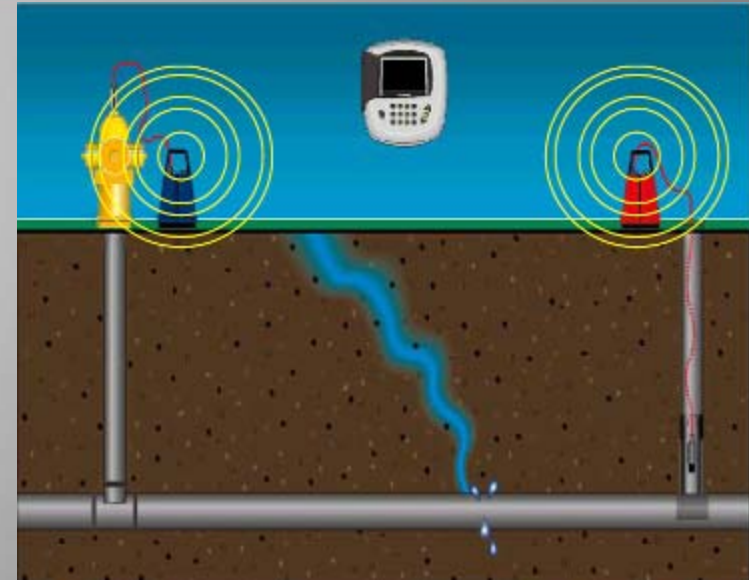


# This presentation premiered at WaterSmart Innovations

[watersmartinnovations.com](http://watersmartinnovations.com)



# What Side of the Meter Are You On?



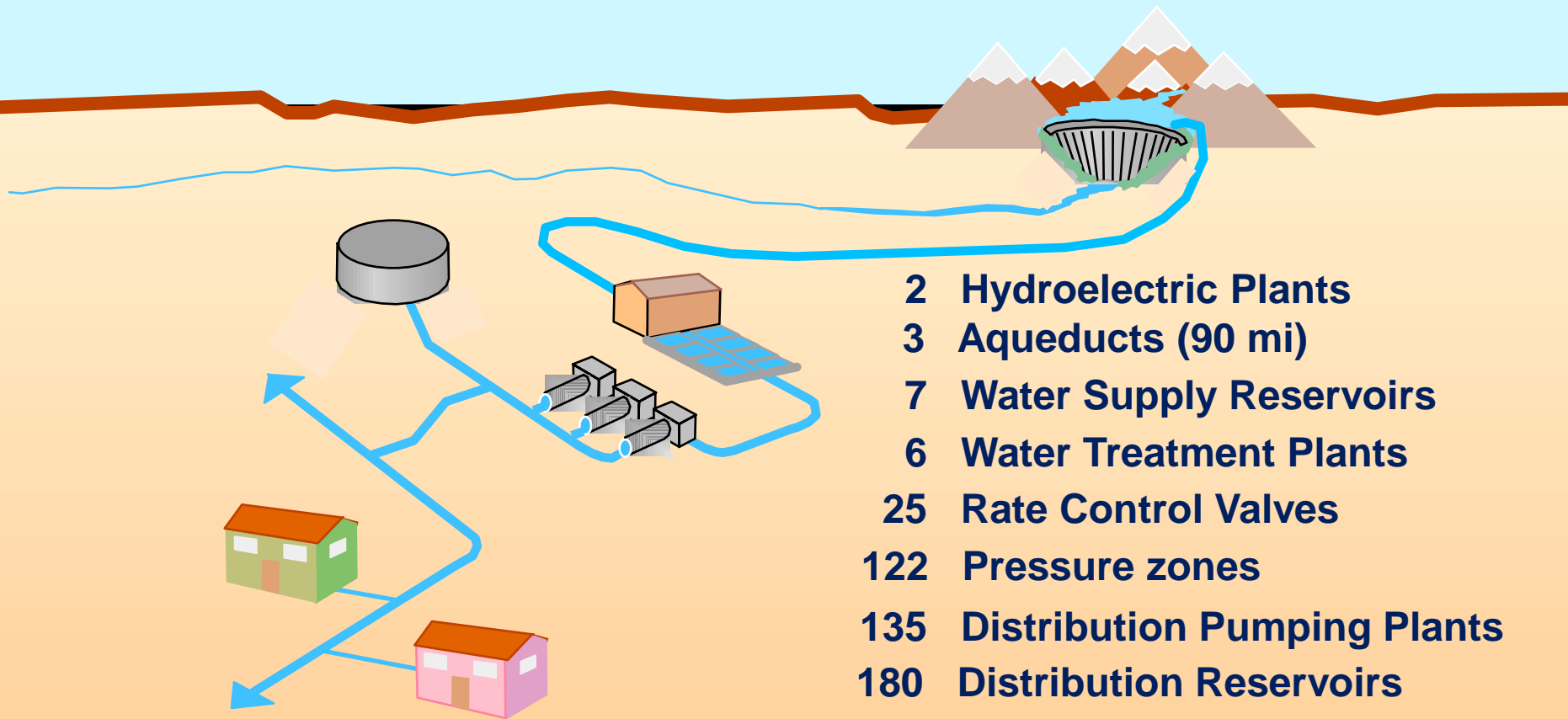
**Proactively Looking and  
Listening for Leaks on  
Pipes and Aqueducts**

**Richard Harris  
David Wallenstein  
William Cain**

**2010 Watersmart Innovations  
Conference & Exposition**



# EBMUD Water System Facilities



- 2 Hydroelectric Plants**
- 3 Aqueducts (90 mi)**
- 7 Water Supply Reservoirs**
- 6 Water Treatment Plants**
- 25 Rate Control Valves**
- 122 Pressure zones**
- 135 Distribution Pumping Plants**
- 180 Distribution Reservoirs**
- >4,000 Miles of Distribution Pipeline**
- Elevation: MSL – 1,450 ft**

**1.34 Million customers**

**2007 Water Production = 210 MGD**

# Summary of Leak Detection Practices



- Pinbars have been used for 100s of years
- During the '77 drought began foot surveys of 330 square mile service area
- Using correlators for about 20 years
- Ground Microphones about 15 years
- Logger lift and shift method for about 10 years
- Permanent logger deployment in limited areas

# Two Projects Being Evaluated



## Large Diameter Pipeline Leak Detection

- Evaluate permanent deployment of loggers vs. lift and shift
- Help determine how much water is lost by leaks
- Determine how long leaks flow before surfacing
- Help determine cause of leaks
- Reduced unplanned pipe repairs
- Save Water
- \$300K grant from U.S. Bureau of Reclamation

