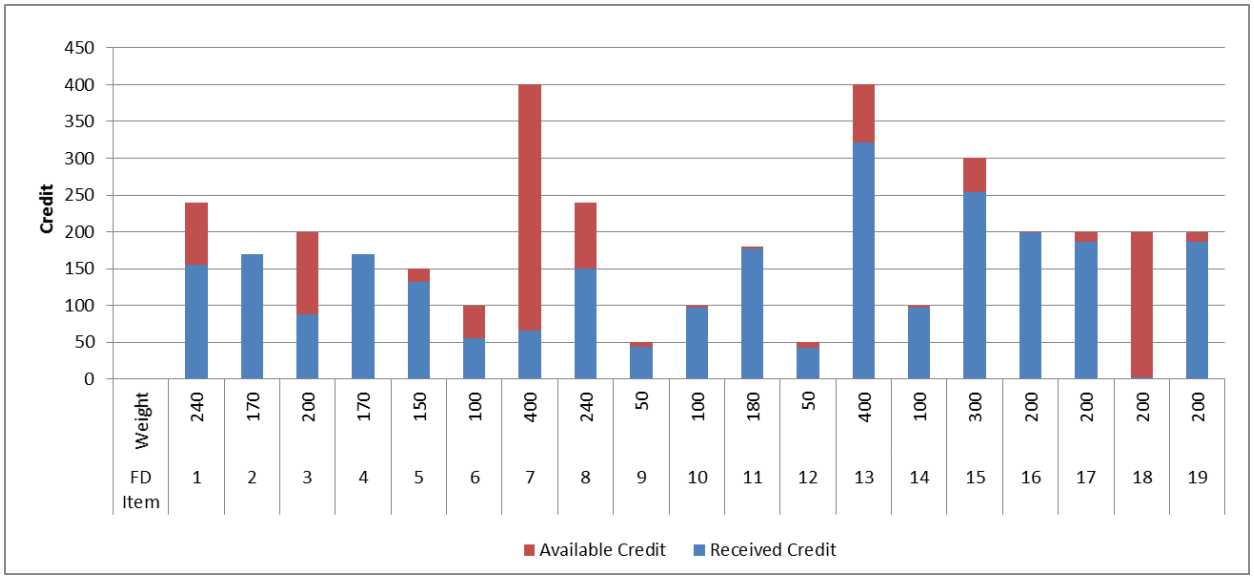
Fire Department Grading Items

The Fire Department grading consists of nineteen (19) items and makes up forty percent (40%) of the Public Fire Protection Classification (PFPC). Please note, each item is divided by sub-items, and carry a different weight within the Fire Department section of the overall classification. It should also be noted that areas containing the most points and weight under Fire Department Grading Items include; Total Fire Force Available and Training & Qualifications. Staffing Levels of various positions have a cascading effect on multiple grading items relating to availability labour force. Similarly, Apparatus available to the Fire Department also has a cascading effect on numerous grading items and should be revered as an area

where consideration needs be given to maintaining adequate and reliable apparatus. Areas reviewed in the assessment of the Fire Department are as follows:

FD-1 – Engine Service
FD-2 – Ladder Service
FD-3 – Distribution of Companies
FD-4 – Engine and Ladder Pump Capacities
FD-5 – Design, Maintenance, and Conditions of Fire Apparatus
FD-6 – Number of Line Officers – Fire Suppression
FD-7 – Total Fire Force Available
FD-8 – Engine and Ladder Company Unit Manning
FD-9 – Master and Special Stream Devices
FD-10 – Equipment for Engines and Ladder Apparatus, General
FD-11 – Fire Hose
FD-12 – Conditions of Fire Hose
FD-13 – Training and Qualifications
FD-14 – Response to Alarms
FD-15 – Fire Ground Operations
FD-16 – Special Protection Required
FD-17 – Miscellaneous Factors and Conditions
FD-18 – Pre-Incident Planning
FD-19 – Administration

Fire Department (40%)



Within the various Fire Department items considered, the two highest weighted categories are FD-7 – Total Fire Force Available and FD-13 – Training & Qualifications. Lakeshore Fire Department has scored very well in the Training & Qualifications category, however a substantial amount of credit is available in item FD-7 – Total Fire Force Available. Increases to staffing, at the career level, will have a positive impact on FD-7. The amount of Career and Non-Career Fire Fighters within the department also has a direct impact on available credit in the category FD-8 – Engine and Ladder Company Unit Manning.

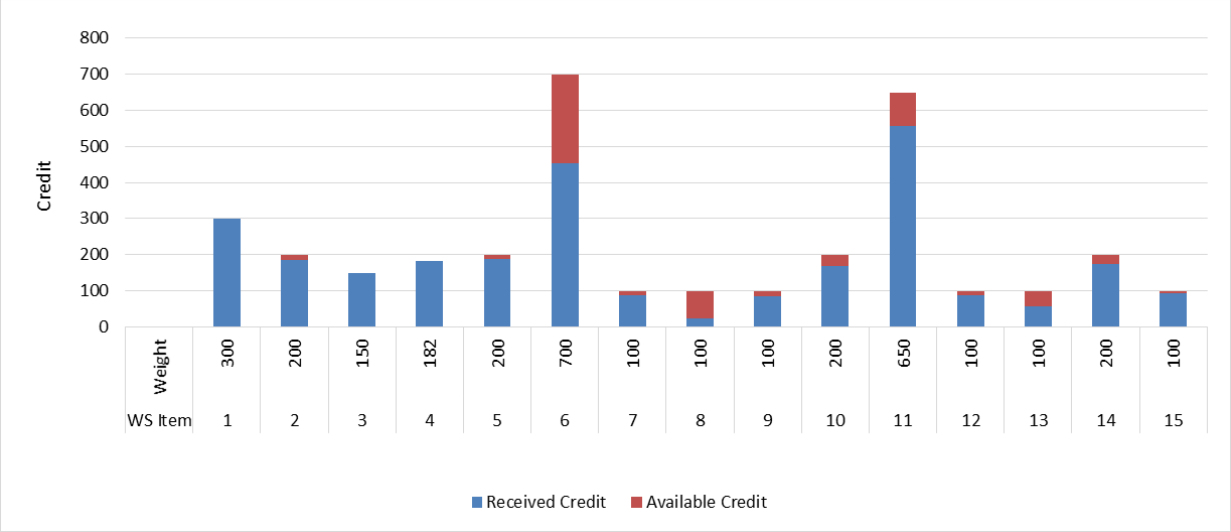
At the time of this fire insurance grade update it was noted that a relatively low amount of the town's inspectable building stock have available pre-fire plans. Significant credit is available under the FD-18 – Pre-Incident Planning category for continued efforts in increasing total number of pre-fire plans as well as accessibility of pre-fire plans to fire fighters in the event of an incident.

