



Water Loss Auditing and Water Leak Detection: How Much is Being Lost and Where Does it Go?

PNWS-AWWA

Annual Conference

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What Will Be Covered

- Determining the magnitude of water loss
 - Quantity
 - Risk level
 - Calculation methods

- Determining the cost of water loss

- Determining how to reduce water loss

What is Water Loss?

Once upon a time, the water industry defined this “unaccounted for water”

... and that was part of the problem. We CAN account for this water ... and we SHOULD account for all the water in the system

... so now, the water industry term is “**Non-Revenue Water**” or **NRW**

Determining the Cost of Water Loss

It is not enough to know the quantity of NRW. It is also important to know what type of loss is present and what is the cost of each type of water loss is impacting the water utility.

Cost of Water Loss

Losing Money

- 💧 *Wasting chemicals*
- 💧 *Wasting electricity*
- 💧 *Paying more for purchased water*
- 💧 *Lost revenue from theft, inadequate billing process and meter inaccuracy*



Cost of Water Loss

Customer Perspective

- 💧 *Heightens inconvenience from interrupting water service and commerce*
- 💧 *Hurts perception of utility as a steward of resources (environmental and financial)*
- 💧 *Brings unwanted negative publicity*



Cost of Water Loss Damage

💧 *Potential damage*

- *Damage to property and other utilities*
- *Surface hazards – ice, ponding, hydroplaning*



💧 *Water supply*

- *Systems with limited water can be threatened*
- *Excessive loss can accelerate the need for more resources, facilities and capital expense.*

