

# Water Loss Control for Military Installations

**Richard J. Scholze**

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US Army Corps of Engineers  
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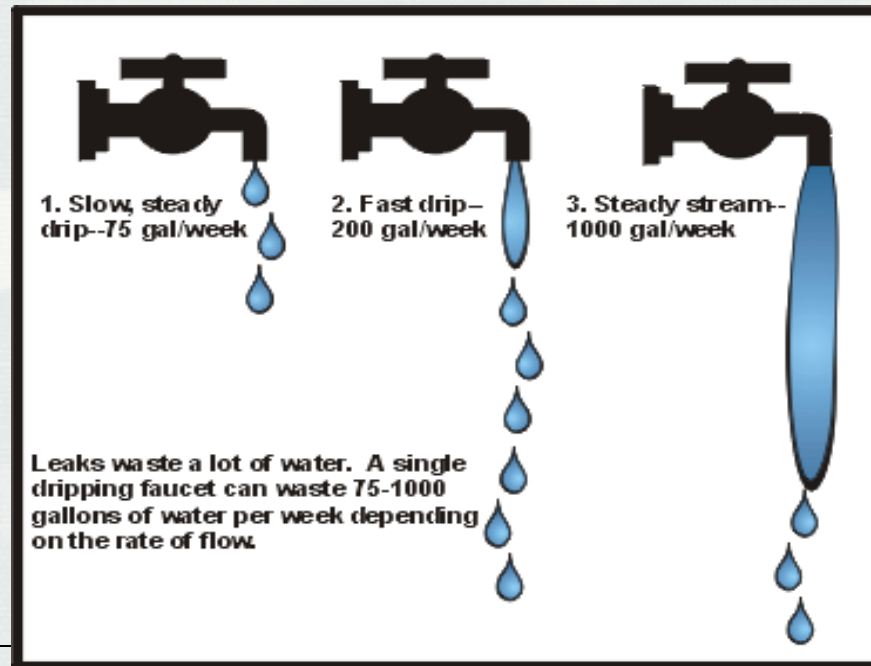
# Background

- Water - Historically, Low Rates
  - ▶ Department of the Army installations used over 41 billion gallons of potable water at a cost of \$67.4M in FY10.
  - ▶ By 2013, **36 states will face shortages**
  - ▶ ASCE Scorecard for Infrastructure – **Drinking Water D-**
  - ▶ North America – 12.3 percent non-revenue water
  - ▶ Leaks – **7 billion gallons per day in U.S.**
  - ▶ **Costs, value increasing**
  - ▶ Military costs much cheaper than private sector
  - ▶ Shortages
  - ▶ Competition for water
- Drivers
  - ▶ Executive Order 13514 requires reductions in water use
  - ▶ Incorporate water efficiency/conservation measures
- In U.S. leakage management is mainly reactive, based on visuals and water loss analysis
  - ▶ No regulatory pressure
  - ▶ Drought, limited resource response to political, economic and environmental concerns
- Preventive maintenance
  - ▶ Water systems underground, out of sight, out of mind



# True Cost of Water

- Applicability to consumers – leak considerations
- Water itself
- Wastewater disposal
- Energy for heating, pumping, treating
- Pretreatment for some wastewater



# Leak Detection

- Extremely Cost-effective, Payback Usually Few Months
- Why?
- Early Leak Detection Can Save Money
- Prevent Loss of Potable Water
- Help Prevent Major Breakages
- Useful to Minimize Expenses



# Financial Incentives

- Less water used = less energy required to pump, treat and distribute
- Less chemicals required
- Production of less wastewater
- Leaks can create voids, sinkholes
- Often leaking water goes into sewers, lowering capacity
- Extended life of pumping and treatment facilities
- Improved operational efficiency
- Less disruption for highways and businesses, residents
- Lowered water system operational costs
- Reduced potential for contamination
- Reduced potential property damage and water system liability
- Reduced water outage events
- USEPA – Reduce the 650 main breaks every day by 0.5%, save 270 million gallons of water a day!



