Hazen

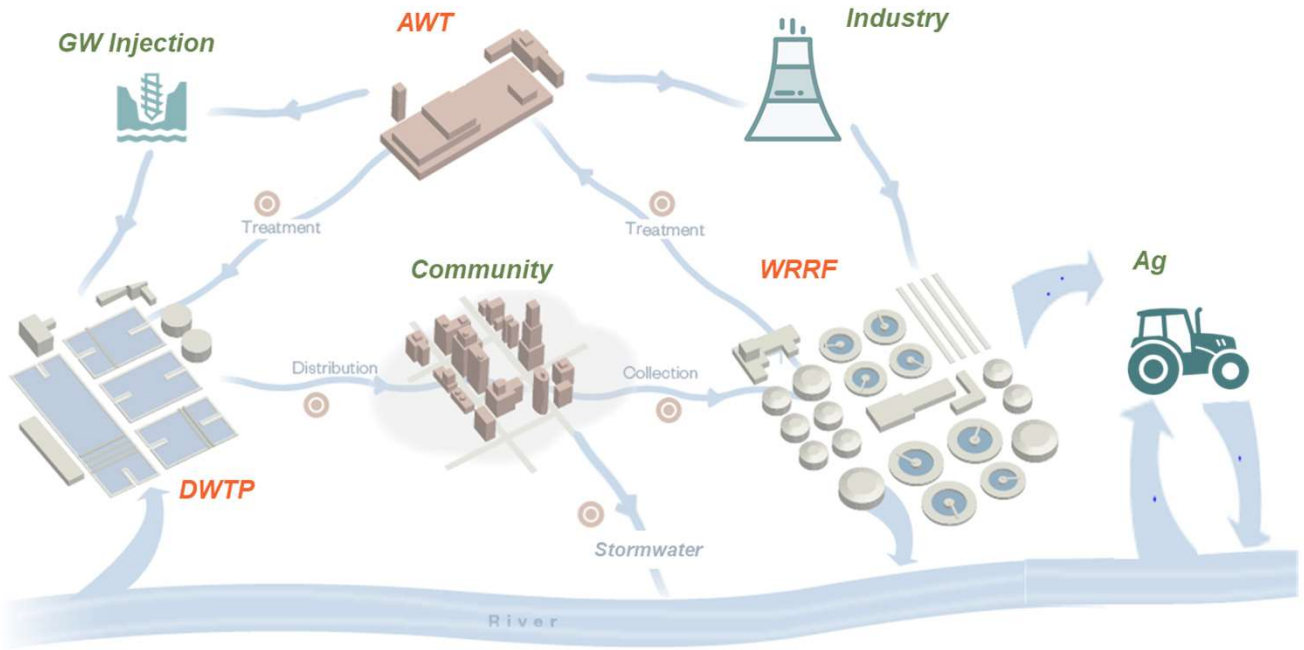
Impacts of Wastewater Treatment Performance on Advanced Water Treatment

WRF Project 4833

Troy Walker Water Reuse Practice Leader

Integrated Water Management…

…acknowledges the entire water cycle as a single, integrated system, in which water in all its forms is recognized as a critical resource



