s1

Understanding Water Supply for Fire Protection

Presented by Sean Tracey,
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NFPA®

Slide 1

s1

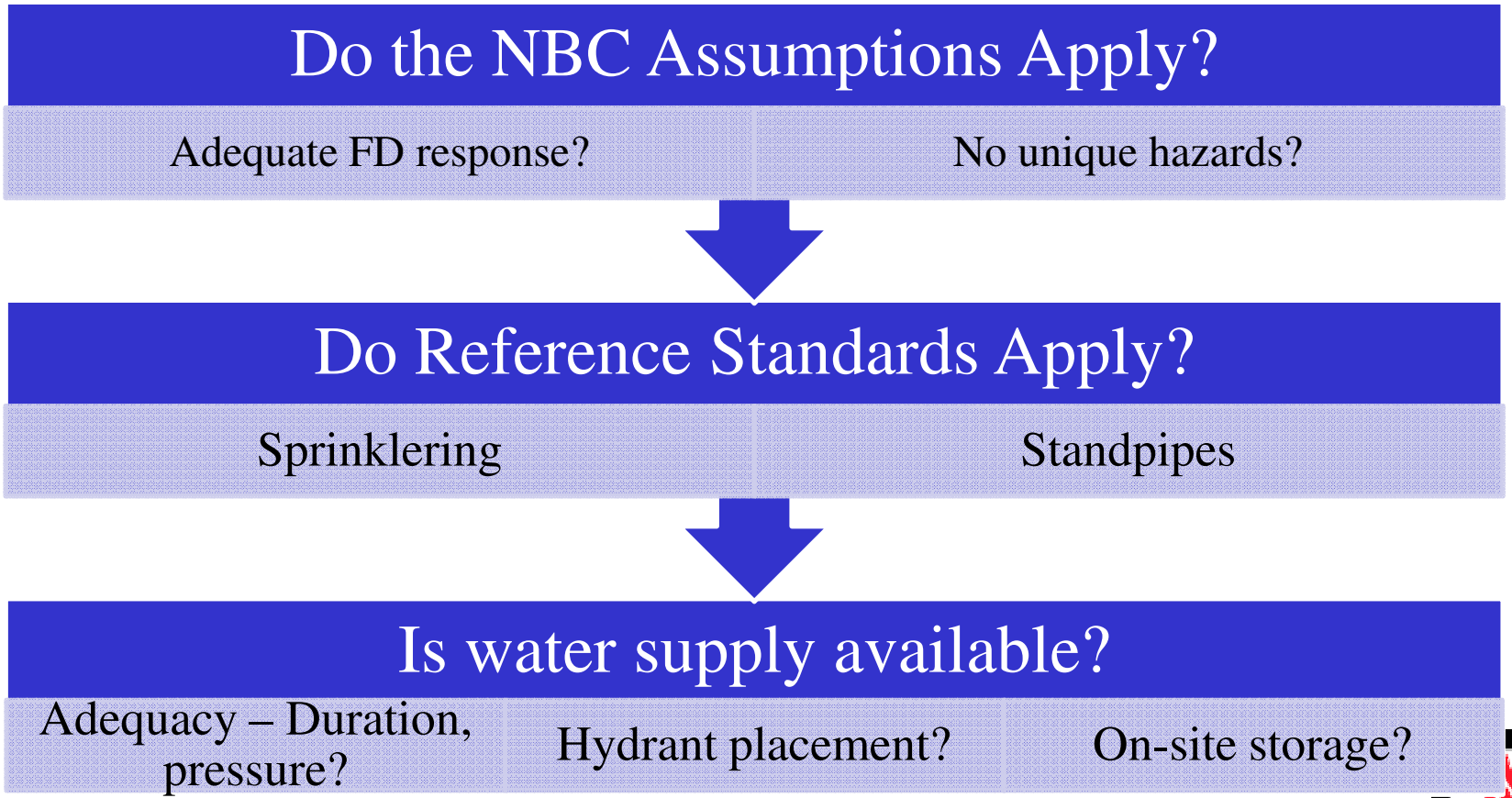
Review the siting distances for hydrants
Make it clearer what te expectations are on building officials.
Give examples to make it more of a workshop based activity.

Consider delivering this to NSBOA, SBOA, BOABC, etc.
stracey, 10/28/2008

Outline

- Assumptions in the NBC
- When do I need to verify water supply adequacy?
- Components in Water Supply
- Hydrant Considerations
- NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting
- Resources

Water Supply Assessment Process



National Building Code

What are the Core Objectives?

- Core Requirements of NBCC
  - Safety
  - Health
  - Accessibility
  - Protection of Buildings

Property preservation is not a core requirement. That is between the building owner and their insurer.

National Building Code

- 3.2.5.7.1) Every building shall be provided with an adequate water supply for fire fighting. *

- Does not apply to Part 9 buildings except assembly occupancies, care and detention, and high hazard occupancies.

Assumptions in the NBC

NBC requires that an adequate water supply for fire fighting be provided for every Part 3 building

When and how is this to be determined?
What are the assumptions used in the reference standards?
What are your fire departments' capabilities?

NBC Intent

- Annex A-3.2.5.7.(1) states that the intent is "be *readily* available and sufficient volume and pressure to enable emergency response personnel to control fire growth so as to *enable safe evacuation* of occupants and the *conduct of search and rescue* operations, *prevent the fire from spreading to adjacent buildings*, and provide a *limited* measure of property protection."

NBC Intent

- Annex A-3.2.5.7.(1)
  - Water supplies for internal systems… as per the reference standards (e.g. NFPA 13, 13R, 13D)
  - Municipal hydrant systems – confirmed unlimited duration = no problem ??
  - Other sites need to determine the water demand and flow requirements

Problems

- No method is give for calculations
  - Several methods are available with varying results – based on assumptions
  - The NBC is out of touch with the communities' expectations of the fire service
- Two provinces (AB, ON) have guidelines published but are the assumptions correct?

- Alberta Standata assumes – if a building is under 600 m2 or under 3 storeys that water supplies can be trucked in.
  - Can in some cases double the area
- ON Guideline has similar assumptions to the NBC
  - Except exposure property protection is beyond the requirements

The Role of the Building Official

- You should be coordinating water supply needs with the local fire department
- This is one area in the codes where you need to exercise judgment
- Just because there is a fire hydrant present does not mean you have adequate water supplies!