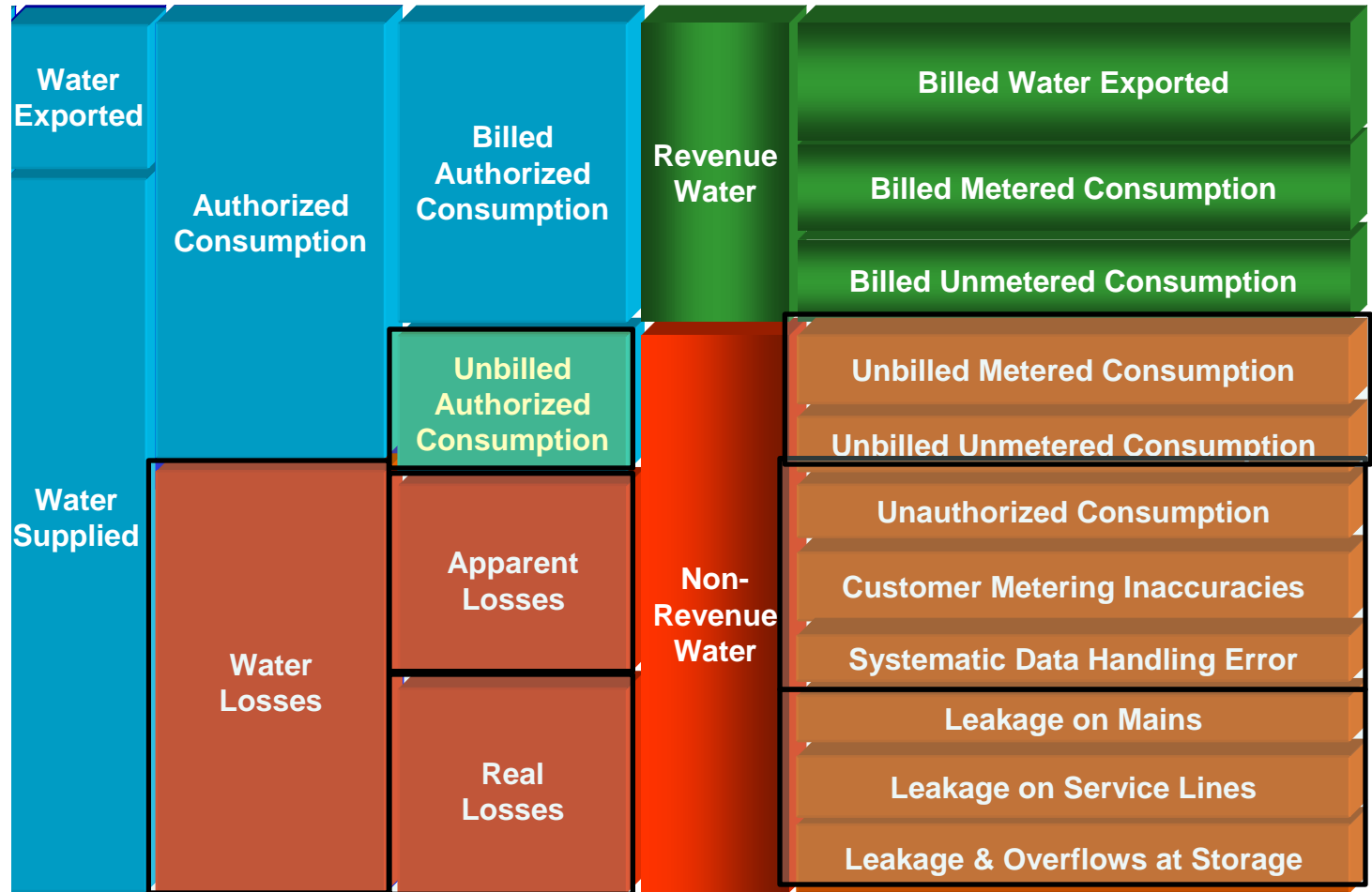


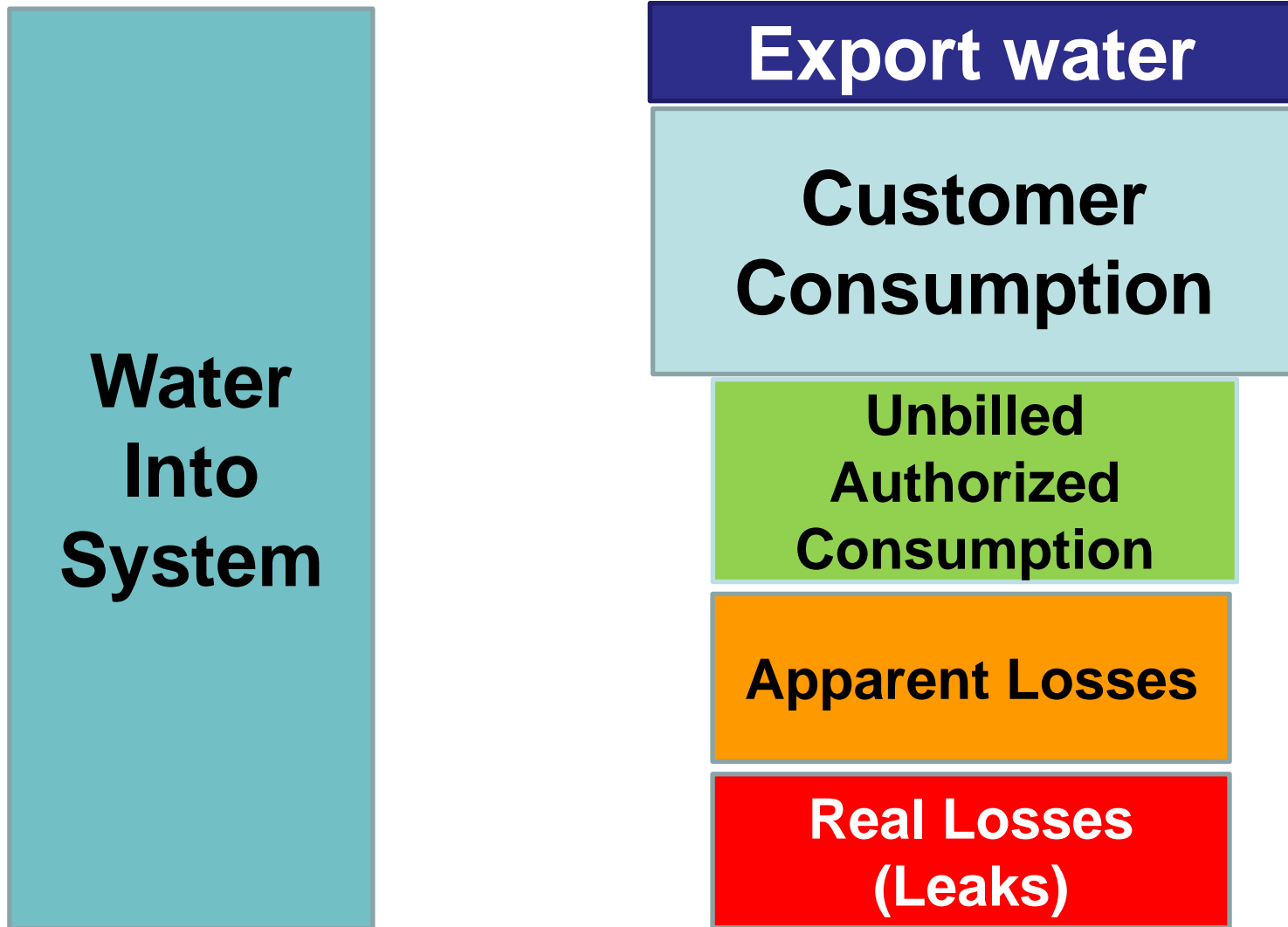
💧 *Water quality*

- *Compromising system integrity – possible contamination*
- *Potential backflow*



Water Audit Process: Component Analysis





Leaks = water in - export water out - billed volume - estimated unbilled authorized - apparent loss estimate