# Two Projects Being Evaluated (Cont.)



## Aqueduct Leak Detection Project

- Perform field condition assessments of selected large diameter pipelines ( $> 24''\varnothing$ )
- Develop a database of physical conditions of large diameter pipelines
- Develop methods to forecast large diameter pipeline renewal requirements
- \$300K grant from U.S. Bureau of Reclamation



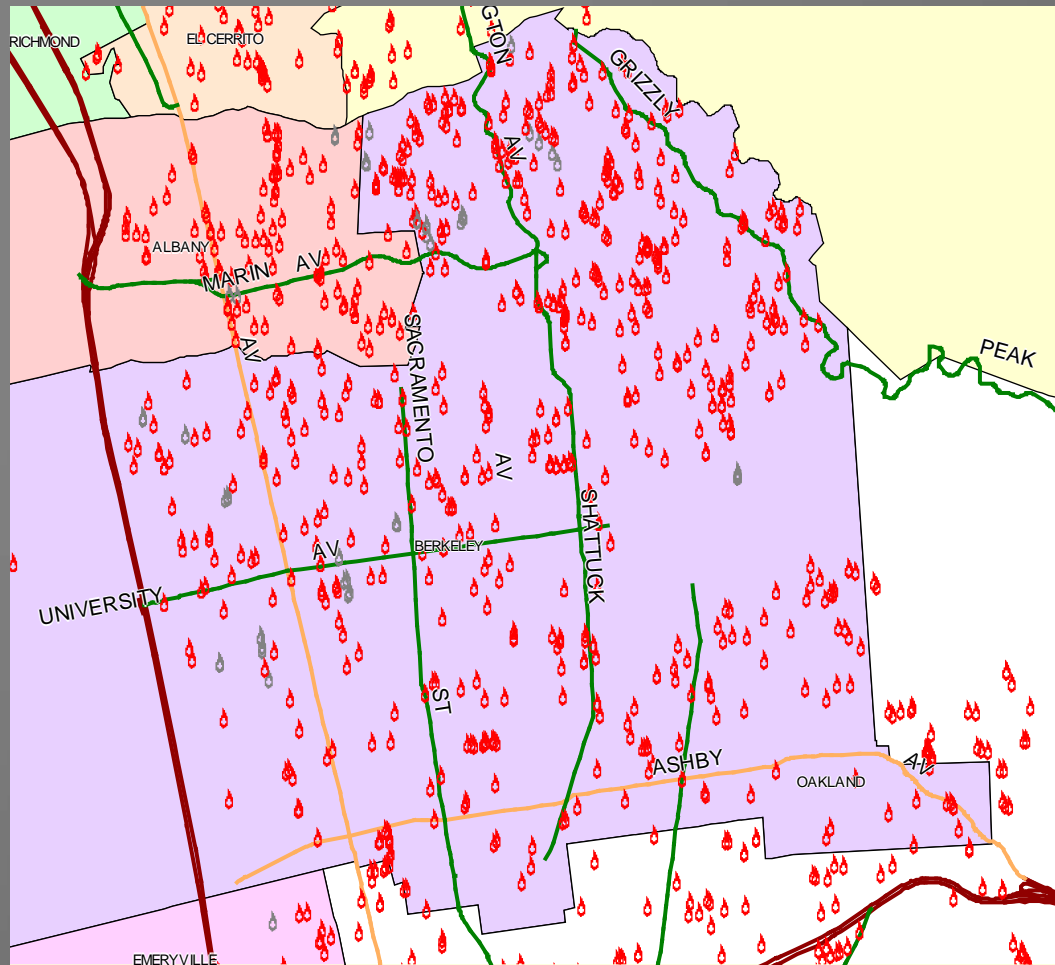
# Large Diameter Pipe Project



## Equipment

- 1,000 loggers (850 placed in City of Berkeley)
  - 200 loggers extension type for submerged use.
- Laptop, receiver, GPS system
- 3 Correlators
- 2 Ground Microphones

# City of Berkeley

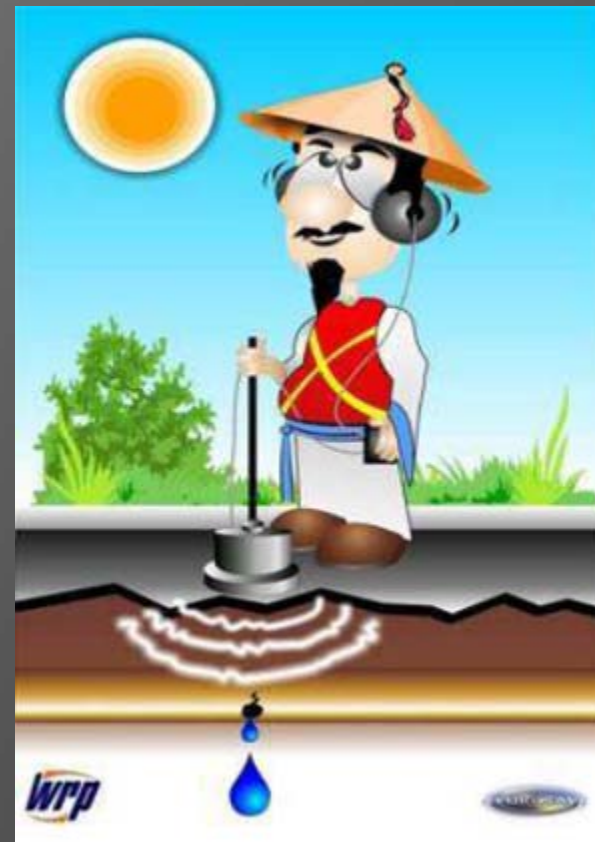


- Older pipes
- High no. of leaks
- Sizable area
- Numerous creeks
- Representative mix of pipe types, age, etc.