Require designers to provide proof of water supply analysis, assumptions, and calculations.

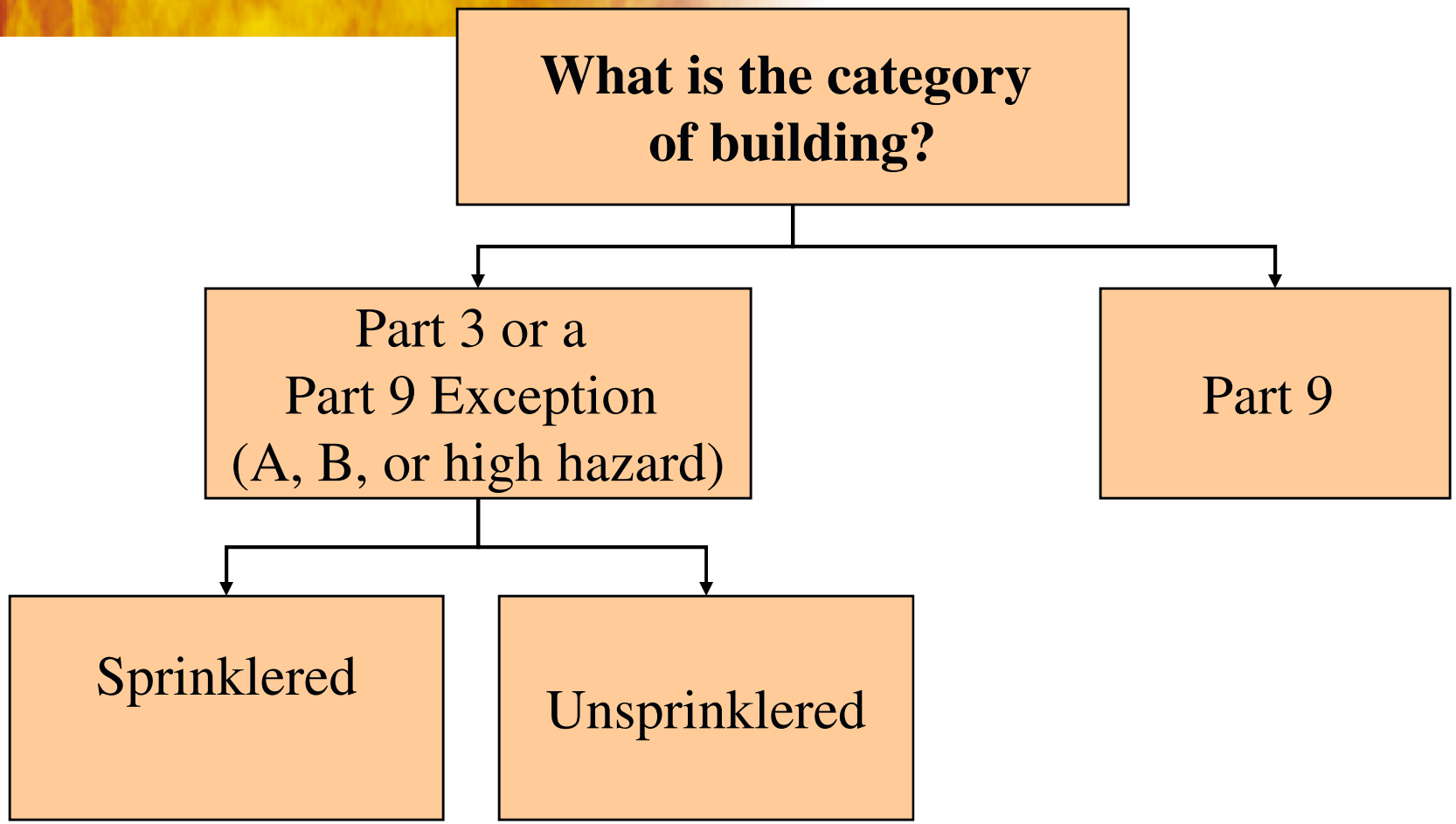
Water supplies

- Water supplies for fire fighting
- Water supplies for sprinklers and standpipe systems

These are separate requirements that need to be confirmed

Where a water supply for fire fighting is required, the drawings submitted for a building permit must contain a description of the supply, e.g., municipal water supply, tanks, etc., amount of total water supply required for fire fighting and the delivery rate. AB Standata

Water Supply Study

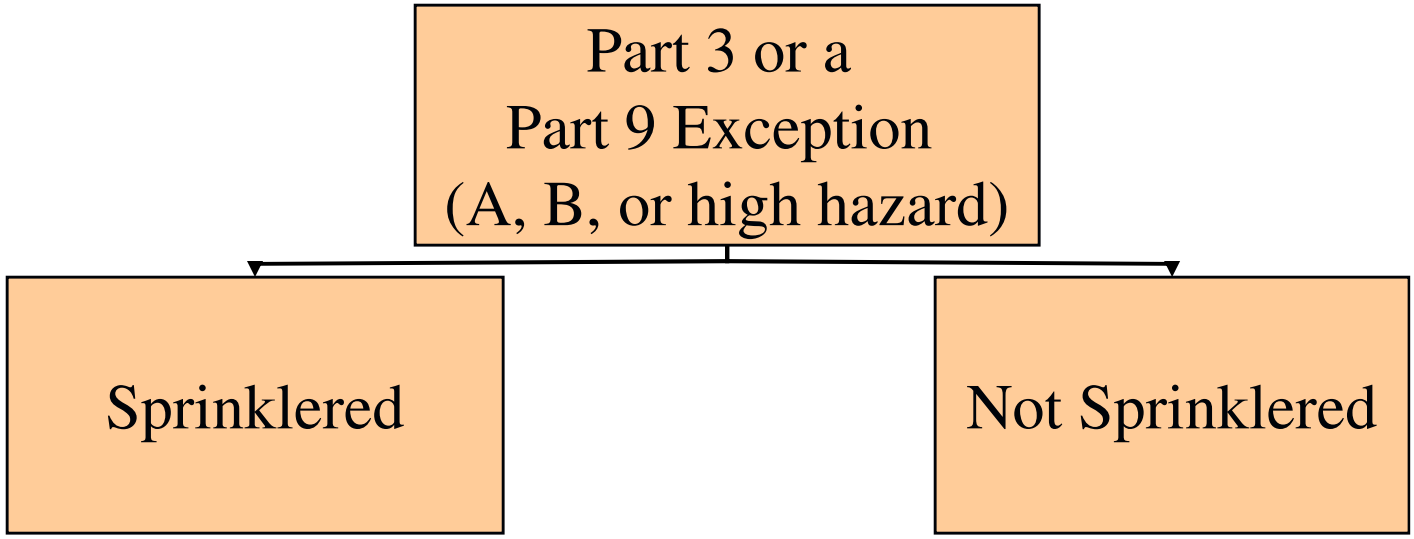


Part 9 Building

- The assumption is that these buildings can be addressed by water carrying capacity of the local FD
  - What about cases where there is no FD?
  - What is the capability of the local FD?

