

Travis Spaeth, P.E.
CUC Acting Water/Wastewater Division Manager

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- ▶ Improved operational efficiency
- ▶ Lowered water system operational costs
- ▶ Increased revenue
- ▶ Extended life of facilities
- ▶ Reduced water outage events
- ▶ Improved public relations
- ▶ Less Non-Revenue Water(NRW)
- ▶ Reduced potential for contamination

Caused by inaccuracies associated with customer metering, consumption and billing data handling error, assumptions and unmeasured use, and any form of unauthorized consumption (theft or illegal use).

		Billed Authorized Consumption	Billed metered consumption	Revenue
	Authorized Consumption	Unbilled Authorized Consumption	Billed unmetered consumption	Water
		Unbilled Unauthorized Consumption	Unbilled metered consumption	
			Unbilled unmetered consumption	
System input volume (allow for known errors)	Water	Apparent Losses	Unauthorized consumption	Non-Revenue Water
			Customer metering inaccuracies and data handling errors	
	Losses		Leakage on transmission and/or distribution mains	(NRW)
		Real Losses	Losses at utility's storage tanks	
			Leakage on service connections up to point of customer use	

Leakage loss, Q , m ³ /s	Diameter of hole, d , mm	Pressure, P , MPa							
		20 PSI	CMP 40 PSI	60 PSI	CMP 80 PSI	CMP 100 PSI	CMP 120 PSI	CMP 140 PSI	CMP 160 PSI
0.1	0.007	1.067	1.51	1.85	2.136	2.388	2.616	2.825	3.021
0.2	0.031	4.271	6.041	7.399	8.544	9.522	10.464	11.330	12.136
0.3	0.07	9.611	13.593	16.648	19.224	21.493	23.544	25.402	27.086
0.4	0.125	17.887	25.719	31.245	36.209	40.741	44.929	48.765	52.254
0.5	0.176	26.659	37.778	46.245	53.399	59.792	65.400	70.240	75.318
0.6	0.282	38.477	55.672	67.851	78.894	87.951	96.176	103.571	110.245
0.7	0.384	52.331	74.007	90.64	106.622	117.101	126.184	134.859	143.104
0.8	0.502	68.35	96.662	118.387	136.701	152.84	167.424	180.394	191.821
0.9	0.636	86.506	122.318	149.833	173.102	193.434	211.886	228.674	244.076
1.0	0.785	106.798	151.033	184.979	215.586	243.007	267.600	282.561	300.762
1.1	0.947	129.259	184.929	225.139	262.419	295.451	324.944	351.599	376.244
1.2	1.131	153.789	215.789	261.470	306.370	347.578	376.704	402.887	434.981
1.3	1.327	180.848	248.048	295.249	341.657	385.977	418.544	447.527	481.934
1.4	1.539	209.324	290.324	346.028	392.559	436.848	472.517	503.539	529.057
1.5	1.767	240.295	329.295	383.829	431.203	480.590	518.601	553.672	579.505
1.6	2.01	273.402	374.02	386.649	473.547	486.805	600.807	723.355	778.595
1.7	2.276	308.649	408.649	421.649	508.649	521.649	634.649	757.649	812.649
1.8	2.545	340.025	440.025	453.393	539.393	552.650	665.650	788.650	843.650
1.9	2.836	385.540	385.540	455.277	627.777	771.081	948.378	1100.000	1080.000
2.0	3.142	427.191	427.191	604.140	739.140	858.283	1046.400	1130.240	1080.240

Leak losses for joints or cracks									
Area of Joint									
or Crack		LEAK LOSSES							
Length, in.	Width, in.	GPM	GPM 40 PSI	GPM	GPM 80 PSI	GPM 100 PSI	GPM 120 PSI	GPM 140 PSI	GPM 160 PSI
		20 PSI	60 PSI						
1.0	1/32	3.2	4.5	5.5	6.4	7.1	7.8	8.4	9.0
1.0	1/16	6.4	9.0	11.0	12.7	14.2	15.6	16.9	18.0
1.0	1/8	12.7	18.0	22.1	25.5	28.5	31.2	33.7	36.0
1.0	1/4	25.5	36.0	44.1	51.0	57.0	62.4	67.4	72.1

If leaks omitted from joints are cracked, render lines (solid line). An orifice coefficient of 0.60 is used.