# Type of Equipment Used

- **Loggers** that can find leaks
- **Correlators** that can pinpoint leaks
- **Ground microphones** that can verify leaks
- **Laptop and software** to store leak information
- **GPS system** to assist with downloading and tracking



# How does a logger work?



- Magnetically attaches to valve pots
- Records sounds every 5 seconds (2-4 a.m; 2 hours = 1,440 reads daily)
- Based on distribution of leak sounds determines leak index from 0-100
- Loggers store leak numbers and graphical data
- Data recovered by a 2-way receiver
- Leak status announced on drive-by

# How does a correlator work?



- Compares the sounds heard at 2 stations on either side of a leak
- Uses the sound velocity multiplied by time lag to calculate distance
- Sound velocity dependent on pipe:
  - Diameter
  - Material
  - Wall thickness
  - Pressure/Temperature-minor effects





# Logger Operations



- Biweekly/monthly patrols takes 3 days
- Using GPS system and programmed route requires only 1 person
- Extension loggers installed on flooded pots
- Results reviewed and prioritized by Water Conservation and delivered to Operations





Data Zoom 13.0

0° (N)

Latitude N37° 54.040'

Longitude W122° 16.160'

0 ft 650

Name	Type	Active	Lock	Count	Date Modified	Directory
<input type="checkbox"/> 2nd Phase logger locations 8-27	Draw	<input checked="" type="radio"/>	<input type="checkbox"/>	191	Friday, September 05, 2008 12:10:32 PM	C:\DeLorme Docs\Draw\2nd Phase logger locatio...
<input checked="" type="checkbox"/> handdrawn route (3)	Draw	<input type="radio"/>	<input type="checkbox"/>	117	Wednesday, August 27, 2008 10:16:44...	C:\DeLorme Docs\Draw\handdrawn route (3).an1

New Import...

Save Export...