- In areas where there is no capable fire department limiting distances are to be doubled
  - Building Official should use judgment on this. You can require a higher standard. Insurers may require a higher standard.

Water Supply Study



- NFPA 13, 13R, or 13D specifies requirements:
- May still require on site storage (duration), pumps pressure), etc.
- *Do you need to consider exposure demand?*

- Need to verify water supplies for use by fire department

Sprinklered Property

- Designer is to provide proof that the design has been in accordance with either NFPA 13, NFPA 13R, or NFPA 13D
- These designs specify the required fire flows for sprinkler systems as well as for inside and outside hose stream requirements
- Design must verify that the required municipal flow rates and duration is present
  - If not may require on site storage, fire pumps, etc.

Water Supplies for Sprinklered Properties – NFPA 13

Table 11.2.3.1.2 Hose Stream Allowance and Water Supply Duration Requirements for Hydraulically Calculated Systems

	Inside Hose		Total Combined Inside and Outside Hose		
Occupancy	**gpm**	**L/m**	**gpm**	**L/m**	**Duration (mins)**
Light hazard	0, 50, or 100	0, 189, 379	100	379	30
Ordinary hazard	0, 50, or 100	0, 189, 379	250	946	60–90
Extra hazard	0, 50, or 100	0, 189, 379	500	1893	90–120

NOTE: All NFPA standards are available for free public viewing on line.

Example from NFPA 13

Table 12.1.9.1.2(a) Control Mode Density-Area Protection of Indoor Storage of Idle Wood Pallets

Type of Sprinkler	Location of Storage	Nominal K-Factor	Maximum Storage Height		Sprinkler Density		Areas of Operation				Hose Stream Demand	
							High Temperature		Ordinary Temperature			
			ft	m	gpm/ft²	mm/min	ft²	m²	ft²	m²	gpm	L/min
Control mode density/area	On floor	K 8 or larger	Up to 6	Up to 1.8	0.2	8.2	2000	186	3000	279	500	1900
		K 11.2 or larger	6 to 8	1.8 to 2.4	0.45	18.3	2500	232	4000	372	500	1900
			8 to 12	2.4 to 3.7	0.6	24.5	3500	325	6000	557	500	1900
			12 to 20	3.7 to 6.1	0.6	24.5	4500	418	—	—	500	1900

Summary of Fire Flow Requirements

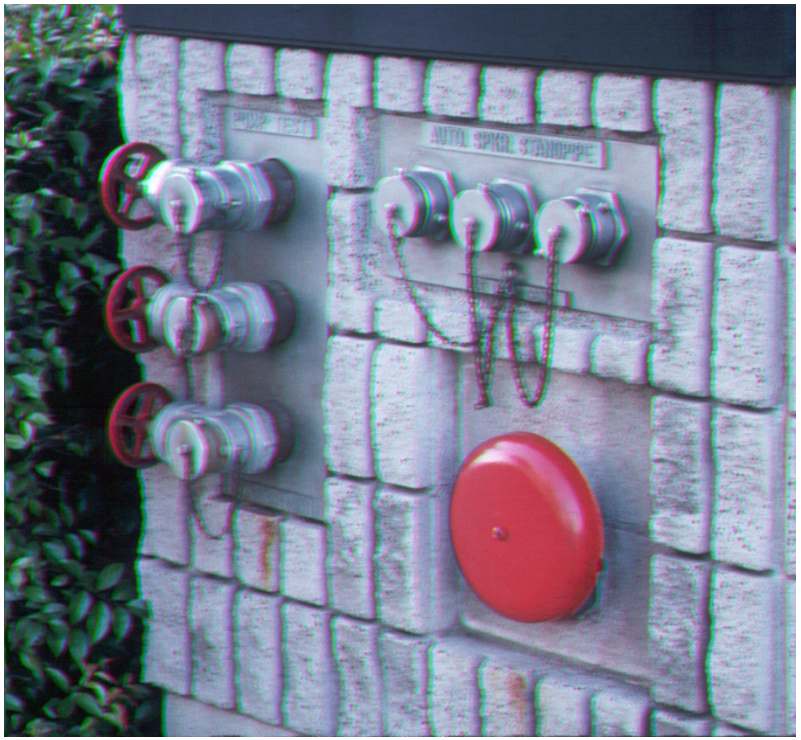
System Type	Sprinkler Flow	Hose demands	Total Flows	Duration
NFPA 13D	26 gpm	None	26 gpm	10 min
NFPA 13R	52 gpm	None	52 gpm	30 min
NFPA 13 LH	150-210 gpm	100 gpm	310 gpm	30 min
NFPA 13 OH 1	225-400 gpm	250 gpm	650 gpm	1 ½ hrs
NFPA 13 OH 2	300-600 gpm	250 gpm	850 gpm	1 ½ hrs
NFPA 13 EH1	750-1000 gpm	500 gpm	1500 gpm	2 hrs
NFPA 13 EH 2	1000-1500 gpm	500 gpm	2000 gpm	2 hrs

AWWA, Impact of Fire Flow on Distribution System Water Quality, Design, and Operation, 2002.