Billed Consumption

💧 Water exported

- Usually to another water system
- Master metered

💧 Billed Customer Consumption

- Metered
- Unmetered but estimated
- Unmetered - flat rate charge

Export water

**Customer
Consumption**



Billed Consumption

Biggest User of Water

- 💧 Exports
 - If you are the seller, make sure the meter is accurate.
- 💧 Residential customer use
 - Usually the prime component of small system use
- 💧 Commercial customer use
 - Many are not significant water users
- 💧 Industrial customer use
 - Can be the most significant user in a small system – may be as factor in night use

Export water

Customer Consumption



Photo courtesy Denver Water

Unbilled Authorized Consumption

💧 Water use that is not billed

- Fire fighting
- Flushing
- Public parks and golf courses
- Street cleaning
- Municipal facilities (pools, City Hall)

💧 How do you account for the amount of water that is being used?

- Metered
- Unmetered but estimated
- Unmetered

💧 *Can your utility control this use more effectively?*

Unbilled Authorized Consumption



Apparent Losses

Apparent Losses

- 🔹 Unauthorized use
 - Illegal taps
 - Theft at hydrants
 - Open unmetered bypasses
 - Illegal use of fire services
 - Meter tampering
- 🔹 Customer meter inaccuracies
- 🔹 Billing handling errors

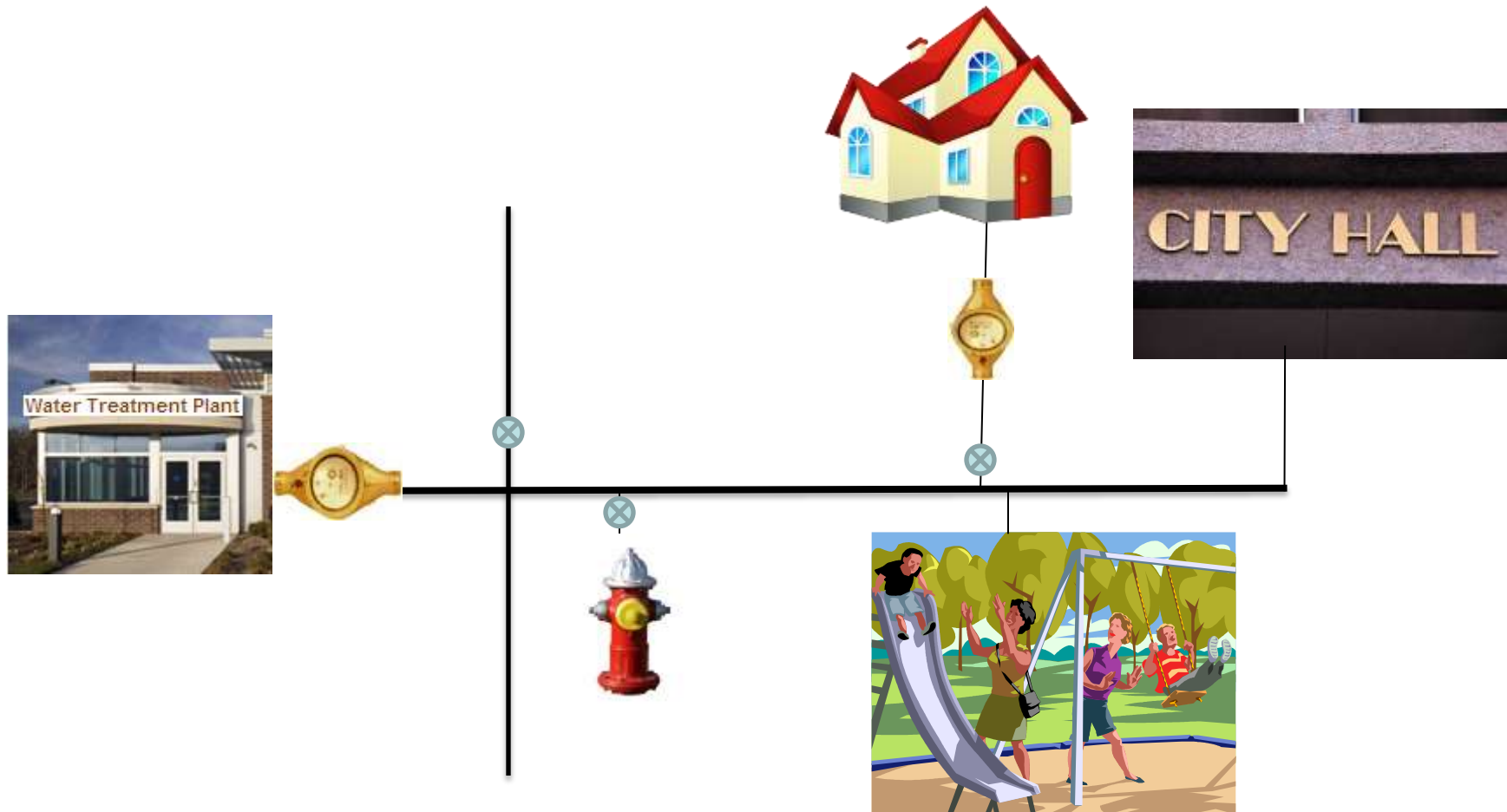


Real Losses

- 💧 Leakage on mains
- 💧 Leakage on service lines
- 💧 Storage leaks and overflows

Real losses





Identify where water loss could be occurring.
Define as unbilled, apparent, or real loss.

