This presentation premiered at WaterSmart Innovations

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Which Showerheads offer the Greatest Opportunity for Water Savings?

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What Constitutes an Efficient Showerhead?

- Well – a **<u>conserving</u>** showerhead is one that saves water and/or energy.
  - Might not provide the best (or even an entirely suitable) showering experience – but it does save water!
  - We <u>conserve</u> our resources when they are scarce.
- An **<u>efficient</u>** showerhead would be one that saves water and/or energy AND that
  - Provides an entirely acceptable showering experience.
  - We should try to be <u>efficient</u> all of the time!

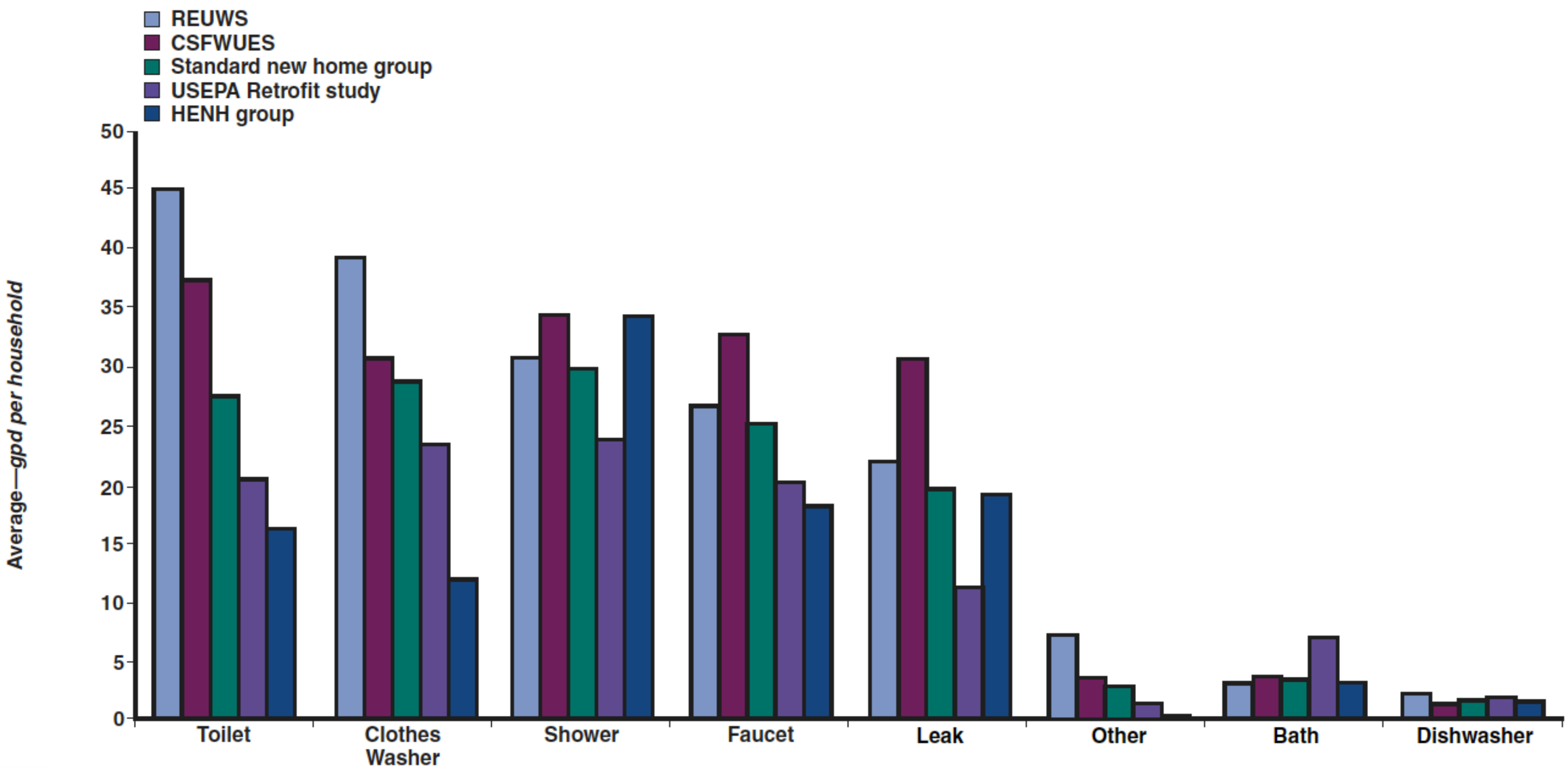
Flow Rate

- Efficiency is not just related to flow rate
- If it were, defining an efficient showerhead would be easy - it would simply be a showerhead with a flow rate less than X gallons per minute
- We know that it is easy for a manufacturer to produce a showerhead with an extremely low flow rate (0.1 gpm anyone?)