Standpipe Systems
NFPA 14

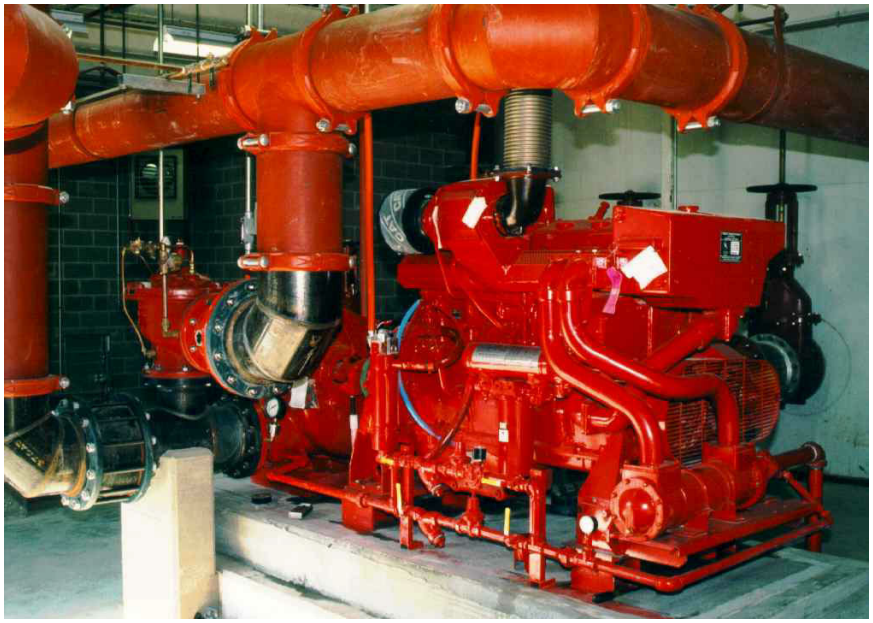
- Replace the requirement for FD personnel to lay hose lines from outside
- Design in accordance with NFPA 14
- Municipal water or if insufficient fire pump

FD Connections



- FD hooks up to this as a first priority to ensure reliability for fire flows
- Primary source is still the municipal supply and/or building systems

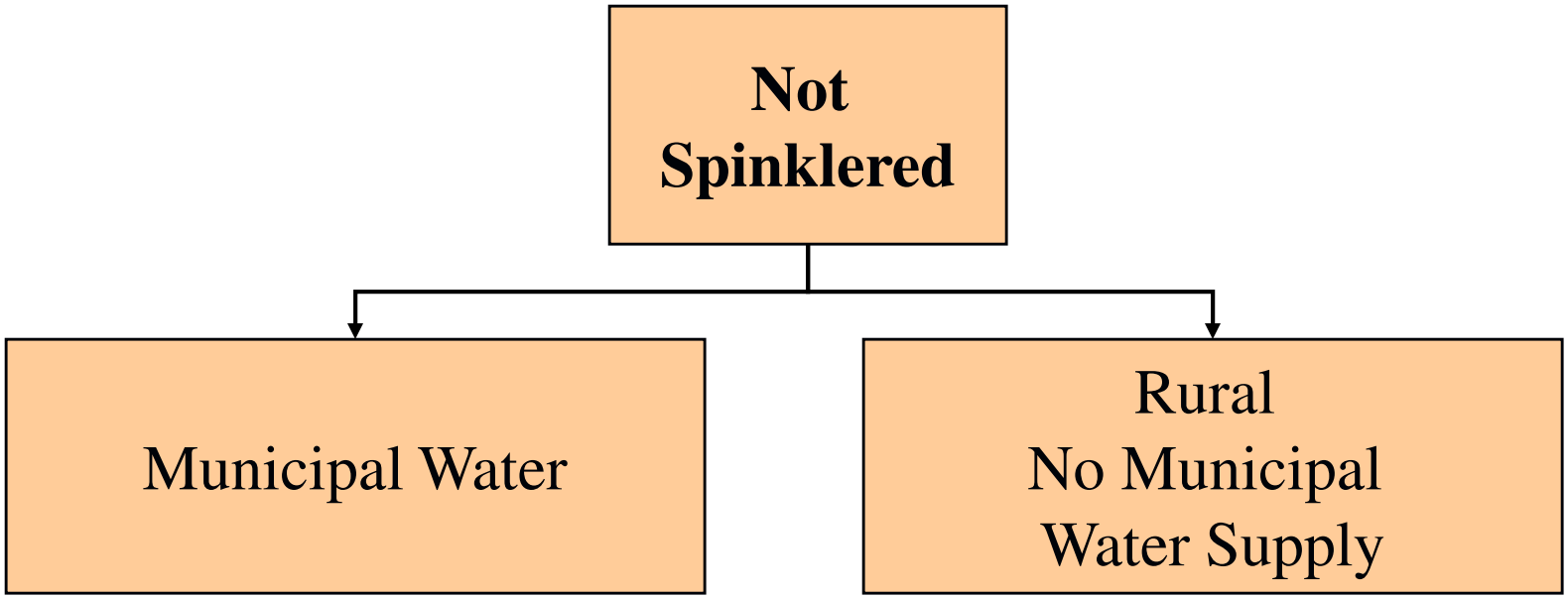
Installation of Fire Pumps



- Needed to meet minimum pressure demands when municipal water supply is insufficient

- NFPA 20 covers the requirement for installed fire pump systems

Properties Not Sprinklered



- Need to verify that water capacity is sufficient
- Adequacy of hydrants

- What is water capability of FD?
- May have to have water stored on site for fire protection added.

Tools for Calculating Water Supply Needs

- ON Guideline
- Alberta Standata
- NFPA 1 Fire Code
- FUS or ISO water supply

} Neither consider property protection or exposures

Both ON and AB documents are only approved in those jurisdictions because there are assumptions made by the provincial AHJ not necessarily approved in other jurisdictions.

CAUTION: Great variance in calculations because of the assumptions used.