Water Supply Grading Items

The Water Supply grading consists of fifteen (15) items and makes up thirty percent (30%) of the Public Fire Protection Classification (PFPC). Please note, each item is divided into sub-items, and carry a different weight within the Water Supply section and the overall classification. Areas reviewed in the assessment of the Water Supply are as follows:

WS-1 – Normal Adequacy of Supply Works
WS-2 – Reliability of Supply Works
WS-3 – Reliability of Pumping Capacity (Pumps and Drivers)
WS-4 – Reliability of Power Supply
WS-5 – Reliability, Condition, Arrangement, Operation and Maintenance of System Components
WS-6 – Fire Flow Delivery by Mains
WS-7 – Reliability of Principal Mains
WS-8 – Installation of Pipe
WS-9 – Arrangement of Distribution System
WS-10 – Additional Factors and Conditions Relating to Supply and Distribution
WS-11 – Distribution of Hydrants
WS-12 – Hydrants – Size, Type and Installation
WS-13 – Hydrants – Condition and Inspection
WS-14 – Other Conditions Affecting Adequacy and Reliability
WS-15 – Management

Water Supply (30%)



In order to ensure sufficient water supply and hydrant marking throughout the community, the Town of Lakeshore is encouraged to develop a hydrant flow testing program in accordance with *NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants*.

Emergency Communication Grading Items

The sections below cover the seven grading items that pertain to Fire Service Communications. Ten percent (10%) of the Public Fire Protection Classification of the Town of Lakeshore comes from the grading of Fire Service Communications. Please note, each item is divided by sub-items, and carry a different weight within the Emergency Communication section of the overall classification. Areas reviewed in the assessment of the Emergency Communications are as follows:

Comm-1 – Communication Centre
Comm-2 – Means of Transmitting Alarm by Public
Comm-3 – Fire Department Telephone Service (Incoming from Public)
Comm-4 – Means of Alarm Dispatch
Comm-5 – Dispatching Service
Comm-6 – Operations Radio
Comm-7 – Miscellaneous Factors

Emergency Communications (10%)

Fire Safety Control Grading Items

Fire Safety Control grading consists of four (4) items and make up twenty percent (20%) of the Public Fire Protection Classification (PFPC). Please note, each item is divided by sub-items, and carry a different weight within the Fire Safety Control section of the overall classification. Fire Safety Control has become an increasingly heavily weighted portion of the fire insurance grading system. This is the result of statistical data showing that communities employing effective programs in these areas have significantly reduced fire related losses.

Areas reviewed in the assessment of the Fire Safety Control (Fire Prevention and Public Education) are as follows:

FSC-1 – General Program
FSC-2 – Codes and Enforcement
FSC-3 – Building Construction Laws
FSC-4 – Electrical Code and Inspection

Fire Safety Control (20%)

A substantial degree of safety to life and property protection from fire should be provided by provincial and municipal control of hazards. Control can be best accomplished by the adoption and enforcement of appropriate codes and standards for manufacturing, storage, and use of hazardous materials, building construction, as well through appropriate training, advisory, and education programs to the public.

Most significant grading items within the Fire Safety Control revolve around the frequency of inspections for varying occupancies found within Lakeshore. The Town of Lakeshore's inspection frequencies have been compared to the FUS Benchmark. Provided below are the recommended frequency of inspections associated with achieving maximum credit points under the Fire Safety Control grading category.

Occupancy	FUS Benchmark
Assembly (A)	6 months
Institutional (B)	12 months
Single Family Dwelling (C)	12 months
Multi-Unit Residential (C)	6 months
Hotel / Motel (C)	6 months
Mobile Homes & Trailers (C)	6 months
Seasonal/Rec. Dwellings (C)	6 months
Commercial (D&E)	12 months
Industrial (F)	3 to 6 months

Lakeshore Fire Department has been reviewed in the effectiveness of their practices with regard to Fire Safety Control, Fire Prevention, and Public Education. From the perspective of improving fire insurance classifications, increases in Fire Prevention/Public Education generally are considered the most cost

effective way to improve fire insurance classifications, while also reducing the risk of fire by educating the public and enforcing fire safety measures in various occupancies found throughout the community.

Increasing the frequency of inspections while continuing to meet legislative requirements of the Fire Prevention and Protection Act 1997, The Ontario Fire Code, and OFMEM Public Safety Guidelines should be a priority of the Fire Prevention/Public Education division of Lakeshore Fire Department

Fire Underwriters Survey has supplied a number of documents within the Appendix of this letter for the purpose of providing information to the Town of Lakeshore with regards to; Frequency of Inspections, Apparatus Life Service Recognition, When Ladders and Aerials are Needed, Apparatus Listing Requirements, Hydrants Public and Private terms of reference, Minimum Requirements for each Dwelling Protection Grade (DPG) – Personal Lines Classifications, as well as corresponding dwelling and commercial fire insurance grade mapping.

