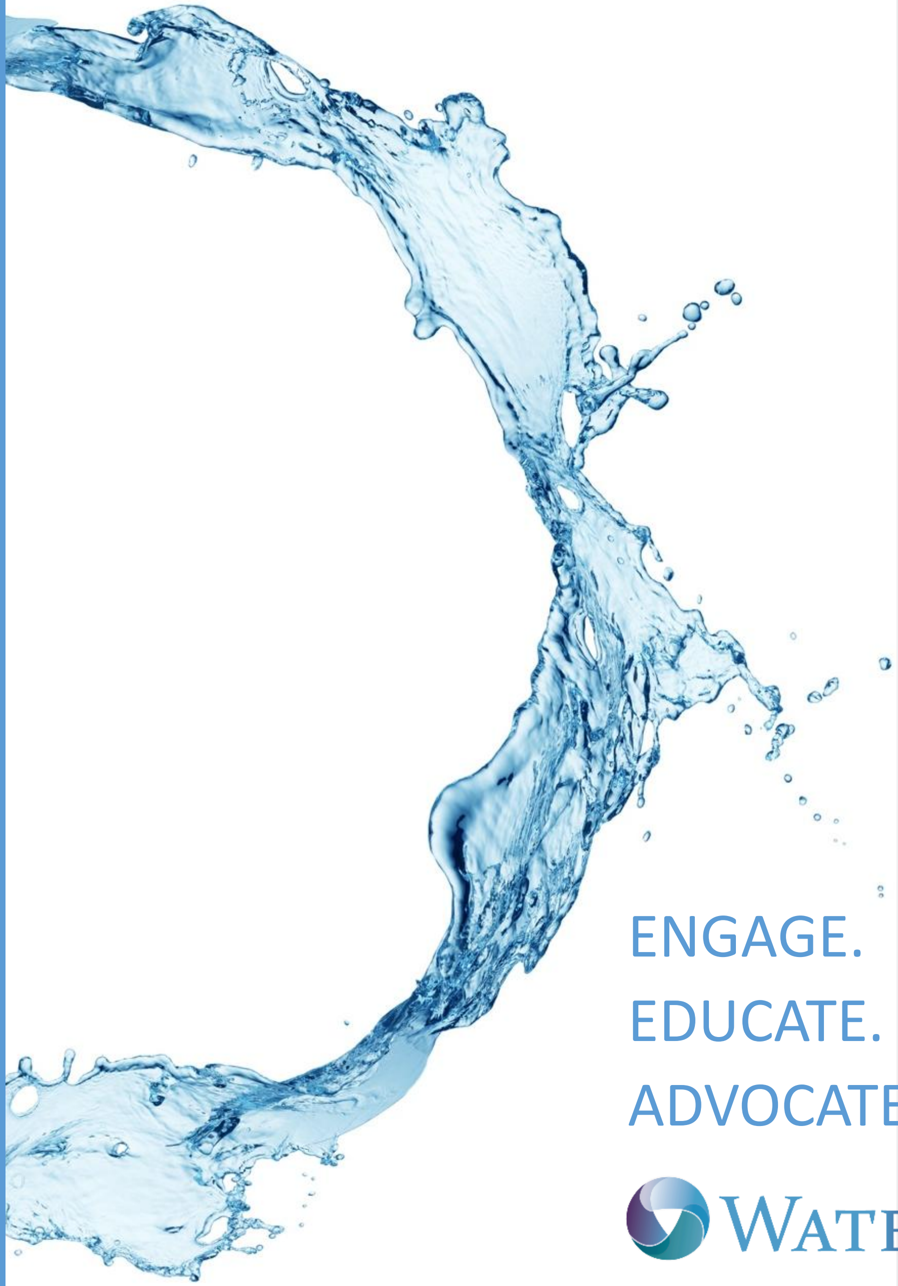
U.S. EPA INSIGHTS ON RISK-BASED APPROACHES TO WATER REUSE

PRESENTED BY: WATEREUSE OHIO

SEPTEMBER 11, 2025

10:00 AM ET | 7:00 AM PT

WATEREUSE ASSOCIATION WEBCAST SERIES



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- There is one (1) Professional Development Hour (PDH) available for this webcast. Please email the PDH form to webcasts@watereuse.org

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Upcoming Webinar:

Water Recycling: Past, Present, and Future Through the Eyes of the Nation's First Potable Reuse Project to Use Surface Water Augmentation

Thursday, November 13, 2025
10 a.m.

WATEREUSE

Moderator:

Jessica Langdon
Asst. Policy Director
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Today's Presenters

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A Risk-Based Approach to Water Reuse

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Office of Research and Development
Center for Environmental Solutions and Emergency Response

September 11, 2025

Challenge

- Existing Federal regulatory frameworks for water use are narrowly defined
  - Ground and surface water sources treated to drinking water quality
  - States regulate planned water reuse for other applications
- Increasing water demands drive the need for alternative water supplies
  - Potable reuse of municipal wastewater
  - Onsite water systems
  - Industrial reuse
- How do we expand these opportunities while protecting human health?
  - States and industry are seeking scientifically-defensible technical assistance on appropriate levels of treatment

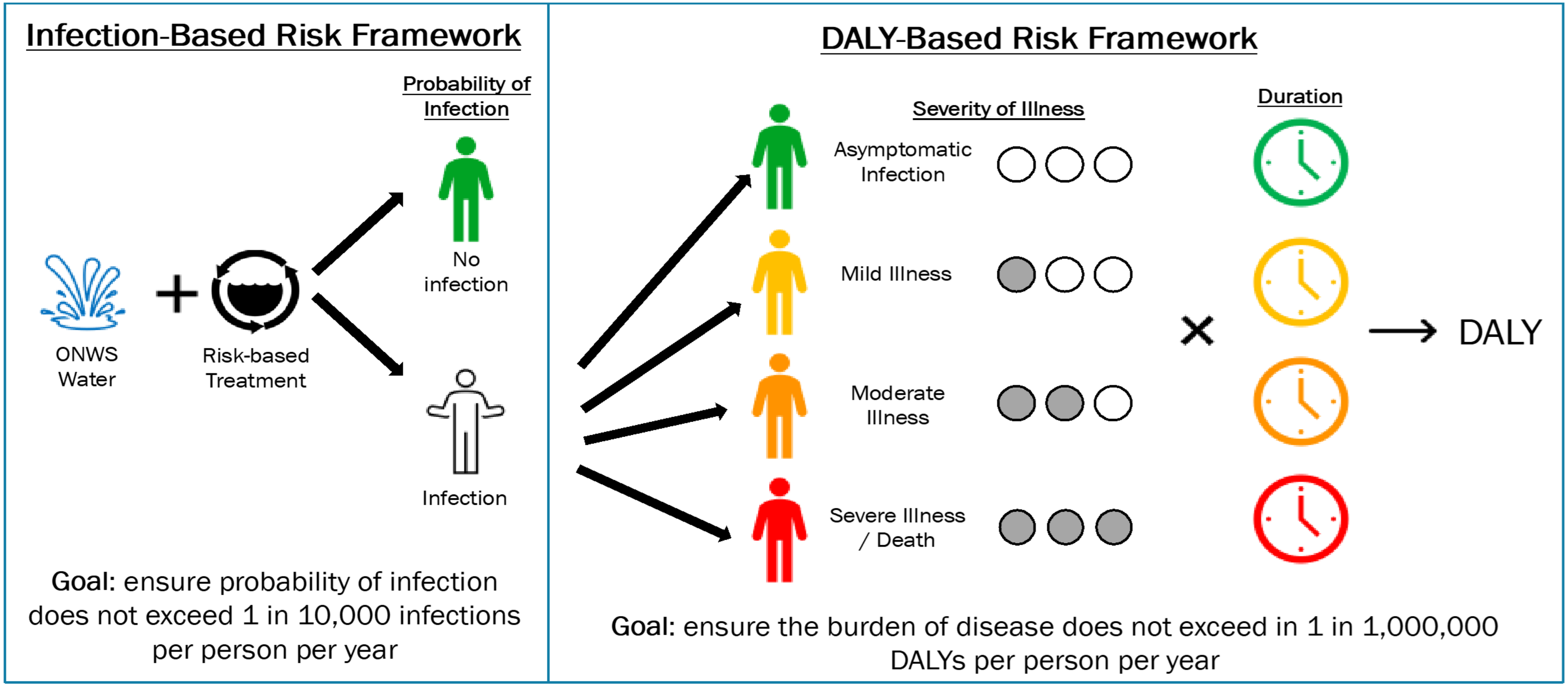
Approach

- Developing risk-based treatment targets
  - Fit-for-purpose assessments considering specific sources of water and end uses
- Treatment levels tailored to different contaminants and types of exposure
  - Pathogens drive treatment requirements for municipal and domestic wastewaters
  - Chemical risks important for potable use and industrial sources
- “Risk-based” targets attempt to achieve a specific level of health protection
  - Pathogen log-reduction targets (LRTs): Calculated 10-fold removal needed by treatment
  - Maximum contaminant level goals (MCLGs), effects-based assays

Microbial Risk Management

Onsite and Municipal Reuse

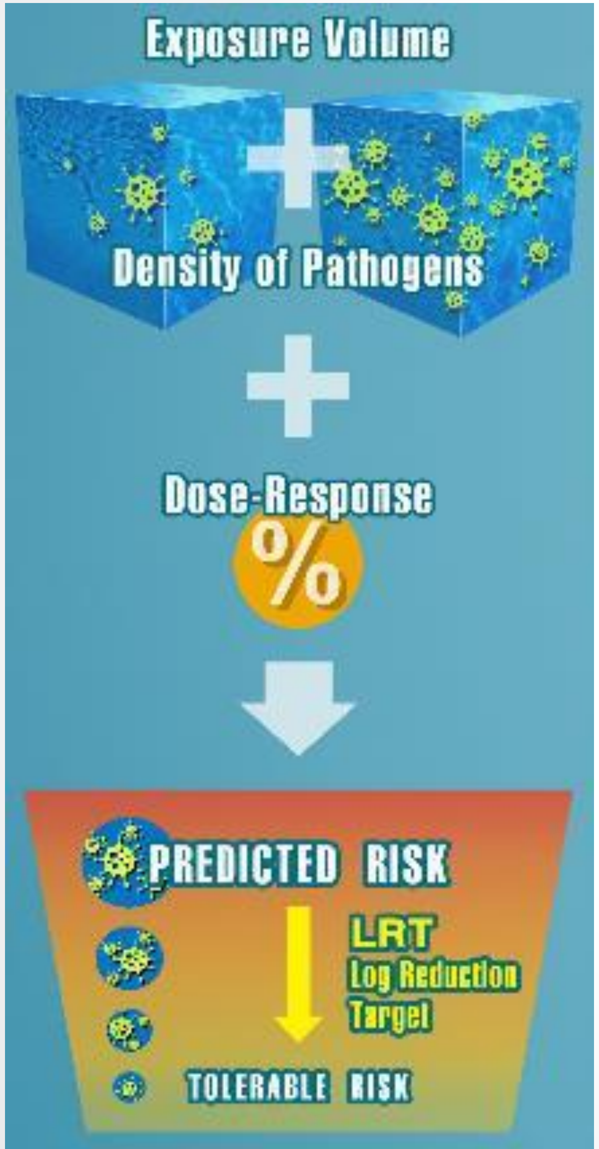
Risk Metrics for Pathogen Exposure



DALY = Disability-Adjusted Life Year
= 1 year of healthy life lost

[NBRC (2023) "Health Risk-based Benchmarks for Onsite Treatment of Water"]

Quantitative Microbial Risk Assessment



Sources of Water

(roof runoff, stormwater, graywater, wastewater)

