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The unintended (and unplanned for!) consequences of water use efficiency

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30+ Years of Significant Reductions!!

TABLE 2-A. WATER CONSUMPTION BY WATER-USING PLUMBING PRODUCTS AND APPLIANCES – 1980 TO 2012

Water-using Fixture or Appliance	1980s Water Use	1990 Requirement	EPAct 1992 Requirement	2009 Baseline Plumbing Code	2012 'Green Code' Requirement	% Reduction in avg water use since 1980s
Residential Bathroom Lavatory Faucet	3.5+ gpm	2.5 gpm	2.2 gpm	2.2 gpm	1.5 gpm	57%
Showerhead	3.5+ gpm	3.5 gpm	2.5 gpm	2.5 gpm	2.0 gpm	43%
Toilet – Residential	5.0+ gpf	3.5 gpf	1.6 gpf	1.6 gpf	1.28 gpf	74%
Toilet - Commercial	5.0+ gpf	3.5 gpf	1.6 gpf	1.6 gpf	1.6 gpf[1]	68%
Urinal	1.5 to 3.0+ gpf	1.5 to 3.0 gpf	1.0 gpf	1.0 gpf	0.5 gpf	67%
Commercial Lavatory Faucet	3.5+ gpm	2.5 gpm	2.2 gpm	0.5 gpm	0.5 gpm	86%
Food Service Pre-rinse Spray Valve	5.0+ gpm	No requirement	1.6 gpm (EPAct 2005)	No requirement	1.3 gpm	74%
Residential Clothes Washer	51 gallons/load	No requirement	26 gallons/load (2012 standard)	No requirement	16 gallons/load	67%
Residential Dishwasher	14 gallons/ cycle	No requirement	6.5 gallons/cycle (2012 standard)	No requirement	5.0 gallons/cycle (ASHRAE S191P)	64%

gpm: gallons per minute
gpf: gallons per flush

Timeline…

- 1940s – sizing supply piping & drain systems
  - No significant code changes since
- 1990s – 2000s
  - Increased water efficiency & water conservation
  - Result: Piecemeal system changes using 21st century…
    - High-efficiency fixtures & fittings
    - Process equipment
    - Appliances

What we have done…

21st Century Results
(of modifying a 1940s system)

- Dry drains & sewers
  - Blockages & clogs
  - Wastewater treatment issues
- User dissatisfaction
  - Long 'wait times' for hot water
- Public health & safety
  - Showers: potential thermal shock & scalding
  - Stagnant water: disappearing chlorine residual
- Increased maintenance
  - Nothing is "maintenance free"

'Starving' the Drains!

- Reduced liquids avail. to move waste in drainlines
- Commercial installations
  - Isolated bathrooms
  - Long horizontal runs – 1% slopes + dips & sags
  - Non-water urinals, ultra low flow lav faucets (0.5 gpm)
  - Proliferation of other water-efficient technologies; medical, food service, industrial & comm'l processes
- Domestic installations
  - Reduced flow - showerheads and faucets
  - Reduced volumes - toilets and appliances
  - Graywater reuse systems – potential to eliminate long duration flows by diverting waste water

