This presentation premiered at WaterSmart Innovations

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INNOVATIONS

MEASURING HOW SHOWERS "FEEL" ON THE SKIN

or

(everything you wanted to know about showerheads but were afraid to ask)

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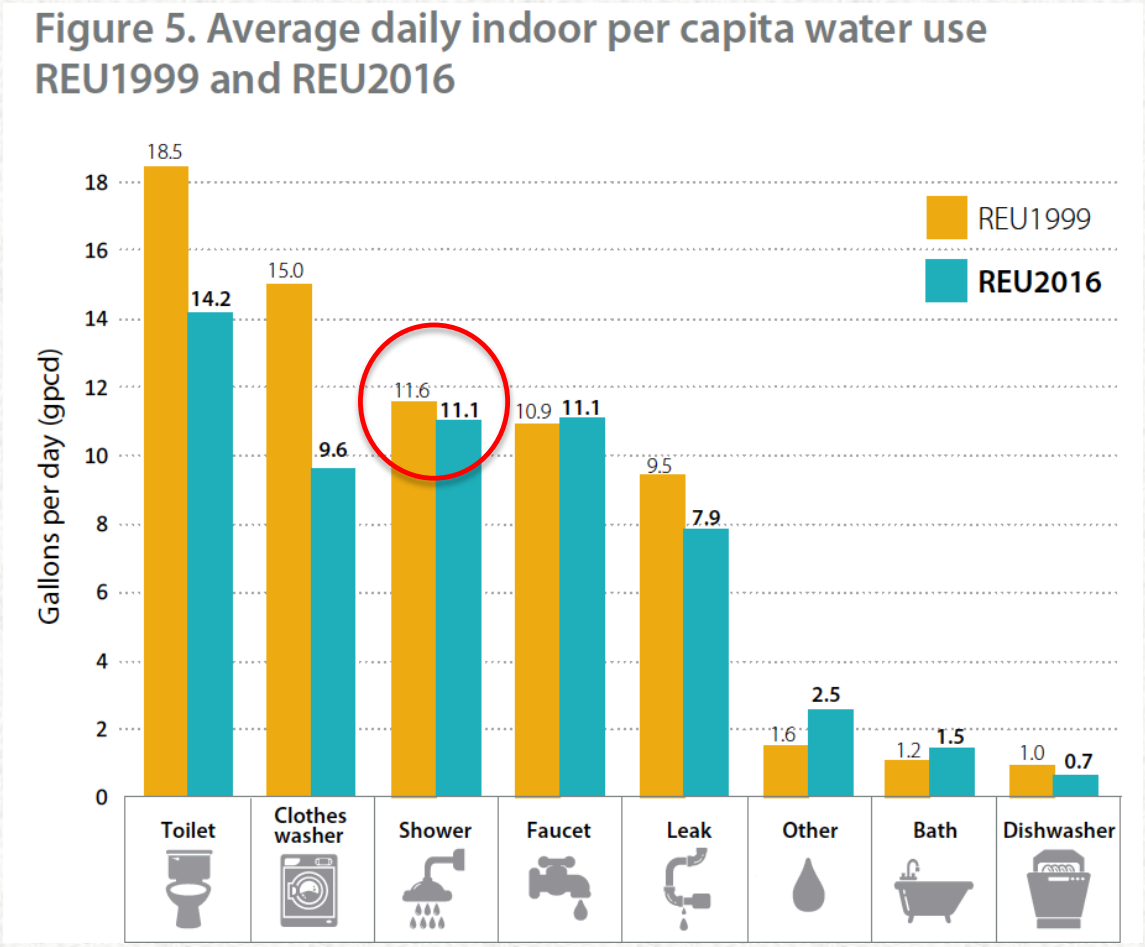
Las Vegas

Showers – Water Demands

- Showering accounts for about 15 - 20% of indoor residential demand
- Per capita demand hasn't declined much since 1999 REUS released
- Why?



Do Lower Flow Rates = Longer Showers?

- Analyzed ~ 42,500 shower events (REUS1999) and 15,500 shower events (REUS2016)
  - data provided by study co-investigator Peter Mayer, P.E.
- **Very little change in average shower duration when flow rate is reduced.**
- Each person has their own shower 'routine'
  - Takes x seconds to wash each part of your body – except perhaps hair - regardless of flow rate
- Every 0.2 gpm decrease = ~ 1.3 gallon savings
- Lower flow rate = water savings!!