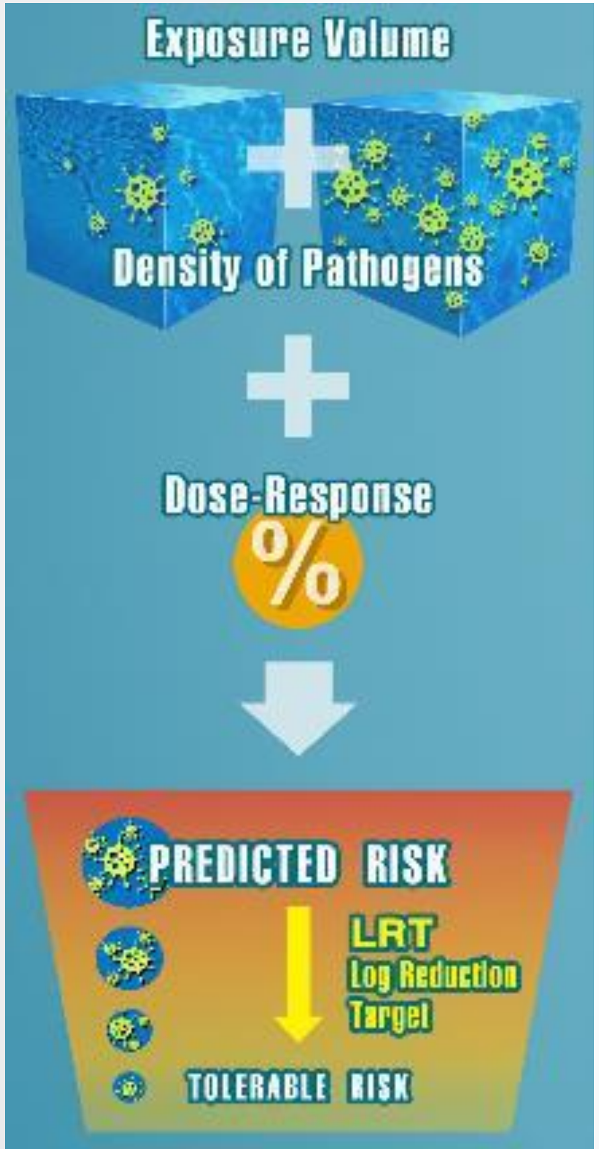
End Uses

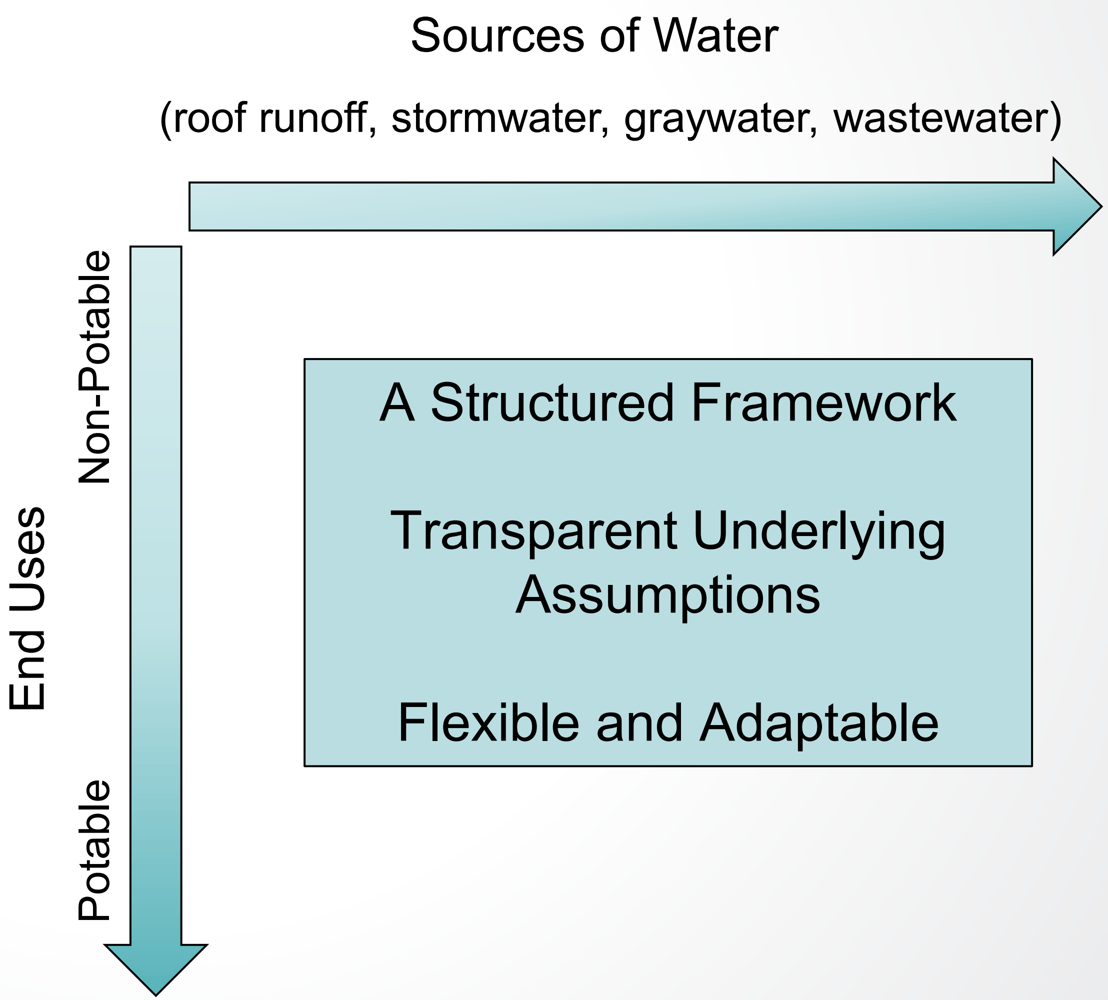
Non-Potable

Potable

A Matrix of
Log Reduction Targets
To Define
Fit-For-Purpose Reuse

Quantitative Microbial Risk Assessment





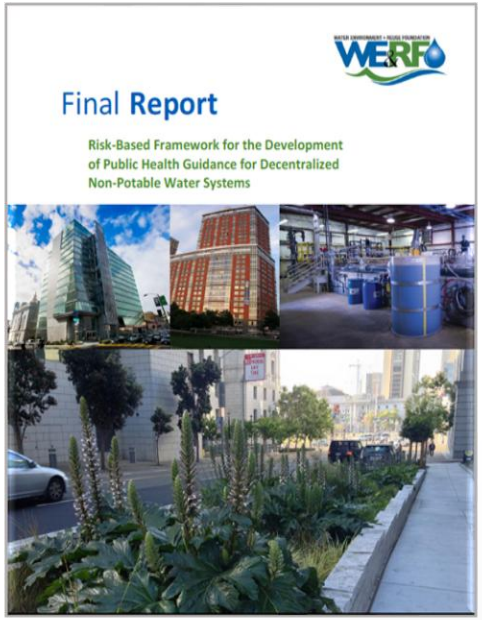
A Structured Framework

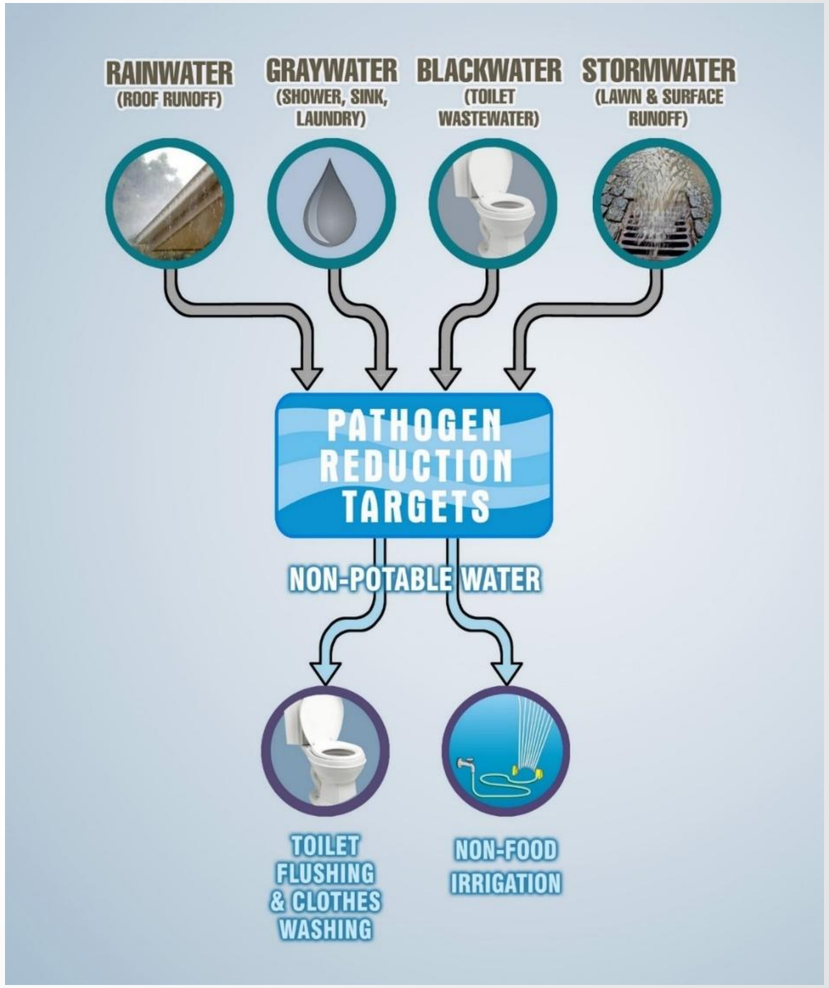
Transparent Underlying Assumptions

Flexible and Adaptable

Onsite Water Systems

- Previous ORD work focused on onsite reuse
  - Quality of alternative source waters?
  - Scaling effects for decentralized systems?
  - Fit-for-purpose water?
- Stakeholder-endorsed LRTs
  - Expert Panel report
  - National Blue Ribbon Commission
  - State/local adoption
  - Building code integration
- Updated in 2023 to incorporate latest science



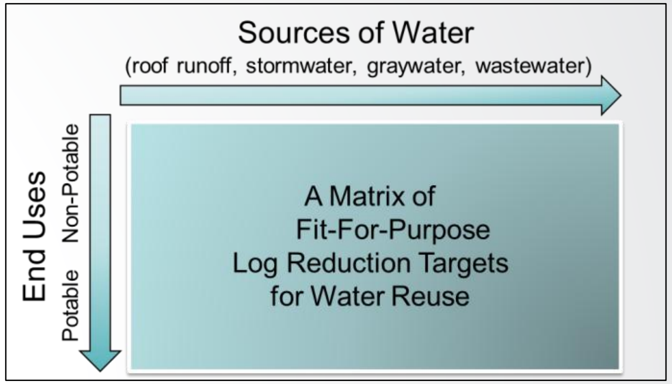


National Blue Ribbon Commission for Onsite Water Systems

Schoen et al. (2017) Microbial Risk Analysis 5, 32-43
Schoen et al. (2023) Environ. Sci. Technol. 57(26):9559-9566

Potable Reuse Harmonization

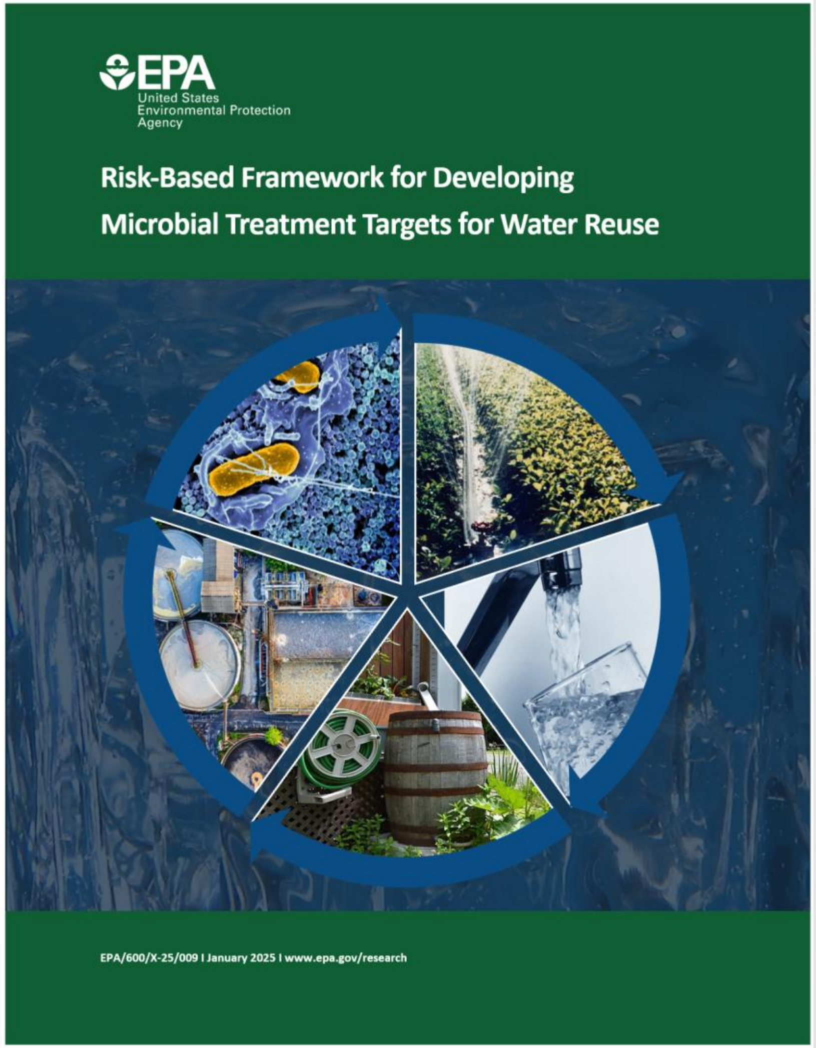
- Previous OW work focused on potable reuse
- Same math, different numbers
  - End use is drinking water
  - Source of water is municipal wastewater
- Direct and indirect potable reuse (DPR/IPR) addressed collectively
  - Environmental buffer could be credited to meet total LRTs
- Harmonization completes "the matrix" of fit-for purpose treatment targets
  - Potable uses of onsite waters
  - Non-potable use of municipal wastewater (purple pipe systems)
- Includes both infection and DALY benchmarks
- Focus on enteric pathogen *treatment*, not opportunistic pathogen *control*