'Starving' Residential Drainlines

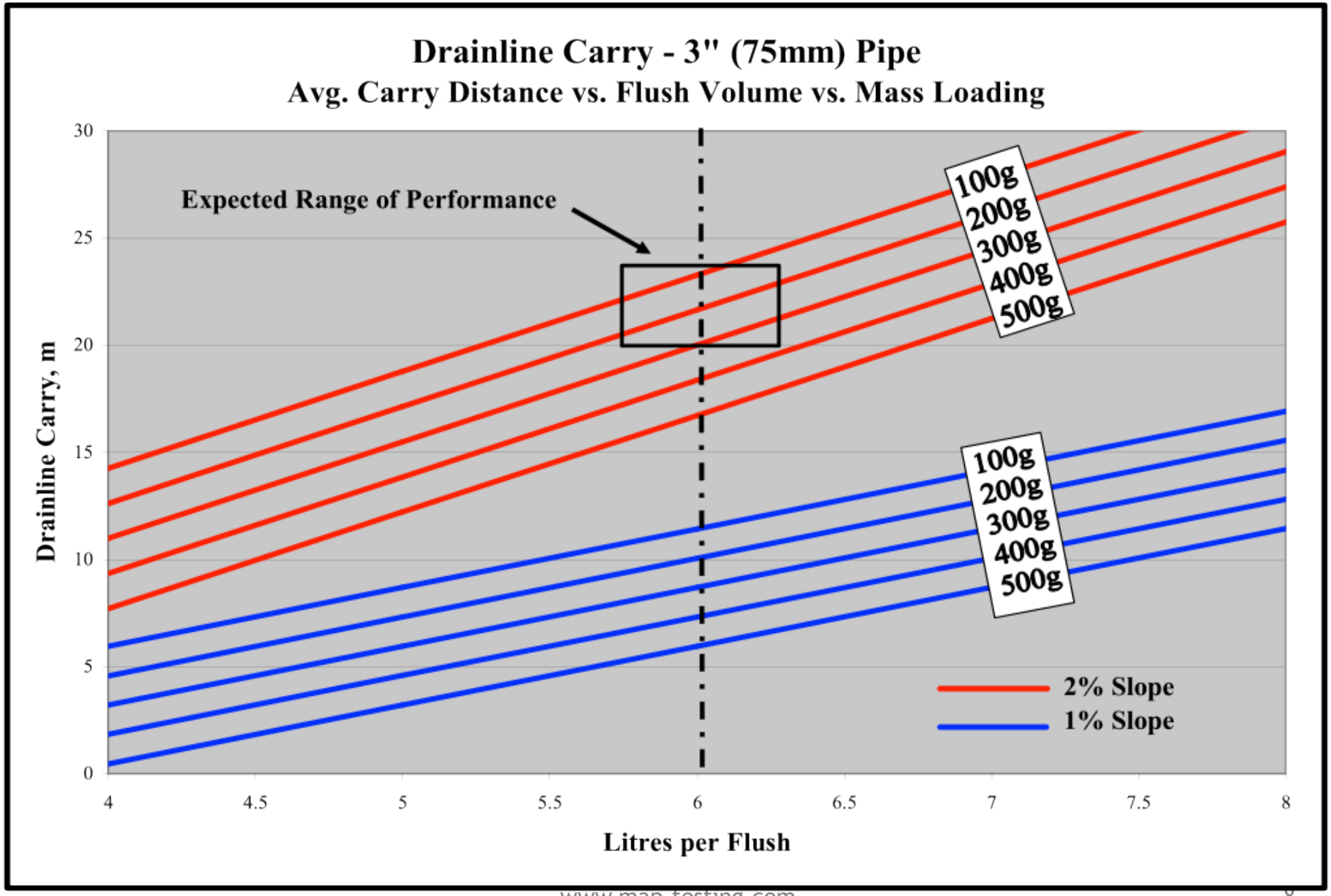
- Graywater collection, treatment, reuse can remove significant volumes of water from the drain system
  - Clothes washers
  - Lavatory faucets
  - Showers & baths

  } 30% of all indoor use

- 2005 study: HETs not a problem in residential

  ……BUT, graywater systems MAY create a problem in the future

Residential Drainline Carry – Findings (2005)



Commercial BuildingDrainlines

- 2008: MaP issued a **CAUTION** statement
- 2009: Plumbing Efficiency Research Coalition (PERC) formed
  - IAPMO - Int'l Assoc of Plumbing & Mech Officials
  - ICC - International Code Council
  - PMI - Plumbing Manufacturers International
  - PHCC - Plumbing Heating Cooling Contractors Assoc
  - AWE - Alliance for Water Efficiency
  - ASPE – American Society of Plumbing Engrs (added in 2011)
- PERC Phase 1 findings
  - **Paper, slope, & water volume** are the determinants of waste transport in building drainlines
  - **NOT** type of toilet, flush curve, or trailing water

    (contrary to what you might have been told!)

