# OTCO 12/11/13

# Water Audits – Meter Testing & Leaks

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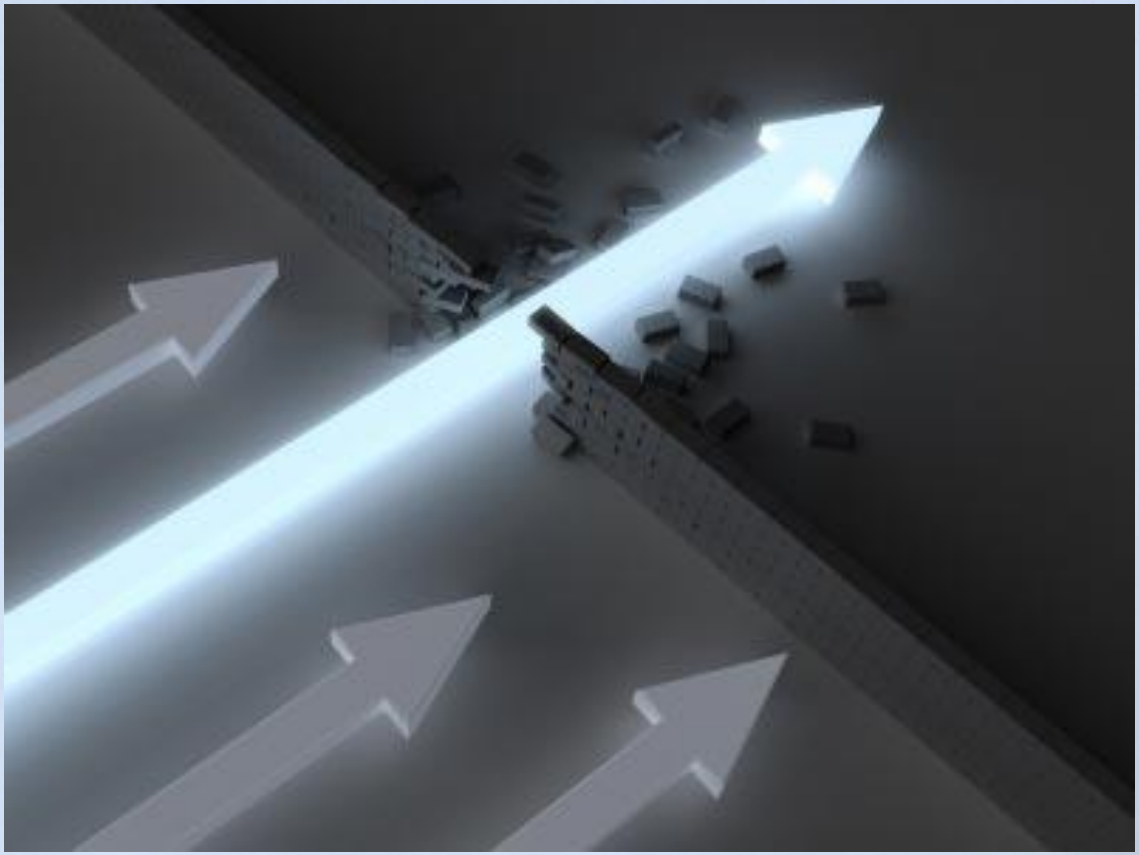
# What is a Water Audit?

# It’s like a Scouting before you hunt….

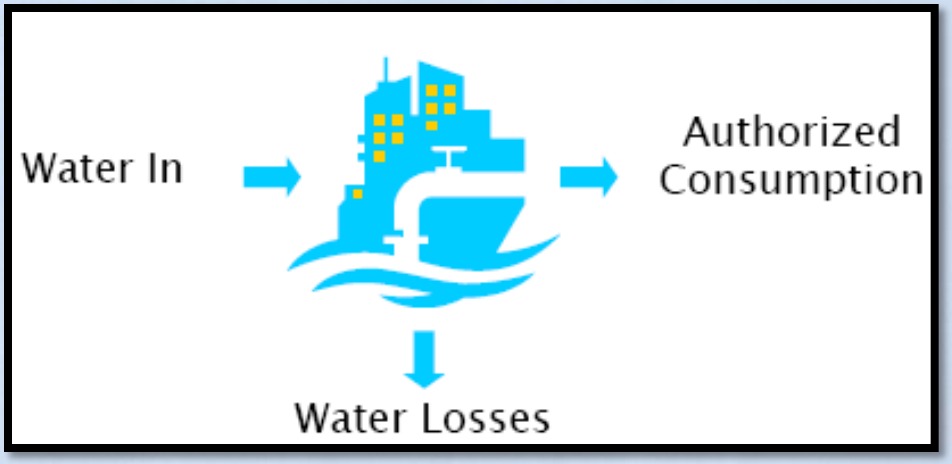

# Why is an Audit Important?

# It tells you where to focus your efforts.

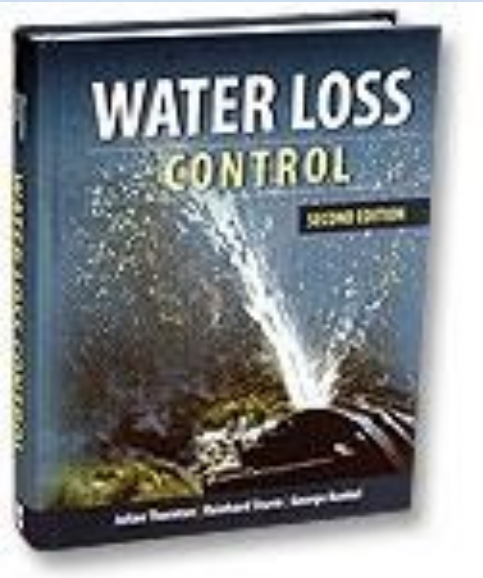


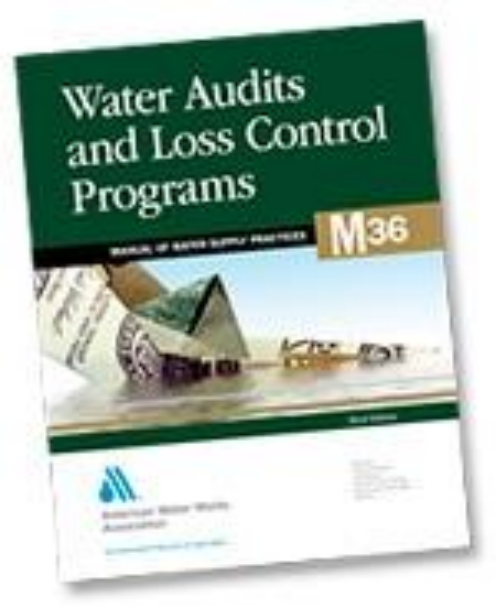
# Water Loss Control

- The difference in the water pumped versus water sold is basically termed “water loss”
- Is it not possible to have a “perfect system”
- Concept of “acceptable loss” levels
  - What is “acceptable”?
  - How do you control losses?



# Information to get started

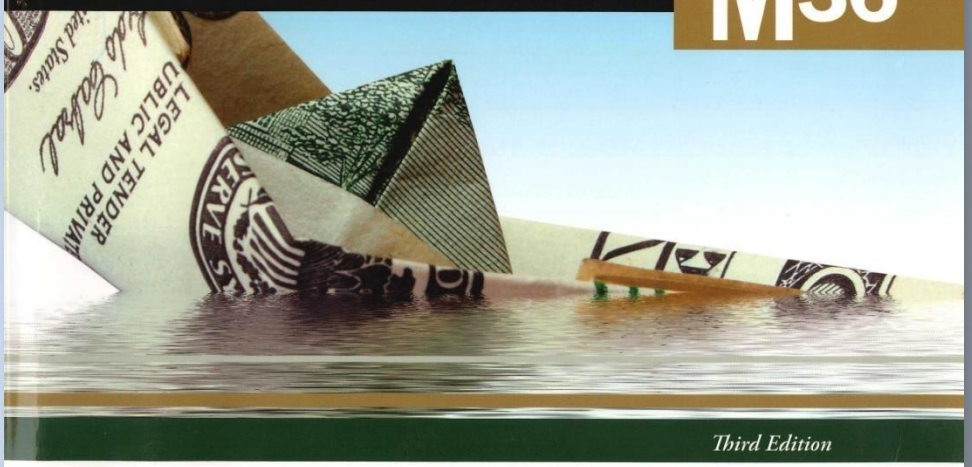



# Water Audits and Loss Control Programs

MANUAL OF WATER SUPPLY PRACTICES

M36



*Third Edition*

American Water Works Association

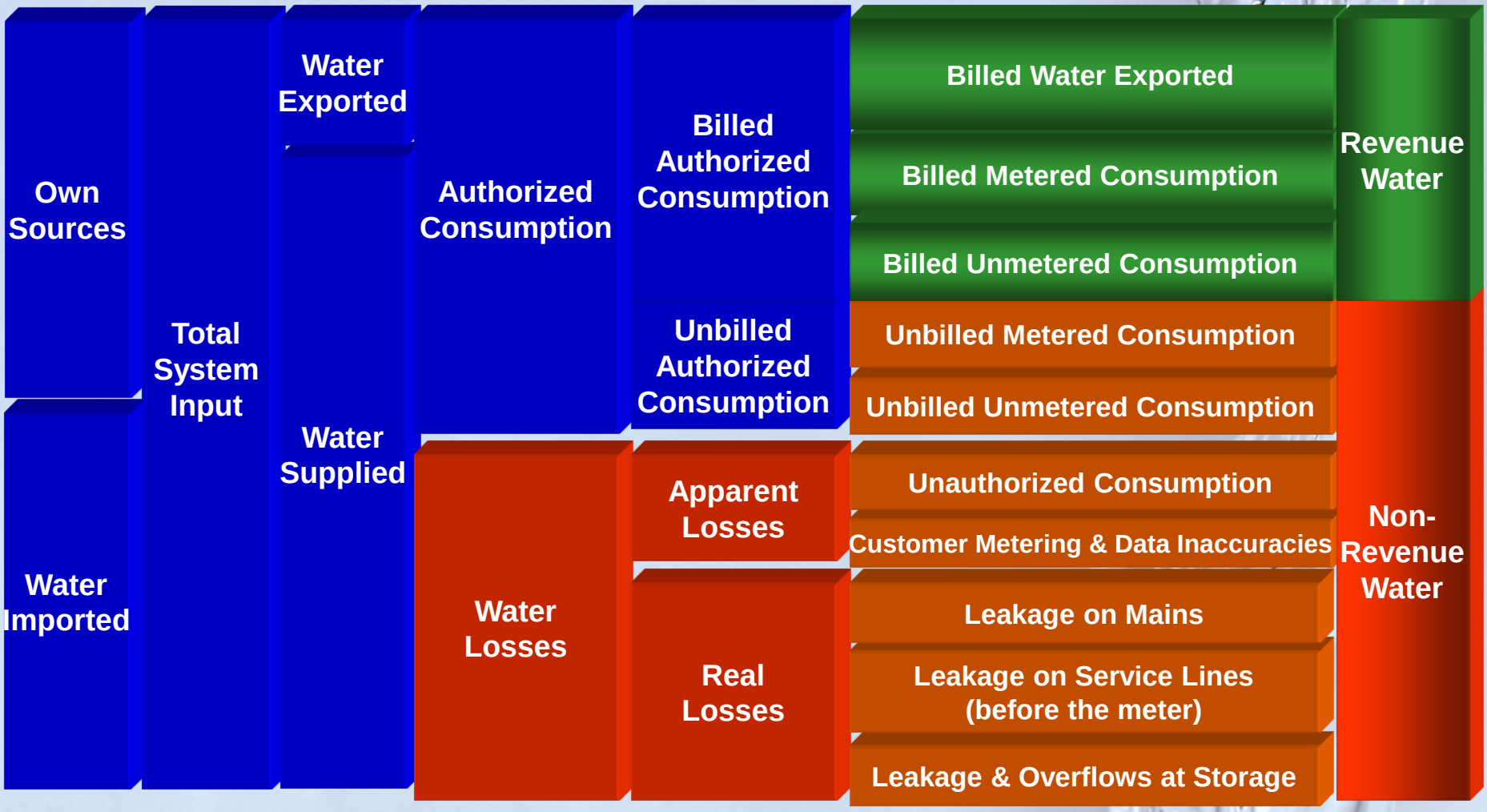
The Authoritative Resource on Safe Water®