Field observations

Aquacraft – *Insights into declining single-family residential water demands*
(AWWA Journal, 2012)

FIGURE 3 Comparison of end uses of water by study group



Flow Rates are Lower…

- In the “good old days” showerheads with flow rates of 5 gpm were not uncommon
- Now showerheads have flow rates of 2.5 gpm or less
- Many available at 1.5 gpm
- Why are we not seeing a decline in demands similar to what we see with toilets and clothes washers?

Why so little savings?

- There are 2 potential reasons –

1. Either people need a certain minimum volume of water to shower regardless of the flow rate, in which case we can never reduce these demands, or

2. Reducing the flow rate also reduces the ‘performance’ of the showerhead and results in a longer shower experience – lower flow rate, longer duration??

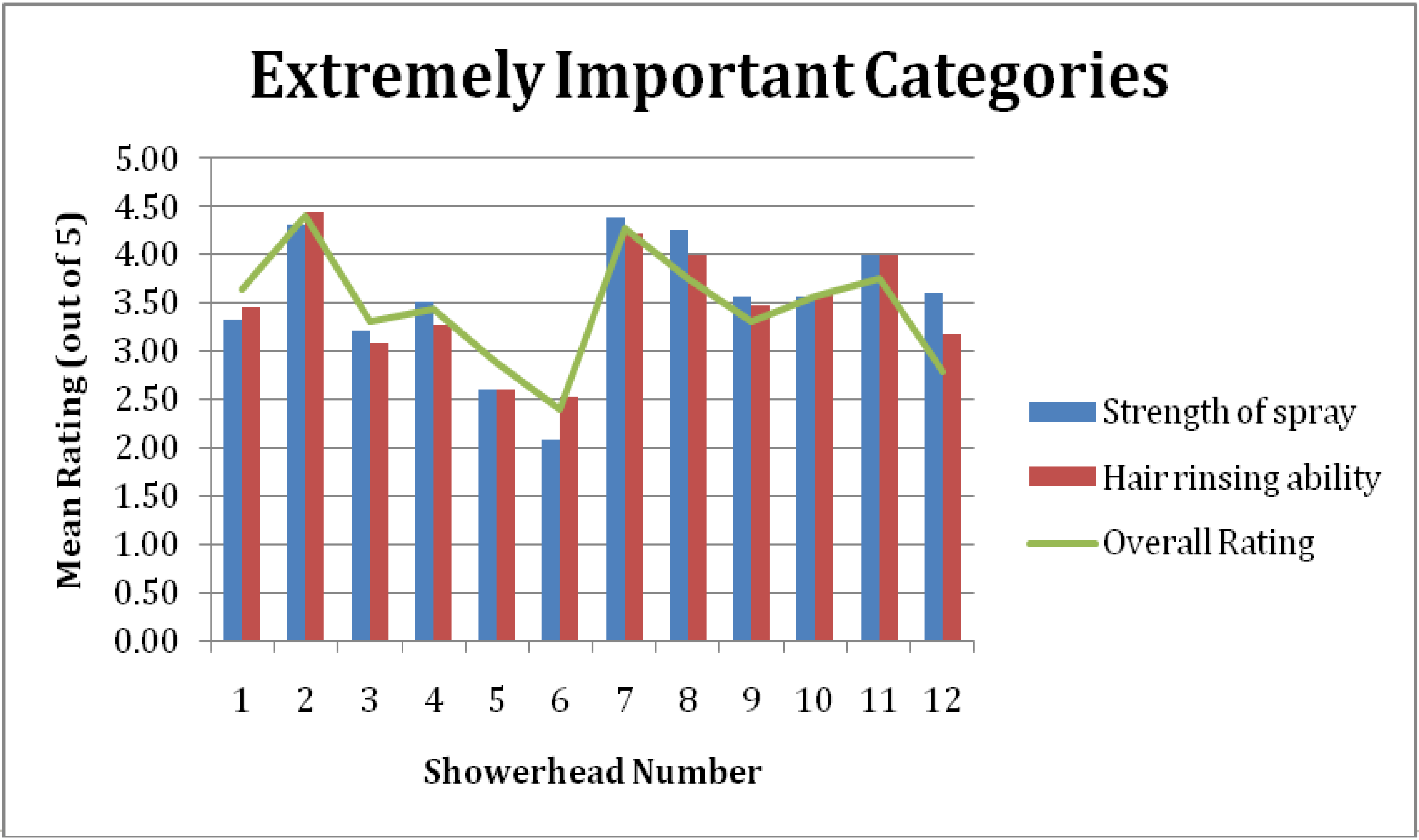
University of Waterloo Showerhead Study

- Male and female participants showered in bathing suits.
- Showerheads were tested in the same order for all participants
- Participant asked what “steps” they normally take during a typical shower (e.g., rinse hair, shampoo, scrub body, etc.).
- Same steps repeated and timed for each showerhead.
- Flowrate recorded remotely.
- Participants were encouraged to make comments during each shower to help illustrate their perceptions.

