



RESEARCH IN RAINWATER CATCHMENT

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Overview of Research

- Basics
- News
- Why it is needed
- Current at Texas A&M
 - First flush diverters
 - Drip tubing testing
 - Storage container water temperature
- University of Texas study



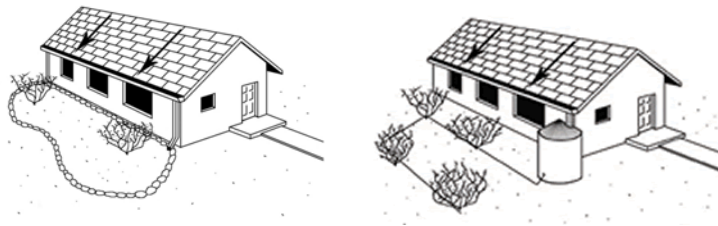
What is Rainwater Harvesting?

- **Rainwater harvesting** is the capture, diversion, and storage of rainwater for later use.



Types of RWH

- **Passive (simple)** – Distributes rainwater immediately. Uses the landscape as storage
- **Active (complex)** – Stores some or all rainwater for later use.



Active RWH Systems

- Tank Based systems
 - Irrigation
 - Landscape water features
 - Pet/livestock/wildlife watering
 - In-home use



The Latest

- HB 3391 – rules are currently being worked out
 - Includes rainwater harvesting in new state buildings
 - Requires municipalities to be trained in rainwater harvesting
 - Does not allow HOAs from prohibiting water conservation practices
 - Allows rainwater harvesting for indoor potable use if connected to municipal supply

Why Research is Needed

- RWH is relatively new...
- Sets standards
- Meets goals of increasing:
 - Safety
 - Efficiency
 - Profit
- More reputable to:
 - Public
 - Permitting authorities



Research at Texas A&M

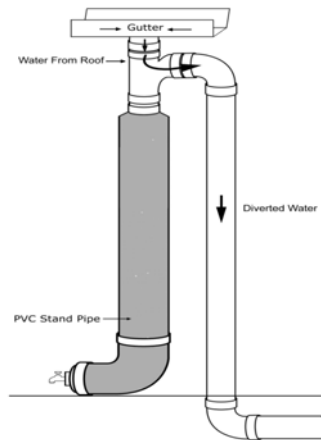
- Contaminant mixing in first flush diverters