*Advocacy*
*Communications*
*Conferences*
*Education and Training*
*Science and Technology*
*Sections*

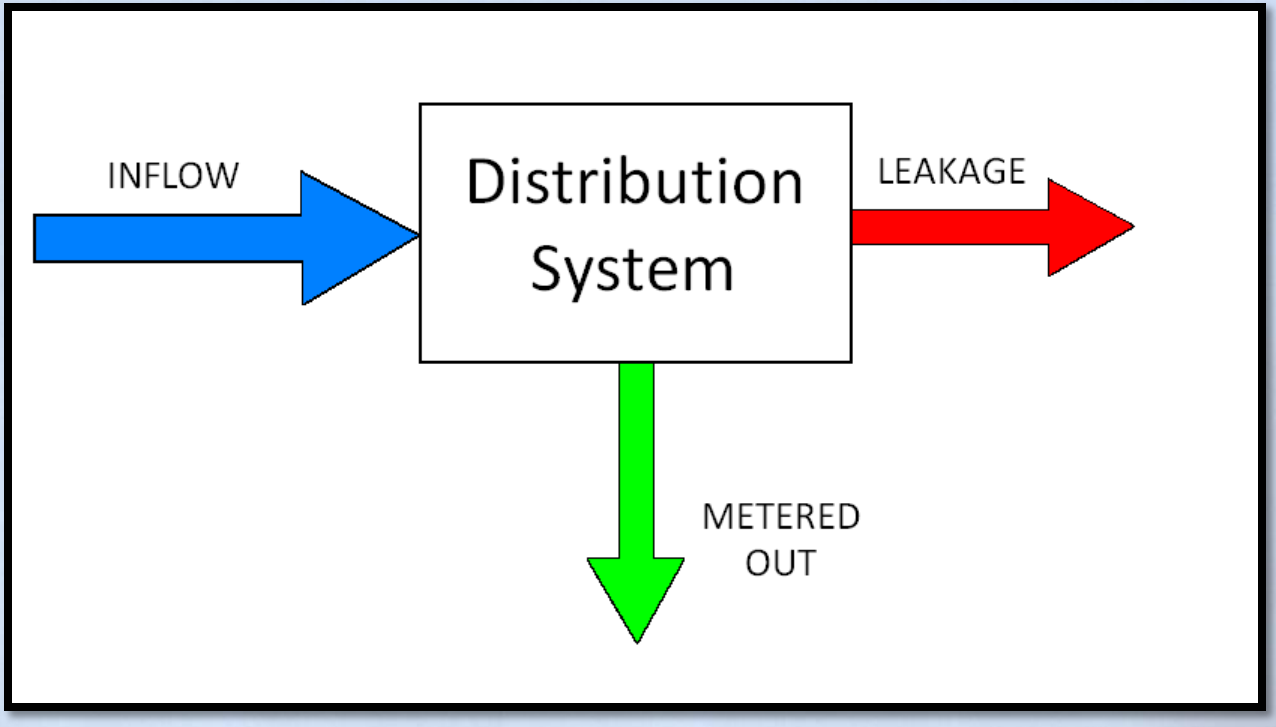
# What does M36, Third Edition provide?

- Clear steps to compile a water audit
- Rational terms, definitions and performance indicators that give water utilities objective ways to assess their water loss standing and reliably plan loss control activities
- Worksheets, sample calculations
- Structured guidance on planning the loss control program

# Standard Water Balance Format

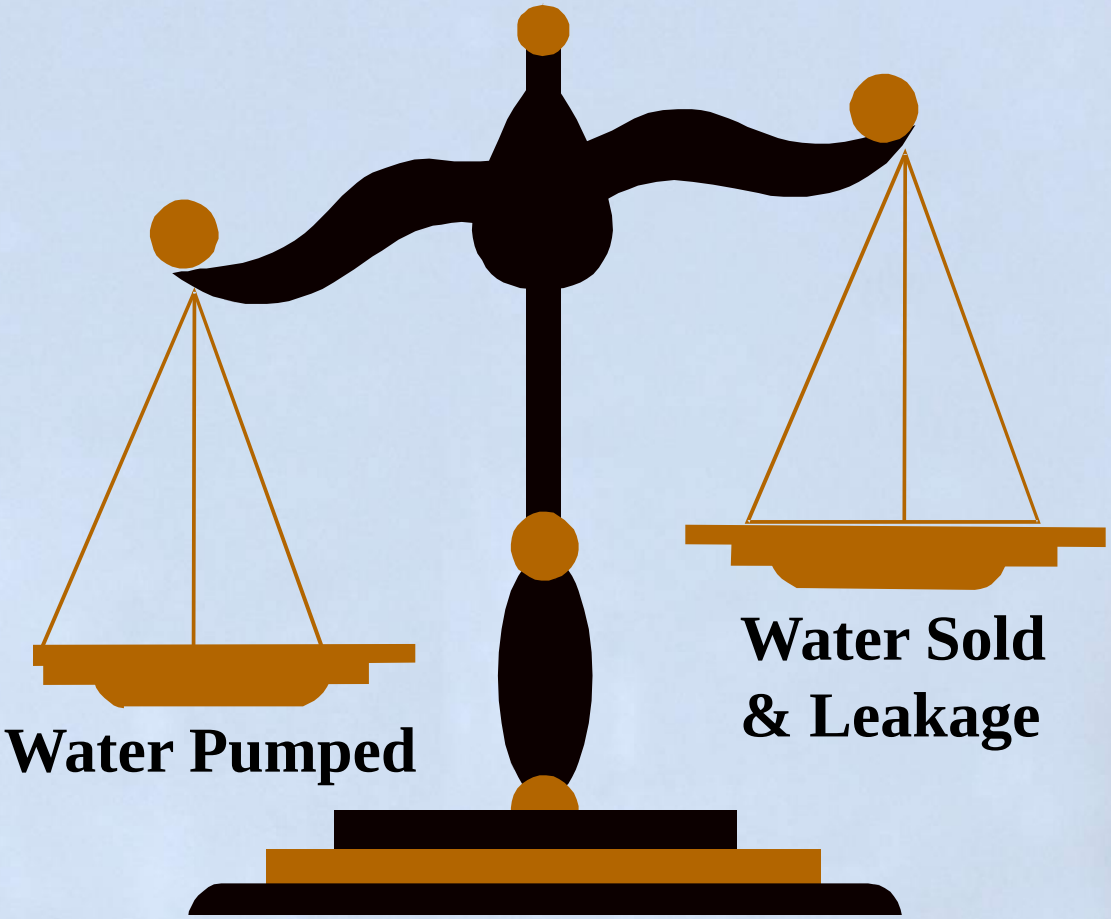


# “How much water are you really putting into the distribution system?”




***INFLOW = METERED OUT + LEAKAGE***

# It’s a Question of Balance

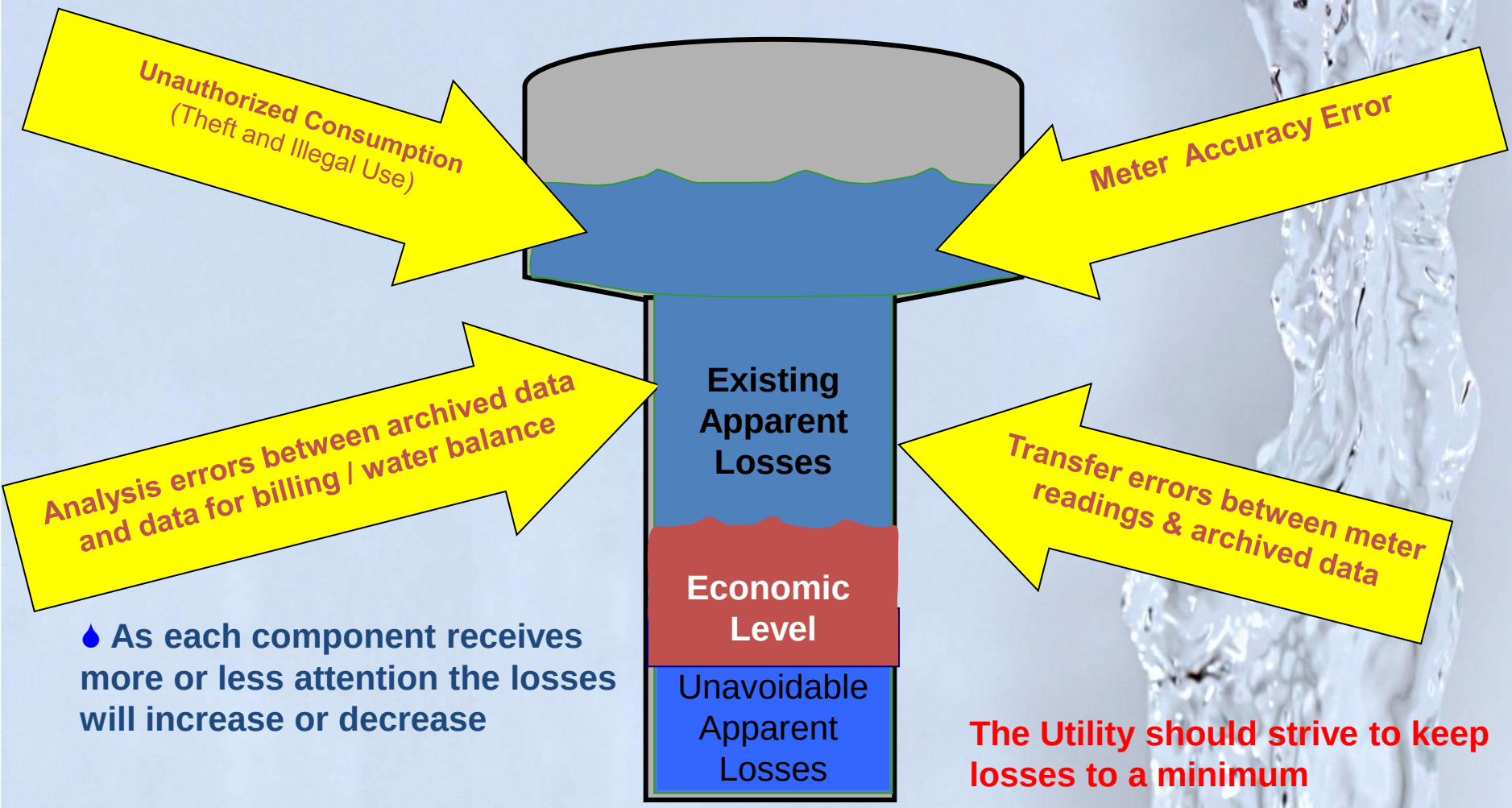


# Water systems are not designed to lose money!

- What is considered “acceptable loss” in a system? 10%, 15%, ???
- Why are these losses unacceptable?
- Law of diminishing returns…