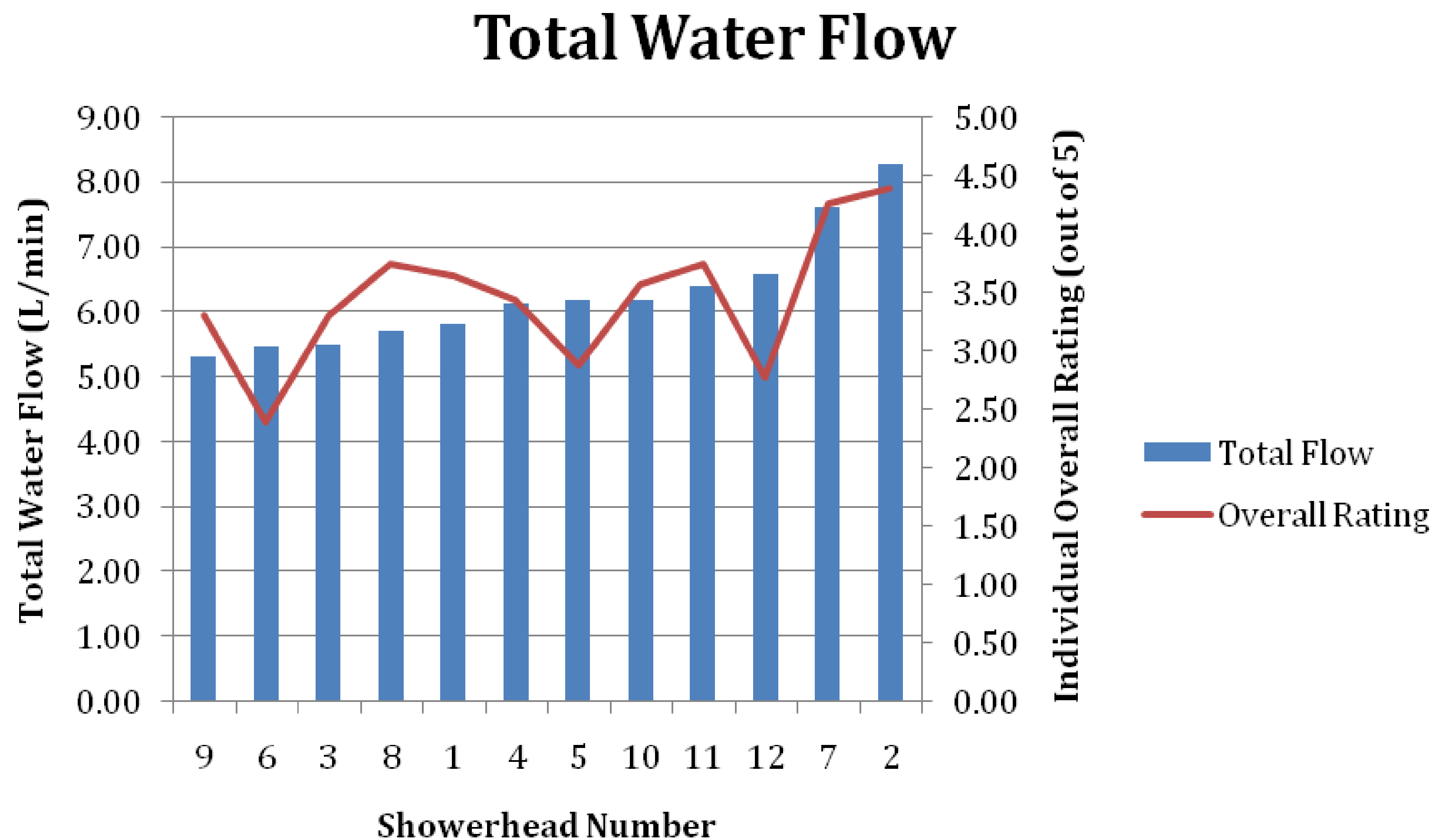
Results

Level of Importance	Category
Extremely Important	Strength of spray
	Hair rinsing ability
Very Important	Overall appeal of spray
	Spray coverage/width of stream
	Distribution of spray
Quite Important	Face rinsing ability
	Body rinsing ability
	Quietness of showerhead
Only Slightly Important	Size of showerhead
	Variety of spray types available
Not at all Important	Attractiveness of showerhead

Results (con't)



Results (con't)

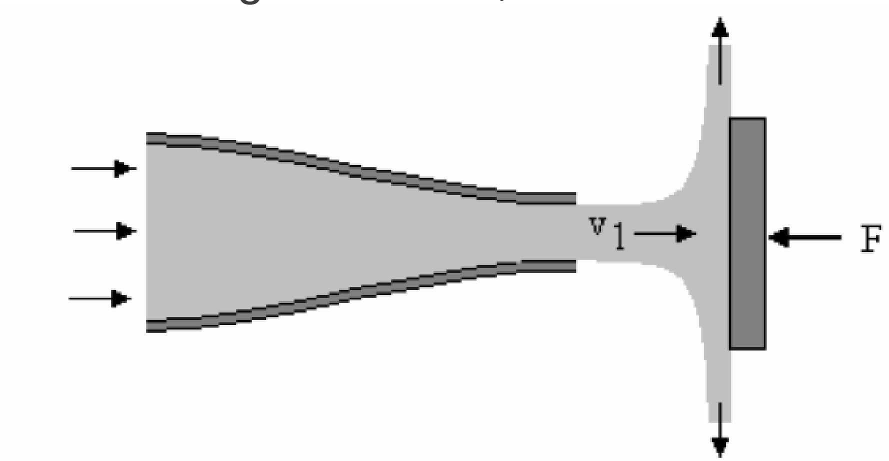


Flow Rate vs. Force

- Relationship between flow rate and force.

- When a jet of fluid strikes a stationary vane, the vane decelerates the fluid in a given direction. Even if the speed of the fluid is unchanged, a change in direction produces changes in the velocity vectors and hence momentum forces are produced. The resulting force on the vane being struck by the fluid is an ***impulsive force.*** Since the fluid is at atmospheric pressure at all times after leaving the nozzle, there are no forces due to pressure change.

$$F = Q\rho V = \rho A V^2$$



Con’t

$$F = Q\rho V = \rho A V^2$$

- Force = density of water (constant) x area of jet (relatively constant for a particular showerhead) x **velocity^2**

Example

- Showerhead with total nozzle area of 0.25 cm^2 and a flow velocity of 6 m/sec would have a flow rate of 9.0 Lpm (2.4 gpm) produce a force of 0.9 N (about 0.2 pounds)
- If we reduce nozzle area to just 0.20 cm^2 and we want to <u>**keep the same flowrate**</u> then we need to increase the velocity of the water leaving the showerhead to 7.5 m/sec.
- So <u>same flow rate</u> but now force = 1.125 N (0.25 pounds)

Garden Hose

How many think you **increase** the flow rate from a hose when you put your thumb over the end?

What does the consumer want from a showerhead?

- Step 1 – get wet
  - Any showerhead will get you wet
- Step 2 – soap up and shampoo hair
  - Don’t even need showerhead, but nice to stay warm
- Rinse soap from skin
  - Don’t need anything special
- Rinse shampoo from hair
  - Oops! Now we need some sufficient ‘force’

More force!!