Thesis research of Justin Mechell



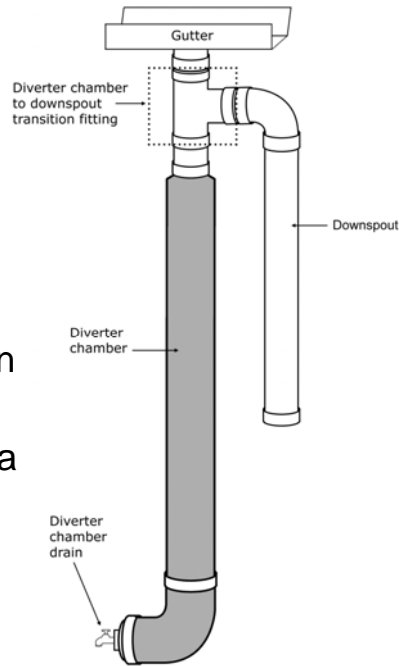
First Flush Diversion

- Method of pre-storage treatment

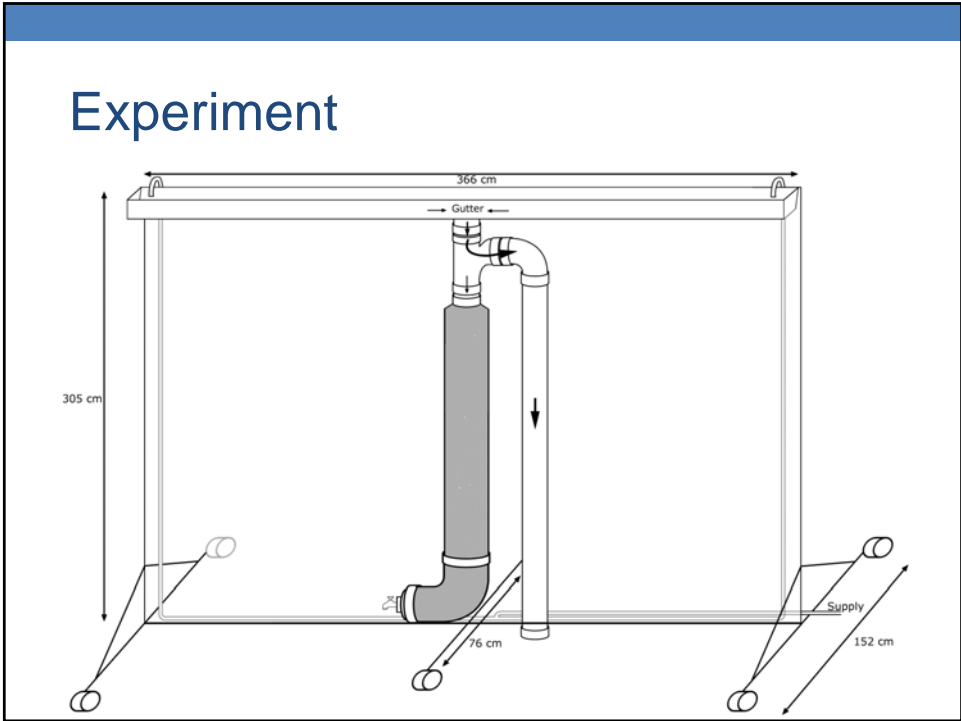


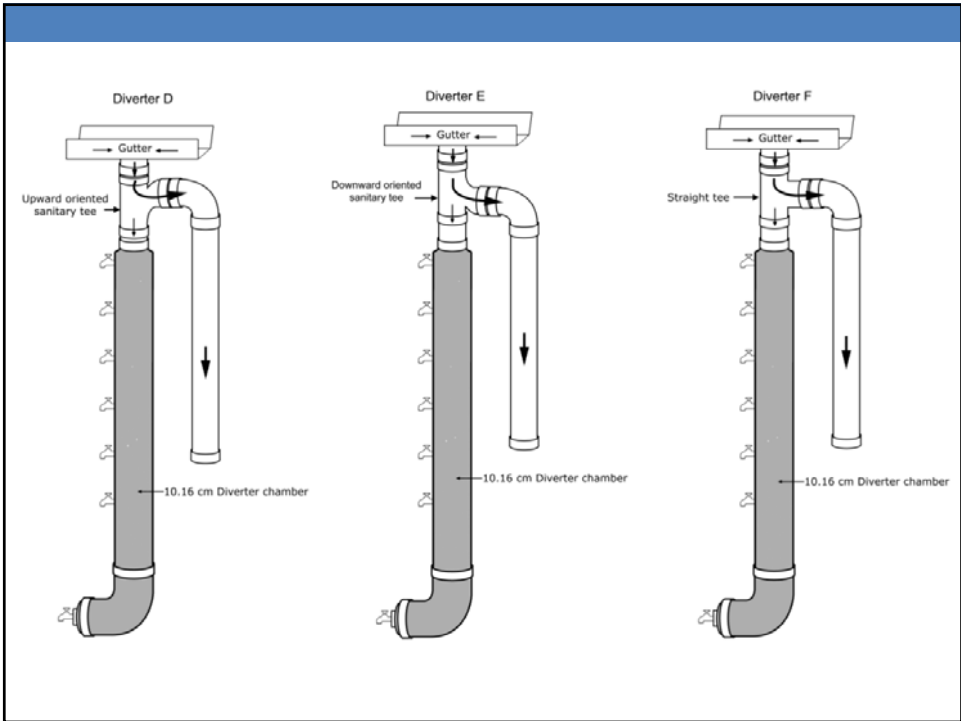
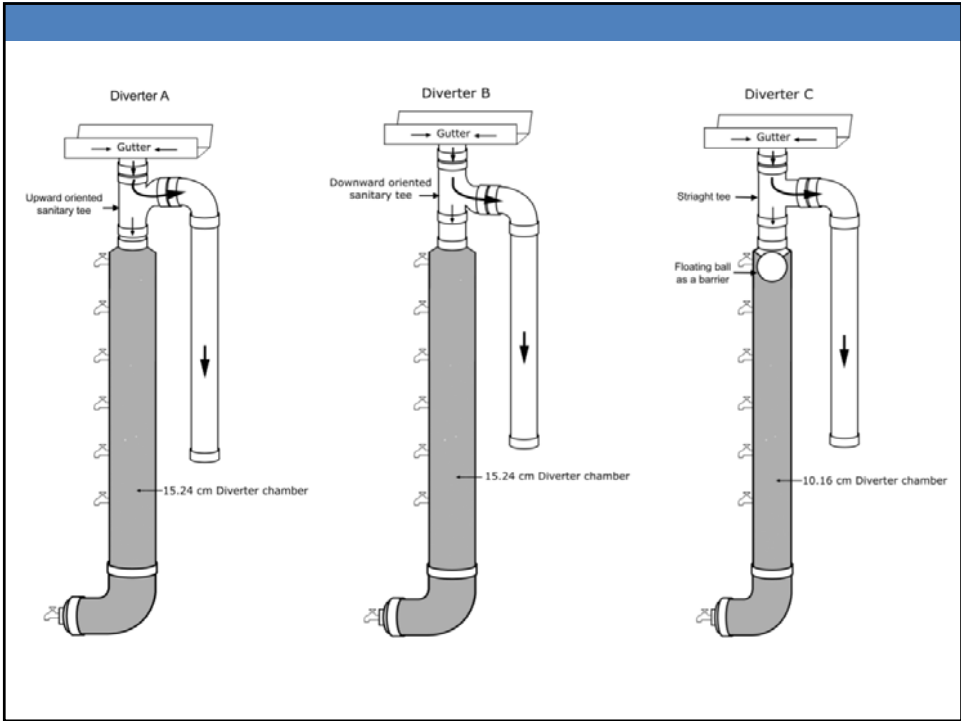
Research Objectives

