2024 Water Distribution Workshop
November 6 - 7
Quest Conference Center – Westerville, OH

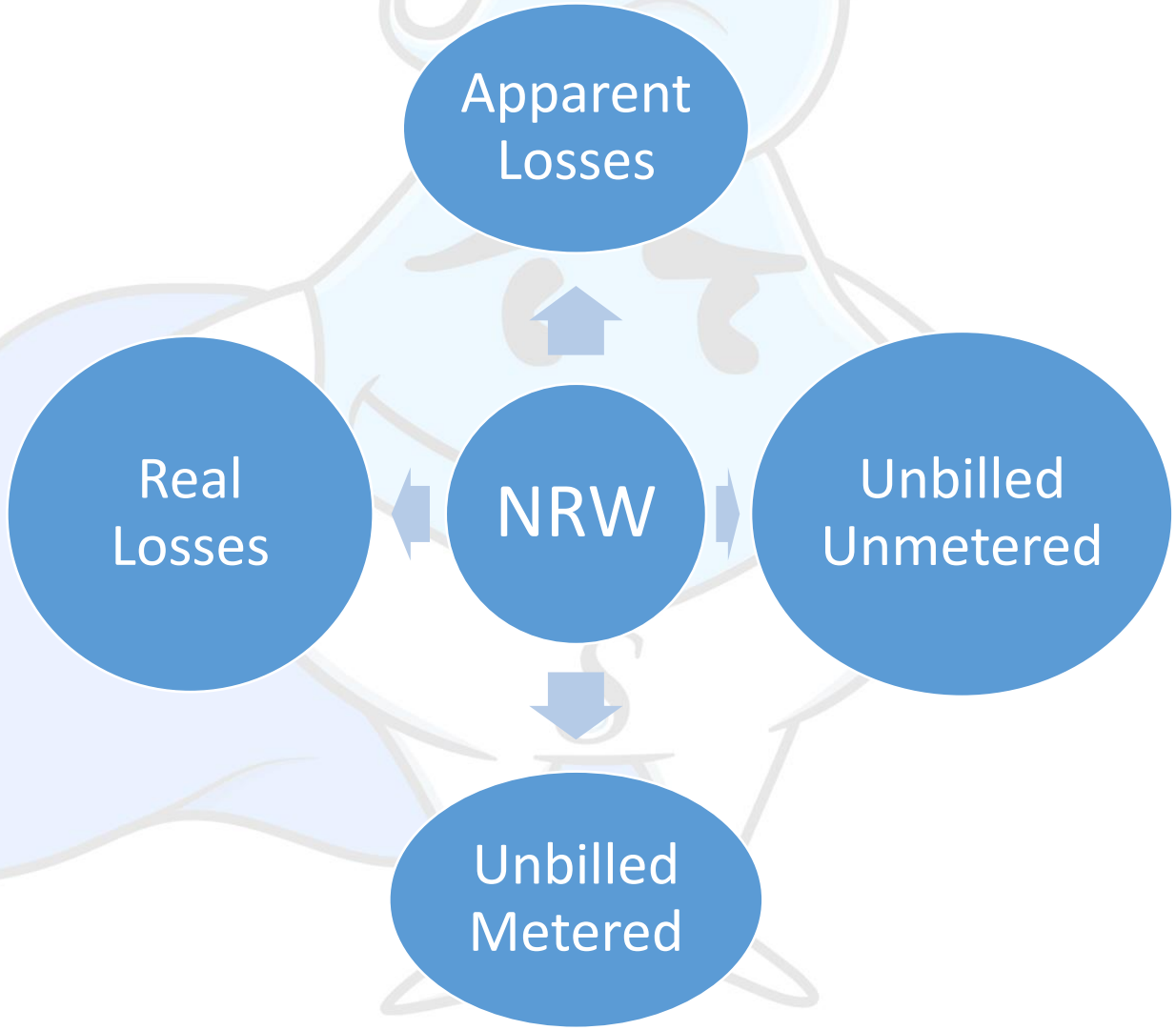
Water Audits – Where to Look and How to Respond

Scott Dompke

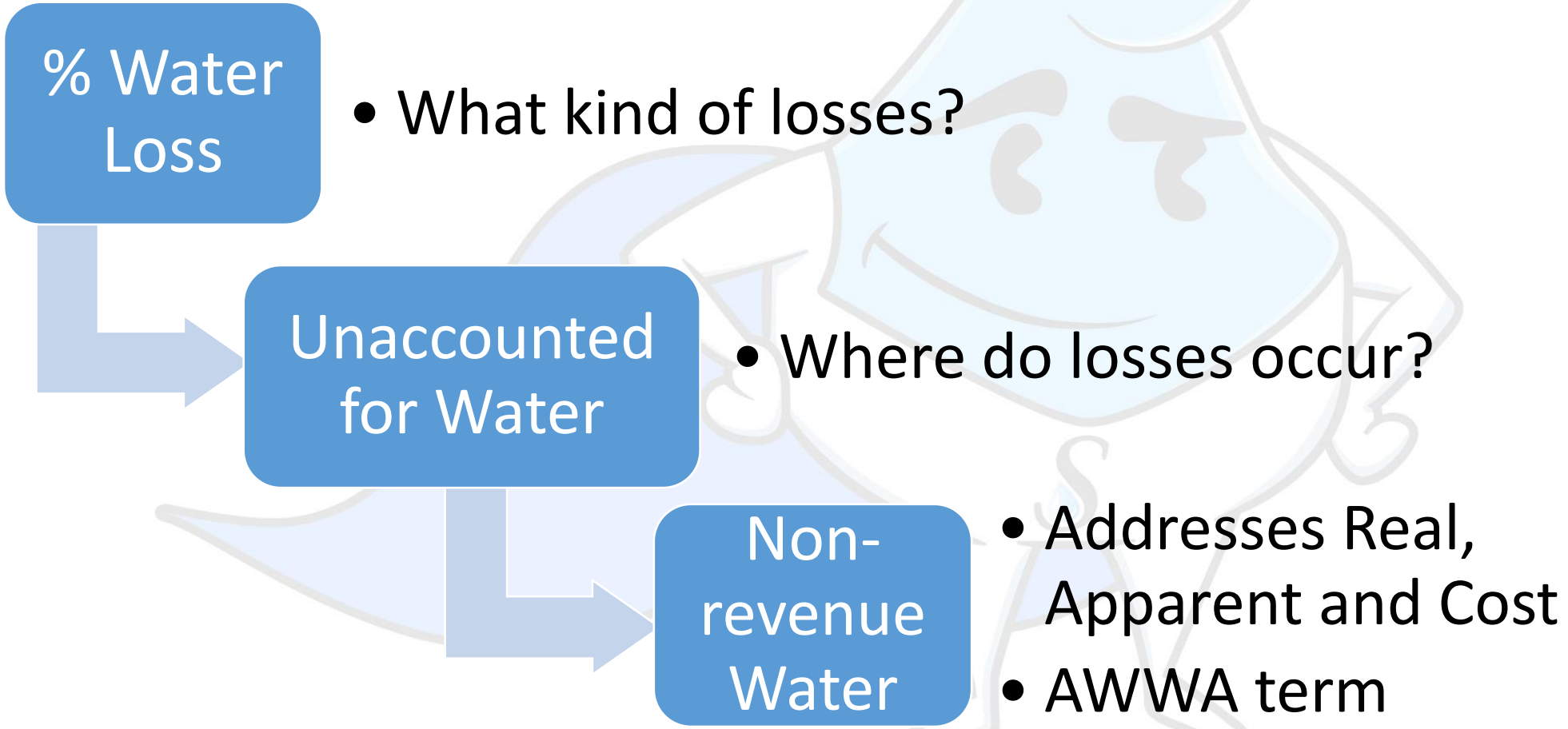
What is Non-Revenue Water?

- Water that does not provide ***revenue potential*** to the utility.

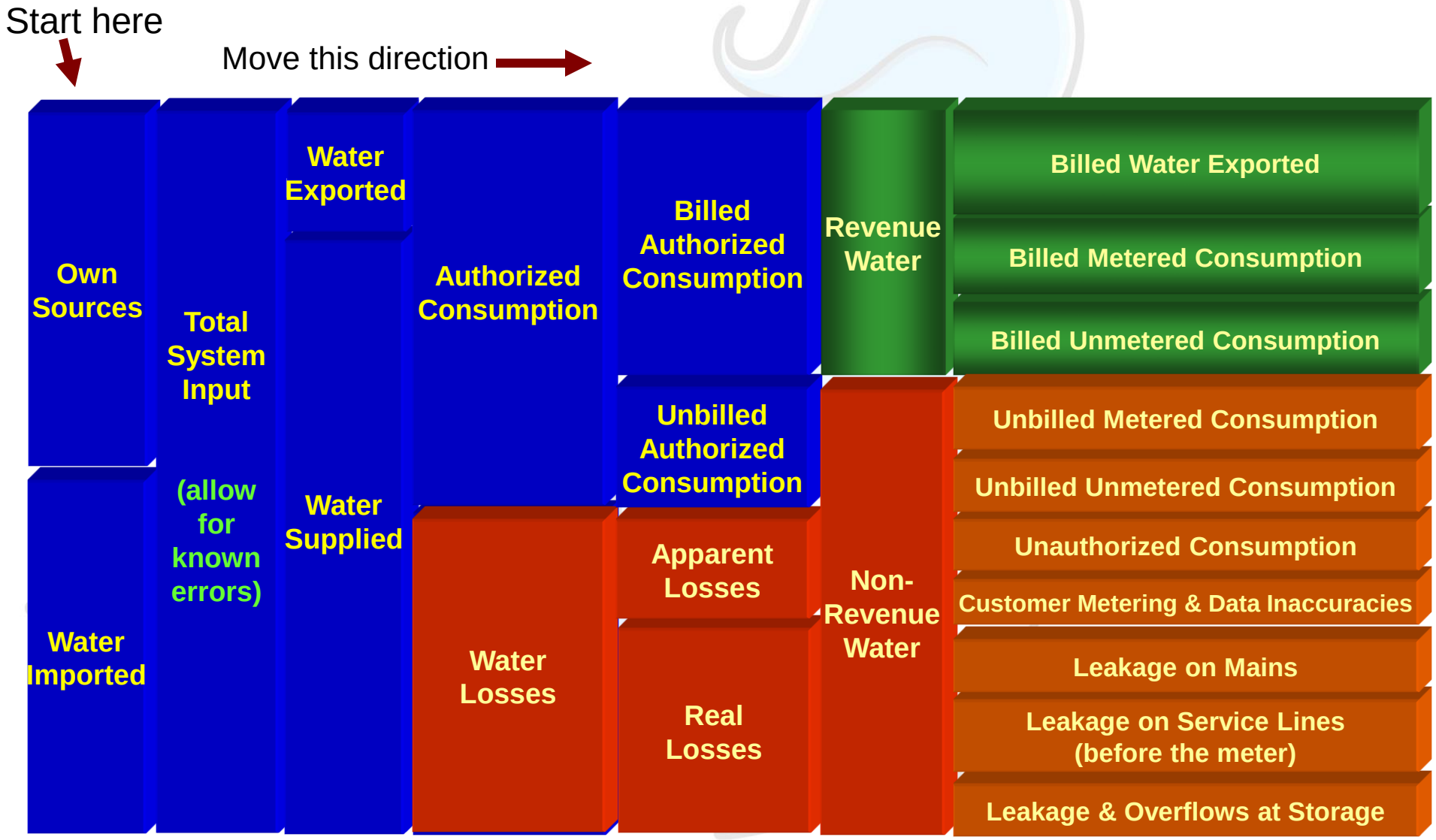
- Definitions created by the IWA and AWWA



What Happened to the Term “Lost Water”?

