How To Maximize Water Loss Control

David Liston

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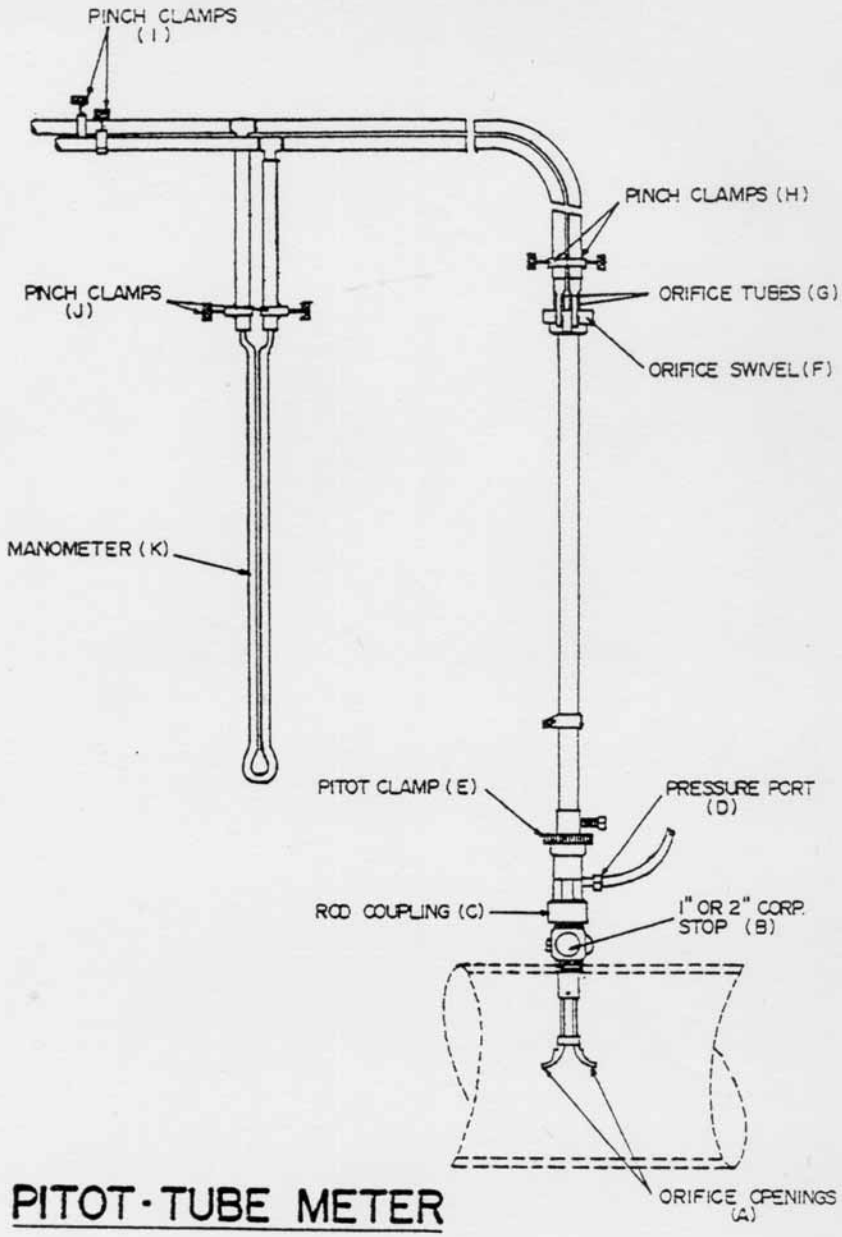
Massachusetts Water Resources Authority

November 18, 2008

How often should a distribution system be checked for hidden leakage?

- Accurate Source Meters
  - check calibration
  - verify accuracy with point velocity probe
- Monitor daily / monthly flow data
  - compare monthly average to prior years
- Determine minimum night rate of flow
  - compare night rate to total flow
- Monitor non-billed water consumption
  - determine pattern for your utility



PITOT-TUBE METER

FIGURE 13

13 Mile Road-West-Greenfield Road

Meter Data

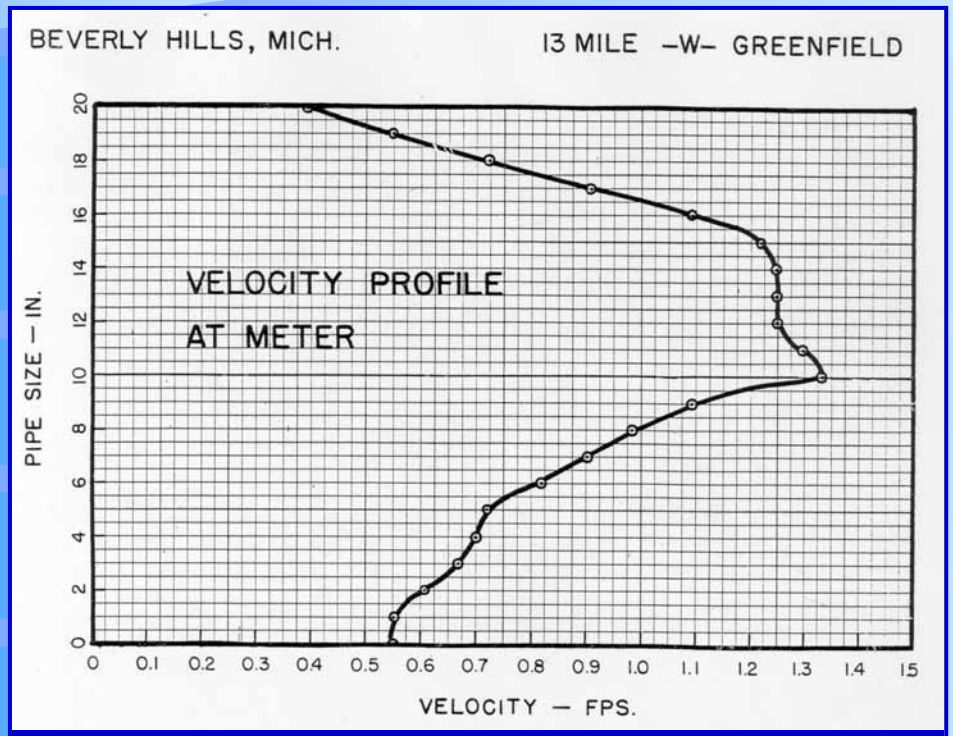
Manufacturer	-	Hersey Sparling
Size	-	20-in. x 5-in.
Number	-	62451

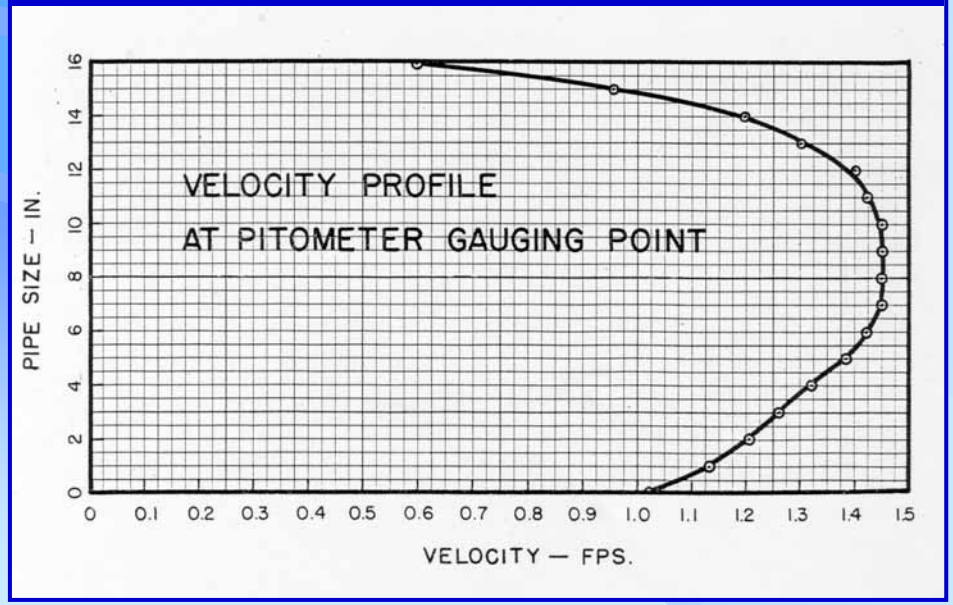
Test Data

Date of Test	-	March 4-5, 1976
Length of Test	-	24 hours
Condition of Test	-	Normal flow
Size of Main	-	16-inch

Results of Test

Pitometer Rate of Flow	-	1,070,000 gallons
Metered Rate of flow	-	1,293,000 gallons
Difference	-	223,000 gallons
Percentage Difference	-	20.8 % over-registration


BEVERLY HILLS, MICH.
13 MILE -W- GREENFIELD
VELOCITY PROFILE
AT METER
PIPE SIZE — IN.
0 2 4 6 8 10 12 14 16 18 20
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
VELOCITY — FPS.


VELOCITY PROFILE
AT PITOMETER GAUGING POINT
PIPE SIZE — IN.
0 2 4 6 8 10 12 14 16
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
VELOCITY — FPS.

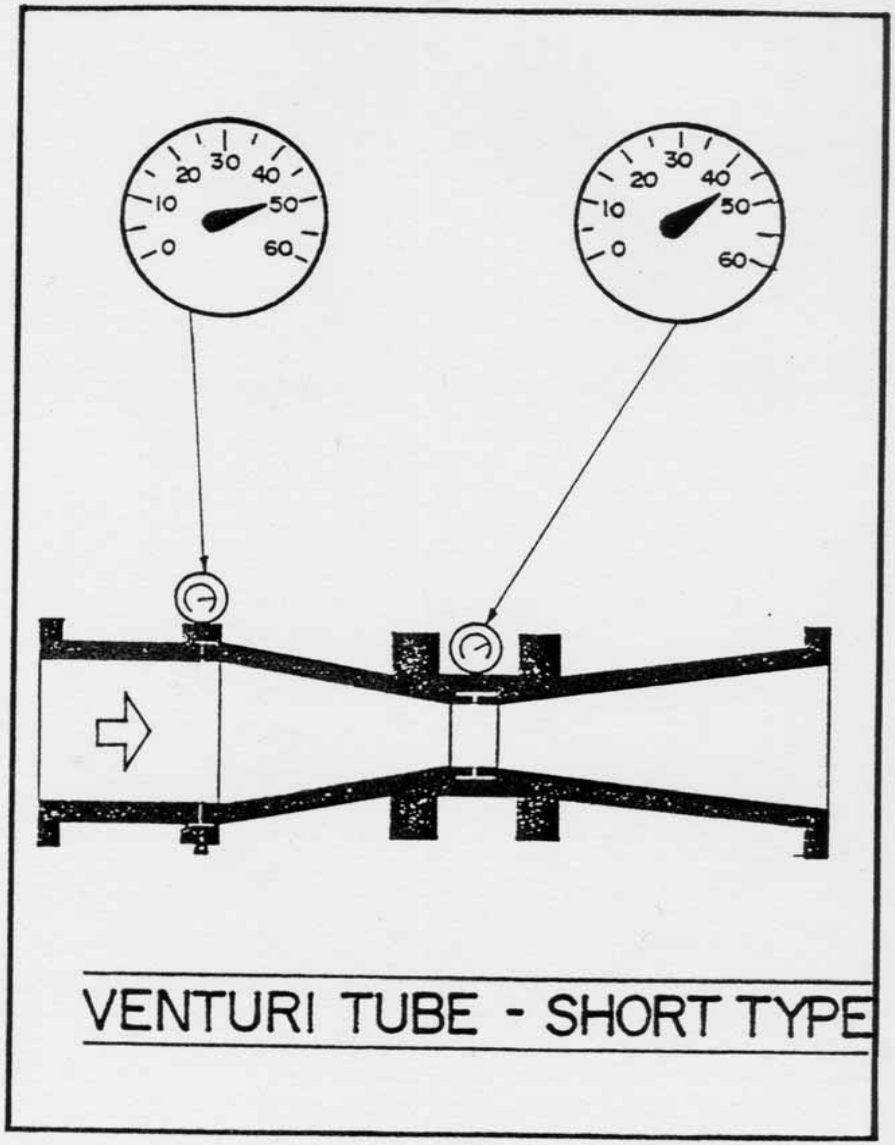
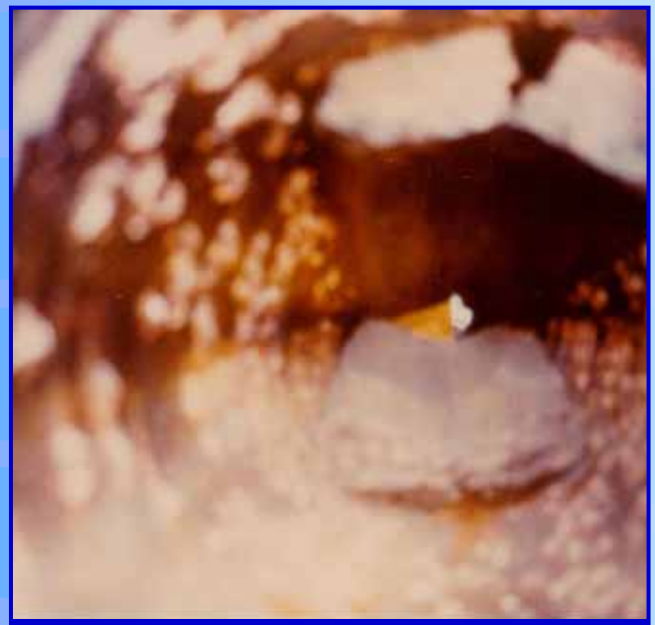


FIGURE 6



How often should your distribution system be checked for hidden leakage?

