SKILLINGS CONNOLLY

Lacey, Washington 360-491-3399

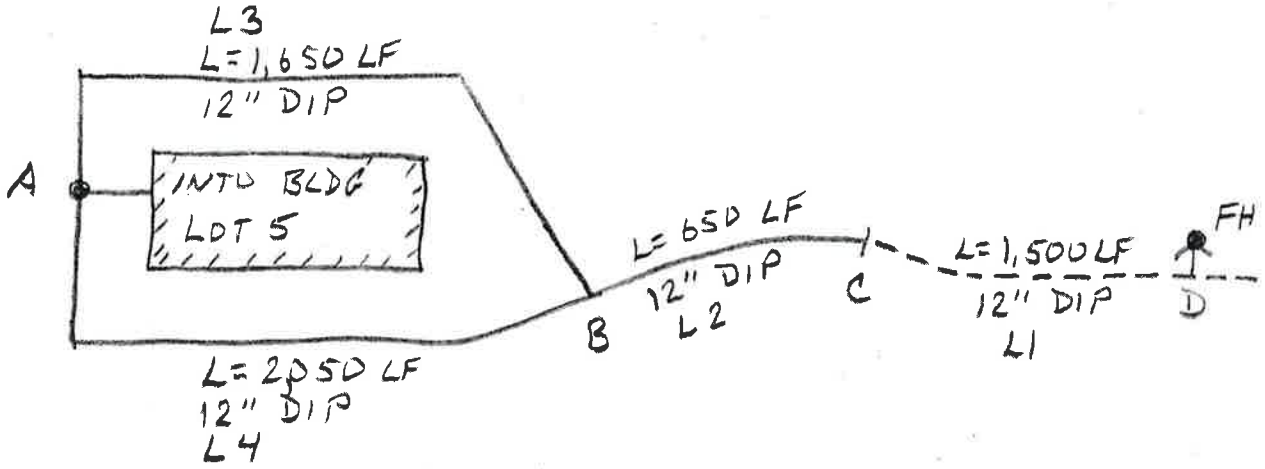
Project Name: KELSO V. ACE

Project No.: 10031

Date: 1-27-2010 By:

Sheet: FIRE FLOW Page 1 of 2

1.) SCHEMATIC



2.) FIRE HYDRANT TEST RESULTS RECEIVED 11-30-2006:

STATIC PRESSURE = 74 PSI
RESIDUAL PRESSURE = 65 PSI
FLOW = 3,075 GPM

3.) USING THE FOLLOWING EQUATION

$$P = 74\ PSI - \left(\frac{3{,}150\ GPM\ (74\ PSI - 65\ PSI)^{0.54}}{3{,}075\ GPM} \right)^{\frac{1}{0.54}}$$

P = 64.6 PSI AT 3,150 GPM

FOR HYDRANT TEST RESULT OF STATIC = 74 PSI AND FLOW OF 3,075 GPM @ 65 PSI RESIDUAL FIND RESIDUAL PRESSURE OF 64.6 PSI AT FLOW OF 3,150 GPM

1/27/10

ROBERT G. CONNOLLY
STATE OF WASHINGTON
23143
REGISTERED
PROFESSIONAL ENGINEER

RECEIVED
CITY OF KELSO
JAN 28 2010
COMMUNITY DEVELOPMENT

SKILLINGS CONNOLLY

Lacey, Washington 360-491-3399

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Sheet: FIRE FLOW Page 2 of 2

4.)

SEGMENT	Q	Ø	h_L*	L
L1	3,150	12"	31.9 FT	1,500 LF
L2	3,150	12"	13.8 FT	650 LF
L3	1,575	12"	9.7 FT	1,650 LF
L4	1,575	12"	12.1 FT	2050 LF

TOTAL $h_L = h_1 + h_2 + h_4$ = 57.8 FT OR 25.0 PSI

5.) RESIDUAL PRESSURE AT BUILDING FIRE SPRINKLER ENTRY POINT FOR THE BUILDING ON LOT 5 WOULD THEN BE:

64.6 PSI − 25.0 PSI = 39.6 PSI AT 3,150 GPM

39.6 PSI IS > 20 PSI ∴ OK

* NOTE: THE HAZEN-WILLIAMS FORMULA WAS USED TO CALCULATE HEADLOSS. A ROUGHNESS COEFFICIENT OF 130 WAS USE FOR THE DUCTILE IRON PIPE

Pipe L1

Project Description

Friction Method	Hazen-Williams Formula
Solve For	Pressure at 2

Input Data

Pressure 1	64.60	psi
Elevation 1	0.00	ft
Elevation 2	0.00	ft
Length	1500.00	ft
Roughness Coefficient	130.000	
Diameter	12.00	in
Discharge	3150.00	gal/min

Results

Pressure 2	50.79	psi
Headloss	31.85	ft
Energy Grade 1	150.25	ft
Energy Grade 2	118.40	ft
Hydraulic Grade 1	149.00	ft
Hydraulic Grade 2	117.16	ft
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Velocity	8.94	ft/s
Velocity Head	1.24	ft
Friction Slope	0.02123	ft/ft

Pipe L2

Project Description

Friction Method	Hazen-Williams Formula
Solve For	Pressure at 2

Input Data

Pressure 1	64.60	psi
Elevation 1	0.00	ft
Elevation 2	0.00	ft
Length	650.00	ft
Roughness Coefficient	130.000	
Diameter	12.00	in
Discharge	3150.00	gal/min

Results

Pressure 2	58.62	psi
Headloss	13.80	ft
Energy Grade 1	150.25	ft
Energy Grade 2	136.44	ft
Hydraulic Grade 1	149.00	ft
Hydraulic Grade 2	135.20	ft
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Velocity	8.94	ft/s
Velocity Head	1.24	ft
Friction Slope	0.02123	ft/ft

Pipe L3

Project Description

Friction Method	Hazen-Williams Formula
Solve For	Pressure at 2

Input Data

Pressure 1	64.60	psi
Elevation 1	0.00	ft
Elevation 2	0.00	ft
Length	1650.00	ft
Roughness Coefficient	130.000	
Diameter	12.00	in
Discharge	1575.00	gal/min

Results

Pressure 2	60.39	psi
Headloss	9.71	ft
Energy Grade 1	149.32	ft
Energy Grade 2	139.61	ft
Hydraulic Grade 1	149.00	ft
Hydraulic Grade 2	139.30	ft
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Velocity	4.47	ft/s
Velocity Head	0.31	ft
Friction Slope	0.00588	ft/ft

Pipe L4

Project Description

Friction Method	Hazen-Williams Formula
Solve For	Pressure at 2

Input Data

Pressure 1	64.60	psi
Elevation 1	0.00	ft
Elevation 2	0.00	ft
Length	2050.00	ft
Roughness Coefficient	130.000	
Diameter	12.00	in
Discharge	1575.00	gal/min

Results

Pressure 2	59.37	psi
Headloss	12.06	ft
Energy Grade 1	149.32	ft
Energy Grade 2	137.26	ft
Hydraulic Grade 1	149.00	ft
Hydraulic Grade 2	136.95	ft
Flow Area	0.79	ft^2
Wetted Perimeter	3.14	ft
Velocity	4.47	ft/s
Velocity Head	0.31	ft
Friction Slope	0.00588	ft/ft

ASCOA Form 17-3

"Automatic" Sprinkler
CORPORATION OF AMERICA

Water Flow Test Data Sheet

Job Name: _____

Location: 2500 BIK TALLEY WAY

Contract or District No. _____ Date: 11-30-06 Time: 10:00 a.m. / p.m.

Remarks: Hydrant A - H-52
Hydrant B - H-53

Static Pressure at Test Hydrant A (psi)	74	Residual Pressure at Test Hydrant A (psi)	65

Flow Hydrant	Hydrant Outlet Size	No. Outlets Flowing	Pitot Pressure (psi)	Hydrant Outlet Coefficient	Theoretical Flow (Cd = 1.00)	Actual Flow (gpm)
B	4½	1	32	0.90	3417	3075
C						
D						
					Total Flow ▶	

TEST OF CITY WATER SUPPLY

To obtain factual information about the water supply that is available for fire protection at any given location:

1. Consult a map which shows the location and size of the water mains and hydrants in the area of the property to be protected.
2. Make an actual Water Flow Test.