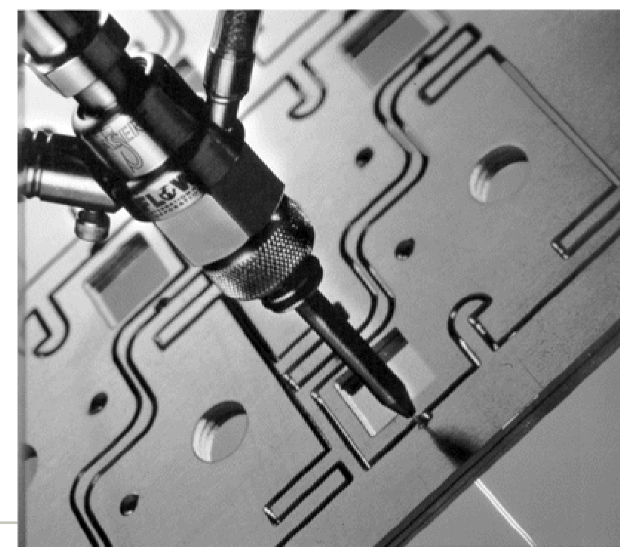
- Remembe $F = Q\rho V = \rho A V^2$
- If we want to increase the Force by 25%

1. We can increase the flow rate by 25%
2. Or, we can increase the flow velocity by 11.8%

- Conversely, it is possible to decrease the flow rate but maintain the same <u>force</u> if we can increase the velocity of the water exiting the showerhead.

Universal Acceptance?

- No!
- Not everyone wants a high velocity showerhead.
- Too much velocity = PAIN
- Luckily, we are limited by PSI
- Decrease jet area, increase jet velocity
- But only to a point



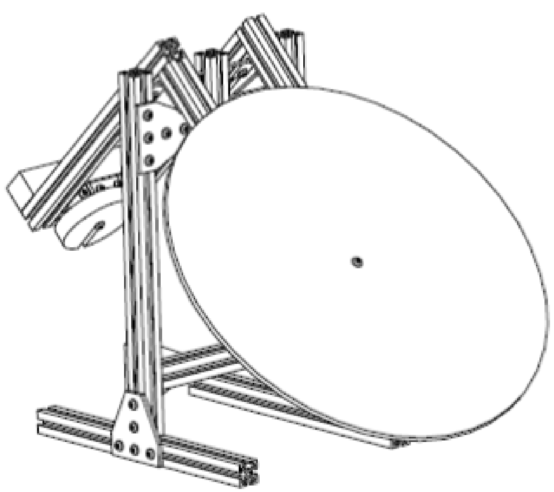
Not all types of showerheads

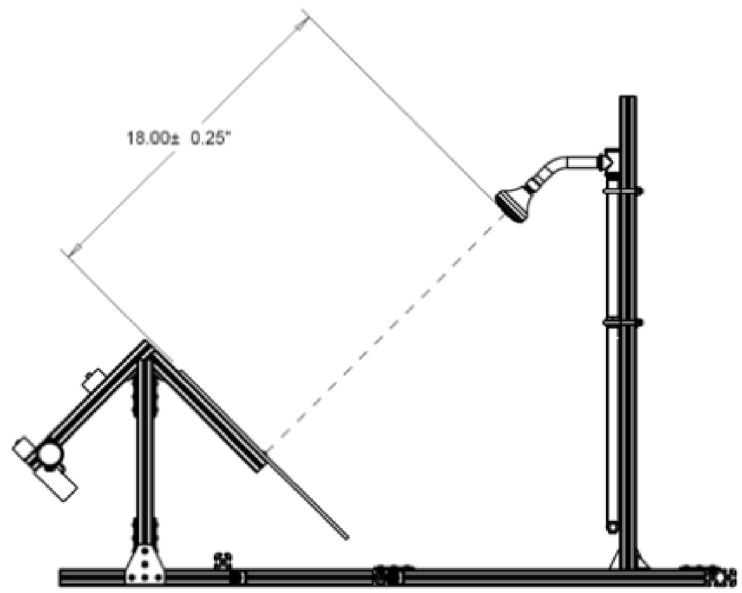
Some showerheads don't provide much force.

Some do.