# Water Loss

- Water is lost through LEAKS and BREAKS
- Leaks - result from loose joints or service connections
- Breaks – occur when a water main fractures
- Different types – service line, valves, but largest source of NRW is leaks in supply lines
- Leak cause factors:
  - ▶ Material, composition, age, joining methods, quality of initial installation
  - ▶ External factors: stray electric current, contact with other structures, stress from traffic vibrations, frost loads and freezing
- Underground leaks: rusting, stray current, heavy traffic, freeze –thaw, transient high pressure events (valve opening and closing, pump operation)



# Water Loss

- “Non-revenue water”
  - ▶ Includes: public use, firefighting demands, unauthorized connections, etc. along with water physically lost from the distribution system
  - ▶ Difference between water produced and metered use
  - ▶ Water loss – all water that is not identified as authorized metered use or authorized un-metered use
  - ▶ Goal - 10 percent maximum



# Signs of Underground Leaks

- Unusually wet spots, water pooling on surface
- Green, wet, or soft area surrounded by drier conditions
- Notable drop in water pressure/flow volume
- Sudden problem with supply quality (rust, dirt, air)
- Irrigated area no longer receives proper pressure
- Heaving or cracking of paved areas
- Sink holes or potholes
- Uneven floor grade or leaning of a structure
- Unexplained sudden increase in water use, consistently high water use, or unexplained climbing use



# Why Do Proactive Leak Detection?

- Because a large proportion of leaks go unnoticed due to:
  - ▶ Highly permeable ground conditions
  - ▶ Proximity of sewers or other trenches
  - ▶ Low flow volume



# Water Loss and Leak Control Technologies

- **Automatic meter reading** – advances in water meter technology can automatically record and report leakage within customer-owned plumbing by detecting a constant flow of water.
- **Continuous acoustic monitoring of water mains via valves** – sensors that record sound vibrations overnight. Downloaded and analyzed by software for leaks.
- **GIS analysis** – reviewing historical leak information by GIS mapping helps identify leak-prone areas in small diameter old pipes.
- **Improved pressure control** –reducing and modulating water pressure in water systems lowers the amount leaking out of pipes and reduces stress.
- **Large transmission main testing** – complex methods and insertion of sensors
- **Leakage control zones** – subdivide systems into zones monitored by master meters that periodically measure water use.
- **Main replacement program** – identify main break and other data to identify and replace aging mains.



# Leak Detection Technologies

- Acoustic – most widely used
- Acoustic with correlation
- Infrared thermography – Detect leaks in pipelines and voids around them good for aircraft overflights, fast and instant feedback shows measurable temperature change
- Chemical (tracer gas)
- Ground penetrating radar – adapted for leak detection, electromagnetic wave propagation, can do rapid reconnaissance over long lines
- Combined acoustic logger and leak noise correlator
- Digital correlation
- Radio-frequency interferometer – UHF radio waves transmit, reflect from leaking water
- In-line detection systems
  - ▶ Sahara
  - ▶ Smartball