**Water Loss = $$ Money Loss**

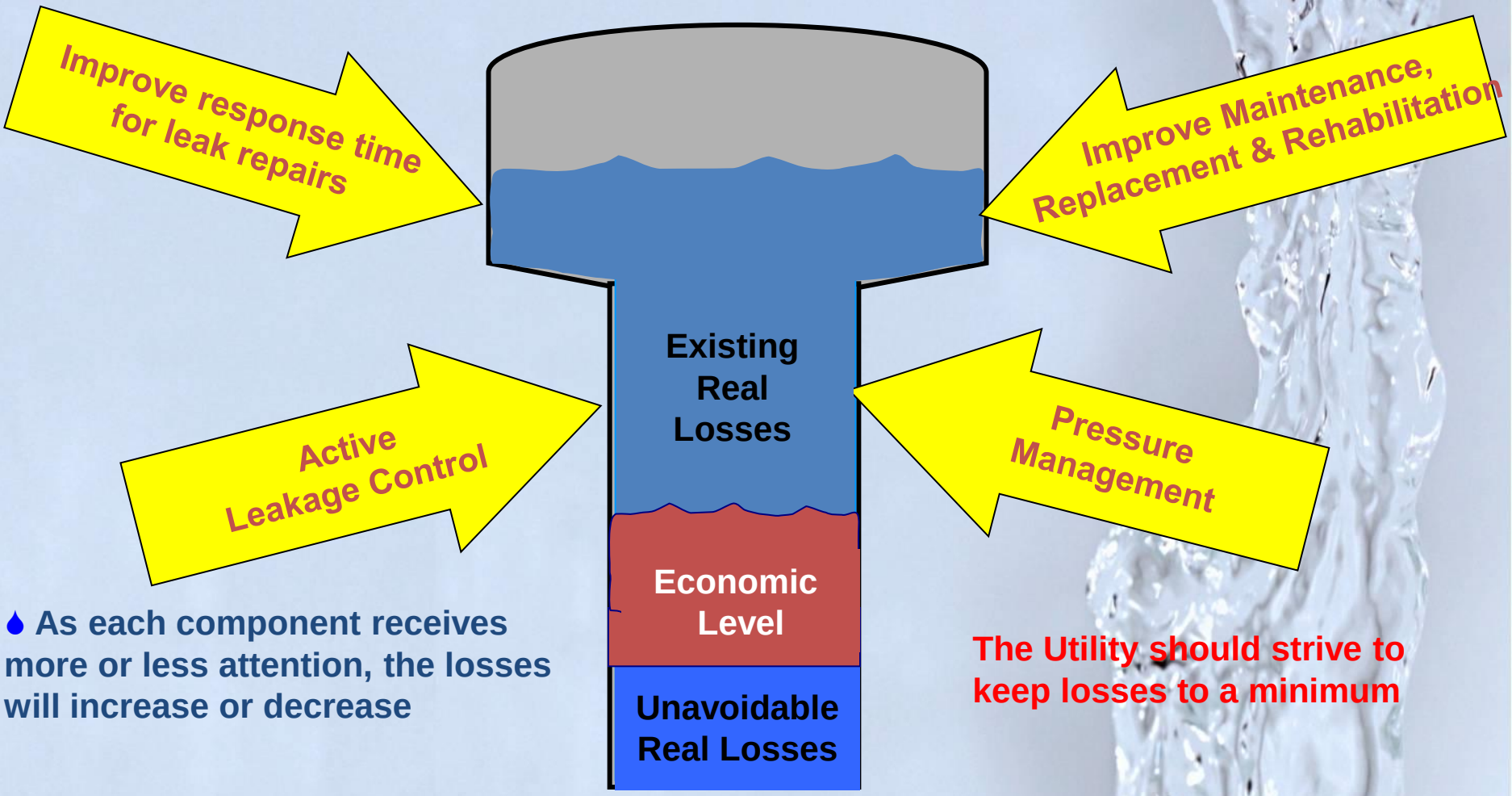
# Four Components of Managing Apparent Losses




- As each component receives more or less attention the losses will increase or decrease

**The Utility should strive to keep losses to a minimum**

# Four Components of Managing Real Losses



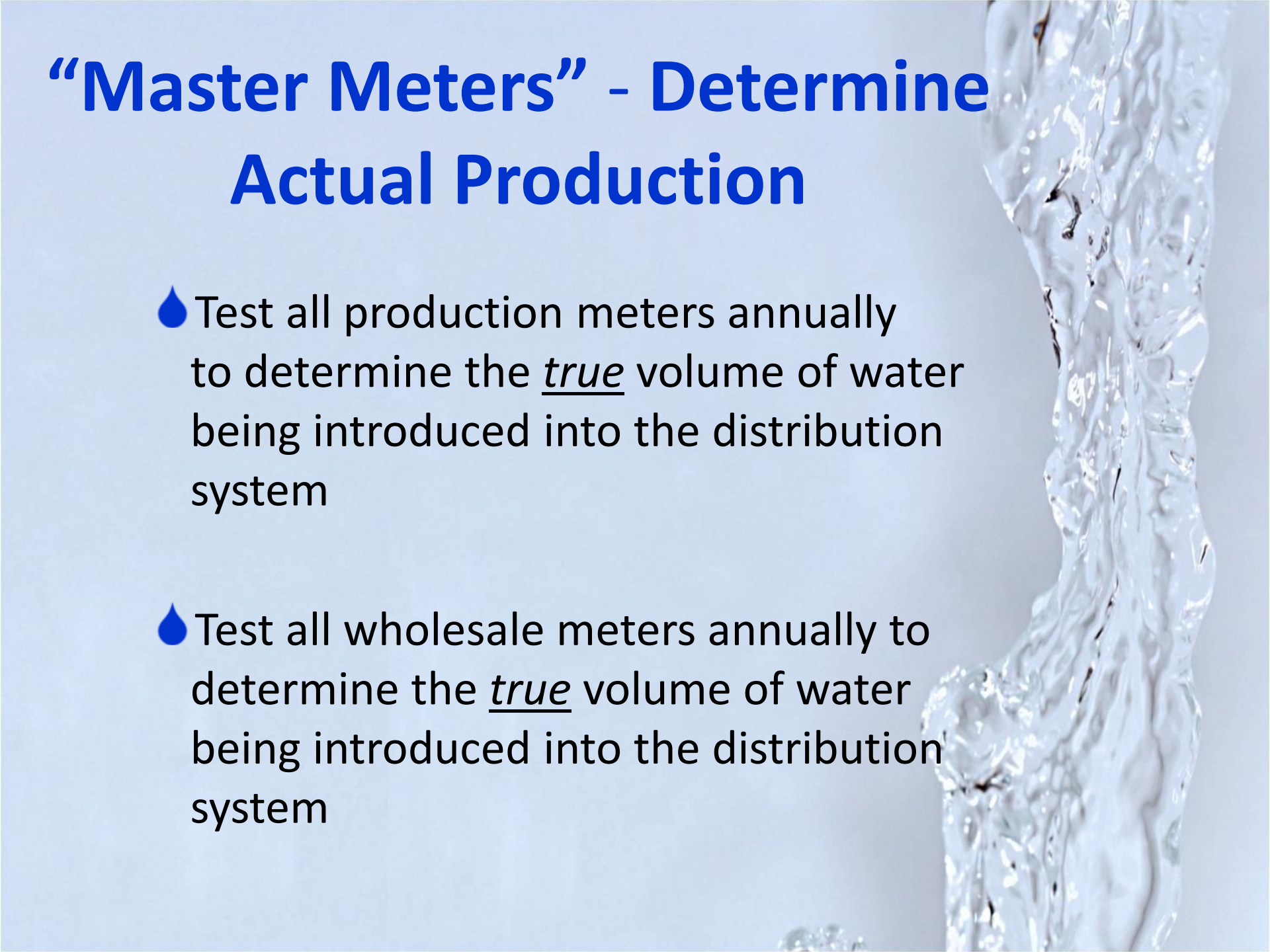

- As each component receives more or less attention, the losses will increase or decrease

**The Utility should strive to keep losses to a minimum**

# "Master Meters" - Determine Actual Production

- Test all production meters annually to determine the *true* volume of water being introduced into the distribution system

- Test all wholesale meters annually to determine the *true* volume of water being introduced into the distribution system



# Why are Large Water Meters so important?

- Used for **Billing** in custody transfers
- Used to determine **Chemical Feed Rates**
- Used to account for the **Total Volume** of Water introduced into a distribution system

***Large Meters Are a Vital Component in any Distribution System***

# Meter Types

- Venturi Meters
- Orifice Plate Meters
- Magnetic Flow meters
- Propeller Meters
- Turbine Meters
- Sonic Flow meters
- Vortex Flow meters
- Averaging Pitot meters

# Turbines


Test Taps for
comparative testing

## Production
## Venturi Meter


## Production
## Mag Meter

**Venturi Meters at High Service Pump Station**

**New Venturi Meter ready to be installed**

# Large Meters are Prone to Failure for a variety of reasons

- **Age**
- **Mechanical Wear and Tear**
- **Corrosion**
- **Mineral Buildup**
- **Fouling**, due to debris
- **Mis-Use,** or operation outside of the meters range
- **Inadequate Plumbing** before and/or after the meter

