ONE WATER SOLUTIONS INSTITUTE

Connecting world class research with real-world water challenges

Colorado State University

Urban Stormwater to Enhance Water Supply

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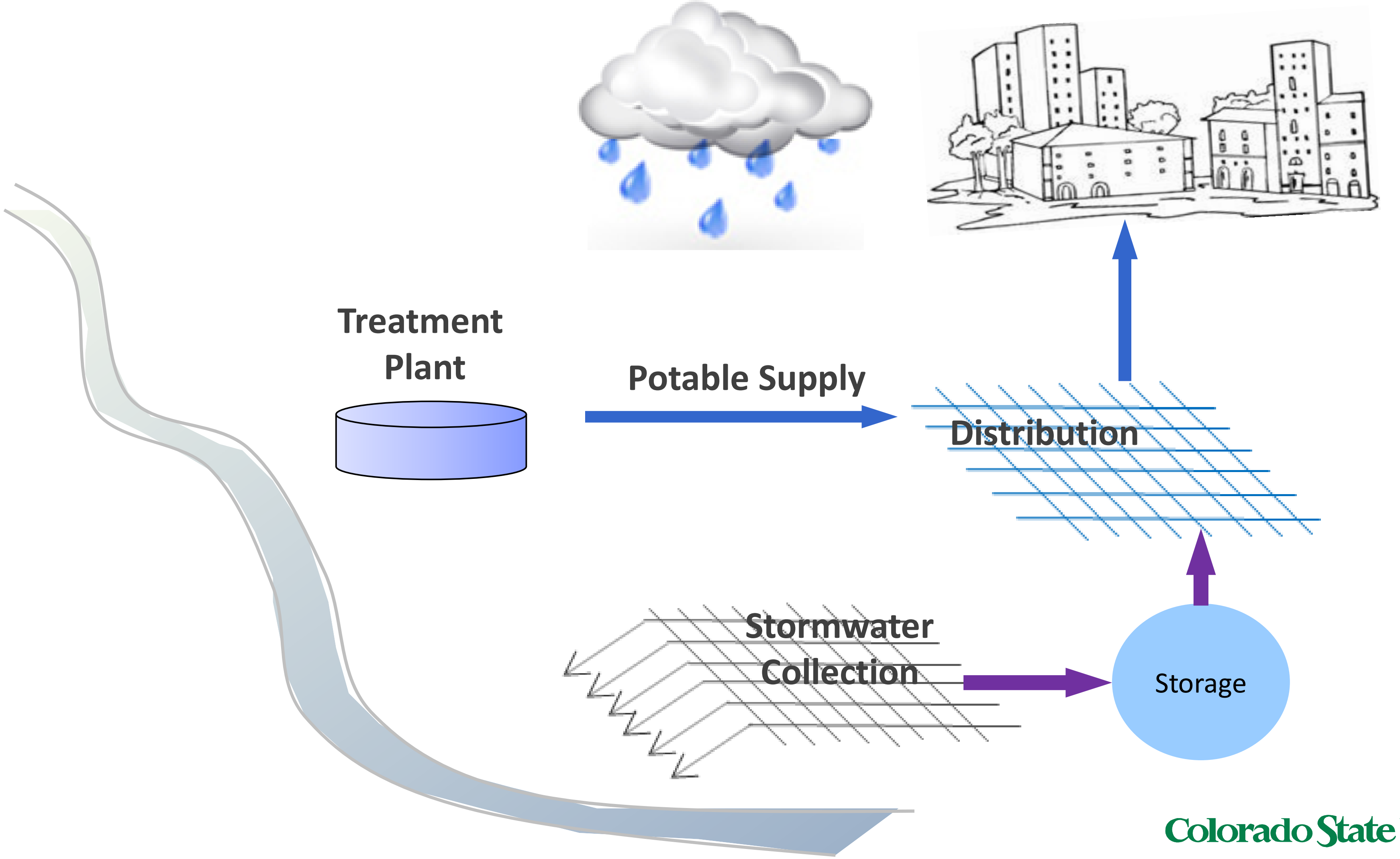
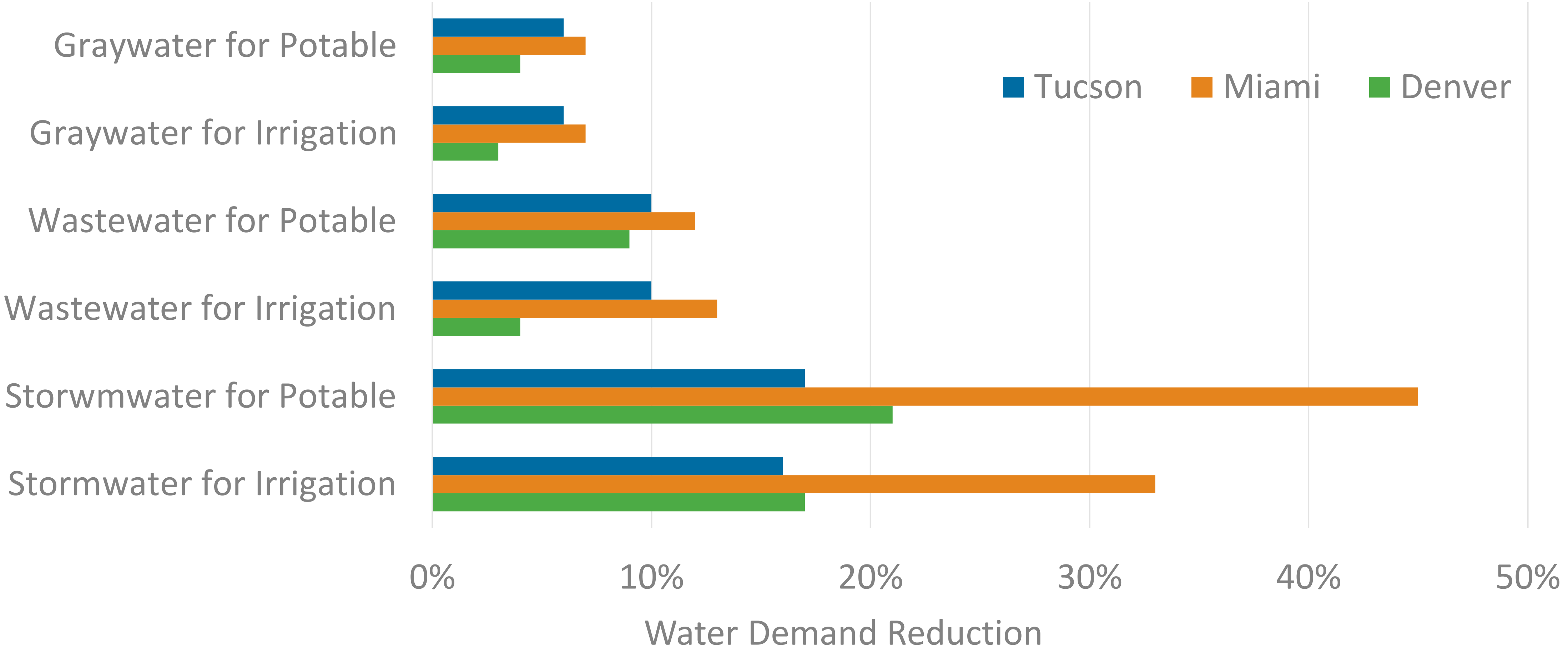
BENEFICIAL USE OF STORMWATER