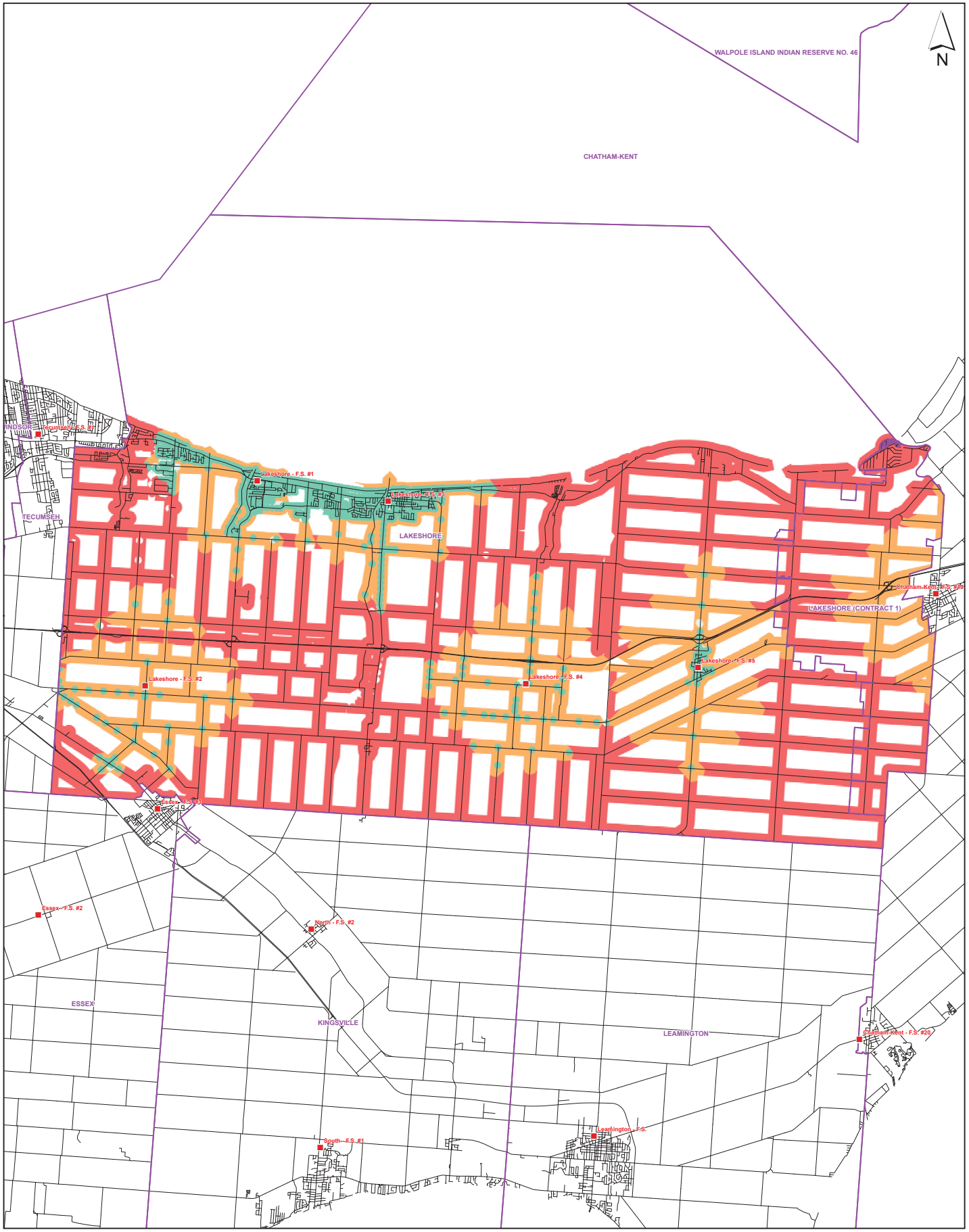
Please note that this letter is private and confidential. The underlying data of this report has primarily been developed for the purpose of fire insurance grading and classification. This letter may be used by the stakeholders of the Town of Lakeshore to assist in planning the future direction of fire protection services for Lakeshore Fire Department.

Fire Underwriters Survey would like to thank all the various officials and staff of Lakeshore for their co-operation and assistance gathering all the necessary information required to complete our survey and update fire insurance classifications for the Town of Lakeshore.

Please contact our office if there are any questions or comments regarding the intent or content found throughout this letter.

David Wilson
Public Fire Protection Specialist
Fire Underwriters Survey

cc: Robert Aguiar
Senior Public Fire Protection Specialist



Lakeshore, ON

Scale = 1:50,000

0 500 1,000 2,000 3,000
Meters

Commercial Lines Insurance - Public Fire Protection Classification

Fire Underwriters Survey
A Service to Insurers and Municipalities

Legend

- Fire Hall
- Road
- Fire Protection Boundary
- 1
- 1 (Private Hydrant Protected)
- 2
- 2 (Private Hydrant Protected)
- 3
- 3 (Private Hydrant Protected)
- 4
- 4 (Private Hydrant Protected)
- 5
- 5 (Private Hydrant Protected)
- 6
- 6 (Private Hydrant Protected)
- 7
- 7 (Private Hydrant Protected)
- 8
- 8 (Private Hydrant Protected)
- 9
- 9P
- 10

These maps and figures are not intended to illustrate the exact response distance or fire insurance grade coverage areas but can be used to aid in determining the fire insurance grade that should be applied to the property in question.
Fire Underwriters Survey does not warrant or make any representations with respect to the quality, completeness, currency or accuracy of anything contained in this map, the fitness of this map for any purpose or results obtained using information contained in this map and is not responsible for any action taken in reliance on information contained in this map. In all cases, field data should be used to confirm the data and accuracy of these maps; if differences are noted please contact Fire Underwriters Survey at 1-800-665-5661.

Date Drawn: 2017-10-18

Drawn By: JU

☐ *Preliminary* ■ *Final*

■ *Commercial* ☐ *Personal*

Lakeshore, ON

Scale = 1:50,000

0 500 1,000 2,000 3,000
Meters

Personal Lines Insurance - Dwelling Protection Grades

Fire Underwriters Survey
A Service to Insurers and Municipalities

Legend

- Fire Hall
- Road
- Fire Protection Boundary
- 1
- 1 (Private Hydrant Protected)
- 2
- 2 (Private Hydrant Protected)
- 3A
- 3A (Private Hydrant Protected)
- 3B(F)
- 3B(L)
- 3B(S)
- 3B
- 4
- 5

These maps and figures are not intended to illustrate the exact response distance or fire insurance grade coverage areas but can be used to aid in determining the fire insurance grade that should be applied to the property in question. Fire Underwriters Survey does not warrant or make any representations with respect to the quality, completeness, currency or accuracy of anything contained in this map, the fitness of this map for any purpose or results obtained using information contained in this map and is not responsible for any action taken in reliance on information contained in this map. In all cases, field data should be used to confirm the data and accuracy of these maps; if differences are noted please contact Fire Underwriters Survey at 1-800-665-5661.