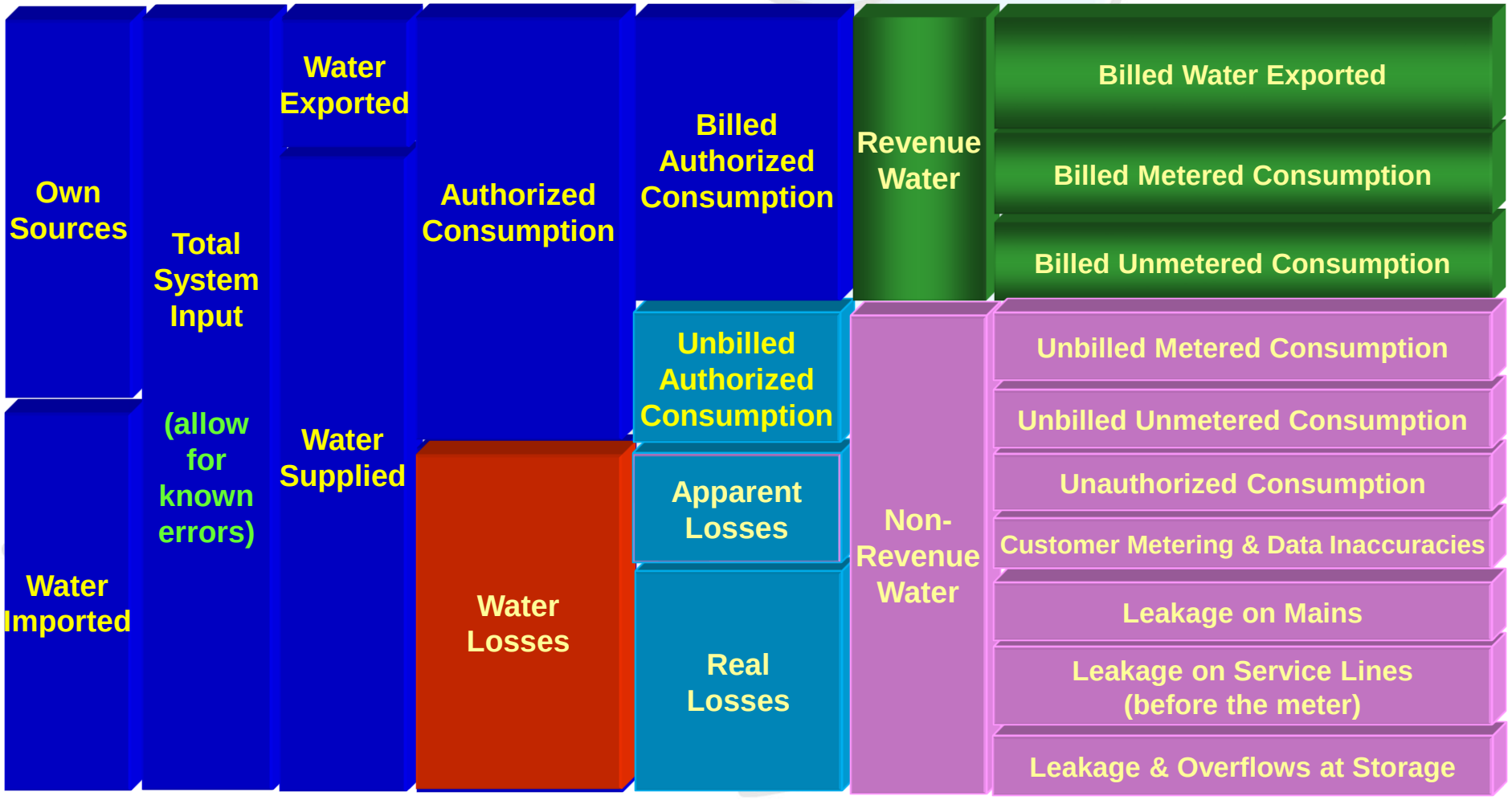


Standard Water Balance Format



Standard Water Balance Format

Shows what contributes to Non Revenue water



Unbilled Authorized Consumption – Unbilled Metered

- By policy
- Utility use
- Treatment or distribution use
- Civic organizations
- Not water to other utilities (Exported)

Unbilled Authorized Consumption – Unbilled Unmetered

- Firefighting
- Flushing
- Street sweeping
- Default 1.25% of Volume Supplied
- Documentation for non-default

Apparent Losses

Unauthorized Consumption

Customer metering inaccuracies

Systematic data handling errors

Theft from hydrants, fire lines, midnight taps

Over estimate Apparent Losses = Under estimate Real Losses

Real Losses

Leaks

Breaks

Tanks

Under estimate apparent losses = over estimate real losses

Water Loss Control Planning Guide Tab - Future Water Loss Control Planning

Water Audit Report for:	Some Water
Audit Year:	2020 Jul 01 2019 - Jun 30 2020
Data Validity Tier:	Tier IV (71-90)

Water Loss Control Planning Guide

	Water Audit Data Validity Tier (Score Range)				
Functional Focus Area	**Tier I (1-25)**	**Tier II (26-50)**	**Tier III (51-70)**	**Tier IV (71-90)**	**Tier V (91-100)**
Audit Data Collection	Launch auditing and loss control team; address supply metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations; Identify data gaps; improve supply metering	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs; Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or AMR/AMI system	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon with PIs for performance comparisons for real losses	Performance Benchmarking with PIs is meaningful in comparing real loss standing	Identify Best Practices/ Best in class; PIs are very reliable as real loss performance indicators for best in class service

For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.

Water Loss Control Planning Guide tab…

Can help with *future Water Loss Control Plannina*

Functional Focus Area	Tier IV (71-90)
Audit Data Collection	Refine data collection practices and establish as routine business process
Short-term loss control	Refine, enhance or expand ongoing programs based upon economic justification
Long-term loss control	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management
Target-setting	Establish mid-range (5 year horizon) apparent and real loss reduction goals
Benchmarking	Performance Benchmarking with PIs is meaningful in comparing real loss standing

Data

Short Term

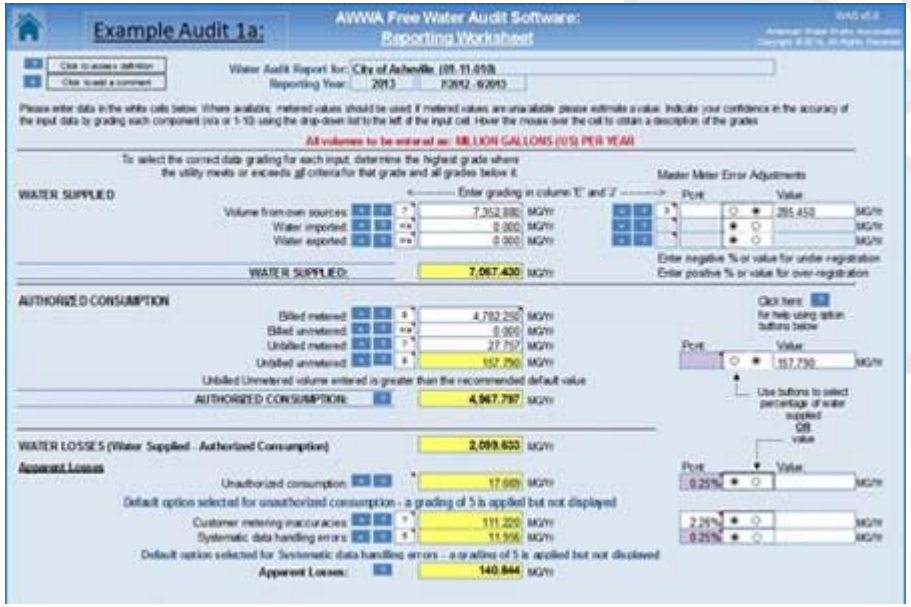
Long Term

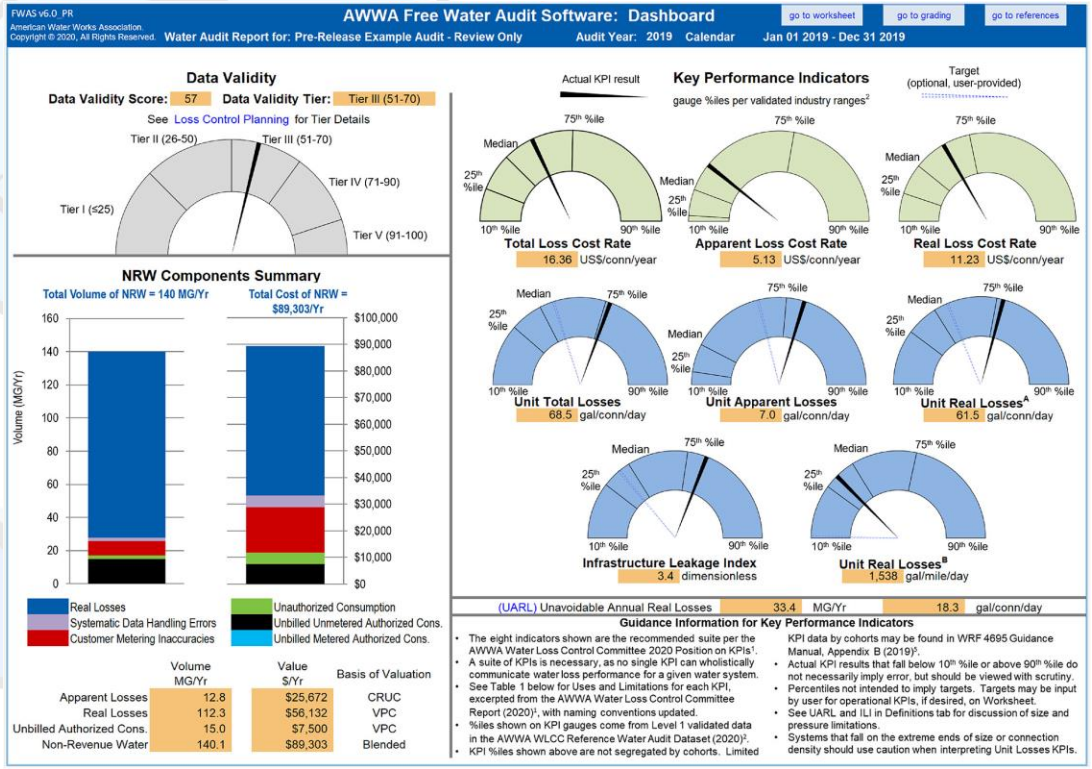
Target

Benchmarking

Water Loss Control – Worksheet and Dashboard

- Water Audits
  - Minimizing water loss
  - Optimizing operational performance
  - Water audit validation