OVERVIEW

- Example Stormwater Systems
- Stormwater Quality and Treatment
- Aquifer Recharge

ALTERNATE WATER: DEMAND REDUCTION



WASHINGTON MALL PROJECT

Source: National Park Service

WASHINGTON MALL PROJECT

Filtration (25 μm)

UV disinfection

Source: National Park Service

STORWATER USE WATER QUALITY

Water Quality Parameter	Unrestricted Irrigation				Indoor Use (Toilet Flushing or Laundry)		
	State of MN	District of Columbia	Los Angeles, CA	San Francisco, CA	District of Columbia	Los Angeles, CA	San Francisco, CA
BOD_5	NS	NS	10 mg/L	NS	NS	10 mg/L	
Turbidity	3 NTU	NS	2 NTU	2 NTU	NS	2 NTU	2 NTU
TSS	5 mg/L	NS	10 mg/L	NS	NS	10 mg/L	NS
pH	6 - 9	NS	6 - 9	NS	NS	6 - 9	NS
Chloride	500 mg/L	NS	NS	NS	NS	NS	NS
Zinc	2 mg/L (long term); 10 mg/L (short term)	15 mg/L	NS	NS	160 mg/L	NS	NS
Copper	0.2 mg/L (long term); 5mg/L (short term)	NS	NS	NS	NS	NS	NS
Pathogens/ Indicators	*E. coli*: 126 CFU/100mL	*E. coli*: 4615 CFU/100mL Crypto.: 0.033 oocysts/L	*E coli*: 2.2 CFU/100mL	Virus: 3.0-log reduction Protozoa: 2.5-log reduction Bacteria: 2.0-log reduction	*E. coli*: 50000 CFU/100mL Crypto.: 0.320 oocysts/L	*E coli:* 2.2 CFU/100mL	Virus: 3.5-log reduction Protozoa: 3.5-log reduction Bacteria: 3.0-log reduction

ISSUES WITH END POINT WATER QUALITY TARGETS

- Does not consider source water quality (loading and type of pathogens)
- Monitoring of indicator organisms is problematic
  - Frequency
  - Assurance that viruses, bacteria and protozoa are sufficiently reduced