- Accurate Source Meters
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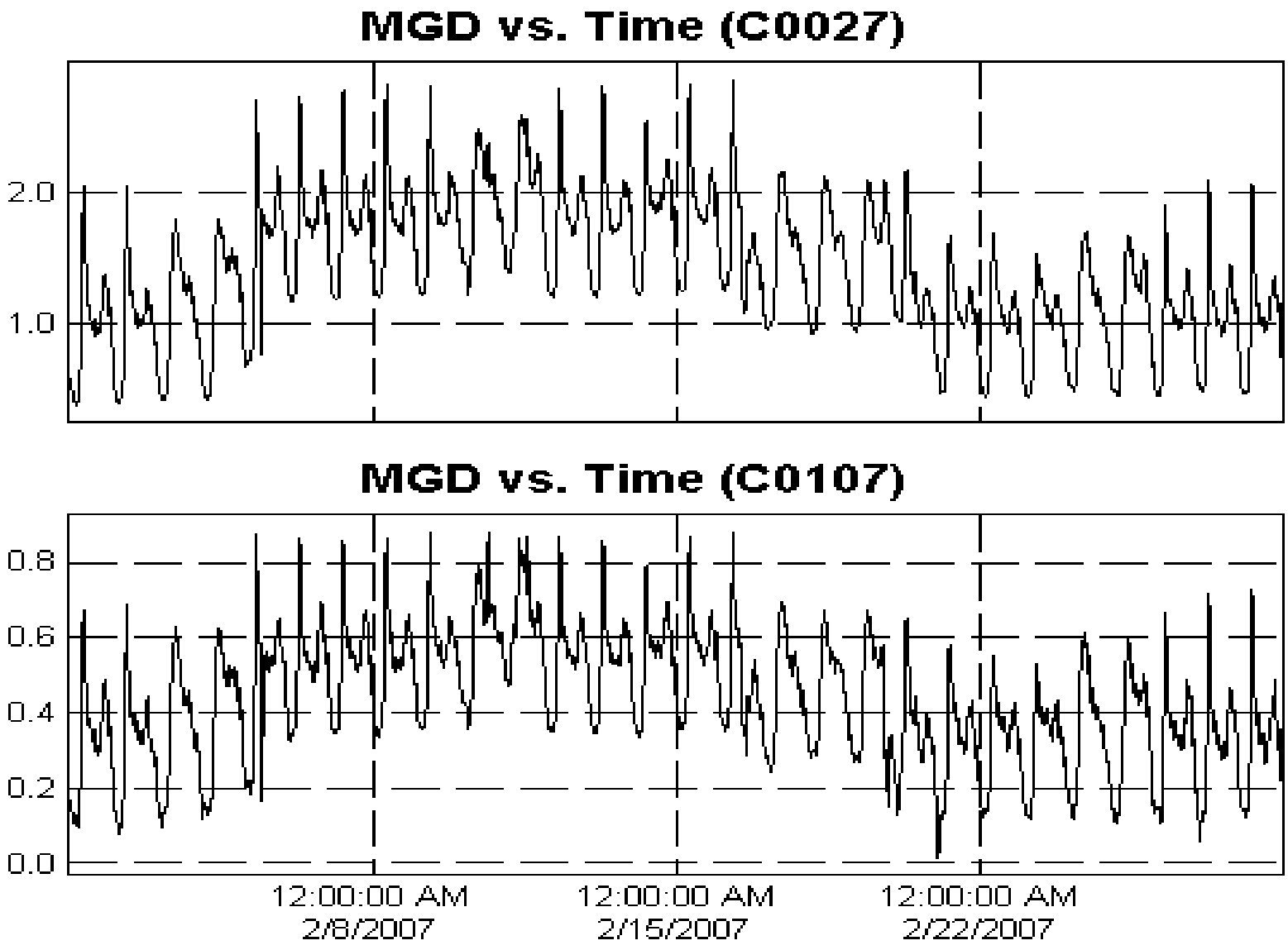
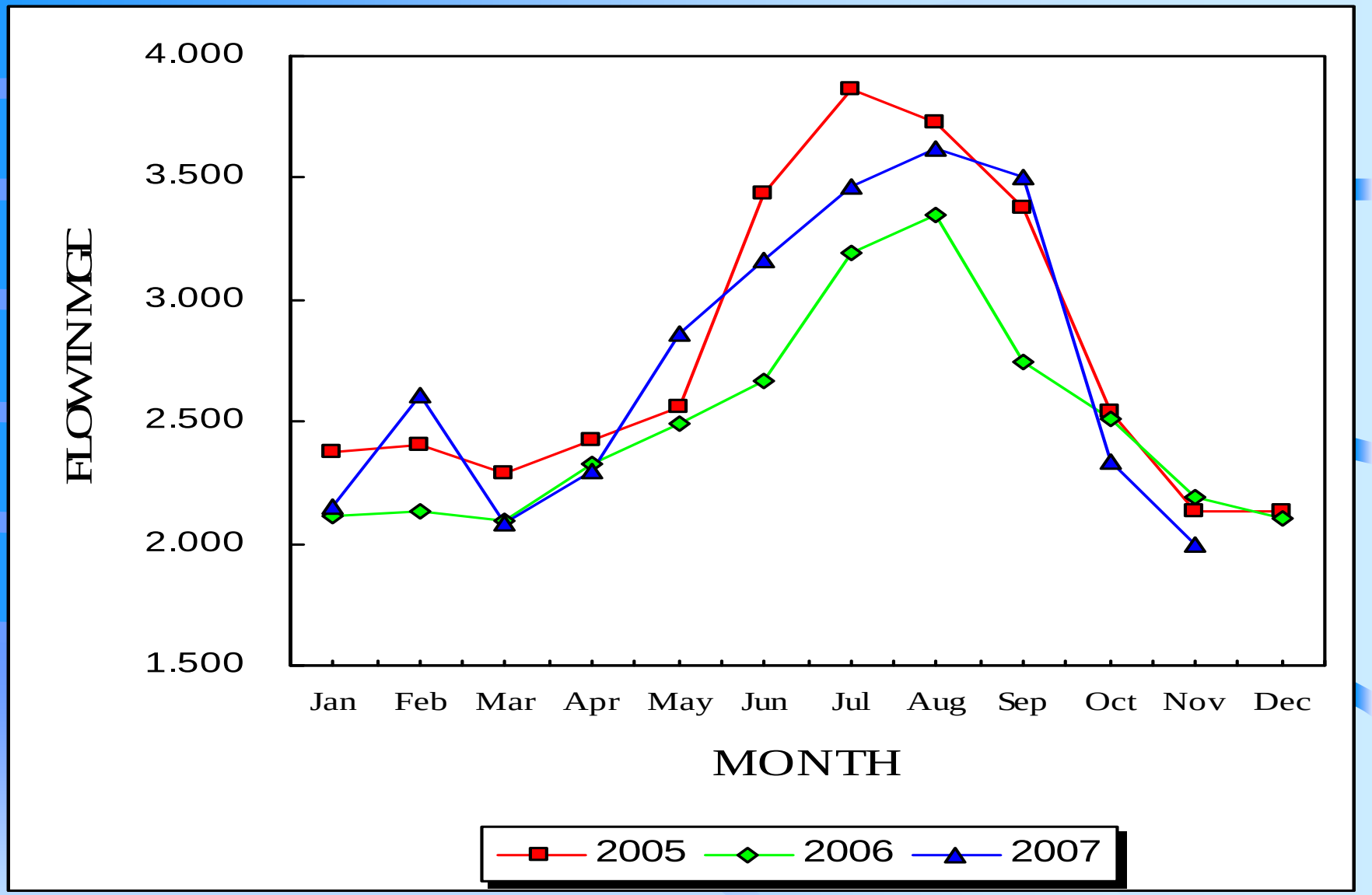
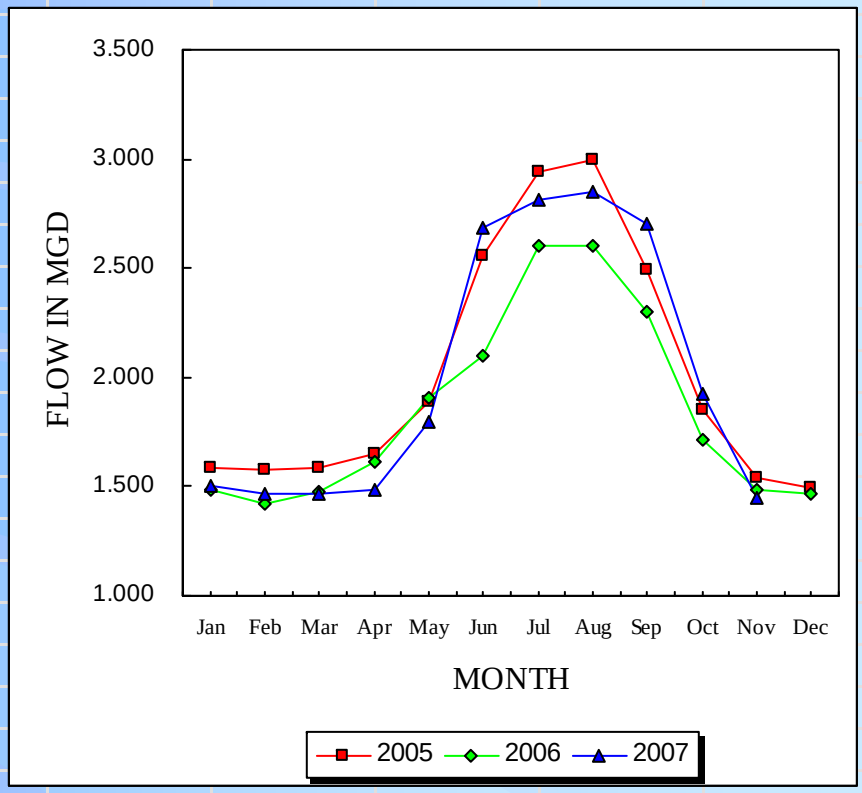
  - verify accuracy with point velocity probe
- Monitor daily / monthly flow data
  - compare monthly average to prior years


MGD vs. Time (C0027)
2.0
1.0
MGD vs. Time (C0107)
0.8
0.6
0.4
0.2
0.0
12:00:00 AM
2/8/2007
12:00:00 AM
2/15/2007
12:00:00 AM
2/22/2007


4.000
3.500
3.000
2.500
2.000
1.500
FLOWINMGL
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MONTH
2005
2006
2007

Marblehead - Total Daily Flow

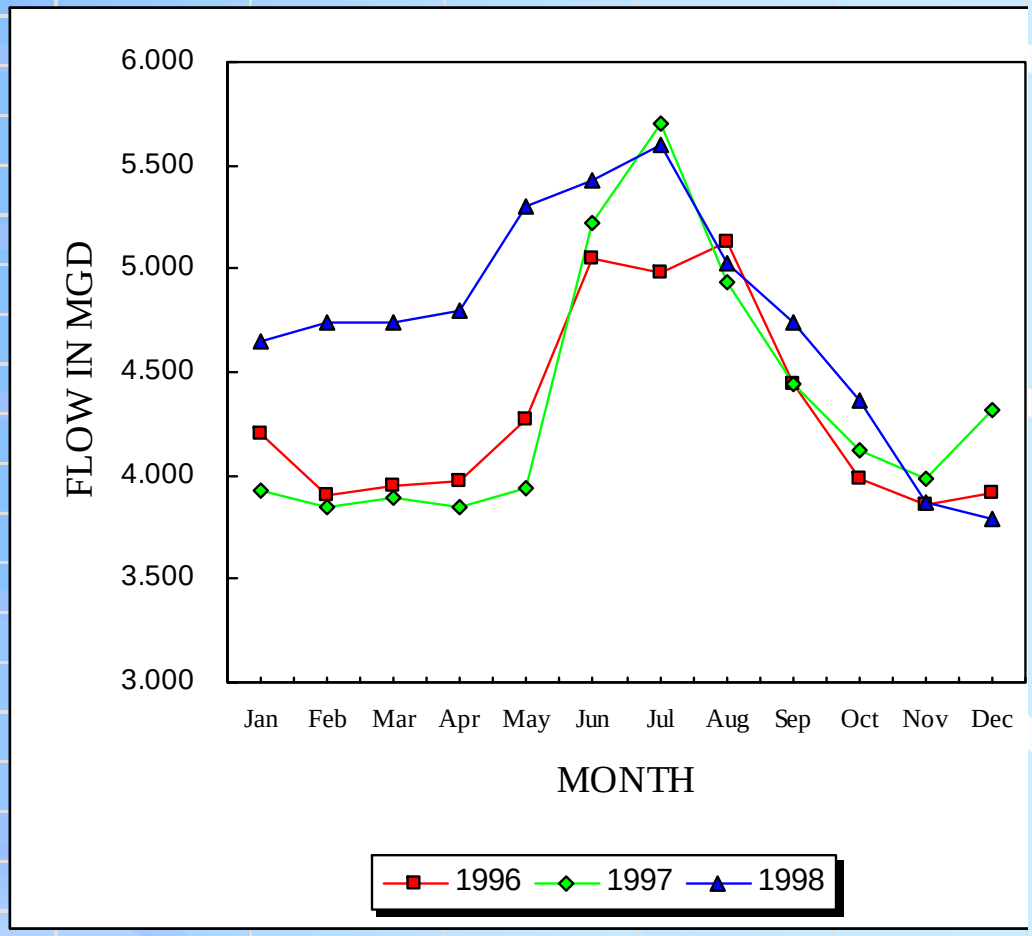
Month	2005 Flow (MGD)	2006 Flow (MGD)	2007 * Flow (MGD)
Jan	1.589	1.489	1.503
Feb	1.579	1.423	1.463
Mar	1.588	1.472	1.467
Apr	1.651	1.617	1.483
May	1.889	1.910	1.798
Jun	2.558	2.097	2.684
Jul	2.941	2.605	2.813
Aug	2.998	2.601	2.847
Sep	2.492	2.303	2.700
Oct	1.850	1.715	1.925
Nov	1.538	1.483	1.445
Dec	1.491	1.470	
Average	**2.017**	**1.852**	