What if Customer Use is not Metered?

💧 Billing options to meters

- Part of general user fee (fixed fee)
- Fixture count
- Property size

💧 Maybe they should be metered

- Equity and fairness
- Accountability
- Regulation



Unmetered – Look at System Use Patterns

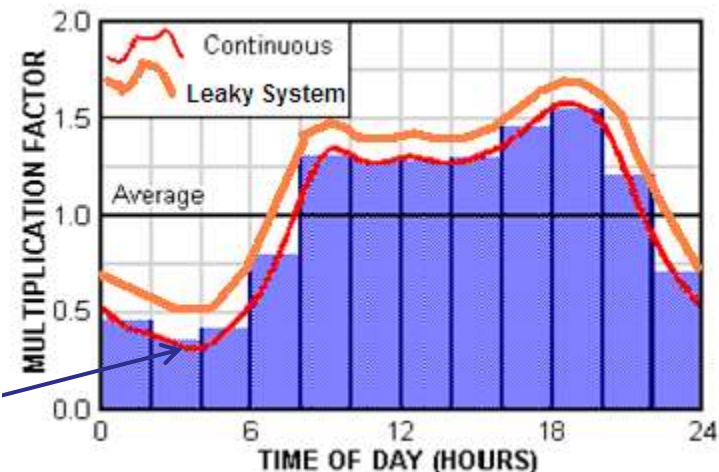
💧 Daily usage patterns

- Somewhat predictable usage pattern especially if no industry
- Usually minimal flow at night
- Some unmetered systems have successfully estimated night flow to calculate leak loss
- Take storage changes into account

💧 Night flow analysis

- Utilities can compare actual volume at night with projected use to evaluate the amount of leakage

Minimum night flow



What is an Acceptable Leakage Amount?

- What is the appropriate level of non-revenue water?
 - Facility and supply limits and economics will help you decide the level of action and you should take and equipment to buy.
- Regulations may apply
 - Washington DOH: < 10% water loss
 - Oregon:
 - Idaho:
 - California: < 10% water loss

Metrics - What is Best to Use?

- 💧 **Percentage of NRW is helpful but not best**
 - Comparison between systems can be impacted by differences in consumption major customers and yearly fluctuations.
 - Heavy summer consumption can distort NRW percentage when comparing year to year.
 - Percentage not as helpful as volume for small systems that need to be careful with limited water.
- 💧 **Using water loss per connection per year is more useful.**



**Water Into
System**

Export water

**Customer
Consumption**

Non Revenue Water

**Unbilled Authorized
Consumption**

Apparent Losses

Real losses

Authorized Unbilled Use

Meter, estimate, report

Unbilled Authorized Consumption

- Municipal services
 - Metering for fountains, municipal buildings, parks
- Flushing
 - Filling mains – compute volume
 - Fire flow tests – measure time and flow
 - Flushing – measure time and flow
- Fire fighting
 - Estimating flows and duration
 - Metering usually not an option
- Other uses??



Apparent Losses Difficult to Estimate

Apparent Losses

- 💧 **Illegal use of hydrants**
- 💧 **Meter Tampering**
- 💧 **Customers opening bypasses**
- 💧 **Illegal connections**
- 💧 **Billing Errors**



Apparent Losses

Evaluate Meter Accuracy

- 💧 Project loss from random testing
- 💧 Test customer meters/master meters
- 💧 Are you metering everyone
- 💧 Are you billing everyone?