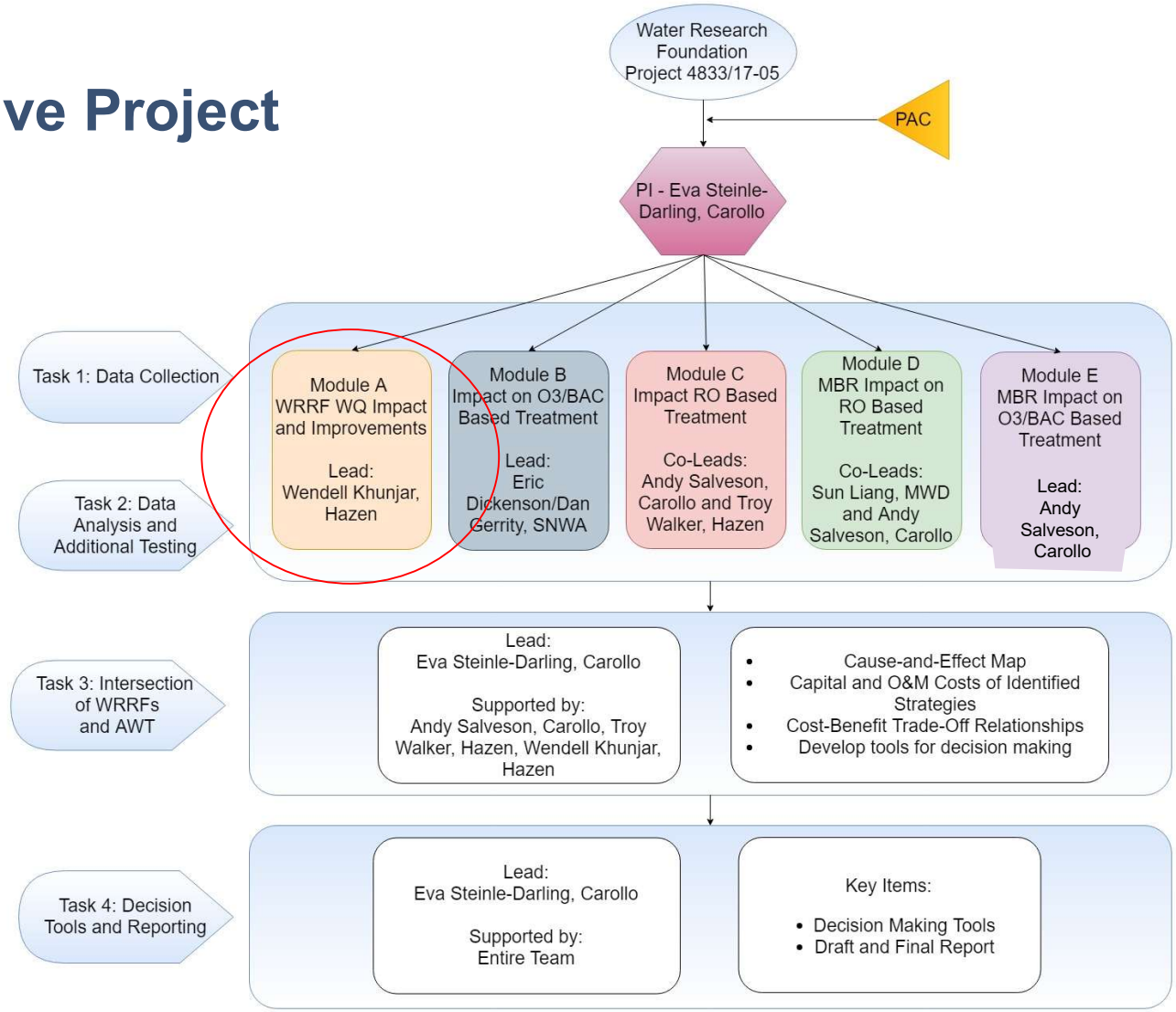
Part of a Comprehensive Project

carollo
Engineers...Working Wonders With Water™

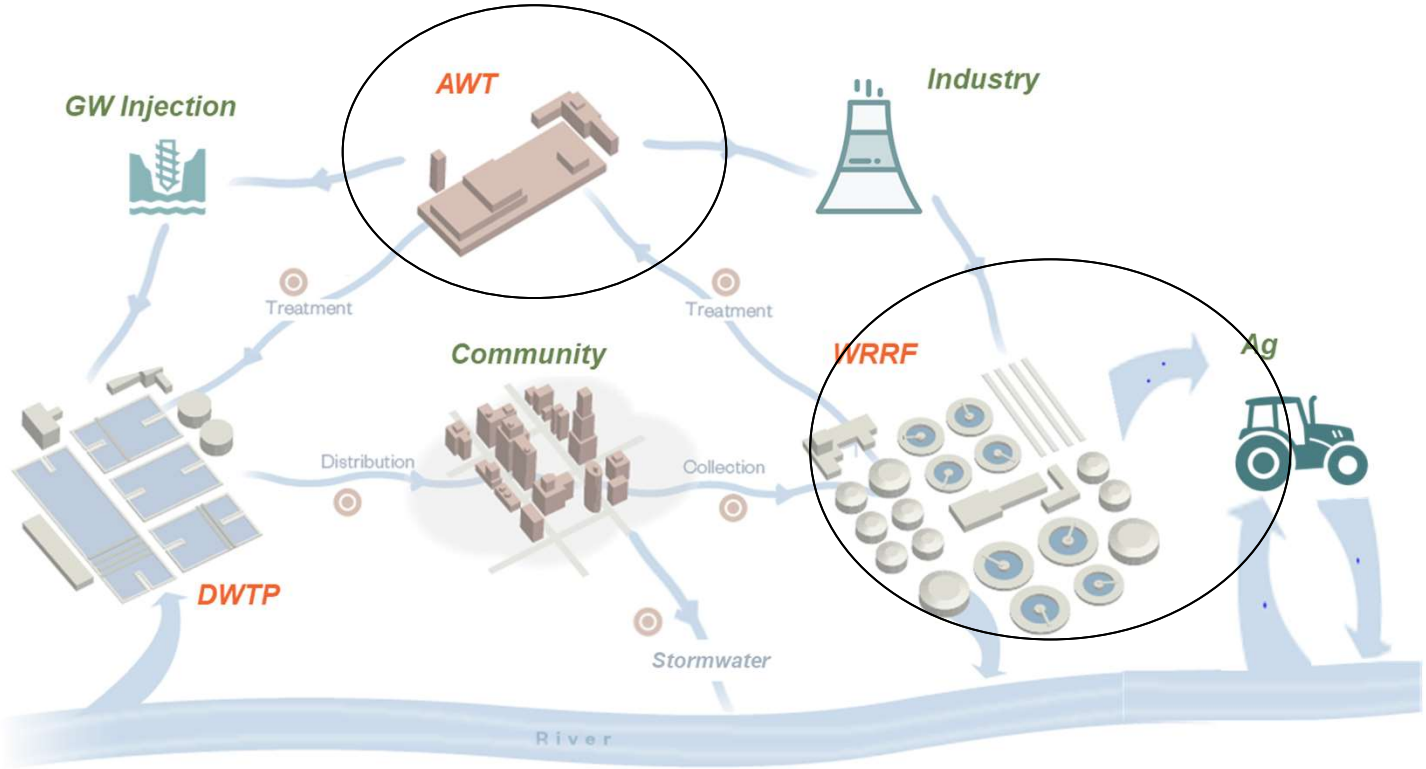
Hazen

SOUTHERN NEVADA WATER AUTHORITY