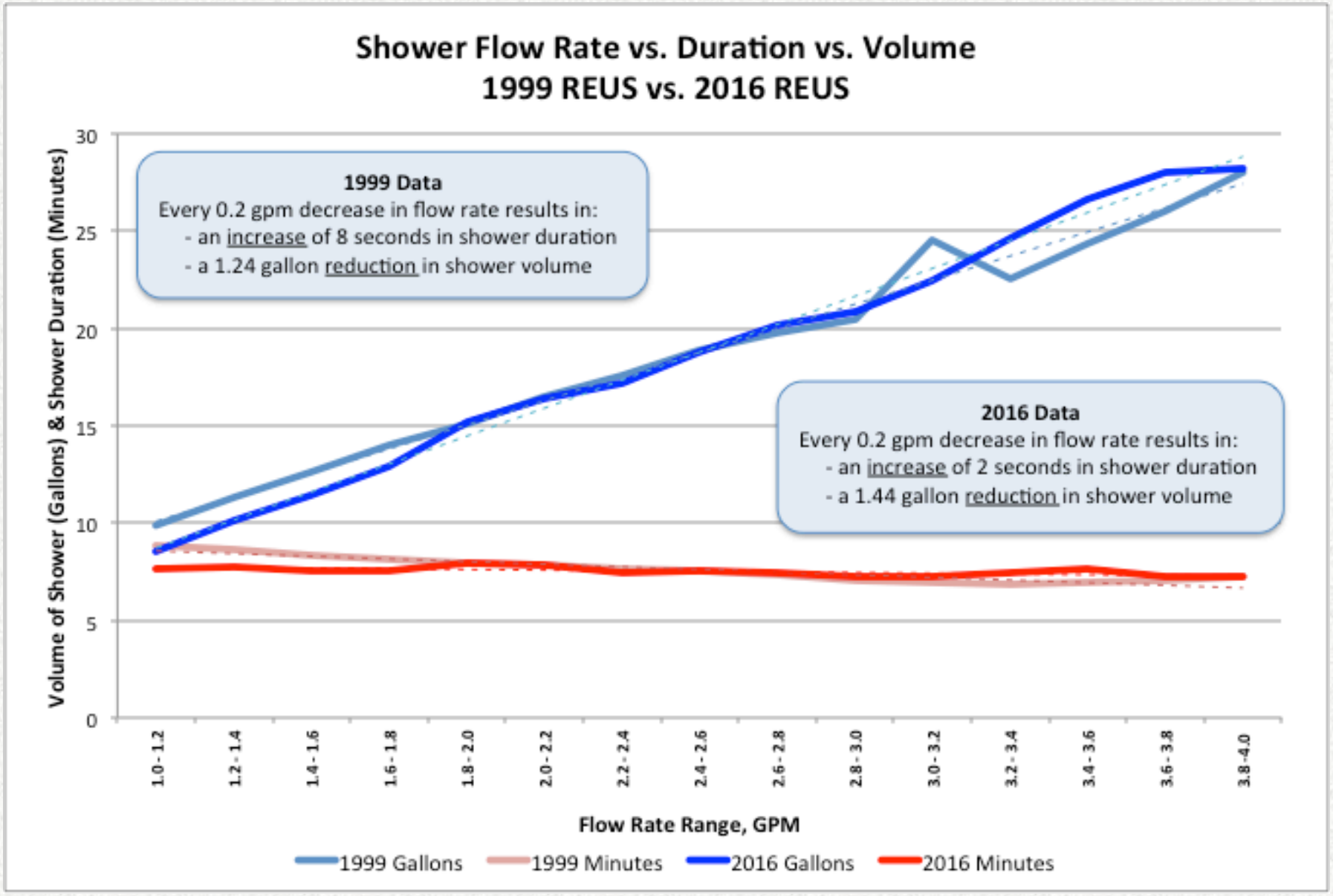
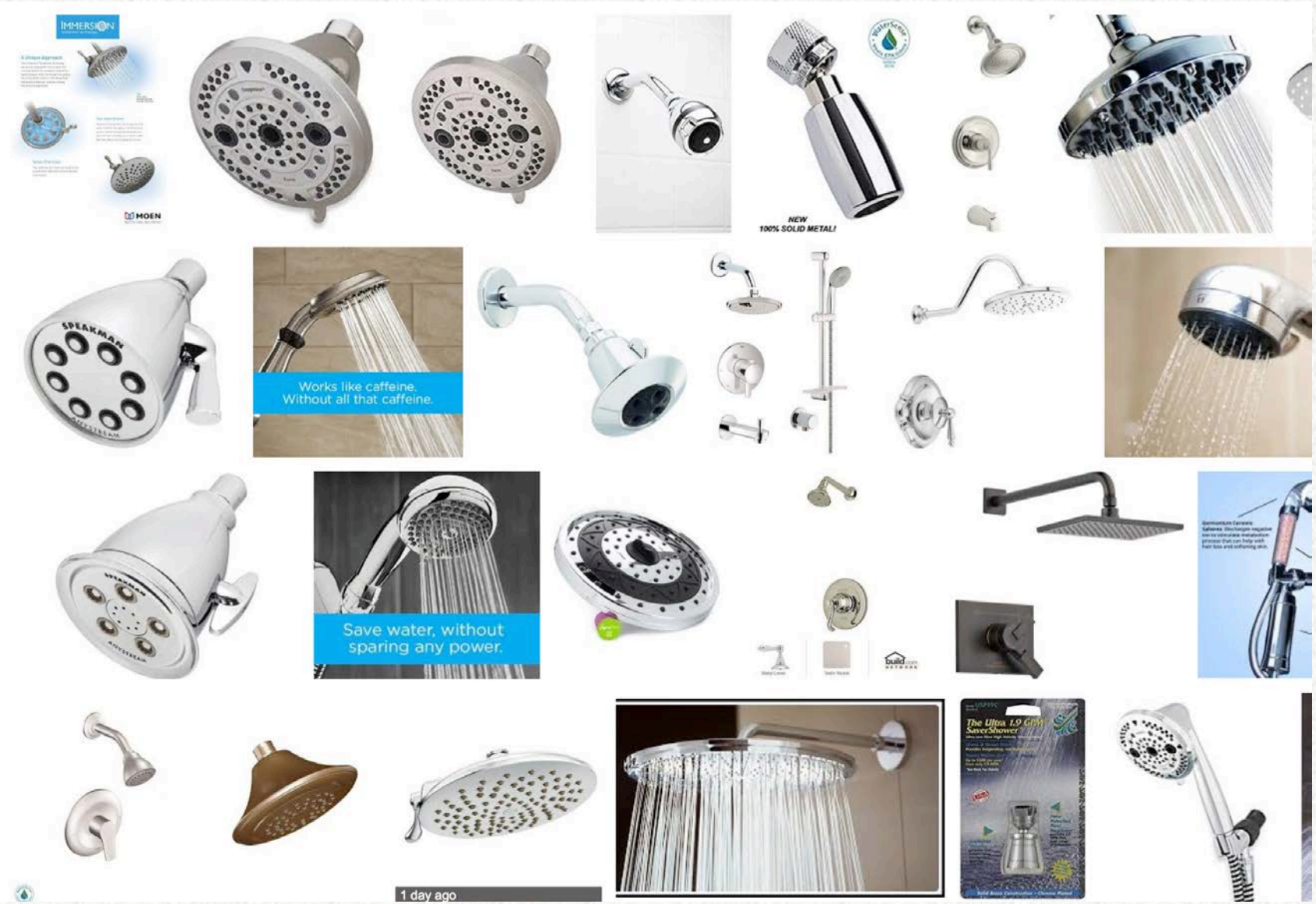

Shower Flow Rate vs. Duration vs. Volume
1999 REUS vs. 2016 REUS
1999 Data
Every 0.2 gpm decrease in flow rate results in:
- an increase of 8 seconds in shower duration
- a 1.24 gallon reduction in shower volume
2016 Data
Every 0.2 gpm decrease in flow rate results in:
- an increase of 2 seconds in shower duration
- a 1.44 gallon reduction in shower volume
Volume of Shower (Gallons) & Shower Duration (Minutes)
0
5
10
15
20
25
30
1.0 - 1.2
1.2 - 1.4
1.4 - 1.6
1.6 - 1.8
1.8 - 2.0
2.0 - 2.2
2.2 - 2.4
2.4 - 2.6
2.6 - 2.8
2.8 - 3.0
3.0 - 3.2
3.2 - 3.4
3.4 - 3.6
3.6 - 3.8
3.8 -4.0
Flow Rate Range, GPM
1999 Gallons
1999 Minutes
2016 Gallons
2016 Minutes

Figure 3

Opportunity for Water/Energy Savings

- Little savings potential with “Take shorter shower” messaging
- Highest savings potential - Reduce flow rate
- But – people prefer high flow/“force” showerheads
- WaterSense - low flow rate PLUS minimum force
  - max flow rate - 2.0 gpm
  - minimum force - 2.0 ounces / 57 grams