Calculating and Identifying Real Losses

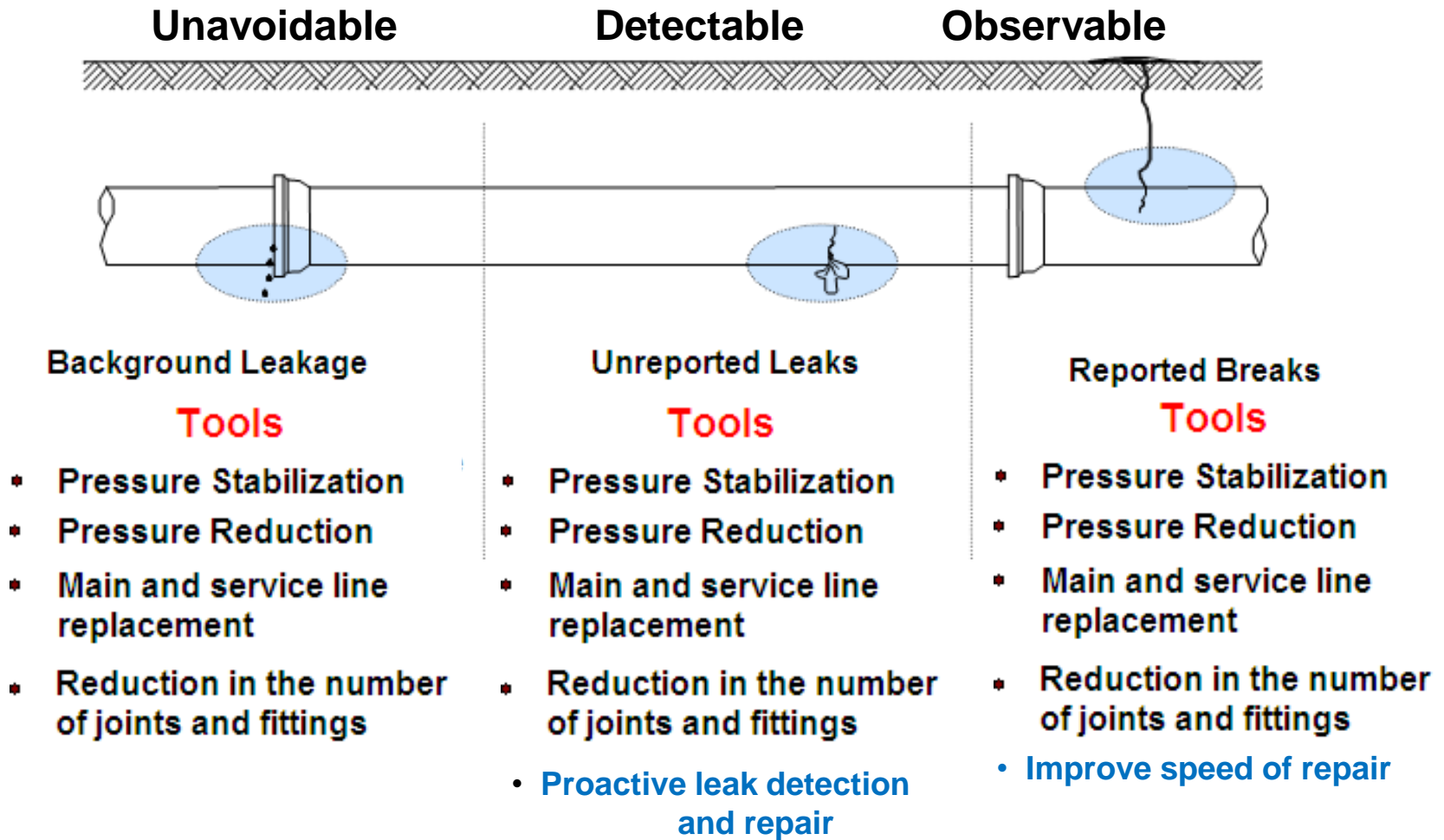


Real losses

- Real Loss is the difference between all NRW and the other forms of NRW (we just covered)
 - Authorized unbilled consumption
 - Apparent loss

The Focus is Usually on Leakage

Leakage and break types *and tools*



How Much Does NRW Cost – Unit Costs

- ◆ Real losses and unbilled authorized use cost the amount of money it takes to produce the water (sale price if bought, treatment and electrical costs if produced).
- ◆ Apparent losses could have been sold at retail price (if used but not stolen or otherwise avoiding payment), so its value is greater at the retail rate, the rate customers pay.



Water Balance Example

- A Water Utility produces 5000 MG annually (13.7 MGD)
- An audit determines Utility has 1000 MG in water losses (250 MG in apparent losses and 750 MG in real losses)
- The cost of production is \$0.50/1000 gal (\$500/MG); Retail charge = \$3/1000 gal (\$3000/MG). Most of the expense of the production cost is in energy
- Lost revenue in apparent losses = $\$3000/\text{MG} \times 250 \text{ MG}$
= \$750,000 annually

Water Balance Example – Cont'd

- ◆ Added cost to the utility for the real losses = $\$500 \times 750$ MG = \$375,000 annually
- ◆ Total annual cost for apparent and real losses is over \$1 million !!