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA



This Project Focuses on Interconnectivity Among Conventional and Advanced Processes



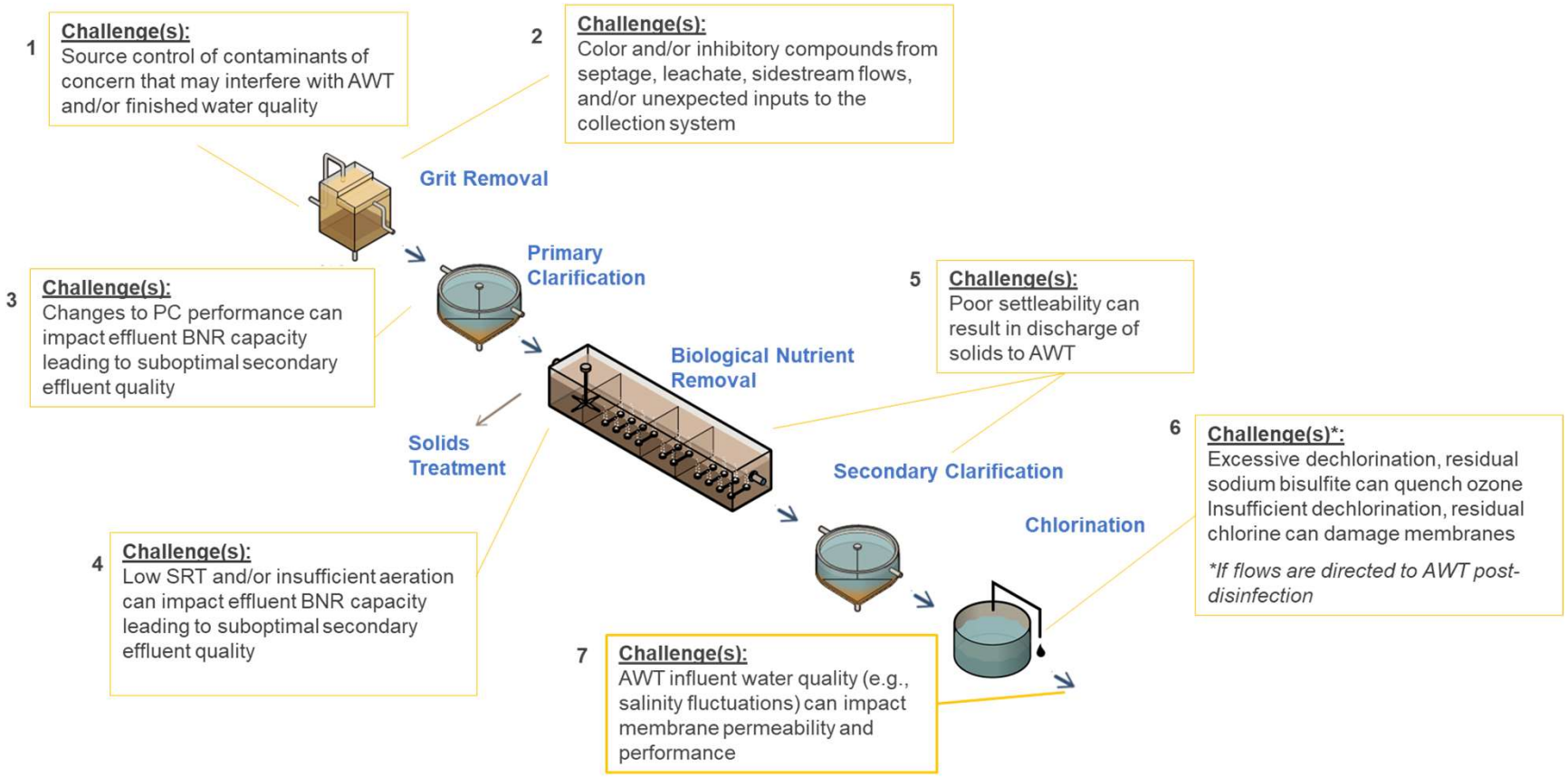
Module A
WRRF Water Quality Impact and Improvements