How to Measure Force

- WaterSense currently measures showerhead Force using a Force Balance Test Apparatus
- Results are Pass / Fail

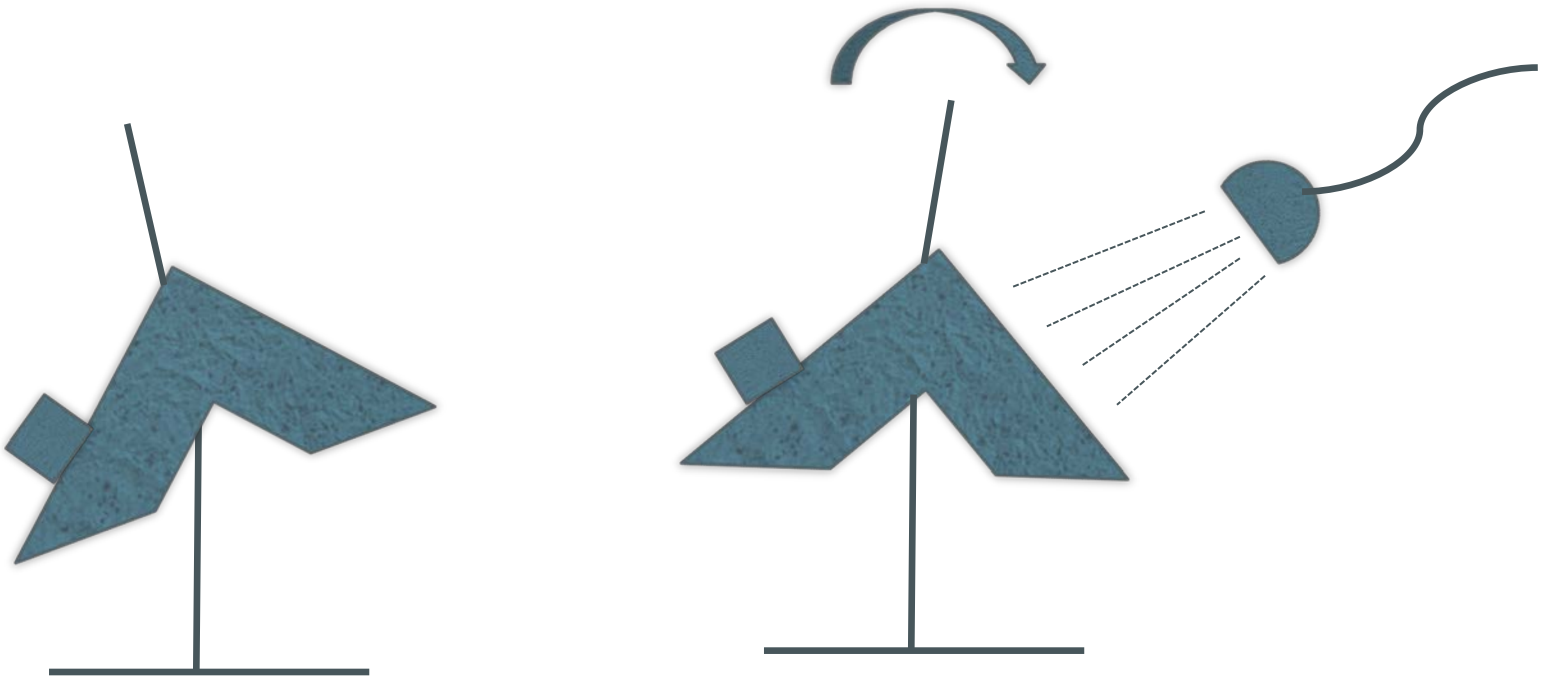




Force Balance Test

- The force of the shower spray (plus the gravitational pull on the water on the disc minus friction) rotates the Force Balance
- Accurately measure degree of rotation (need to at least rotate to vertical)
- Convert degree of rotation to “force”
- Meet minimum degree of rotation = PASS
- Do no meet minimum degree of rotation = FAIL

Measure Rotation



Force Gauge

So, you want to measure Force?