Jahne et al. (2024) Environ. Sci. Technol. Letters 11(11):1175-1181

Risk-Based Framework Report

- Scientific resource for states adopting reuse
  - Collaboration between ORD and OW Water Reuse Program
- Describes QMRA framework and current parameter assumptions
  - Reference pathogens to consider
  - Pathogen density characterizations (municipal and onsite)
  - Exposure estimates for potable and non-potable uses
  - Pathogen dose-response models
  - Risk characterization approaches
- Includes computed log-reduction targets and information needed for new calculations
- Summarizes related policy decisions and future research needs



U.S. EPA (2025) EPA/600/R-25/009

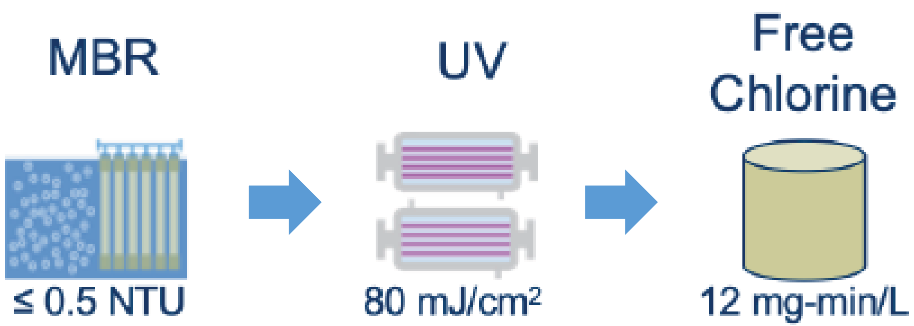
Harmonized LRT Table

End Use	Source of Water	Norovirus		Adenovirus		*Cryptosporidium* spp.		*Giardia* spp.		*Campylobacter* spp.		*Salmonella* spp.	
		LRT_{INF}	LRT_{DALY}	LRT_{INF}	LRT_{DALY}	LRT_{INF}	LRT_{DALY}	LRT_{INF}	LRT_{DALY}	LRT_{INF}	LRT_{DALY}	LRT_{INF}	LRT_{DALY}
Potable use	Untreated municipal wastewater	14.5	12.5	NSD	NSD	10.5	10.0	9.5	8.5	11.0	7.5	9.5	9.5
	Untreated onsite wastewater	14.5	12.5	NSD	NSD	11.5	11.0	10.0	9.0	12.0	9.5	8.0	8.0
	Graywater	13.0	11.0	NSD	NSD	9.0	8.5	8.0	7.0	9.5	7.5	5.5	5.5
	Stormwater (10% wastewater)	13.5	11.5	NSD	NSD	9.5	9.0	8.5	7.5	10.0	6.5	8.5	8.5
	Roof runoff	n/a	n/a	NSD	NSD	NSD	NSD	5.5	4.5	9.0	6.5	8.0	8.0
Unrestricted access landscape irrigation	Untreated municipal wastewater	10.0	8.5	NSD	NSD	6.5	6.0	5.5	4.5	6.5	4.0	5.5	5.5
	Untreated onsite wastewater	10.5	8.5	NSD	NSD	7.0	6.5	6.0	5.0	7.5	5.5	3.5	3.5
	Graywater	8.5	6.5	NSD	NSD	4.5	4.0	3.5	2.5	5.5	3.0	1.5	1.5
	Stormwater (10% wastewater)	9.0	7.5	NSD	NSD	5.5	5.0	4.5	3.5	5.5	3.0	4.5	4.5
	Roof runoff	n/a	n/a	NSD	NSD	NSD	NSD	1.5	0.5	5.0	2.5	3.5	3.5
Indoor non-potable use	Untreated municipal wastewater	10.5	9.0	NSD	NSD	7.5	7.0	6.5	5.5	7.5	5.5	6.5	6.5
	Untreated onsite wastewater	11.5	10.0	NSD	NSD	7.0	6.5	6.5	5.5	7.5	5.5	4.0	4.0
	Graywater	9.0	7.5	NSD	NSD	4.5	4.0	4.0	3.0	5.5	3.5	2.0	1.5
	Stormwater (10% wastewater)	9.5	8.0	NSD	NSD	6.5	6.0	5.5	4.5	6.5	5.0	5.5	5.5
	Roof runoff	n/a	n/a	NSD	NSD	NSD	NSD	2.0	1.0	5.0	3.0	3.5	3.5

NSD = not sufficient data; n/a = not applicable

Risk-Based Treatment: Putting it Together

Example Treatment Trains for Indoor Use of Onsite Wastewater/Blackwater



Pathogens	LRV Achieved by Treatment Process			Total LRV Achieved	LRV Required for Indoor Use
	MBR	UV	Free Cl_2		
Enteric Virus	1.0	3.5[b]	4.0	8.5	8.5
Giardia	2.5	6.0	--	8.5	7.0
Crypto	2.5	6.0	--	8.5	7.0
Bacteria	4.0	6.0[d]	4.0	14	6.0

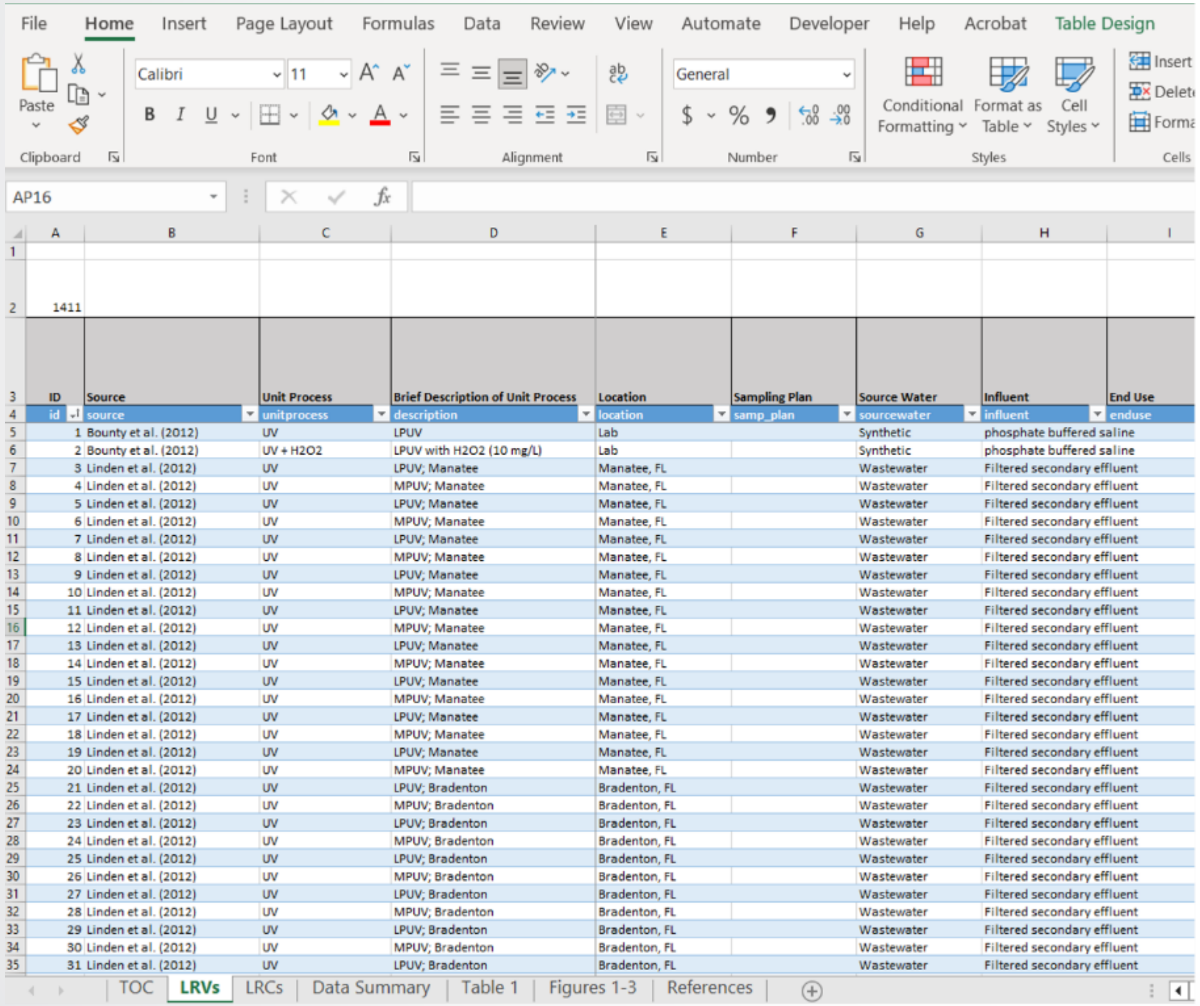
✓

Sum of reduction values must meet LRTs

MBR = Membrane bioreactor (compact biological treatment)
UV = Ultraviolet disinfection
LRV = Log reduction target (pathogen removal required)
LRV = Log reduction value (pathogen removal achieved by process)

NBRC (2023) "Health Risk-based Benchmarks for Onsite Treatment of Water"

Unit Process Log Reduction Values



ID	Source	Unit Process	Brief Description of Unit Process	Location	Sampling Plan	Source Water	Influent	End Use
id	source	unitprocess	description	location	samp_plan	sourcewater	influent	enduse
1	Bounty et al. (2012)	UV	LPUV	Lab		Synthetic	phosphate buffered saline	
2	Bounty et al. (2012)	UV + H2O2	LPUV with H2O2 (10 mg/L)	Lab		Synthetic	phosphate buffered saline	
3	Linden et al. (2012)	UV	LPUV; Manatee	Manatee, FL		Wastewater	Filtered secondary effluent	
4	Linden et al. (2012)	UV	MPUV; Manatee	Manatee, FL		Wastewater	Filtered secondary effluent	
5	Linden et al. (2012)	UV	LPUV; Manatee	Manatee, FL		Wastewater	Filtered secondary effluent	
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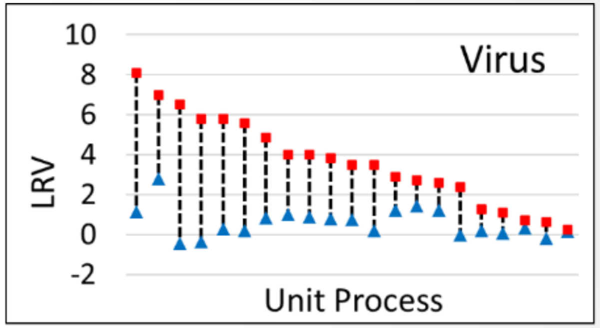
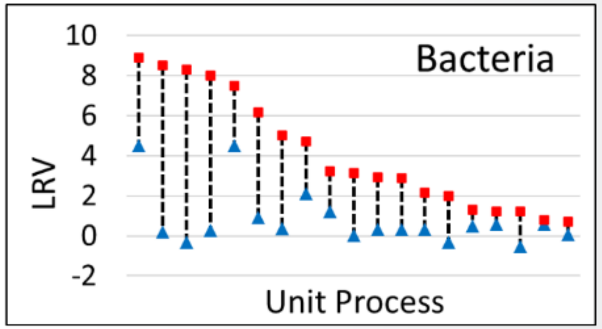
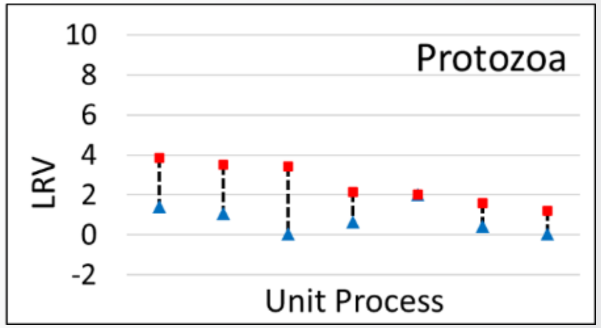
22	Linden et al. (2012)	UV	MPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
23	Linden et al. (2012)	UV	LPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
24	Linden et al. (2012)	UV	MPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
25	Linden et al. (2012)	UV	LPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
26	Linden et al. (2012)	UV	MPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
27	Linden et al. (2012)	UV	LPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
28	Linden et al. (2012)	UV	MPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
29	Linden et al. (2012)	UV	LPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
30	Linden et al. (2012)	UV	MPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	
31	Linden et al. (2012)	UV	LPUV; Bradenton	Bradenton, FL		Wastewater	Filtered secondary effluent	







