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To:	Village of Belcarra	Date:	May 6, 2020
Attention:	Lorna Dysart	Project No.:	32482
Reference:	Belcarra Water System		
From:	Chris Boit, P.Eng		

ISL has been requested by the Village to review the existing water system and provide comments on its adequacy in providing water for firefighting purposes. We have conducted a high level review, to determine if there are potential deficiencies in the water system. It should be noted that, if the Village were to proceed with constructing a new reservoir, in depth reviews and models should be generated to ensure accurate fire flows and pressures within the distribution network.

Fire Flow Analysis

There are no set industry standards that instruct Municipalities on how they should design their firefighting. Typically, most Municipalities refer to the Fire Underwriter Survey (FUS) guidelines, as this ensures their residents can insure their personal properties against fire damage. However, water system design requirements are also set out in subdivision and development bylaws. Municipalities should consider both of these methods when developing Fire flows and ensure the minimum requirements of FUS are obtained.

Bylaw 492, 2015 - Subdivision and Development

- 2.8 Fire flow & Design Requirements**
For subdivisions served by the Village of Belcarra water system and those not served by the Village of Belcarra Water System.

Flow	Land Use	Zoning	Design Fire Flow	Interim Fire
			(F) litres/sec.	(f) litres/sec.
Residential	Single Family	RS-1	60	45
	Single Family	RS-2	60	45
	Cluster Housing	RS-2, RS-3	120	90
Suburban	Rural & Recreational A-1		60	45
	Campgrounds		60	45
	Institutions	P-1	90	65
Commercial &, Industrial	Isolated Commercial		90	65
	Small Grp. Commercial		120	90

Figure 1: Extract from Subdivision and Development Bylaw 492, 2015

The above table establishes a flow of **60 l/s** for residential properties and **90 l/s** for Institutions. We have discounted Commercial as the Village currently does not have properties that fall within this category.

Fire Underwriter Survey (FUS) Guidelines

FUS develops fire flow requirements by reviewing buildings within a Municipality and applying statistical analysis, likelihood of fire and the potential to spread the fire. The following is a sample analysis of required fire flows for the Village hall (a copy is contained at the end of this memo).

1.	Type of Construction	1.5	Choose Type of Construction from Table A	
			Box-> Wood Frame (All Combustible)	
	Ground Floor Area	450 m ²	see footprint calculations --->	
	Height in Storeys	1		
Step 1	Required Fire Flow	7000 L/min		117 L/s
2.	Fire Hazard Occupancies	Charge	Choose Classification	----->
		0.85	Box-> Limited Combustible	
Step 2	Required Fire Flow	5950 L/min		99 L/s
3.	Sprinkler Protection			
	Choose Classification From Table C	Charge		
Box->	No Sprinklers	0		
	Choose Additional Credits (If Applicable)			
Box->	Standard Water Supply for Both System and Fire Hose I	0.1		
	Total Charge	0.1		
Step 3	Sprinkler Protection Deduction	595.03 L/min		10 L/s
4.	Exposures			
		Separation	Charge	
	Side A	30.1 to 45m	0.05	
	Side B	>45m	0	
	Side C	>45m	0	
	Side D	>45m	0	
	Total Charge		0.05	
Step 4	Exposure FF Charge	297.52 L/min		5 L/s
	Total Required Fire Flow	5653 L/min		94 L/s
	=Step 2-Step 3+Step4			
	Rounded Answer	6000 L/min		100 L/s

Based on the above analysis, FUS requires a demand supply of 100 l/s.