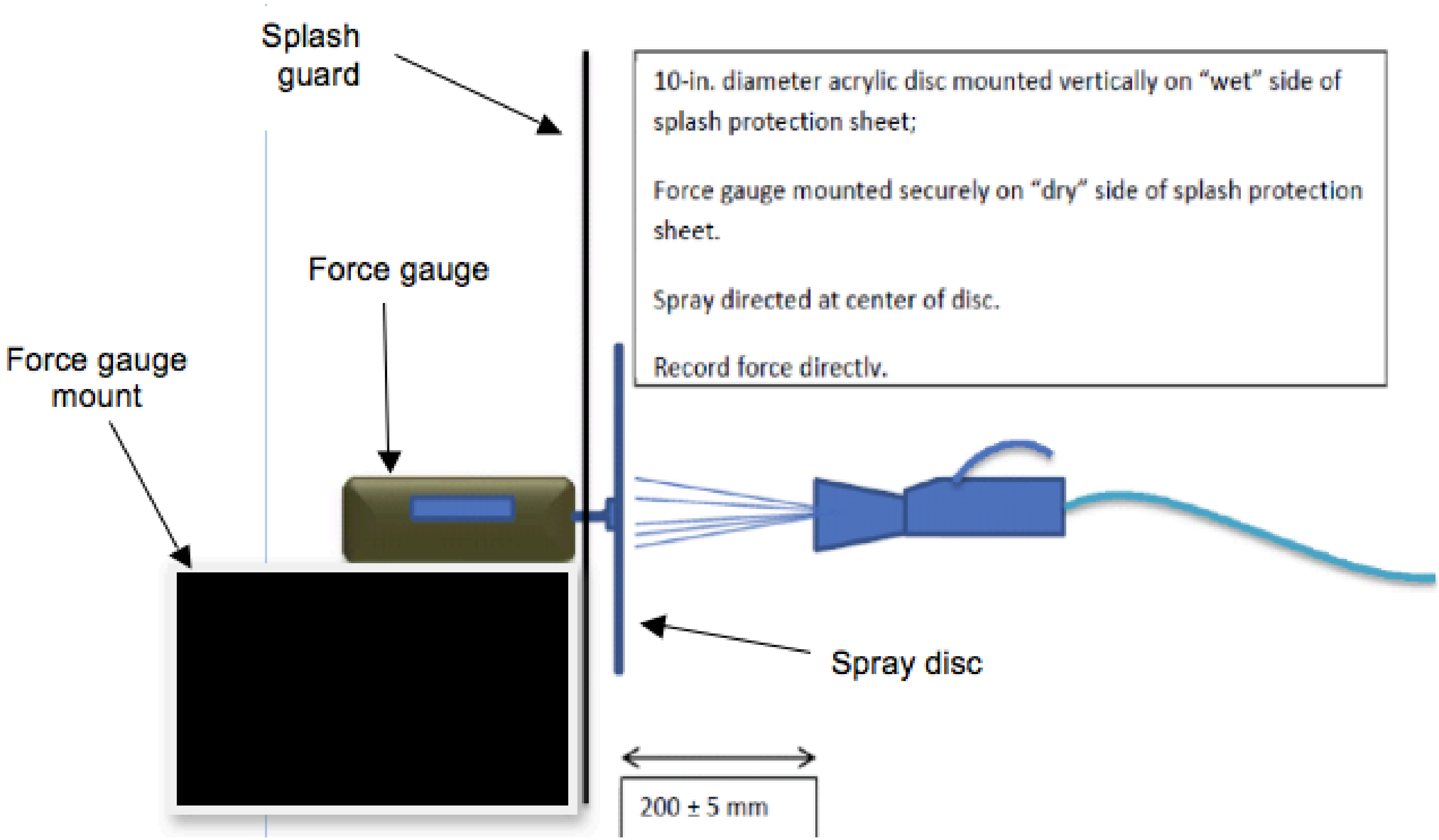
Why not use a force gauge?

Use a vertical plate to eliminate effect of gravity on water.

Eliminate friction losses.

Direct Measurement!

Direct Force Measurement



MaP Website

- Starting in the Fall of 2012, results to be posted on www.map-testing.com
- Not Pass / Fail
- Actual “Force” readings provided
- As well as actual flow rate at test pressure(s)
- Give the consumer info they need to select showerhead that is both efficient and forceful!
- (not useful for consumers looking for a rainwater model)

Future…

- Maybe if we identify showerhead models that offer efficiency and performance we will start to see per capita water demands associated with showering begin to decline.
- Consumers want efficiency – but they don't want to sacrifice.
- And they want to get the shampoo out of their hair!

Thank You

Questions?

www.map-testing.com