Engineering Selection Module
ESM

Practice Test

No calculators may be used for this test. You will be furnished scratch paper. Keep your scratch paper organized this will save you time because the answer for question 20 may require some of the calculations you did for question 6.

There are currently two tests being given, test A or B. Test A is a fictitious natural gas company, and test B is a fictitious water company. Both tests are basically the same, the only difference is the numbers for the gas test deal in cubic feet of gas, and the water test deals in gallons of water.

This practice test is based on the water test, but if you don't have any problems with it you shouldn't have any problems with the gas test.

The test starts out with several pages of data relating to the company followed by 55 questions. Your score is based on the number of correct answers, **not the percentage of correct answers**. You should strive for accuracy in your calculations for the first fifteen or so questions, this is because some of the answers later in the test are derived from these calculations. Do your best to answer the questions that involve the calculations, however; if you reach a point where you will run out of time before completion it will not hurt if you guess at some of the answers as they explain you are judged based on the number of *"correct"* responses.

The following is not a copy of the test, but a very close rendition. Some things will look very familiar when you take the test. For example GPH means gallons per hour, GPM means gallons per month and CGM means hundreds of gallons per month.

While taking the test you can assume that the rate of change is a constant. *Note:* The rate of change is different than the year over year change. Watch for exponential rate of changes.

In an attempt to make this test a little easer, I have assigned years to the practice test. In the real test you will be told this year, last year, next year, 2 years ago, 2 years from now, etc.

ESM

The Chesapeake Well Association, Unit 2108 (known as CWA 2108) is divided into 3 districts with 3 classes of customers. Their engineering department forecasts usage based on past and present usage. For example, if a district used 1000 GPH last year & 1500 GPH this year they would forecast usage of 2000 GPH next year.

Distribution of classes of customers.

District	Irrigation hydrants	Houses	Apartments
Hunt Valley	87.5%	50.0%	25.0%
Fairview Park	0.0%	50.0%	0.0%
Calverton	12.5%	0.0%	75.0%

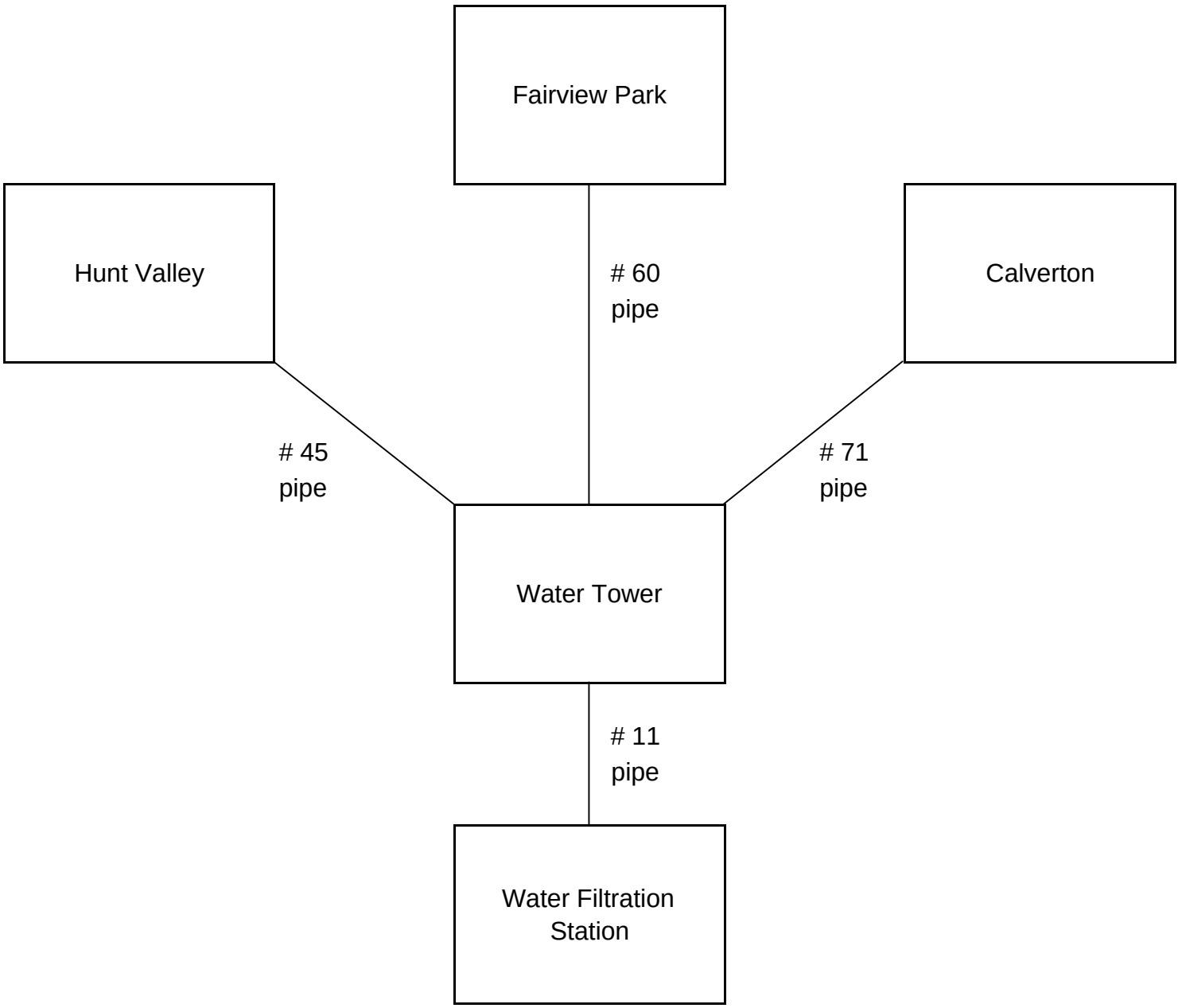
Average Monthly Usage
By Class of Customer