Note, that an important determining factor of flow rate, is based upon Exposure (step 4). This requirement is typically based on the adjacent property, because fire fighters are concerned with limiting the spread of fire to adjacent properties. In Belcarra, there is a large separation between properties. However, it is ISL's opinion that exposure would be determined by separation from the tree line in Belcarra's case. As the trees have the potential to spread fire through the undergrowth and canopy to the next property. If the same building were evaluated, with this type of exposure, the following flows are determined:

1.	Type of Construction	1.5	Choose Type of Construction from Table A	
			Box-> Wood Frame (All Combustible)	
	Ground Floor Area	450 m ²	see footprint calculations --->	
	Height in Storeys	1		
Step 1	Required Fire Flow	7000 L/min		117 L/s
2.	Fire Hazard Occupancies	Charge	Choose Classification	----->
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	Choose Classification From Table C	Charge		
Box->	No Sprinklers	0		
	Choose Additional Credits (If Applicable)			
Box->	Standard Water Supply for Both System and Fi	0.1		
	Total Charge	0.1		
Step 3	Sprinkler Protection Deduction	595.03 L/min		10 L/s
4.	Exposures			
		Separation	Charge	
	Side A	30.1 to 45m	0.05	
	Side B	0 to 3m	0.25	
	Side C	0 to 3m	0.25	
	Side D	0 to 3m	0.25	
	Total Charge		0.75	
Step 4	Exposure FF Charge	4462.7 L/min		74 L/s
	Total Required Fire Flow	9818 L/min		164 L/s
	=Step 2-Step 3+Step4			
	Rounded Answer	10000 L/min		167 L/s

If the tree exposure is considered, there is a significant jump in the required flow rate to 167l/s from 100 l/s.

Typically, in most Municipalities the Civic buildings are generally the largest structures. However, in Belcarra that is not the case and it is not unreasonable to see properties in excess of 9000 sq ft. If such a property were considered, flow rates of approximately 225 l/s would be required.

As you can see, there is are a variable number of flow rates that could potentially be accepted as correct. The decision on which one to apply, becomes a risk tolerance decision for the Village.

If we were to base our fire flow requirement on the Village's existing Bylaw, the Village should be considering a Fire flow that meets 90 l/s. As this is the recommend flow for Institutions and the category the Village Hall falls within.

The existing Bylaw does not refer to the required duration of fire flow. Therefore, we recommend basing the duration of fire flow as identified in the FUS, which is between 1.75 and 2 hrs. We would recommend the upper limit of 2 hours.

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	1.50
5,000	1.75
6,000	2.0
8,000	2.0
10,000	2.0
12,000	2.5
14,000	3.0
16,000	3.5
18,000	4.0

Figure 2: Extract from FUS

Therefore, the amount of water required to fight a fire would be:

Volume of water for fire flow = (90 l/s x 60 x 60) x 2hrs = 648,000 liters.

Reservoir sizing

To determine the size of a required reservoir, a number of factors need to be considered, fire flow, residential demand for water and the supply rate of water.

Typically, when determining a reservoir capacity, a theoretical water demand is developed. For the purpose of this memo we have not undertaken this process as it will take a significant amount of time and cost. Therefore, for this review we have referred to OPUS' report dated August 4th, 2017. Within this report, it identifies maximum daily flow rates (residential demand) established via a flow meter. The maximum flow recorded was 2.5 l/s. In lieu of theoretical numbers, we feel it is appropriate to base our analysis on this actual recorded flow rate.

The village's supply of potable water is supplied by the District of North Vancouver. The original agreement between the two parties was for the supply of 14 l/s. However, this was later revised to 21 l/s.

Using the identified flow rates, we can determine the flow capacity within the Village's system

$$\begin{aligned}
 \text{Flow Capacity} &= \text{Supply rate} - (\text{Fire Demand} + \text{Residential flow demand}) \\
 &= 21 - (90 + 2.5) \\
 &= -71.5 \text{ l/s}
 \end{aligned}$$

Therefore, during a fire there needs to be storage to offset the deficient flow of 71.5 l/s

$$\begin{aligned}
 \text{Storage required} &= 71.5 \times 60 \times 60 \times 2 \text{ hrs} \\
 &= 514,800 \text{ liters or } 515 \text{ m}^3
 \end{aligned}$$

The existing Tatlow reservoir has an operational storage volume of approximately 300,000 liters, which is less than the required storage volume required. The existing reservoir can supply 70 mins of fire flow at 90 l/s.