Wendell Khunjar, Ph.D., PE
Associate Vice President
Director of Wastewater Innovation

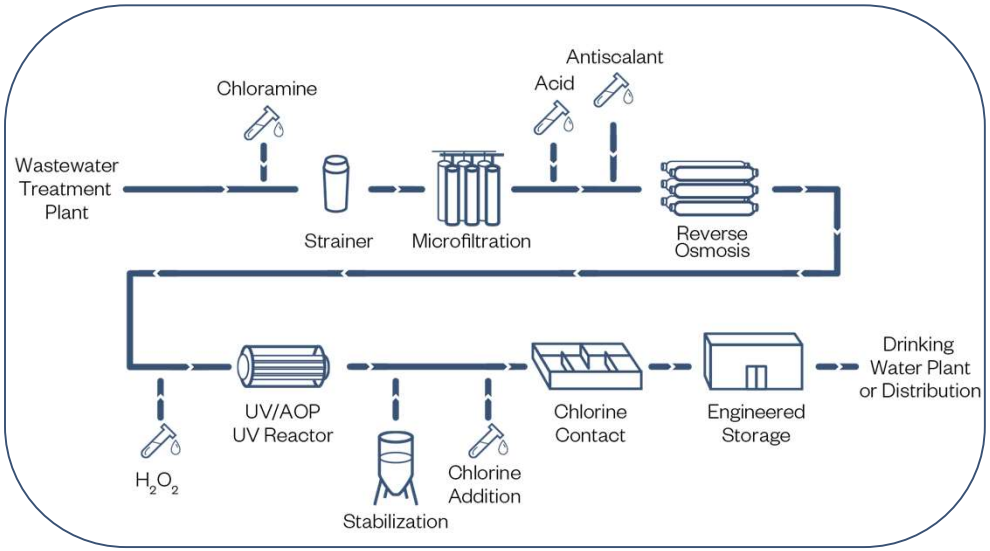
Kelly Landry, Ph.D., ENV SP
Scientist

Background

AWT Success Depends on WRRF Performance

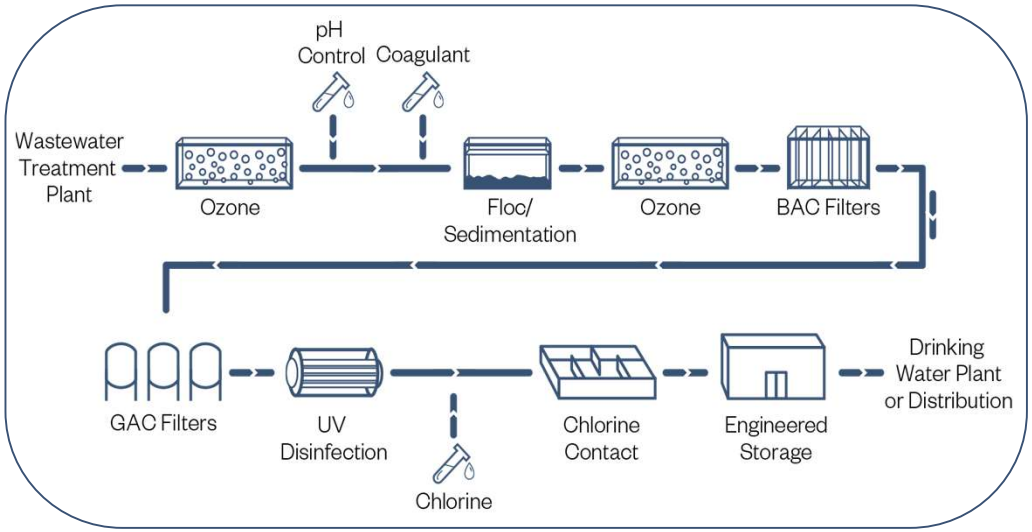


Two Typical Approaches to Advanced Wastewater Treatment



RO-Based Treatment

Non-RO-Based Treatment



Module A Research Goals and Objectives

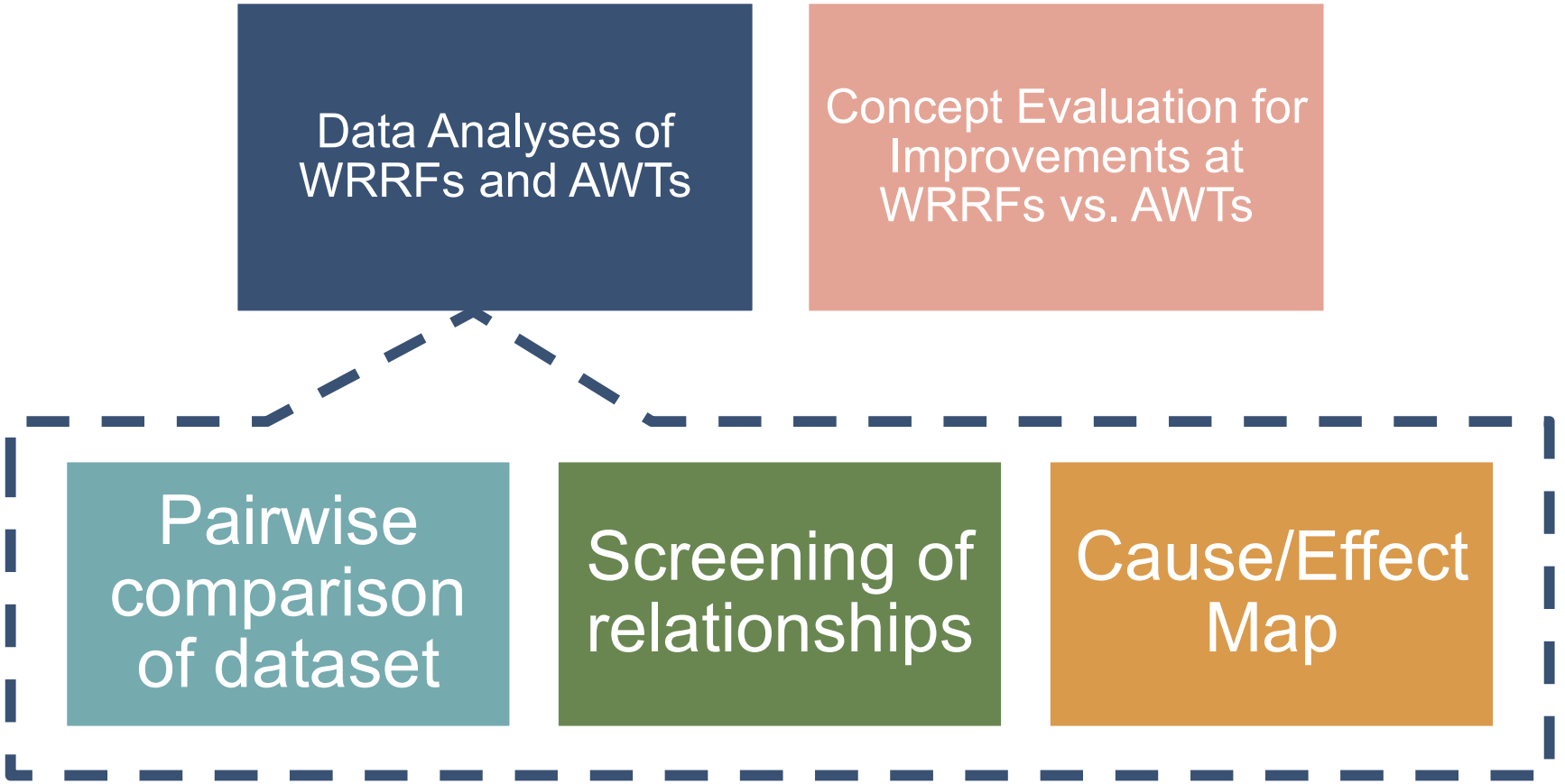
Document how performance at WRRFs can impact AWT process performance