conn—connection, CRUC—Customer Retail Unit Charge, FWAS—Free Water Audit Software, ILI—Infrastructure Leakage Index, KPI—key performance indicator, NRW—nonrevenue water, UARL—Unavoidable Annual Real Loss, VPC—Variable Production Cost, WLCC—Water Loss Control Committee, WRF—The Water Research Foundation

Real Losses

- Assessed at the rate you make (or buy) water
- Always costs less to make it than sell it
- Use Variable Production Cost to evaluate impact

Apparent Losses

- Assessed at the rate you sell water
- Always means more revenue when found
- Don’t forget to account for sewer revenue
- Use Customer Retail Unit Charge to evaluate impact

Financial Impact Calculations
Real v Apparent Losses

VPC

- Variable Production Cost
- Annual cost of power and chemicals ($/MG)

CRUC

- Customer Retail Unit Charge
- Average volumetric rate charge ($/kgal)

Water Audit Dashboard

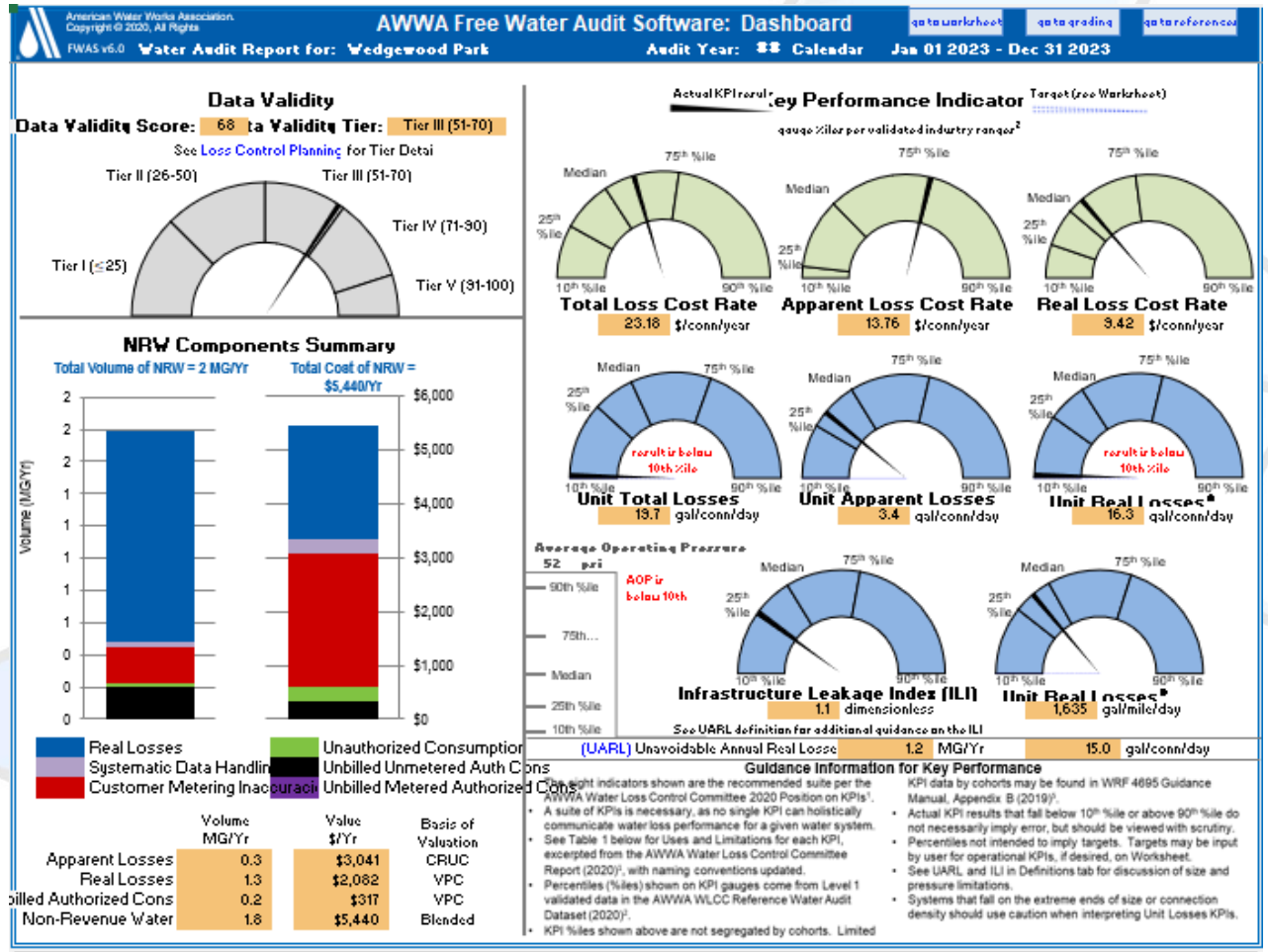
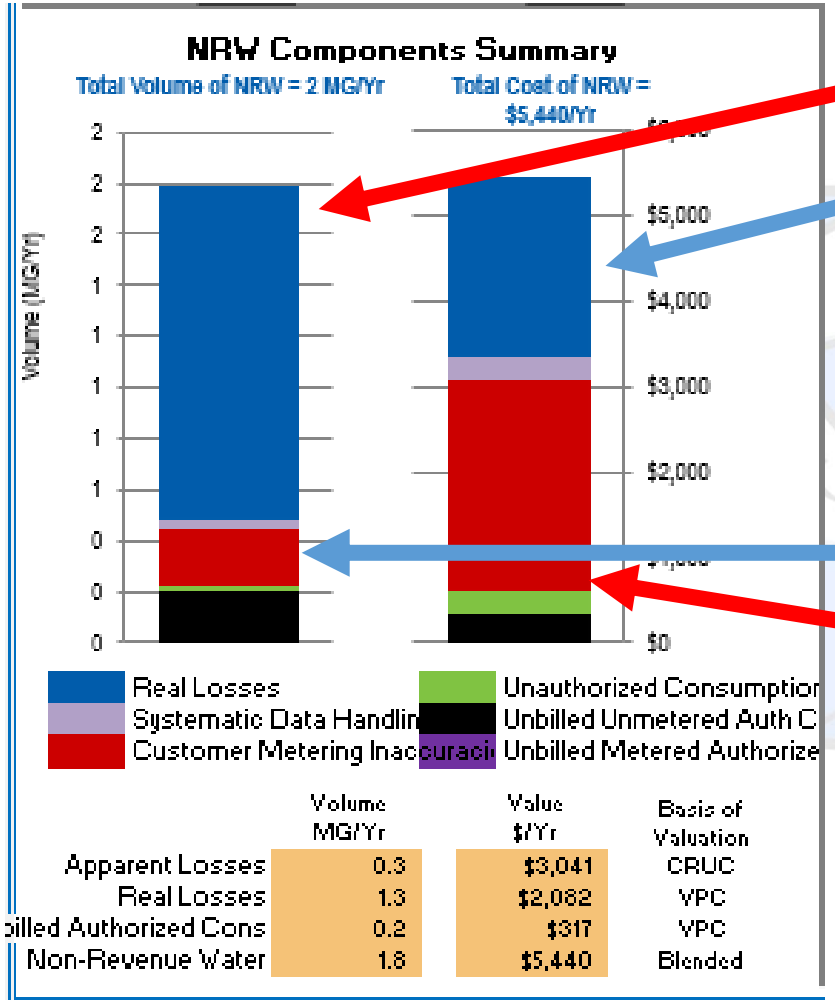


Table 1 Source: AWWA Water Loss Control Committee Report (2020)[1], with naming conventions updated

2020 AWWA Water Audit Method – Water Audit Outputs and Key Performance Indicators: Uses and Limitations

Non-revenue Water Volume v Cost



	Volume MG/Yr	Value $/Yr	Basis of Valuation
Apparent Losses	0.3	$3,041	CRUC
Real Losses	1.3	$2,082	VPC
billed Authorized Cons	0.2	$317	VPC
Non-Revenue Water	1.8	$5,440	Blended

- Real loss volume is large
- Real loss cost is low
- Real losses mean you make more water

- Apparent loss volume is low
- Apparent loss cost is high
- Apparent losses mean you sell less water