[Arden et al. (2024) Water Research X 23(1):100226]

Risk-Based Management

Traditional Monitoring Approach

Alternative Water Sources → Treatment System → **Daily Effluent Quality Testing (e.g., fecal indicator bacteria)**

- Slow, expensive
- Not predictive of risks

Risk-Based Monitoring Approach

Risk Analysis Defines Treatment Targets → Treatment System

Sensors Monitoring Critical Control Points

- Lower cost
- Directly relating performance to risk

Continuous Process Monitoring

Example Treatment Process	Available Pathogen Reduction Credits Virus / Protozoa / Bacteria	Example Information Included in an Engineering Report	Example Continuous Monitoring Methods
Microfiltration or Ultrafiltration	0 / 4 / 0	Description and calculation of how the system defines an acceptable pressure decay test value per the US EPA's Membrane Filtration Guidance Manual to detect 3.0 µm breach	• Daily pressure decay test • Effluent turbidity
Membrane Biological Reactor	1.5 / 2 / 4	Operation within the Tier 1 operating envelope as defined in the AWRCE Membrane bio-reactor, WaterVal validation protocol	• Effluent turbidity
Reverse Osmosis	Up to 2 / 2 / 2	Demonstration of ability to meet salt rejection criteria and a description of surrogate parameter used to calculate pathogen reduction credits	• Influent and effluent total organic carbon (TOC) • Influent and effluent electrical conductivity
Ultraviolet Light Disinfection	Up to 6 / 6 / 6	UV reactor's validation report following US EPA UV Disinfection Guidance Manual or NSF/ANSI 55 Class A validation and demonstration of ability of system to meet criteria to achieve specified UV dose	• UV intensity • Flow rate
Chlorine Disinfection	Up to 5 / 0 / 5	Demonstration of ability to achieve a target CT[1] including description of chlorine contactor, contact time provided, and monitoring of chlorine residual	• Chlorine residual • Flow rate
Ozone Disinfection	Up to 4 / 3 / 4	Demonstration of ability to achieve a target CT[1] including description of ozone contactor, contact time provided, and monitoring of ozone residual	• Ozone residual • Flow rate

SFPUC (2022) "Onsite Water Reuse Program Guidebook"

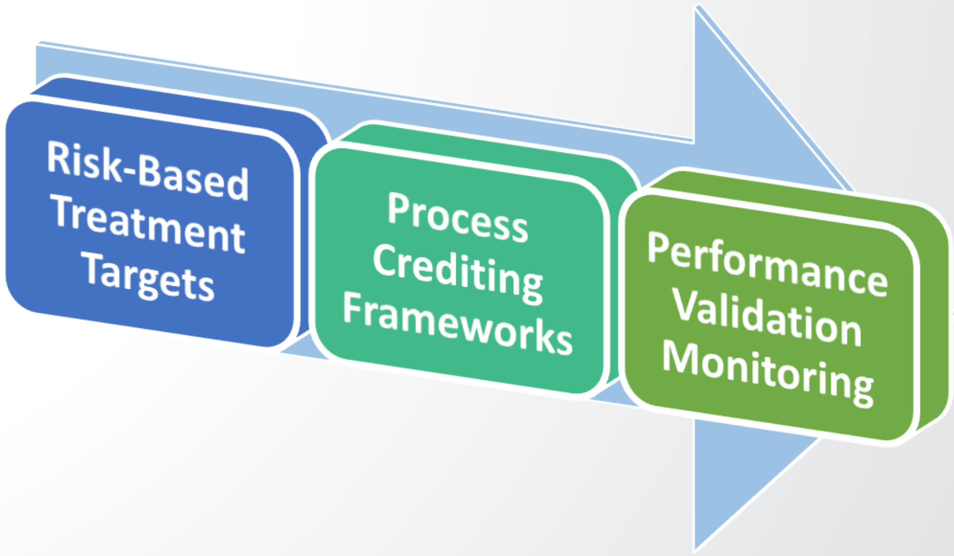
Future Research Needs

- Pathogen Dose-Response
  - Dose-dependent probabilities of illness?
  - Ingestion exposure to enteric adenoviruses
- Pathogen Characterization
  - Additional high-sensitivity measurements
  - Updated modeling inputs and approaches
  - Norovirus culture methods
- Log-reduction crediting and monitoring
  - LRTs are only the first step in risk-based reuse
  - Treatment trains must be credited to meet them
  - Unit processes must be monitored for ongoing performance
  - *Key priorities for advancement by states!*

A Structured Framework

Transparent Underlying Assumptions

Flexible and Adaptable



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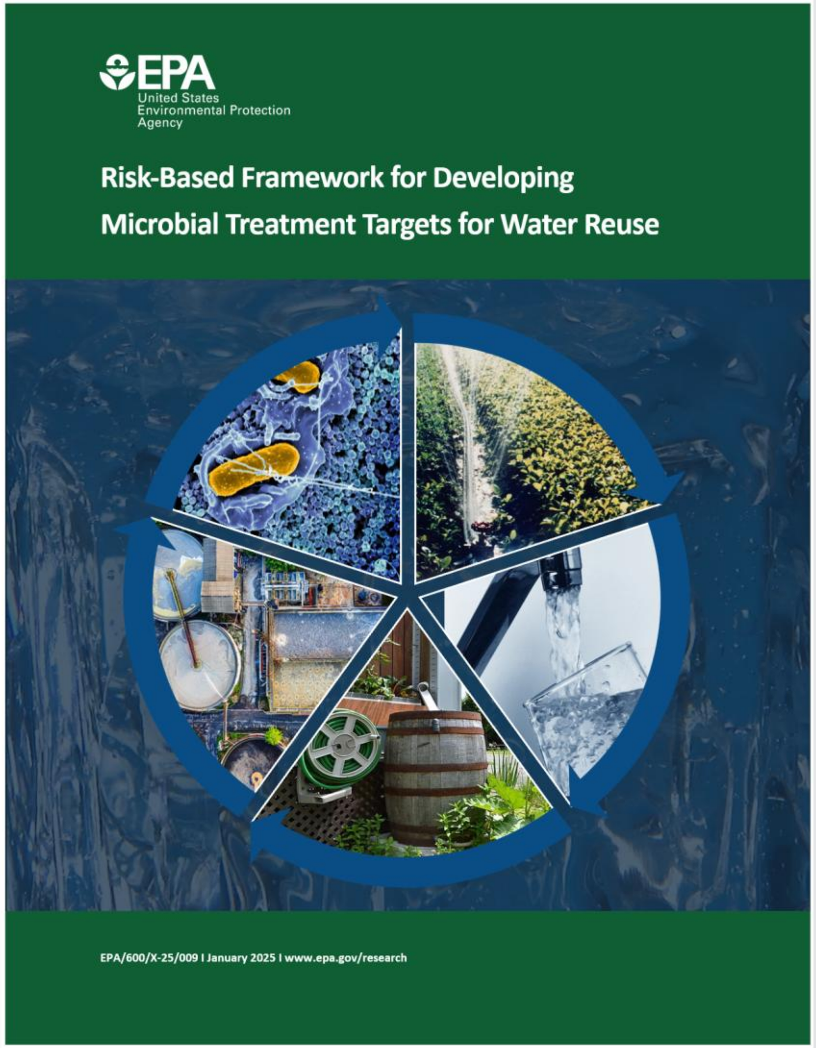


U.S. EPA (2025) EPA/600/R-25/009

Chemical Risk Management

Industrial and Produced Water Reuse

Case-Study Applications

Protein Processing Wastewater

- Animal slaughtering, meat and poultry product production, rendering of byproducts
- Water reuse permitted provided it has been treated by “*onsite advanced wastewater treatment facility*” and meets *National Primary Drinking Water Standards*
- Similar challenge to municipal DPR – potable regulations tied to source water

Oil and Gas Produced Water

- Byproduct of oil and gas extraction containing formation fluid and chemical additives
- Growing interest in off-field reuse as disposal options reach capacity
- Complex and variable mixture – what is “*good enough quality*” for different uses?

How do you define effective treatment?

Tyson Project Objectives

- **Task 1: Source Characterization**
  - Focus on microbial contaminants likely to drive treatment train
  - Include conventional contaminants (biochemical oxygen demand, solids, oil & grease, nitrogen)
  - Secondary assessment of industry-specific chemicals (antibiotics, hormones, cleaning compounds)
- **Task 2: Treatment Target Development**
  - Based on microbial contaminants: quantitative microbial risk assessment (QMRA) to develop pathogen log reduction targets (LRTs)
- **Task 3: Treatment Train Configurations**
  - Identify unit processes to meet LRTs
  - Additional consideration of conventional contaminants and chemicals; does treatment train for microbials manage these or need additional unit process(es)
  - Will not provide actual engineering design

Study Design

- **Facilities**:
  - 3 beef sites
  - 3 pork sites
  - 4 poultry sites
- **Sampling**:
  - Post-DAF (dissolved air flotation)
  - 2 sites rotating weekly
  - Separate microbial and chemical phases
- **Samples**:
  - 8-12 each for microbial
  - 3 each for chemical screening

Microbial Targets

- **Fecal Indicator Bacteria (culture):**
  - Enterococci
  - *Escherichia coli*
- **Pathogens (molecular):**
  - *Listeria*
  - *Salmonella*
  - *Campylobacter*
  - Pathogenic *E. coli*
  - *Cryptosporidium*
  - *Giardia*

LRT Results for Potable Use

	Salmonella	*Campylobacter*	Pathogenic *E. coli*	*Listeria*	*Giardia*	*Cryptosporidium*	Norovirus
Beef	8.2	11.4	6.8	*8.9*	*6.5*	*7.7*	n/a
Pork	10.7	13.3	7.1	*8.7*	*7.3*	*7.7*	n/a
Poultry	8.7	15.8	*2.8*	*9.2*	*0*	*0*	n/a
Combined	10.3	14.7	7.2	*9.3*	*7.1*	*7.5*	n/a
WW-DPR	9.5	11	n/a	n/a	9.5	10.5	14.5

**italics indicate greater uncertainty for rare pathogens*

Chemical Detections

- **Antibiotics**
  - Tylosin
  - Lincomycin
  - Sulfadimethoxine
  - Trimethoprim
  - Ampicillin
  - Sulfamethazine
  - Sulfanilamide
  - Monensin sodium
  - Erythromycin
  - Virginiamycin
  - Dicyclohexylcarbodiimide
  - Clarithromycin
  - Tiamulin
  - Thiabendazole
  - Penicillin G
  - Novobiocin
  - Azithromycin
  - Oxolinic acid
- **Hormones**
  - Progesterone
  - Testosterone
  - Equilin
  - Equilenin
  - Medroxyprogesterone
  - Levonorgestrel
  - Estrone
  - Genistein
  - Norethindrone
  - Estriol
  - Hydrocortisone
  - Drospirenone
  - Gestodene
  - Triclocarban
  - Formononetin
  - Prednisone
  - Diethylstilbestrol
  - Coumestrol
  - 4-Androstene-3,17-dione
  - 17beta-Estradiol
  - 7,4'-Dihydroxyisoflavone
  - Nomegestrol acetate
  - 17beta-Estradiol
  - 5alpha-Dihydrotestosterone
  - 17alpha-Ethinylestradiol
- **Plant use chemicals**
  - Cyclohexylamine
  - (S)-Lactic acid
  - Didecyldimethylammonium

Typically trace concentrations (ng – µg/L)