Data Analyses of WRRFs and AWTs

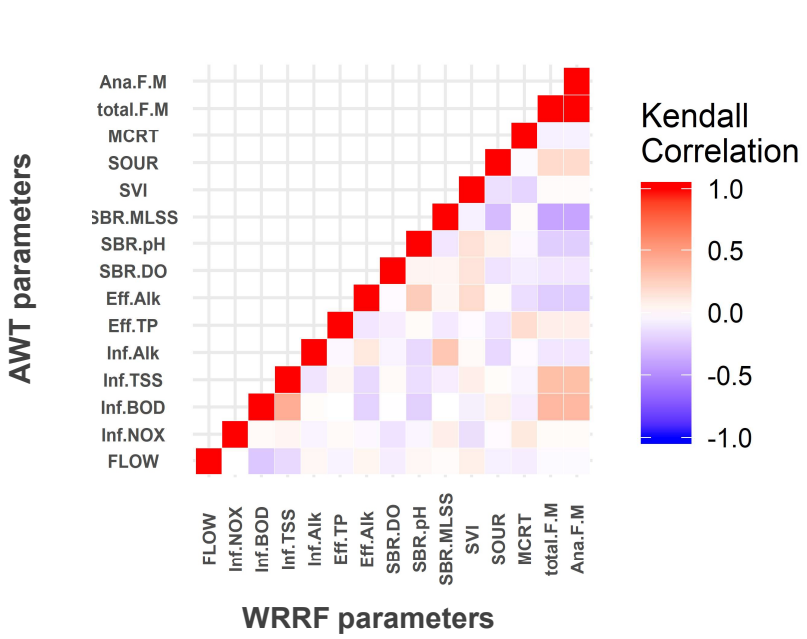
Concept Evaluation for Improvements at WRRFs vs. AWTs