# In-line Leak Detection

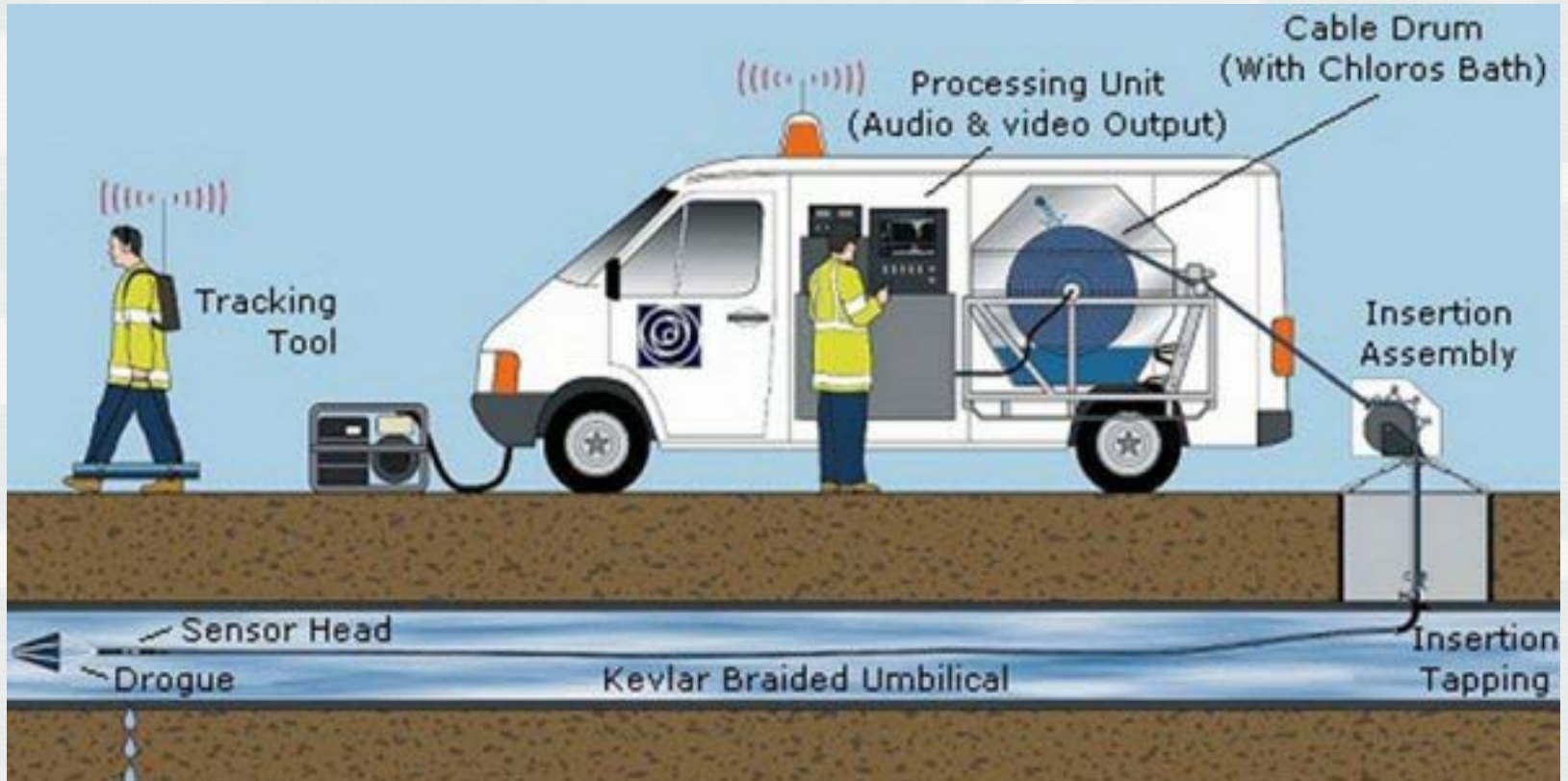
- Pass hydrophone through the pipeline
  - ▶ Very sensitive
  - ▶ Smartball- free swimming foam ball contains core with instrumentation



**SmartBall® Inspection Method –  
Insertion, Travelling, and Removal**



# Sahara in Action

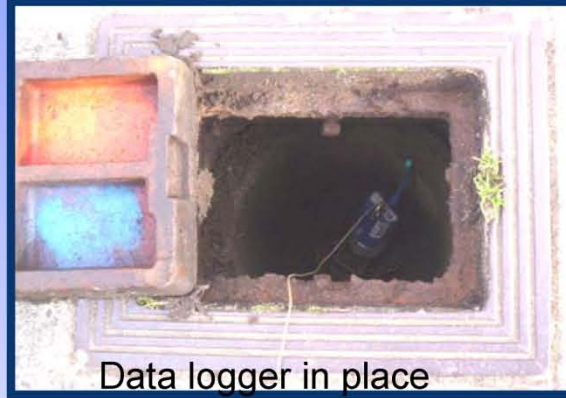


# External Leak Detection

- Acoustic
  - ▶ Directly locate leak
  - ▶ Contact water main
  - ▶ Hydrophone
- Correlators
  - ▶ Based on velocity of sound as it travels– most widely used
  - ▶ Two hydrophones or sensors bracket leak
- Monitoring units
- Permanent installations over time connect to valves and water service lines
- Monitor acoustics
  - ▶ Download to or transmit to base station or website