	CGM
Irrigation hydrants	504.23
Houses	24.56
Apartments	13.24

Number of Customers
for the last 3 years

Year	Irrigation hydrants	Houses	Apartments
2004	68	4810	1564
2003	36	4958	1475
2002	20	5128	1384

Neptune Water Company
Water Main Map



Pipe Size	Capacity in GPH
81	500
80	1000
79	1500
78	2000
77	2500
76	3000
75	3500
74	4000
73	4500
72	5000
71	5500
70	6000
69	6500
68	7000
67	7500
66	8000
65	8500
64	9000
63	9500
62	10000
61	10500
60	11000
59	11500
58	12000
57	12500
56	13000
55	13500
54	14000
53	14500
52	15000
51	15500
50	16000
49	16500
48	17000
47	17500
46	18000
45	18500
44	19000
43	19500
42	20000

Pipe Size	Capacity in GPH
41	20500
40	21000
39	21500
38	22000
37	22500
36	23000
35	23500
34	24000
33	24500
32	25000
31	25500
30	26000
29	26500
28	27000
27	27500
26	28000
25	28500
24	29000
23	29500
22	30000
21	31000
20	32000
19	33000
18	34000
17	35000
16	36000
15	37000
14	38000
13	39000
12	40000
11	41000
10	42000
9	43000
8	44000
7	45000
6	46000
5	47000
4	48000
3	49000
2	50000

The Test

1. What was the total number of houses in Fairview Park in 2004 ?

   A. 2,405
   B. 4,810
   C. 50
   D. 4,958

2. What was the total number of irrigation hydrants in Calverton in 2004 ?

   A. 68.0
   B. 12.5
   C. 8.5
   D. 36.0

3. What will be the estimated number of houses in Hunt Valley in 2005 ?

   A. 2,479
   B. 2,342
   C. 50
   D. 4,684

4. What will be the estimated number of commercial apts. in Calverton in 2005 ?

   A. 413
   B. 1,651
   C. 1,564
   D. 1,238

5. What is the average GPH usage for the Fairview Park District in 2004 ?

   A. 82
   B. 8,201
   C. 24,050
   D. 2,405

6. What is the average GPH usage for the Hunt Valley District in 2004 ?

A. 8,201
B. 13,087
C. 26,175
D. 2,754

7. What is the average GPH usage for the Calverton district in 2004 ?

A. 2,158
B. 15,780
C. 27,536
D. 2,754

8. What is the estimated GPH usage for the Hunt Valley district in 2005 ?

A. 25,021
B. 10,100
C. 17,409
D. 30,000

9. Based on the 2005 estimated usage for Calverton, should the water main size _____

A. be enlarged
B. be reduced.
C. remain the same.

Without using a calculator, try to complete the following charts. This should take you about an hour & a half.