Date Drawn: 2017-10-18

Drawn By: JU

☐ Preliminary ■ Final

☐ Commercial ■ Personal

APPENDIX C

WATER SUPPLY
FOR
PUBLIC FIRE PROTECTION

1999

FIRE UNDERWRITERS SURVEY

A SERVICE TO INSURERS AND MUNICIPALITIES

For further information on this document or any matters relating to the Fire Underwriters Survey please contact the appropriate offices of CGI Risk Management Services (formerly the Insurers' Advisory Organization) as follows:

Western Canada	CGI Risk Management Services Fire Underwriters Survey 3999 Henning Drive Burnaby BC V5C 6P9	Local: 604-6841581 Toll Free: 1-800-665-5661 Fax: 604-688-6986
Central Canada	CGI Risk Management Services Fire Underwriters Survey Suite 800, 7015 Macleod Tr. SW Calgary Alberta T2H 2K6	Local: 403-296-1300 Toll Free: 1-800-465-4264 Fax: 403-296-1316
Quebec	CGI Risk Management Services Fire Underwriters Survey 1611 Crémazie Blvd. East Montreal, Quebec H2M 2P2	Local: 514-735-3561 Toll Free: 1-800-263-5361 Fax: 514-844-0777
Ontario	CGI Risk Management Services Fire Underwriters Survey Lock Box 200 150 Commerce Valley Drive, West Markham, Ontario L3T 7Z3	Local: 905-882-6300 Toll Free: 1-800-387-4356 Fax: 905-695-6543
Atlantic Canada	CGI Insurance Business Services Fire Underwriters Survey 238 Brownlow Avenue, Suite 300 Park Place Center Dartmouth, Nova Scotia B3B 1Y2	Telephone: 902-423-9287 Toll-Free: 1-800-639-4528 Fax: 902-423-7376

FIRE UNDERWRITERS SURVEY is financed by the Canadian Insurance industry and utilizes technical staff of CGI Risk Management Services (formerly the Insurers' Advisory Organization Inc.) Its purpose is to survey fire protection conditions in Canadian communities and municipalities, providing data and advisory services to fire insurance underwriters and public officials concerned.

The text of this publication includes copyright material of Insurance Services Offices with its permission.

TABLE OF CONTENTS

WATER SUPPLY FOR PUBLIC FIRE PROTECTION

PREFACE

This guide summarizes the more significant recommendations of Fire Underwriters Survey with respect to fire protection requirements in municipal water works system design. It reflects the manner in which FUS assesses the water supply aspect of a municipality's fire risk potential during surveys on behalf of the Canadian property insurance industry and represents the accumulated experience of many years of study of actual fires. Water supply is one of a number of components evaluated by FUS in the municipal fire protection system. Recommendations applying to the fire departments and code enforcement are covered in other publications of Fire Underwriters Survey. FUS local offices are prepared to assist municipal officials or their consultants with advice on special problems, as time limits permit, in accordance with the intent of this guide. The minimum size water supply credited by FUS must be capable of delivering not less than 1000 L/min for two hours or 2000 L/min for one hour in addition to any domestic consumption at the maximum daily rate. Static suction supplies to fire department pumpers are recognized as a supplement to the piped system.

In the FUS assessment of a water supply system, the major emphasis is placed upon its ability to deliver **adequate** water to control major fires throughout the municipality on a **reliable** basis via sufficient and suitable **hydrants**. What is ultimately available to the fire department is the critical test in this fire protection evaluation.

Rates of flow for firefighting purposes are expressed in litres per minute as this is the adopted unit for the firefighting field.

In this edition all quantities are specified in S.I. units.

PART I

GENERAL

ADEQUACY AND RELIABILITY. An adequate and reliable water supply for firefighting is an essential part of the fire protection system of a municipality. This is normally a piped system in common with domestic potable water service for the community.

A water supply system is considered to be fully adequate if it can deliver the necessary fire flow at any point in the distribution gridiron for the applicable time period specified in the table “Required Duration of Fire Flow” with the consumption at the maximum daily rate (average rate on maximum say of a normal year). When this delivery is also possible under certain emergency or unusual conditions as herein specified, the system is considered to be reliable. In cities of population in excess of 250,000 (or smaller places with high fire incident and severe hazard conditions) it is usually necessary to consider the possibility of two simultaneous major fires in the area served by the system.

Fire flows are amounts of water necessary to control fires. These are determined as shown in Part II. System design should contemplate meeting the required fire flows existing or probable with the possible exception of gross anomalies where there is no fire threat to the remainder of the community. In these cases, the properties should preferably be modified in hazard to reduce the required flow as part of a coordinated community fire protection system.

The protection of buildings by automatic sprinkler systems is a significant contribution to the fire protection of the community and should be encouraged, not penalized by onerous service charges or metering requirements.

In order to provide reliability, duplication of some or all parts of the system will be necessary, the need for duplication being dependent upon the extent to which the various parts may reasonably be expected to be out of service as a result of maintenance and repair work, an emergency or some unusual condition. The introduction of storage, either as part if the supply works or on the distribution system, may partially or completely offset the need for duplicating various parts of the system, the value of the storage depending upon its amount, location and availability.

STORAGE. In general, storage reduces the requirements of those parts of the system through which supply has already passed. Since storage usually fluctuates, the normal daily minimum maintained is the amount that should be considered as available for fires. Because of the decrease in pressure when water is drawn down in standpipes, only the portion of this normal daily minimum storage that can be delivered at a residual pressure of 150kPa at the point of use is considered as available. As well as the quantity available, the rate of delivery of water to the system from storage for the fire flow period is critical to this consideration.

PRESSURE. The principal requirement to be considered is the ability to deliver water in sufficient quantity to permit fire department pumpers to obtain an adequate supply from hydrants. To overcome friction loss in the hydrant branch, hydrant and suction hose, a minimum residual water pressure of 150 kPa in the street main is required during flow. Under conditions of exceptionally low suction losses, a lower residual may be possible. This includes the use of 100 mm and larger outlets for fire department pumper use and hydrants with large waterways.

Higher sustained pressure is of importance in permitting direct continuous supply to automatic sprinkler systems, to building standpipe and hose systems, and in maintaining a water plan so that no portion of the protection area is without water, such as during a fire at another location. Residual pressures that exceed 500 kPa during large flows are of value as they permit short hose-lines to be operated directly from hydrants without supplementary pumping.

SUPPLY WORKS

NORMAL ADEQUACY OF SUPPLY WORKS. The source of supply, including impounding reservoirs, and each part of the supply works should normally be able to maintain the maximum daily consumption rate plus the maximum required fire flow. Each distribution service within the system should similarly support its own requirements. In large cities where fire frequency may result in simultaneous fires, additional flow must be considered in accordance with the potential. Filters may be considered as capable of operating at a reasonable overload capacity based upon records and experience. In general, overload capacity will not exceed 25 percent, but may be higher in well designed plans operating under favourable conditions.

The absolute minimum supply available under extreme dry weather conditions should not be taken as the measure of the normal ability of the source of supply such as supply from wells. The normal or average capacity of wells during the most favourable nine month period should be considered, or the normal sustained flow of surface supplies to the source.