Module A Research Approach

Project Scope

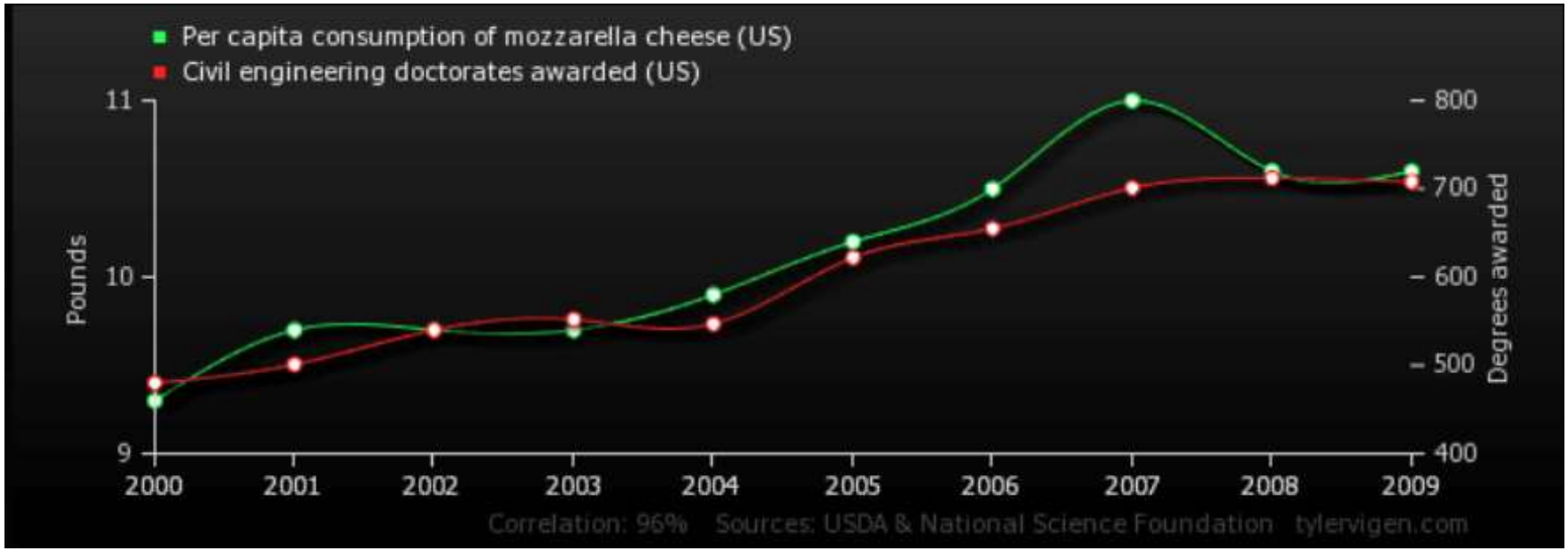


Example Approach - Residuals Management for O_3/BAF Configuration

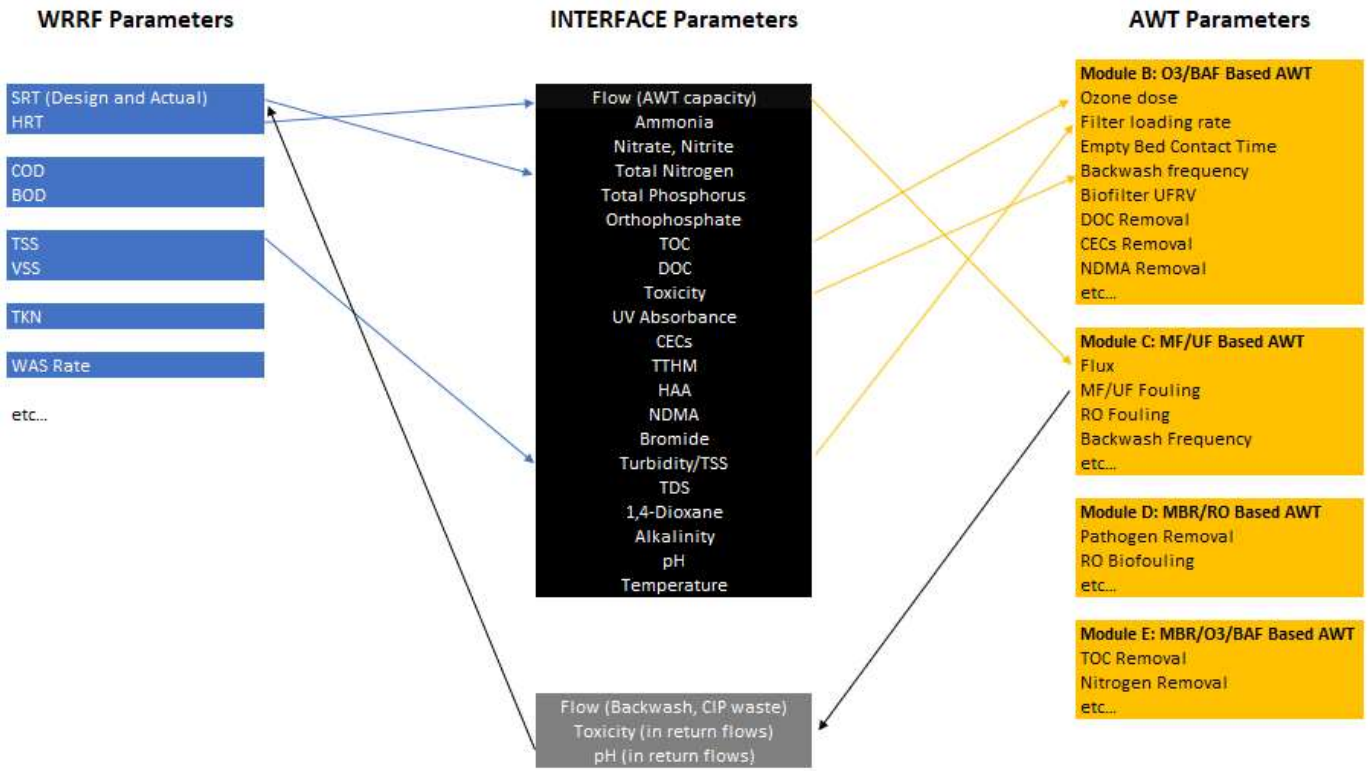


AWT Parameter	Combination of WRRF parameters that significantly impact AWT ($p < 0.05$)	Mitigation Approach
DOC removal	Influent BOD	Pre-treatment Load EQ
	PC removal efficiency	Change # of clarifiers in service Change PS blanket Implement CEPT Load EQ