Consequences – Municipal Systems

- Municipal sewer flows reduced
  - Stoppages require extra maintenance $$
  - Additional flushing of sewer mains required
- Dilution of waste stream (with additional water) being required at the inflow to the municipal wastewater treatment facility

On the water supply side…

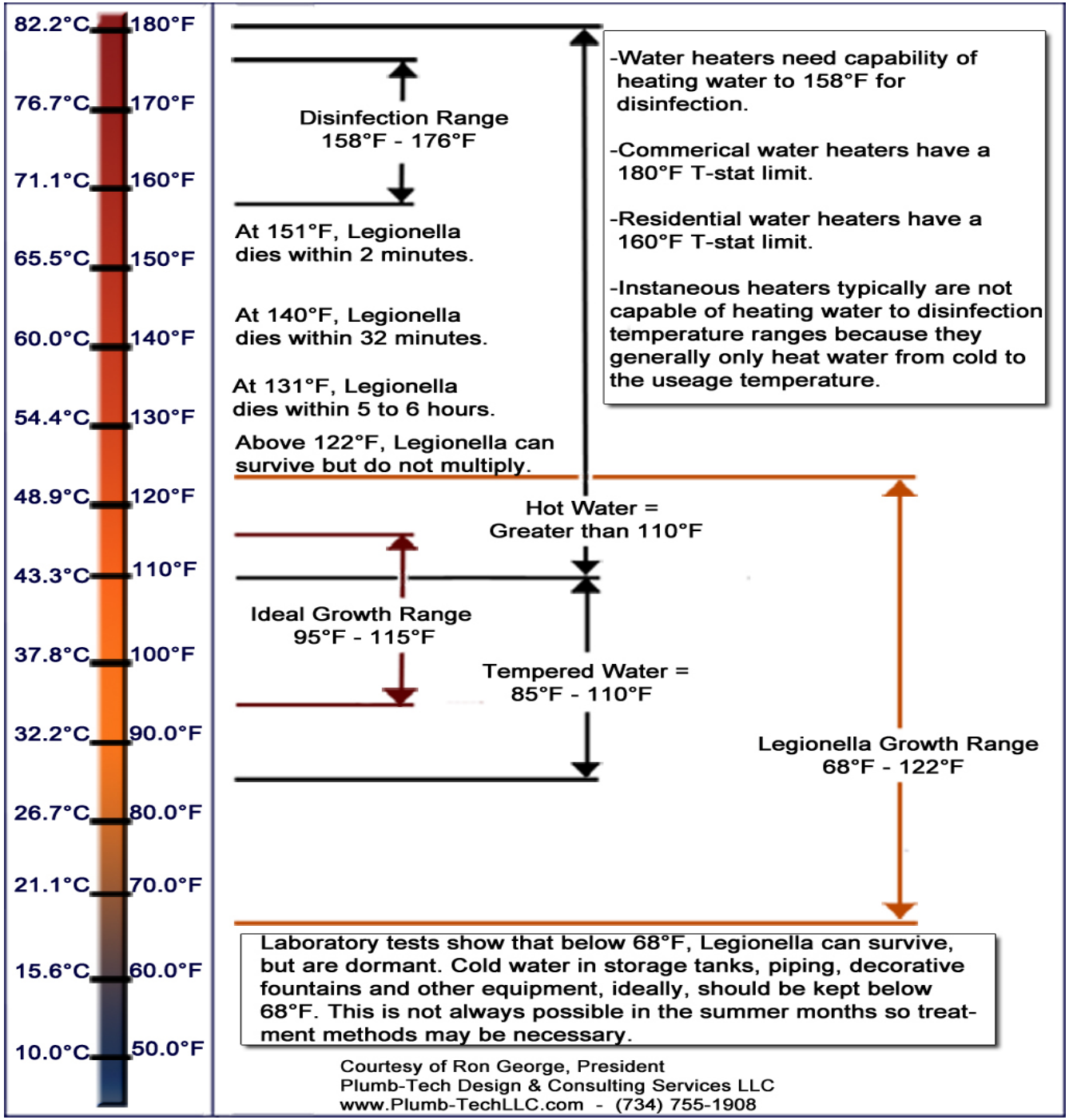
- Over-sizing of water supply lines due to outdated demand estimate models

  (remember the chart you saw at the beginning?)