Total	2007	2006	2005	2004	2003	2002	2001
Total Houses				4,810	4,958	5,128	
Year over Year Change							
Rate of Change (Constant)							
GPH used for Houses							
Usage in GPH for houses							
Total apartments				1,564	1,475	1,384	
Year over Year Change							
Rate of Change (Constant)							
GPH used for apts.							
Usage in GPH for apts							
Total hydrants				68	36	20	
Year over Year Change							
Rate of Change (Constant)							
GPH used for hydrants							
Usage in GPH for hydrants							
Total usage							

Calverton								
Total Houses	0.0%							
Total usage in GPH for Houses								
Total apartments	75.0%							
Total usage in GPH for apts.								
Total hydrants	12.5%							
Total usage in GPH for hydrants								
Total usage for Calverton								

Fairview Park								
Total Houses	50.0%							
Total usage in GPH for Houses								
Total apartments	0.0%							
Total usage in GPH for apts.								
Total hydrants	0.0%							
Total usage in GPH for hydrants								
Total usage for Fairview Park								

Hunt Valley								
Total Houses	50.0%							
Total usage in GPH for Houses								
Total apartments	25.0%							
Total usage in GPH for apts.								
Total hydrants	87.5%							
Total usage in GPH for hydrants								
Total usage for Hunt Valley								

The Test with Answers Explained

1. What was the total number of houses in Fairview Park in 2004 ?

A.	2,405
B.	4,810
C.	50
D.	4,958

Answer is A

From the chart:

	4,810	=	Total number of houses in CWA
x	50.0%	=	Percent of houses in the Fairview Park District
	2,405	=	Number of houses in the Fairview Park last year

2. What was the total number of irrigation hydrants in Calverton in 2004 ?

A.	68.0
B.	12.5
C.	8.5
D.	36.0

Answer is C

From the chart:

	68	=	Total number of irrigation hydrants
x	12.5%	=	Percent of irrigation hydrants in Calverton
	8.5	=	Number of irrigation hydrants in Calverton

3. What will be the estimated number of houses in Hunt Valley in 2005 ?

A.	2,479
B.	2,342
C.	50
D.	4,684

Answer is B

	4810	=	Total number of houses in 2004		
-	4958	=	Total number of houses in 2003		
	-148	=	Year over year change	2003	2004
	4958	=	Total number of houses in 2003		
-	5128	=	Total number of houses in 2002		
	-170	=	Year over year change	2002	2003
	-148	=	Year over year change	2003	2004
-	-170	=	Year over year change	2002	2003
	22	=	Rate of change		
	-148	=	Year over year change	2003	2004
+	22	=	Rate of change		
	-126	=	Year over year change	2004	2005
	4810	=	Total number of houses in 2004		
+	-126	=	Year over year change	2004	2005
	4684	=	Estimated number of houses for	2005	
	4684	=	Estimated number of houses for	2005	
x	50.0%	=	Percent of houses in Hunt Valley		
	2342	=	Estimated number of houses in Hunt Valley in	2005	

note: watch your signs (- & +)

4. What will be the estimated number of commercial apts. in Calverton in 2005 ?

A.	413
B.	1,651
C.	1,564
D.	1,238

Answer is D

	1564	=	Total number of apartments in	2004	
-	1475	=	Total number of apartments in	2003	
	89	=	Year over year change	2004	2003
	1475	=	Total number of apartments in	2003	
-	1384	=	Total number of apartments in	2002	
	91	=	Year over year change	2003	2002
	89	=	Year over year change	2004	2003
-	91	=	Year over year change	2003	2002
	-2	=	Rate of change		
	89	=	Year over year change	2004	2003
+	-2	=	Rate of change		
	87	=	Year over year change	2003	2004
	1564	=	Total number of apartments in	2004	
+	87	=	Year over year change	2003	2004
	1651	=	Estimated number of apartments for	2005	
	1651	=	Estimated number of apartments for	2005	
x	75.0%	=	Percent of apartments in Calverton		
	1238.25	=	Estimated number of apartments in Calverton for	2005	

5. What is the average GPH usage for the Fairview Park District in 2004?

A.	82
B.	8,201
C.	24,050
D.	2,405

Answer is B

* For the next series of questions, which start around 13 on the real test, you will need to convert the monthly usage chart from hundreds of gallons per month to (CGM) to gallons per hour (GPH). To do this simply move the decimal point over 2 places and divide by 720. (The 720 is the amount of hours in a 30 day month. It is a standard average for hours in a month)