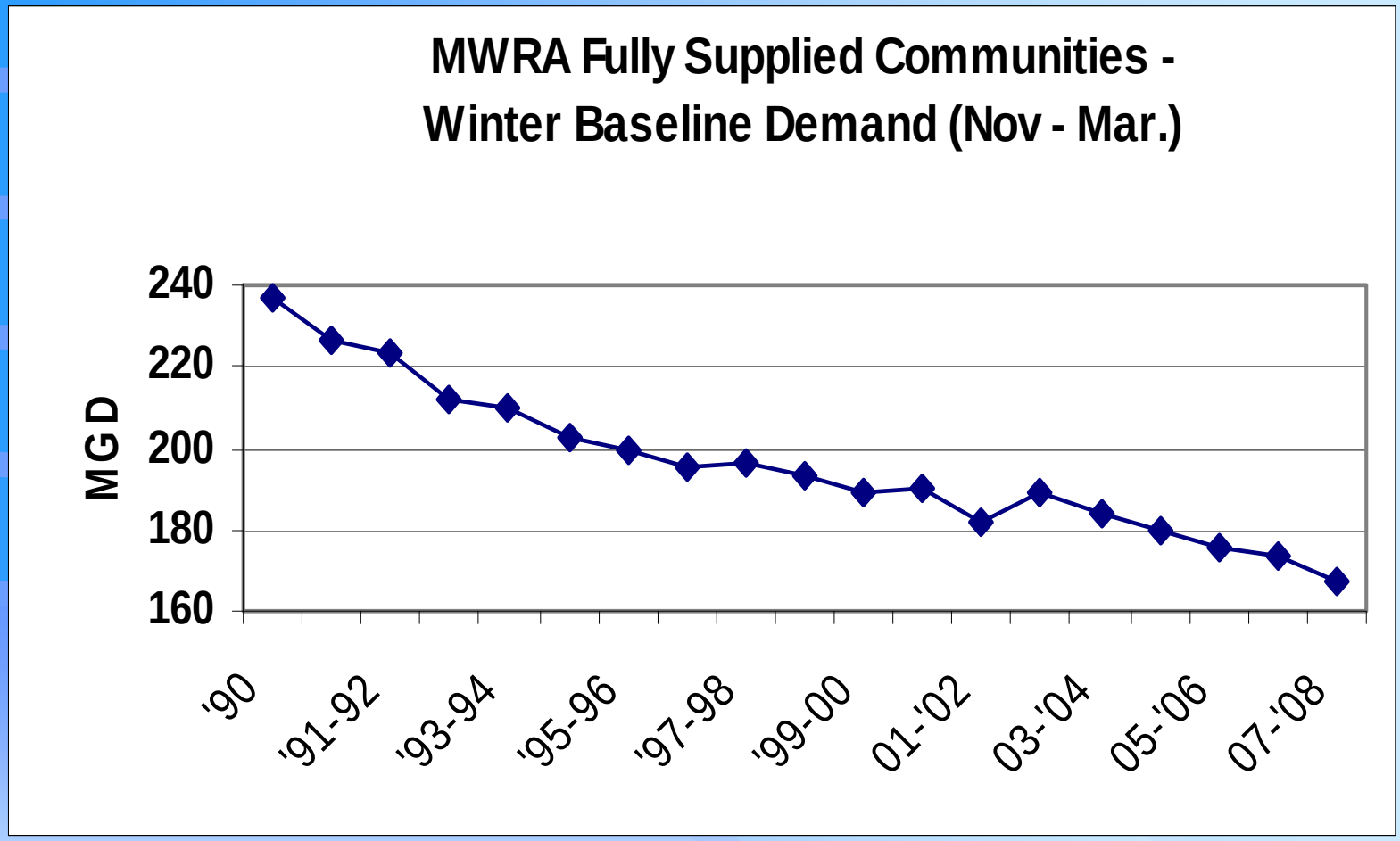


* The average for November 2007 is only for the first 19 days of the month.

Arlington - Total Daily Flow

Month	1996 Flow (MGD)	1997 Flow (MGD)	1998 Flow (MGD)
Jan	4.202	3.930	4.647
Feb	3.910	3.847	4.736
Mar	3.949	3.892	4.737
Apr	3.974	3.848	4.792
May	4.267	3.943	5.305
Jun	5.055	5.224	5.425
Jul	4.979	5.699	5.595
Aug	5.127	4.930	5.021
Sep	4.440	4.448	4.746
Oct	3.987	4.120	4.358
Nov	3.863	3.984	3.868
Dec	3.920	4.319	3.790
Average	**4.308**	**4.353**	**4.742**

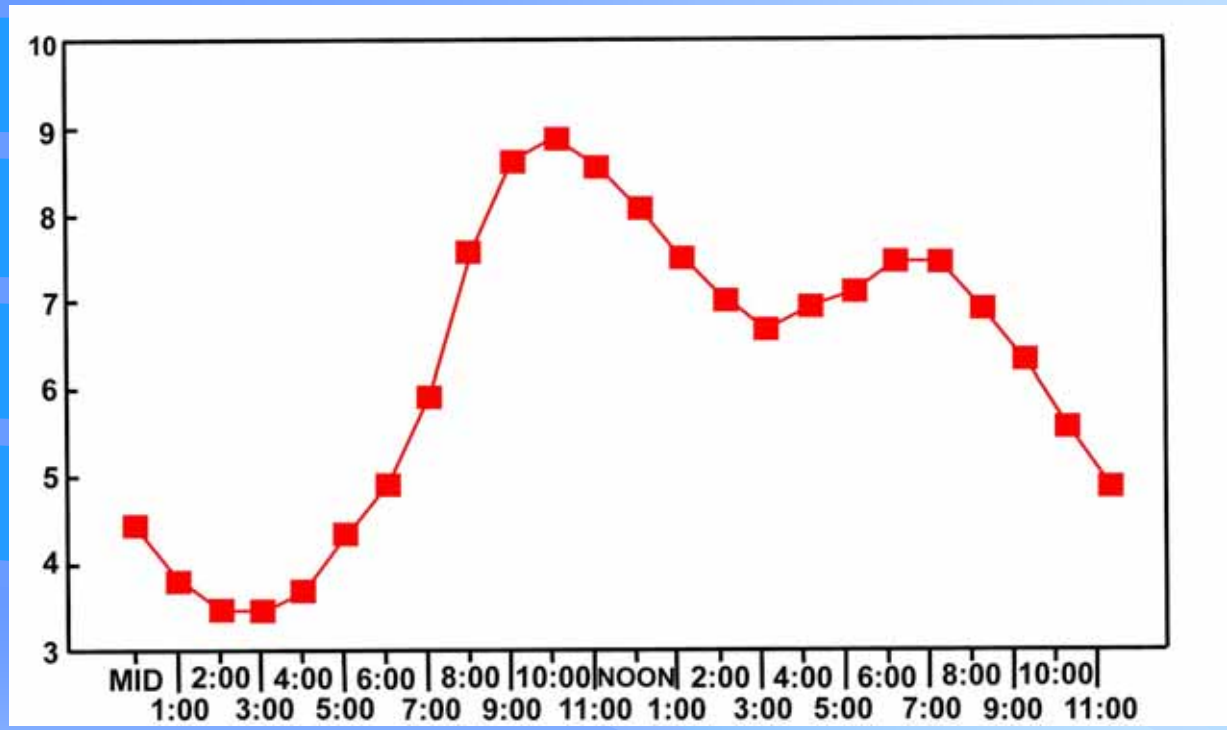



MWRA Fully Supplied Communities -
Winter Baseline Demand (Nov - Mar.)
MGD
240
220
200
180
160
'90
'91-92
'93-94
'95-96
'97-98
'99-00
01-'02
03-'04
05-'06
07-'08

Determine minimum night rate of flow.

- Monitor change in storage elevation
  - determine volume per foot
  - compute rate of flow in and out
  - compare to rate of flow into distribution system
  - determine twenty-four hour flow pattern
  - supply system using only storage capacity
- Compare night rate of flow to total
  - ratio's above 35-40% indicate potential for hidden leakage
  - compare to prior measurements
  - identify commercial/industrial usage

TOTAL
MALDEN - September 20, 1998

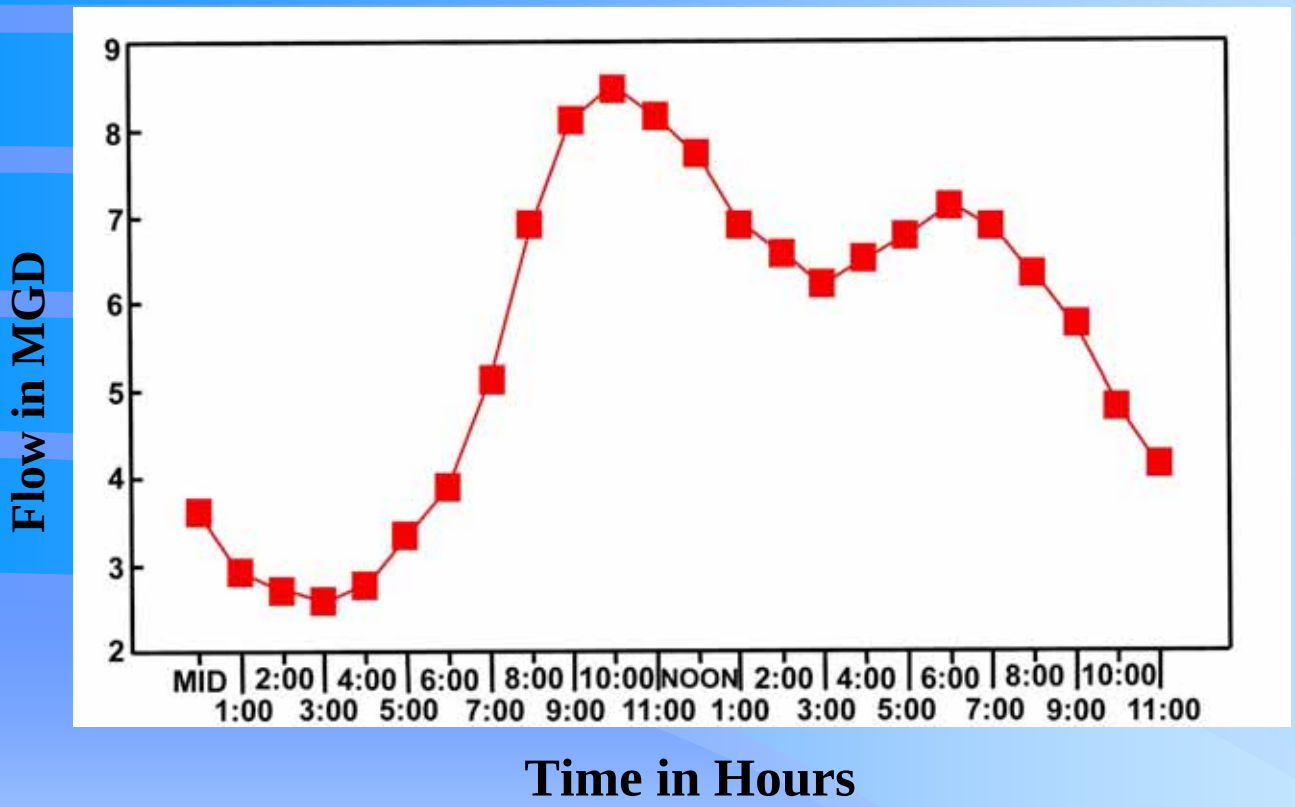


Average Daily Flow	MGD
	6.398

Minimum Night Flow	MGD
	3.460

Ratio Min./Avg.	
	54%

TOTAL
MALDEN - October 04, 1998



Average Daily Flow	MGD
	5.600

Minimum Night Flow	MGD
	2.596

Ratio Min./Avg.	
	46%

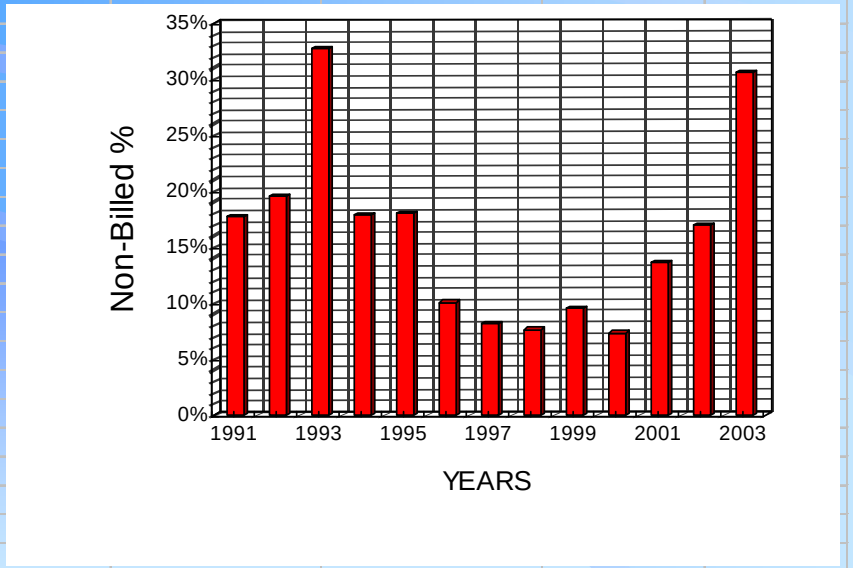
Monitor non-billed water consumption.