- Effect of transition fittings on mixing depth
- Effect of diverter chamber diameters on mixing depth
- Impact of utilizing a floating barrier in first flush diverter on mixing depth
- Impact of utilizing a drain on a downspout first flush diverter in relation to mixing depth



Experiment





Conclusions

- 1) Upward and downward oriented sanitary and straight tee transition fittings do not have a significant impact on the mean difference in initial and final TDS concentrations observed at multiple sample ports.
- 2) Utilizing a straight tee as a transition fitting with a floating ball, limited diverted water from interacting with the subsequent flow of harvested rainwater.

Conclusions

- 3) There is not a significant difference between the use of a downspout first flush diverter with diameters of 4 and 6 inch

Research at Texas A&M

- Effects of Storage Container Color and Shading on Water Temperature

Thesis research of Brent Clayton



Research Goal

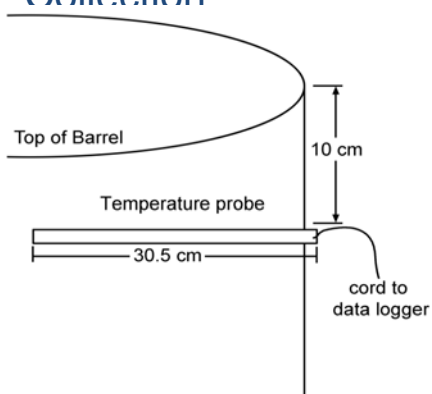
- Determine the effect of the water storage container color and its shading on the temperature of the water inside that container