# What are the Consequences when these Meters Fail?

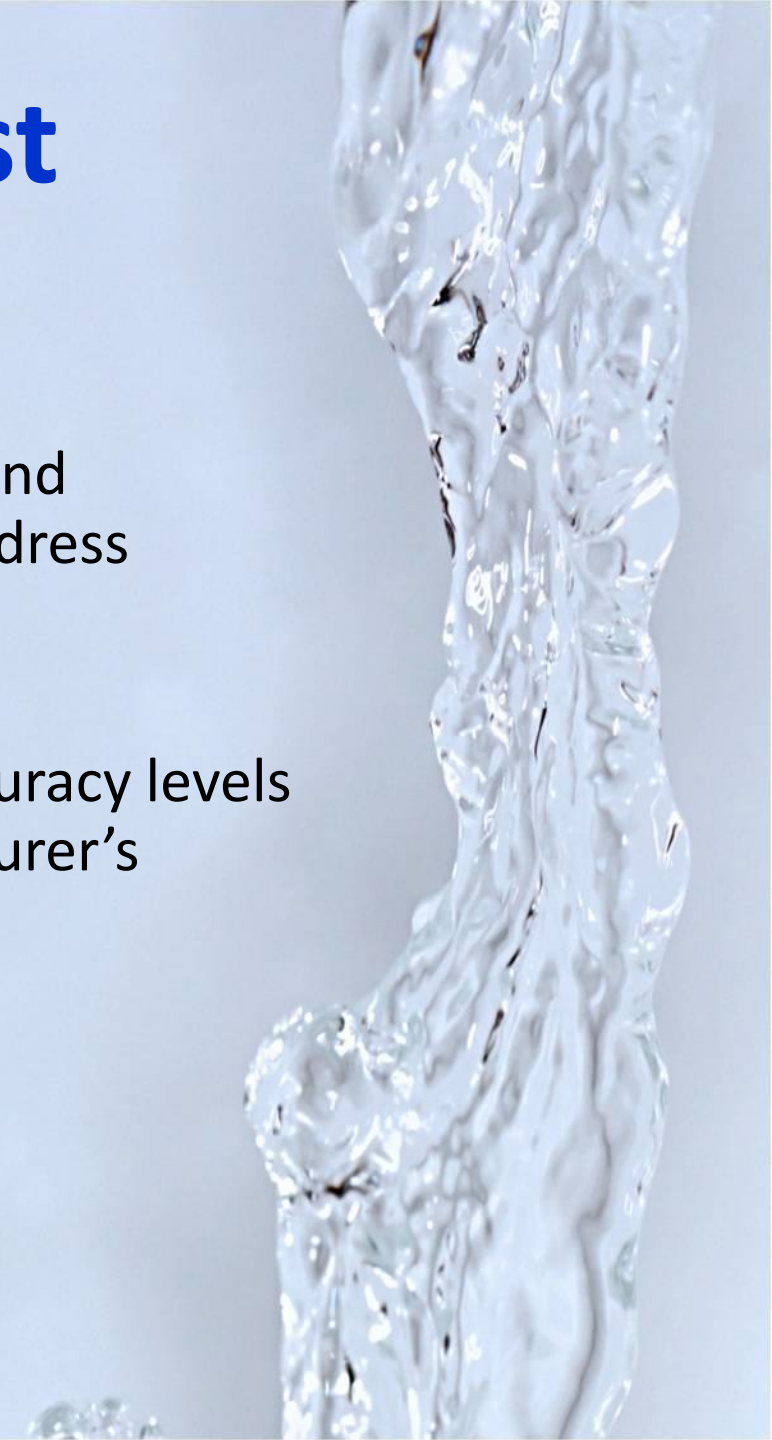
- Inaccurate Billing
- Lost Revenue
- Over and Under Feeding of Chemicals
- Inaccurate Annual Reports and Usage Estimates
- An Overall Loss of Control

**So What Can You Do?**

# Master Meter Test Standards

- **M-6** manual addresses turbines and propeller meters but does not address Venturi meters or other types.

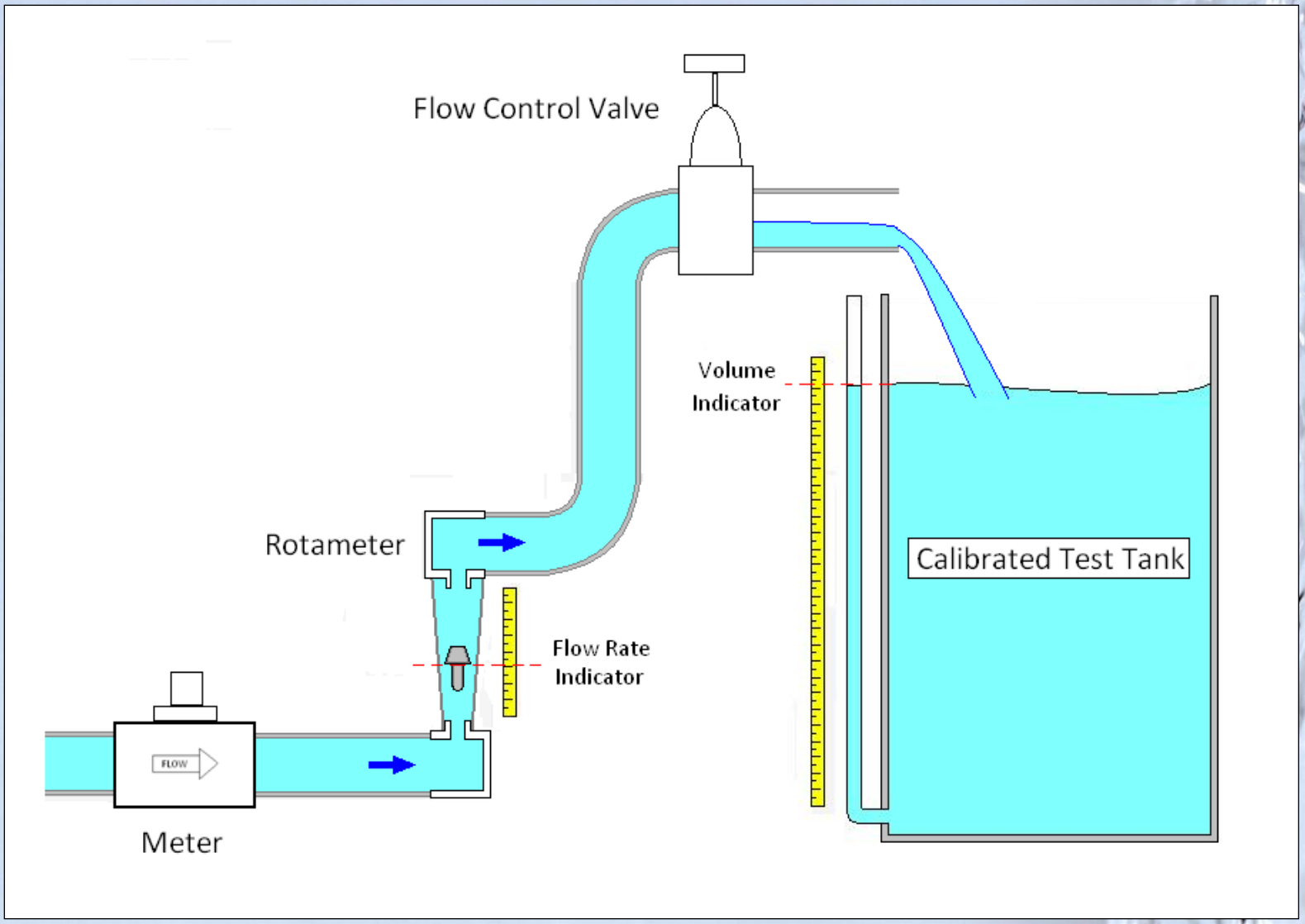
- **M-33** doesn't state allowable accuracy levels (except to mention the manufacturer's specs)



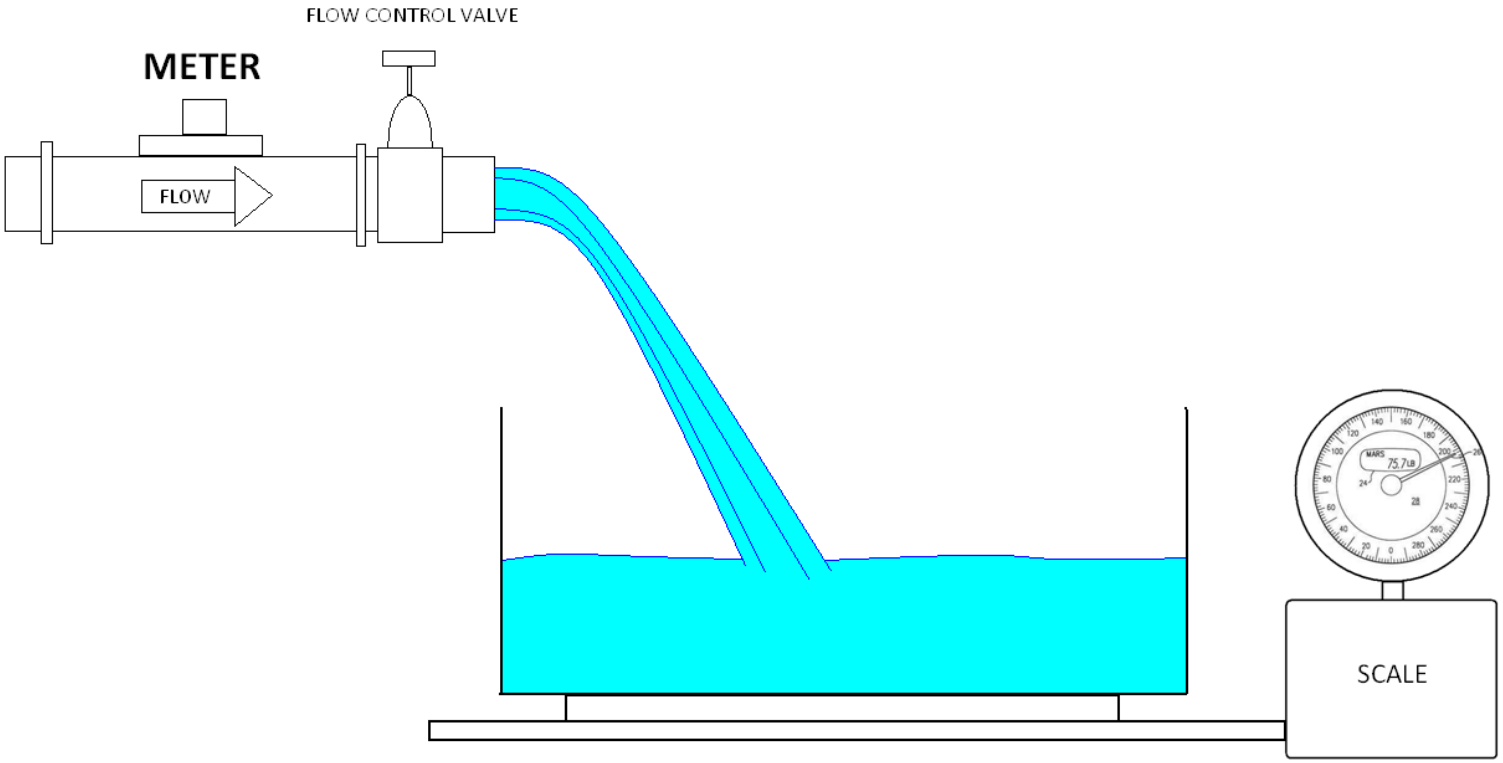
# Should they be removed and sent to a test facility?