EXPOSURE SCENARIO

Activity	Type	Ingestion (liter) per activity	Uses per year	Fraction of population	Reference
Toilet flush water	Ingestion of spray	0.00001	1100	1	(NRMMC et al., 2006)
Clothes washing	Ingestions of spray	0.00001	100	1	(NRMMC et al., 2006)
Unrestricted irrigation and dust suppression	Ingestion of sprays	0.001	50	1	(NRMMC et al., 2006)
Cross-connection of non-potable water with potable water	Ingestion	2[b]	1	0.1	(NRMMC et al., 2006)

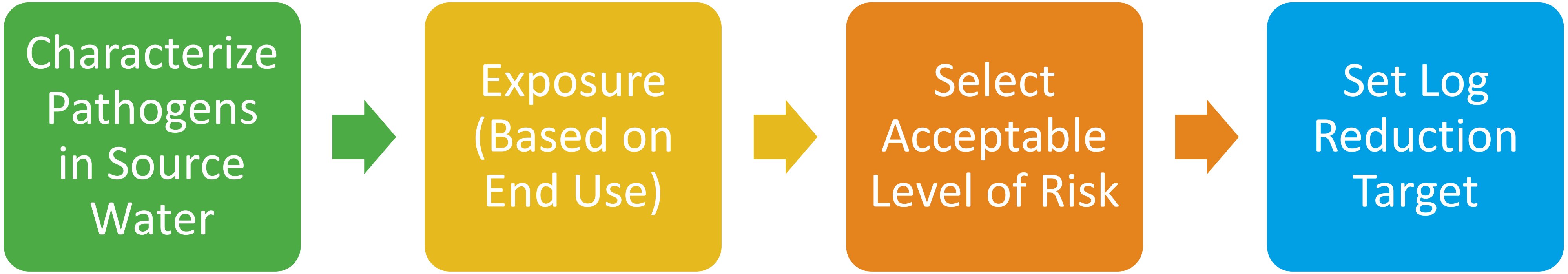
WATER ENVIRONMENT & REUSE FOUNDATION

WE&RF

Final **Report**

Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems

QUANTITATIVE MICROBIAL RISK ASSESSMENT (QMRA)



Jahne, M., Schoen, M.; Ashbolt, N.; Garland, J. Simulation of Enteric Pathogen Concentrations in Locally-Collected Graywater and Wastewater for Microbial Risk Assessments. *Microbial Risk Analysis,* 2017, 5:44-52.

Schoen, M.; Ashbolt, N.J.; Jahne, M.; Garland, J, Risk-Based Enteric Pathogen Reduction Targets for Non-Potable and Direct Potable Use of Roof Runoff, Stormwater, Graywater, and Wastewater. *Microbial Risk Analysis,* 2017, 5:32-43.

LOG10 PATHOGEN REDUCTION TARGETS

	Log_{10} Reduction Targets for 10^{-4} (10^{-2}) / person•y Benchmarks		
Water Use Scenario	**Enteric Virus**	**Parasitic Protozoa**	**Enteric Bacteria**
Domestic Wastewater or Blackwater (1000 persons)			
Unrestricted irrigation	8.0 (6.0)	7.0 (5.0)	6.0 (4.0)
Indoor use	8.5 (6.5)	7.0 (5.0)	6.0 (4.0)
Graywater (1000 persons)			
Unrestricted irrigation	5.5 (3.5)	4.5 (2.5)	3.5 (1.5)
Indoor use	6.0 (4.0)	4.5 (2.5)	3.5 (1.5)
Stormwater (10^{-1} Dilution)			
Unrestricted irrigation	5.0 (3.0)	4.5 (2.5)	4.0 (2.0)
Indoor use	5.5 (3.5)	5.5 (3.5)	5.0 (3.0)
Stormwater (10^{-3} Dilution)			
Unrestricted irrigation	3.0 (1.0)	2.5 (0.5)	2.0 (0.0)
Indoor use	3.5 (1.5)	3.5 (1.5)	3.0 (1.0)
Roof Runoff Water			
Unrestricted irrigation	Not applicable	No data	3.5 (1.5)
Indoor use	Not applicable	No data	3.5 (1.5)

AQUIFER RECHARGE

Source: Fresno Metropolitan Flood Control District

CHEMICAL QUALITY

- Pollutants
  - Metals, nutrients, salts, hydrocarbons
    - Removed during percolation
  - Polar organic chemicals
    - Flame retardants, biocides, plastics
    - Predicted to migrate through vadose zone

AQUIFER RECHARGE: AUSTRALIA

- Microbial Risk
  - Risk assessment and management plan based on source water quality, groundwater quality, and inactivation
  - Credits for inactivation of pathogens
    - Pre-commissioning estimate based on literature inactivation times
    - Validation required for site specific decay rates
- Chemical Risk
  - In-situ or laboratory studies required to confirm attenuation of contaminants
- No standard design criteria exist in Australia or US

SUMMARY

- Stormwater capture and use has high potential to reduce demand on traditional supplies
- Lack of guidance and regulation for treatment limit use of stormwater
- Aquifer recharge is attractive to foster use of stormwater
  - Limited guidance in US and Australia for design

Thank you.

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