Variable occurrence

Hazard Comparison

VH - Very High | H - High | M - Medium | L - Low | I - Inconclusive | No Data

Authoritative | Screening | *QSAR Model*

Name	Human Health Effects: Acute Mammalian Toxicity: Oral	Acute Mammalian Toxicity: Inhalation	Acute Mammalian Toxicity: Dermal	Carcinogenicity	Genotoxicity Mutagenicity	Endocrine Disruption	Reproductive	Developmental	Neurotoxicity: Repeat Exposure	Neurotoxicity: Single Exposure	Systemic Toxicity: Repeat Exposure	Systemic Toxicity: Single Exposure	Skin Sensitization	Skin Irritation	Eye Irritation	Ecotoxicity: Acute Aquatic Toxicity	Ecotoxicity: Chronic Aquatic Toxicity	Fate: Persistence	Fate: Bioaccumulation
Norethindrone	L			VH	VH	H	H	H								L	VH		L
Didecyldimethylammonium	H	I	I	I	L	L	I	L	I	I	I	I	I	I	I	I		M	H
7,4'-Dihydroxyisoflavone	M				L	H		H	M							H	VH		L
Estrone	L	I	L	VH	VH	H	H	H	H	I	H	I	I	I	I	H	VH	M	M
(S)-Lactic acid	M	L	L	I	L	L	I	H	L	I	L	I	I	VH	VH	L	L	L	L
17beta-Estradiol	L			VH	VH		H				H					VH	VH		L
Estriol	L				L	H	H	H								H	VH		L
Levonorgestrel	L				L	H	H	H								VH			I
Medroxyprogesterone	M				L	L	M	H								H	M		L
17alpha-Ethinylestradiol	M			VH	VH		H				H					H	VH	H	H
Diethylstilbestrol	M	I	I	VH	VH	H	H	H			H	M	H	I	I	H	H		M

U.S. EPA CompTox Cheminformatics Modules
https://www.epa.gov/comptox-tools/cheminformatics

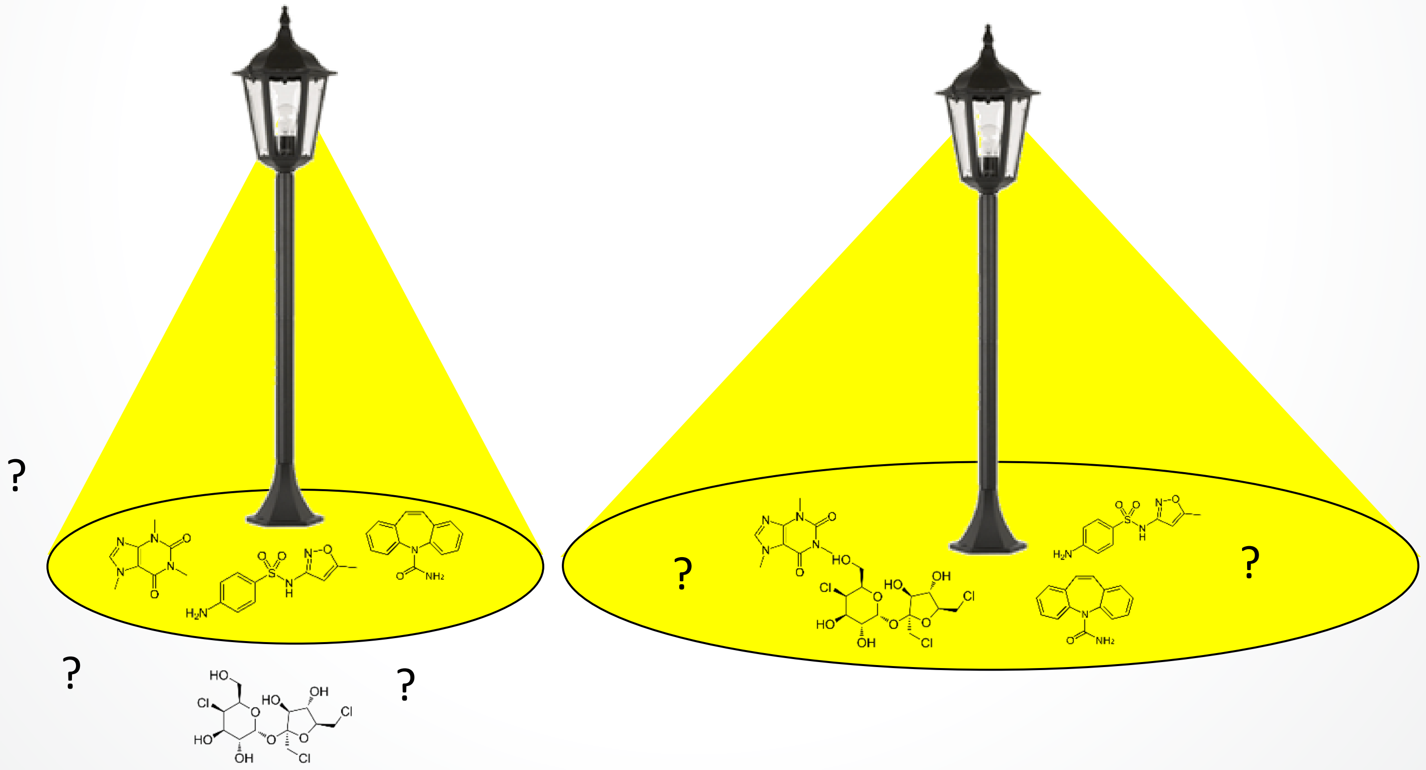
Next step: Assess removal needs by comparing observed concentrations to reported toxicity thresholds

Bioassays

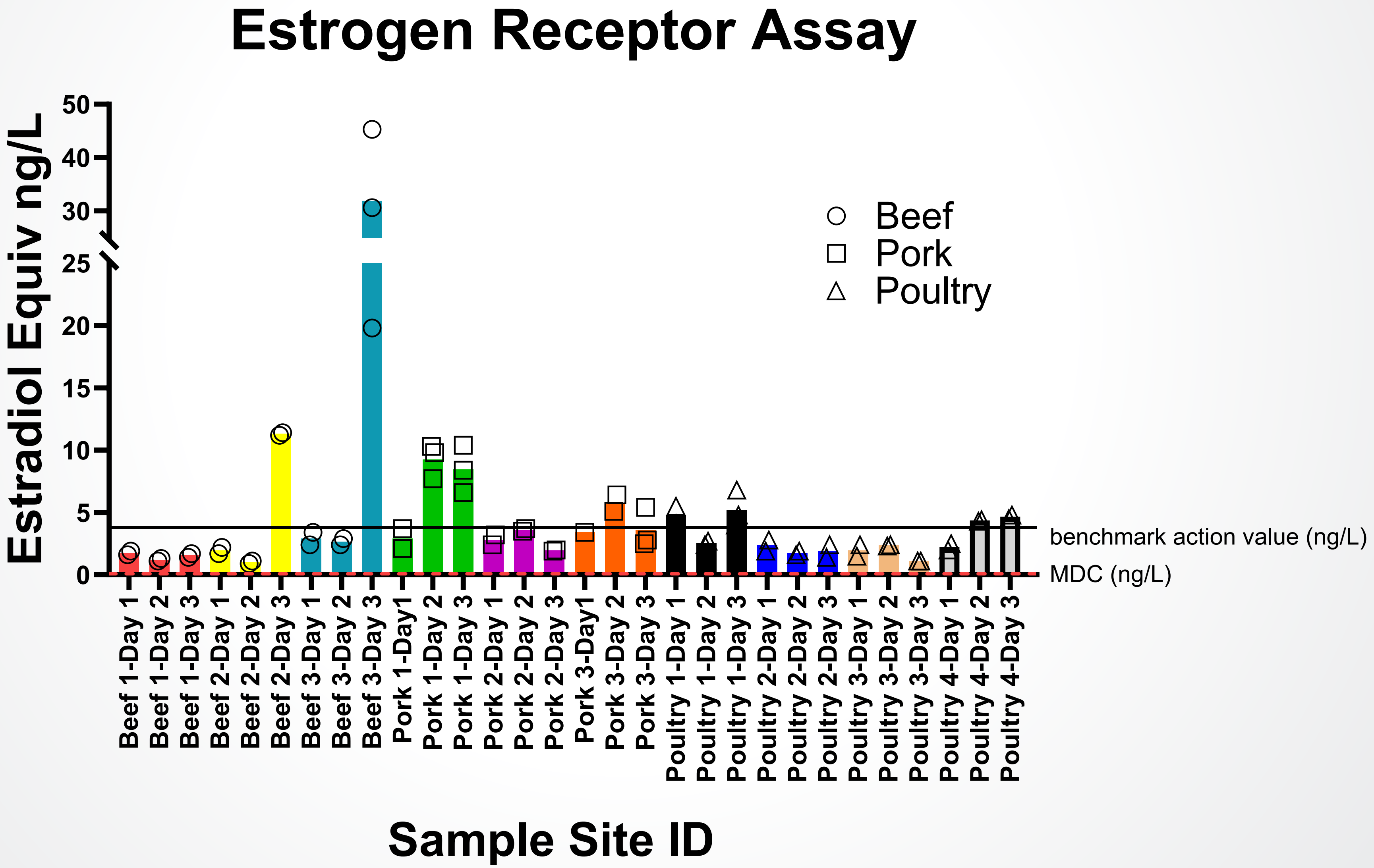
Analytical Space

Targeted Chemical Analysis

Effects-based Analysis



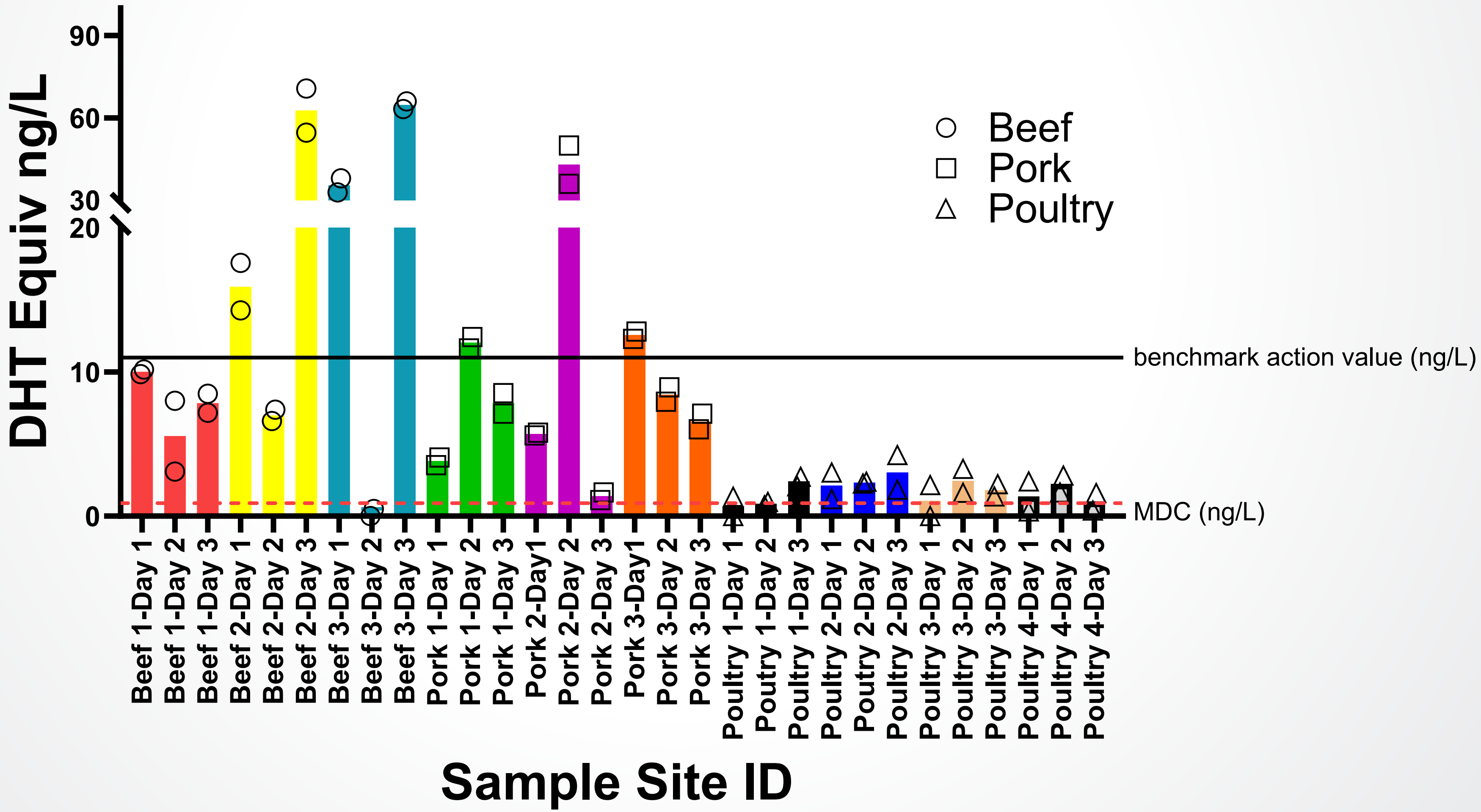
Bioassays



Estrogen Receptor Assay
Estradiol Equiv ng/L
50
40
30
25
20
15
10
5
0
Beef
Pork
Poultry
benchmark action value (ng/L)
MDC (ng/L)
Beef 1-Day 1
Beef 1-Day 2
Beef 1-Day 3
Beef 2-Day 1
Beef 2-Day 2
Beef 2-Day 3
Beef 3-Day 1
Beef 3-Day 2
Beef 3-Day 3
Pork 1-Day1
Pork 1-Day 2
Pork 1-Day 3
Pork 2-Day 1
Pork 2-Day 2
Pork 2-Day 3
Pork 3-Day1
Pork 3-Day 2
Pork 3-Day 3
Poultry 1-Day 1
Poultry 1-Day 2
Poultry 1-Day 3
Poultry 2-Day 1
Poultry 2-Day 2
Poultry 2-Day 3
Poultry 3-Day 1
Poultry 3-Day 2
Poultry 3-Day 3
Poultry 4-Day 1
Poultry 4-Day 2
Poultry 4-Day 3
Sample Site ID