Remember! Correlation Does Not Equal Causation



Interface Parameter Concept



Interface Parameter

Process parameters monitored at the interface between mainstream WRRF and AWT

WRRF effluent = AWT influent

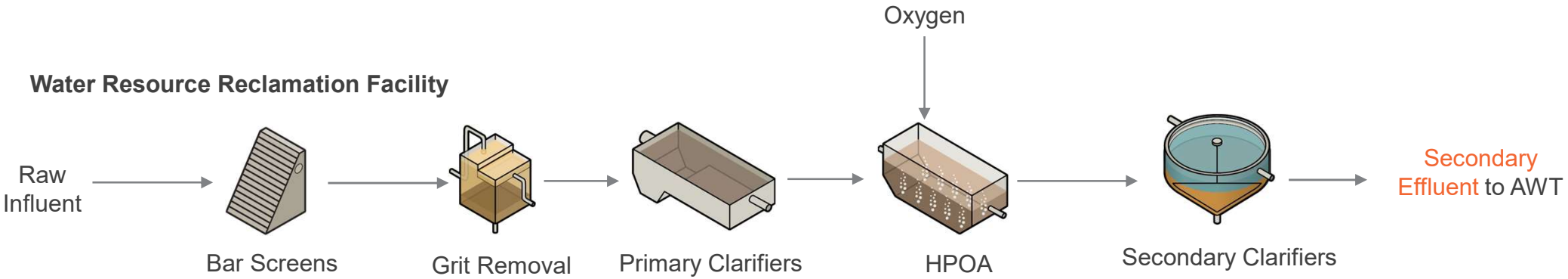
Utilities Evaluated

WRRF Utility Name	WRRF Train	AWT Train
Utility No. 1	1°, 2° Nit	MF/RO/UV AOP
Utility No. 2	1°, 2° Nit, 3° Filter/UF	O3 /BAC/O3
Utility No. 3	1°, 2° Nit/Denit, MBR	BAC/GAC