MANY Types of Showerhead



Many Offer Different Spray Patterns

Certification Requirements

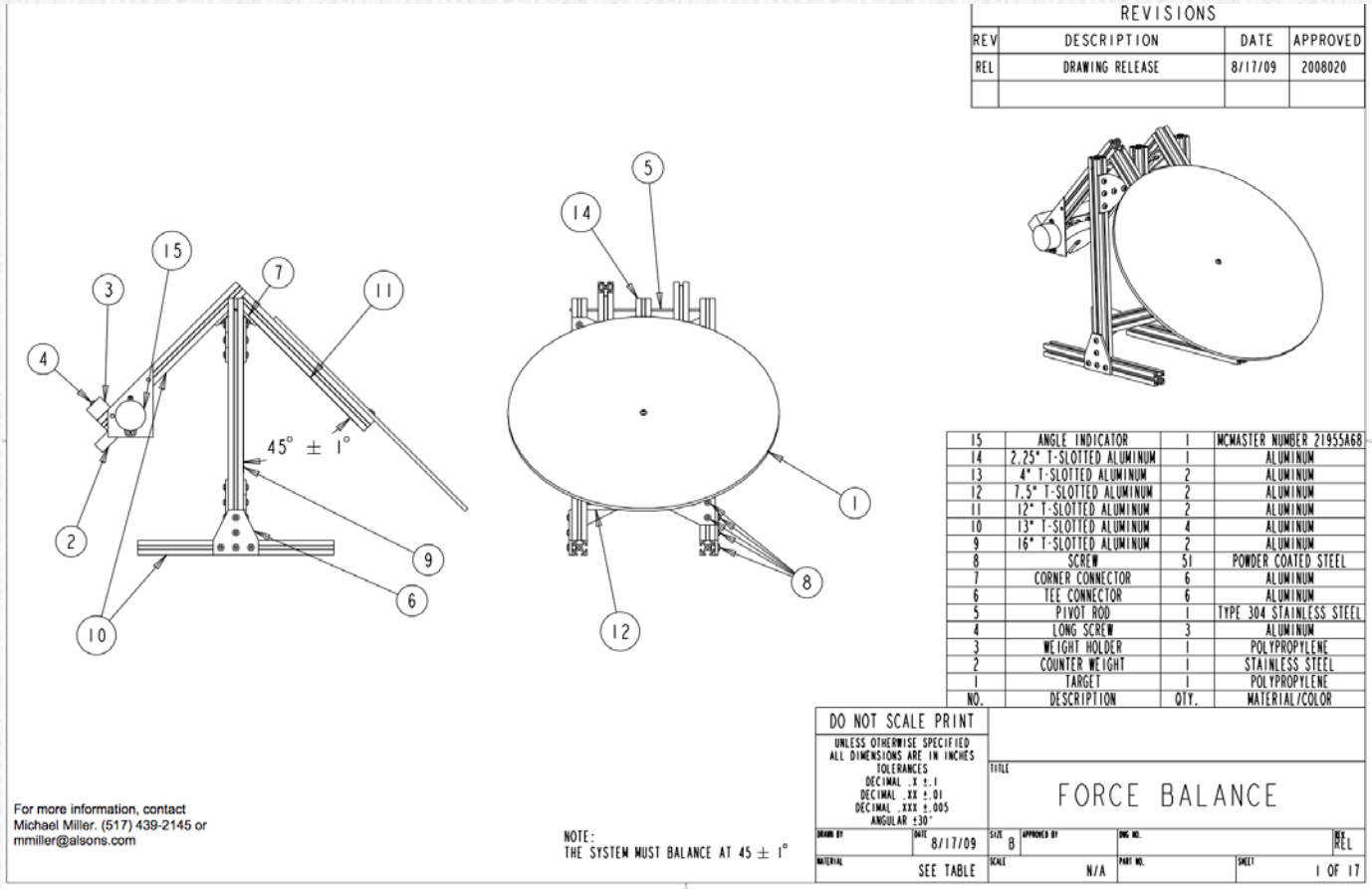
- All certification requirements must be Pass/Fail
- If product meets minimum requirement – it 'passes' and is certified
- Cannot differentiate between "Pass at 50%" and "Pass at 100%"
- Pass/Fail results do not promote innovation
  - Why would a manufacturer spend time/money to improve its showerhead models if no market benefit?
- Currently, showerheads are largely purchased based on aesthetics & price and not performance

So – How do We Improve Showerhead Efficiency

First – Measure Actual Force

- Instead of just measuring to a minimum acceptable force (e.g., 2 ounces)…
- Measure and post online the true force provided by the showerhead
- This allows the consumer to differentiate between showerheads offering different levels of force.
- Help promote competition among manufacturers

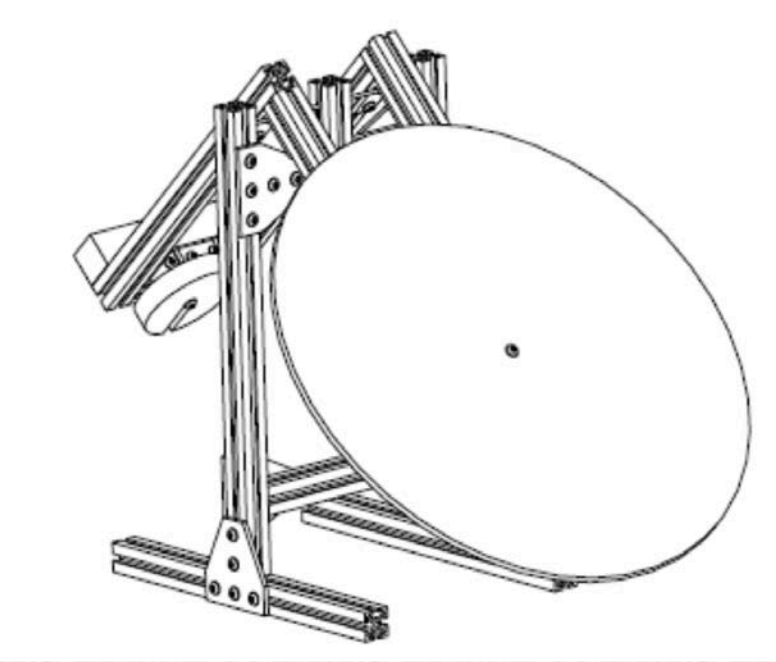
WaterSense Force Balance



- Indirect force measurement via degree of rotation
- Greater rotation = greater force
- Pass if meet minimum required rotation

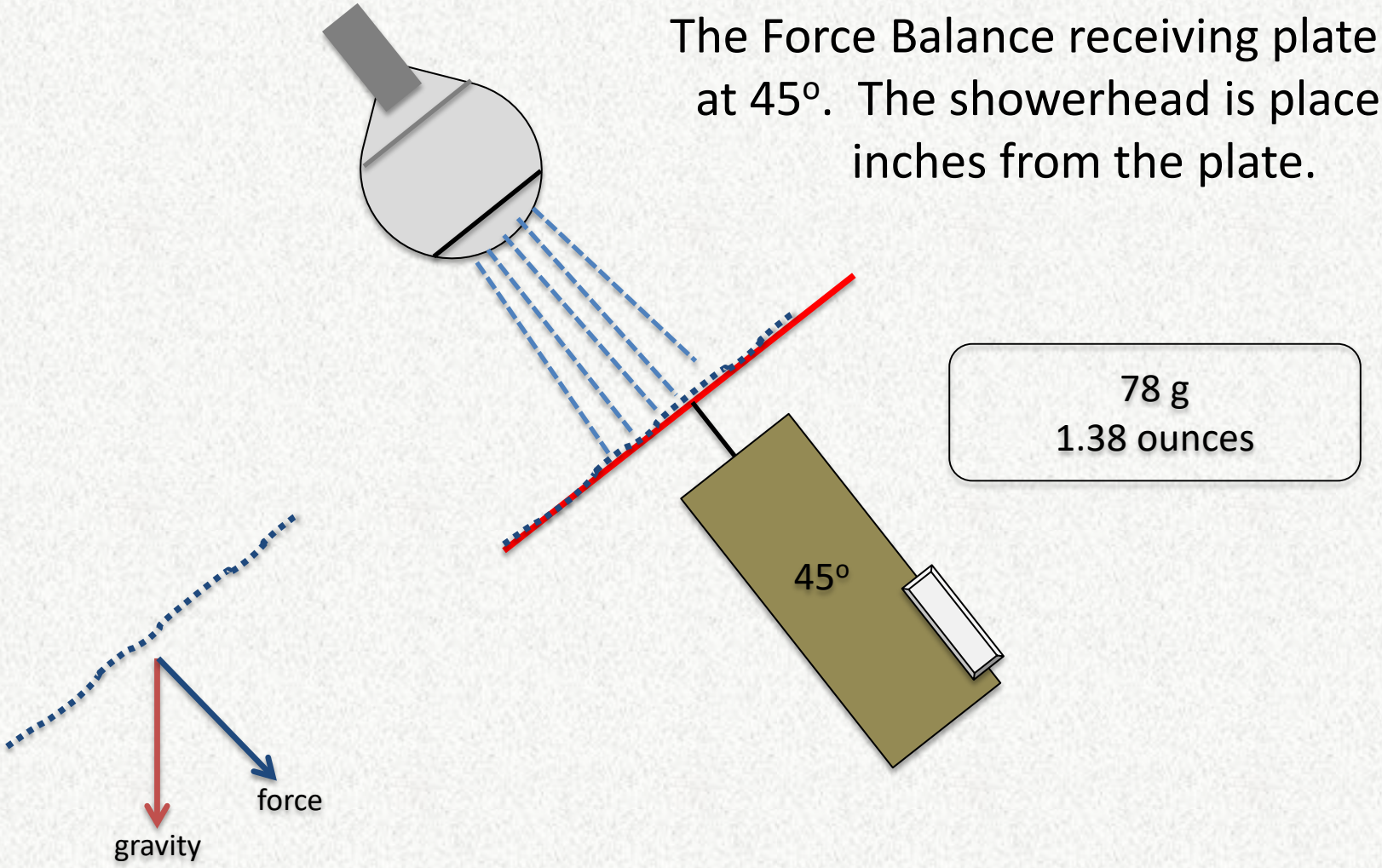
Direct vs. Indirect Measurement of Force