RELIABILITY OF SOURCE OF SUPPLY. The effect on adequacy must be considered for such factors as frequency, severity and duration of droughts, physical condition of dams and intakes; danger from earthquakes, floods, forest fires, and ice dams or other ice formations; silting-up or shifting of channels; possibility of accidental contamination of watershed or source; absence of watchmen or electronic supervision where needed; and injury by physical means. Where there is a risk of disruption, special precautions or alternate supplies should be arranged.

Where the supply is from wells, some consideration should be given to the absolute minimum capacity of the wells under the most unfavourable conditions; also to the length of time that the supply from the wells would be below the maximum daily consumption rate, and the likelihood of this condition recurring every year or only at infrequent intervals. It should be recognized that some water is generally available from wells and that the most extreme conditions are not as serious as a total interruption of the supply, as would be the case in the breaking of a dam or shifting of a channel. The possibility of clogging, salinity, and the need for periodic cleaning and overhauling must be considered. Dependence upon a single well, even where records are favourable, may be considered a feature of unreliability.

Frequent cleaning of reservoirs and storage tanks may be considered as affecting reliability.

Continuity of, and delay in implementing water supplies obtained from systems or sources not under the control of the municipality or utility should be considered also from these aspects.

GRAVITY SYSTEMS. A gravity system delivering supply from the source to distribution directly without the use of pumps is advantageous from a fire protection point of view because of its inherent reliability, but a pumping system can also be developed to a high degree of reliability.

PUMPING

RELIABILITY OF PUMPING CAPACITY. Pumping capacity, where the system or service is supplied by pumps, should be sufficient, in conjunction with storage when the two most important pumps are out of service, to maintain the maximum daily consumption rate plus the maximum required fire flow at required pressure for the required duration. For smaller municipalities (usually up to about 25,000 population) the relative infrequency of fires is assumed as largely offsetting the probability of a serious fire occurring at times when two pumps are out of service. (The most important pump is normally, but not always, the one of largest capacity, depending upon how vital is its contribution to maintaining flow to the distribution system.)

To be adequate, remaining pumps in conjunction with storage, should be able to provide required fire flows for the specified durations at any time during a period of five days with consumption at the maximum daily rate. Effect of normal minimum capacity of elevated storage located on the distribution system and storage of treated water above low lift pumps should be considered. The rate of flow from such storage must be considered in terms of any limitation of water main capacity. The availability of spare pumps or prime movers that can quickly be installed may be credited, as may pumps of compatible characteristics which may be valved from another service.

POWER SUPPLY FOR PUMPS. Electric power supply to pumps should be so arranged that a failure in any power line or the repair or replacement of a transformer, switch, control unit or other device will not prevent the delivery, in conjunction with elevated storage, of required fire flows for the required durations at any time during a period of two days with consumption at the maximum daily rate.

Power lines should be underground from the station or substation of the power utility to water plants and pumping stations and have no other consumers enroute. The use of the same transmission lines by other consumers introduces unreliability because of the possibility of interruption of power or deterioration of power characteristics.

Overhead power lines are more susceptible to damage and interruption than underground lines and introduce a degree of un-reliability that depends upon their location and construction. In connections with overhead lines, consideration should be given to the number and duration of lightning, wind, sleet, and snow storms in the area; the type of poles or towers and wires; the nature of the country traversed; the effect of earthquakes, forest fires, and floods; the lightning and surge protection provided; the extent to which the system is dependent upon overhead lines; and the ease of, and facilities for, repairs.

The possibility of power systems or network failures affecting large areas should be considered. In-plant auxiliary power or internal combustion driver standby pumping are appropriate solutions to these problems in many cases, particularly in small plants where high pumping capacity is required for fire protection service. When using automatic starting, prime 'movers' for auxiliary power supply and pumping should have controllers listed by Underwriters' Laboratories of Canada to establish their reliability.

FUEL SUPPLY. At least a five day supply of fuel for internal combustion engines or boilers used for regular domestic supply should be provided. Where long hauls, condition of roads, climatic conditions, or other circumstances could cause interruptions of delivery longer than five days, a greater storage should be provided. Gas supply should be from two independent sources or from duplicate gas-producer plants with gas storage sufficient for 24 hours. Unreliability of regular fuel supply may be offset in whole or in part by suitable provisions for the use of an alternate fuel or power supply.

BUILDINGS AND PLANT

BUILDINGS AND STRUCTURES. Pumping stations, treatment plants, control centres and other important structures should be located, constructed, arranged, and protected so that damage by fire, flooding, or other causes will be held to a minimum. They should contain no combustible material in their construction, and, if hazards are created by equipment or materials located within the same structure, the hazardous section should be suitably separated by fire-resistive partitions or fire walls.

Buildings and structures should have no fire exposures. If exposures exist, suitable protection should be provided, Electrical wiring and equipment should be installed in accordance with the Canadian Electrical Code. All internal hazards should be properly safeguarded in accordance with good practice. Private in-plant fire protection should be provided as needed.

MISCELLANEOUS SYSTEM COMPONENTS, PIPING AND EQUIPMENT. Steam piping, boiler-feed lines, fuel-piping (gas or oil lines to boilers as well as gas, oil or gasoline lines to internal-combustion engines), and air lines to wells or control systems should be so arranged that a failure in any line or the repair or replacement of a valve, fuel pump, boiler-feed pump, injector, or other necessary device, will not prevent the delivery, in conjunction with storage, of the required fire flows for the specified duration at any time during a period of two days with consumption at the maximum daily rate.

Plants should be well arranged to provide for effective operation. Among the features to be considered are: ease of making repairs and facilities for this work, danger of flooding because of broken piping; susceptibility to damage by spray; reliability of priming and chlorination equipment; lack of semi-annual inspection of boilers or other pressure vessels; dependence upon common non-sectionalized electric bus bars; poor arrangement of piping; poor condition or lack of regular inspections of important valves; and factors affecting the operation of valves or other devices necessary for fire service such as design, operation, and maintenance of pressure regulating valves, altitude valves, air valves, and other special valves or control devices, provision of power drives, location of controls, and susceptibility to damage.

Reliability of treatment works is likely to be influenced by the removal from service of at least one filter or other treatment unit; the reduction of filter capacity by turbidity, freezing or other conditions of the water; the need for cleaning basins; and the dependability of power for operating valves, wash-water pumps, mixers and other appurtenances.

OPERATIONS. Reliability in operation of the supply system and adequate response to emergency or fire demands are essential. Instrumentation, controls and automatic features should be arranged with this in mind. Failure of an automatic system to maintain normal conditions or to meet unusual demands should result in the sounding of an alarm where remedial action will be taken.