- Determine pattern for your utility
  - quantify category's of non-billed
    - bulk construction water sales
    - tank drainage
    - flushing program
    - blow offs
  - be consistent
- Express water loss in terms of volume
  - don't be misled by percentages
- Convert water loss to dollars
  - all water loss results from underground leakage
  - all water loss results from under-registering water meters
- Weigh the costs

MILTON

Non-Billed Water Consumption

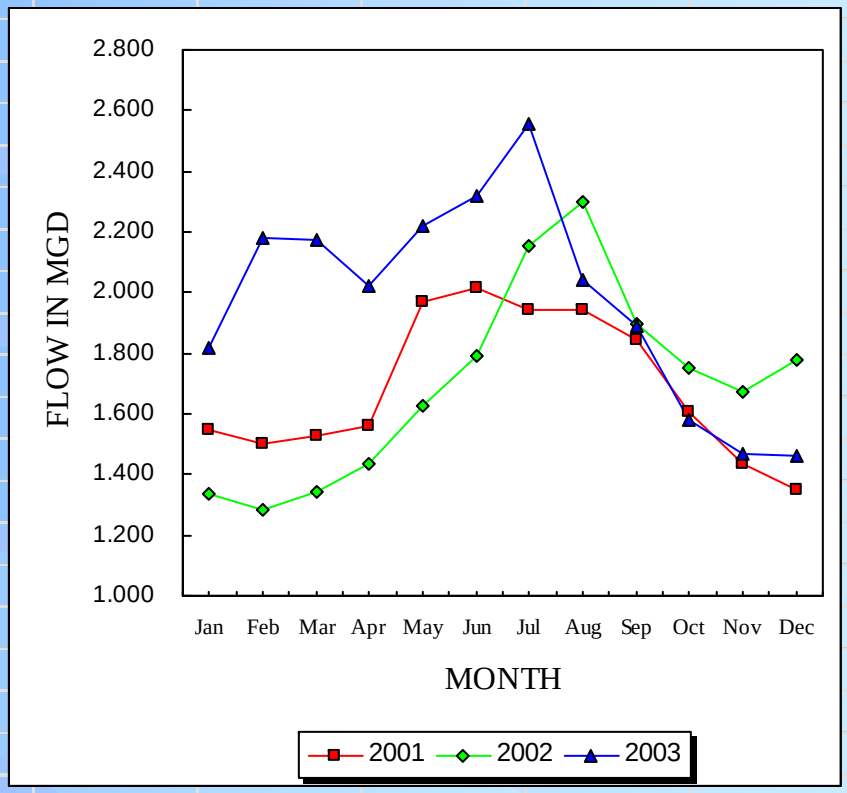
Year	Total Water Use (mg)	Total Water Sales (mg)	Non-Billed (mg)	Non-Billed (%)
1991	977	804	173	18%
1992	944	759	185	20%
1993	1,063	715	348	33%
1994	976	802	174	18%
1995	986	808	178	18%
1996	992	892	100	10%
1997	982	902	80	8%
1998	984	909	75	8%
1999	1,004	908	96	10%
2000	912	845	67	7%
2001	960	829	131	14%
2002	943	783	160	17%
2003	1,042	723	319	31%



Milton - Total Daily Flow

Southern High Service

Month	2001 Flow (MGD)	2002 Flow (MGD)	2003 Flow (MGD)
Jan	1.546	1.338	1.820
Feb	1.504	1.282	2.183
Mar	1.528	1.344	2.176
Apr	1.558	1.436	2.025
May	1.967	1.624	2.218
Jun	2.014	1.790	2.316
Jul	1.943	2.155	2.557
Aug	1.946	2.302	2.040
Sep	1.847	1.899	1.888
Oct	1.609	1.753	1.582
Nov	1.434	1.671	1.468
Dec	1.352	1.780	1.462
Average	**1.690**	**1.701**	**1.978**



Arlington - Total Daily Flow

Month	1996 Flow (MGD)	1997 Flow (MGD)	1998 Flow (MGD)
Jan	4.202	3.930	4.647
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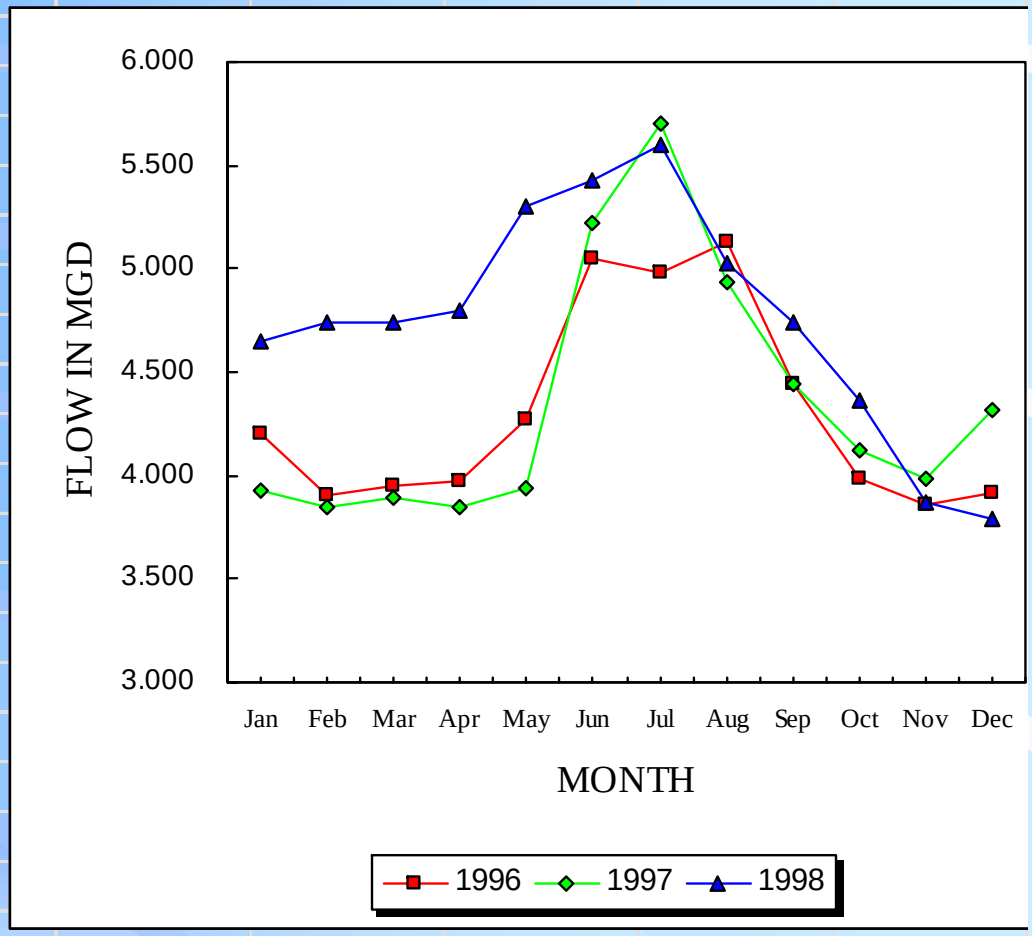
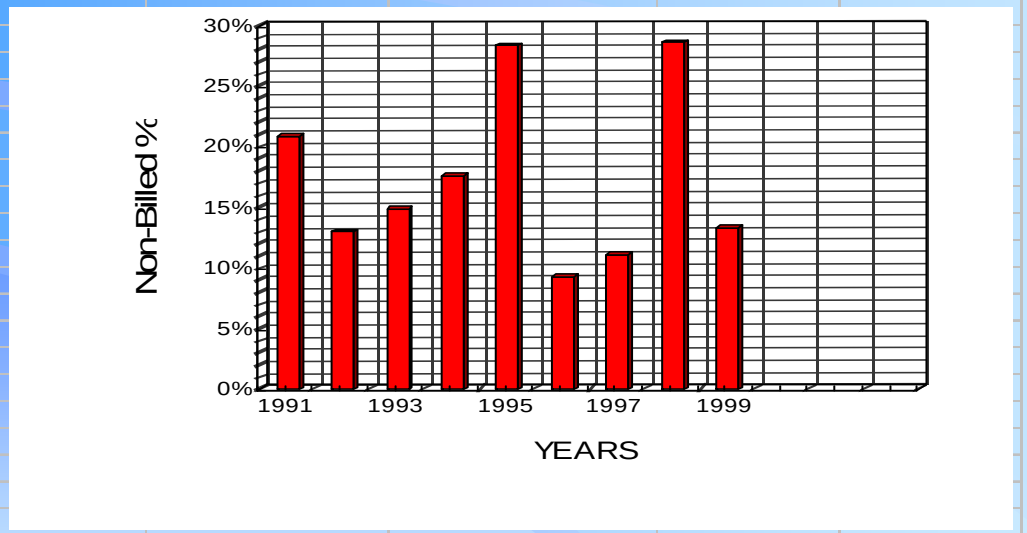


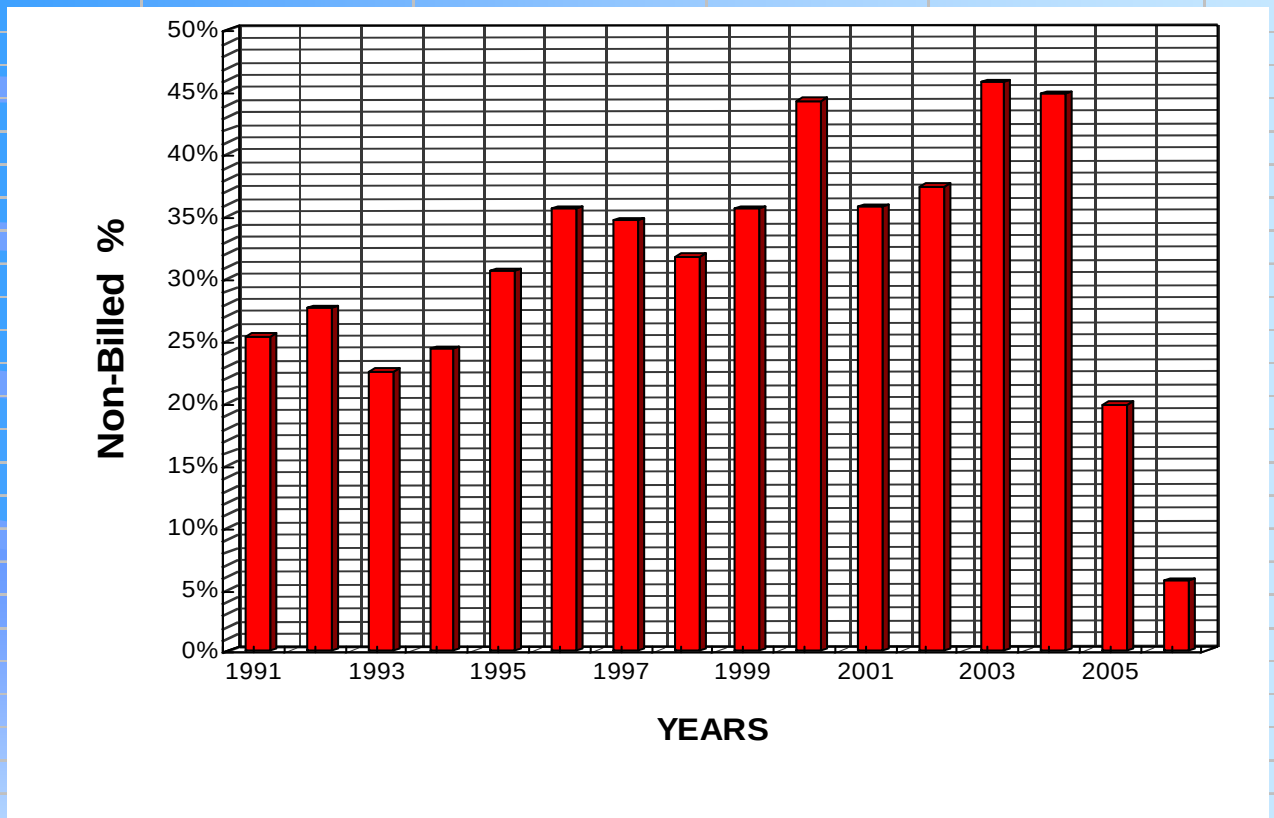
ARLINGTON

Non-Billed Water Consumption

Year	Total Water Use (mg)	Total Water Sales (mg)	Non-Billed (mg)	Non-Billed (%)
1991	1,567	1,240	327	21%
1992	1,497	1,303	194	13%
1993	1,372	1,168	204	15%
1994	1,502	1,238	264	18%
1995	1,635	1,172	464	28%
1996	1,577	1,430	146	9%
1997	1,589	1,413	176	11%
1998	1,731	1,236	495	29%
1999	1,644	1,425	219	13%