- Indirect may be OK for Pass/Fail
- But direct measurement is better and, in fact, required for any type of rating program
- Accurate and Repeatable

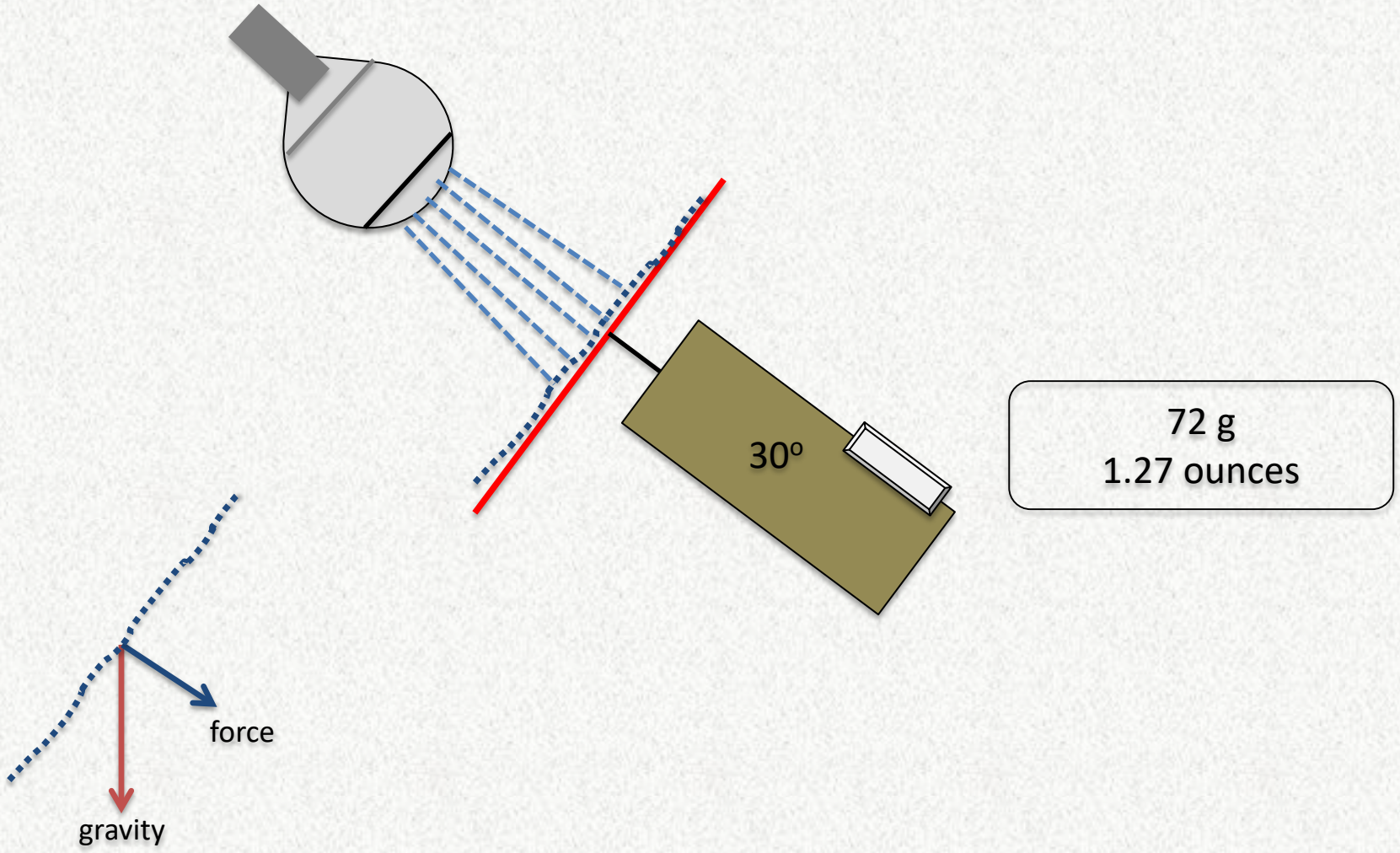


Second – Determine if angle of receiving plate impacts force measurement

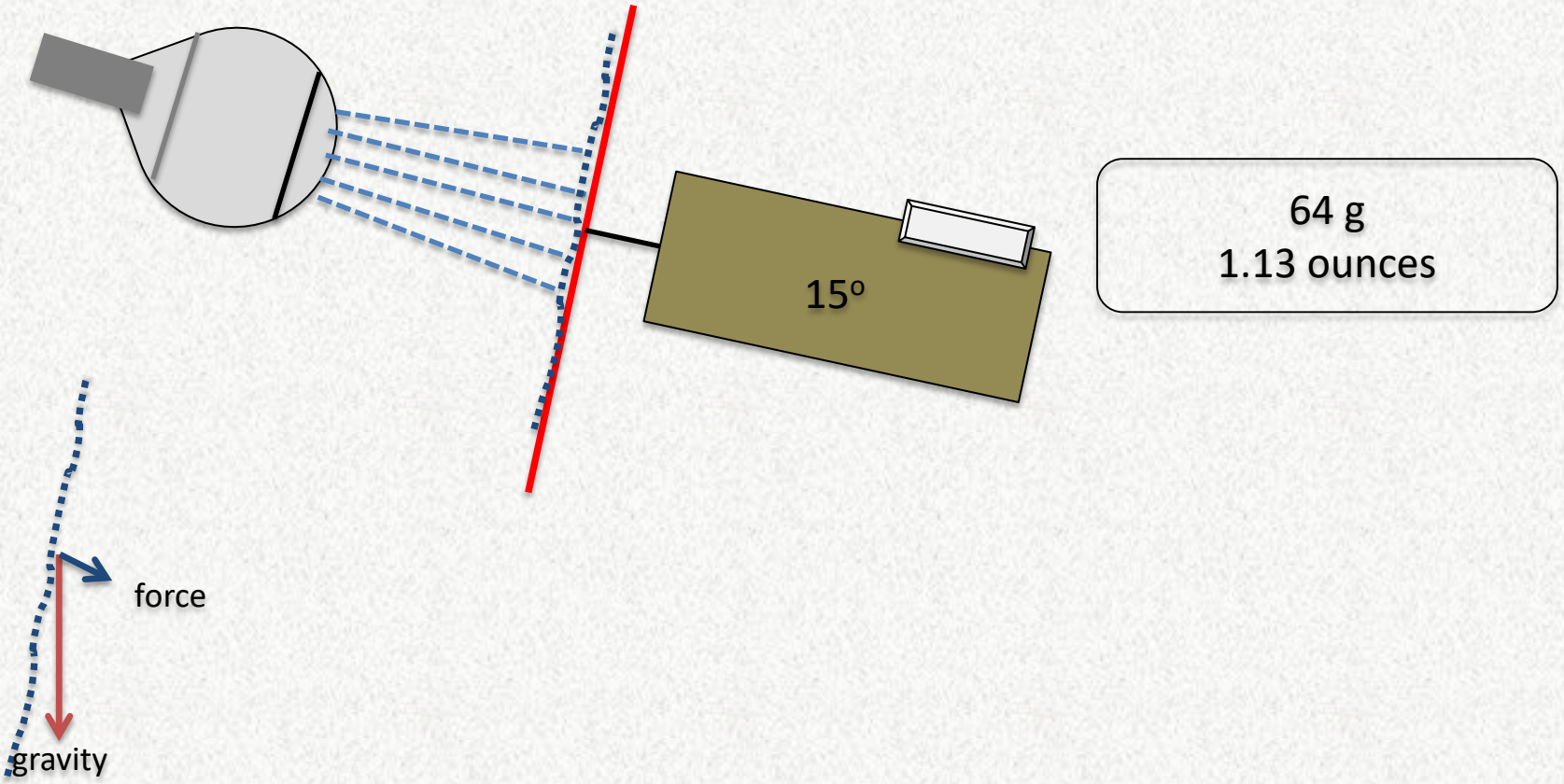
The Force Balance receiving plate is set at 45°. The showerhead is placed 18 inches from the plate.