Controlling Apparent Losses

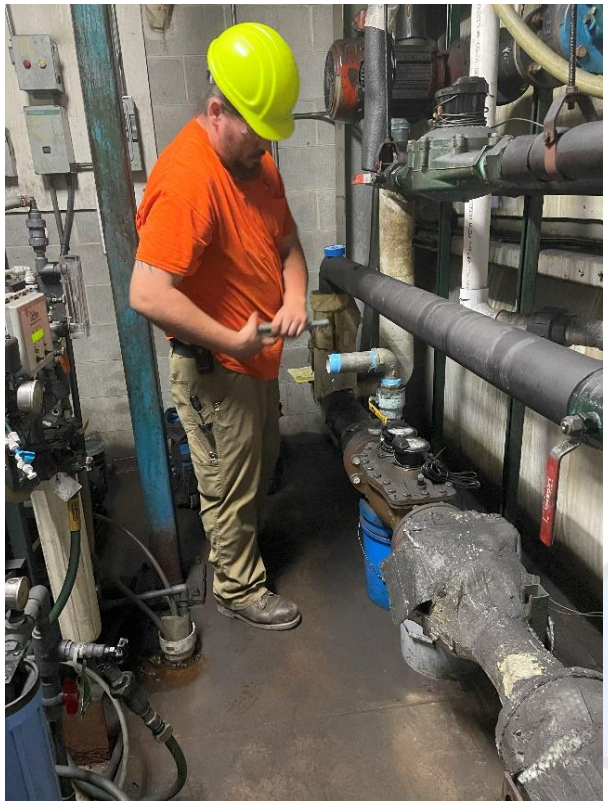
Often, easy to ID

It's in the data

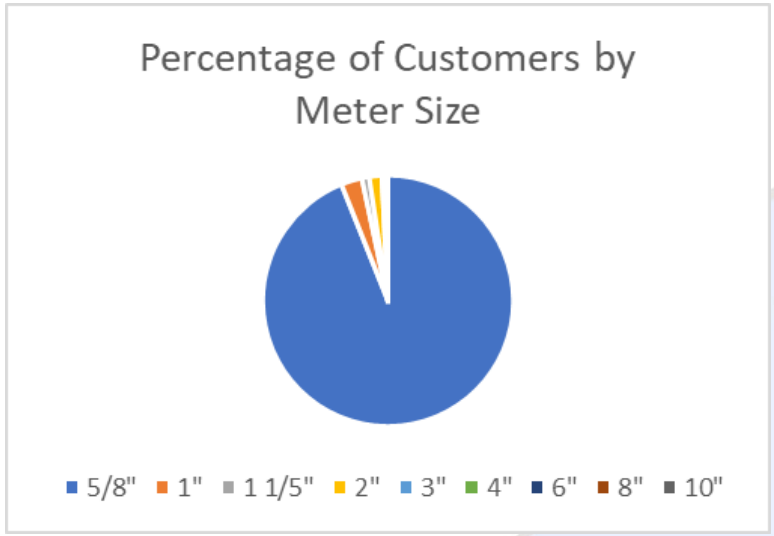
Hard to quantify

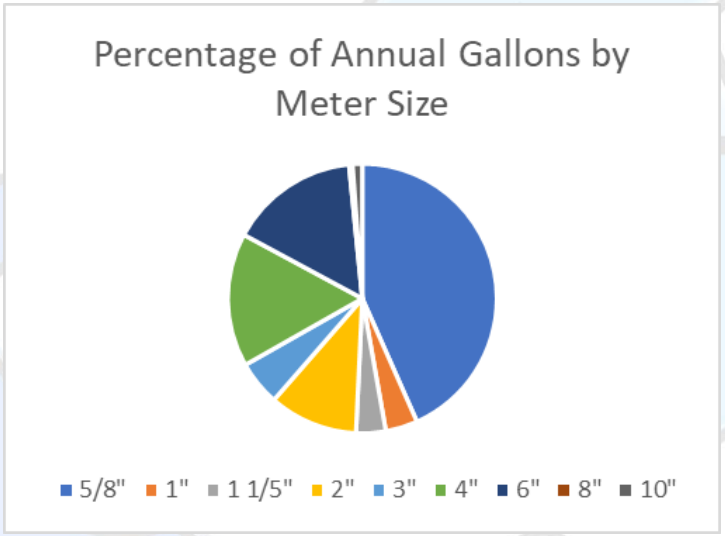
Some simple solutions

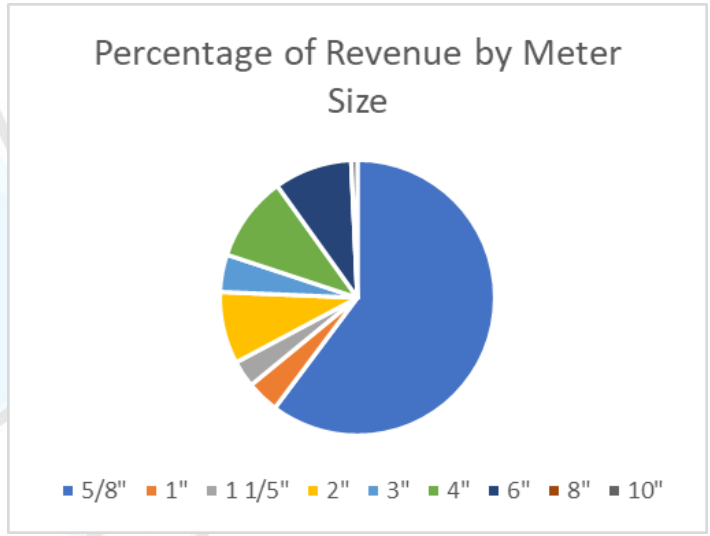
Apparent Losses
Large Meter Testing



Look at Customers, Consumption and Revenue by Meter Size







Values for Columbus City Utilities 2018

Water Consumption by Meter Size – Columbus 2018
Assume Large Meters Under Register by 1%

Water Consumption by Meter Size 2018							
Meter Size	Meter Count	Percentage	Annual Gallons	Percentage	Revenue	Percentage	Monthly avg (gal/meter/ month)
5/8"	16,144	94%	807,983,780	43%	$ 1,931,004.00	60%	4,171
1"	466	3%	71,756,430	4%	$ 122,831.14	4%	12,846
1 1/5"	164	1%	66,319,290	4%	$ 100,956.00	3%	33,699
2"	280	2%	199,088,430	11%	$ 270,814.88	8%	59,288
3"	65	0%	100,132,330	5%	$ 140,682.00	4%	127,557
4"	48	0%	298,722,200	16%	$ 321,190.00	10%	521,330
6"	18	0%	290,331,000	16%	$ 294,050.40	9%	1,344,125
8"	2	0%	7,937,000	0%	$ 1,187.23	0%	345,087
10"	1	0%	21,630,000	1%	$ 22,507.00	1%	1,802,500
Total	**17,187**	**100%**	**1,863,900,460**	**100%**	**$ 3,205,222.65**	**100%**	9,037

- 69 meters 4-inch and larger
- Account for 33% of consumption and 20% of revenue
- 1% of 618 BG = 6.18 MG * $2.19 / kgal = $13,500 in lost water revenue

Customer Retail Unit Charge (CRUC) = $2.19 / kgal

Sewer Consumption by Customer Class – Columbus 2018
Assume Large Meters Under Register by 1%

Sewer Consumption by Meter Size 2018						
Meter Size	**Customers**	**Percentage**	**Annual Gallons**	**Percentage**	**Revenue**	**Percentage**
Apartment	969	4%	215,133,080	13%	$ 1,242,060.00	13%
Commercial	6,221	27%	195,748,620	12%	$ 1,182,290.00	12%
Governmental	56	0%	26,606,660	2%	$ 134,750.00	1%
Industrial	97	0%	413,897,119	25%	$ 1,502,181.00	15%
Institutional	153	1%	79,538,000	5%	$ 394,587.00	4%
Residential	15,552	67%	752,085,680	45%	$ 5,411,279.00	55%
Total	**23,049**	**100%**	**1,683,009,159**	**100%**	**$ 9,867,147.00**	**100%**

$5.86 / kgal
approximated rate

- Assume lost water from previous slide
- 6.18 MG sewer billing * $5.86 / kgal = $36,200 in lost sewer revenue

Water Consumption by Meter Size – Columbus 2018
Assume Residential Meters Under Register by 1%

Water Consumption by Meter Size 2018							
Meter Size	Meter Count	Percentage	Annual Gallons	Percentage	Revenue	Percentage	Monthly avg (gal/meter/ month)
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Total	**17,187**	**100%**	**1,863,900,460**	**100%**	**$ 3,205,222.65**	**100%**	9,037

- 16,144 meters 5/8th-inch
- Account for 43% of consumption and 60% of revenue
- 1% off = 8.07 million gallons * $2.19 / kgal = $17,700 in lost water revenue

Customer Retail Unit Charge (CRUC) = $2.19 / kgal

Sewer Consumption by Customer Class – Columbus 2018
Assume Residential Meters Under Register by 1%

Sewer Consumption by Meter Size 2018						
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Residential	15,552	67%	752,085,680	45%	$ 5,411,279.00	55%
Total	**23,049**	**100%**	**1,683,009,159**	**100%**	**$ 9,867,147.00**	**100%**