Delete Copy To

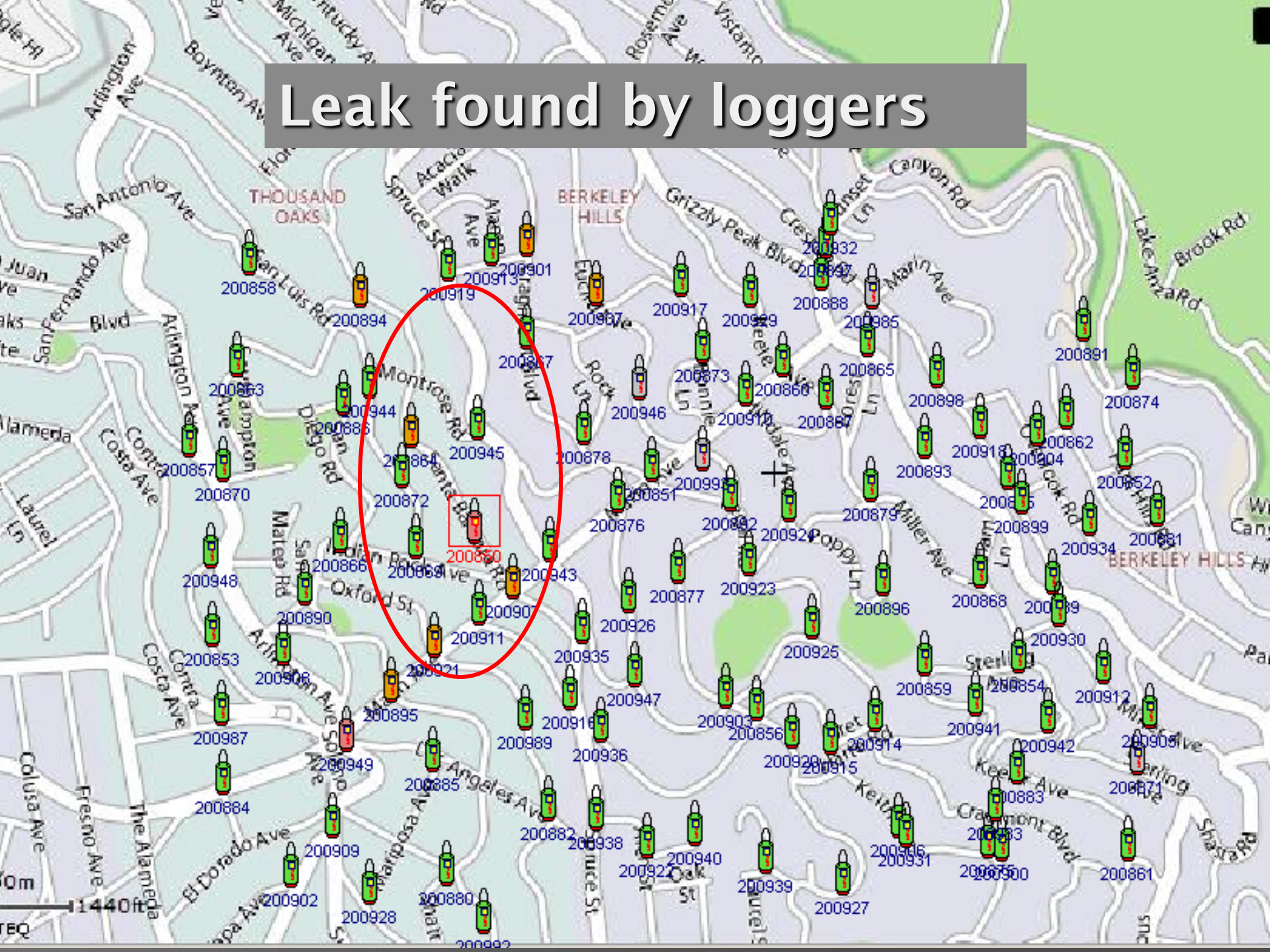
Done Less

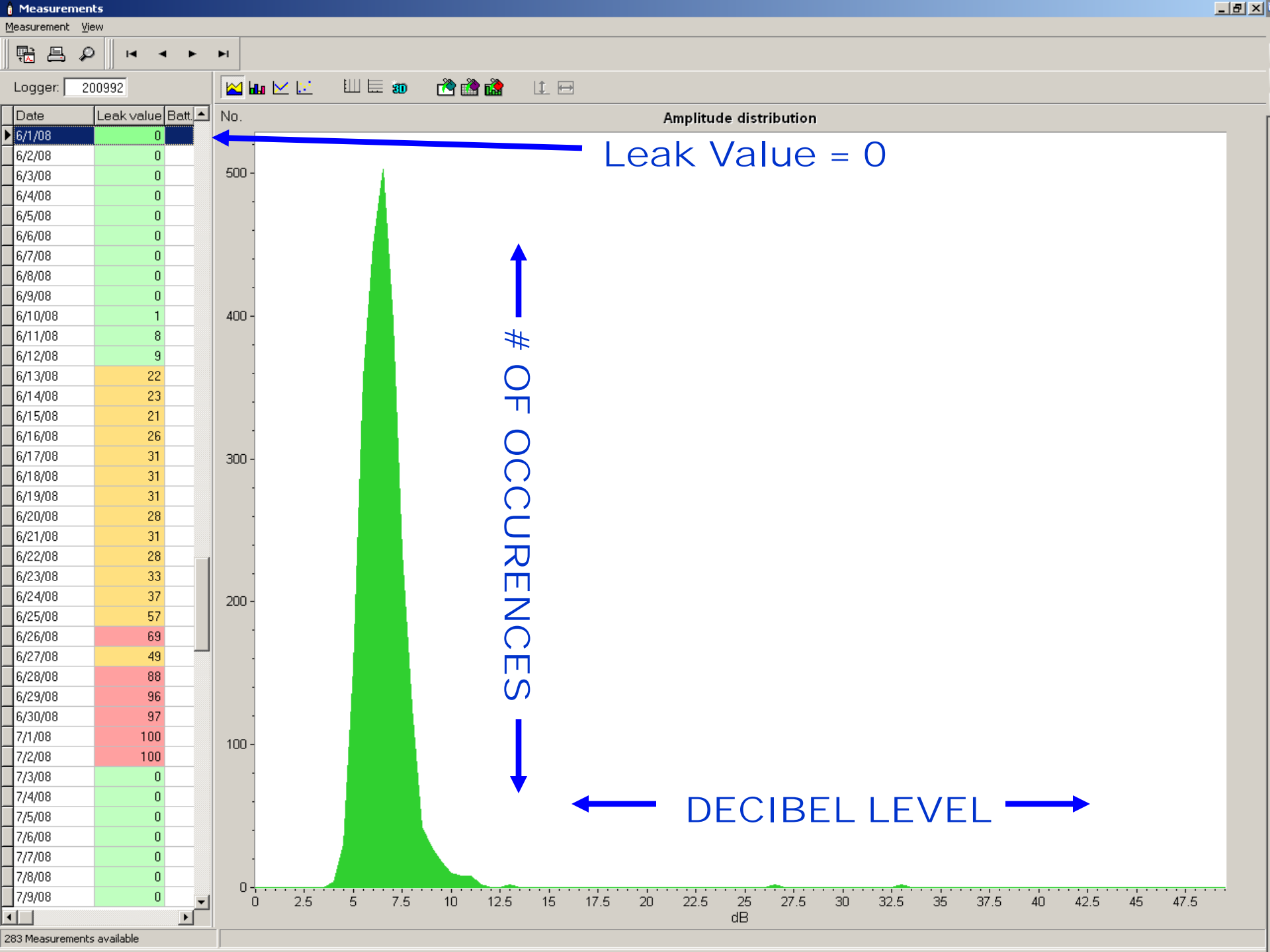
Name	Comment	URL	Date Modified	Type
			8/27/2008 2:46:36 PM PDT	Line
			8/27/2008 2:16:08 PM PDT	Line
			8/27/2008 2:44:13 PM PDT	Line
	093		8/27/2008 11:11:07 AM PDT	Symbol





# Leak found by loggers





# EBMUD Leak Analysis Database



## Update General Work Order

[Close this Window](#)

Order #	Status	Status Date	Last Updated By	Last Updated On	Total Hours	Closed By
1347225	COMPLETED	10/07/2009	TBEREL	10/07/2009 00:00	28.3	TBEREL

Entered By: DWASHING    Entered On: 10/02/2009    Service No: 4061335    Construction status:

Bldg	Fract	Street	Apt	City	Cross Street
911		<input type="text"/> CRAGMONT ? <input type="text"/> AVE		BER <input type="text"/> Get	MARIN AVE

186 ft    S of    MARIN AVE    on    E side of    CRAGMONT

Map    1488    512    Tap # 309169    Thomas Bros: Page: 609 Grid: H5    From Org: 722

CS Flag:     GWO FEMA Code:     Service Improvement Nu:

Water Discharge? ☒ Y    Est Flow Rate GPM 7    Discharge to storm drain? ☒ Y    FMP Used? ☒ Y

Cause    CORRECTIVE MAINTENANCE    Priority 4 ?    Pipe Ext E-22784    Backbone/Critical? N

Problem Description    STREET LEAK>>USA EXP DATE 10/30/09 UPDATE BY 10/28/09

Damage Rpt? ☒ N    Shut Down? ☒ N    USA# 308291    USA Notif. Due Date/Time 10/02/2009 18:06

Permit #     OT Code     # of Surveys Issued

## Current Tasks

Action	Device	Device #	Assign To	Org	Issue Date	Comp Date	Pgm/Proj	Est. Hrs	Act. Hrs
REPAIR	MAIN	E-22784	DGUARAGL	723	10/02/2009	10/06/2009	5761	28	27.5
Size 6	Comments REPAIR FULL CIR BREAK ON 6" CI MN W/ 6 X 7.5 FULL CIR CLAMP						Qty 1	Delete <input type="checkbox"/>	
Action	Device	Device #	Assign To	Org	Issue Date	Comp Date	Pgm/Proj	Est. Hrs	Act. Hrs
INVESTIGATE			HWELCH	722	10/02/2009	10/02/2009	5729	0.5	0.8
Size	Comments LEAK ON THE 6 IN CI MN						Qty 1	Delete <input type="checkbox"/>	





# Logger Analysis and Findings



- 127 investigations defined
  - 16 customer leaks
  - 56 False positives due to logger malfunction
  - 47 real water leaks
    - 16 on distribution mains
    - 31 on appurtenances (service lines, hydrants, meters)
- 14 additional leaks tracked and eventually repaired



# Review of Fixed Leaks



- 116 Repaired Leaks
  - 76 times no loggers heard the leaks  
(no change in leak index after repair)
  - 36 times the loggers heard the leaks  
(decrease in noise index)
  - 4 times the data was inconclusive