The operating force should be competent, adequate, and continuously available as may be required to maintain both the domestic and fire services.

EMERGENCY SERVICES. Emergency crews, provided with suitable transportation, tools and equipment, should be continuously on duty in the larger systems and be readily available upon call in small systems. Spare pipe and fittings, and construction equipment should be readily available. Alarms for fires in buildings should be received by the utility at a suitable location where someone is always on duty who can take appropriate action as required, such as placing additional equipment in operation, operating emergency or special valves, or adjusting pressures. Receipt of alarms may be by fire alarm circuit, radio, outside alerting device, or telephone, but where special operations are required, the alarm service should be equivalent to that needed for a fire station.

Response of an emergency crew should be made to major fires to assist the fire department in making the most efficient use of the water system and to ensure the best possible service in the event of a water main break or other emergency. The increase of pressures by more than 25 percent for fires is considered to increase the possibility of breaks.

PIPING

RELIABILITY OF SUPPLY MAINS. Supply mains cut off for repair should not drastically reduce the flow available to any district. This includes all pipe lines or conduits on which supply to the distribution system is dependent, including intakes, suction or gravity lines to pumping stations, flow lines from reservoirs, treatment plant piping, force mains, supply and arterial mains, etc. Consideration should be given to the greatest effect that a break, joint separation or other failure could have on the delivery of the maximum daily consumption rate plus required fire flow at required pressure over a three day period. Aqueducts, tunnels or conduits of substantial construction may be considered as less susceptible to failure and equivalent to good mains with a long history of reliability.

INSTALLATION OF PIPE. Mains should be in good condition and properly installed. Pipe should be suitable for the service intended. Asbestos-cement, poly-vinyl chloride (PVC), cast and ductile iron, reinforced concrete and steel pipe manufactured in accordance with appropriate Canadian Standards Association or ANSI/AWWA standards, or any pipes listed by Underwriters' Laboratories of Canada for fire service are considered satisfactory. Normally, pipe rated for a maximum working pressure of 1000 kPa is required, Service records, including the frequency and nature of leaks, breaks, joint separations, other failures and repairs, and general conditions should be considered as indicators of reliability. When mains are cleaned they should be lined.

Mains should be so laid as not to endanger one another, and special construction should be provided to prevent their failure at stream crossings, railroad crossings, bridges, and other points where required by physical conditions; supply mains should be valved at one and one half kilometre intervals and should be equipped with air valves at high points and blow offs at low points. Mains should not be buried extremely deep or be unusually difficult to repair, though depths to ten feet may be required because of frost conditions.

The general arrangement of important valves, of standard or special fittings, and of connections at cross-overs, intersections, and reservoirs, as well as at discharge and suction headers, should be considered with respect to the time required to isolate breaks. The need for check valves on supply or force mains and for other arrangements to prevent flooding of stations or emptying of reservoirs at the time of a break in a main should also be considered, as well as the need for relief valves or surge chambers. Accessibility of suitable material and equipment and ease of making repairs should be considered.

Arterial feeder mains should provide looping throughout the system for mutual support and reliability, preferably not more than 1000 metres between mains. Dependence of a large area on a single main is a weakness. In general the gridiron of minor distributors supplying residential districts should consist of mains at least 150mm in size and arranged so that the lengths on the long sides of blocks between intersecting mains do not exceed 200 metres. Where longer lengths of 150mm pipe are necessary 200mm or larger intersecting mains should be used. Where initial pressures are unusually high, a satisfactory gridiron may be obtained with longer lengths of 150mm pipe between intersecting mains.

Where deadends and a poor gridiron are likely to exist for a considerable period or where the layout of the streets and the topography are not well adapted to the above arrangement, 200mm pipe should be used. Both the ability to meet the required fire flows and reliability of a reasonable supply by alternate routing must be taken into account in this consideration.

VALVES. A sufficient number of valves should be installed so that a break or other failure will not affect more than 400 metres of arterial mains, 150 metres of mains in commercial districts, or 250 metres of mains in residential districts. Valves should be maintained in good operating condition. The recommended inspection frequency is once a year, and more frequently for larger valves and valves for critical applications.

A valve repair that would result in reduction of supply is a liability, but because of the probable infrequency of occurrence, it might be considered as introducing only a moderate degree of unreliability even if it resulted in total interruption. The repair of a valve normally should be accomplished in two days. Valves opening opposite to the majority are undesirable and when they do occur they should be clearly identified.

HYDRANTS

SIZE, TYPE AND INSTALLATION. Hydrants should conform to American Water Works Standard for Dry Barrel Fire Hydrants or Underwriters' Laboratories of Canada listing. Hydrants should have at least two 65mm outlets. Where required fire flows exceed 5000 l/min or pressures are low there should also be a large pumper outlet. The lateral street connection should not be less than 150mm in diameter. Hose threads, operating and cap nuts on outlets should conform to Provincial Standard dimensions. A valve should be provided on lateral connections between hydrants and street mains.

Hydrants that open in a direction opposite to that of the majority are considered unsatisfactory. Flush hydrants are considered undesirable because of delay in getting into operation; this delay is more serious in areas subject to heavy snow storms. Cisterns are considered unsatisfactory as an alternative to pressure hydrants. The number and spacing of hydrants should be as indicated in the table titled "Standard Hydrant Distribution".

INSPECTION AND CONDITION. Hydrants should be inspected at least semi-annually and after use. The inspection should include operation at least once a year. Where freezing temperatures occur, the semi-annual inspections should be made in the spring and fall of each year. Because of the possibility of freezing they should be checked frequently during extended periods of severe cold. Hydrants should be kept in good condition and suitable records of inspections and repairs be maintained. Hydrants should be painted in highly visible colours so that they are conspicuous and be situated with outlets at least twelve inches above the grade. There should be no obstruction that could interfere with their operation. Snow should be cleared promptly after storms and ice and snow accumulations removed as necessary.

HYDRANT DISTRIBUTION. Hydrant locations and spacing should be convenient for fire department use. Hydrants should be located at intersections, in the middle of long blocks and at the end of long dead-end streets. To allow for convenient utilization of water supplies, distribution density of hydrants should be in accordance with the required fire flows indicated in the table titled "Standard Hydrant Distribution" (page 16). The maximum recommended spacing of hydrants in commercial, industrial, institutional and multi-family residential areas is 90 metres; in single family residential areas 180 metres is recommended. In areas where fire apparatus have access (e.g. large properties, private developments, etc.), hydrants should be required by bylaw. The planning of hydrant locations should be a cooperative effort between the water utility and fire department.