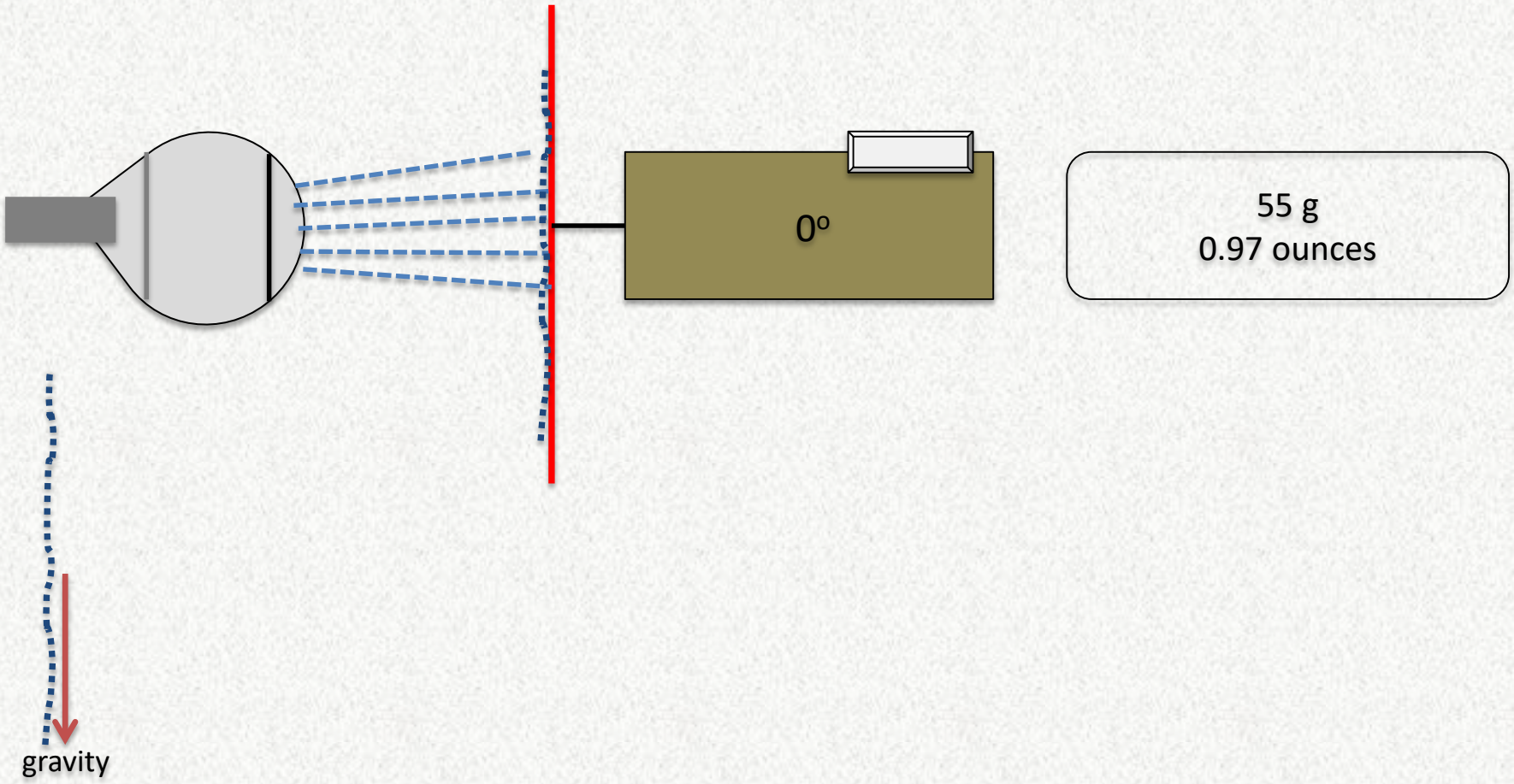
Changing angle of receiving plate does affect force measurement



As angle gets closer to vertical, less water ‘sits’ on plate and direction of the force of gravity on ‘sitting’ water is reduced



At vertical position minimal water ‘sits’ on plate and force of gravity on sitting water is eliminated