# Use of Data Loggers



# Results from loggers

Input pipe information to pinpoint leak

**Correlation Analysis**

Ductile Iron  
Cast Iron  
Cast Iron (Cement-lined)  
**Cast Iron (> 60 yrs)**  
Steel (Cement-lined)  
PVC  
LDPE (low-density poly)  
MDPE (med-density poly)  
HDPE (high-density poly)  
Multiple sections:  
Reinforced Concrete  
Concrete  
Asbestos Cement  
Copper  
Steel  
Lead

Sensor Distance: \_\_\_\_\_  
Pipe Material: Cast Iron (> 60 yrs)  
Pipe Diameter: 8 inches  
Sound Velocity: 4115 ft/s

Correlate    Advanced Analysis    Close

**Automatic Analysis of Zone My Zone**

1 2 3 4  
5 6 7 8

No. of loggers processed: 2  
No. of correlations detected: 1

100%

Time Remaining: \_\_\_\_\_

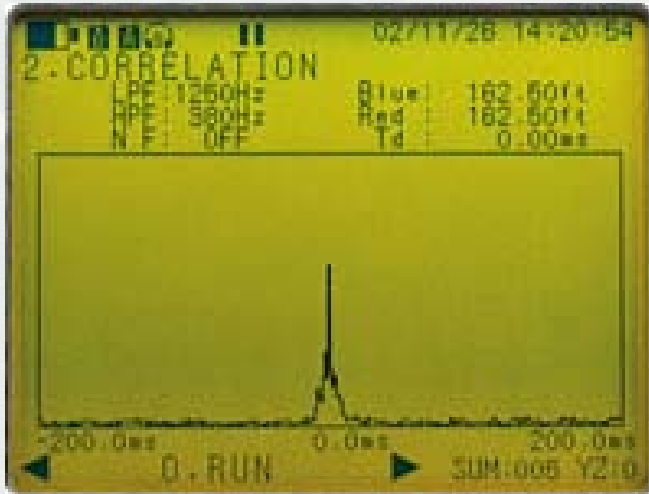
Analyze    Cancel

Corr. Results    Listen    Summary    Close



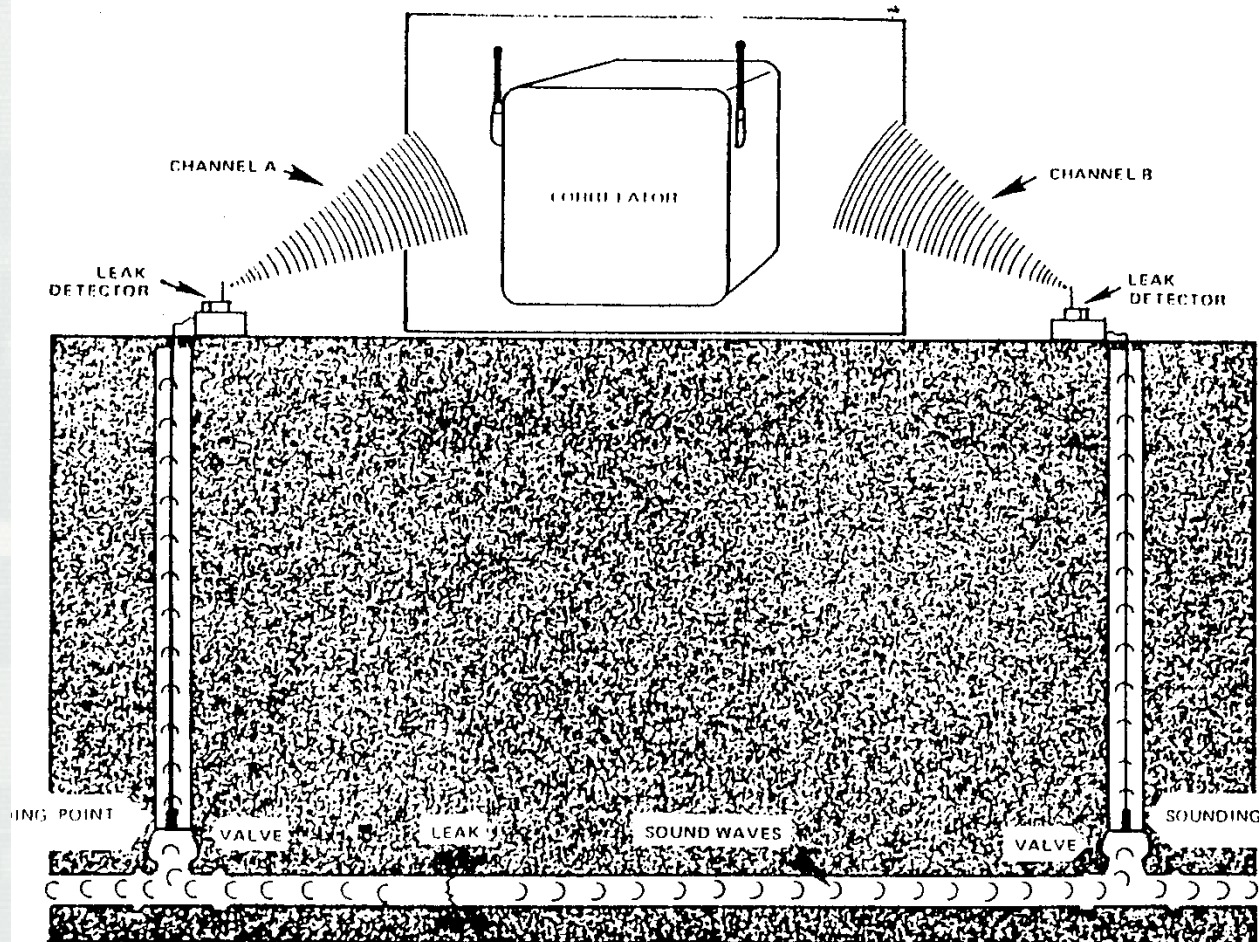


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# Principle of Noise Correlation for Pinpointing Leaks