Water loss perspective

- ▶ Leaking Toilet @ 0.5 GPM = 21,600 Gal/mo
- ▶ Small leak @ 0.1 GPM = 4,320 Gal/mo
- ▶ Drip Irrigation @ 1 GPM = 43,200 Gal/mo
- ▶ Unattended Water Hose/Overflowing Tank 1 Night @ 15 GPM = 5,400 Gal/mo
- ▶ Broken Service Line 1 week @ 15 GPM = 151,200 Gal

7

Methods of Leak Detection

- ▶ Sonic Leak Detection Equipment
 - Final step for most leak detection.
 - Takes a trained ear
 - Can be the only process used.
 - Accurate As-builts with pipe locations very helpful
 - Reasonable price



8

Methods of Leak Detection

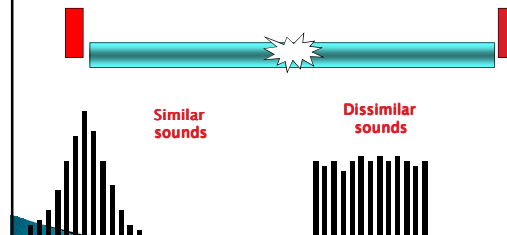
- ▶ Acoustic Data Loggers/Correlators
 - Calculates leak location in-between 2 points
 - Graphically shows leak
 - Still want to pin point with Acoustic leak detection equipment
 - Takes multiple iterations finalize location
 - Fairly expensive equipment



9

The 3 Rules of Correlation

- 1) To obtain a good correlation display, noise **MUST** be heard at each sensor.



10

- 2) Be wary if leak appears at or close to a tee, cross, or service connection
- 3) Be wary if leak appears close to Red or Blue outstation / preamp.

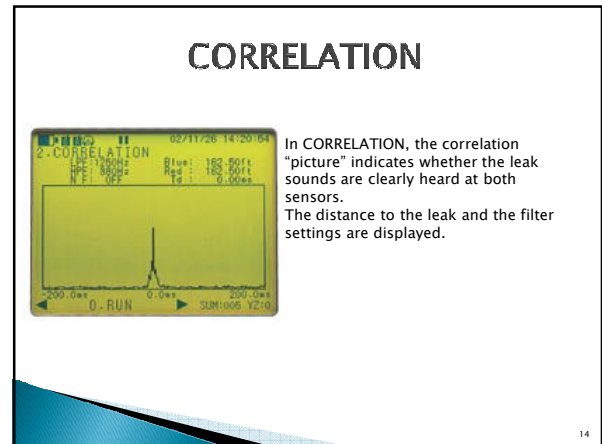
11

Correlation Formula

$$L = \frac{D - (V \times Td)}{2}$$

L = Leak position (Feet)
D = Length of pipe (Feet)
V = Velocity of sound along pipe (Feet per millisecond)
Td = time delay (milliseconds)

12



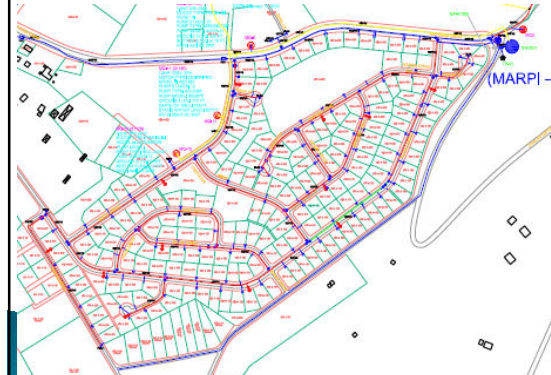
- # Correlators
- ▶ Utility Example
 - ▶ <http://www.youtube.com/watch?v=-CfONBORTto>
 - ▶
- 
- The image displays a set of utility correlator equipment. It includes five vertical sensors, each with a blue and yellow body and a black loop at the top. A central processing unit with a silver faceplate and two ports is positioned in the center. To the left of the unit is a black antenna with a coiled cable. To the right is a handheld device with a screen and buttons. The equipment is arranged on a white background.
- 16

