Water Loss Control for Military Installations

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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

Leaks waste a lot of water. A single dripping faucet can waste 75-1000 gallons of water per week depending on the rate of flow.
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

- Data logger with caution plate
- Data logger in place
- Portable patroller
Results from loggers

Input pipe information to pinpoint leak
Principle of Noise Correlation for Pinpointing Leaks
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
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

<table>
<thead>
<tr>
<th>Source</th>
<th>Number</th>
<th>GPM</th>
<th>% Total</th>
<th>% Total GPM</th>
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</thead>
<tbody>
<tr>
<td>Main</td>
<td>15</td>
<td>307</td>
<td>14</td>
<td>67</td>
</tr>
<tr>
<td>Services</td>
<td>51</td>
<td>79</td>
<td>47</td>
<td>17</td>
</tr>
<tr>
<td>Valves</td>
<td>24</td>
<td>68</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Hydrants</td>
<td>18</td>
<td>7</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>460</td>
<td>100</td>
<td>100</td>
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</table>
## Example 3

<table>
<thead>
<tr>
<th>Leak Type</th>
<th>Number</th>
<th>Mgal</th>
<th>Cost ($) @ $0.90/kgal</th>
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</thead>
<tbody>
<tr>
<td>Main</td>
<td>7</td>
<td>80.9</td>
<td>72,810</td>
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<tr>
<td>Hydrant</td>
<td>26</td>
<td>6.8</td>
<td>6,120</td>
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<tr>
<td>Valve</td>
<td>19</td>
<td>5.0</td>
<td>4,500</td>
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<tr>
<td>Service</td>
<td>3</td>
<td>4.7</td>
<td>4,230</td>
</tr>
</tbody>
</table>
## Example from Vancouver

### How Costly Can A Leak Be?

<table>
<thead>
<tr>
<th>HYDRANT (Slide Gate)</th>
<th>Leak Hole Size</th>
<th>Start cu ft</th>
<th>Stop cu ft</th>
<th>Total cu ft</th>
<th>7.48 US GAL = 1-cu ft US gals/per hr</th>
<th>$ / m³ (GVRD Rate) 35.3cu ft = 1m³</th>
<th>1 Hour</th>
<th>24 hours</th>
<th>7 days</th>
<th>365 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor 1/2-Turn from closed</td>
<td>27.01</td>
<td>36.86</td>
<td>9.85</td>
<td>73.68</td>
<td>$0.52</td>
<td>$0.15</td>
<td>$3.48</td>
<td>$24.38</td>
<td>$1,271.10</td>
<td></td>
</tr>
<tr>
<td>Moderate 2-Turns from closed</td>
<td>1.15</td>
<td>27.01</td>
<td>25.86</td>
<td>193.48</td>
<td>$0.52</td>
<td>$0.38</td>
<td>$9.14</td>
<td>$64.01</td>
<td>$3,337.80</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>Leak Hole Size</th>
<th>Start cu ft</th>
<th>Stop cu ft</th>
<th>Total cu ft</th>
<th>7.48 US GAL = 1-cu ft US gals/per hr</th>
<th>$ / m³ (GVRD Rate) 35.3cu ft = 1m³</th>
<th>1 Hour</th>
<th>24 hours</th>
<th>7 days</th>
<th>365 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor 1/4 inch cut through copper</td>
<td>266</td>
<td>331</td>
<td>65</td>
<td>486.2</td>
<td>$0.52</td>
<td>$0.96</td>
<td>$22.98</td>
<td>$160.86</td>
<td>$8,387.76</td>
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</tr>
<tr>
<td>Moderate 1/2 inch cut through copper</td>
<td>423</td>
<td>555</td>
<td>132</td>
<td>987.36</td>
<td>$0.52</td>
<td>$1.94</td>
<td>$46.67</td>
<td>$326.67</td>
<td>$17,033.61</td>
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</tr>
<tr>
<td>Major 3/4 inch cut through copper</td>
<td>555</td>
<td>795</td>
<td>240</td>
<td>1795.2</td>
<td>$0.52</td>
<td>$3.54</td>
<td>$84.85</td>
<td>$593.95</td>
<td>$30,970.20</td>
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</tbody>
</table>


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

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