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# What Should be Done

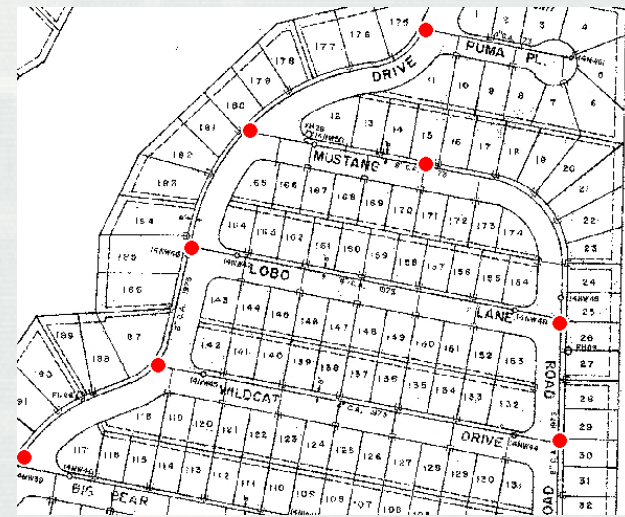
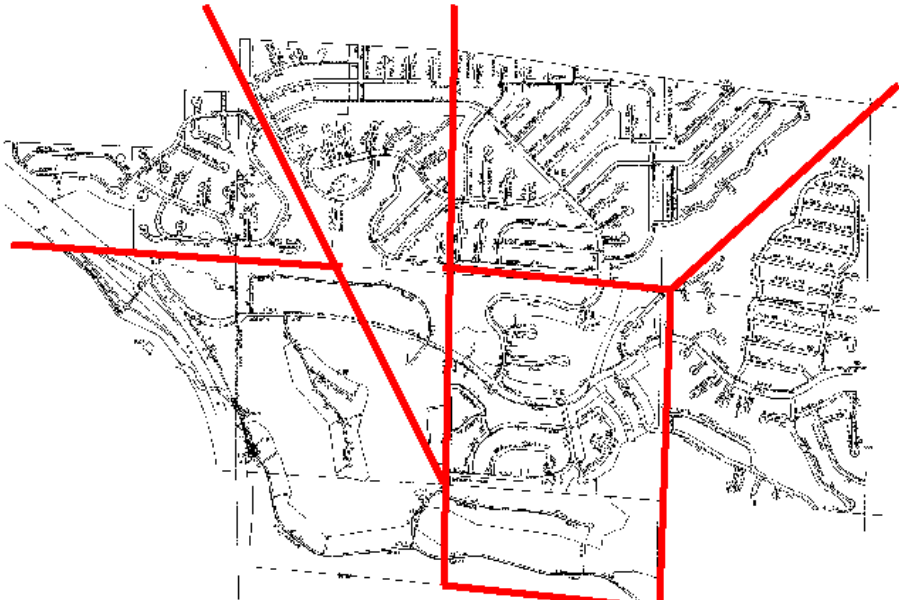
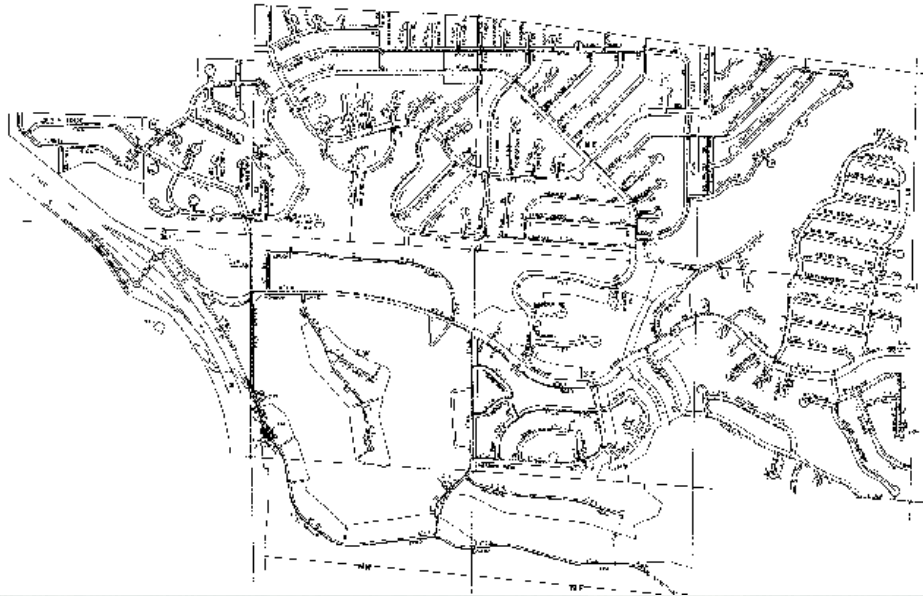
- Record review and analysis
  - ▶ Pump records, energy costs, etc.
- Determine non-revenue water
- Update maps
- Test master meters, major consumer meters
- Inventory of defects
- Recommendations for future



# Standard Water Audit

- Quantify water consumption and water production via measurement or estimate
- Undertake water balance calculation





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# Leak Detection Survey

- Distribution system
  - ▶ Contact every hydrant
  - ▶ Contact at least 50 percent of valves
  - ▶ Contact every 200 - 300 feet
- Contractor will usually do listening first,  
Then use correlation equipment for  
locating leaks



# Special Consideration

- PVC Piping
  - ▶ Sound at curb stops
  - ▶ Sound every 50 feet
  - ▶ Difficult, but can be done
  - ▶ Consider impact when expanding system
  - ▶ Requires special treatment by contractor