$5.86 / kgal approximated rate

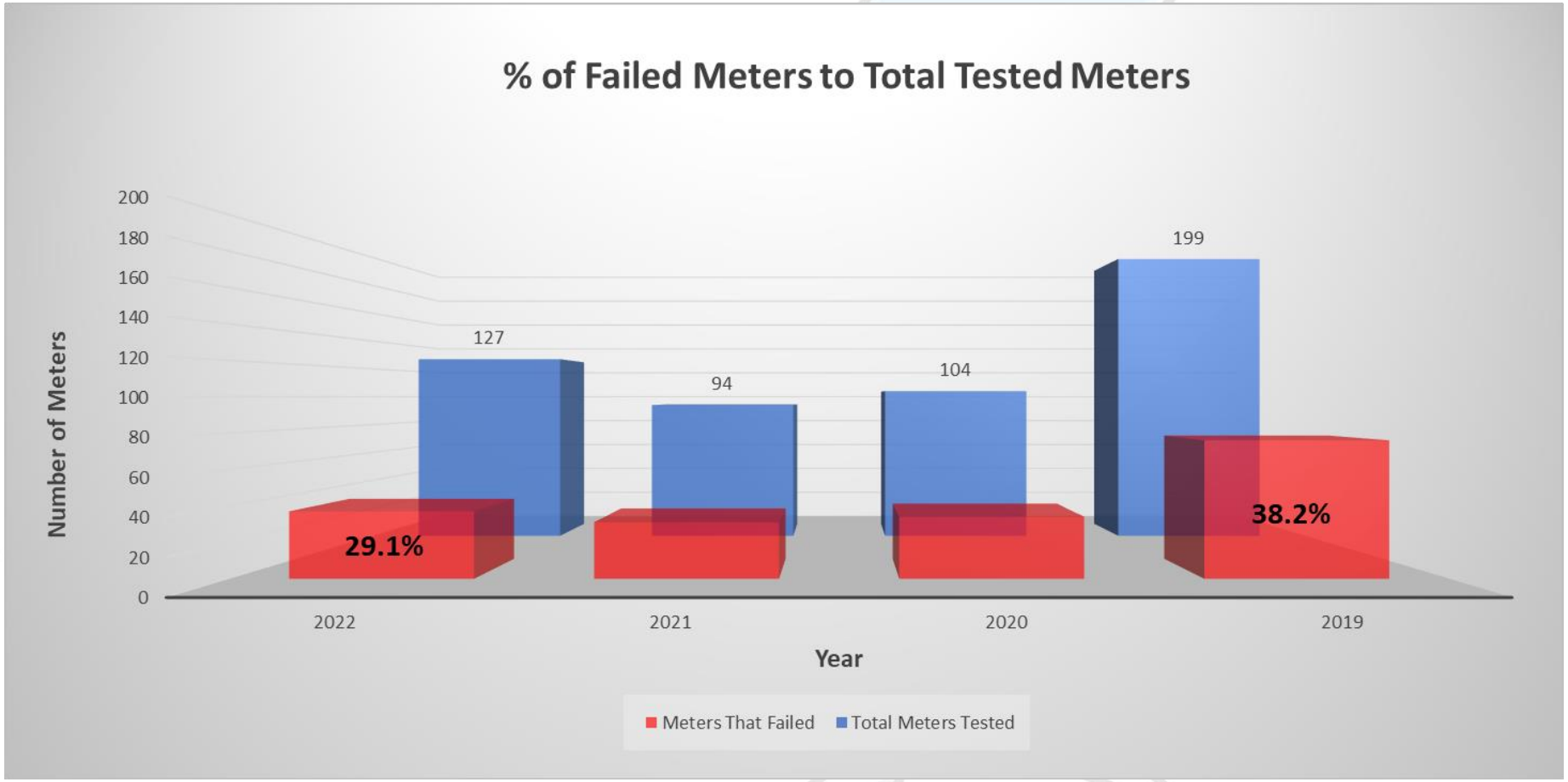
- Assume 1% meter under registration to sewer volume
- 7.52 MG * $5.86 / kgal = $44,000 in lost sewer revenue

Residential Meter Under Registration on a Small System

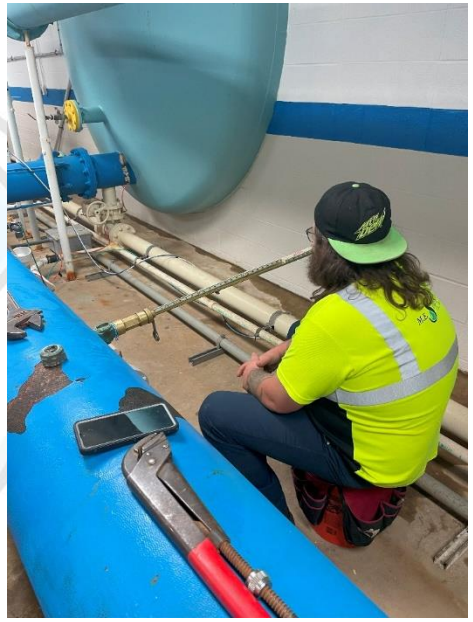
WATER LOSSES				1.590	MG/Yr	
Apparent Losses						
Default option selected for Systematic Data Handling Errors, with automatic data grading of 3						choose entry option:
Systematic Data Handling Errors:	n	g	3	0.027	MG/Yr	0.25% default
Customer Metering Inaccuracies:	n	g	2	0.223	MG/Yr	2.00% percent
Unauthorized Consumption:	n	g	3	0.027	MG/Yr	0.25% default
Default option selected for Unauthorized Consumption, with automatic data grading of 3						
Apparent Losses:				0.277	MG/Yr	

- In this example, client initially used 0% customer metering inaccuracies
- Using 2% under registration of customer metering accounts for 80% of apparent losses
- Customer Retail Unit Charge = $10.90 / kgal
- 223 kgal / yr * $10.90 / kgal = $2,430 in potential lost revenue

Residential Meter Failures Example
Estimated Average Meter Age 15 ~ 18 years



Water Loss Control – Plant Meter Calibration



Plant Meter Testing – Apparent Losses Assume 1% Under Registration

In this case, you are not producing as much as you thought.

Volume from Own Sources (VOS) = 2,876* MG

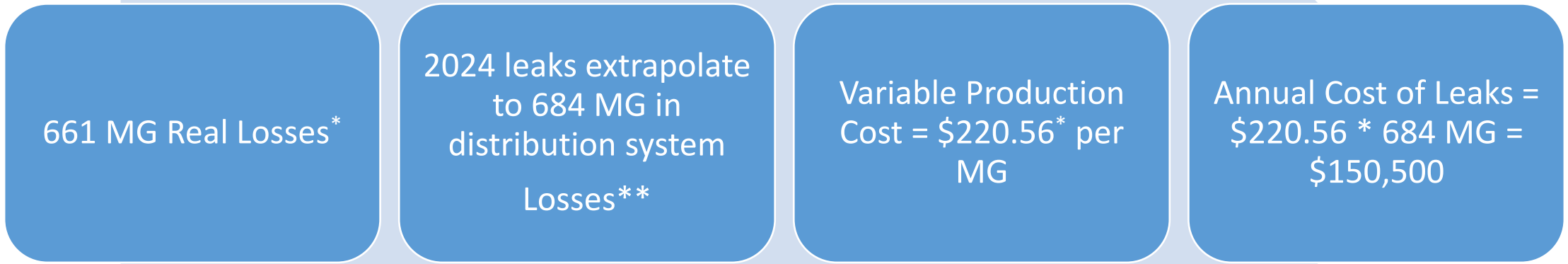
Under Registration 1% of 2,876 MG = 28.76 MG

Total Apparent Losses = 69.30* MG

If Plant Meter Under Registers by 1%, It Accounts for 42% of Apparent Losses

Values for Columbus City Utilities taken from IFA 2022 Water Loss Report

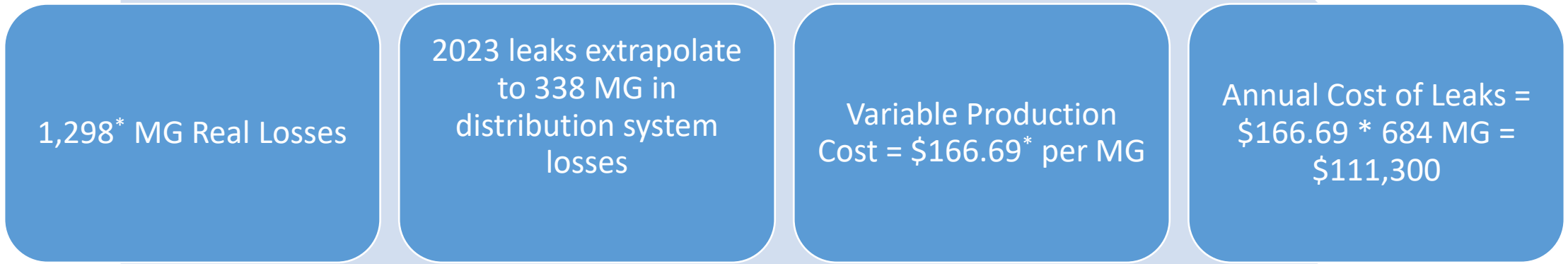
Distribution System – Real Losses



*Values for Columbus City Utilities taken from IFA 2022 Water Loss Report

** 2024 MES leak survey found 7 leaks on 13% of system estimated at 28.5 MG / yr losses

Distribution System – Real Losses



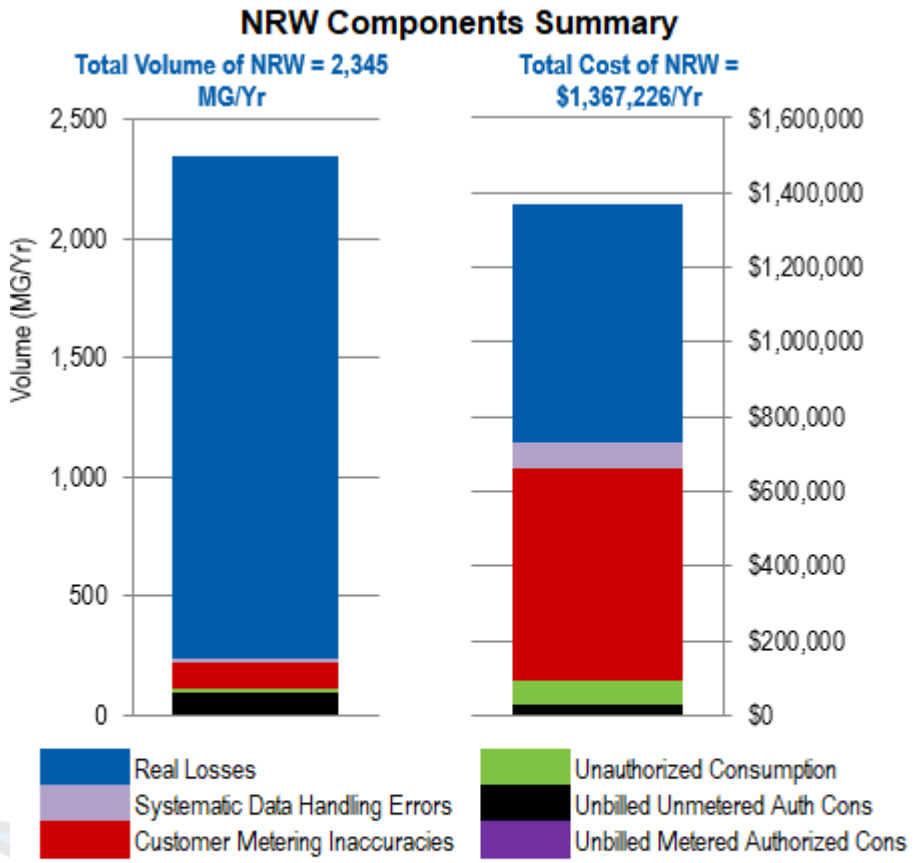
*Values for South Bend Water taken from IFA 2022 Water Loss Report

** 2023 MES leak survey found 132 leaks on 73% of system estimated at 247 MG / yr losses

Developing Water Loss Mitigation Plans

What do we tackle first?