The proper method of making a Water Flow Test of the city water supply is to use 2 or more hydrants in the vicinity of the property. The static and residual pressures are measured at the hydrant in front of or nearest to the property (designate as Test Hydrant A). The water is allowed to flow from the hydrant next nearest the property and farthest from the source of supply (designate as Flow Hydrant B).

The Water Flow Test is conducted as follows:

1. Attach a gage to Test Hydrant A and read the static pressure.
2. Either attach a second gage to Flow Hydrant B or use a pitot gage at an outlet. With Flow Hydrant B wide open, read the pressure at both hydrants.
3. The pressure at Flow Hydrant B is used to compute the gallons flowing per minute.
4. The pressure reading at Test Hydrant A is the residual pressure.

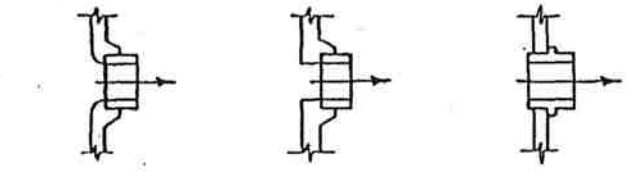
For best results, the volume of water flowing during a test should exceed the estimated demand for the system, including any allowance for hose streams. To accomplish this, it may be necessary to provide further tests with 2 outlets open on Flow Hydrant B, or by using additional hydrants.

The next hydrant adjacent to the flowing hydrant may be opened (designate as Flow Hydrant C) and the test conducted with 3 or 4 outlets flowing. Each flowing stream must be measured with the pitot gage, and the residual pressure at Test Hydrant A must remain the same during the time all pitot gage readings are taken.

HYDRANT OUTLET COEFFICIENT

The hydrant coefficient is the degree to which water is impeded by the hydrant parts, including the outlet. If the hydrant could be constructed to pass all of the water through without any pressure loss, the coefficient would be 1.00. Because this is not possible, the theoretical flow from a hydrant is adjusted by a factor referred to as the Hydrant Outlet Coefficient (Cd).

Before a Water Flow Test is made, all hydrant outlets must be checked to determine the correct coefficient.



Outlet Smooth and Rounded (Cd = 0.90)	Outlet square and sharp (Cd = 0.80)	Outlet square and projecting into barrel (Cd = 0.70)

The sketches above show 3 general types of hydrant outlets and the coefficient each gives. To determine the type on the hydrant to be flowed, feel the contour of the inner edge. Then compare the internal opening with the sketches to get the proper coefficient. If the hydrant being checked is not like the sketches, or if the inner edge is rough and deeply corroded, it may be necessary to adjust the coefficient, e.g., from 0.90 to 0.85 or from 0.80 to 0.75.

See Page 2 for the means of determining actual flow (gpm).

OUTLET SIZE

The actual size of the openings used in the Water Flow Test must be determined. Therefore, the inside diameter of hydrant outlets are measured to the nearest 1/16th of an inch.

Most hydrants encountered will have 2½" hose outlets and 4" or 4½" pumper connections. For this reason, the Theoretical Flow table below includes only these sizes. If other size outlets are used, the actual flow is calculated using the Discharge Formula.

The table is based on a Theoretical Flow for a coefficient of 1.00. Discharge values given in the table must be multiplied by the Hydrant Outlet Coefficient (Cd) to arrive at the gallons flowing per munite (gpm).

Example: The Flow Hydrant has 2 hose outlets. These are examined and found to have square and sharp inner edges (Cd = 0.80). The outlets, when measured, are found to be exactly 2½". A Water Flow Test is made with the 2 outlets flowing simultaneously. The pitot gage reading at each outlet is 14 psi.