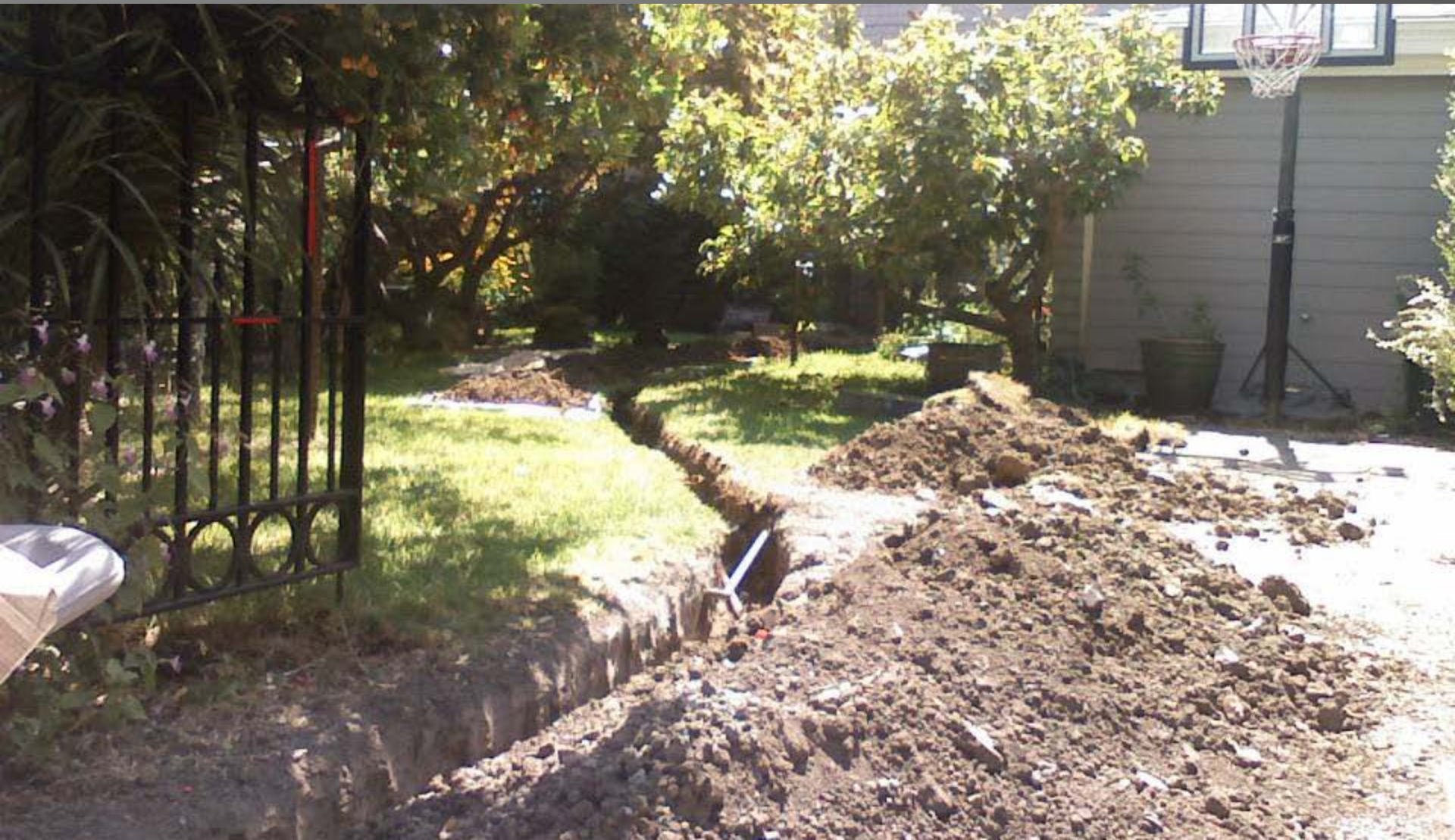


# Review of Fixed Leaks



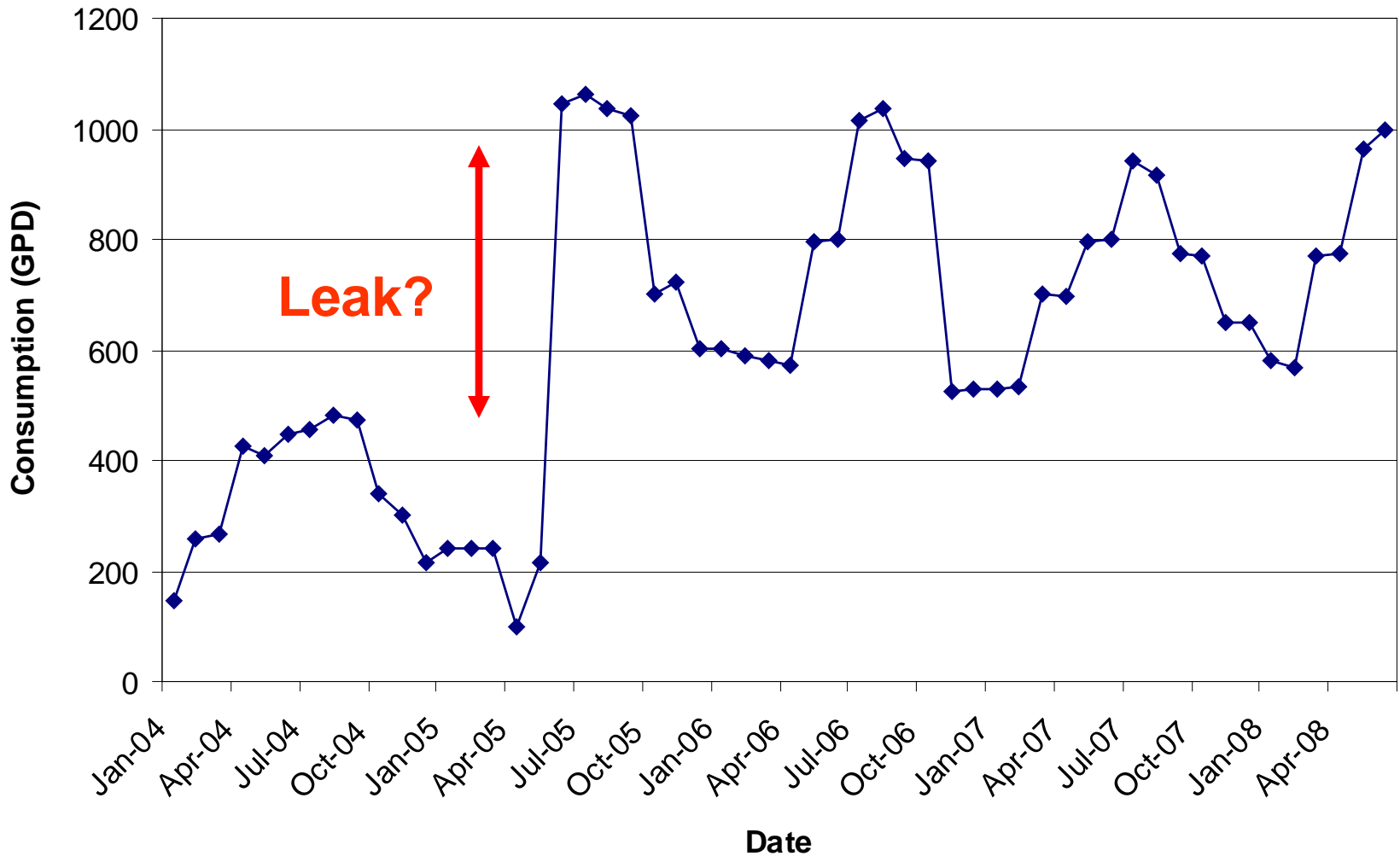
- Non heard leaks are either:
  - Background noises screens out leak noise
  - Loggers too far from leak depending on material (1,000 ft. spacing)
  - Loggers not attached to metallic pipe (dirt intrusion)
  - Logger malfunction
  - Data mishandling due to logger changeouts