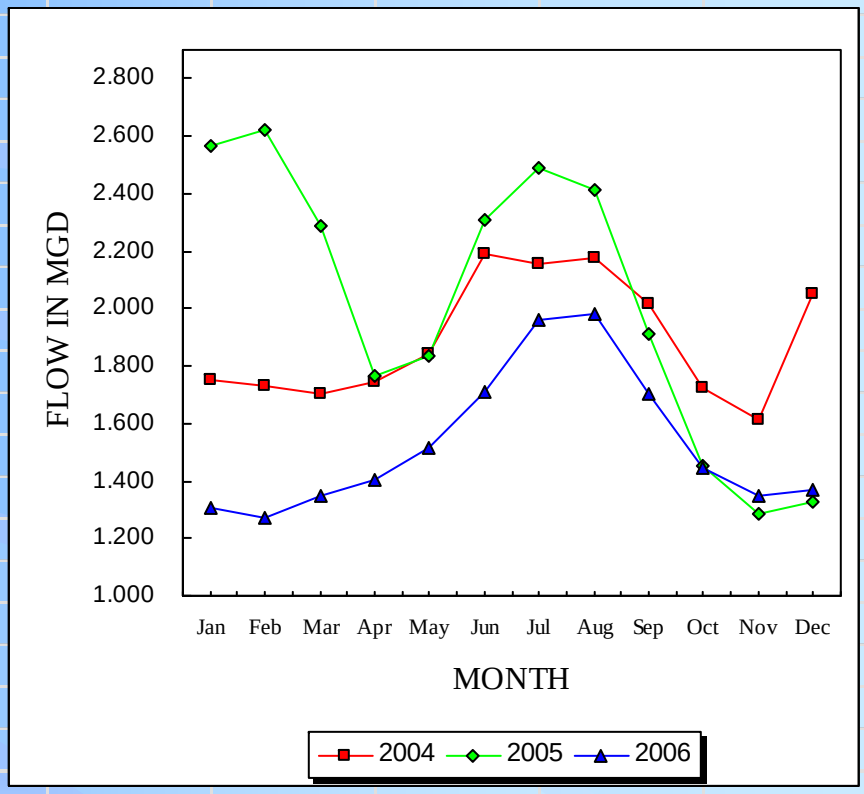


Swampscott


50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Non-Billed %
1991
1993
1995
1997
1999
2001
2003
2005
YEARS

Swampscott - Total Daily Flow

Month	2004 Flow (MGD)	2005 Flow (MGD)	2006 Flow (MGD)
Jan	1.751	2.564	1.305
Feb	1.731	2.624	1.271
Mar	1.706	2.290	1.346
Apr	1.743	1.763	1.401
May	1.842	1.838	1.516
Jun	2.189	2.306	1.708
Jul	2.152	2.492	1.963
Aug	2.173	2.410	1.982
Sep	2.016	1.914	1.701
Oct	1.727	1.450	1.445
Nov	1.611	1.282	1.349
Dec	2.052	1.324	1.367
Average	**1.892**	**2.019**	**1.531**



Different Levels of Leak Detection

- Hydrant Listening survey
  - available points of direct contact
- Comprehensive listening survey
  - available points of direct contact
  - used ground microphone over main every 6-10 feet
- Multi Point Leak Correlation Survey
  - using correlating loggers at available points of direct contact
- District Measurements
  - minimum night rate
  - night-time subdivision
  - comprehensive listening

TRUCKS

91
A4
U.S.MAIL

OfficeMax
JO-ANN
hajjar's
BIG TALL

Different Levels of Leak Detection

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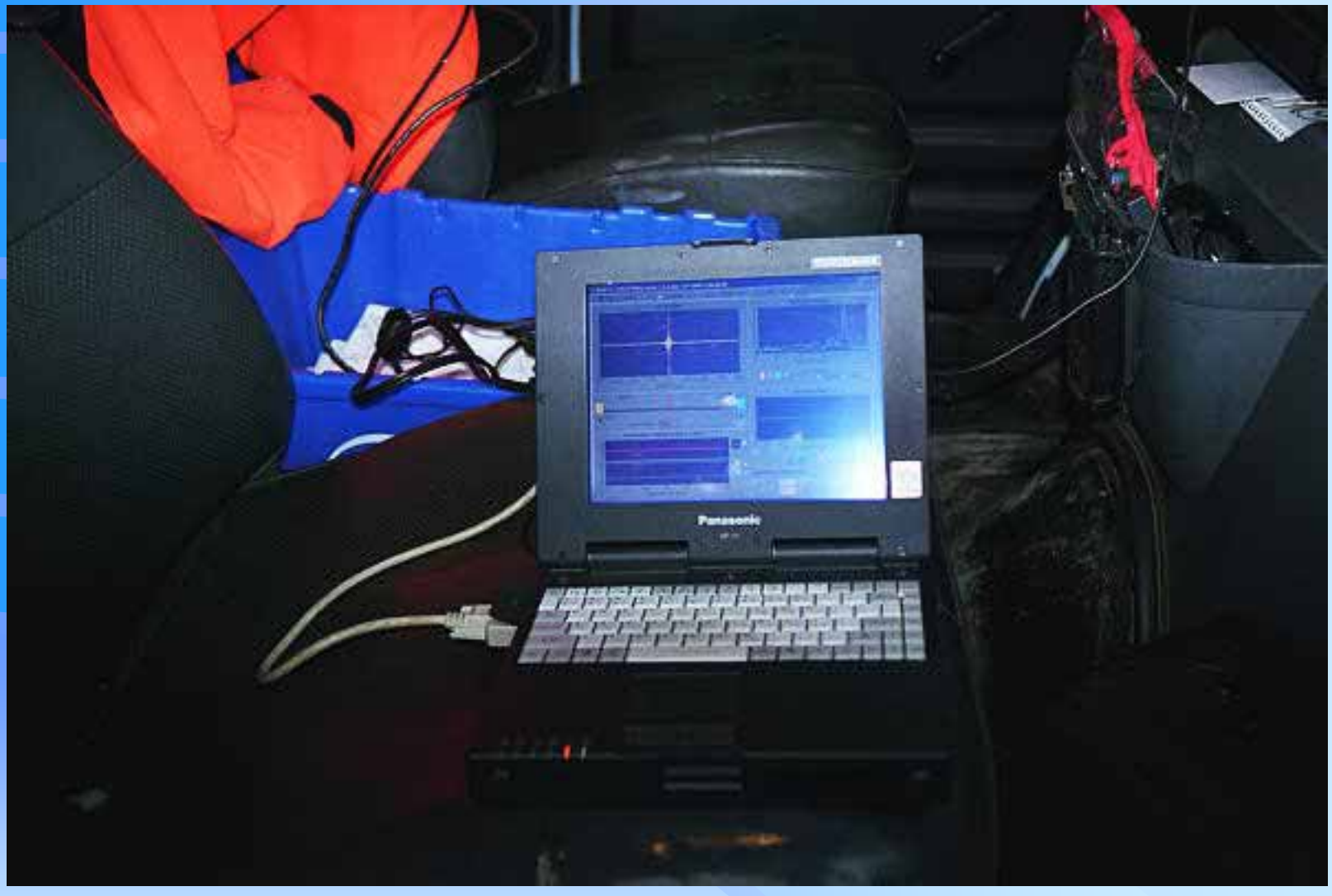
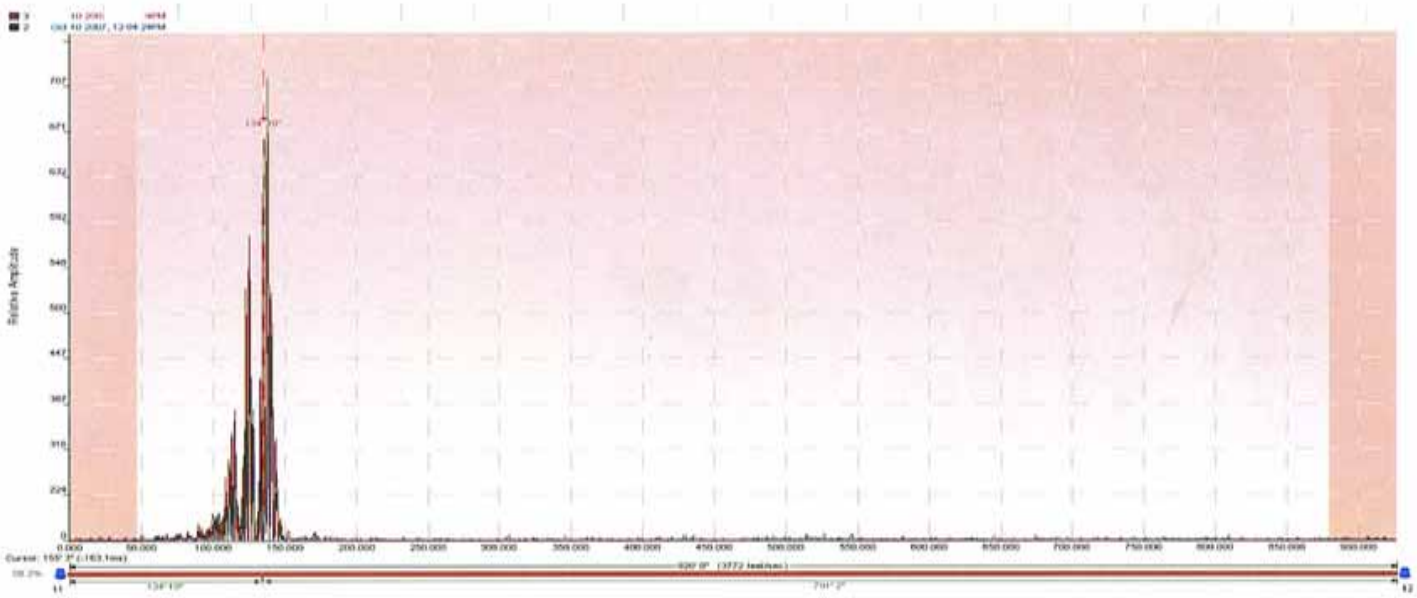
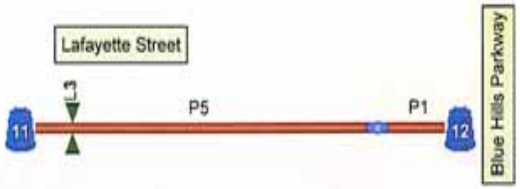
- Multi Point Correlation Survey
  - Using correlating loggers at available points of contact


Panasonic



Pipe ID	Length	Diameter	Material	Sound Velocity
P1	6' 0"	6"	Cast Iron	4072 feet/sec
P5	920' 0"	12"	Cast Iron	3770 feet/sec

Leak ID	Leak Position	Correlation Between	Confidence	Recording Time
L1	137' 11" from 11	11 -> 12	89.0%	Oct 10 2007, 12:02:24PM
L2	135' 2" from 11	11 -> 12	88.0%	Oct 10 2007, 12:04:24PM
L3	134' 10" from 11	11 -> 12	88.2%	Oct 10 2007, 12:06:24PM