504.2	x	100	=	50,423	Gallons per month for irrigation hydrants
50,423	÷	720	=	70.03	GPH for irrigation hydrants
24.56	x	100	=	2,456	Gallons per month for houses
2,456	÷	720	=	3.41	GPH for houses
13.24	x	100	=	1,324	Gallons per month for houses
1,324	÷	720	=	1.84	GPH for houses

At this time it would help if you made a chart up like the one on page 2 and added the GPH in the far right column.

	CGM	GPH
Street hydrants	504.23	70.03
Houses	24.56	3.41
Apartments	13.24	1.84

OK, now for the real problem.

	4810	=	Number of houses 2004
x	50.0%	=	Percent of houses in Fairview Park
	2405	=	Number of houses in Fairview Park in 2004
x	3.41	=	Usage per house
	8,201.05	=	GPH usage for houses in Fairview Park in 2004
	8,201	=	GPH usage rounded to nearest whole number

6. What is the average GPH usage for the Hunt Valley District in 2004 **?**

A. 8,201
B. 13,087
C. 26,175
D. 12,368

Answer is B

	68	=	Number of street hydrants in 2004
x	87.5%	=	Percent of street hydrants in Hunt Valley
	59.5	=	Number of street hydrants in Hunt Valley in 2004
x	70.03	=	Usage per street hydrants
	4,166.79	=	GPH usage for hydrants in Hunt Valley 2004
	4810	=	Number of houses in 2004
x	50.0%	=	Percent of houses in Hunt Valley
	2405	=	Number of houses in Hunt Valley in 2004
x	3.41	=	Usage per houses
	8,201.05	=	*GPH usage for houses in Hunt Valley in 2004
			*If you are keeping good notes you should have this answer already. See question 5.
	1564	=	Number of apartments in 2004
x	25.0%	=	Percent of apartments in Hunt Valley
	391	=	Number of apartments in Hunt Valley in 2004
x	1.84	=	Usage per apartments
	719.44	=	GPH usage for apartments in Hunt Valley in 2004
	4,166.79	=	GPH usage for apartments in Hunt Valley in 2004
	8,201.05	=	GPH usage for houses in Hunt Valley in 2004
+	719.44	=	GPH usage for apartments in Hunt Valley in 2004
	13,087.28	=	Total GPH usage for Hunt Valley in 2004
	13,087	=	GPH usage rounded to nearest whole number

7. What is the average GPH usage for the Calverton district in 2004 ?

A. 2,158
B. 15,780
C. 27,536
D. 2,754

Answer is D

	68	=	Number of hydrants 2004
x	12.5%	=	Percent of hydrants in Calverton
	8.5	=	Number of hydrants in Calverton in 2004
x	70.03	=	Usage per hydrants
	595.26	=	GPH usage for hydrants in Calverton in 2004
	4810	=	Number of houses in 2004
x	0.0%	=	Percent of houses in Calverton
	0	=	Number of houses in Calverton in 2004
x	3.41	=	Usage per houses
	0.00	=	GPH usage for houses in Calverton in 2004
	1564	=	Number of apartments in 2004
x	75.0%	=	Percent of apartments in Calverton
	1173	=	Number of apartments in Calverton in 2004
x	1.84	=	Usage per apartments
	2,158.32	=	GPH usage for apartments in Calverton in 2004
	595.26	=	GPH usage for hydrants in Calverton 2004
	0.00	=	GPH usage for houses in Calverton in 2004
+	2,158.32	=	GPH usage for apartments in Calverton in 2004
	2,753.58	=	Total GPH usage for Calverton in 2004
	2,754	=	GPH usage rounded to nearest whole number

8. What is the estimated GPH usage for the Hunt Valley district in 2005 **?**

A. 8,746
B. 11,129
C. 16,834
D. 13,090

Answer is C

First we will look at houses & apartments, because the hydrants are exponential.