Bioassays

Androgen Receptor Assay



Next Step: Demonstration Projects

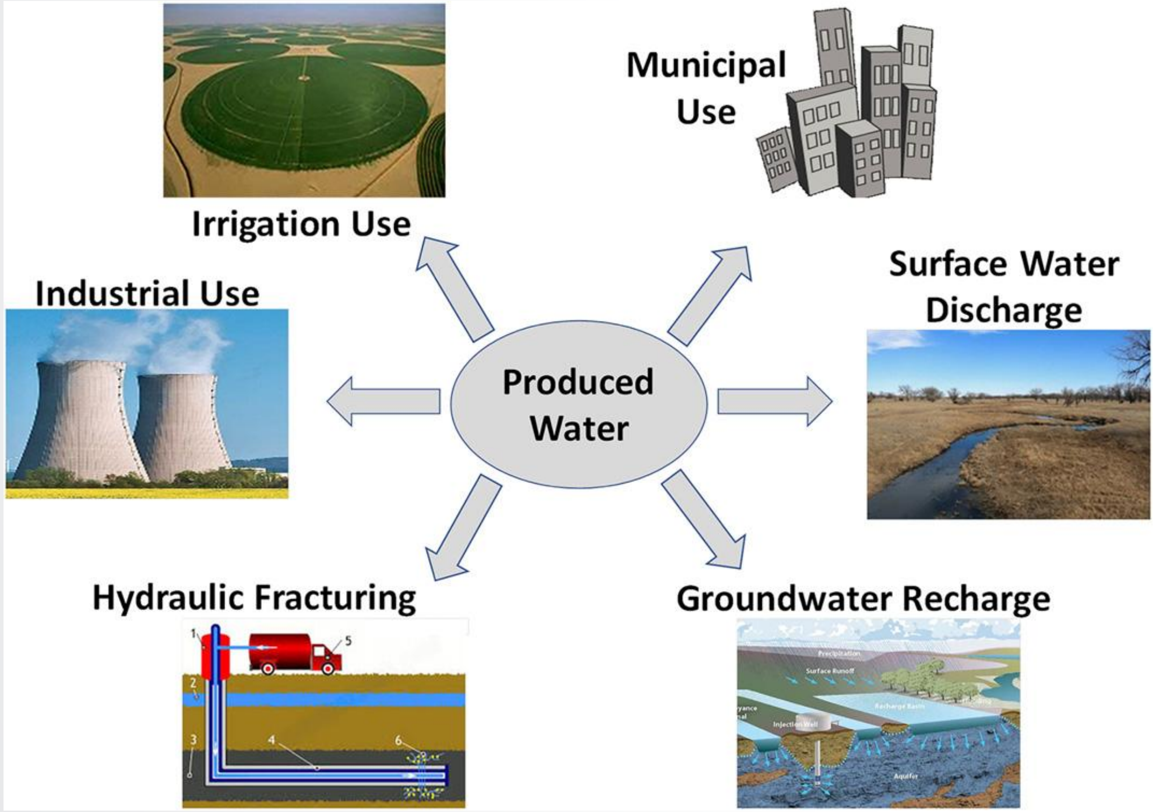
- **Tyson Foods developing potable reuse pilot project at Kansas facility**
  - Demonstrating “potability” of water to state and federal regulators
  - Seeking waiver for product contact use in final rinse
  - Treatment design based on study results
- **Proof of concept for further expansion**
  - Water scarcity is critical driver, despite treatment costs
  - Need to establish both technical and regulatory processes
- **Beyond Tyson: Ohio turkey plant**
  - Local water and wastewater constraints
  - Similar microbial evaluation by ORD
  - Working with Ohio EPA and local municipality on potential reuse

Collaborators

- Jay Garland (EPA/ORD/CESER)
- Nichole Brinkman (EPA/ORD/CESER)
- Scott Keely (EPA/ORD/CEMM)
- Emily Wheaton (EPA/ORD/CESER)
- Maitreyi Nagarkar (EPA/ORD/CESER)
- Silver Homa (EPA/ORD/CESER)
- Elizabeth MedlockKakaley (EPA/ORD/CPHEA)
- Nicki Evans (EPA/ORD/CPHEA)
- Sean Thimons (ORISE)
- Raghu Venkatapathy (Pegasus)
- Nick Sylvest (Pegasus)
- Kim Dirks (Tyson Foods)
- Daniel Snow (UNL)
- Clinton Williams (USDA-ARS)

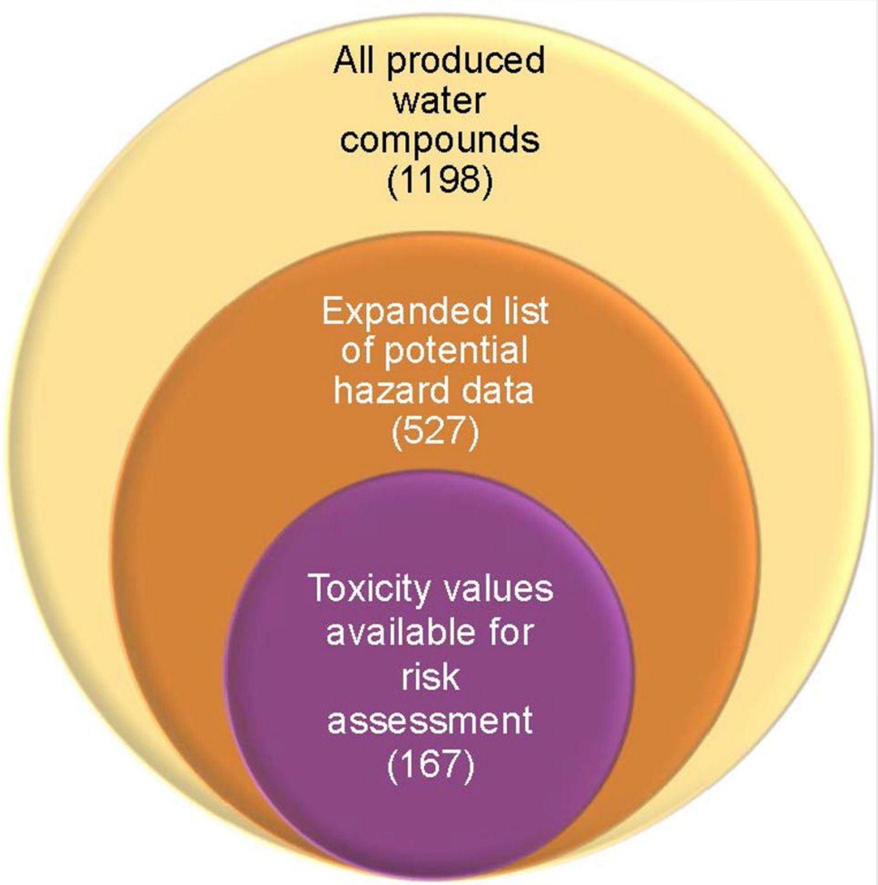
Risk-Based Treatment of Produced Water

Opportunities



Scanlon et al. (2020) *Sci. Tot. Environ.* 717:137085

Challenges



Danforth et al. (2020) *Environ. Int.* 134:105280

Produced Water Research: Objectives

- **Integrated risk assessment to inform treatment guidance**
  - Holistic characterization of produced water using analytical, computational, and effects-based methods
  - Development of risk-based, fit-for-purpose treatment targets
  - Test case for R&D of risk frameworks extendible to other complex waters
- **Linking bulk toxicity to constituent organics**
  - Biological endpoints (*in vivo, in vitro*)
  - Gene expression (high-throughput transcriptomics)
  - Non-targeted analysis
  - Computational prediction

Toxicity (biological endpoints, gene expression)

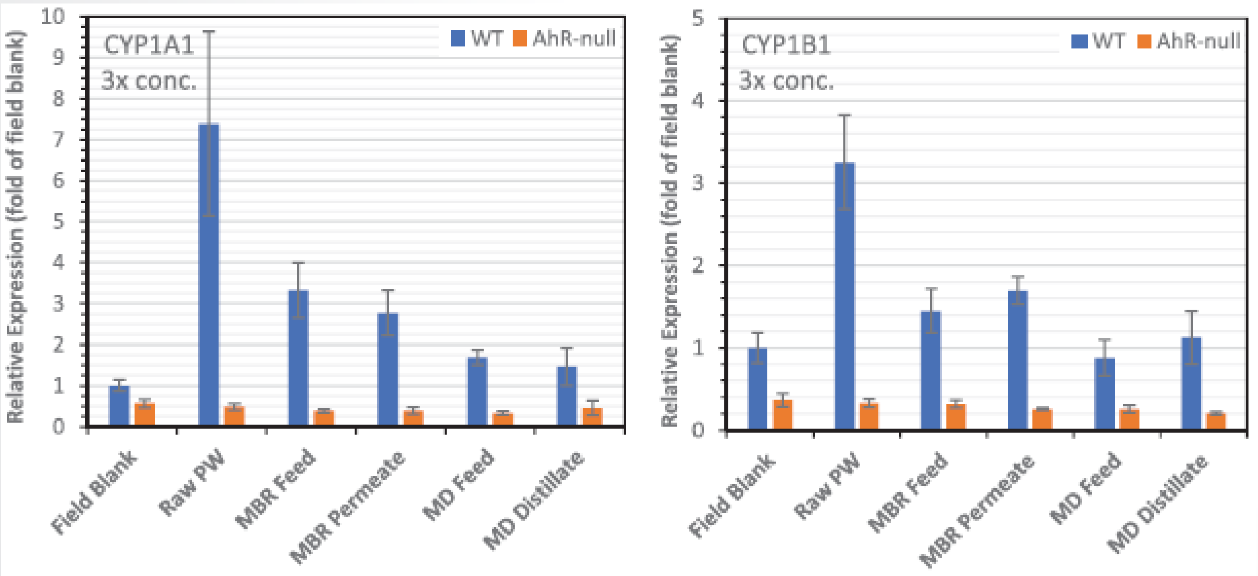
Chemistry (non-targeted analysis, computational prediction)

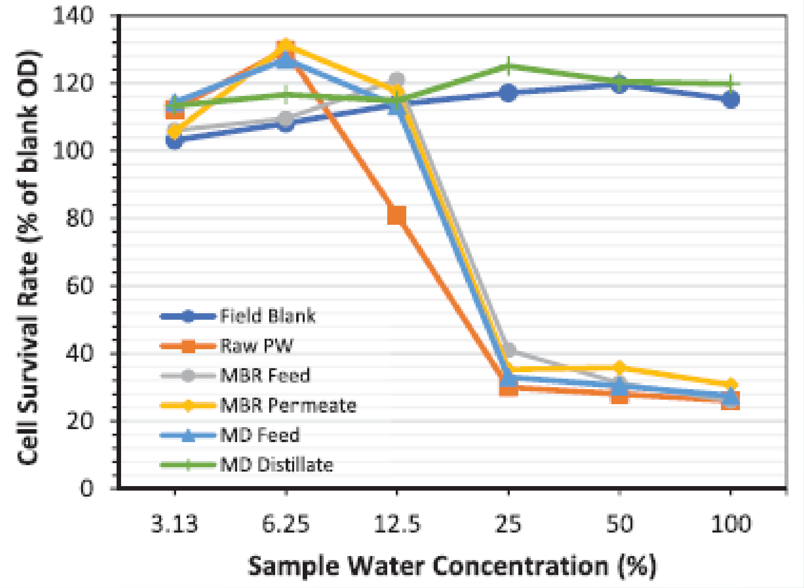
Produced Water Research: Applications

- **Assessing treatment processes for water reuse**
  - Characterization and monitoring of treatment performance
  - Collaborations with Colorado School of Mines (CSM), New Mexico State University (NMSU), and research partners on treatment train testing
- **Evaluation of produced water discharges**
  - Understanding effects on receiving streams
  - Data generation supports reuse risk assessments