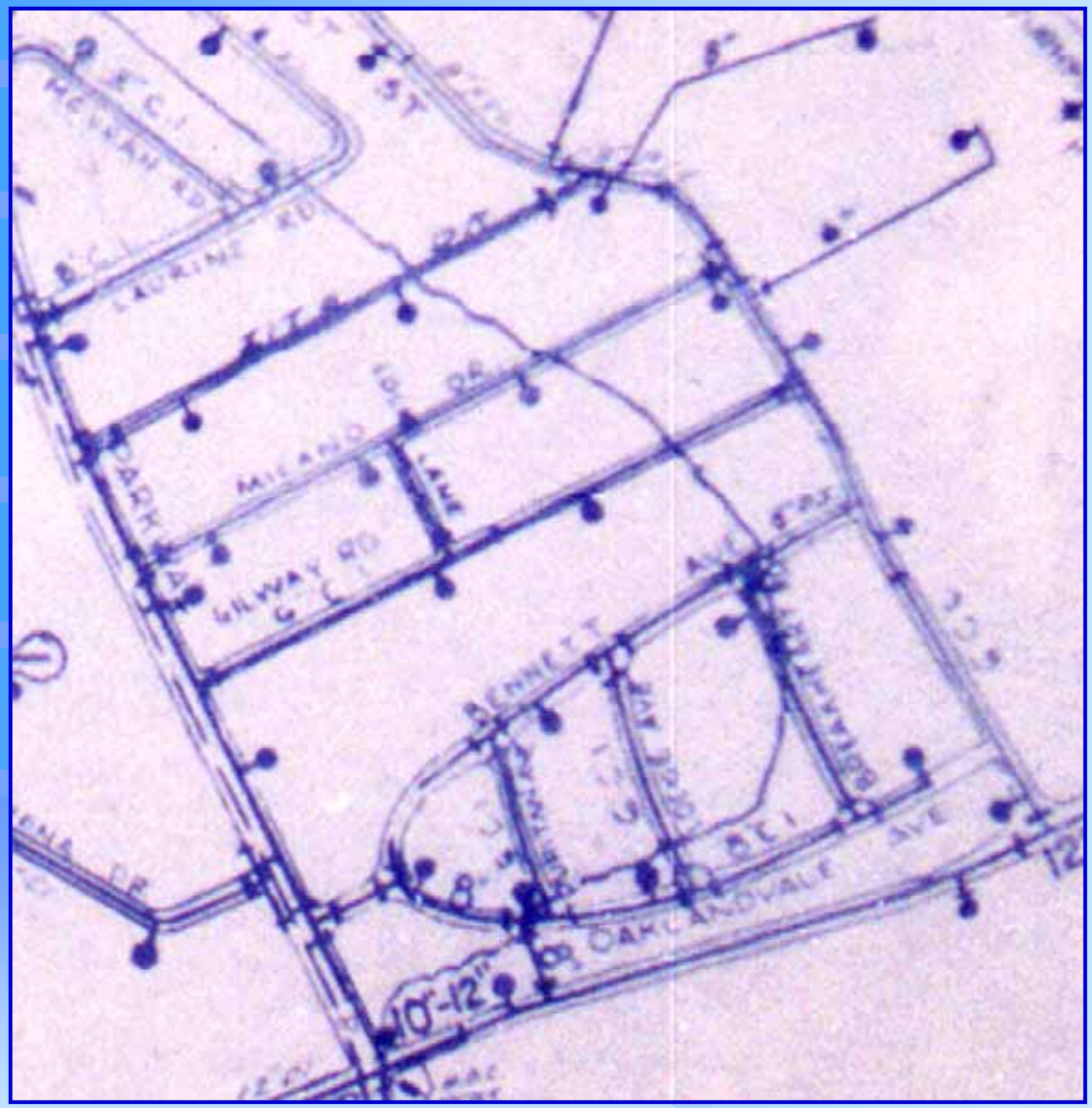


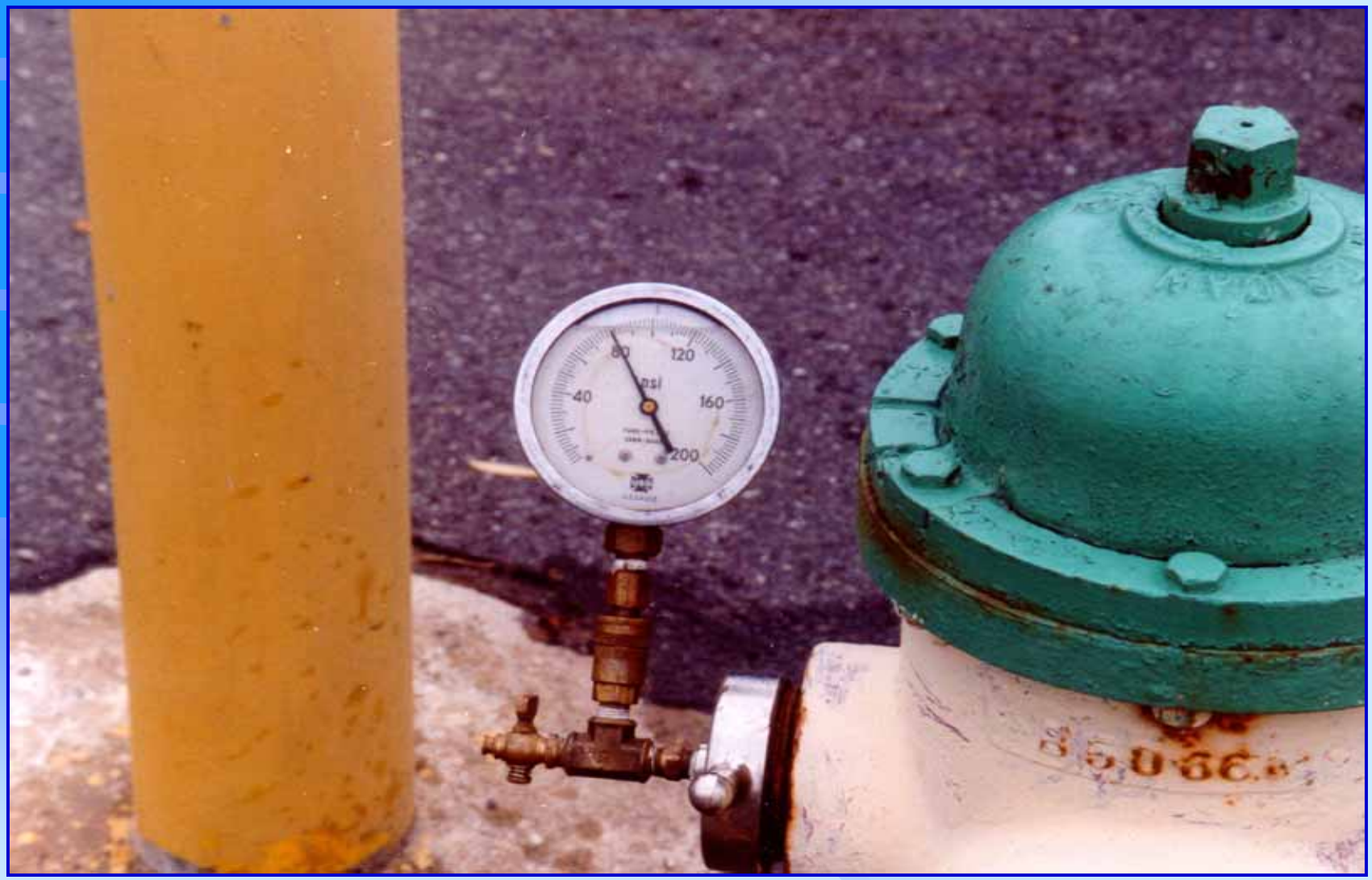
Printed Oct 10 2007, 04:39:52PM, Recorded Oct 10 2007, 12:06:24PM

RADCOM SoundSens

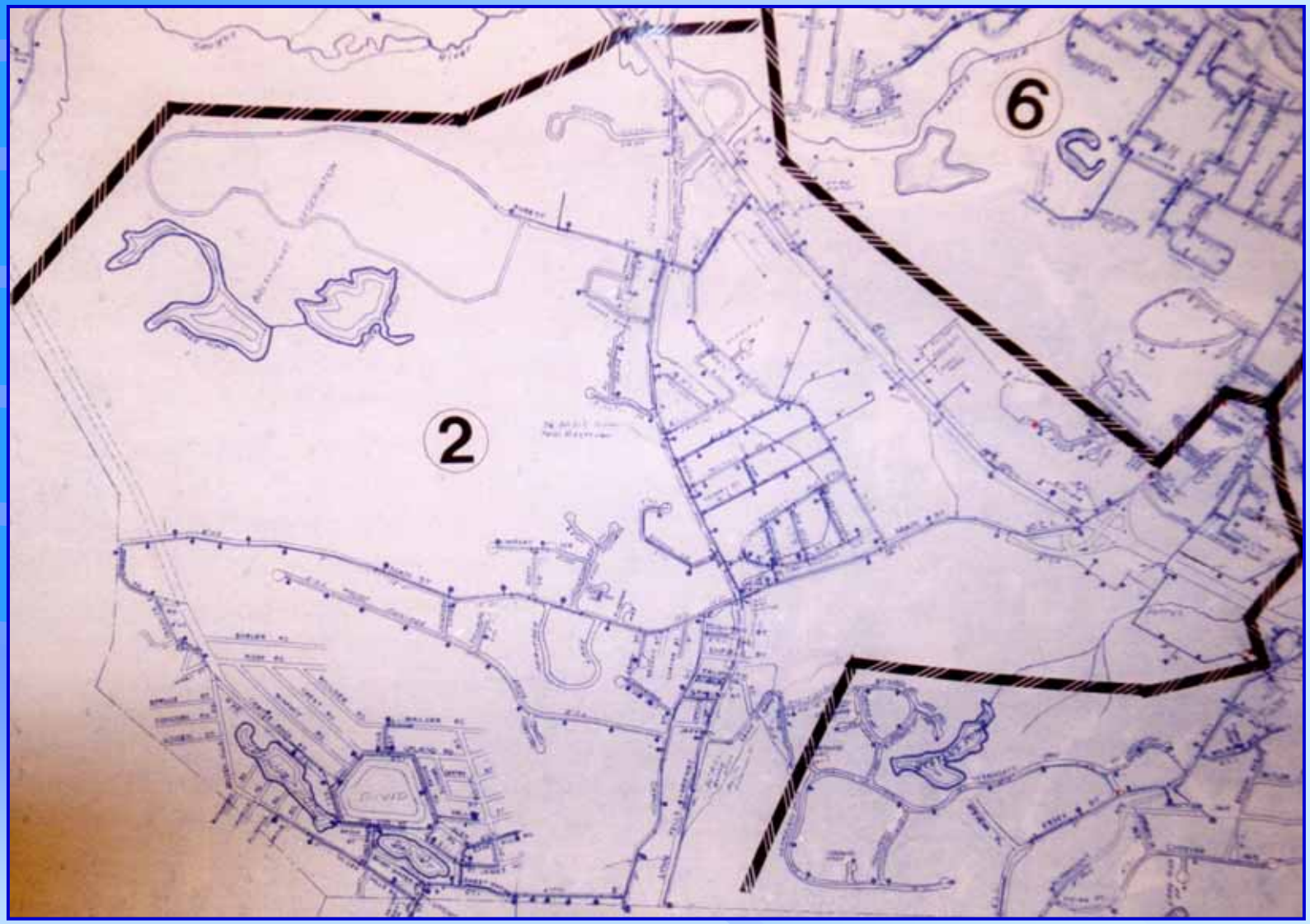
Different Levels of Leak Detection

- Hydrant Listening survey
  - available points of direct contact
- Comprehensive listening survey
  - available points of direct contact
  - used ground microphone over main every 6-10 feet
- Multi Point Leak Correlation Survey
  - using correlating loggers at available points of direct contact
- District Measurements
  - minimum night rate
  - night-time subdivision
  - comprehensive listening


LAURINE RD
MILANO
GILWAY RD
BENNETT
OAKLANDVALE AVE
10"-12"


40
80
120
160
200
psi

SAUGUS FIRE DEPARTMENT
LADDER


6
2

District No. 5

General Boundaries:	North - System Limits East - Atlantic Ocean South - Whales Beach West - Puritan Lane, Glen Rd. and Laurel Ln.
Gauging Point:	In - Forest Ave.-W-Whitman Rd.
Size of Feed Main:	In - 10-inch
Date of Measurement:	May 1-2, 2001
Results of Twenty-four Hour Measurement:	
Total Consumption	- 610,000 gallons
Maximum Rate	- 1,040,000 gpd.
Minimum Night Rate	- 340,000 gpd.
Ratio: Minimum Night Rate to Total	- 56 %
Miles of Main	5.6 miles

SUMMARY

(Water quantities in gallons per day)

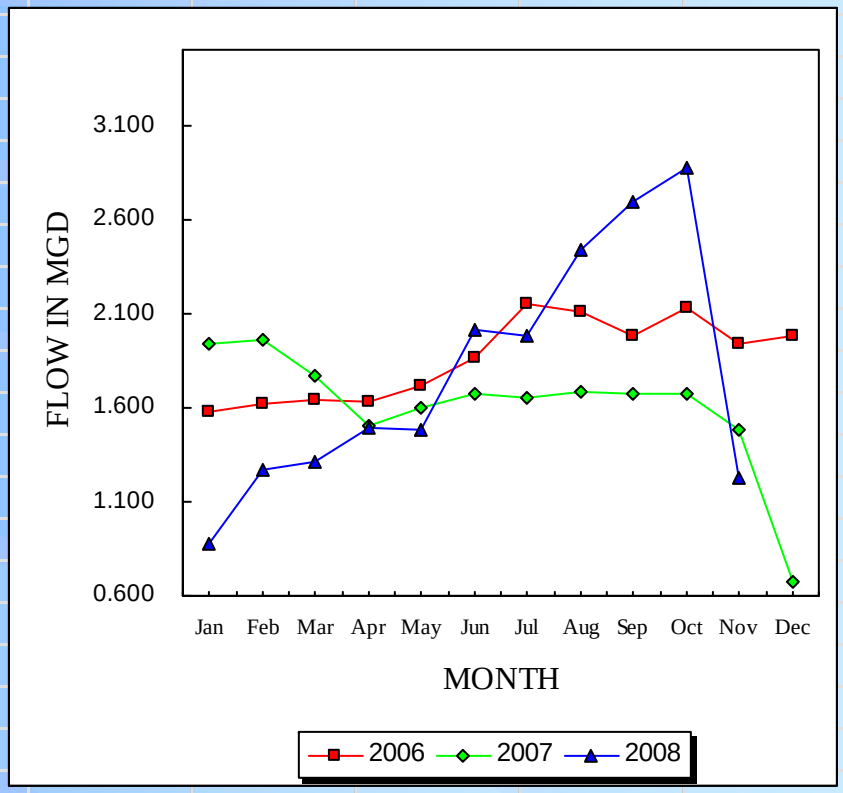
The following table presents a summary of the results obtained during the measurements.