Look at NRW for What Can be Recovered

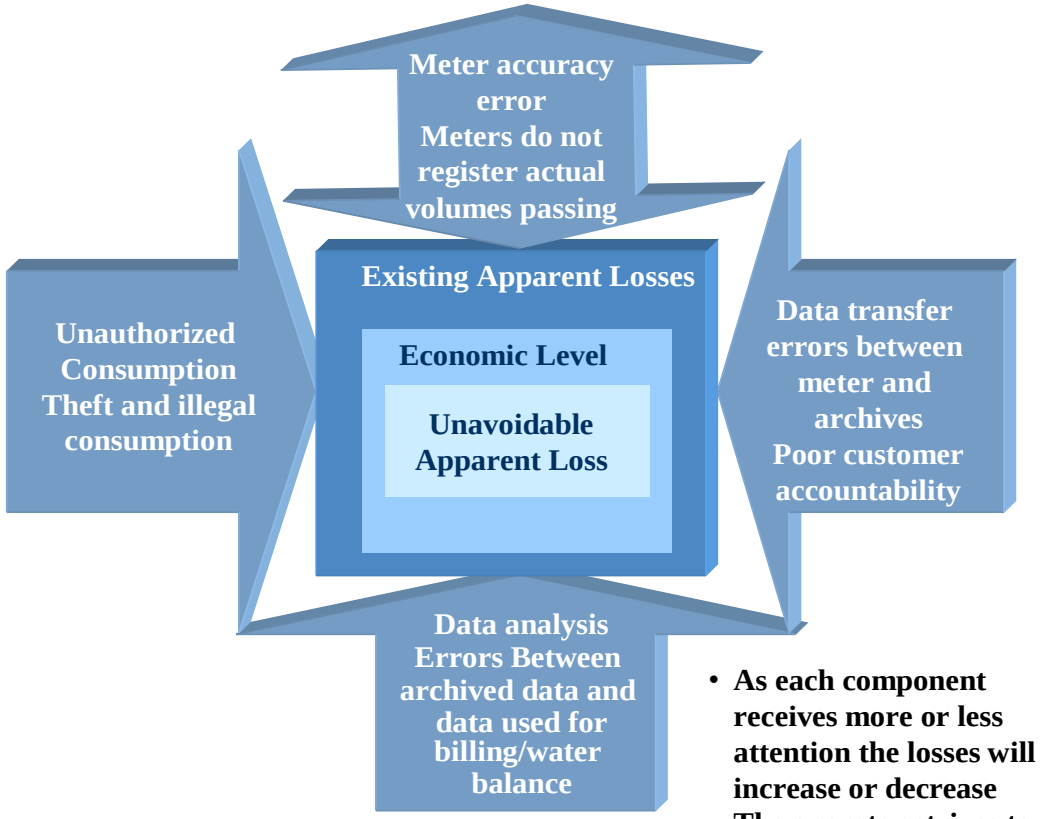


	Volume MG/Yr	Value $/Yr	Basis of Valuation
Apparent Losses	142.1	$702,205	CRUC
Real Losses	2,108.1	$636,122	VPC
Unbilled Authorized Cons	94.4	$28,479	VPC
Non-Revenue Water	2,344.5	$1,366,806	Blended

What $$'s are recoverable?

Apparent Losses	142.1	$702,205
Real Losses	2,108.1	$636,122

“4 Pillars” of Apparent Loss Management



- **As each component receives more or less attention the losses will increase or decrease**
- **The operator strives to keep losses to a minimum**

NRW Management Team:

- ✓ Billing
- ✓ Meter Reading
- ✓ Customer Services
- ✓ Revenue Water
- ✓ Field Services
- ✓ System Development
- ✓ IT

Unauthorized Use and Solution

- Problem: Landscaper with tanker truck hooked to hydrant
- Solution: Water ATM at WD. Strict policy on hydrant meters.
- Problem: Unmetered Fire lines for businesses
- Solution: Meter all fire lines with appropriate meter
- Problem: Unmetered use on fire lines (flushing)
- Solution: Install correct meter
- Problem: Unmetered lines
- Solution: look for “Sewer only” or “Trash only” accounts, meter all uses. Period!
- Problem: “mail in” meter reads (usually with indoor sets)
- Solution: AMI/AMR

** Usually… this area of water use is small.

Unauthorized Uses

- Illegal hydrant use
- Inspection after service termination
- ID meter tampering
- Open bypass lines on big meters
- System interconnects
- Summer only meters

Controlling Meter Inaccuracies

- Meter testing
- Meter sizing using plumbing code for demand and manufacturing data for max and min flow
- Meter change outs

Meter = Cash register

3" OMNI C²

$$ Cha - Ching!! $$

Commercial and Industrial Meters – Test, repair and replace obsolete meters

10% to 15%
of users

50% to 60%
of usage

Large Meter Testing Requirements

- Isolation valves that work
- Bypass line w/ working valve
- Test port
- Beware ultrasonics w/o test port – add spool piece w/ test port

Meter Testing Frequency Rules of Thumb – Monthly Revenue v Testing Frequency

$3,000 / month	$1,500 / month	$750 to $1,500 / month	$375 to $750 / month
• Every 6 months	• Every year	• Every 2 years	• Every 3 years

Meter Sizing

AWWA M6

Pipe size always > meter size

Fixture unit counts

Manufacturer guidelines

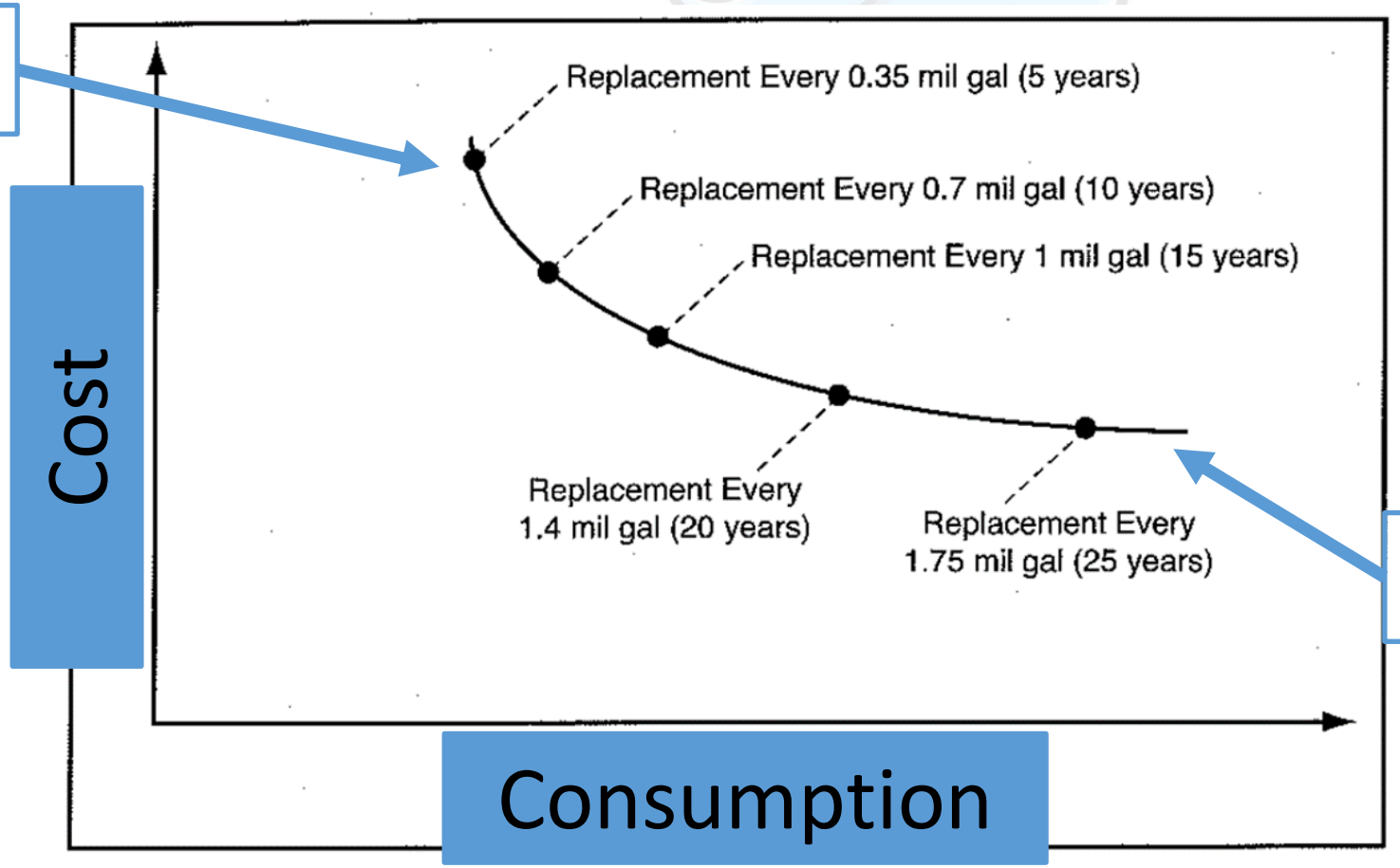
Low flow and high flow characteristics

Meter Change Outs

- Develop a business case
- Annual replacements, new installations
- AMI and AMR fit to your operations and budget