CSM Treatment Pilot

- Coagulation + membrane bioreactor (MBR) + granular activated carbon (GAC) + ion exchange (IX) + membrane distillation (MD)
- Cell-line assays for aryl hydrocarbon [dioxin] receptor (AhR) and cytotoxicity
- Toxicity dependent on AhR pathway and reduced during treatment

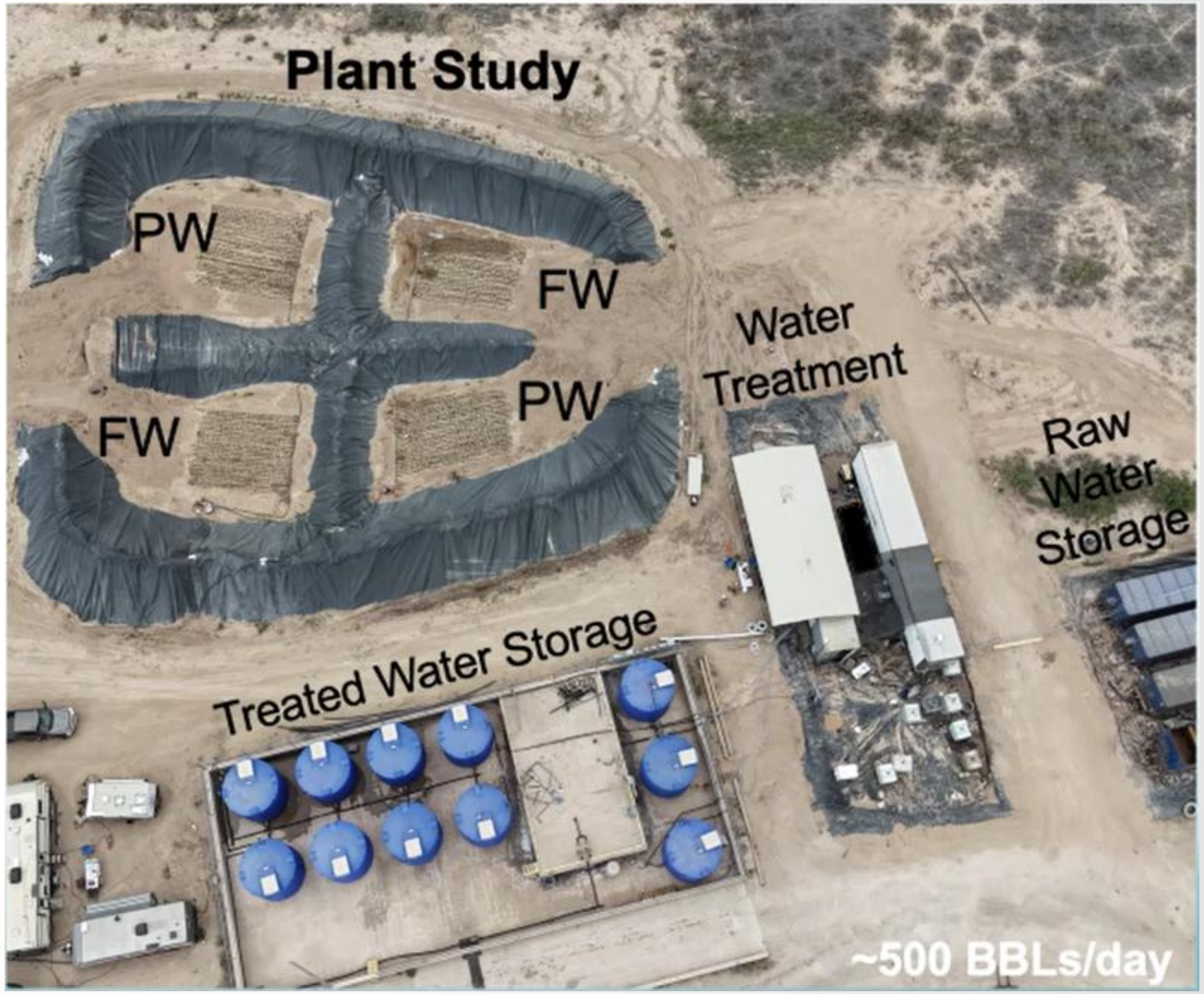




Van Houghton et al. (2024) ACS *EST Water* 4(4):1293-1302

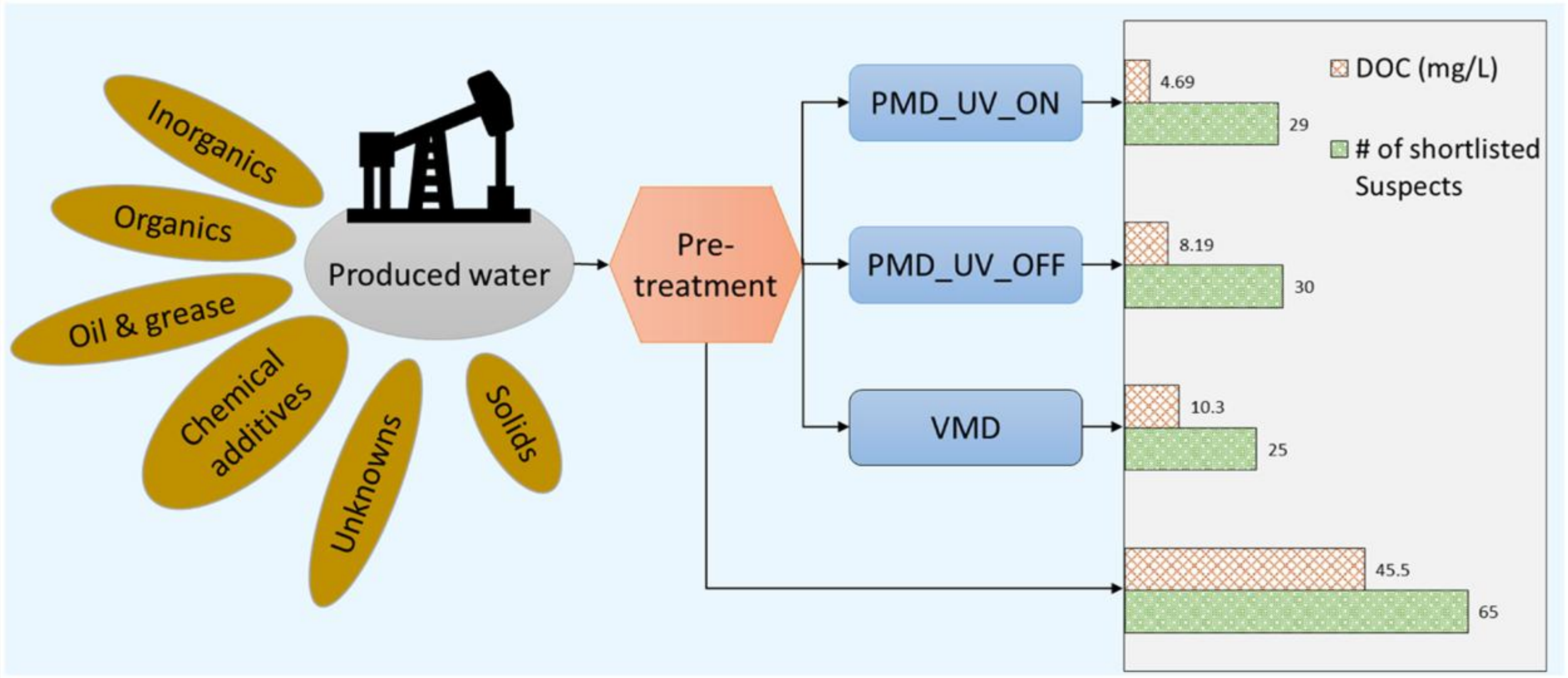
CSM Treatment Pilot

- New study in progress: Field-scale including crop irrigation
- Industry and academic partners
  - PWR, NGL, Exxon, CSM, Colorado State
- Adding new effects-based methods for endocrine disruption and aquatic toxicity



NMSU Treatment Pilot

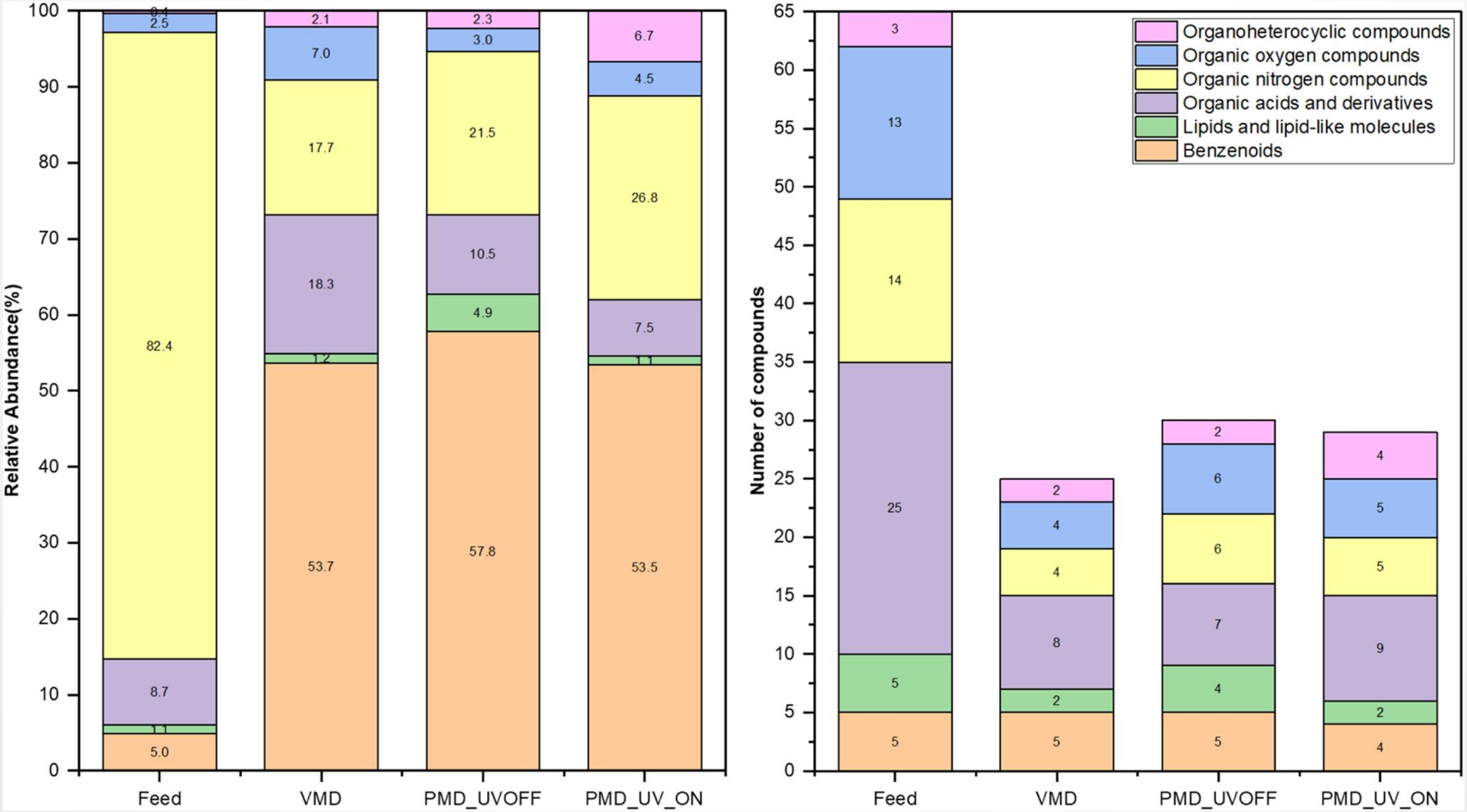
- Cartridge filtration + membrane distillation (MD)
  - Comparing vacuum (VMD) and photocatalytic (PMD)
- Non-targeted analysis (NTA) and toxicity prediction