Courtesy of Primary Flow Signal

# Tank & Rotameter Test



# Weighing Meter Test



# It is best to test them In–Place

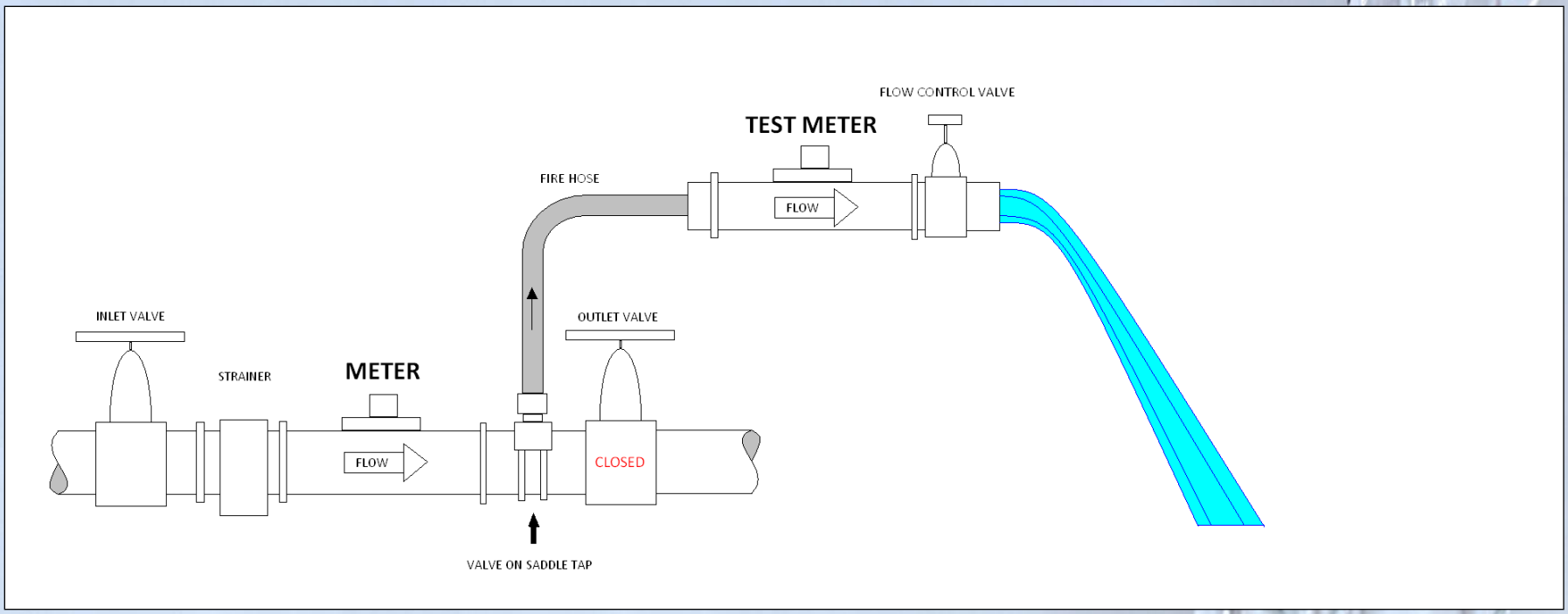
**Advantages**

- Practical - do not have to remove meter
- Test under conditions of current operation
- Able to inspect and assess flow conditions

**Disadvantages**

- Meter may be in a compromised setting
- Test sites may be compromised
- Flows may be limited
- You have to settle for what is available/practical

# Comparative Test



# Flow Measurement

$$Q = V * A$$

**Q** is " Quantity" of water

**V** is velocity of flow measured in ft / s

**A** is inside Area of pipe in $ft^2$

# “Strap-On” Flow Meters

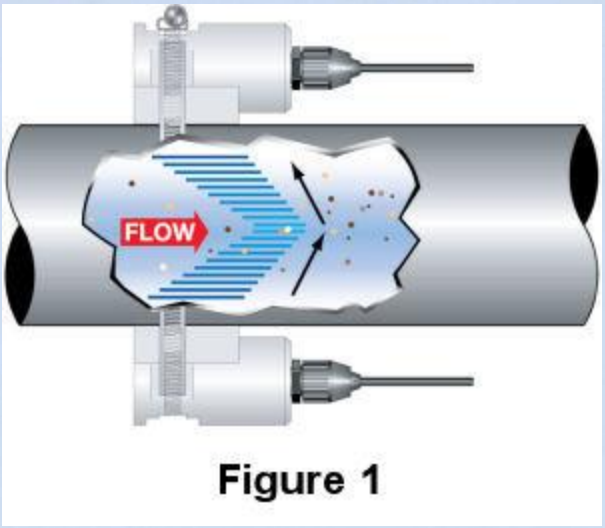
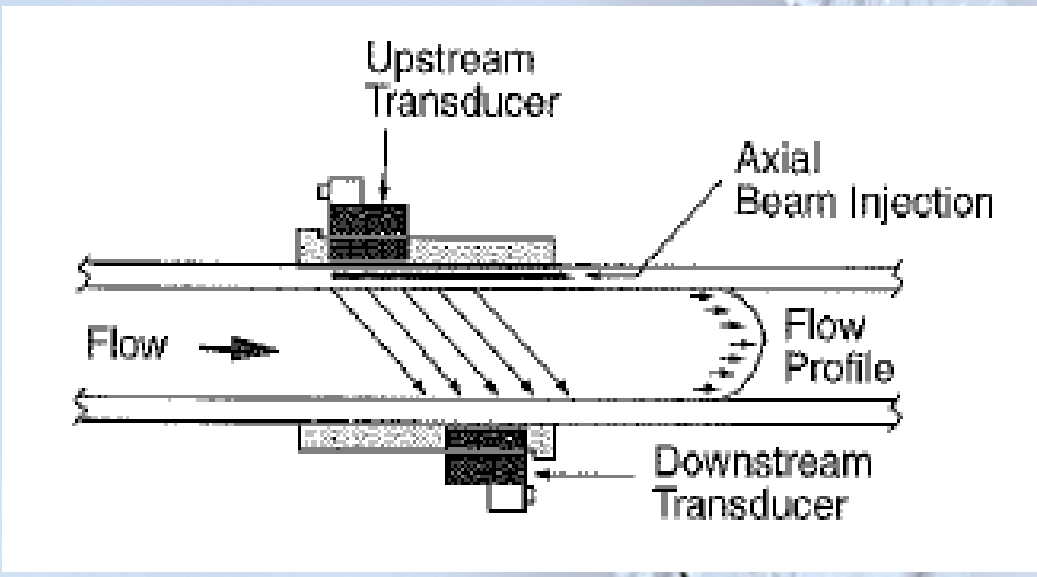