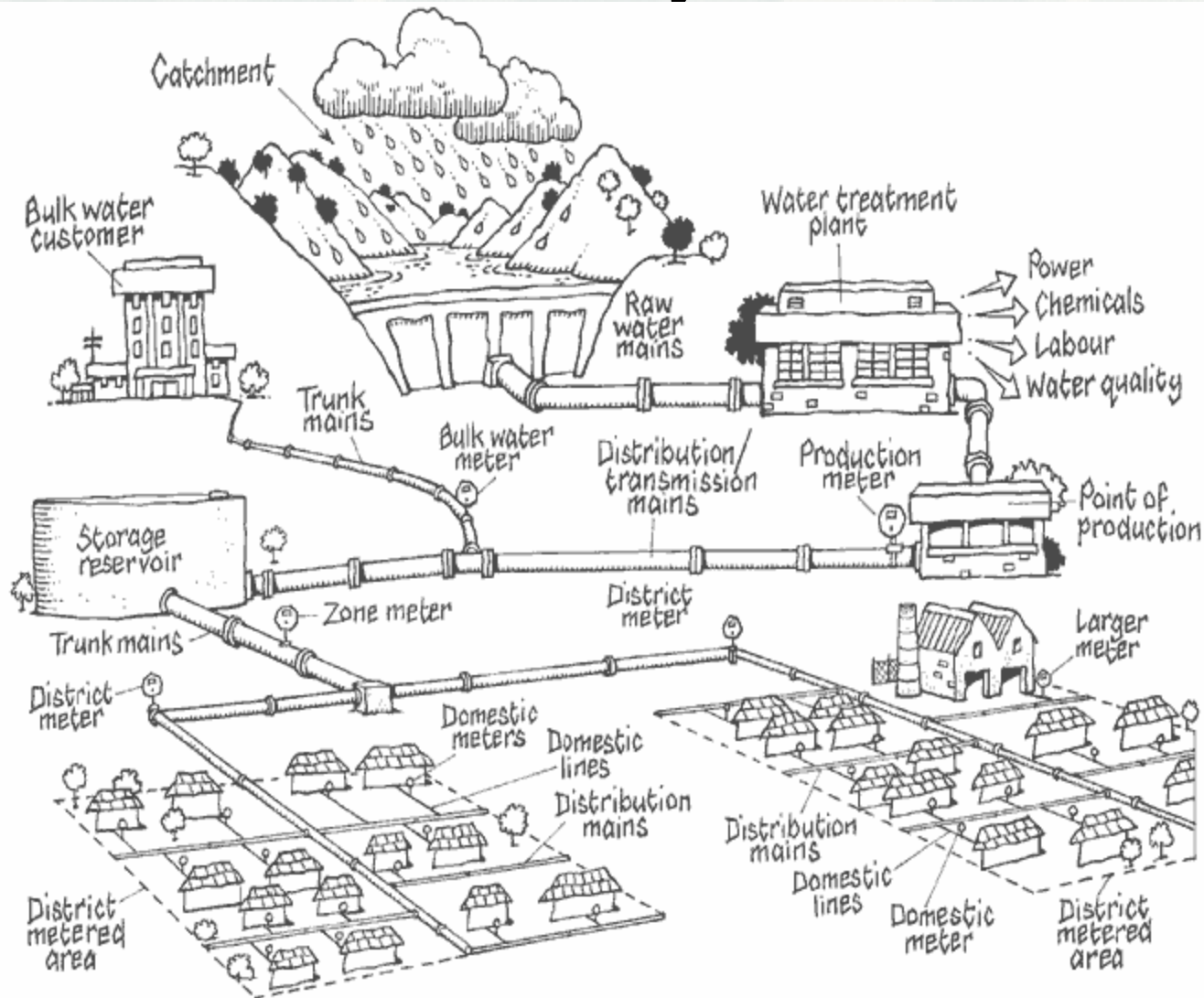


# District Metering Areas

- ▶ Some countries – water utilities subject to government regulation – pro-active leak management
- ▶ Intensive use of District Metering Areas (DMAs) common in some other countries
- ▶ DMAs approx. 500 – 300 connections
- ▶ Catching on in U.S.
- ▶ Constant feedback, ability to monitor



# Water System



# Installation Example

- 1989
  - ▶ 26 Leaks; 309,000 gpd total
  - ▶ 227,000 gpd in maintenance area valves
  - ▶ Hydrants - 59,000 gpd
  - ▶ Leakage cost = \$126,000/year
- 1995
  - ▶ 43 Leaks; 344,000 gpd
  - ▶ 25 Leaks in maint. Areas - 200,000 gpd
  - ▶ 15 Leaks in hydrants - 138,000