- May result in:
  - Longer wait times for hot water to arrive at point of use
  - Lower velocities in pipes, less scouring action, possible increase of biofilm growth > more flushing of lines req'd
  - Concerns magnified in health care facilities
    - John Hopkins report regarding electronic faucets
    - ASPE led effort to investigate validity of Hopkins study

Public Health & Safety

- Showers – scalding & thermal shock issues
  - ✓ No compensating valve in older homes *(approx pre-1987)*
  - ✓ Showerhead mismatched with compensating valve in newer installations; example…
    - ✓ 2.5 gpm rated compensating valves
    - ✓ 1.5-2.0 gpm rated showerheads
  - ✓ Water heaters set to dangerously low temperatures (120°F), breeding Legionella bacteria
  - ✓ Aerating showerheads


82.2°C 180°F
76.7°C 170°F
71.1°C 160°F
65.5°C 150°F
60.0°C 140°F
54.4°C 130°F
48.9°C 120°F
43.3°C 110°F
37.8°C 100°F
32.2°C 90.0°F
26.7°C 80.0°F
21.1°C 70.0°F
15.6°C 60.0°F
10.0°C 50.0°F
Disinfection Range
158°F - 176°F
At 151°F, Legionella dies within 2 minutes.
At 140°F, Legionella dies within 32 minutes.
At 131°F, Legionella dies within 5 to 6 hours.
Above 122°F, Legionella can survive but do not multiply.
-Water heaters need capability of heating water to 158°F for disinfection.
-Commerical water heaters have a 180°F T-stat limit.
-Residential water heaters have a 160°F T-stat limit.
-Instaneous heaters typically are not capable of heating water to disinfection temperature ranges because they generally only heat water from cold to the useage temperature.
Hot Water = Greater than 110°F
Ideal Growth Range
95°F - 115°F
Tempered Water =
85°F - 110°F
Legionella Growth Range
68°F - 122°F
Laboratory tests show that below 68°F, Legionella can survive, but are dormant. Cold water in storage tanks, piping, decorative fountains and other equipment, ideally, should be kept below 68°F. This is not always possible in the summer months so treatment methods may be necessary.
Courtesy of Ron George, President
Plumb-Tech Design & Consulting Services LLC
www.Plumb-TechLLC.com - (734) 755-1908

New York City Outbreak and Response

Conditions Common in Outbreaks

- Loss of disinfection coming into the building.
- Lack of familiarity with how water is processed in complex building water systems.
- Lack of effective microbiological controls.
- Lack of coordinated prevention efforts.

-Used with permission from: Claressa Lucas, PhD
-Centers for Disease Control and Prevention (CDC), Atlanta, GA
-Division of Bacterial Diseases
-Environmental *Legionella* Isolation and Techniques Evaluation (ELITE) Certification Program Coordinator
-Microbiologist involved in most US legionellosis outbreak investigations
-http://smartwaterleadership.com/CDC.aspx (June 2013)

Most Legionnaire's disease deaths tied to plumbing systems, CDC says

Public Health & Safety - Buildings

- Legionella bacteria – chlorine tolerant
- Legionnaires' disease in U.S.
  - 8,000 to 10,000 cases per year
  - 10%+ fatal
- Risk factors – water flow/velocity, stagnation, scale & sediment, biofilms, temperature
- So..
  - Maintain domestic water heaters @ 140°F
  - Water to a faucet @ 122°F minimum

Public Health & Safety

- Stagnant water in large plumbing systems
  - ✓ Dead ends – buildings & municipal systems
  - ✓ Leads to disappearing chlorine residual
  - ✓ Pathogen growth threatens public health
  - ✓ Requires more frequent system ‘flushing’

The CUL-DE-SAC problem

The ‘cul-de-sac problem’

- Many ‘dead ends’ & stagnant water
- Disappearing chlorine residual
- Requires more frequent mains flushing
  - ✓ Fire flows
  - ✓ Mains scouring & cleansing
- Water is ‘wasted’
- Public’s reactions to perceived ‘waste’ discourages their own conservation efforts

Summary – unintended consequences

- 'Dry Drains & sewers' - starving for water
- Wastewater treatment – dilution of inflows
- Public health – increased flushing of water supply systems (buildings & municipal)
- Public safety – shower dangers + Legionella
- Public perception of waste

MaP
Maximum Performance

Alliance for Water Efficiency

Thank you…

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