The actual flow is:

$$2 \times 0.80 \times 698 = 1119 \text{ gpm.}$$

THEORETICAL FLOW FROM HYDRANT OUTLETS

Discharge Coefficient = 1.00

Pitot Gage psi	Inside Diameter of Outlet		
	2½"	4"	4½"
1	186	477	604
2	264	675	854
3	323	827	1046
4	373	955	1208
5	417	1067	1351
6	457	1169	1480
7	493	1263	1598
8	527	1350	1709
9	559	1432	1812
10	590	1509	1910
11	618	1583	2003
12	646	1653	2093
13	672	1721	2178
14	698	1786	2260
15	722	1848	2340
16	746	1909	2416
17	769	1968	2491
18	791	2025	2562
19	813	2080	2633
20	834	2134	2701
22	874	2239	2833
24	913	2338	2959
26	951	2434	3080
28	987	2526	3196
30	1021	2614	3309
32	1055	2700	3417
34	1087	2783	3522
36	1119	2864	3624
38	1149	2942	3724
40	1179	3019	3820
42	1209	3093	3915
44	1237	3166	4007
46	1264	3237	4097
48	1292	3307	4185
50	1318	3375	4271
52	1344	3442	4356
54	1370	3507	4439
56	1395	3572	4520
58	1420	3635	4600
60	1444	3697	4679
62	1468	3758	4756
64	1491	3818	4832
66	1515	3877	4907
68	1537	3936	4981
70	1560	3993	5054
72	1582	4050	5126
74	1604	4106	5196
76	1625	4161	5266
78	1647	4215	5335
80	1668	4269	5403
82	1688	4322	5470
84	1708	4374	5536
86	1729	4426	5602
88	1749	4477	5667
90	1769	4528	5731

DISCHARGE FORMULA

With the size of the outlet known and the Hydrant Outlet Coefficient ascertained, the actual discharge from the Flow Hydrant can be calculated using a Discharge Formula.

$$Q = 29.83 \, Cd \, D^2 \sqrt{P}$$

Q = Flow in gpm (gallons per minute)
Cd = Hydrant outlet coefficient
D = Diameter of hydrant outlet
P = Pressure in psi (pounds per square inch)

Example: The Water Flow Test was made from a 2 5/8" hose outlet and Cd = 0.90. The pitot gage reading was 22 psi.

$$Q = 29.83 \times 0.90 \times (2.625)^2 \times \sqrt{22}$$
$$Q = 29.83 \times 0.90 \times 6.89 \times 4.69$$
$$Q = 868 \text{ gpm}$$

CAUTIONS

1. Have permission from the Water Authority before making a Water Flow Test. Whenever possible, have a representative of Authority present to assist with and witness the test.
2. Make certain that the discharge from Flow Hydrants will not tear up roadways, lawns, or otherwise cause damage to and/or flood any property.
3. Hydrants are always opened and closed slowly.
4. Allow water to flow clear before placing gages on hydrants or taking pitot gage readings.
5. Hydrant outlets must be flowing full solid streams during all tests.

SKETCH OF TEST LOCATION

1. Provide a layout of the underground pipe and indicate the size, length, location, and type of material (cement lined cast iron, asbestos cement, etc.).
2. Locate and identify all hydrants used in the test.
3. Establish the elevation of Test Hydrant A with respect to the property (e.g., the difference in elevation between the hydrant and the finished floor at the building).
4. Show the point of connection for the proposed system.
5. If required, provide additional information and details which will permit the test results to be adjusted to another location by means of hydraulic calculations.

ASCOA Form 17-3

"Automatic" Sprinkler
CORPORATION OF AMERICA

Water Flow Test Data Sheet

Job Name: _____

Location: COWEEMAN PARK DR. (END)

Contract or District No. _____ Date: 1-19-07 Time: 9:30 (a.m.) p.m.

Remarks:
HYDRANT A - H59 -
HYDRANT B - H60 DONE BY: MARC WELLS

Static Pressure at Test Hydrant A (psi)	68	Residual Pressure at Test Hydrant A (psi)	36

Flow Hydrant	Hydrant Outlet Size	No. Outlets Flowing	Pitot Pressure (psi)	Hydrant Outlet Coefficient	Theoretical Flow (Cd = 1.00)	Actual Flow (gpm)
B	4½	1	22	0.90	2833	2550
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					Total Flow ▶	2550

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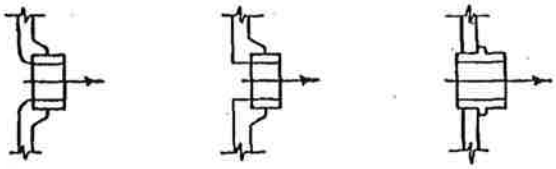

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