Houses	Apartments			
4958	1475	2003	Totals	
5128	1384	2002	Totals	
-170	91	Year over year change	2003	2002
4810	1564	2004	Totals	
4958	1475	2003	Totals	
-148	89	Year over year change	2004	2003
-148	89	Year over year change	2004	2003
-170	91	Year over year change	2003	2002
22	-2	Rate of change (constant)		
-148	89	Year over year change	2004	2003
22	-2	Rate of change (constant)		
-126	87	Year over year change	2005	2004
4810	1564	2004	Totals	
-126	87	Year over year change	2005	2004
4684	1651	2005	Estimated totals	
4684	1651	2005	Estimated totals	
50.0%	25.0%	Percentages for Hunt Valley		
2342	412.75	2005	Est. for Hunt Valley	
2,342	413	2005	Rounded Est.	
3.41	1.84	Usage levels		
7,986.22	759.46	Total usages		

hydrants	
36	2003 Total hydrants in CWA
- 20	2002 Total hydrants in CWA
16	Year over year change for 2003 2002
68	2004 Total hydrants in CWA
- 36	2003 Total hydrants in CWA
32	Year over year change for: 2004 2003
36	2003 Total hydrants in CWA
- 32	Year over year change for: 2004 2003
4	Difference added to each exponent to get total. It should be the same thing each time, but it is always a good idea to check.
20	2002 Total hydrants in CWA
- 16	Year over year change for 2003 2002
4	This is your check, to see if the difference is the same as above. It is so you now know that this is an exponential change
16	2002 To get the exponent for each year, all you are doing is multiplying the previous years exponent by something. In our case it is 2. Then you add the difference between the exponent and the number you started with. In this case it is 4.
16 x 2 = 32	2003
32 x 2 = 64	2004
64 x 2 = 128	2005
128	2005 Exponent
+ 4	Difference added to each exponent to get total.
132	2005 Estimated total hydrants for CWA
x 87.5%	Percent of hydrants for Hunt Valley
115.5	2005 Estimated hydrants in Hunt Valley
116	2005 Estimated hydrants in Hunt Valley
x 70.03	GPH for hydrants
8,088.47	2005 Estimated GPH for hydrants in Hunt Valley

7,986.22	2005	Estimated GPH for houses in Hunt Valley
759.46	2005	Estimated GPH for apartments in Hunt Valley
+ 8,088.47	2005	Estimated GPH for hydrants in Hunt Valley
16,834.15	2005	Total estimated usage in GPH for Hunt Valley
16,834	2005	Rounded

9. Based on the 2005 estimated usage for Calverton, should the water main size _____

A. be enlarged
B. be reduced.
C. remain the same.

Answer is C

Again, first we will look at houses & apartments, because the hydrants are exponential.

Houses	Apartments			
4958	1475	2003	Totals	
5128	1384	2002	Totals	
-170	91	Year over year change	2003	2002
4810	1564	2004	Totals	
4958	1475	2003	Totals	
-148	89	Year over year change	2004	2003
-148	89	Year over year change	2004	2003
-170	91	Year over year change	2003	2002
22	-2	Rate of change (constant)		
-148	89	Year over year change	2004	2003
22	-2	Rate of change (constant)		
-126	87	Year over year change	2005	2004
4810	1564	2004	Totals	
-126	87	Year over year change	2005	2004
4684	1651	2005	Estimated totals	
4684	1651	2005	Estimated totals	
0.0%	75.0%	Percentages for Calverton		
0	1238.25	2005	Est. for Calverton	
0	1,238	2005	Rounded Est.	
3.41	1.84	Usage levels		
0.00	2,278.38	Total usages		

hydrants*		
36		2003 Total hydrants in CWA
- 20		2002 Total hydrants in CWA
16		Year over year change for 2003 2002
68		2004 Total hydrants in CWA
- 36		2003 Total hydrants in CWA
32		Year over year change for: 2004 2003
36		2003 Total hydrants in CWA
- 32		Year over year change for: 2004 2003
4		Difference added to each exponent to get total. It should be the same thing each time, but it is always a good idea to check.
20		2002 Total hydrants in CWA
- 16		Year over year change for 2003 2002
4		This is your check, to see if the difference is the same as above. It is so you now know that this is an exponential change
16	2002	To get the exponent for each year, all you are doing is multiplying the previous years exponent by something. In our case it is 2. Then you add the difference between the exponent and the number you started with. In this case it is 4.
16 x 2 = 32	2003	
32 x 2 = 64	2004	
64 x 2 = 128	2005	
128		2005 Estimated hydrants in CWA
+ 4		Difference added to each exponent to get total.
132		Difference added to each exponent to get total.
x 12.5%		Percent of hydrants for Calverton
16.5		2005 Estimated hydrants in Calverton
17		2005 Estimated hydrants in Calverton
x 70.03		GPH for hydrants
1,155.50		2005 Estimated GPH for hydrants in Calverton