[illegible]

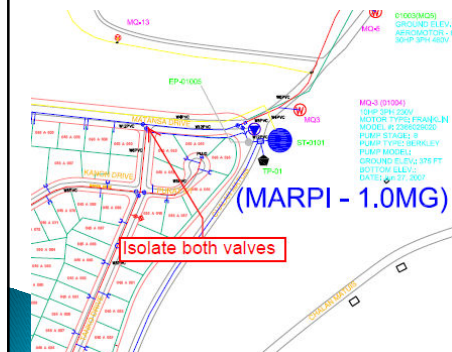
Field Example 1

- ▶ As Matuis – Flowmeter/pressure logging
 - Used a pressure gauge and flowmeter at the upper As Matuis Booster.
 - Isolated valves to isolate the leaking pipe.
 - Checked pressures and flows as we isolated different areas of As Matuis.

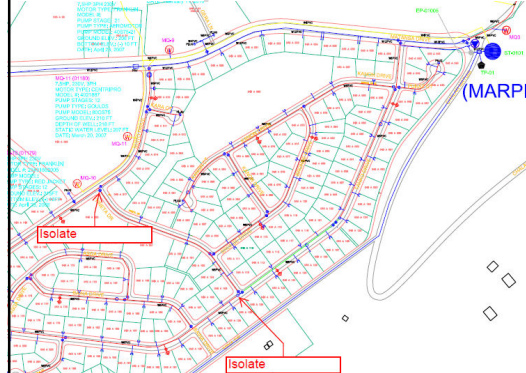
As Matuis



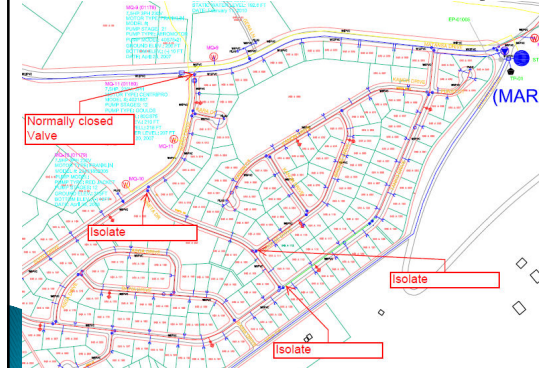
Pressure 42 psi, GPM 20



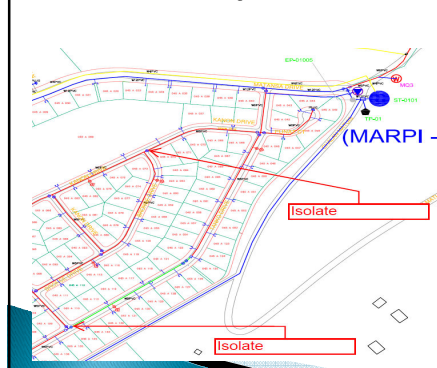
Pressure 20 psi, 250 GPM

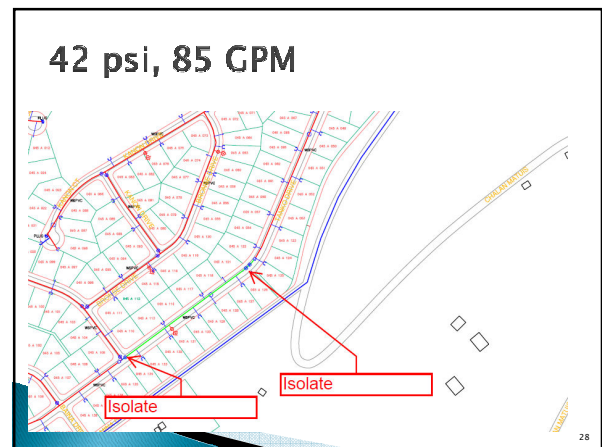
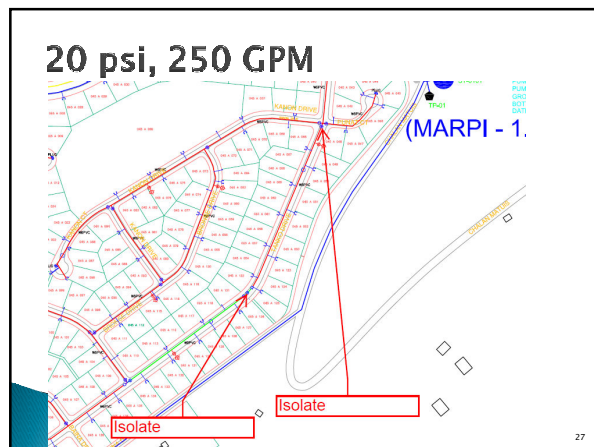
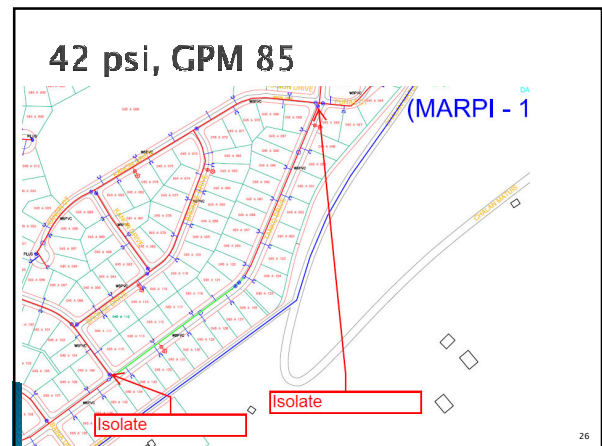
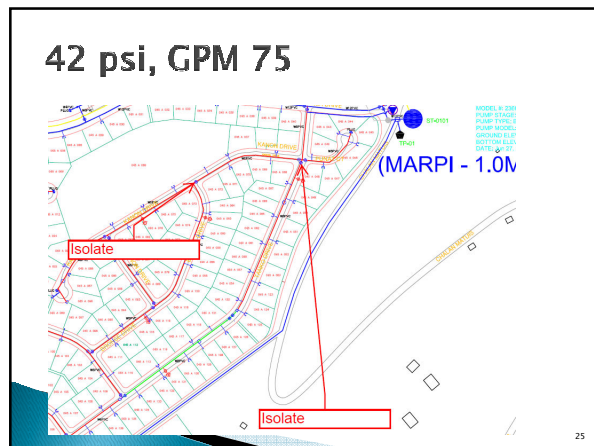


Pressure 20 psi, GPM 250 gpm



20 psi 250 gpm





Send out the A-Team

- ▶ Sound the leak in-between the valves