# Example 2 212 Miles

## 242,000,000 gallons per year

Source	Number	GPM	% Total	% Total GPM
Main	15	307	14	67
Services	51	79	47	17
Valves	24	68	22	15
Hydrants	18	7	17	1
Total	108	460	100	100



# Example 3

Leak Type	Number	Mgal	Cost (\$) @ \$0.90/kgal
Main	7	80.9	72,810
Hydrant	26	6.8	6,120
Valve	19	5.0	4,500
Service	3	4.7	4,230



# Example from Vancouver

## How Costly Can A Leak Be ?

HYDRANT (Slide Gate)	Leak Hole Size volume- cu/ft	Start cu ft	Stop cu ft	Total cu ft	7.48 US GAL= 1-cu ft us gals/per hr	\$ / m <sup>3</sup> (GVRD Rate) 35.3cu ft = 1m <sup>3</sup>	1 Hour	24 hours	7 days	365 days
Minor	1/2-Turn from closed	27.01	36.86	9.85	73.68	\$0.52	\$0.15	\$3.48	\$24.38	\$1,271.10
Moderate	2-Turns from closed	1.15	27.01	25.86	193.48	\$0.52	\$0.38	\$9.14	\$64.01	\$3,337.80

SERVICE	Leak Hole Size volume- cu/ft	Start cu ft	Stop cu ft	Total cu ft	7.48 US GAL= 1-cu ft us gals/per hr	\$ / m <sup>3</sup> (GVRD ate) 35.3cu ft = 1m <sup>3</sup>	1 Hour	24 hours	7 days	365 days
Minor	1/4 inch cut through copper	266	331	65	486.2	\$0.52	\$0.96	\$22.98	\$160.86	\$8,387.76
Moderate	1/2 inch cut through copper	423	555	132	987.36	\$0.52	\$1.94	\$46.67	\$326.67	\$17,033.61
Major	3/4 inch cut through copper	555	795	240	1795.2	\$0.52	\$3.54	\$84.85	\$593.95	\$30,970.20



# Recommendations

- Conduct comprehensive LDS every 2 years; may vary
- Initiate valve exercising program
- Install meters at critical points
- Update maps
- Disconnect lines no longer in use

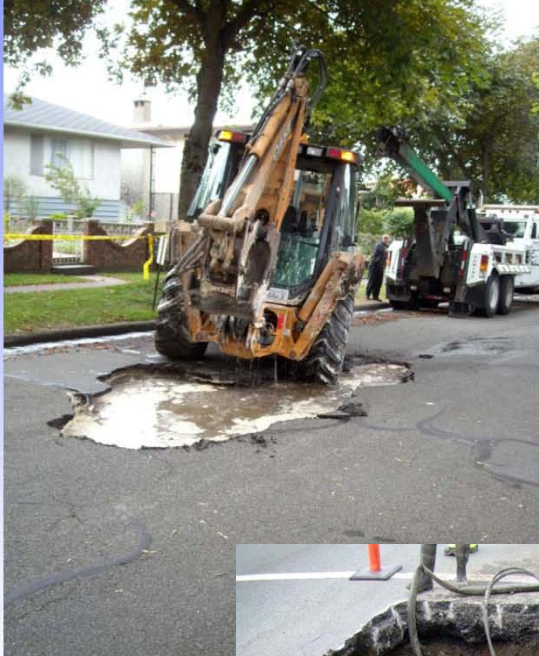


# Benefits

- Reduction in O & M costs
- Deferment of new facilities construction/expansion
- Conservation of resources
- Continuity of utility services
- Improved distribution system control
- Improved work force productivity
- Up-to-date records
- Improved knowledge of water system
- Minimize future breaks



# Leak Liabilities



# Summary

- Leak detection saves
  - ▶ Water
  - ▶ Money
  - ▶ Energy
  - ▶ Payback- few mos. to year
  - ▶ Variety of methods
- Other options also contribute to water loss control
  - ▶ Pressure management
  - ▶ DMAs
  - ▶ AMI, AMR



# Questions, Comments?

Contact information or for additional information or resources

[Richard.J.Scholze@usace.army.mil](mailto:Richard.J.Scholze@usace.army.mil)

217-398-5590



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