Meter Change Outs

More Cost



More Lost

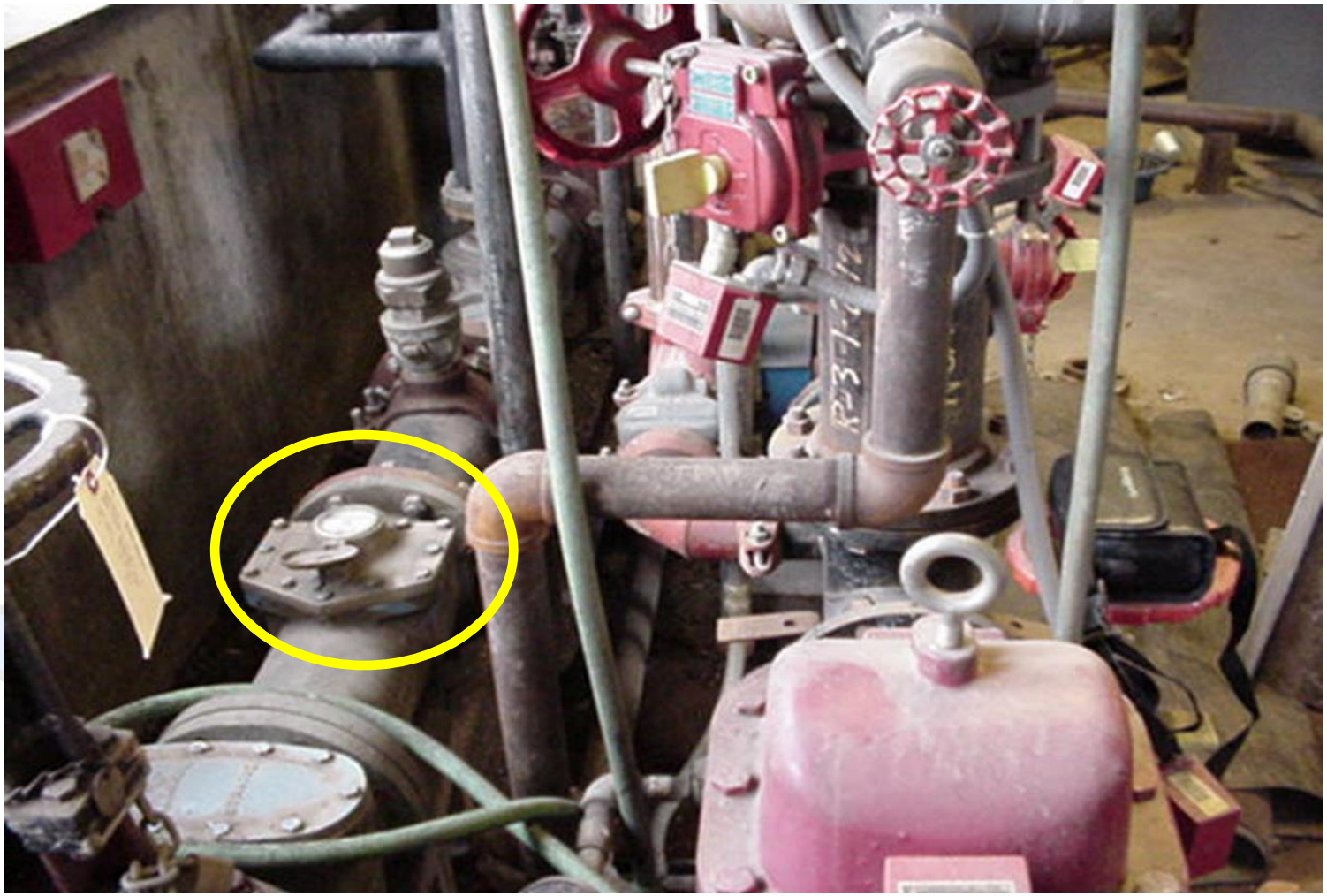
Figure 5-21 Cost curve for meter replacement program

Source: *AwwaRF 2007*

Data Handling Errors

- Wrong # of fixed zeros
- Incorrect initial programming
- Detector check meters not being billed
- Sewer or trash only accounts
- Minimum bill accounts

Reason for AMI / AMR



Controlling Apparent Losses

Meters

- Sized right, set right
- Data transfer
- Correct readings

Customer Info Systems

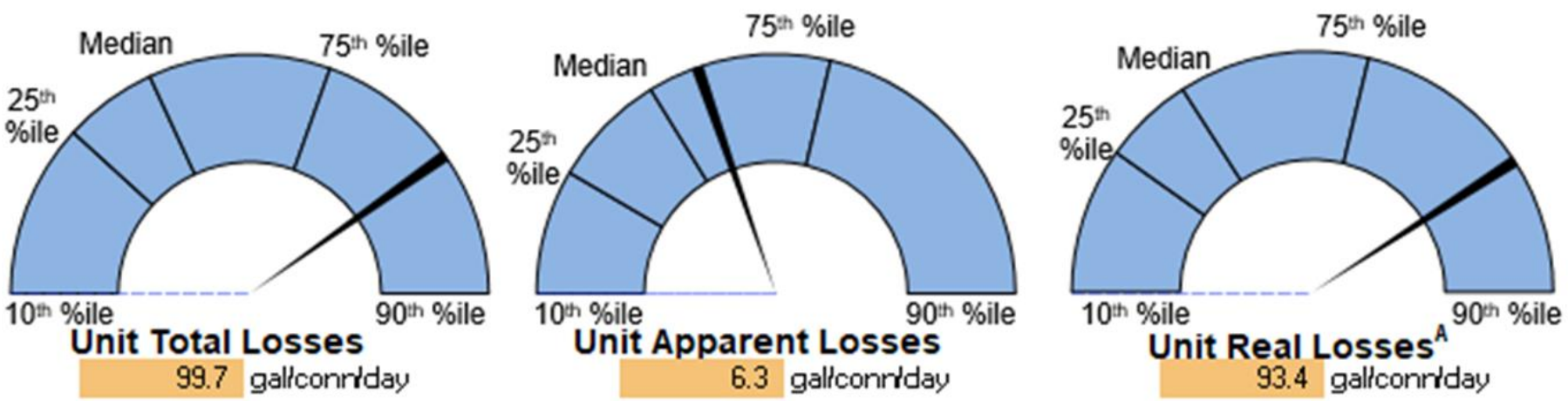
- Software
- Analytics
- Look for anomalies

Policies

- Meter all connections
- Unauthorized consumption
- Billing procedures
- Use of hydrants

Controlling Real Losses

How Did the System Do?

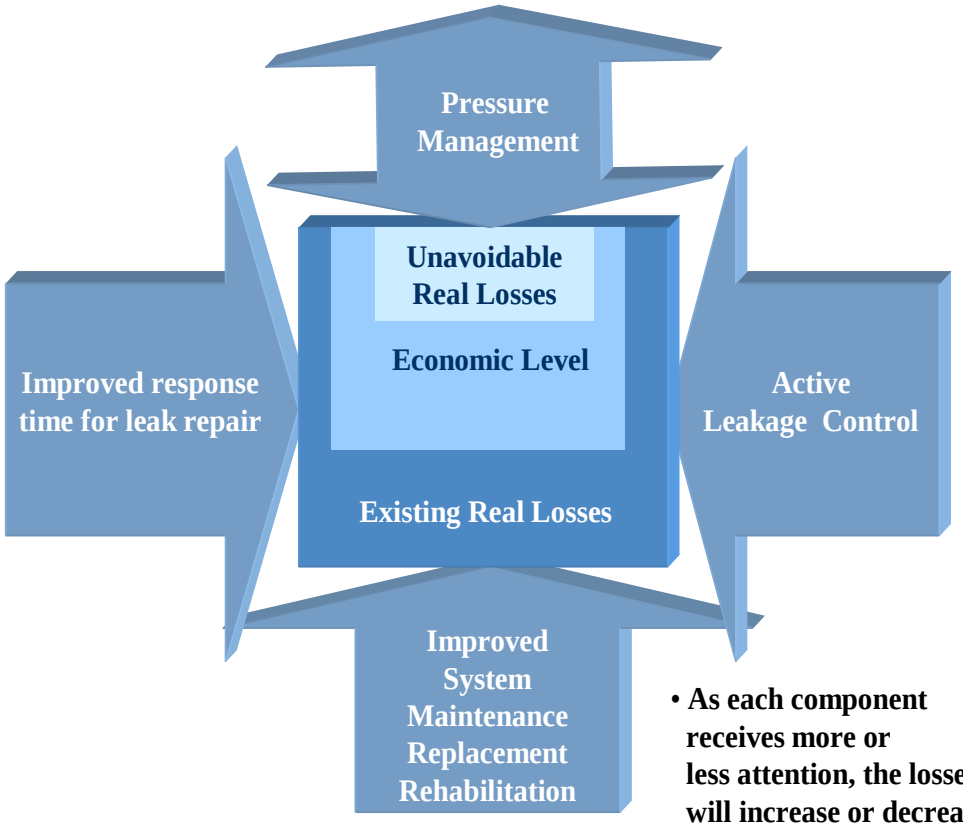


Total Losses

Apparent Losses

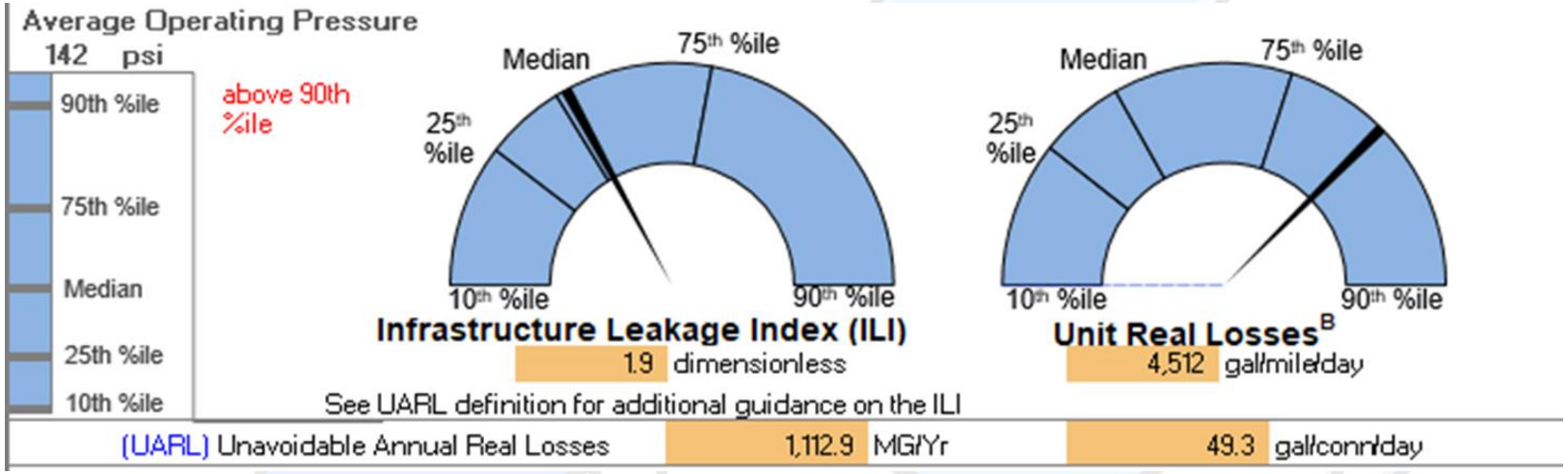
Real Losses

Four Pillars of Real Loss Management



- As each component receives more or less attention, the losses will increase or decrease
- The operator strives to keep losses to a minimum

How Did the System Do?