Materials and Methods – Storage Containers

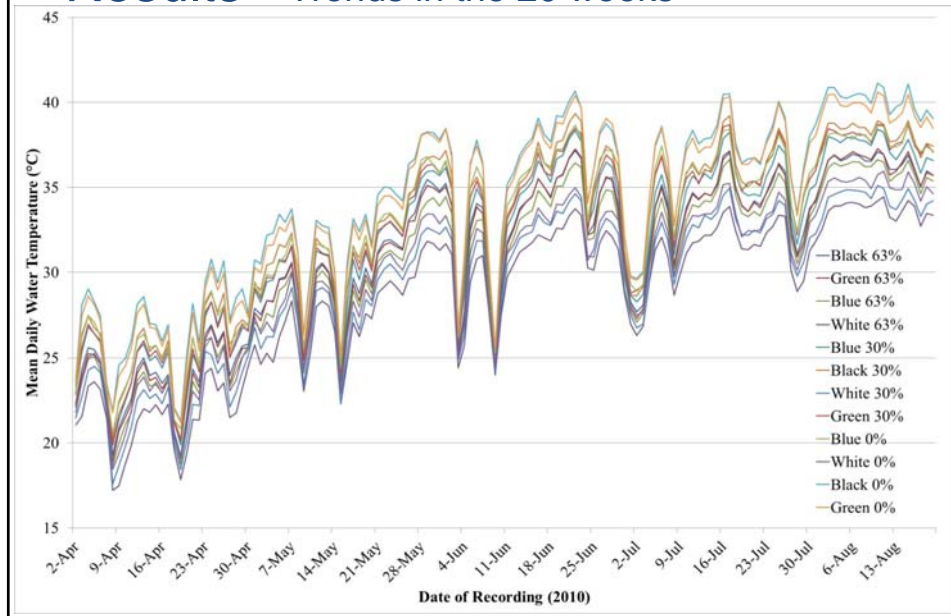


Materials and Methods – Data Collection



- Temperatures were recorded 3 times a day for 20 weeks.
- Recorded: April 2 – August 19, 2010

Results – Trends in the 20 weeks



Results – Interaction Effect

- Black and green colors and 0% and 30% shade had the greatest temperatures
- White color and 63% shade had lowest temperatures
- Why?
 - White color has lower absorptivity value than black
- Greatest difference: 5.61°C
- Least difference: 0.16°C

Treatment	Mean (°C)
Black / 0%	34.16
Green / 0%	33.87
Black / 30%	32.64
Blue / 0%	32.57
Green / 30%	32.27
Blue / 30%	31.94
Black / 63%	31.06
Green / 63%	30.90
Blue / 63%	30.45
White / 0%	29.93
White / 30%	29.33
White / 63%	28.55

Results – Interaction Effect

Most unexpected result?

Source	DF	Sum of Squares	Mean Square	F Ratio
Color	3	8779.94	2926.65	273.30
Shade	2	4813.26	2406.63	224.74

Treatment	Mean (°C)
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Conclusions

Color

- Color is more important at controlling water temp. than shade
- Rainwater harvesting installers should use a white coating for tank to have coolest water temperatures (regardless of shading)
 - Container must be opaque*



Conclusions

Shade

- Shade cloth *does* lower temp. (3.1°C in black containers), however cost and aesthetics will limit use
- Natural shading usually substitutes this. However, it does lead to debris...



Research at Texas A&M

- Drip irrigation tubing utilizing gravity pressure

Research Project for Rio Grande Basin Initiative



Research Goal

- Determine the lateral lengths of drip irrigation tubing for rainwater harvesting applications utilizing gravity pressure



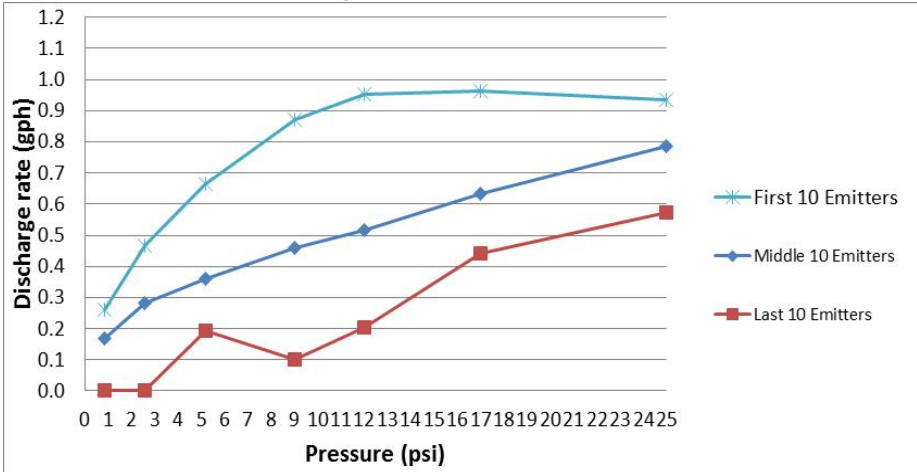
Materials and Methods

- Two types of commercially available drip tapes:
 - Mister LS
 - Toro Drip in PC
- Design discharge rates:
 - Mister LS: 1.00 gph @ 25 psi
 - Toro Drip in PC: 0.53 gph @ 30 psi
- Both tapes had emitter spacing of 12 inches
- 300 foot long length connected to testing apparatus
- Samples taken from first, middle and last 10 emitters
- Samples were weighed to obtain volume