RECORDS

PLANS AND RECORDS. Complete, up-to-date plans and records essential for the proper operation and maintenance of the system should be available in a convenient form, suitably indexed and safely filed. These should include plans of the source as well as records of its yield and a reliable estimate of the safe yield; plans of the supply works including dams, intakes, wells, pipelines, treatment plants, pumping stations, storage reservoirs and tanks; and a map of the distribution system showing mains, valves, and hydrants. Plans and maps should be in duplicate and stored at different locations.

Detailed distribution system plans, in a form suitable for field use, should be available for maintenance crews. Records of consumption, pressures, storage levels, pipes, valves, hydrants, and of the operations of the supply works and distribution system, including valve and hydrant inspections and repairs should be maintained.

TABLES

STANDARD HYDRANT DISTRIBUTION	
Fire Flow Required (litres per minute)	Average Area per Hydrant (m^2)
2,000	16,000
4,000	15,000
6,000	14,000
8,000	13,000
10,000	12,000
12,000	11,000
14,000	10,000
16,000	9,500
18,000	9,000
20,000	8,500
22,000	8,000
24,000	7,500
26,000	7,000
28,000	6,500
30,000	6,000
32,000	5,500
34,000	5,250
36,000	5,000
38,000	4,750
40,000	4,500
42,000	4,250
44,000	4,000
46,000	3,750
48,000	3,500

REQUIRED DURATION OF FIRE FLOW	
Fire Flow Required (litres per minute)	Duration (hours)
2,000 or less	1.0
3,000	1.25
4, 000	1.5
5,000	1.75
6,000	2.0
8000	2.0
10,000	2.0
12,000	2.5
14,000	3.0
16,000	3.5
18,000	4.0
20000	4.5
22,000	5.0
24,000	5.5
26,000	6.0
28,000	6.5
30,000	7.0
32000	7.5
34,000	8.0
36,000	8.5
38,000	9.0
40,000 and over	9.5

Interpolate for intermediate figures

Area refers to surface area of blocks and bounding streets. For a street without adjacent streets, a depth of one-half block is used.

A water supply system is considered to be adequate for fire protection when it can supply water as indicated above with consumption at the maximum daily rate. Certain types of emergency supplies may be included where reasonable conditions for their immediate use exist. Storage on the system is credited on the basis of the normal daily minimum maintained insofar as pressure permits its delivery at the rate considered.

PART II

GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOW
COPYRIGHT I.S.O.

N.B. It should be recognized that this is a "guide" in the true sense of the word, and requires a certain amount of knowledge and experience in fire protection engineering for its effective application. Its primary purpose is for the use of surveyors experienced in this field, but it is made available to municipal officials, consulting engineers and others interested as an aid in estimating fire flow requirements for municipal fire protection.

Required Fire Flow may be described as the amount and rate of water application required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure. This may include as much as a city block.

1. An estimate of the fire flow required for a given area may be determined by the formula:

$$F = 220C\sqrt{A}$$

where

F = the required fire flow in litres per minute.

C = coefficient related to the type of construction.

= 1.5 for wood frame construction (structure essentially all combustible).

= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior).

= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls).

= 0.6 for fire-resistive construction (fully protected frame, floors, roof).

Note: For types of construction that do not fall within the categories given, coefficients shall not be greater than 1.5 nor less than 0.6 and may be determined by interpolation between consecutive construction types as listed above. Construction types are defined in the Appendix.

A = The total floor area in square metres (including all storeys, but excluding basements at least 50 percent below grade) in the building being considered.

For fire-resistive buildings, consider the two largest adjoining floors plus 50 percent of each of any floors immediately above them up to eight, when the vertical openings are inadequately protected. If the vertical openings and exterior vertical communications are properly protected (one hour rating), consider only the area of the largest floor plus 25 percent of each of the two immediately adjoining floors.

For one family and two family dwellings not exceeding two storeys in height, see **Note J.**

2. The value obtained in No. 1 may be reduced by as much as 25% for occupancies having a low contents fire hazard or may be increased by up to 25% surcharge for occupancies having a high fire hazard. Those may be classified as to contents as follows:

Non-Combustible	-25%	Free Burning	+15%
Limited Combustible	-15%	Rapid Burning	+25%
Combustible	No Charge		

As guide for determining low or high fire hazard occupancies, see the list in the Appendix. The fire flow determined shall not be less than 2,000 L/min,

3. The value obtained in No.2 above may be reduced by up to 50% for complete automatic sprinkler protection depending upon adequacy of the system. The credit for the system will be a maximum of 30% for an adequately designed system conforming to NFPA 13 and other NFPA sprinkler standards. Additional credit of up to 10% may be granted if the water supply is standard for both the system and fire department hose lines required. The percentage reduction made for an automatic sprinkler system will depend upon the extent to which the system is judged to reduce the possibility of fires spreading within and beyond the fire area. Normally this reduction will not be the maximum allowed without proper system supervision including water flow and control valve alarm service. Additional credit may be given of up to 10% for a fully supervised system.

4. To the value obtained in No. 2 above a percentage should be added for structures exposed within 45 metres by the fire area under consideration. This percentage shall depend upon the height, area, and construction of the building(s) being exposed, the separation, openings in the exposed building(s), the length and height of exposure, the provision of automatic sprinklers and/or outside sprinklers in the building(s) exposed, the occupancy of the exposed building(s), and the effect of hillside locations on the possible spread of fire.

   The charge for any one side generally should not exceed the following limits for the separation:

Separation	Charge	Separation	Charge
0 to 3m	25%	20.1 to 30 m	10%
3.1 to 10m	20%	30.1 to 45m	5%
10.1 to 20m	15%		

   The total percentage shall be the sum of the percentage for all sides, but shall not exceed 75%.

   The fire flow shall not exceed 45,000 L/min nor be less than 2,000 L/min.

Notes to Calculation

Note A: The guide is not expected to necessarily provide an adequate value for lumber yards, petroleum storage, refineries, grain elevators, and large chemical plants, but may indicate a minimum value for these hazards.

Note B: Judgment must be used for business, industrial, and other occupancies not specifically mentioned.

Note C: Consideration should be given to the configuration of the building(s) being considered and accessibility by the fire department.

Note D: Wood frame structures separated by less than 3 metres shall be considered as one fire area.

Note E: Fire Walls: - In determining floor areas, a fire wall that meets or exceeds the requirements of the current edition of the National Building Code of Canada (provided this necessitates a fire resistance rating of 2 or more hours) may be deemed to subdivide the building into more than one area or may, as a party wall, separate the building from an adjoining building.