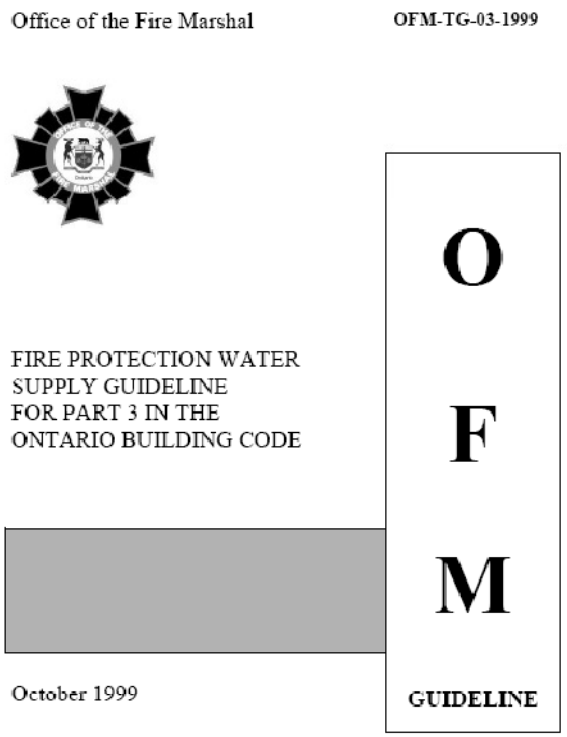
Alberta Standata
Assumptions

- Minimum water supplies are for life safety requirements i.e safe evacuation of the structure *not preservation of property and no protection of exposures*. Owners should be made aware of this.

- Where fire department response is not adequate then consideration should be given to sprinklering

- Compartmentation is an option

Ontario Guidelines Produced by MMAH and OFM



- Used to determine water supply needs for Part 3 buildings that are neither sprinklered nor excluded

Verifying Water Supply Needs OFM-TG-03-1999

- Fire protection Water Supply Guideline for Part 3 in the Ontario Building Code
- Developed by the OFM and MMAH to address water supply evaluation

- 1st – for adequate water for fire protection to support evacuation
- 2nd – a good measure of water for property protection

Downloadable from the OFM website

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Determine Needed Flow Rate

- Caution even municipal water supply may not be enough in either flow rate and residual pressure and so should be verified by the engineer on record.

All Fire Flow Models

- Fire flows are determined by:
  - Type of occupancy
  - Type of construction
  - Size
  - Exposures

Calculating Total Water Needs

$$Q = KVS_{Tot}$$

- The total need water flow is based on the type of construction and occupancy (K), the volume of the structure and the total exposures (S)

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

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Example

$$Q = KVS_{Tot}$$

- A 3 storey (12 m tall) apartment building of combustible construction with dimensions 30m by 25m is to be built – no exposures
- Q= 18X(12X30X25) = 162,000 litres
  - Note: if there were exposures this could be raised to up to 2X

TABLE 2
MINIMUM WATER SUPPLY FLOW RATES

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

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

- Once the total water supply need is determined the minimum flow rate is determined.
- This should be verified back to the fire departments capacity.

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Example

- Same structure – needing a total supply of 162,000 litres
- From the table you need a flow rate of 5400 litres/min
- You would then need to verify if this can be delivered by your FD or municipal supply

A typical tanker may only carry 11,500 litres. Also 900 litres/min is considered excellent and the equivalent of a municipal flow. Few rural departments can meet this in Ontario.

CAUTION

NOTE: Alberta Standata is significantly less for minimum flow rates than OFM

It only requires flows of 2700 l/min if less than 75,000 l and 3600 l/min if over this.

REMEMBER: The ON and AB examples assume no flows past that for Search and Rescue and do not consider exposure protection. If these are concerns use the NFPA calculations.

NFPA 1 Fire Code Computation Method

- Annex H – provides a method based on ISO calculation and therefore includes requirements for fire protection for the anticipated duration.
- Annex I gives information on determining the number and spacing for hydrants

NFPA 1 Fire Code Computation Method

Table H.5.1 Minimum Required Fire Flow and Flow Duration for Buildings

Fire Area ft² (×0.0929 for m²)					Fire Flow gpm[2] (× 3.785 for L/min)	Flow Duration (hours)
I(443),I(332), II(222)[1]	II(111), III(211)[1]	IV(2HH), V(111)[1]	II(000), III(200), III(000)[1]	V(000)[1]		
0–22,700	0–12,700	0–8,200	0–5,900	0–3,600	1,500	2
22,701–30,200	12,701–17,000	8,201–10,900	5,901–7,900	3,601–4,800	1,750	
30,201–38,700	17,001–21,800	10,901–12,900	7,901–9,800	4,801–6,200	2,000	
38,701–48,300	21,801–24,200	12,901–17,400	9,801–12,600	6,201–7,700	2,250	
48,301–59,000	24,201–33,200	17,401–21,300	12,601–15,400	7,701–9,400	2,500	
59,001–70,900	33,201–39,700	21,301–25,500	15,401–18,400	9,401–11,300	2,750	
70,901–83,700	39,701–47,100	25,501–30,100	18,401–21,800	11,301–13,400	3,000	3
83,701–97,700	47,101–54,900	30,101–35,200	21,801–25,900	13,401–15,600	3,250	
97,701–112,700	54,901–63,400	35,201–40,600	25,901–29,300	15,601–18,000	3,500	
112,701–128,700	63,401–72,400	40,601–46,400	29,301–33,500	18,001–20,600	3,750	
128,701–145,900	72,401–82,100	46,401–52,500	33,501–37,900	20,601–23,300	4,000	4
145,901–164,200	82,101–92,400	52,501–59,100	37,901–42,700	23,301–26,300	4,250	
164,201–183,400	92,401–103,100	59,101–66,000	42,701–47,700	26,301–29,300	4,500	
183,401–203,700	103,101–114,600	66,001–73,300	47,701–53,000	29,301–32,600	4,750	
203,701–225,200	114,601–126,700	73,301–81,100	53,001–58,600	32,601–36,000	5,000	
225,201–247,700	126,701–139,400	81,101–89,200	58,601–65,400	36,001–39,600	5,250	
247,701—271,200	139,401–152,600	89,201–97,700	65,401–70,600	39,601–43,400	5,500	
271,201–295,900	152,601–166,500	97,701–106,500	70,601–77,000	43,401–47,400	5,750	
295,901–Greater	166,501–Greater	106,501–115,800	77,001–83,700	47,401–51,500	6,000	
295,901–Greater	166,501–Greater	115,801–125,500	83,701–90,600	51,501–55,700	6,250	
295,901—Greater	166,501–Greater	125,501–135,500	90,601–97,900	55,701–60,200	6,500	
295,901–Greater	166,501–Greater	135,501–145,800	97,901–106,800	60,201–64,800	6,750	
295,901–Greater	166,501–Greater	145,801–156,700	106,801–113,200	64,801–69,600	7,000	
295,901–Greater	166,501–Greater	156,701–167,900	113,201–121,300	69,601–74,600	7,250	
295,901–Greater	166,501–Greater	167,901–179,400	121,301–129,600	74,601–79,800	7,500	
295,901–Greater	166,501–Greater	179,401–191,400	129,601–138,300	79,801–85,100	7,750	
295,901–Greater	166,501–Greater	191,401–Greater	128,301–Greater	85,101–Greater	8,000	

[1] Type of construction are based on NFPA 220.