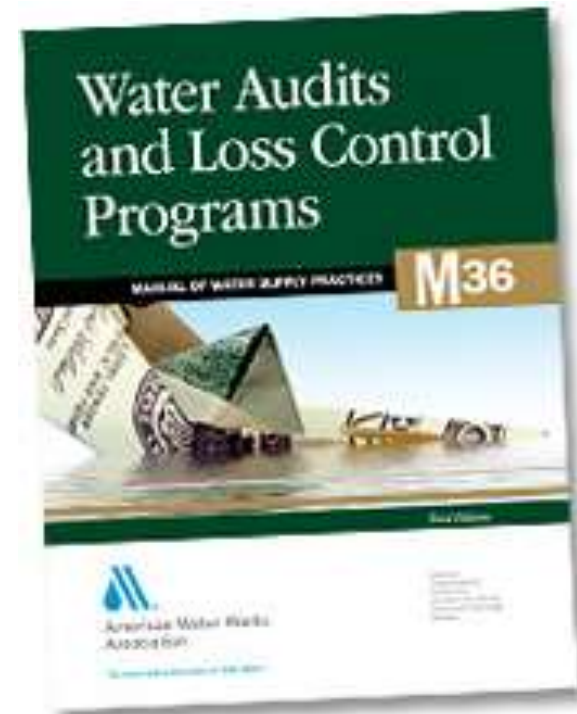
Bottom Line: Getting a handle on real losses will mean less pumping which means less energy purchased which mean lower energy costs

Estimating Leakage - Summary

- Start by getting an estimate of the non-revenue water by components
- Then see if you can estimate areas of authorized unbilled and other losses
- Work to minimize different categories of loss (note it may vary within your system)

Useful Tool for Water Audits

- 💧 **AWWA Manual M36, 3rd edition (2009)**
 - Section devoted to small systems
- 💧 **The AWWA Water Loss Control Committee (WLCC) working on 4th edition**
- 💧 **Free software available on AWWA website – Version 5.0 released in 2014**