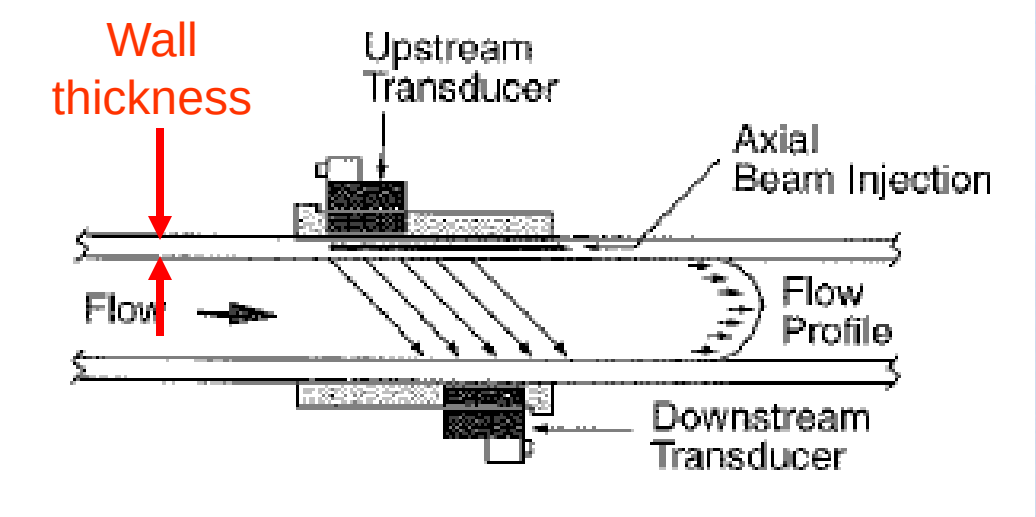

Figure 1

Doppler Meter

Transit Time Meter



# Q=VA



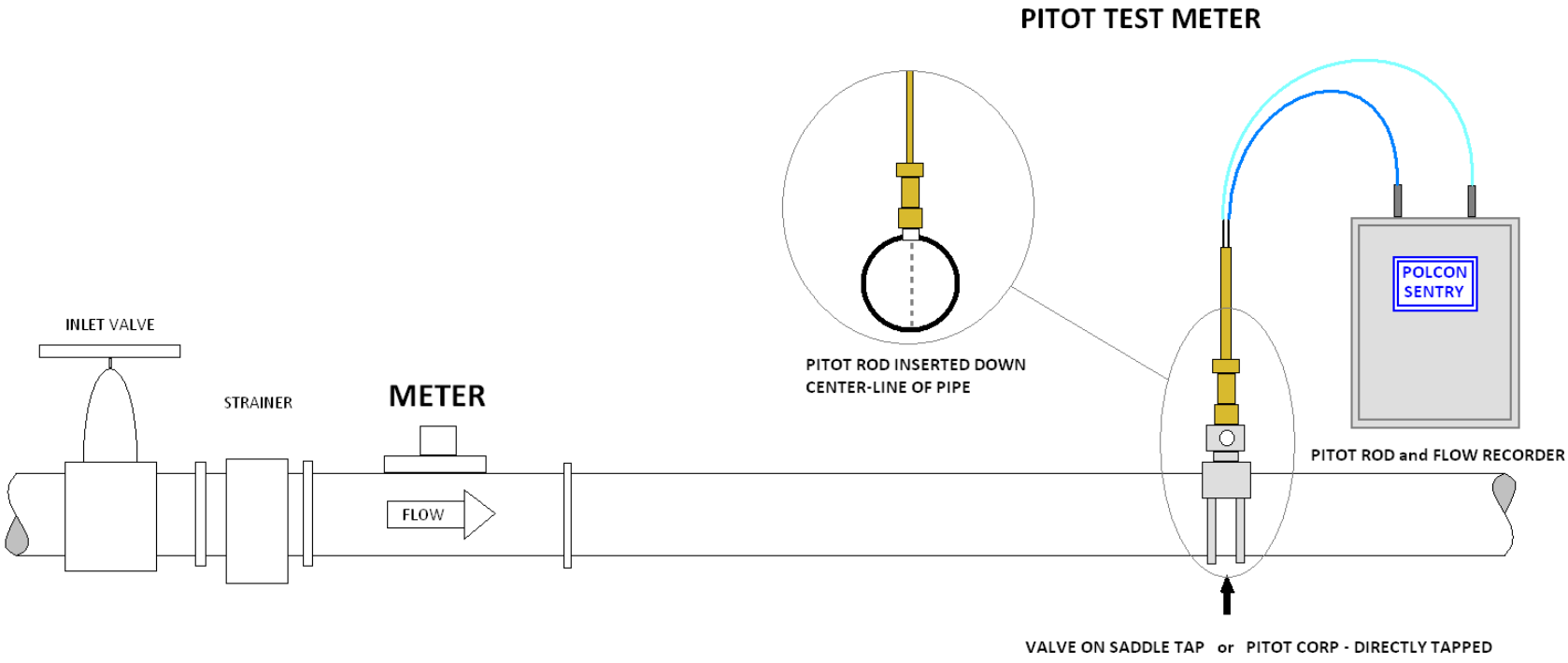

**Generally thickness gauges are used to determine Pipe Wall thickness**

**Then ID of pipe is determined…**

**“Strap-On” meters can be inaccurate.**

**This is because the hydraulic conditions inside the pipe are often unknown.**

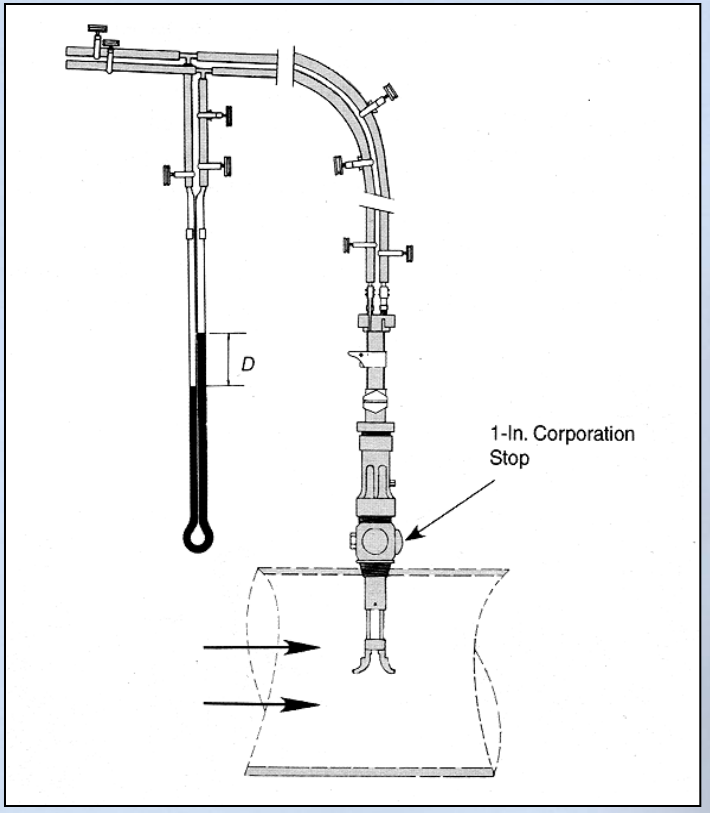
# Pitot Test


PITOT TEST METER
INLET VALVE
STRAINER
METER
FLOW
PITOT ROD INSERTED DOWN
CENTER-LINE OF PIPE
POLCON
SENTRY
PITOT ROD and FLOW RECORDER
VALVE ON SADDLE TAP or PITOT CORP - DIRECTLY TAPPED

# Pitot Testing can be done On-Site

- **Pitot Testing** is the most accurate portable testing method

**This form of Pitot tube was designed by Edward S. Cole in 1896.**



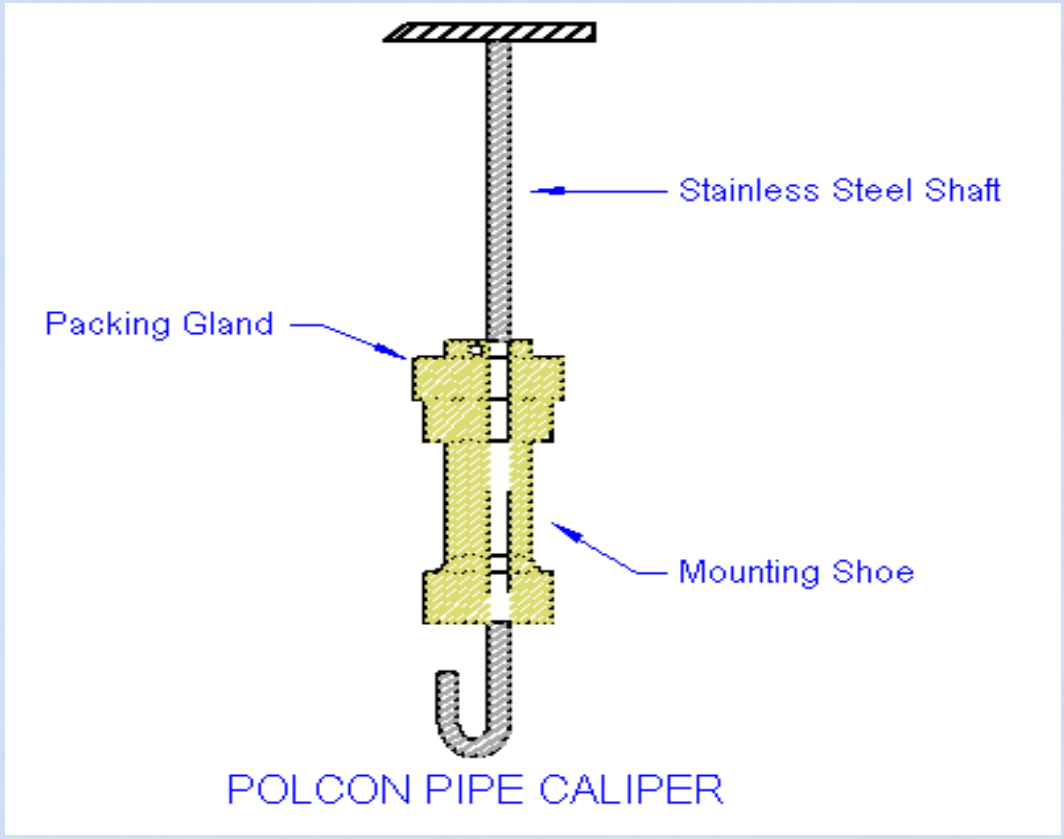
# Test Site Installation

Pitot tap being installed inside the Plant

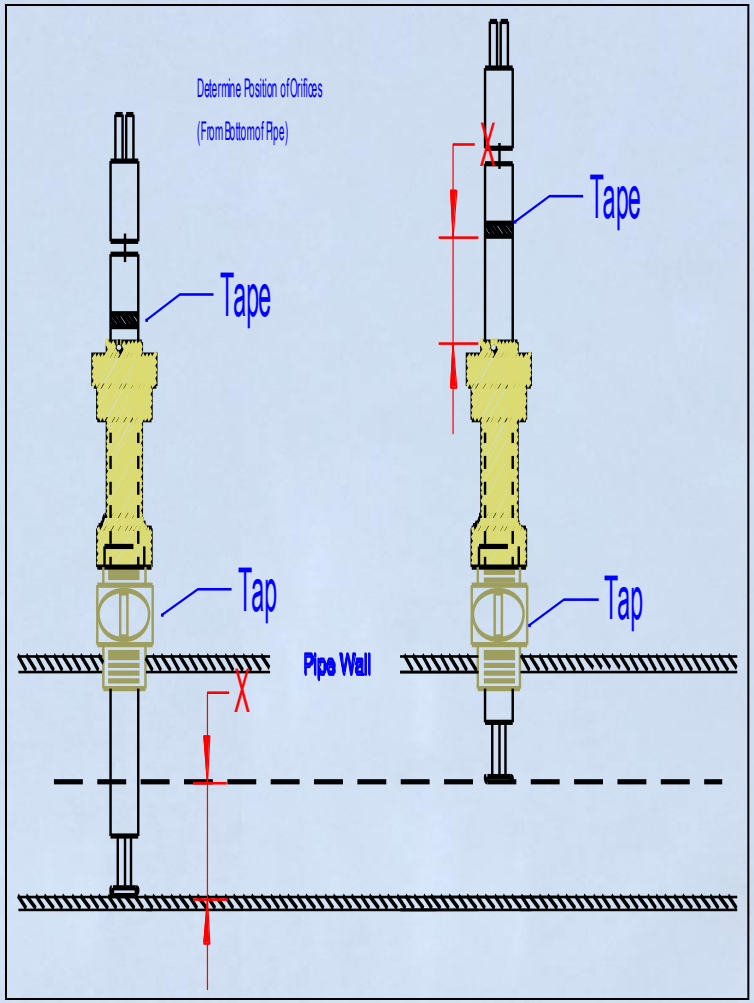
Test site outside of the Plant, in trench