Delanka-Pedige et al. (2024) *Journal of Hazardous Materials* 471:134436

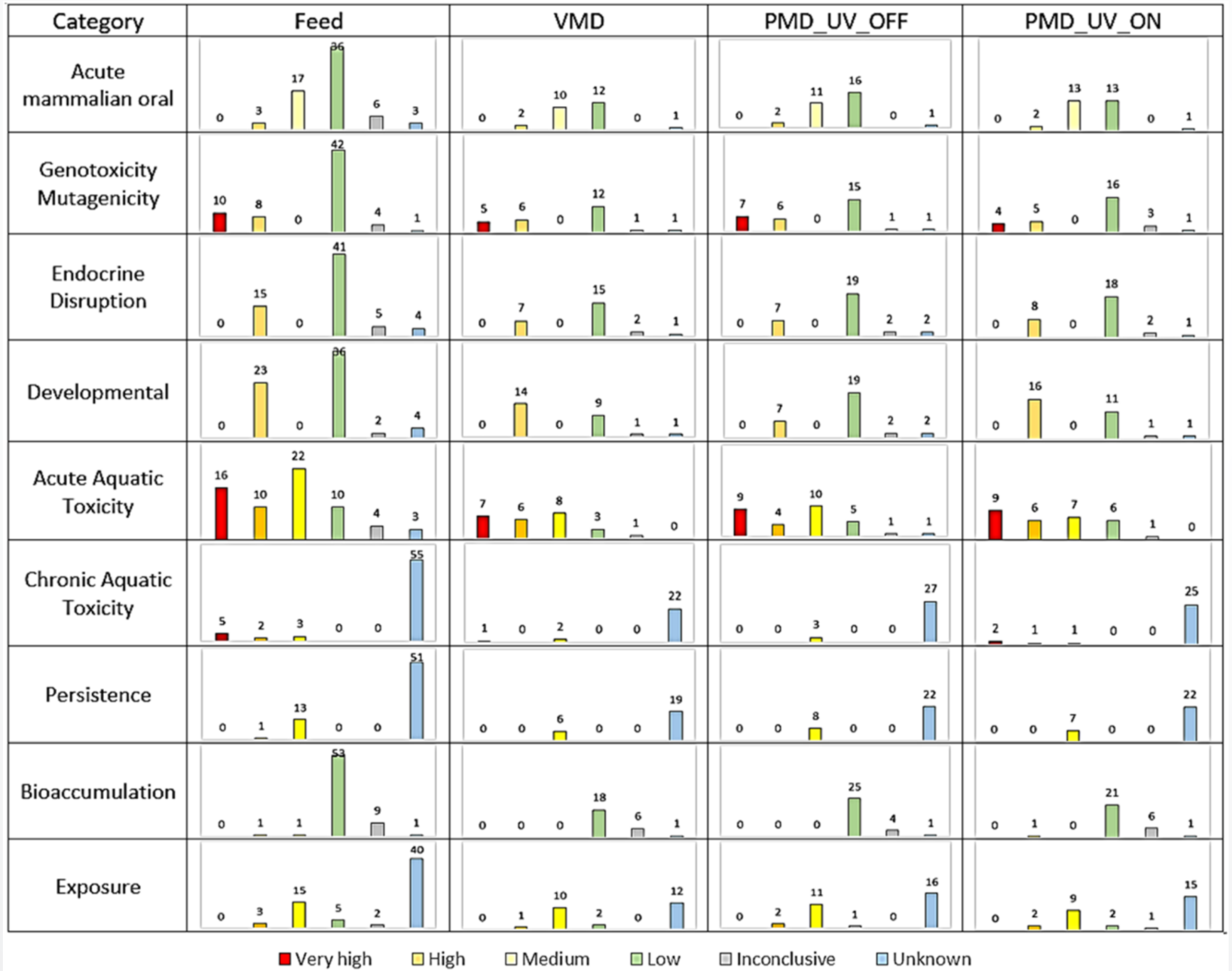
NMSU Treatment Pilot

- Classification of suspect compounds shifts following treatment



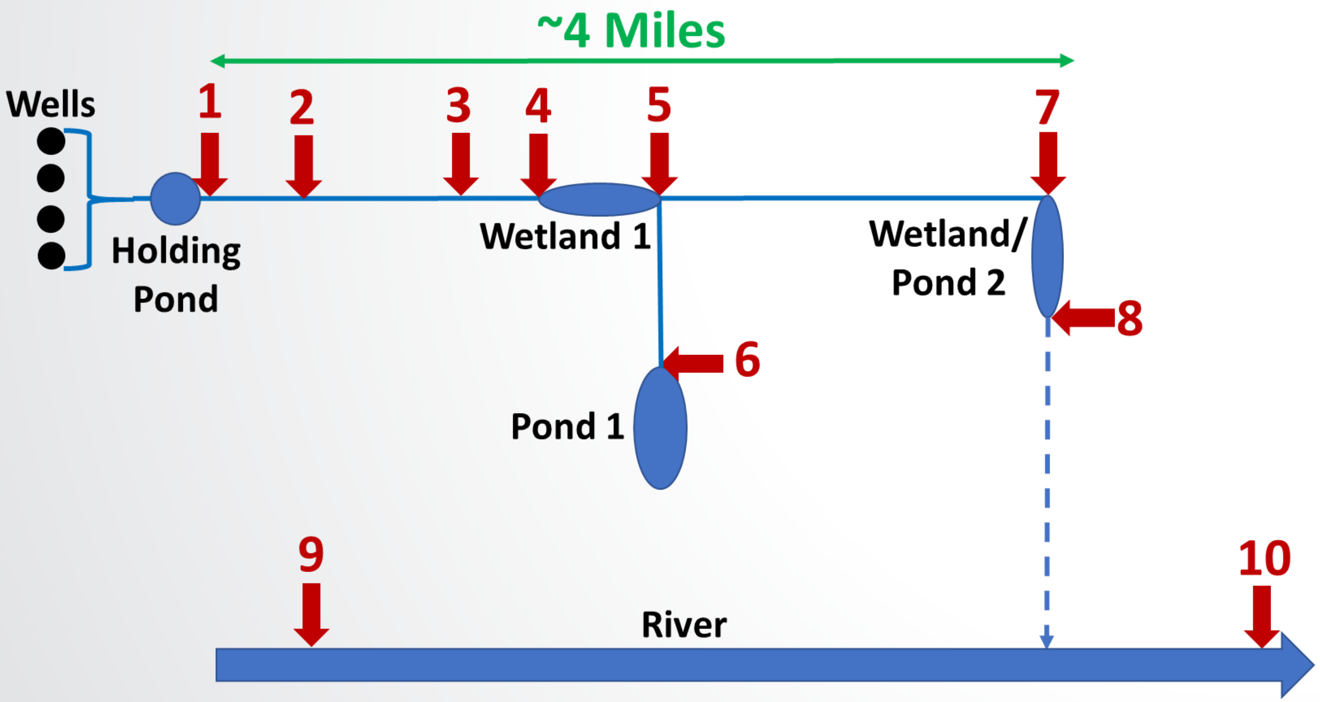
NMSU Treatment Pilot

- CompTox tools predict toxicity of suspect compounds across treatment

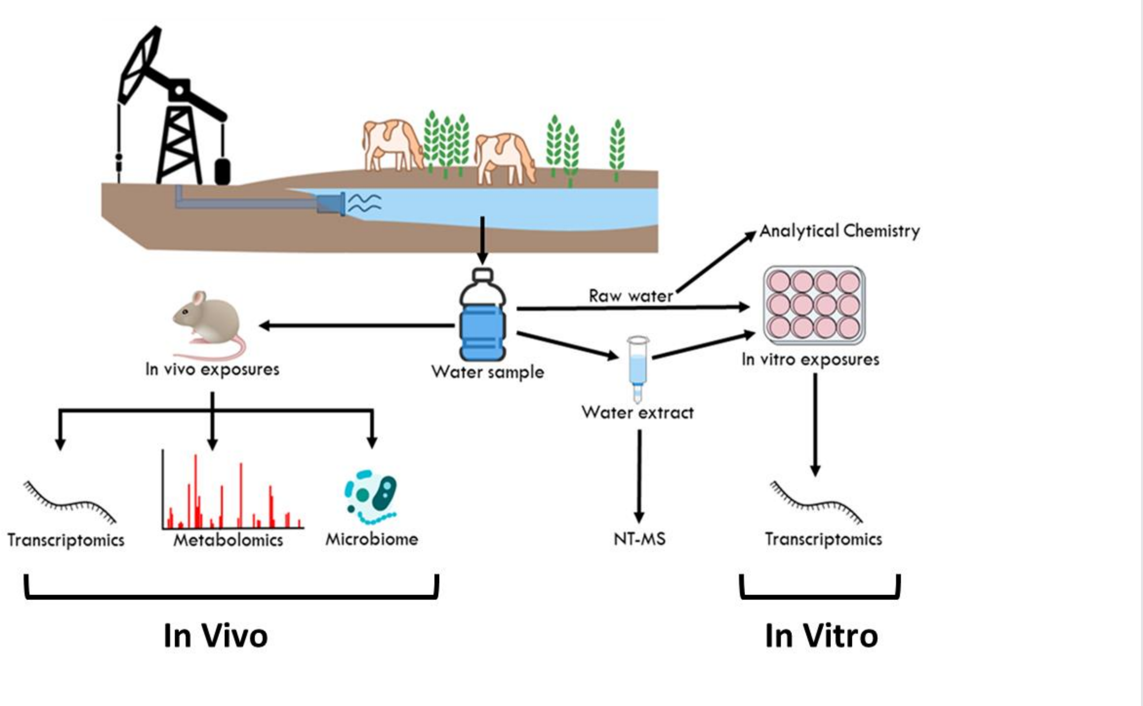


Produced Water Discharges

- Ongoing study: evaluating downstream effects from existing discharges
- *In vitro* and *in vivo* toxicity, high-throughput transcriptomics (HTTr), NTA



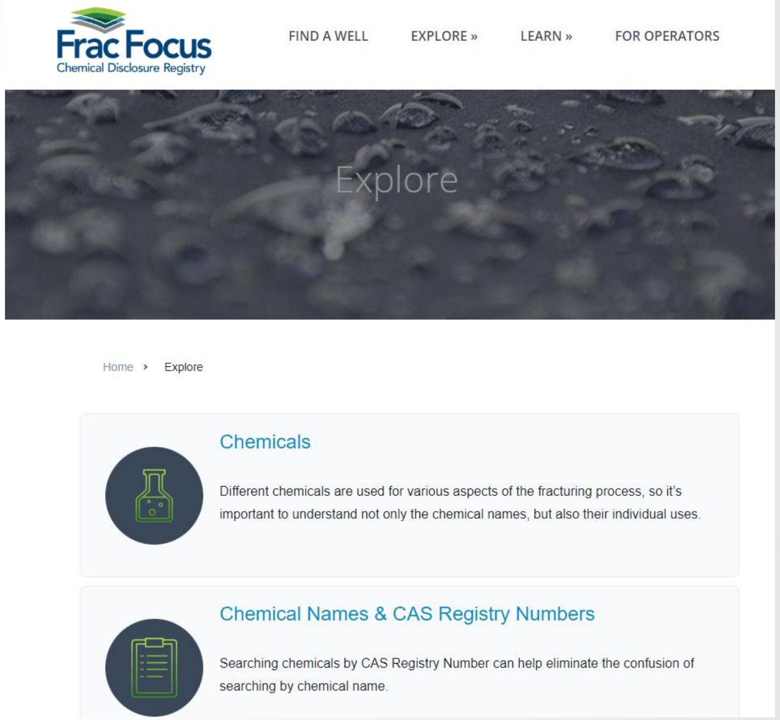
Sampling Design



Testing Design

Hydraulic Fracturing Data Curation

- Computational analysis of FracFocus database for chemical use disclosures
- Data cleaning and organization
  - Provided “as is” and requires preprocessing
- Chemical-functional usage relationships
  - Understanding the purposes for which chemicals used
  - Identifying different chemicals used for similar functions
- Toxicity screening
  - Linking reported chemicals to potential human and ecological health effects
  - Proprietary information presents limitations



CPDat
Chemical and Products Database

https://comptox.epa.gov/chemexpo

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Shane Knockemus

Produced Water Partnerships

- New Mexico Produced Water Research Consortium (NMPWRC)
- New Mexico State University (NMSU)
- Colorado School of Mines (CSM)
- DOE National Energy Technology Laboratory (NETL)
- Special thanks to:
  - Pei Xu (NMSU)
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  - James Rosenblum (CSM)
  - Brett Van Houghton (CSM)
  - Elliese Wright (CSM)
  - Nick Seifert (NETL)

Thank You
Questions?

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The views expressed in this presentation are those of the author and do not necessarily reflect the views and policies of the U.S. EPA.