As-Matuis leak Savings
of 165 GPM

Or 237,600 Gal/day

Enough to pressurize
San Roque/ Tanapag 24
hrs/day

Current Readings
Pressure 42 psi 100
GPM

29

- ▶ Leak in home 0:48–
<http://www.youtube.com/watch?v=UFxcB5NHDuA&feature=related>
- ▶ Major Leak –
http://www.youtube.com/watch?v=R_2V56KQ6UM&feature=related

30

Field Example 2

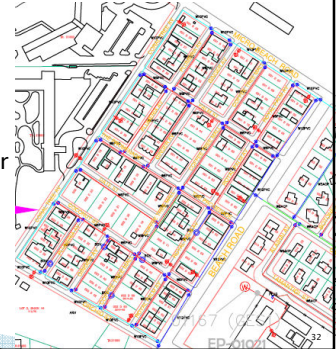
▶ Ground Survey



31

Complete Survey with Acoustic Equipment

- ▶ Up and down all streets in area surveyed.
- ▶ Listen to sounds.
- ▶ Mark known leaks.
- ▶ Need >20 psi to hear properly
- ▶ Document and schedule repairs.



Plumbing Video

- ▶ <http://www.youtube.com/watch?NR=1&v=WVdzP53X9vw>

33

Questions??

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34