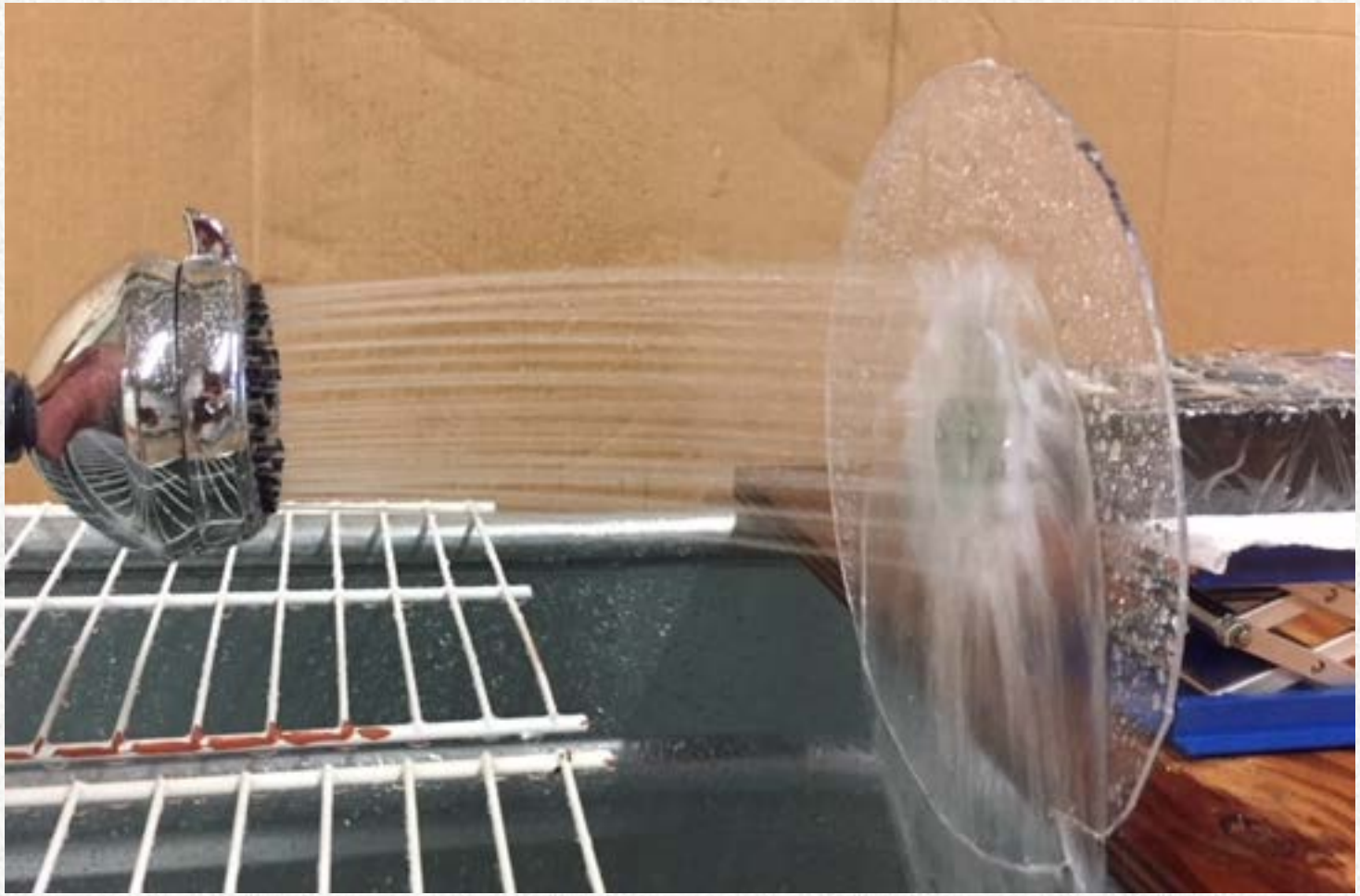
Influence of Gravity on Measured “Force”

Receiving Plate Degrees from Horizontal	Measured “Force”, grams	Measured “Force”, ounces
0	55	0.97
15	64	1.13
30	72	1.27
45	78	1.38

Need to eliminate influence of gravity by using vertical receiving plate!

Third – Determine Sensitivity of Distance Between Showerhead and Receiving Plate

16 inches



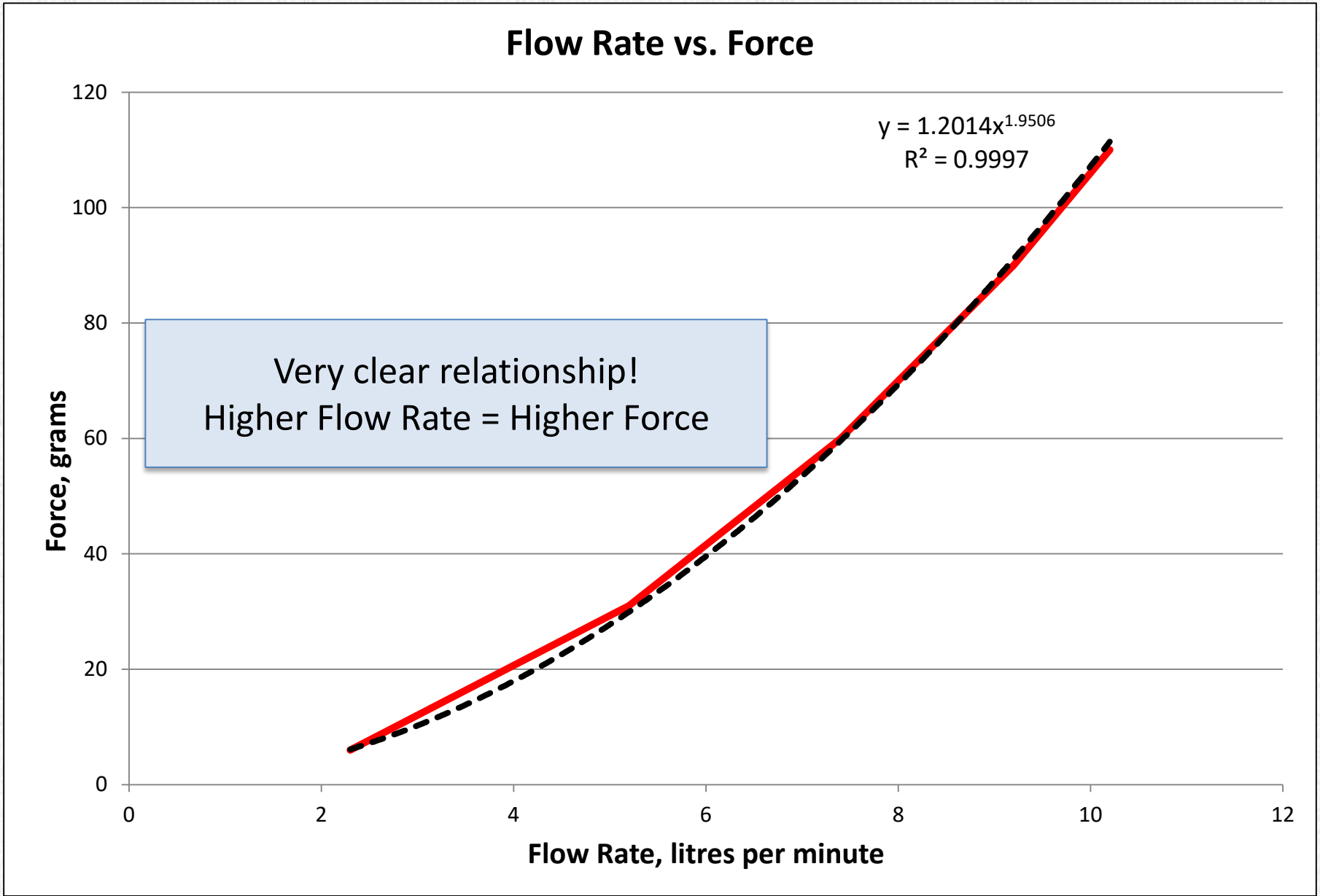
8 inches

4 inches

55.1 grams at 16 inches
55.2 grams at 4 inches

Distance to receiving plate <u>is not critical</u> (as long as all flow strikes plate)