# Leak repaired by customer





# Leak had been going - 3 years?



# Conclusions



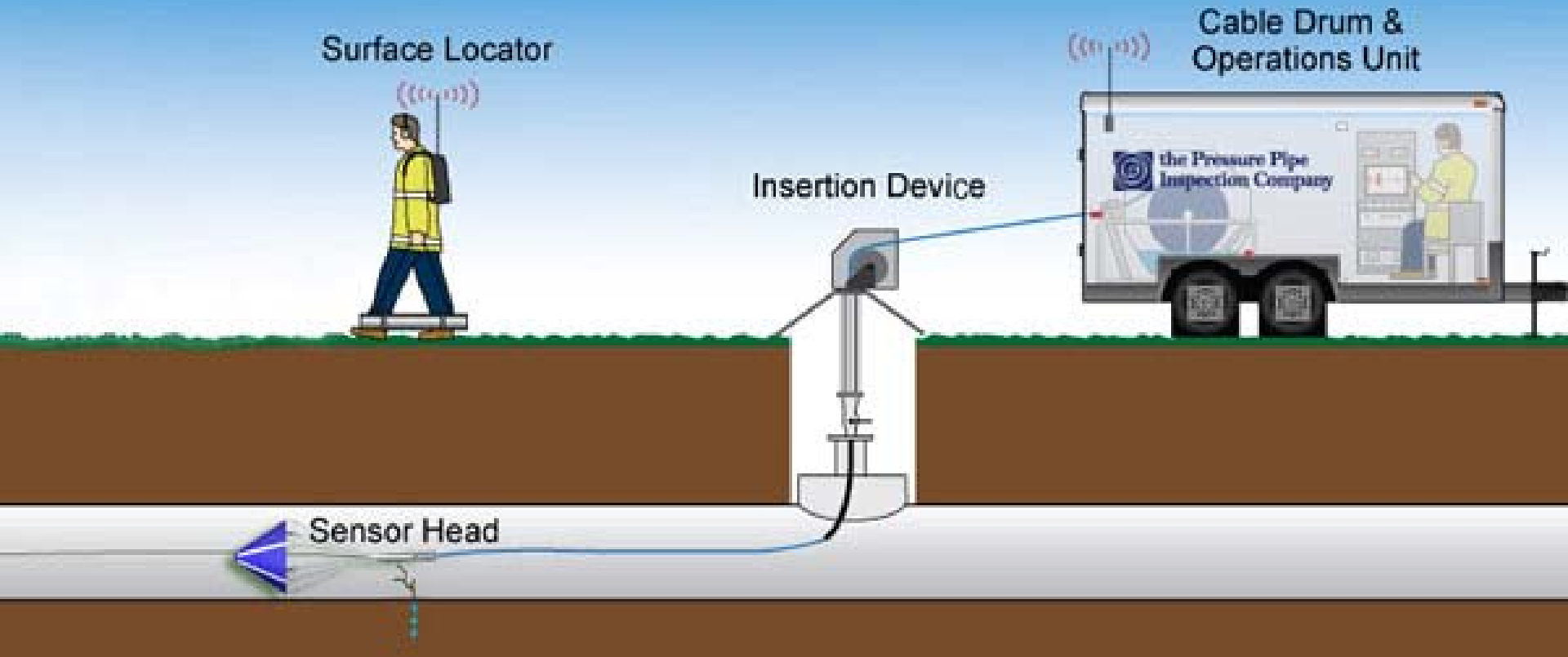
- Loggers currently spaced 1,000 feet apart; for reliable correlation recommend 500 feet spacing
- Loggers not currently as effective in detecting leaks as hoped (50% instantaneous and 50% took a long time developing)
- Accurate data analysis hindered by incomplete recordkeeping; need more accurate leak flow rates and notation if leak identified through program
- Semi-permanent deployment ok in select problem areas, not recommended as general practice

# Aqueduct Leak Detection Technologies Tested



- Pressure Pipe Inspection Company "SAHARA" System
  - Tethered acoustic sensor drawn by parachute
  - Capability to 5,000 feet/run or 270 degrees of bends
- Pure Technologies U.S. Ltd. "Smart Ball"
  - Free-rolling Ball (not tethered)
  - Capable of 12-15 hours at about 90% of water velocity ( $> 1$  ft/s)
  - Can pass through "some" obstructions
- Echologics Engineering "Leakfinder RT"
  - Acoustic and auto correlation functions
  - Capable of 300-5,000 foot spans in steel pipe