District No.	Miles Of Main	Total Daily Consumption	Minimum Night Rate	Ratio: Minimum Night Rate to Total
1	3.8	TSTM	TSTM	TSTM
2	8.2	600,000	260,000	43
3	10.2	920,000	510,000	54
4	5.4	50,000	TSTM	TSTM
5	15.6	610,000	340,000	56
Total	43.2	2,180,000	1,110,000	51

Everett - Total Daily Flow

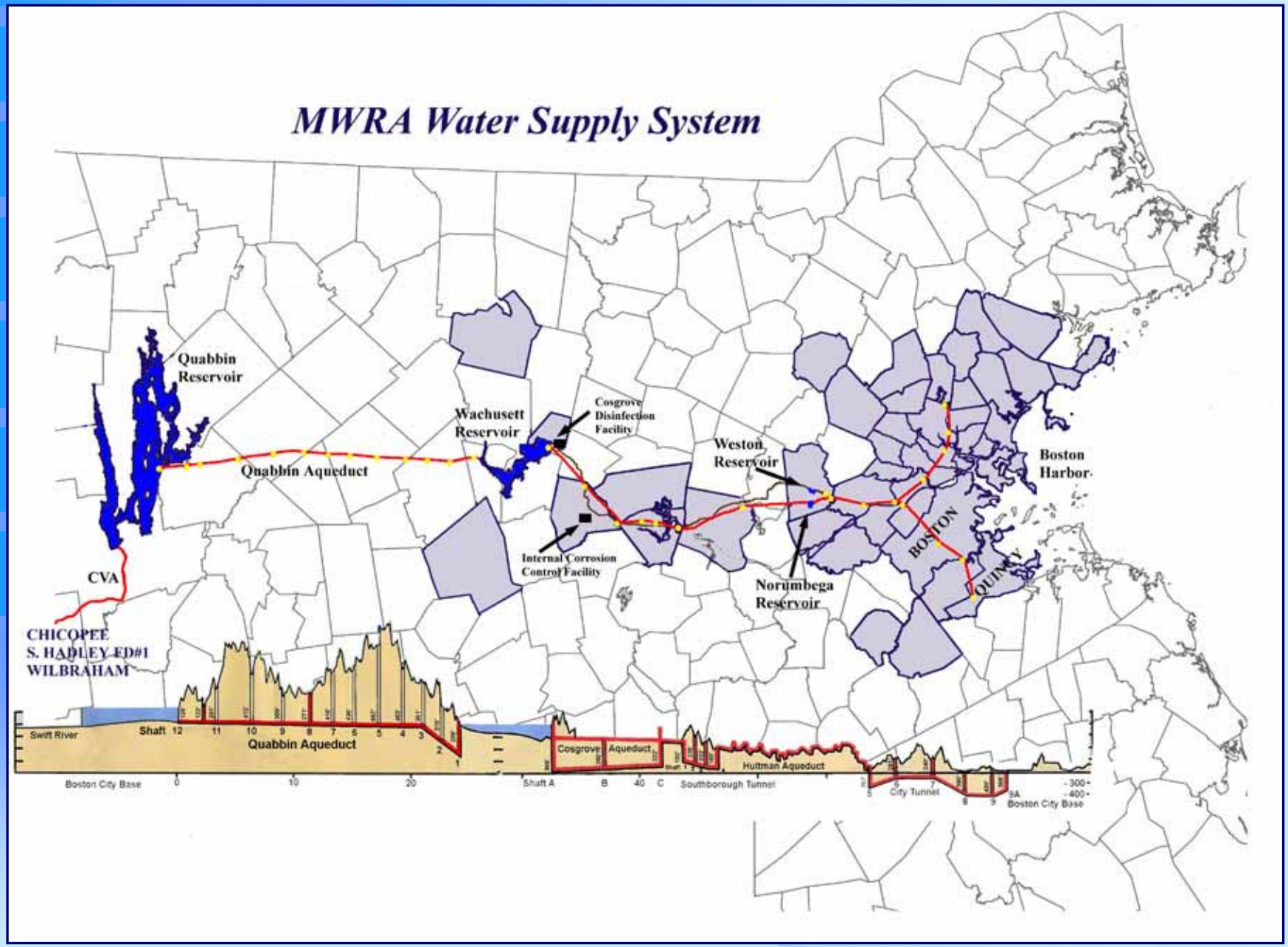
LOW

Month	2006 Flow (MGD)	2007 Flow (MGD)	2008 * Flow (MGD)
Jan	1.572	1.942	0.872
Feb	1.625	1.965	1.274
Mar	1.639	1.769	1.310
Apr	1.628	1.505	1.491
May	1.711	1.595	1.484
Jun	1.862	1.669	2.016
Jul	2.154	1.655	1.983
Aug	2.108	1.681	2.443
Sep	1.979	1.670	2.697
Oct	2.127	1.673	2.870
Nov	1.936	1.482	1.228
Dec	1.983	0.679	
Average	**1.862**	**1.605**	



* November average for November 5-11, 2008

MWRA Water Supply System

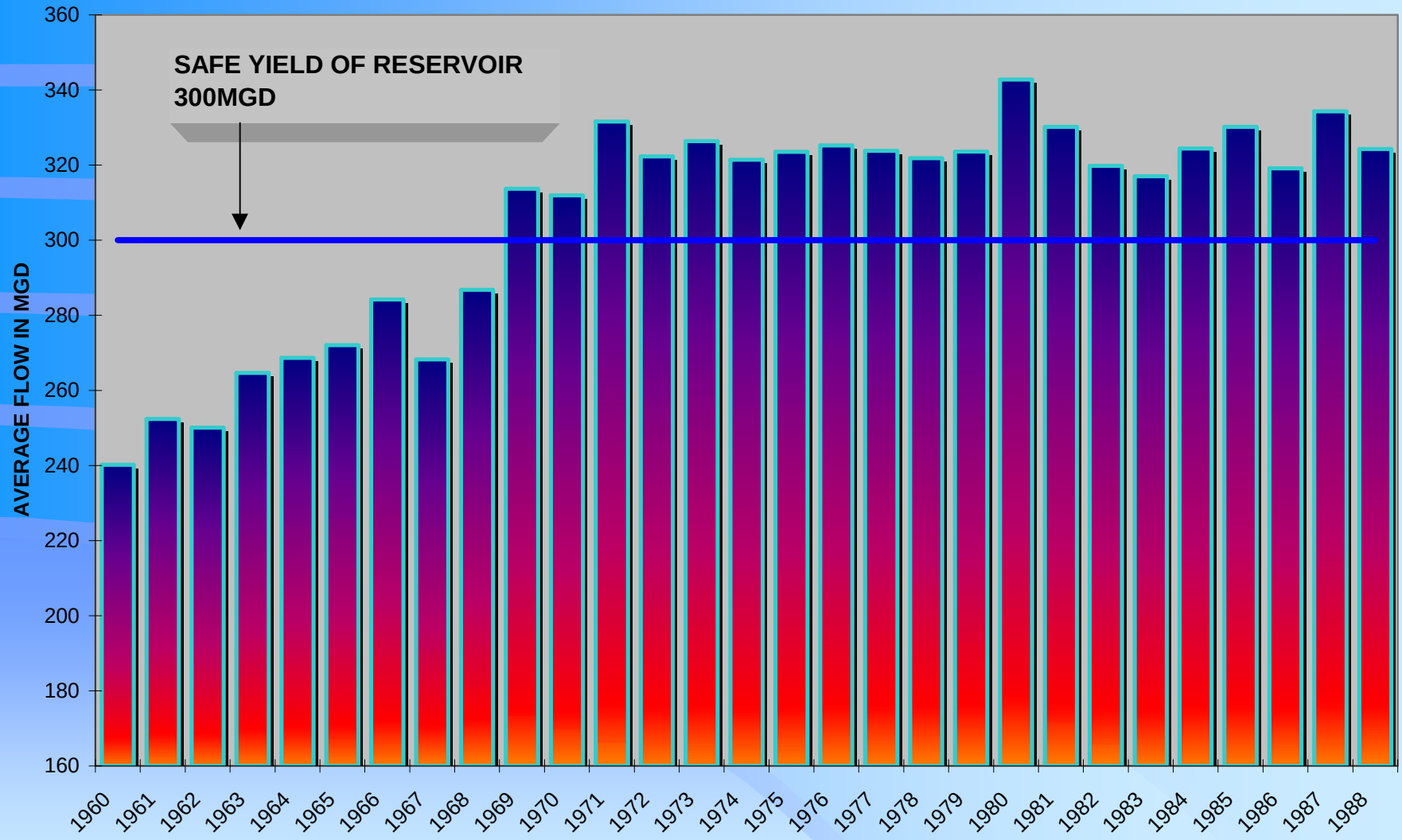


Quabbin Reservoir

Maximum storage: 412,200 million gallons
Required release to Swift River: 20 mgd
Length of Reservoir: 17.9 miles

Maximum depth: 150 feet
High water elevation: 530 feet

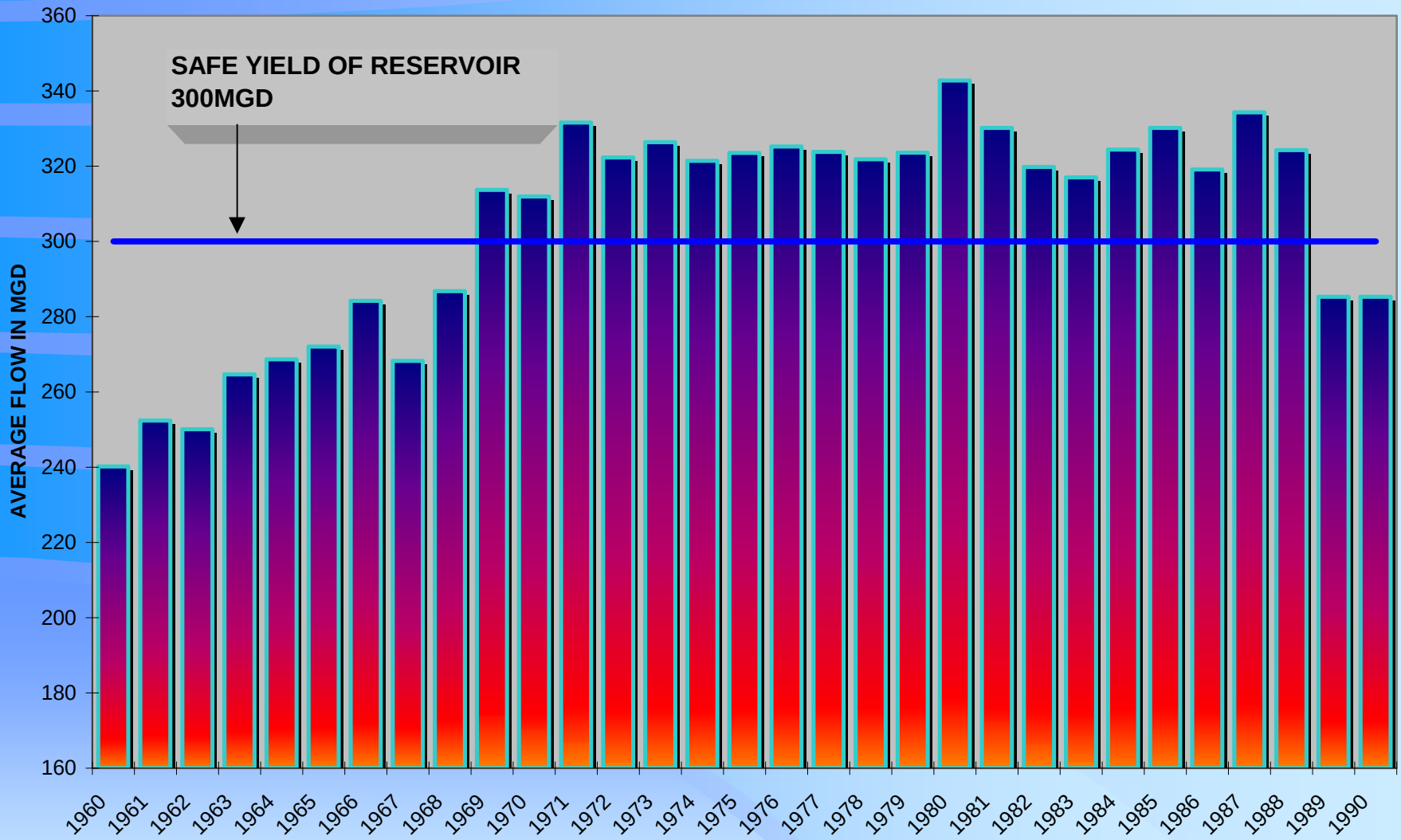
MWRA YEARLY AVERAGE WATER USE: 1960-1988



Results from once through Leak Detection Survey

- MWRA owned pipelines
  - First annual survey (6/87-10/88)
  - located 87 leaks wasting 3.8 MGD
  - 6085 miles surveyed (6/88-8/90)
- Community owned pipelines
  - 318 main leaks wasting 10.77 MGD
  - 1094 service leaks wasting 14.41 MGD
  - 962 hydrant and valve leaks wasting 5.26 MGD
  - 2,374 total leaks wasting 30.44 MGD

MWRA YEARLY AVERAGE WATER USE: 1960-1990



Leak Detection Regulations

- became effective on July 1, 1991
- complete leak survey no less than every two years
- standard survey techniques