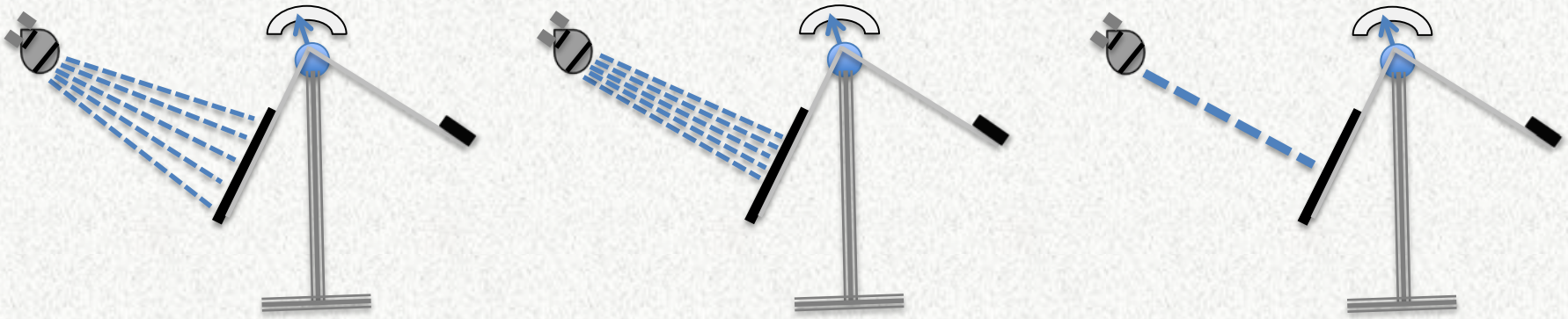
Forth: Determine Impact of Flow Rate on Force



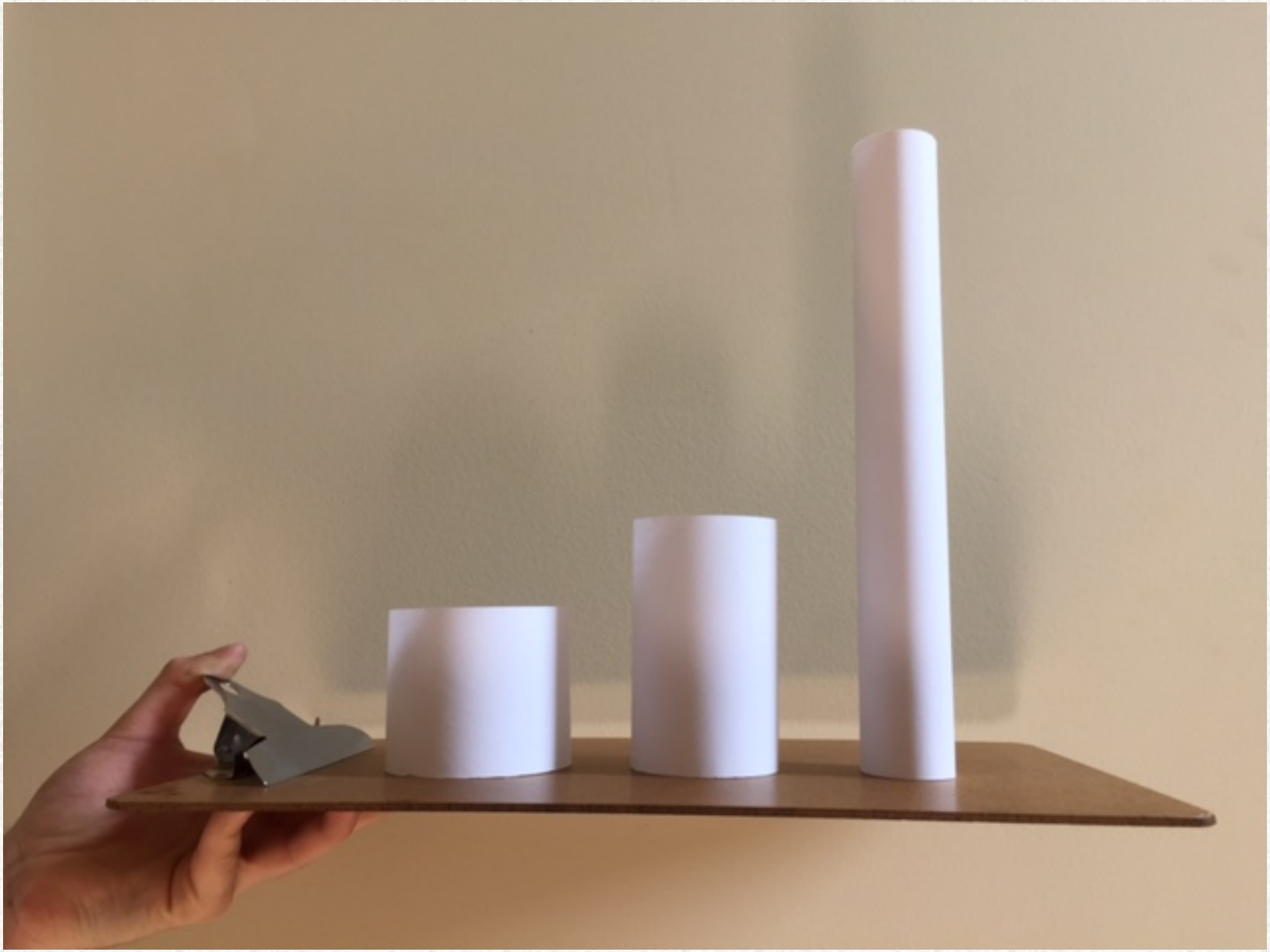
Total Force Measurement is not Enough

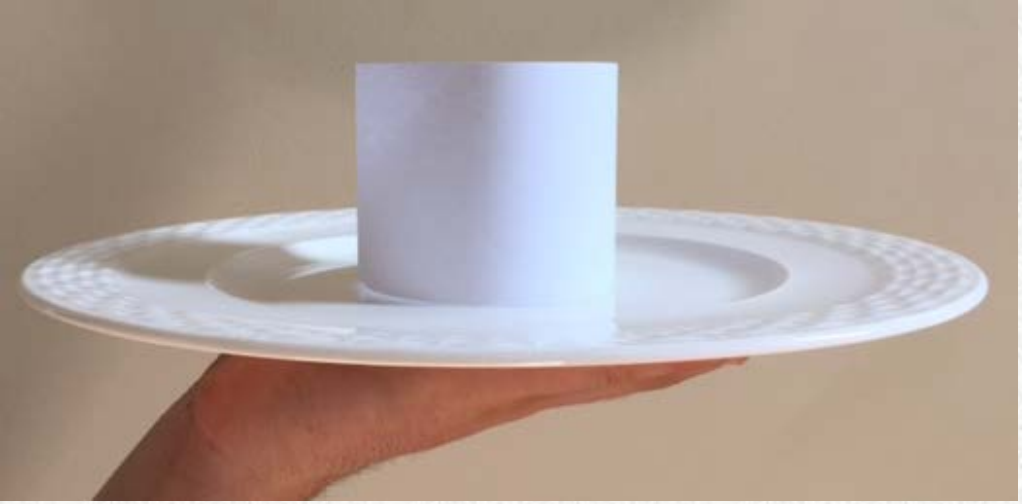
- All things being equal – showerheads with higher flow rate will provide higher total force
- Goal is to achieve the highest force with the lowest flow rate
- Listing just overall force will promote development of even higher flow rate showerheads
- One way is to rate by “Force per gpm/Lpm”
- One way is to rate based on how spray ‘feels’ on the skin