0.00	2005	Estimated GPH for houses in Calverton
2,278.38	2005	Estimated GPH for apartments in Calverton
+ 1,155.50	2005	Estimated GPH for hydrants in Calverton
3,433.88	2005	Total estimated usage in GPH for Calverton
3,434	2005	Rounded

The current pipe size is # 71, which is rated at 5,500 GPH, which is more than adequate to handle **3,434 GPH**, so the pipe does not need to be replaced.

Answers to Chart. Did you remember that the rate of change for hydrants was exponential?

Total	2007	2006	2005	2004	2003	2002	2001
Total Houses	4,498	4,580	4,684	4,810	4,958	5,128	5,320
Year over Year Change	82	104	126	148	170	192	214
Rate of Change (Constant)				22			
GPH used for Houses	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Usage in GPH for houses	15,338.18	15,617.80	15,972.44	16,402.10	16,906.78	17,486.48	18,141.20
Total Commercial apts.	1,819	1,736	1,651	1,564	1,475	1,384	1,291
Year over Year Change	-83	-85	-87	-89	-91	-93	-95
Rate of Change				-2			
GPH used for apts.	1.84	1.84	1.84	1.84	1.84	1.84	1.84
Usage in GPH for apts	3,346.96	3,194.24	3,037.84	2,877.76	2,714.00	2,546.56	2,375.44
Total Irrigation hydrants	516	260	132	68	36	20	4
Year over Year Change	256	128	64	32	16	8	4
Rate of Change is exponential							
GPH used for hydrants	70.03	70.03	70.03	70.03	70.03	70.03	70.03
Usage in GPH for hydrants	234,387.61	223,692.63	212,739.94	201,529.53	190,061.42	178,335.60	166,352.06
Total usage Rounded	253,073	242,505	231,750	220,809	209,682	198,369	186,869

Calverton		2007	2006	2005	2004	2003	2002	2001
Total houses	0.0%	0	0	0	0	0	0	0
Total usage in GPH for Houses		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total apartments	75.0%	1,364	1,302	1,238	1,173	1,106	1,038	968
Total usage in GPH for apts.		2,510.22	2,395.68	2,278.38	2,158.32	2,035.50	1,909.92	1,781.58
Total hydrants	12.5%	65	33	17	9	5	3	1
Total usage in GPH for hydrants		4,516.94	2,275.98	1,155.50	595.26	315.14	175.08	35.02
Total usage for Calverton		7,027.16	4,671.66	3,433.88	2,753.58	2,350.64	2,085.00	1,816.60

Fairview Park		2007	2006	2005	2004	2003	2002	2001
Total houses	50.0%	2,249	2,290	2,342	2,405	2,479	2,564	2,660
Total usage in GPH for Houses		7,669.09	7,808.90	7,986.22	8,201.05	8,453.39	8,743.24	9,070.60
Total apartments	0.0%	0	0	0	0	0	0	0
Total usage in GPH for apts.		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total hydrants	0.0%	0	0	0	0	0	0	0
Total usage in GPH for hydrants		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total usage for Fairview Park		7,669.09	7,808.90	7,986.22	8,201.05	8,453.39	8,743.24	9,070.60

Hunt Valley		2007	2006	2005	2004	2003	2002	2001
Total houses	50.0%	2,249	2,290	2,342	2,405	2,479	2,564	2,660
Total usage in GPH for Houses		7,669.09	7,808.90	7,986.22	8,201.05	8,453.39	8,743.24	9,070.60
Total apartments	25.0%	455	434	413	391	369	346	323
Total usage in GPH for apts.		836.74	798.56	759.46	719.44	678.50	636.64	593.86
Total hydrants	87.5%	452	228	116	60	32	18	4
Total usage in GPH for hydrants		31,618.55	15,931.83	8,088.47	4,166.79	2,205.95	1,225.53	245.11
Total usage for Hunt Valley		40,124.38	24,539.29	16,834.15	13,087.28	11,337.84	10,605.41	9,909.57