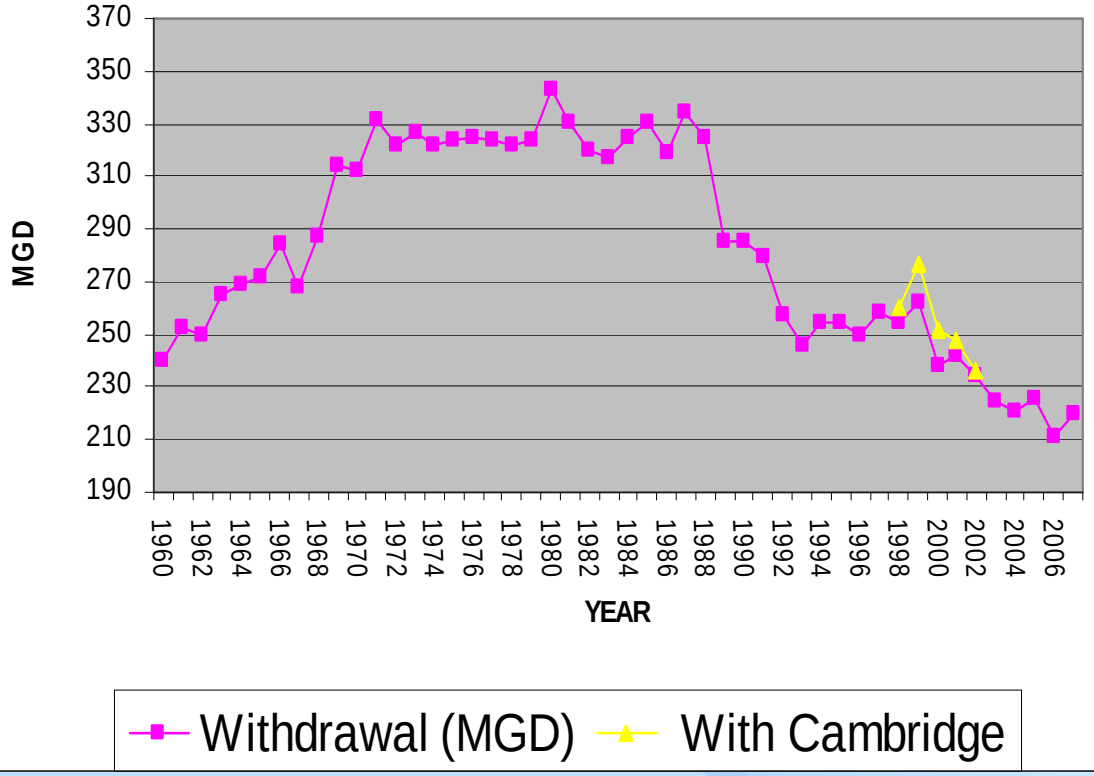
Leak Detection Regulations continued

- qualified personnel or contractors
  - one year experience
- certain reporting requirements
  - when surveys are conducted
  - CY non-billed data
- prompt repair of leakage

Results from MWRA Leak Detection Program

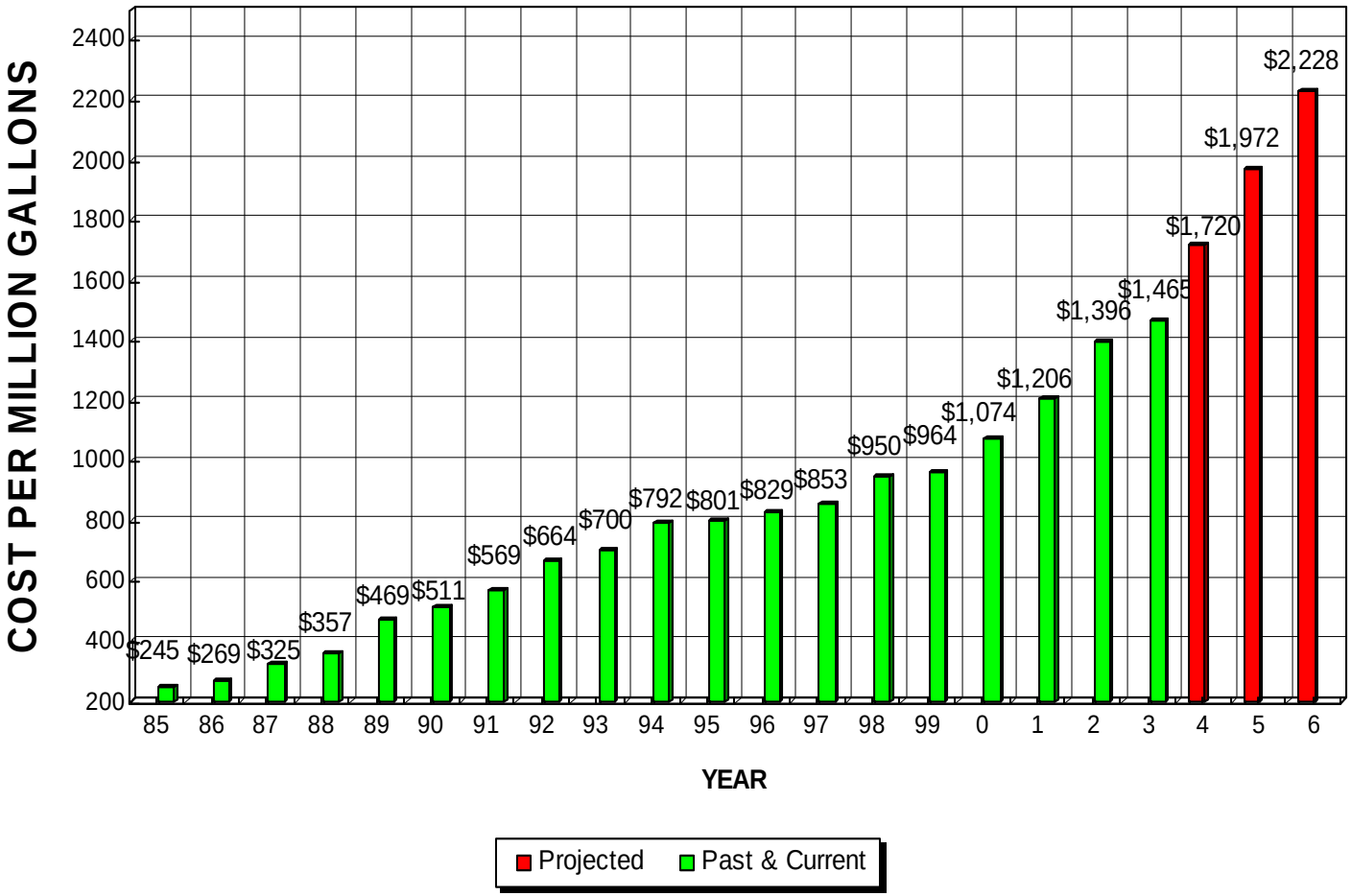
- Once through leak detection results in MWRA communities (6/88- 8/90)
  - 2374 leaks wasting 30.4 MGD
- MWRA leak detection regulations (7/1/91)
  - 7/1/91- 6/30/93 1988 leaks wasting 24.7 MGD
  - 7/1/93- 6/30/95 1134 leaks wasting 14.1 MGD
  - 7/1/95- 6/30/97 1527 leaks wasting 17.8 MGD
  - 7/1/97- 6/30/99 1264 leaks wasting 12.5 MGD
  - 7/1/99- 6/30/01 1035 leaks wasting 11.1 MGD
  - 7/1/01-6/30/03 1004 leaks wasting 8.4 MGD
  - 7/1/03-6/30/05 1159 leaks wasting 11.5 MGD
  - 7/1/05-6/30/07 1002 leaks wasting 9.8 MGD

MWRA YEARLY AVERAGE WATER USE 1960-2007



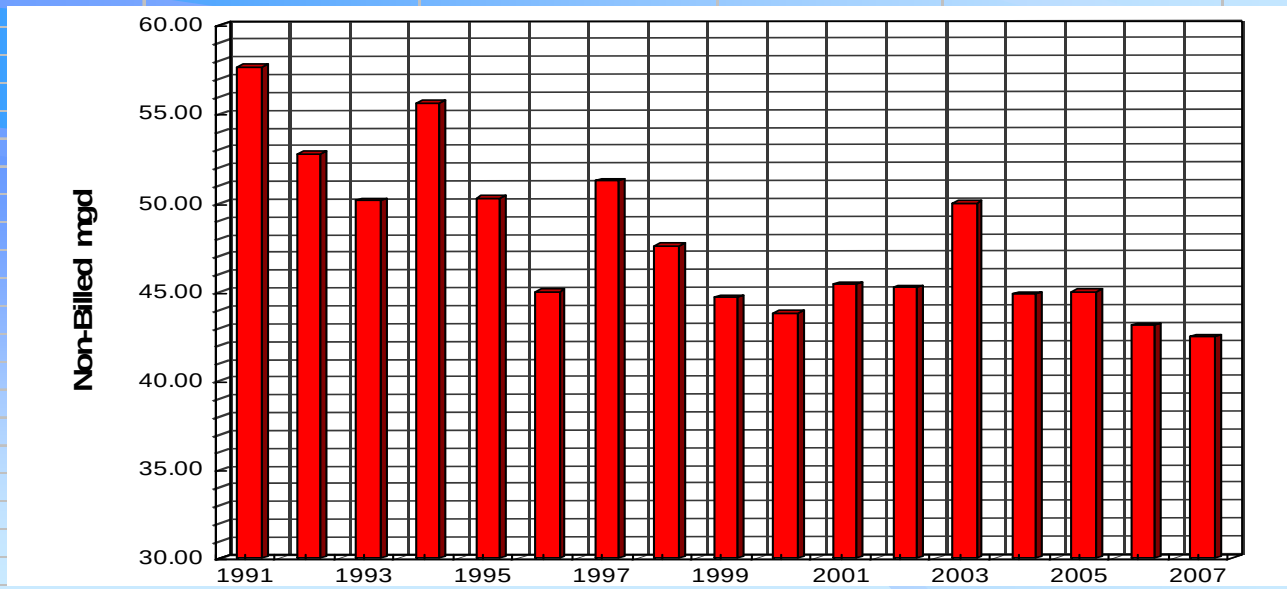
MWRA WATER RATES

FY 1985 - FY 2006



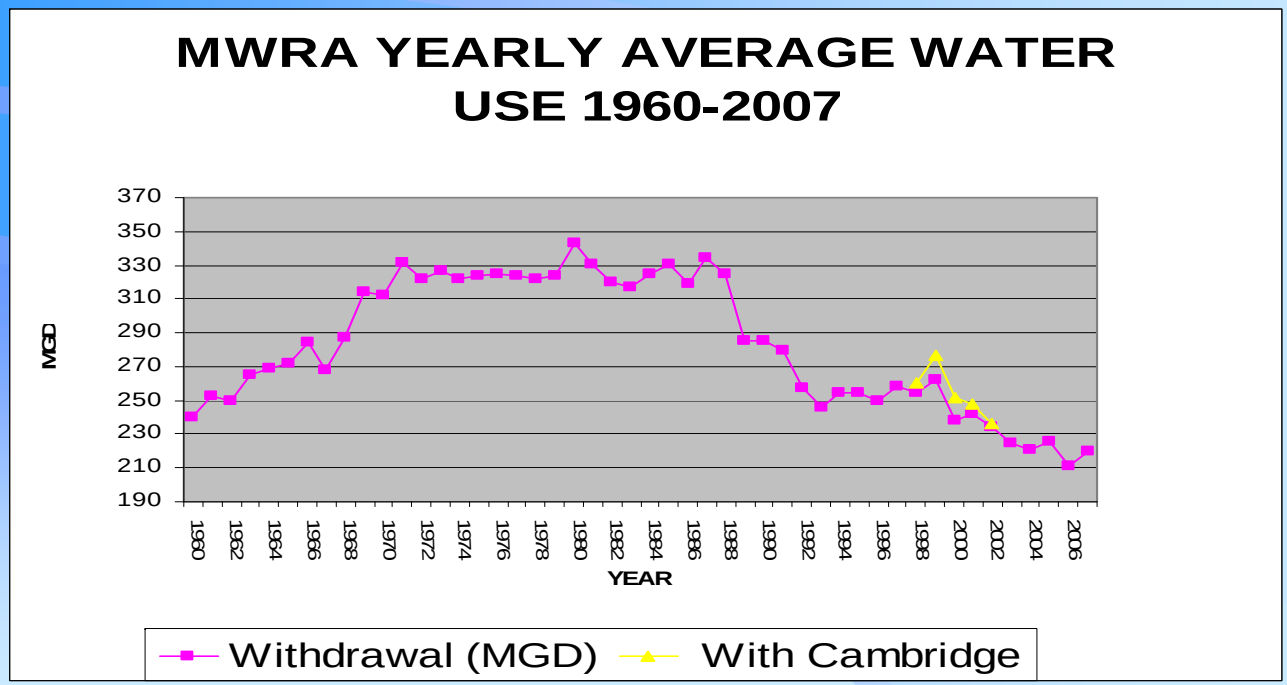
Non-Billed Water Consumption
MWRA Served Communities

Year	Water Purchases and Production (mgd)	Total Water Sales (mgd)	Non-Billed (mgd)	Non-Billed %
1991	291.45	233.83	57.62	20%
1992	273.48	220.73	52.75	19%
1993	270.46	220.36	50.10	19%
1994	280.00	224.39	55.61	20%
1995	265.20	214.95	50.25	19%
1996	260.07	215.06	45.01	17%
1997	265.02	213.81	51.21	19%
1998	262.07	214.49	47.58	18%
1999	264.69	220.02	44.67	17%
2000	252.15	208.35	43.80	17%
2001	258.30	212.90	45.40	18%
2002	257.35	212.13	45.22	18%
2003	253.56	203.58	49.98	20%
2004	247.20	202.36	44.84	18%
2005	251.56	206.57	44.99	18%
2006	240.59	197.49	43.10	18%
2007	241.66	199.19	42.47	18%



Conclusions of MWRA Leak Detection Program

- 80 MGD below our safe yield
- New customers
- 42 MGD of non-billed water
- Increasing wholesale water rate
- Survey frequency
- Increase level of leak detection



Conclusions on how often your distribution system should be checked for hidden leakage.

- Accurate Source Meters
- Monitor monthly flow data
- Determine minimum night rate of flow
- Monitor non-billed water consumption
- Different levels of leak detection