# PPIC "SAHARA" Acoustic System





# Sahara - Components & Tracking



Acoustic  
Sensor

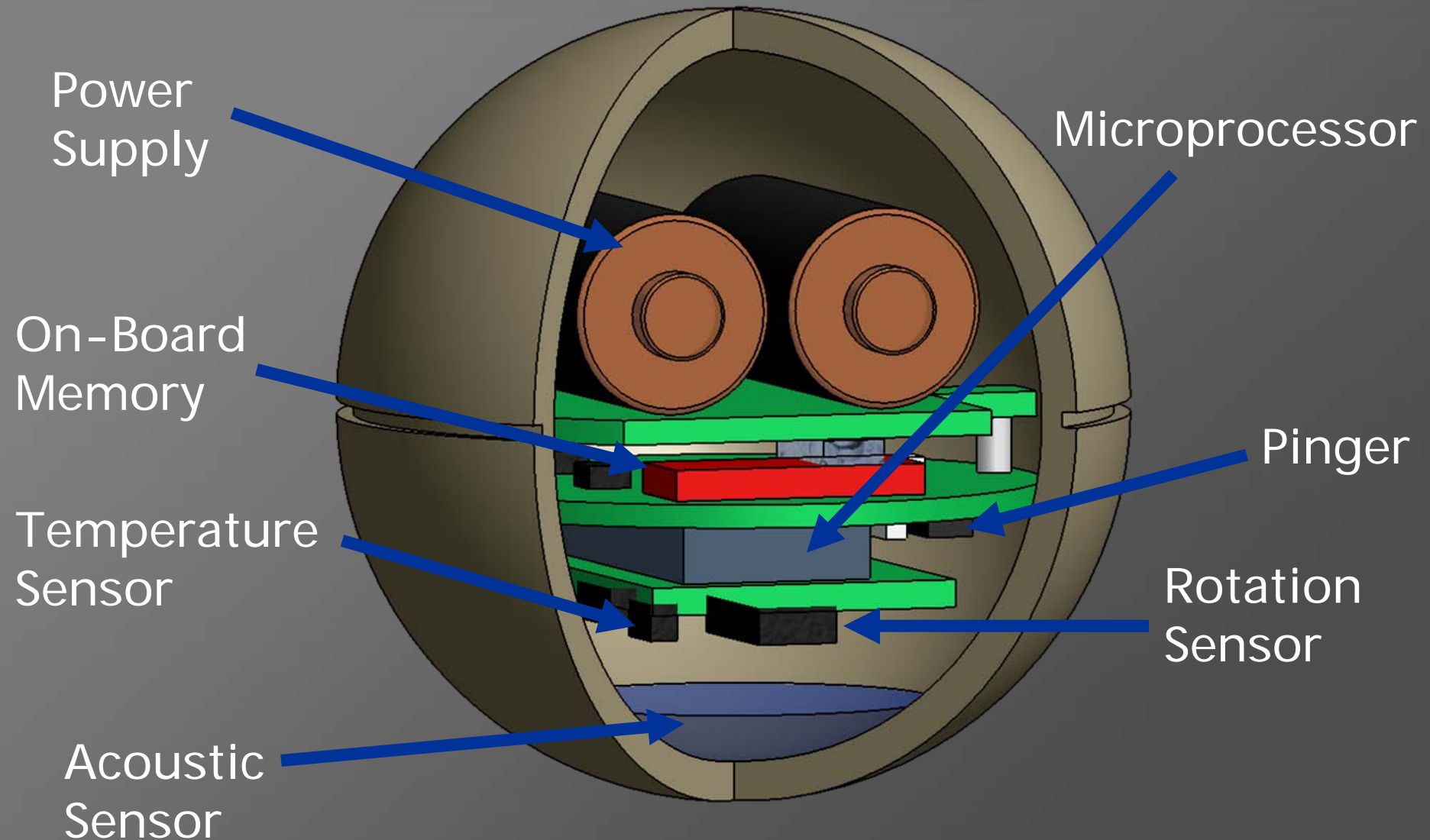


Parachute

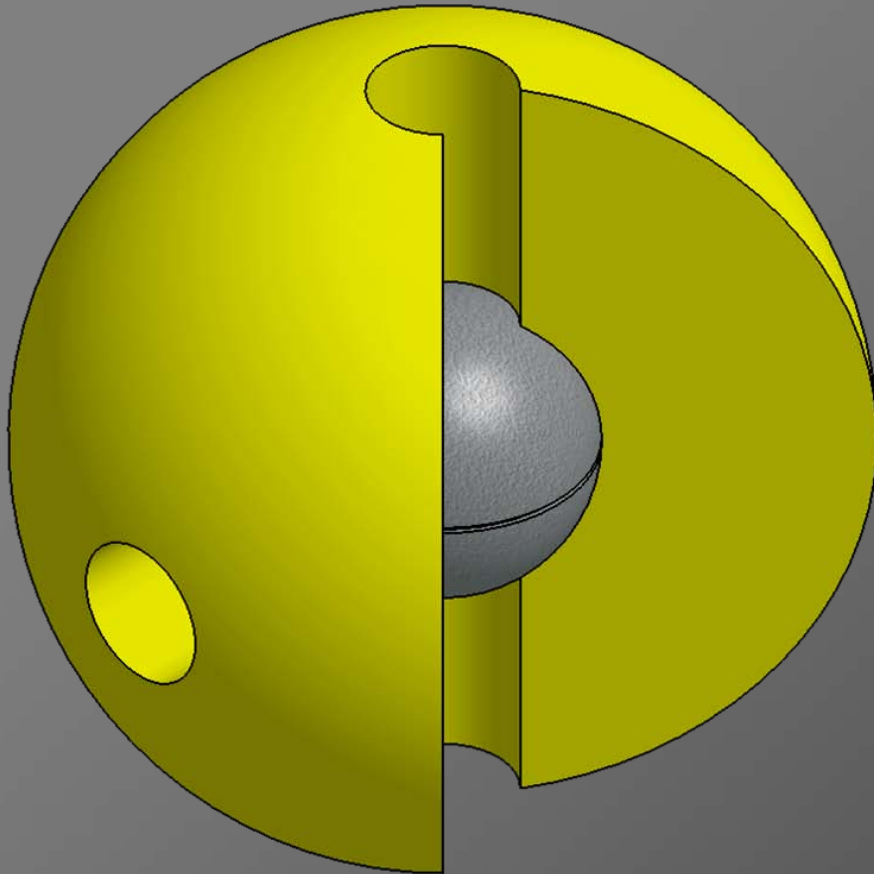


Surface Tracking

# Pure Technologies “Smart Ball”



# Smart Ball & Foam Covering

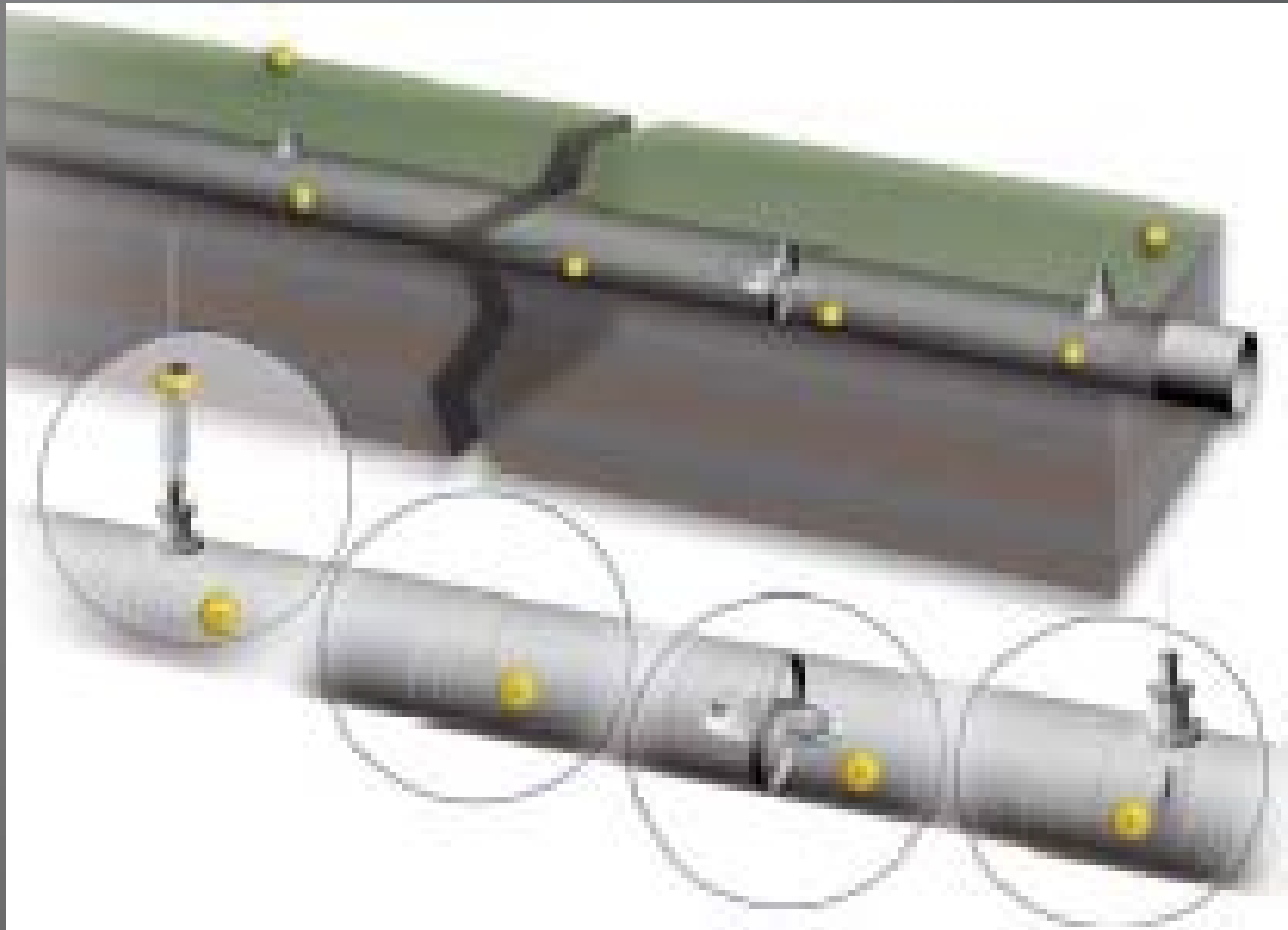




# Pure Technologies “Smart Ball”



# Pure Technologies “Smart Ball”



# Echologics Engineering “Leakfinder RT”

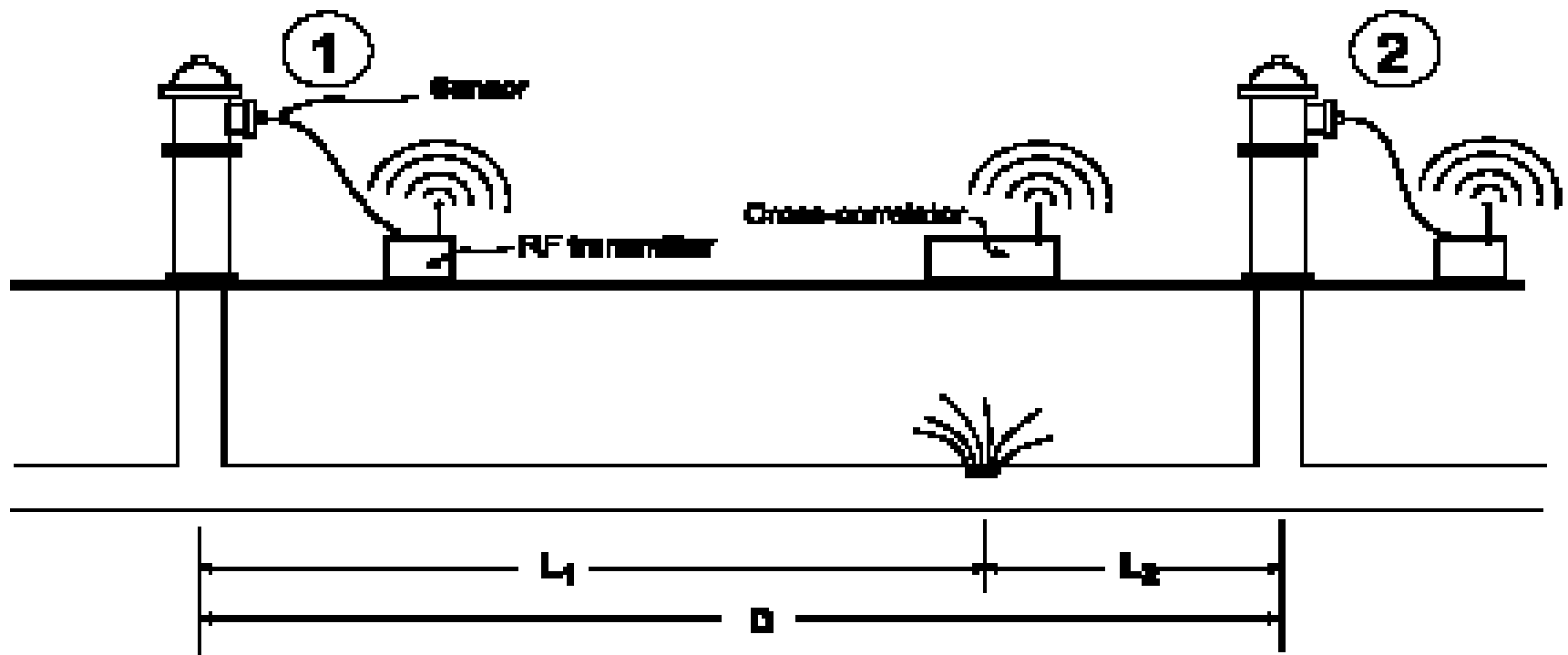


Figure 1 Schematic illustration of the cross-correlation method



# Echologics LeakFinderRT



# Aqueduct Leak Detection

## Phase 1 Preliminary Findings



- Phase 1 (\$150K) head-to-head test complete
- Each vendor/technology found all known and simulated leaks
- Precision of locating leak: 0.1 – 5.0 ft
- Speed of surveys: 1,000–8,000 feet per day
- Length of pipe surveyed: 9,500 – 114,000 ft
- Total per foot cost: \$0.55 – \$8.22
  - District cost: \$0.11 – \$3.09
  - Vendor cost: \$0.44 – \$5.13

# Aqueduct Leak Detection Conclusions



- Use of technology dependent on:
  - pipeline and field conditions
  - desired accuracy in locating leaks
  - length of survey desired
  - available budget
- Likely to use a combination of technologies in future



# Aqueduct Leak Detection Next Steps



- September 2010      Phase 2 (\$150K) initiated w/Echologics LeakFinder RT
- November 2010      Survey add'l 63 miles of pipe
- December 2010      Final report to USBR

- For more information please contact:

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