SUMMARY –

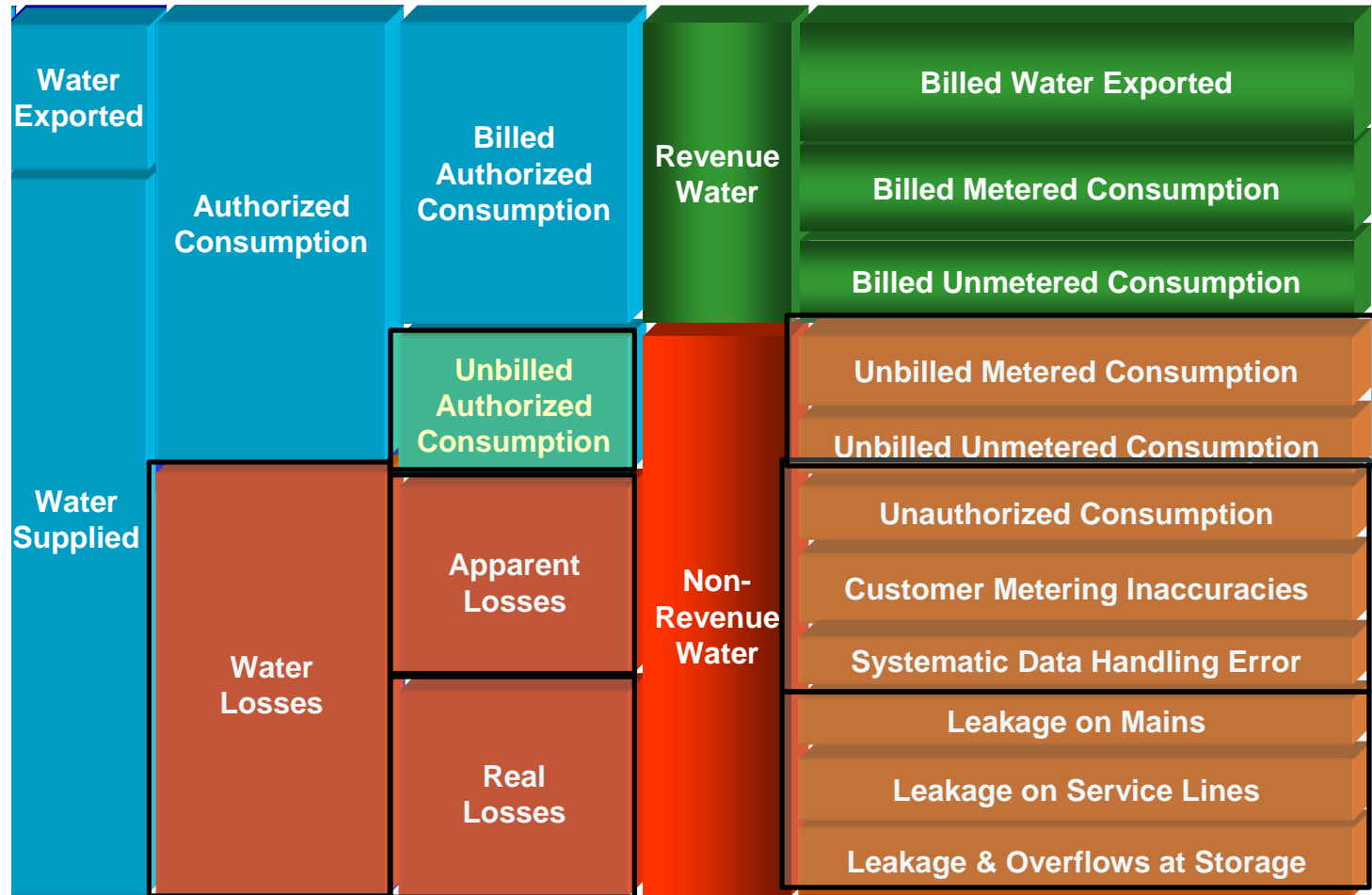
How to Get the Free AWWA Water Audit

- **Go to awwa.org**
- **Enter [water audit software](#) in the search box (upper right)**
- **Navigate to the **Water Loss Control** page**
- **Click on [AWWA Water Loss Control Committee Free Water Audit Software v5.0 \(2014\) \(XLS\)](#)**
- **Click on the compiler [AWWA Water Loss Control Committee Water Audit Software Compiler v5.0 \(2014\) \(XLS\)](#)**

Determining Amount of NRW

- ◆ Start with what is known and readily obtainable
 - Compare water leaving the treatment facility with consumer billing records
 - Estimate unbilled authorized consumption and sources of apparent loss
 - Leakage (Real loss) = Measured Total Water Production
less Total Revenue Sales Volume
less Estimated Apparent Loss Volumes
less Calculated Authorized Unbilled Water Volume

Determining NRW Leakage Component

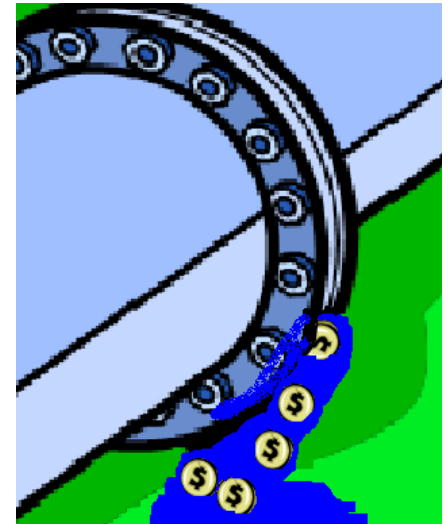


How Good is the Data?

- The Audit is only as good as the supporting data
- Check into data that is missing, poor or questionable quality
 - Work to improve weak or missing data
 - Focus on critical data (like master meters)
 - Worry about the big stuff first

Focus on the Economics

- Make your best estimate of leakage
 - Use water audit and night flow to gauge how much volume you lose per year.
- Calculate what that avoidable leakage is costing you
 - Multiply the annual loss by the cost to produce the water (higher if purchased as finished water)
- Examine possible leak detection approaches and costs
 - Leak surveys (in house, consultant, step tests, district metering)



The Economics of Leak Reduction

- Compare cost of a program with potential savings.
 - *Expect that you can only reduce part of leakage with any leak detection program*
- Contingency plan - be prepared to deal with a severe break that may threaten your supply.
 - Know where to get help



Approaches to finding pipe

- 💧 Using maps
- 💧 Finding surface items and using physical clues
- 💧 Finding metallic pipe
- 💧 Finding nonmetallic pipe



Components of good maps

- Good maps show pipe location horizontally relative to permanent surface points.
- Good maps provide reference information about significant changes in depth.
- Good maps show pipe material and size.
- To remain good maps there should be a plan to adjust them when new pipe installed or need correction.