[2] Measured at 20 psi (139.9 kPa).

Exception: A reduction in required fire flow of 50 percent, as approved, shall be permitted when the building is provided with an approved automatic sprinkler system.

- NFPA 1 model has flow requirements for durations up to 4 hours in some cases.
- AB and ON calculations only go to 30 minutes.

Comparison of results

Resource	**Total Water Needed**	**Flow rate**	**Duration**
AL Standata	171,000 l [45,178 g]	3600 l/min [951 gpm]	Not specified
ON Guideline	162,000 l [42,800 g]	5400 l/min [1426 gpm]	30 minutes
NFPA Fire Code	2,952,300 l [780,000 g]	3250 gpm	4 hours

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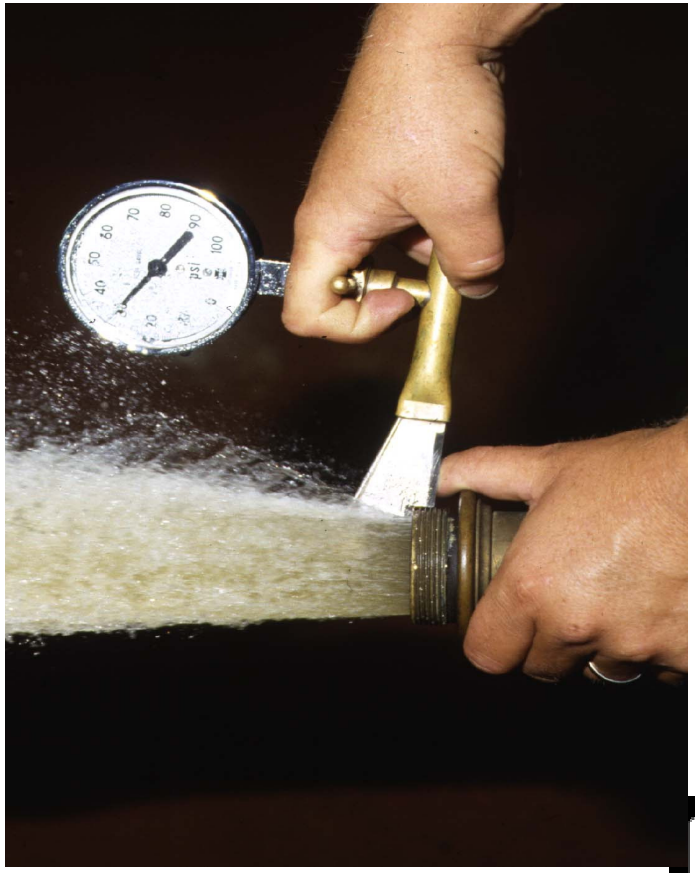
- Once needed water quantities and flow are needed it needs to be verified to capacity of the municipal system and or fire department response capabilities

- NFPA 1 minimum requirements for a SFD is 1000 gpm if under 3600 sq ft

Municipal Water Supply

Water Supply

- Must be matched to design of sprinklers
- Must provide adequate flow and pressure
- Must be reliable
- Minimum residual pressure is measured at 20 psi (137.9 kPa)



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Reliability of the Municipal System

- NFPA 292 Recommended Practice for the Flow testing and Marking of Hydrants 2007 Edition
  - Need to keep a residual pressure of 20 psi for health reasons

Water Supply Testing

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Water Supply Testing

Hydrant Marking
As per NFPA 291

TABLE 10.3.7 *Hydrant Classification*

Class	Flow		Color of Bonnets and Nozzle Caps
	gpm	L/min	
AA	1500 or greater	5680	Light blue
A	1000–1499	3785–5677	Green
B	500–999	1893–3782	Orange
C	Less than 500	1890	Red

Hydrant Placement

- Minimum 6-inch connection to main
- Locate at least 40 feet from buildings
- Spacing based on fire flow demands
- Nominal 250 ft. spacing on private systems

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Placement of Hydrants

Table I.3 Number and Distribution of Fire Hydrants

Fire Flow Requirements (gpm)	Number and Distribution of Fire Hydrants		
	Minimum Number of Hydrants	Average Spacing Between Hydrants [1,2,3] (ft)	Maximum Distance from any Point on Street or Road Frontage to a Hydrant[4] (ft)
1750 or less	1	500	250
2000 – 2250	2	450	225
2500	3	450	225
3000	3	400	225
3500 – 4000	4	350	210
4500 – 5000	5	300	180
5500	6	300	180
6000	6	250	150
6500 – 7000	7	250	150
7500 or more	8 or more[5]	200	120

Note: 1 gpm = 3.8 L/min; 1 ft = 0.3 m.

[1] Reduce by 100 ft (30.5 m) for dead-end streets or roads.

[2] Where street are provided with median dividers which can be crossed by fire fighters pulling hose lines, or arterial streets are provided with four or more traffic lanes and have a traffic count of more than 30,000 vehicles per day, hydrant spacing shall average 500 ft (152.4 m) on each side of the street and be arranged on an alternating basis up to a fire flow requirement of 7000 gpm (26,500 L/min) and 400 ft (122 m) or higher fire flow requirements.

[3] Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at spacing not to exceed 1000 ft (305 m) to provide for transportation hazards.

[4] Reduce by 50 ft (15.2 m) for dead-end streets or roads.

[5] One hydrant for each 1000 gpm (3785 L/min) or fraction thereof.