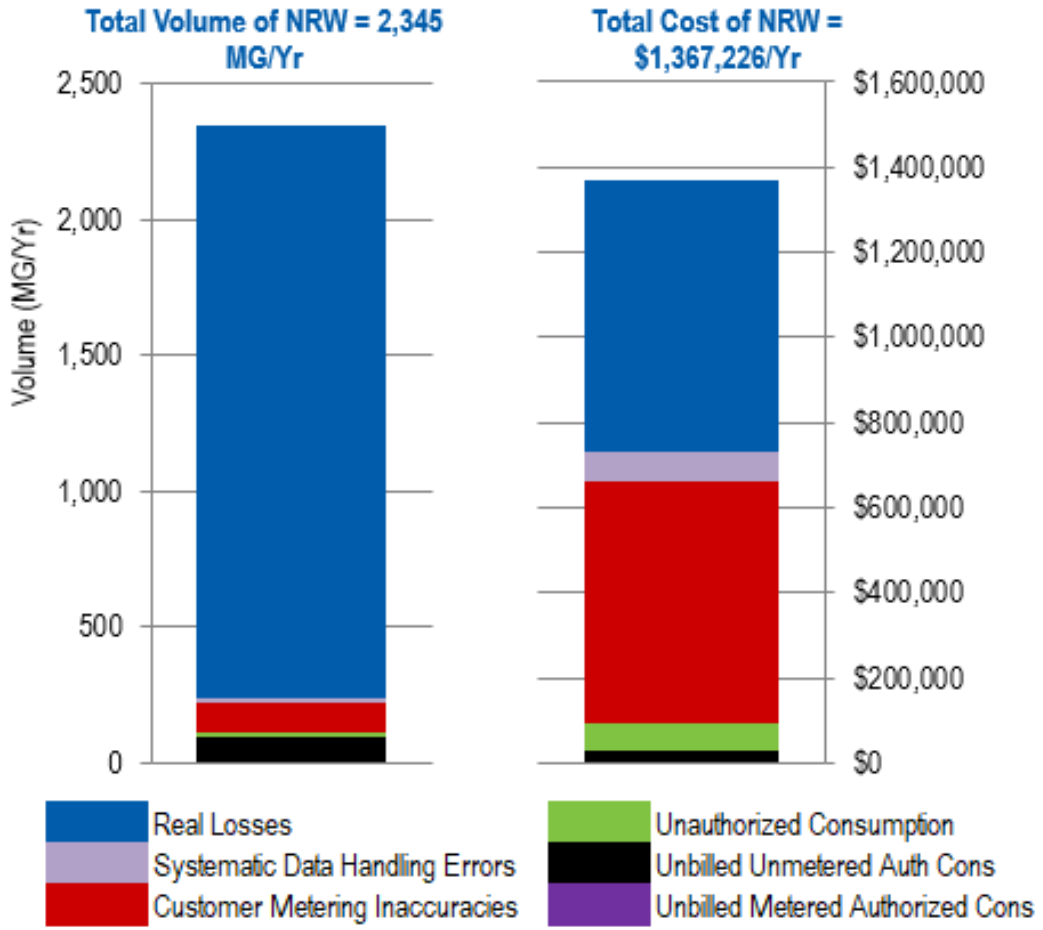


Avg pressure – Higher = more real loss

Infrastructure Leak Index (ILI)

Unavoidable Annual Real Losses (UARL)

NRW Components Summary



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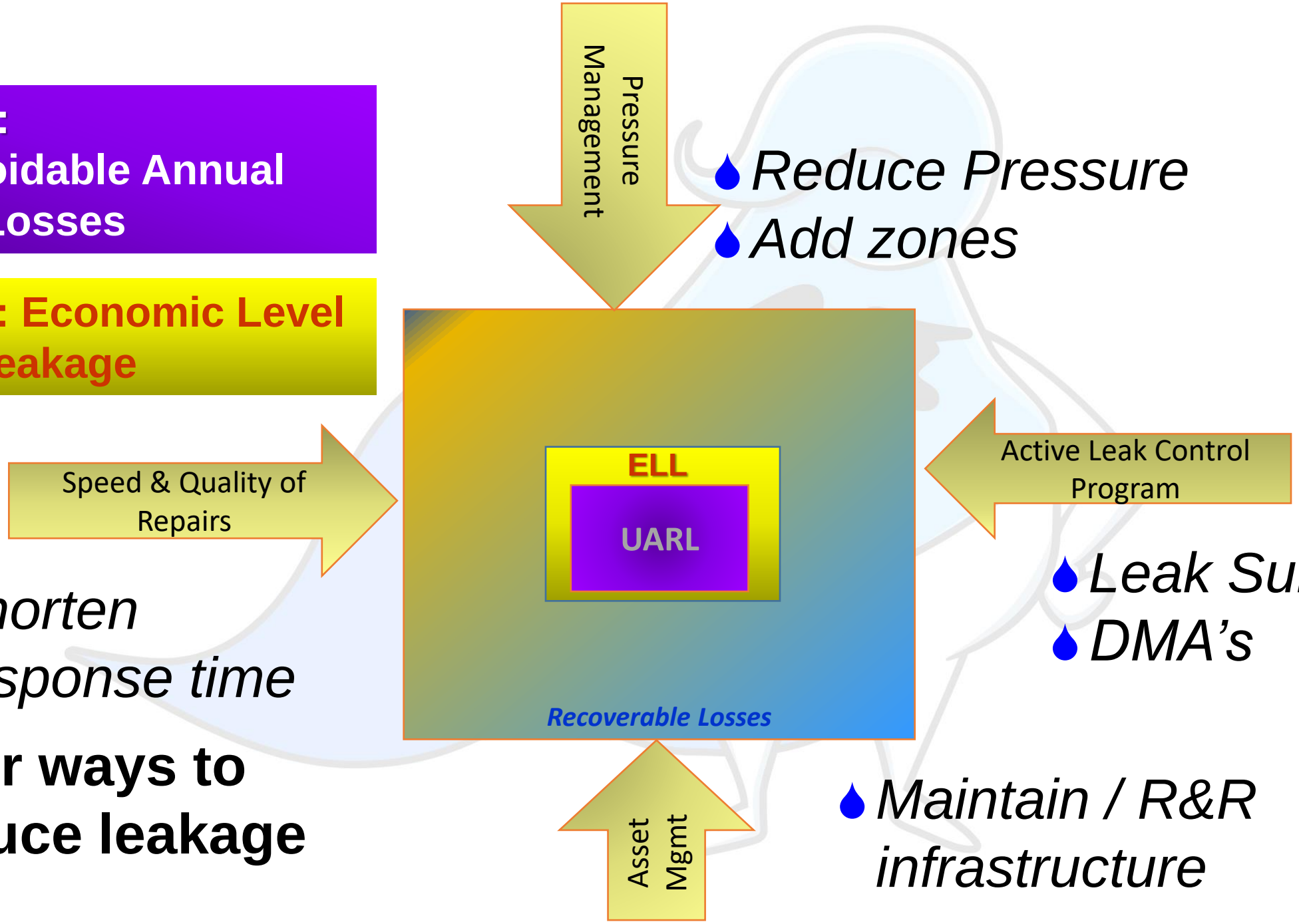
UARL:
Unavoidable Annual Real Losses

ELL: Economic Level of Leakage



- *Reduce Pressure*
- *Add zones*

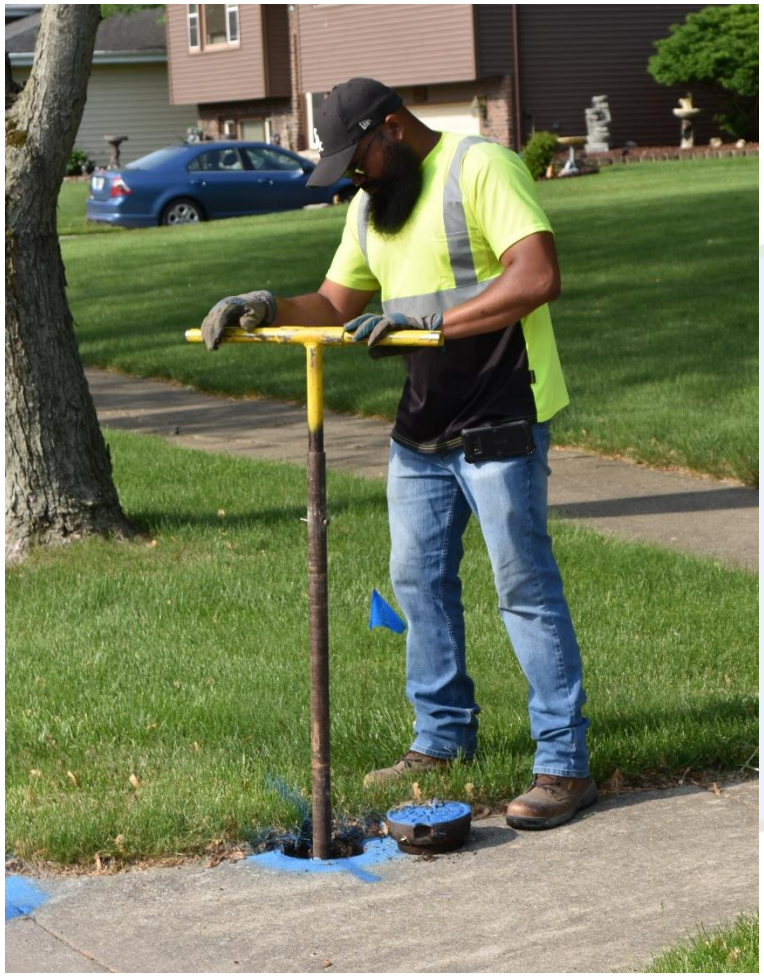
- *Shorten response time*

- *Leak Surveys*
- *DMA's*

- *Maintain / R&R infrastructure*

Four ways to reduce leakage

Asset Management



- Hydrant Maintenance for ISO Compliance
  - Annual inspections for highest ISO score
- Hydrant Flow Testing (watermain capacity testing)
  - Operate and flow all hydrants using AWWA M17 standards
  - 20% of hydrants flow tested every year for highest ISO score

Water Loss Control – Real Losses

- Water Distribution System Leak Survey
  - 75% of leaks found are hydrants
  - 25% are mains and services
  - Volumes vary with each system
- Transmission Main Leak Detection
  - Much more involved
  - Large main leak detection
  - Non-invasive and invasive techniques

Benefits of Controlling Non-revenue Water

More $

Lower Costs

Realistic Rates

Conservation

Reduce Expenses

Equitable Billing

Questions?