Force Balance / Force Gauge Can't Distinguish Between Different Patterns with Same Force



- Spray is directed onto a disc
- Force balance/gauge "see" all spray patterns as same
  - Note: WaterSense also requires minimum spray coverage
- But your skin can distinguish difference in force and coverage!





More than about just force and coverage.

A Gram is Not Just a Gram

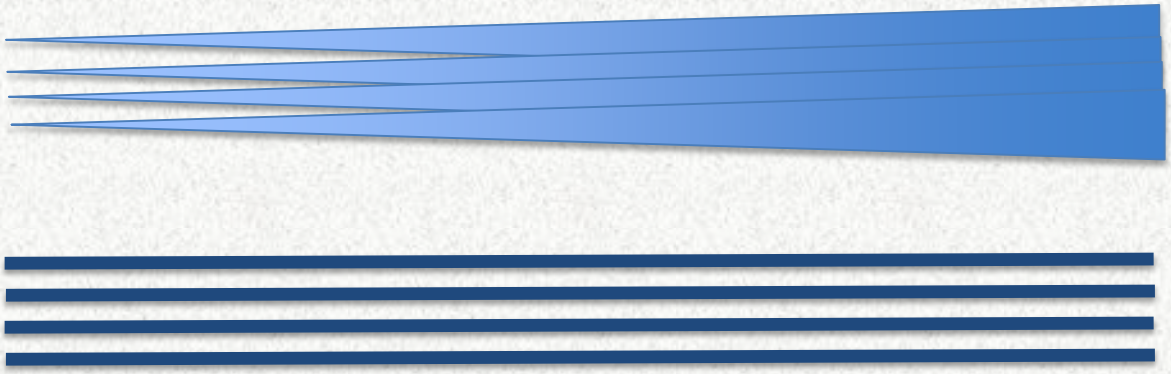
- Our muscles feel weight
- Our skin feels pressure
- One pound over an area of 1 $in.^2$ = 1 PSI
- One pound over an area of 1/8 $in.^2$ = 64 PSI
- Defined jet of water ‘feel’ more forceful on skin even if overall force is same
- Potentially incorporate defined jets into new showerhead designs – feel more forceful without increasing flow rate

Well Defined Jets of Water

Poorly Defined Jets of Water

Designed for “Feel”

- Option #1: showerhead can be designed that deliver well defined jets of water to offer the feel of greater force



Option #2

- Our skin is elastic – it can stretch
- When a jet of water hits our skin, it stretches
- When the jet stops, our skin ‘bounces’ back – but it takes some time
- Instead of steady stream jets…

- Rapidly pulsed alternating jets…

- Potentially feel same force with 50% of flow rate

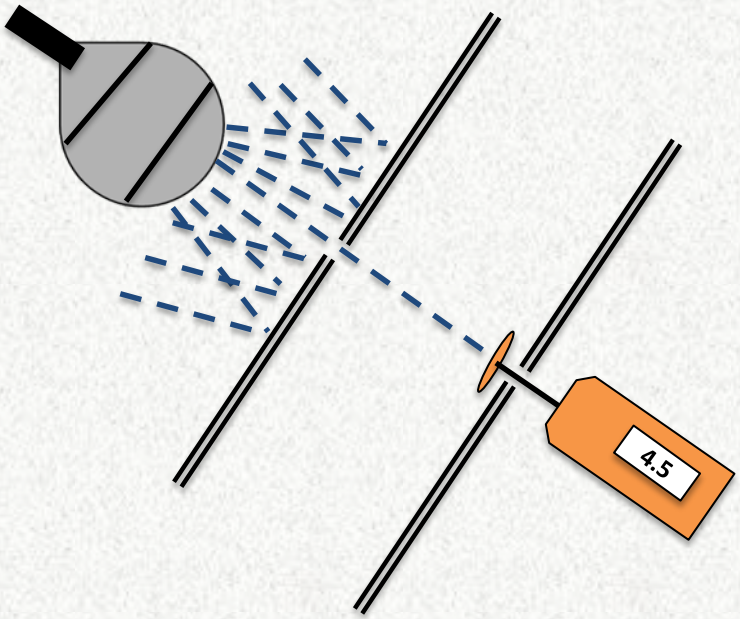
Option #3

- Concentrate the available force by having fewer jets

What's Next…

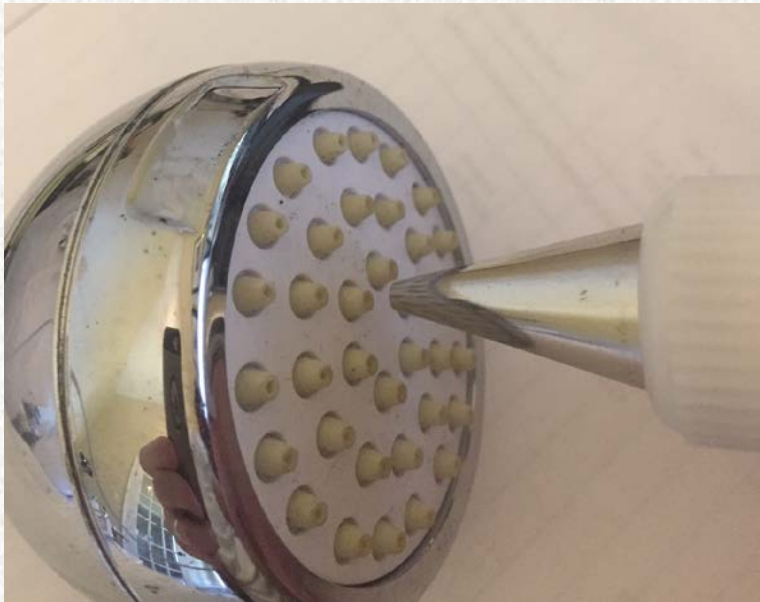
- Continue to conduct lab testing on a variety of showerhead types
- Define important rating characteristics
- Develop a MaP Testing for Showerheads
- Post the test results online
- Create competition among showerhead manufacturers to develop *higher force-lower flow rate* models – they'll figure it out!

Possibly Even Measure Force of Single Jet



- Small hole in Plexiglas allows a single jet of water to pass
- Single jet strikes force gauge
- Measured force plus cross sectional area used to determine PSI (feel on skin)


TRI FLOW
3.5GPM/13.2LPM MAX
SPRAY
MASSAGE
NIAGARA



Make Rating System Easy for Consumers Understand

Thank You!

Questions

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