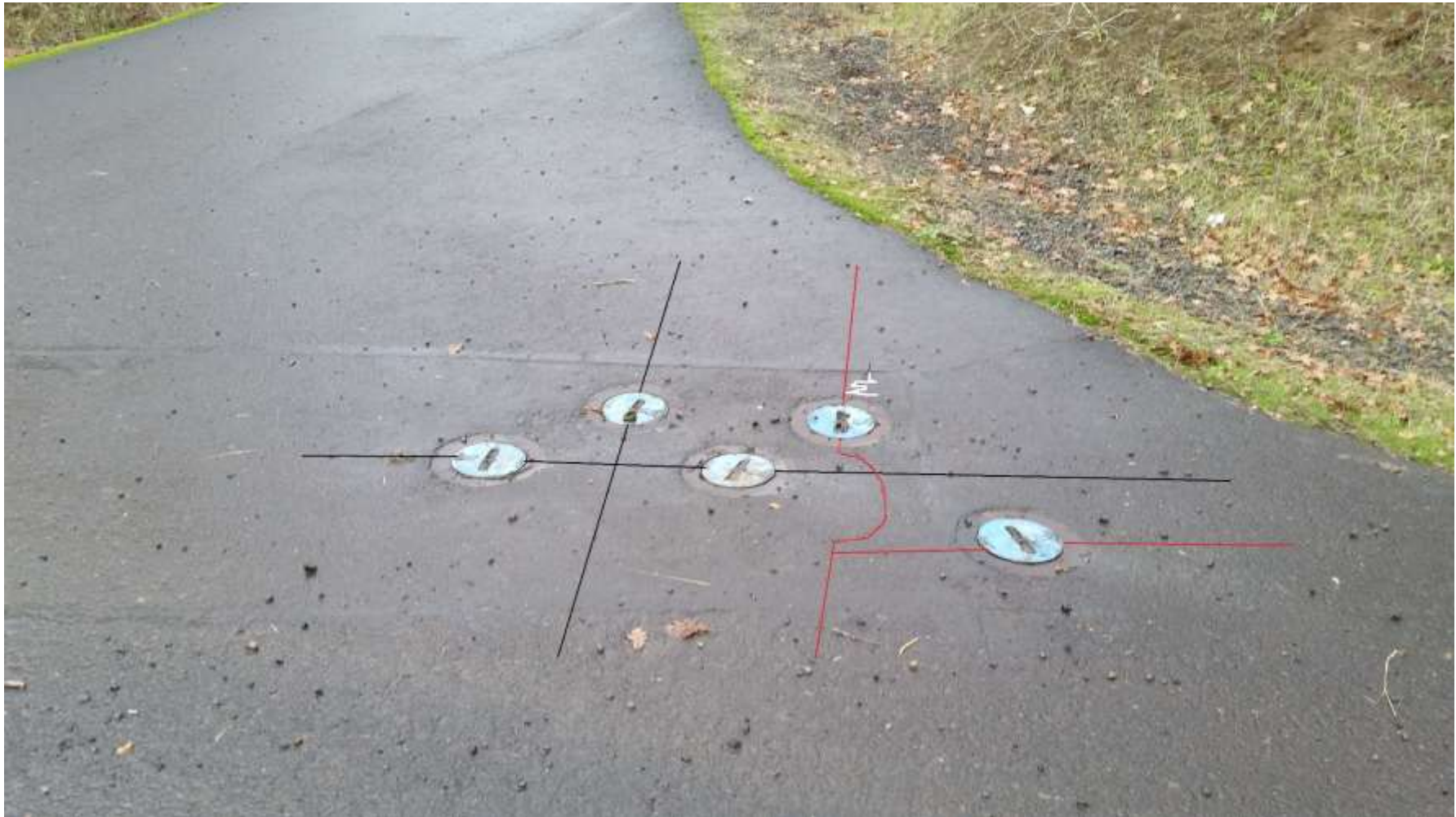


Surface locating

- Hydrants, blow-off pipe discharges, valve boxes, meter pits, curb boxes are either visible and contain some steel or iron.
- Magnetic locaters are common in the industry.



Valve Layout for Water Lines to & from a Pump Station



Valve Layout at a Road Intersection (3 Water Lines, 5 Valves)



Operating valves?

- ◆ A study for the City of Houston (*Wachs Water Services, 2011*) evaluated more than 4,000 valves
 - Could not locate 17% of the valves initially (lowered to 12% after locating effort)
 - Map discrepancies, 14%
 - Paved-over valves, 6%
 - 45% initially inoperable (lowered to 19%)
 - 10% in the wrong position (closed/open)

Finding metallic pipe

- ◆ Numerous manufacturers (and distributors) provide inductive/conductive transmitter/receiver devices to locate pipe.



Locator Issues

- ◆ Signal can jump to other nearby pipes; best to work slowly away from transmitter.
- ◆ Watch for cable lines give strong signals as they are shallow and good conductors.
- ◆ When using conductive method, the transmitter needs a good ground.
- ◆ Some devices can provide depth; this is usually center of pipe – not top of pipe.
- ◆ Failing batteries can cause erratic signals.

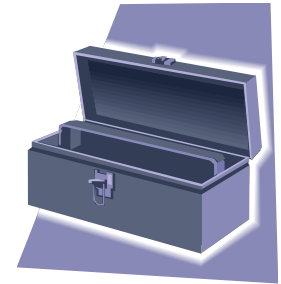
Finding nonmetallic pipe

- Not conductive, limited ability to locate.
- Some devices induce vibration for acoustic sensing – limited range.
- No reliable method for readily signaling through water mains is available at this time.



Thomas Edison once said, "I have not failed. I've just found ten thousand ways that won't work."

What should you have in your toolbox?



- A good metal detector (think about time saved finding valve box buried under paving, snow, soil and landscaping).
- An inductive/conductive locator if the system has mostly metallic mains or services.
- If the system is nonmetallic, divining rods with access to more sophisticated methods for emergencies recommended.



Thanks for listening to the presentation

Questions or Comments?

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