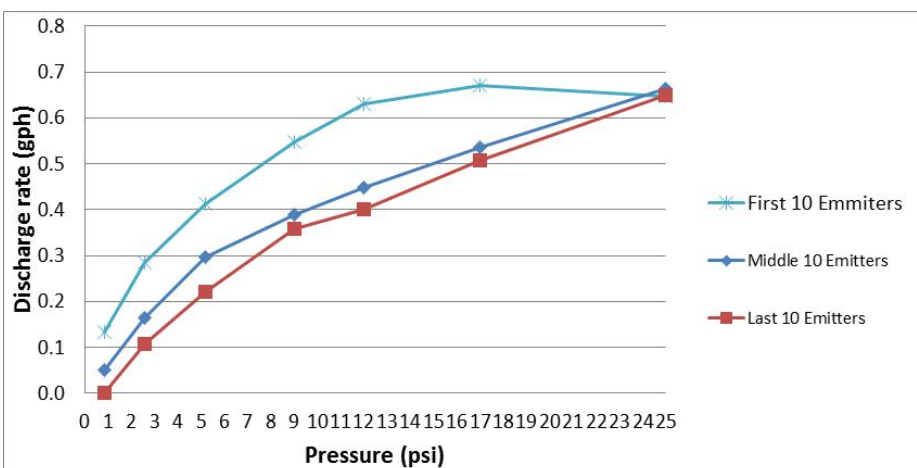
Results

Average emitter discharge rate of Mister Irrigator (Mister_LS (MLD-HDT100)) drip product at low pressures along a 300 foot lateral run



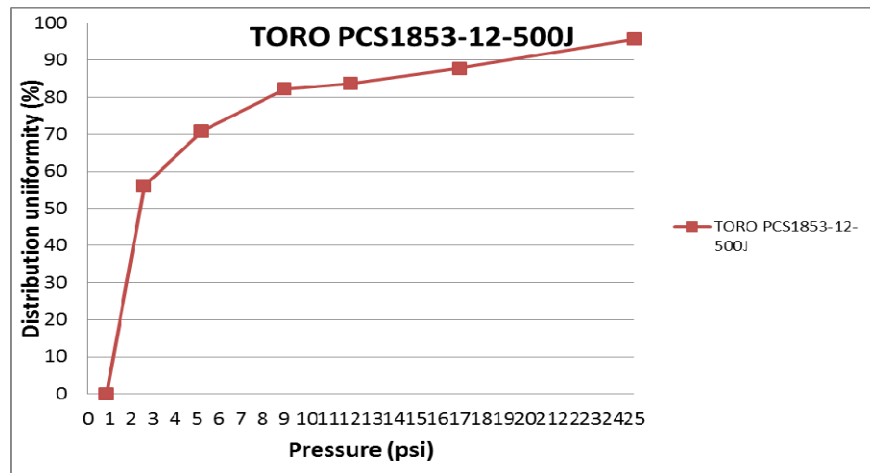
Results

Average emitter discharge rate of Toro (PCS1853-12-500J) drip product at low pressures along a 300 foot lateral run



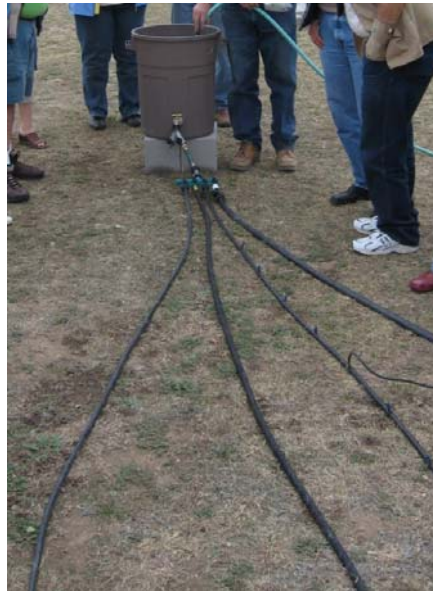
Results

Average emitter discharge distribution uniformity Toro (PCS1853-12-500J) drip product at low pressures along a 300 foot lateral run



Conclusions

- Discharge rates and distribution uniformity are reasonable at low system pressures
- Lines exceeding 100 feet should have supplemental pressure to ensure appropriate distribution uniformity



University of Texas study

- The effect of roofing material on the quality of harvested rainwater

*Texas Water Development Board research grant done
by University of Texas*

As seen in: *Water Research* 45 (2011) 2049-2059



Research Goal

“Thoroughly examine the effect of roofing material on the quality of harvested rainwater from the standpoint of suitability for domestic use.”