# A Pitot Corp, Tapped Into Ductile-Iron Pipe

# Using a Polcon™ Caliper to Measure the Inside Pipe Diameter

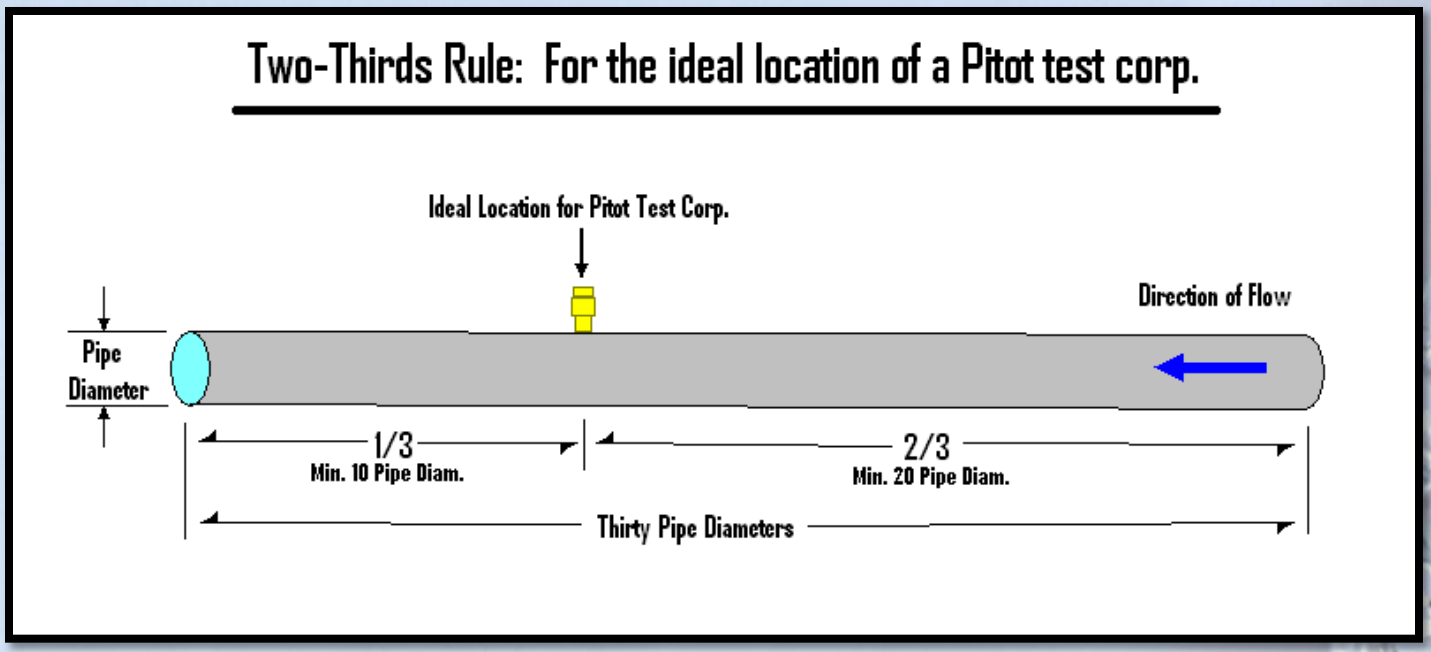


# Positioning the Sensor in the Center of the Pipe



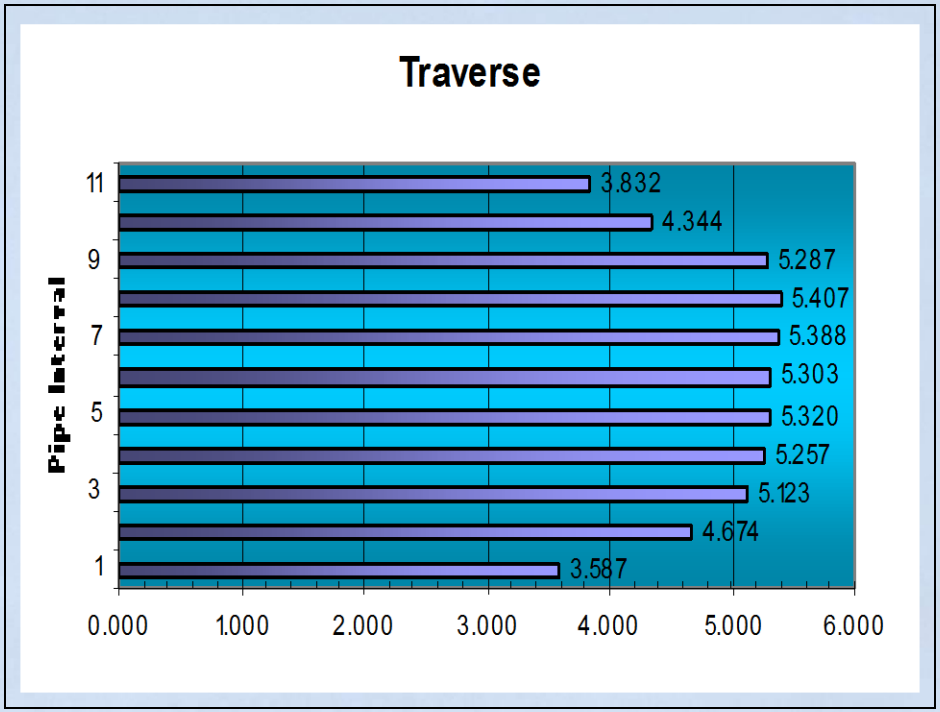
# Flow conditioning

- Test sites need conditioned flow
- Meters need conditioned flow
- Site issues come into play such as straight runs of pipe, concrete pipe, valves, tees, elbows…

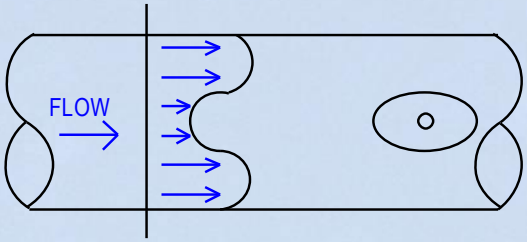


# Velocity Profile is Very Important

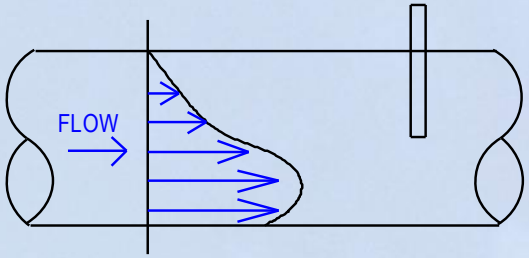
- Used to help calculate mean velocity of flow
- Used to “see” flow profile inside pipe