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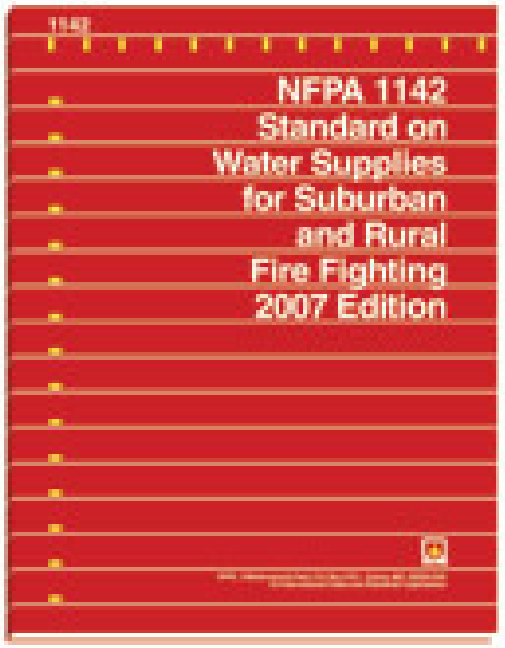
Factors to Consider in Hydrant Placement

- Outlet to be orientated to the street and no higher than 18 inches
- Maintain 3 ft from obstructions
- Bollards if there is no curb
- Should be sited by the FD for their ops considerations
- Colour coded

When we do not have a reliable water source



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Fire Protection
Water Supply Plan
TOWN
OF

NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting 2007 Edition

- Identifies minimum requirements for water supplies for fire fighting purposes in rural and suburban areas
- Translated into French for adoption in Quebec
- Methods for calculating water supply needs, and then the proper design, operation and maintenance of these means
- Used by IAO in the determination of community protection ratings

NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting 2007 Edition

- Tells how to conduct a water supply needs assessment. (Note: Total water supply needs *not flow rates*)
  - First classification of occupancies, and classification of construction
  - Formula for determining water supply needs
- Annex material on the design of cisterns, dry hydrants, etc..
- Extensive materials on fire fighting operations in low water supply areas

Determining Your Community's Water Flow Capabilities

- The Fire Department should have these figures
  - For proven flow tests for the required duration
  - Accreditation by FUS
  - Calculated using NFPA 1142 Annex C
- Otherwise the assumption should be that they have no proven capacity and the design should reflect this.

Formula For Water Supply

$$\text{minimum water supply} = \frac{\left(\text{total volume of structure}\right)}{\left(\text{occupancy hazard classification number}\right)} \times \text{construction classification number}$$

- A *lower* occupancy hazard number means a *higher* hazard and thus *more* water
- A *lower* construction class means *less* water
- This is for total water supply needs

NFPA 1142 – Annex C
Water Hauling Operations

- Extracts of some of the appropriate information on apparatus standards taken from NFPA 1901.
- Very detailed information on how to conduct these operations including how to calculate your maximum continuous flow capability

$$Q = \frac{V}{A + (T_1 + T_2) + B} \times 0.9$$

Maximum Continuous Flow Capability

$$Q = \frac{V}{A + (T_1 + T_2) + B} \times 0.9$$

- Do not need to conduct water hauling during emergency operations
  - Q = max cont. flow
  - T1, T2 = travel times
  - A , B = dump and fill times

You want to maximize flow rates. The best and safest way to do this is reducing dump and fill times.

Maximum Continuous Flow Capability

$$T = 0.65 + XD$$

- T= avg time of travel
- X= avg safe constant speed

$$X = \frac{60}{\text{average safe constant speed}} = \frac{60}{35 \text{ mph}} = 1.70$$

NFPA 1142 Table 4.6.1

Minimum Capability of Fire Department to Deliver Water

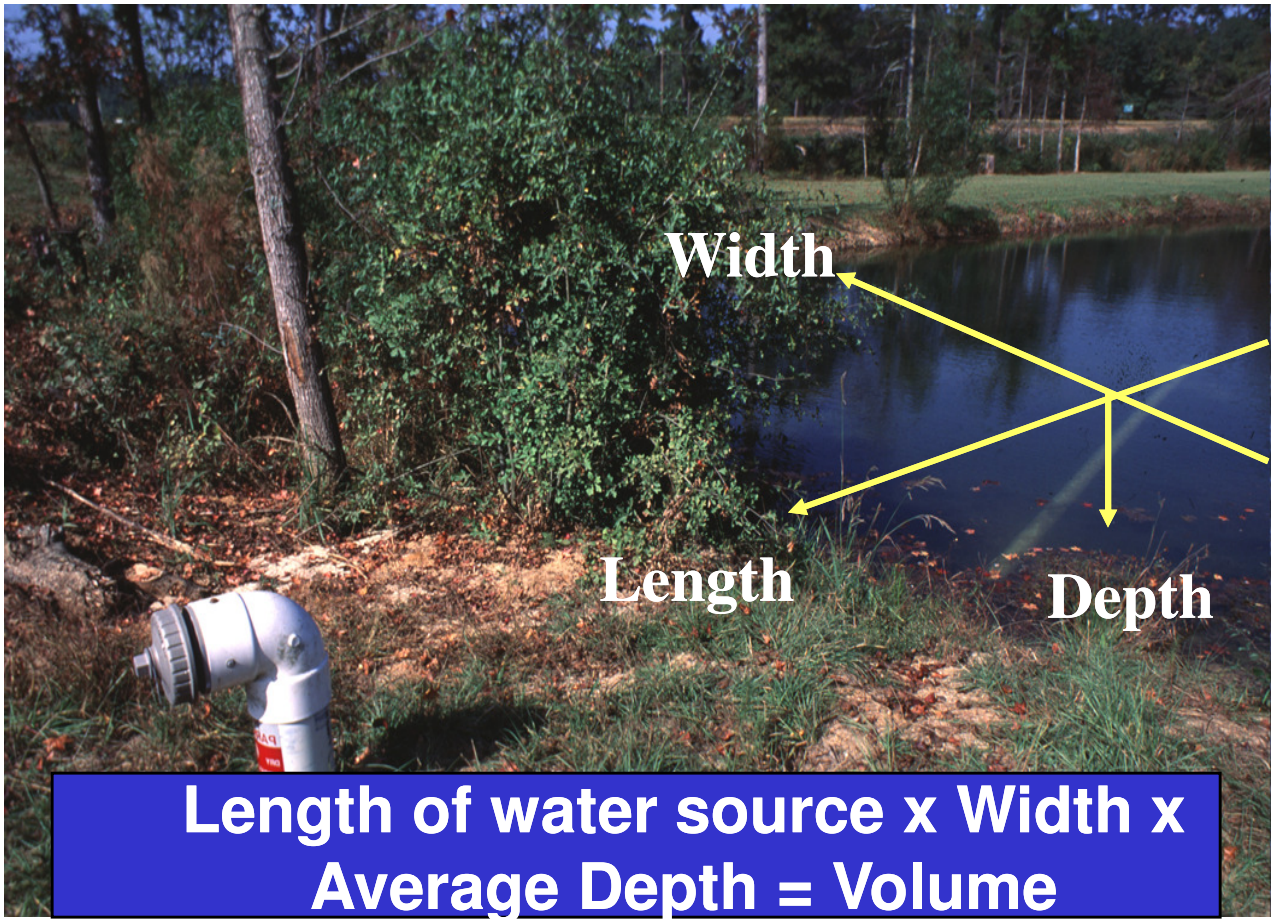
NFPATable 4.6.1 Minimum Capability of Fire Department to Deliver Water			
Total Water Supply Required		**Rate Water Is Available at the Incident**	
gal	**L**	**gpm**	**L/min**
<2,500	9,459	250	950
2,500–9,999	9,460–37,849	500	1,900
10,000–19,999	37,850–75,699	750	2,850
20,000	75,700	1,000	3,800