Risk Consideration

The current infrastructure with the Village has provided residents with the ability to insure their homes against Fire. Many property owners are under the impression that there is a standardized level for fire protection and once this is met, they can be assured they are adequately protected and that everyone has the same level of service, i.e protection in Belcarra is the same as in Vancouver. However, this is not the case and the costs of insurance reflect this. There are 5 levels of Dwelling protection grades, higher the level the better the system and the lower the cost of insurance. The following table identifies these:

Dwelling Protection Grades.	Simplified "3 tier" system.	Insurance Companies refer to this grade as :
1		
2	Table 1	Protected
3A		
3B	Table 2	Semi - Protected
4	Table 2 Or Table 3	Semi – Protected Or Unprotected
5	Table 3	Unprotected

Belcarra is currently assessed as 3A. To achieve a grade of 3A the following is required.

Public Water Supply

Water supply system designed in accordance with Fire Underwriters Survey standard "Water Supply for Public Fire Protection" must meet all minimum standards specified in the document. In general terms, to meet all minimum standards, the water supply system should be designed to be capable of providing required fire flows simultaneously with Maximum Daily Consumption at a minimum residual pressure of 138 kPa (20 psi), and have not less than 110,000 Litres (24,000 l.gal) in available storage.

Fire Department

Apparatus

For each fire hall with a Dwelling Protection Grade 3A, fire apparatus must include a minimum of one triple combination pumper rated at not less than 3000 LPM (625 l.gpm at 150 psi) and designed in accordance with:

- Underwriters' Laboratories of Canada (ULC) S515 Automobile Fire Fighting Apparatus, or
- National Fire Protection Association (NFPA) 1901 Standard for Automotive Fire Apparatus

Credit for fire apparatus will be based on evidence of reliability indicators including the listing of apparatus by ULC, design specifications, fire pump service test records, age, maintenance history, etc. Apparatus is evaluated from the perspective of the capacity to provide structural fire protection.

To be credited, apparatus must be stored in a suitably constructed and arranged fire hall.



Fire Force

For each fire hall with a Dwelling Protection Grade 3A, the credited available responding fire force will include at a minimum:

- 1 Fire Chief (required to respond but not required to be on-duty)
- 15 auxiliary fire fighters scheduled to respond

Emergency Communications

An adequate and reliable means of receiving alarms of fire and dispatching fire fighters is necessary (ex. public fire number, pagers etc.).

Fire Protection Service Area

The boundary of the protected area must be clearly established and registered with the Provincial Government.

Based on the terms laid out by the Fire Underwriter Survey, the Village may not be meeting several requirements, namely the required fire flows/storage and possibly a suitable Fire Hall. The Fire Hall may be unsuitable because it does not meet current Health and Safe Codes and Seismic requirements.

The Village meets the requirements of appropriate fire force, but it should be noted that the fire fighters are volunteers and not career fire fighters. Therefore, the Village will likely have increased response times to an emergency, which is likely to increase the intensity of incident. Also, as the fire department is not manned by career fire fighters, they could potentially be in a position where the lead fire fighter is not an experienced member of the crew. This could consequently lead to an increase in time fighting the fire, which would result in more water to fight the fire. As the Village relies on Volunteers to fight fires, we would recommend providing the best tools available, as the Health and Safety of these individuals should be paramount, as they do not receive compensation for the risk they expose themselves to.

Next Steps

The following are high level next steps for the Village to undertake

1. Village to decide if they want to proceed with the construction of a new reservoir
2. Continue applying for Grant funding opportunities
3. Engage Engineering consultant to review potential locations and sizing of proposed reservoir.
4. Apply for use of Crown Land (if required)
5. Complete Concept designs for reservoir
6. Apply for Federal and Provincial permits, such as Environmental assessments, Archeology
7. Complete Detailed designs
8. Complete Tender Documents and issue for tender
9. Select and award to Contractor
10. Construct Reservoir
11. Commission Reservoir and tie into the existing water system

Recommendations

Based on the afore mentioned analysis, it is ISL's opinion that the Village of Belcarra should investigate options for increasing capacity within the water network, to ensure they meet the requirements as set out by FUS.