Normally any unpierced party wall considered to form a boundary when determining floor areas may warrant up to a 10% exposure charge.

Note F: High one storey buildings: When a building is stated as 1=2, or more storeys, the number of storeys to be used in the formula depends upon the use being made of the building. For example, consider a 1=3 storey building. If the building is being used for high piled stock, or for rack storage, the building would probably be considered as 3 storeys and, in addition, an occupancy percentage increase may be warranted.

However, if the building is being used for steel fabrication and the extra height is provided only to facilitate movement of objects by a crane, the building would probably be considered as a one storey building and an occupancy credit percentage may be warranted.

Note G: If a building is exposed within 45 metres, normally some surcharge for exposure will be made.

Note H: Where wood shingle or shake roofs could contribute to spreading fires, add 2,000 L/min to 4,000 L/min in accordance with extent and condition.

Note I: Any non-combustible building is considered to warrant a 0.8 coefficient.

Note J: Dwellings: For groupings of detached one family and small two family dwellings not exceeding 2 stories in height, the following short method may be used. (For other residential buildings, the regular method should be used.)

Exposure distances	Suggested required fire flow	
	Wood Frame	Masonry or Brick
Less than 3m	See Note "D"	6,000 L/min
3 to 10m	4,000 L/min	4,000 L/min
10.1 to 30m	3,000 L/min	3,000 L/min
Over 30m	2,000 L/min	2,000 L/min

If the buildings are contiguous, use a minimum of 8,000 L/min. Also consider Note H.

OUTLINE OF PROCEDURE

A. Determine the type of construction.

B. Determine the ground floor area.

C. Determine the height in storeys.

D. Using the fire flow formula, determine the required fire flow to the nearest 1,000 L/min.

E. Determine the increase or decrease for occupancy and apply to the value obtained in D above. Do not round off the answer.

F. Determine the decrease, if any, for automatic sprinkler protection. Do not round off the value.

G. Determine the total increase for exposures, Do not round off the value.

H. To the answer obtained in E, subtract the value obtained in F and add the value obtained in G.

The final figure is customarily rounded off to the nearest 1,000 L/min.

APPENDIX

TYPES OF CONSTRUCTION

For the specific purpose of using the Guide, the following definitions may be used:

Fire-Resistive Construction - Any structure that is considered fully protected, having at least 3-hour rated structural members and floors. For example, reinforced concrete or protected steel.

Non-combustible Construction - Any structures having all structural members including walls, columns, piers, beams, girders, trusses, floors, and roofs of non-combustible material and not qualifying as fire-resistive construction. For example, unprotected metal buildings.

Ordinary Construction - Any structure having exterior walls of masonry or such non-combustible material, in which the other structural members, including but not limited to columns, floors, roofs, beams, girders, and joists, are wholly or partly of wood or other combustible material.

Wood Frame Construction - Any structure in which the structural members are wholly or partly of wood or other combustible material and the construction does not qualify as ordinary construction.

OCCUPANCIES

Examples of Low Hazard Occupancies:

Apartments
Asylums
Churches
Clubs
Colleges & Universities
Dormitories
Dwellings
Hospitals
Hotels
Institutions
Libraries, except Large Stack Room Areas
Museums
Nursing, Convalescent and Care Homes
Office Buildings
Prisons
Public Buildings
Rooming Houses
Schools
Tenements

Generally, occupancies falling in National Building Code Groups A, B, C and D are of this class.

Examples of High Hazard Occupancies:

- Aircraft Hangars
- Cereal, Feed, Flour and Grist Mills
- Chemical Works - High Hazard
- Cotton Picker and Opening Operations
- Explosives & Pyrotechnics Manufacturing
- Shade Cloth Manufacturing
- Foamed Plastics, Storage or use in Manufacturing
- High Piled Combustibles Storage in excess of 6.5 metres high
- Linseed Oil Mills
- Match Manufacturing
- Oil Refineries
- Paint Shops
- Pyroxylin Plastic Manufacturing & Processing
- Solvent Extracting
- Varnish and Paint Works
- Woodworking with Flammable Finishing
- Linoleum and Oilcloth Manufacturing

Other occupancies involving processing, mixing storage and dispensing flammable and/or combustible liquids. Generally, occupancies falling in National Building Code Group F, Divisions 1 and 2 would be in this class.

For other occupancies, good judgment should be used, and the percentage increase will not necessarily be the same for all buildings that are in the same general category - for example "Colleges and Universities": this could range from a 25% decrease for buildings used only as dormitories to an increase for a chemical laboratory. Even when considering high schools, the decrease should be less if they have extensive shops.

It is expected that in commercial buildings no percentage increase or decrease for occupancy will be applied in most of the fire flow determinations. In general, percentage increase or decrease will not be at the limits of plus or minus 25%.

EXPOSURES

When determining exposures it is necessary to understand that the exposure percentage increase for a fire in a building (x) exposing another building (y) does not necessarily equal the percentage increase when the fire is in building (y) exposing building (x). The Guide gives the maximum possible percentage for exposure at specified distances. However, these maximum possible percentages should not be used for all exposures at those distances. In each case the percentage applied should reflect the actual conditions but should not exceed the percentage listed.

The maximum percentage for the separations listed generally should be used if the exposed building meets all of the following conditions:

a. Same type or a poorer type of construction than the fire building.
b. Same or greater height than the fire building.
c. Contains unprotected exposed openings.
d. Unsprinklered.

CONVERSION FACTORS

Multiply	By	To Obtain
Centimetre	0.3937	Inches
Cubic Foot	0.0283	Cubic Metres
Cubic Metre	35.3145	Cubic Feet
Cubic Metre	219.97	Imperial Gallons
Cubic Metre	1.000	Litres
Foot	0.3048	Metres
Horsepower	0.7457	Kilowatt
Imperial Gallon	4.546	Litres
Inch	2.54	Centimetres
Kilogram	2.2046	Pounds
Kilogram of Water	1	Litres
Kilopascal	0.1450	Pounds per sq. inch
Kilowatt	1.341	Horsepower
Litre	0.21997	Imperial Gallons
Litre of Water	1	Kilograms
Metre	3.281	Feet
Metre of Water	10	Kilopascals
Pound	0.4536	Kilograms
Pound per sq. inch	6.89476	Kilopascals
U.S. Gallons	0.8327	Imperial Gallons
Imperial Gallons	1.201	U.S.Gallons