- 4.6.2 The water shall be available on a continuous basis at the rate shown in Table 4.6.1 within 5 minutes of the arrival of the first apparatus at the incident.

What are Appropriate Water Sources?

- Need to determine what these are for the site in advance
- Must be coordinated with the local fire department
- Only sources that have been prepared and preplanned should be used…

Water Sources

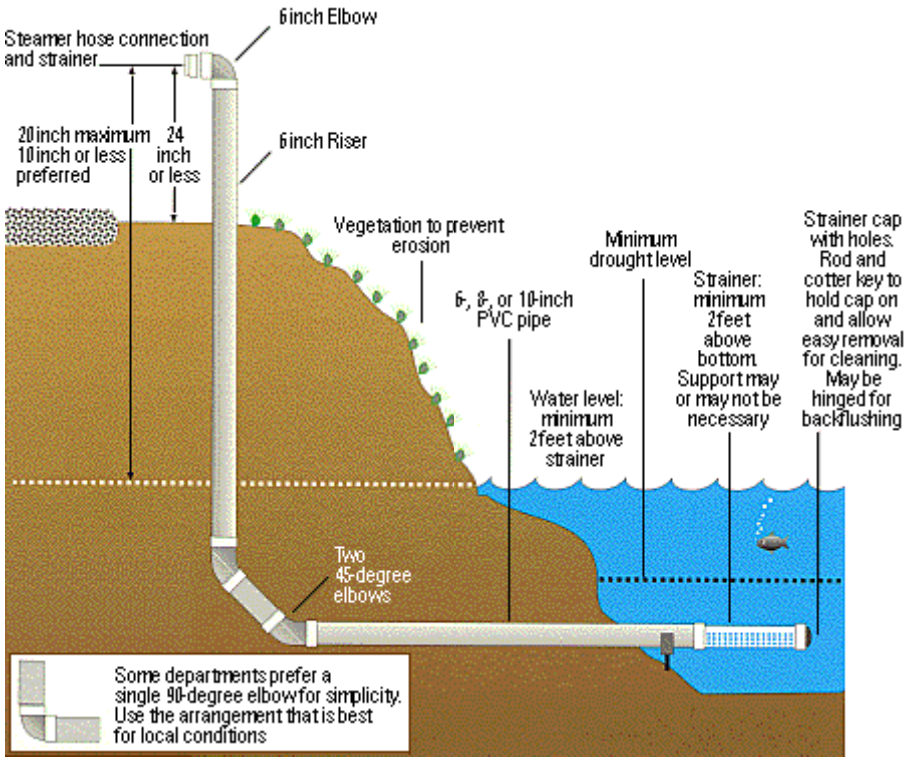


Volume x 7.5 gal/cu ft = Total number of gallons available

Calculating the Quantity Available

Annex Material

Annex B: Design of Water Supply Systems



- Design of Cisterns, Dry Hydrants, etc.
- Use for tendering, etc.
- Annex I – design worksheets for dry hydrants

www.firewise.org Has a on-line training program on water supply entitled Operation Water

Availability of Volunteer Fire Fighting Resources

- Problem is resources and availability
- These are assessed by FUS and determine insurance gradings in communities

Tanker Shuttle Operations

- Fire department uses tankers to bring water to the fire
- Relay operations is source is near by
- Dump tanks and shuttles to sustain flow
- All these take time to set up and preplanning

When do I need on site water storage or a local source?

- Are you an exception to the need for on site water?
- If Yes – document this
- If no need to determine the sources and capacities of your local department
- Either on site storage or local water supply sources

NFPA 22 Standard for Water Tanks for Private Fire Protection 2003 Edition

- Covers design of private water tanks
- This standard provides the minimum requirements for the design, construction, installation, and maintenance of tanks and accessory equipment that supply water for private fire protection.

All NFPA standards are available for free public viewing on line at www.nfpa.org.

Application of OFM Guideline Exception to On-Site Water

- A building does not require an on-site water supply when serviced by a municipal water supply system with a residual pressure of 140 kpa or 20 psi
  - All of the required hydrants flowing at the needed rate and the pressure does not drop below this rate.
- They can prove to meet the required flow rates through over means
- Or an F-3 occupancy with negligible combustible loading (caution processes change!)

Application of OFM Guideline Exception to On-Site Water

A building does not require an on-site water supply when all of the following are met:

(i) area is 200 m2 or less,

(ii) height is 2 storeys or less,

(iii) does not have a Group B occupancy

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

(v) limiting distance criteria, and

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

Assumption is responding fire pumper will have adequate capacity for smaller structures.

Conclusion

- In the absence of policy from the province you need to make the informed decision based on the assumptions in the code
- The code is the absolute minimum
- Just because you are on municipal water does not guarantee adequacy (duration and pressure) of water for fire flows – these need to be verified.

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QUESTIONS?