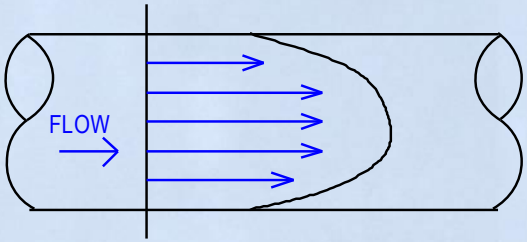
# Common Velocity Profile Shapes



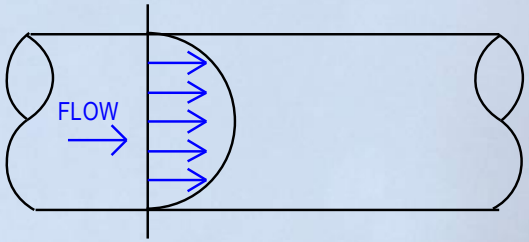

BUTTERFLY VALVE




PARTIALLY CLOSED GATE VALVE



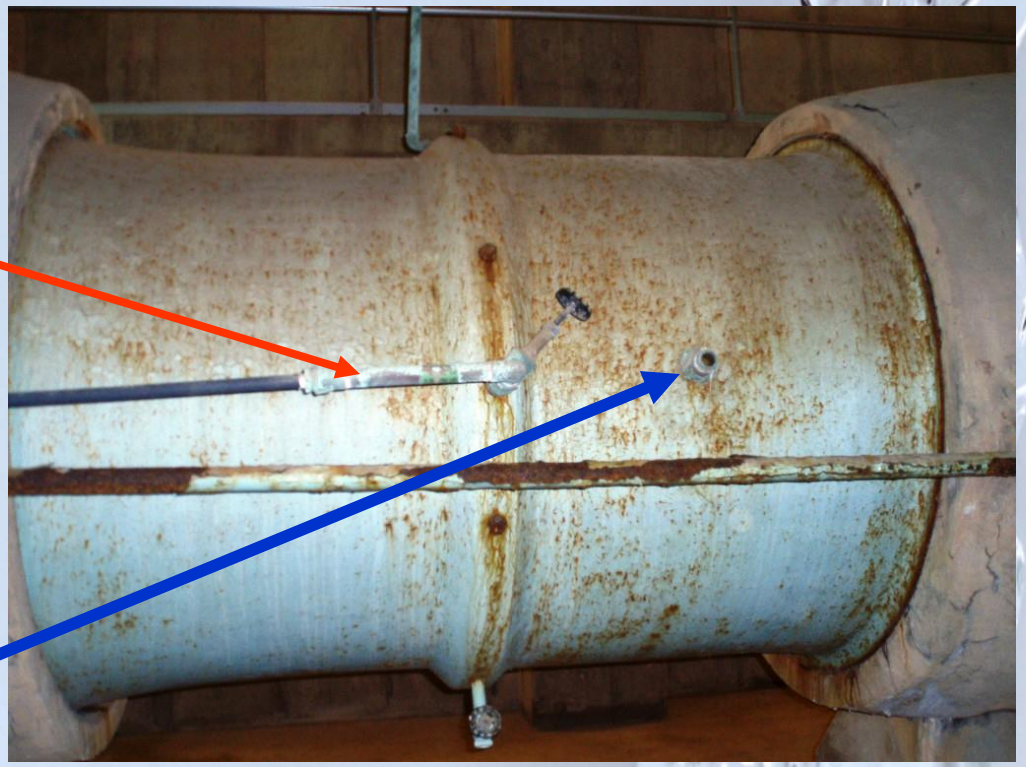

INCRUSTATION / TUBERCULATION
BUILD-UP ON WALLS




SMOOTH INTERIOR PIPE WALL

# Tap installed on diverging cone of Venturi due to Concrete pipe

Low Pressure line



1” Pitot Corp

# Linear Correction Factor

$$C_F = \frac{100}{Acc\ \%}$$

$$C_F = \frac{100}{90.6\ \%} = 1.104$$

# Venturi Test Setup

- Pitot Rod DP
- DP from Venturi
- 4-20 mAmp signal
- SCADA readings in Excel

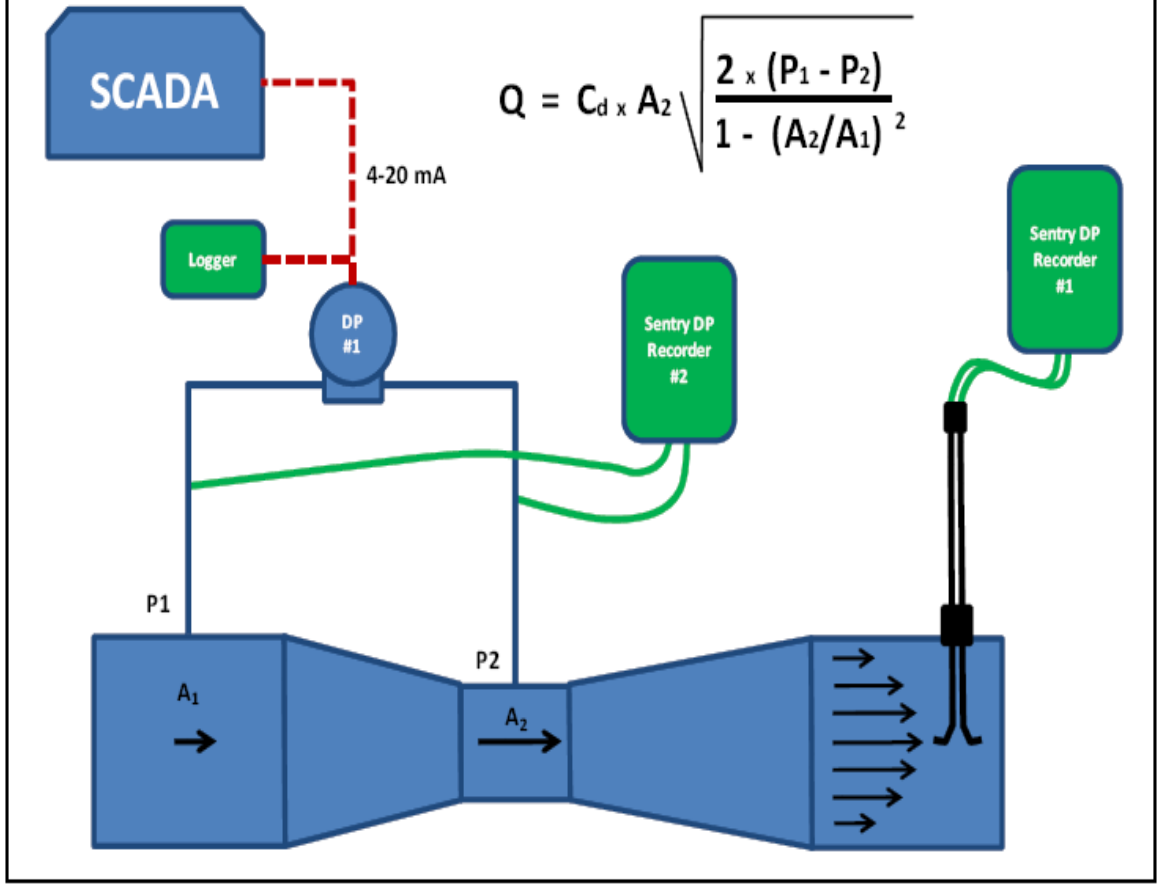
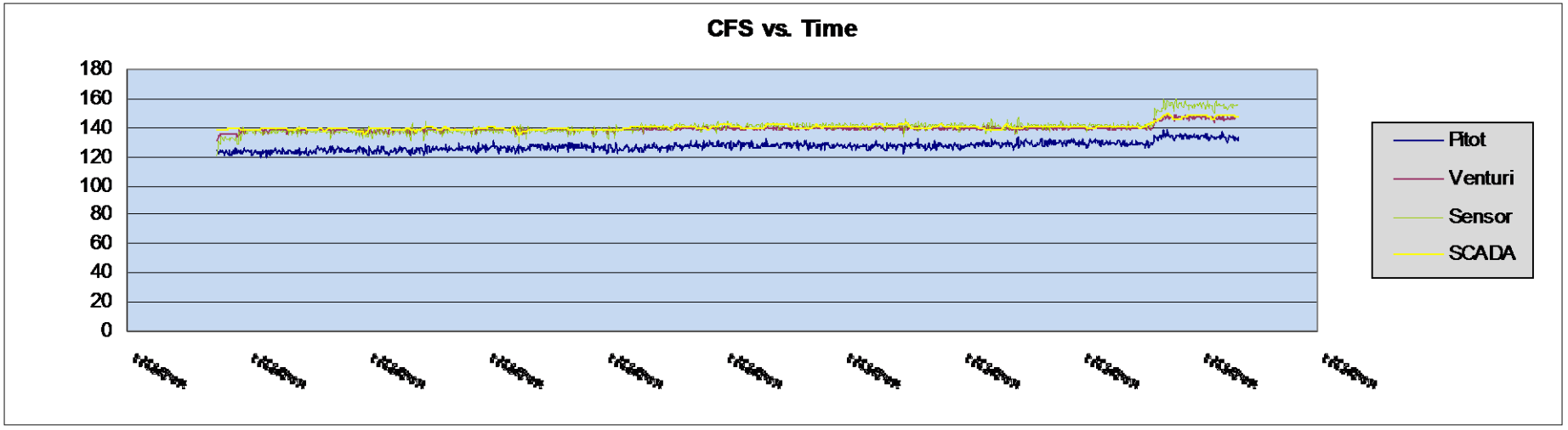



Fig. 1 – Venturi Meter Test Set Up

# Flow Test Results



# 84” Venturi Meter Test Results from Pitot Flow Testing

| | |
|---|---|
| **SCADA Accuracy:** | **110.48%** |

| | | |
|---|---|---|
| **Post Calibration SCADA Accuracy:** | **98.71%** | **@ 188.45 CFS** |

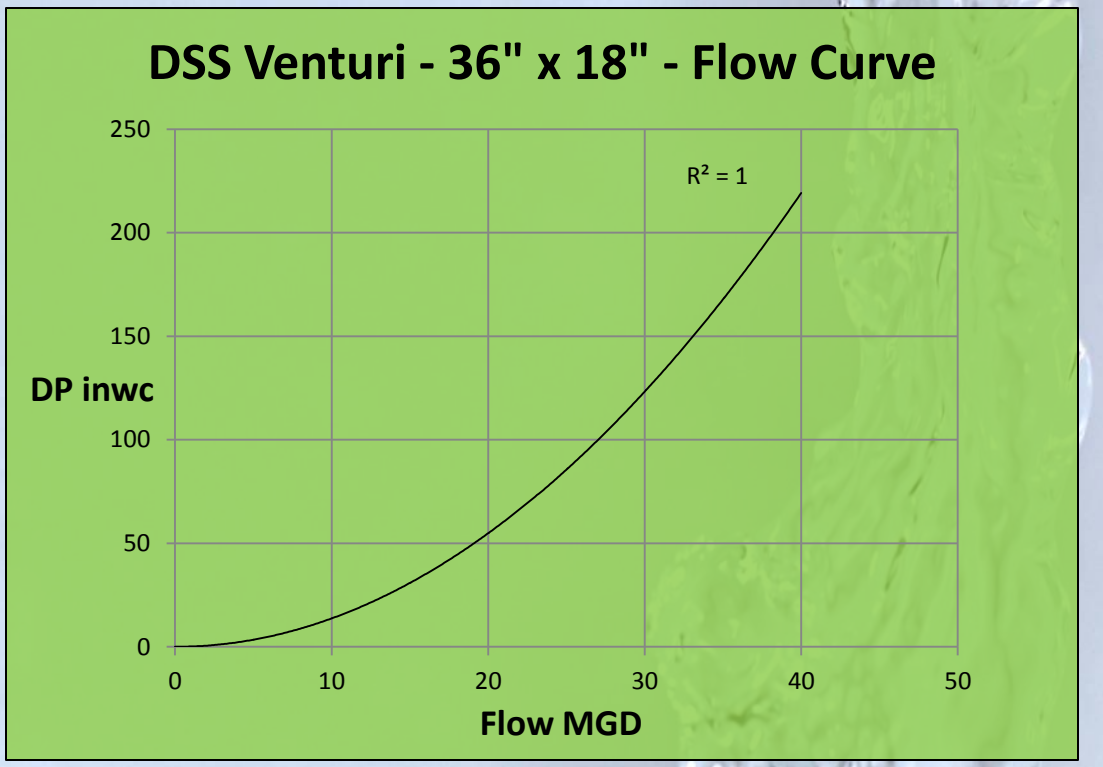
| | Total Flow | Average Test Parameters | | |
|---|---|---|---|---|
| | Million Cubic Feet | Million Cubic Feet/Day | ft / s | CFS |
| **PITOT ROD:** | 9.45 | 11.01 | 3.18 | 122.05 |
| **VENTURI:** | 10.37 | 12.08 | 3.49 | 133.95 |
| **SENSOR:** | 10.44 | 12.16 | 3.52 | 134.86 |
| **SCADA:** | 10.44 | 12.16 | 3.52 | 134.84 |

# Calibrated Flow Curve

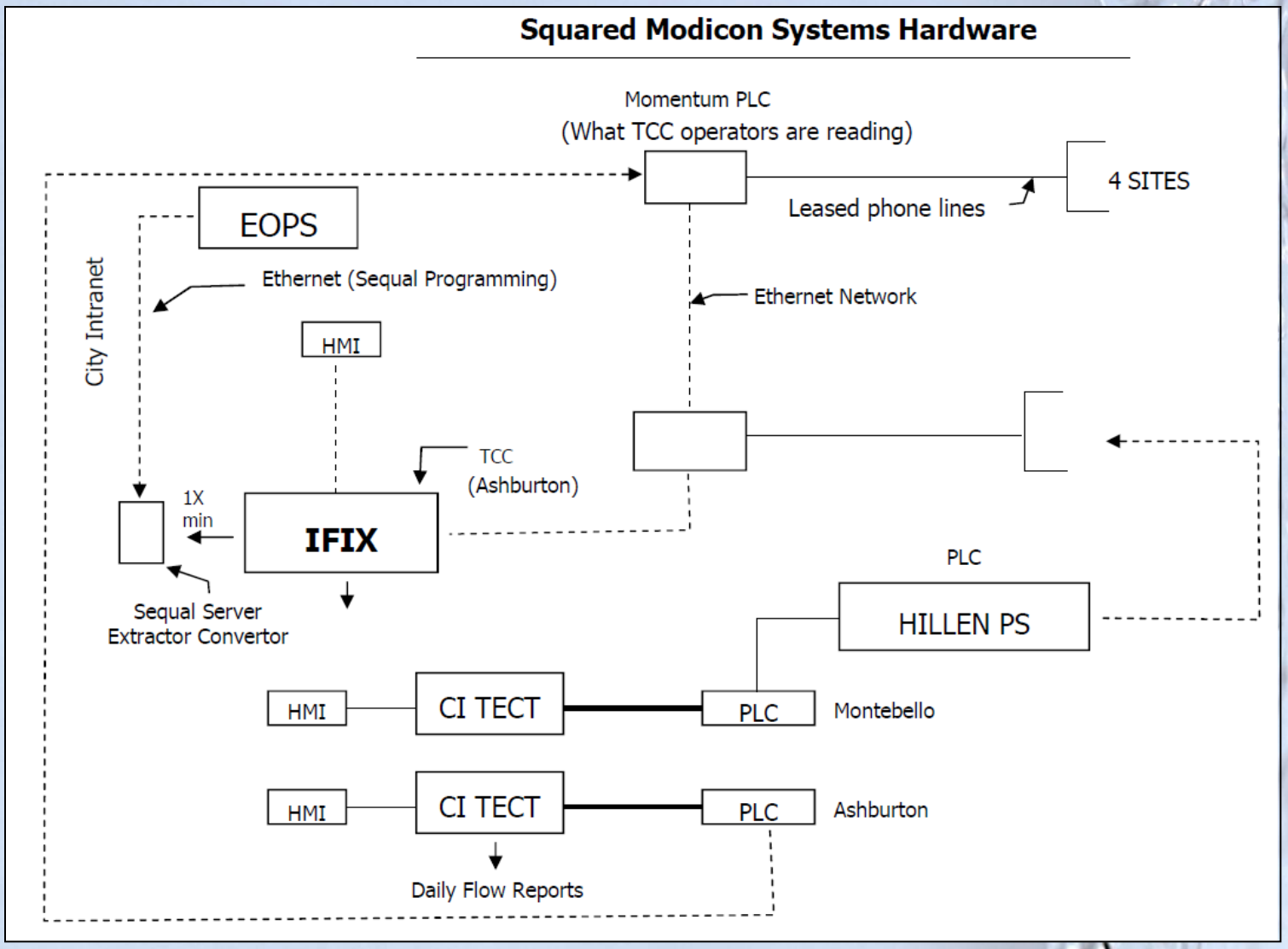
## DSS Venturi Meter - 36" x 18"

| | | |
|---|---|---|
| Pitot Q: | 17.51 | MGD |
| Venturi DP: | 42.00 | inwc |
| Coeff: | 2.7019 | |

| Pitot Q | Venturi DP |
|---|---|
| 0 | 0.00 |
| 5 | 3.42 |
| 10 | 13.70 |
| 15 | 30.82 |
| 20 | 54.79 |
| 25 | 85.62 |
| 30 | 123.29 |
| 35 | 167.81 |
| 40 | 219.18 |



# SCADA Setup Can Cause Error



# QUESTIONS?

M.E. SIMPSON Co., Inc.