If you should have any further questions, please contact the undersigned.

Regards

Chris Boit, P.Eng

Determination of Required Fire Flow

FUS, 1999

Existing Developments

LOW EXPOSURE

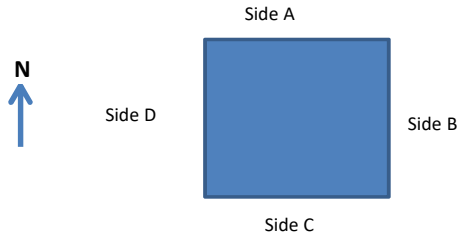
Location:

Village Hall



Address:
4084 Bedwell Bay Rd, Belcarra, V3H 4P8

Exposure Calculation Schematic



Required Field

Step

1.	Type of Construction	1.5	Choose Type of Construction from Table A
			Box-> Wood Frame (All Combustible)
	Ground Floor Area	450 m²	see footprint calculations --->
	Height in Storeys	1	
Step 1	Required Fire Flow	7000 L/min	117 L/s
2.	Fire Hazard Occupancies	Charge	Choose Classification ----->
		0.85	Box-> Limited Combustible
Step 2	Required Fire Flow	5950 L/min	99 L/s
3.	Sprinkler Protection		
	Choose Classification From Table C	Charge	
	Box-> No Spinklers	0	
	Choose Additional Credits (If Applicable)		
	Box-> Standard Water Supply for Both System and F	0.1	
	Total Charge	0.1	
Step 3	Sprinkler Protection Deduction	595.03 L/min	10 L/s
4.	Exposures		
		Separation	Charge
	Side A	30.1 to 45m	0.05
	Side B	>45m	0
	Side C	>45m	0
	Side D	>45m	0
	Total Charge		0.05
Step 4	Exposure FF Charge	297.52 L/min	5 L/s
	Total Required Fire Flow	5653 L/min	94 L/s
	=Step 2-Step 3+Step4		
	Rounded Answer	6000 L/min	100 L/s

Table A - Type of Construction

Type of Construction	Charge
Wood Frame (All Combustible)	1.5
Ordinary Construction (Brick or other masonry walls, combustible floor and interior)	1
Non-combustible Construction (unprotected metal structural component, masonry or metal walls)	0.8
Fire-resistive construction (fully protected frame, floors, roof)	0.6

Table B - Fire Hazard Occupancy Classification

No.2 Classification	Charge
Non-Combustible	0.75
Limited Combustible	0.85
Combustible	1
Free Burning	1.15
Rapid Burning	1.25

Table C - Sprinkler Protection

No. 3 Classification	Charge
Automatic Sprinkler Protection	50%
NFPA Sprinkler Standards	30%
No Spinklers	0

Table D - Additional Protection Credits

No. 3 Additional Credits	Charge
Standard Water Supply for Both System and Fire Hose Lines	10%
Fully Supervised System	10%
N/A	0%

Footprint Calculations:



Table E - Separation

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

Determination of Required Fire Flow

FUS, 1999

Existing Developments

HIGH EXPOSURE

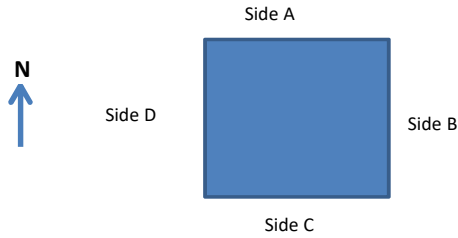
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Table A - Type of Construction

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20.1 to 30m	10%
30.1 to 45m	5%
>45m	0%