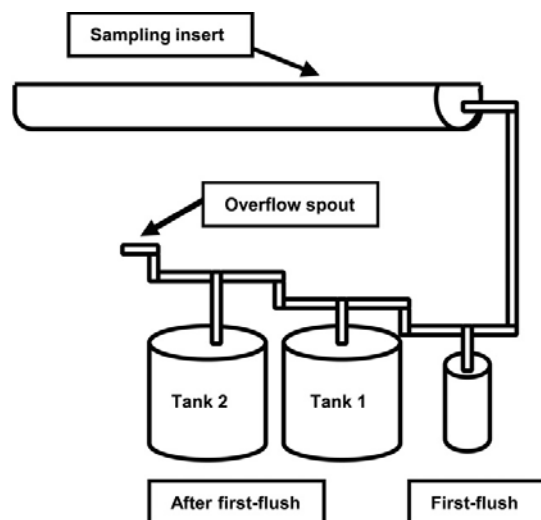


Materials and Methods

- Pilot-scale roofs
 1. Asphalt fiberglass shingle
 2. Metal
 3. Concrete tile
 4. Green
 5. Polypropylene cool modified bituminous membrane
- Full Scale Residential Roofs
 1. 12-year-old Galvalume roof (22° from horizontal)
 2. 5-year-old asphalt shingle roof (23° from horizontal)
 3. 5-year-old asphalt shingle roof (18° from horizontal)

Materials and Methods

- Sampling device used to collect water from pilot roofs and residential roofs
- Collection device was also used to collect pure rainfall

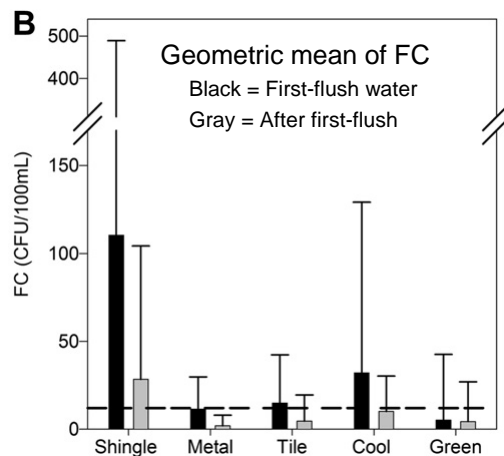


Materials and Methods

- Rainwater harvested from roofs were sampled from various rain events during 2009
- Pilot-scale roofs tested for: pH, conductivity, total coliform (TC), fecal coliform (FC), turbidity, total suspended solids (TSS), dissolved organic carbon (DOC), nine metals (aluminum, arsenic, cadmium, chromium, copper, iron, lead, selenium, and zinc), nitrate, nitrite, pesticides, and PAHs
- Full-scale roofs tested for: TC, FC, TSS, DOC, lead, zinc, pH, conductivity, turbidity, nitrate, nitrite, and volatile and semi-volatile organic compounds (VOCs and SVOCs)

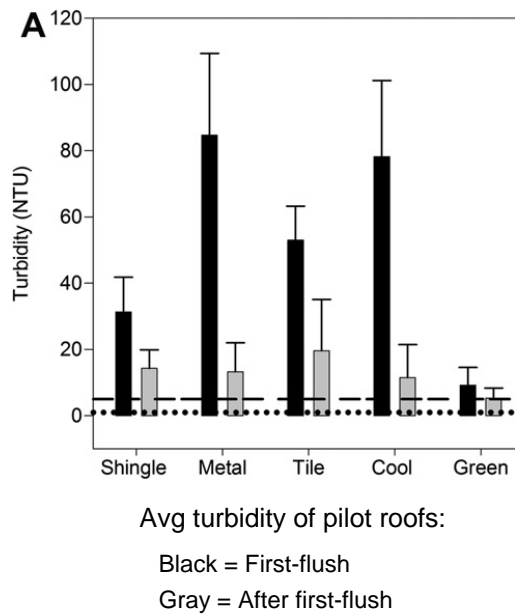
Results

- Bacteria concentrations from metal roofs were significantly lower than others



Results

- Turbidity levels were significantly higher in first-flush water than sample water



Conclusions

- Additional treatment (after first-flush) needed to treat TC, FC, turbidity and aluminum to meet EPA guidelines
- Concrete tile and cool roofs are good candidates for RWH roofs
- Shingle and green roofs have high DOCs concentrations which could lead to disinfection byproducts when using chlorine.

Questions?