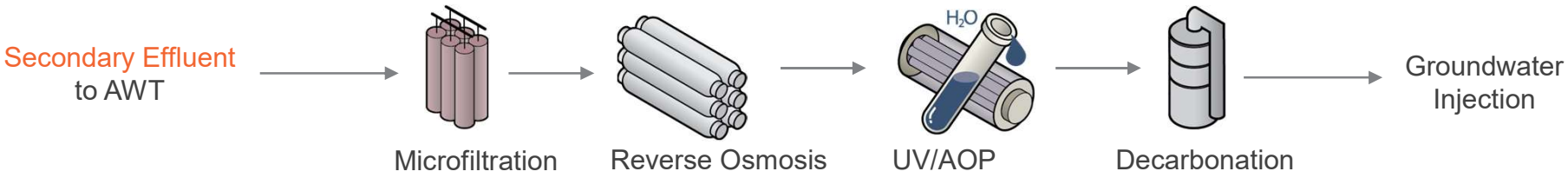
Utility No. 1 Process Flow Diagram

Interface Parameters = Secondary Effluent

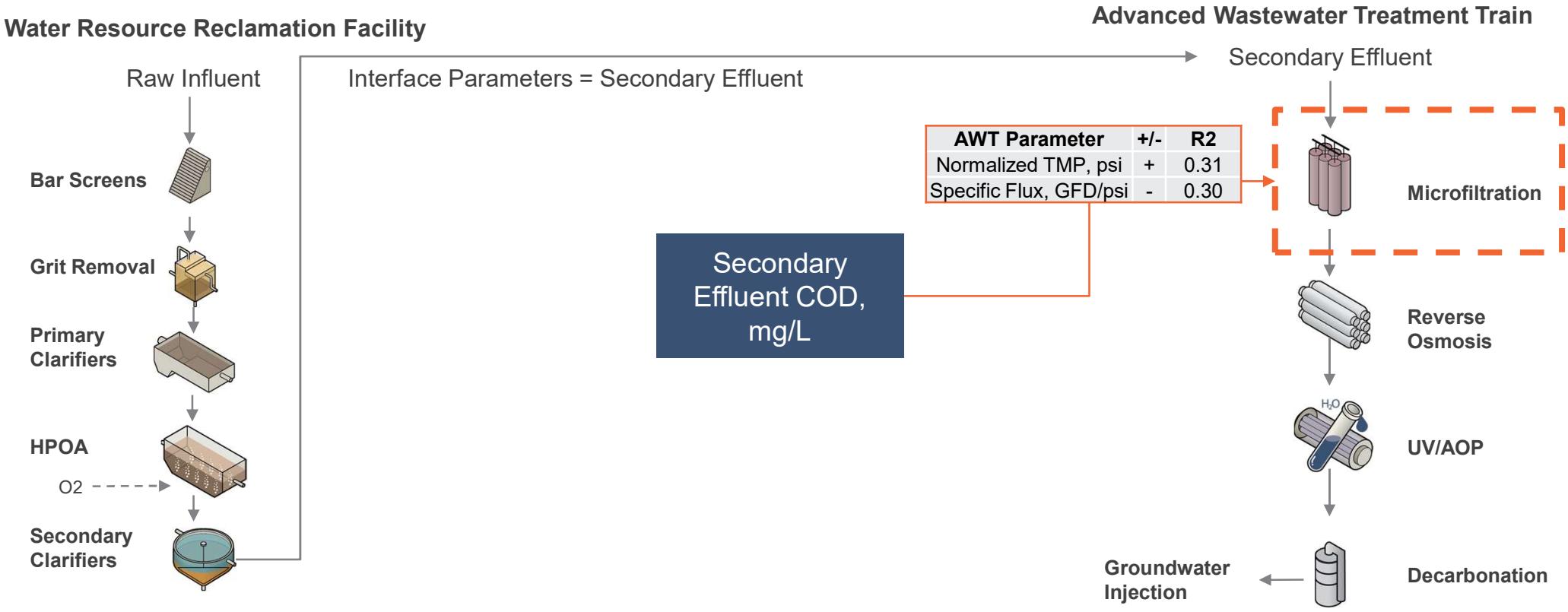
Water Resource Reclamation Facility



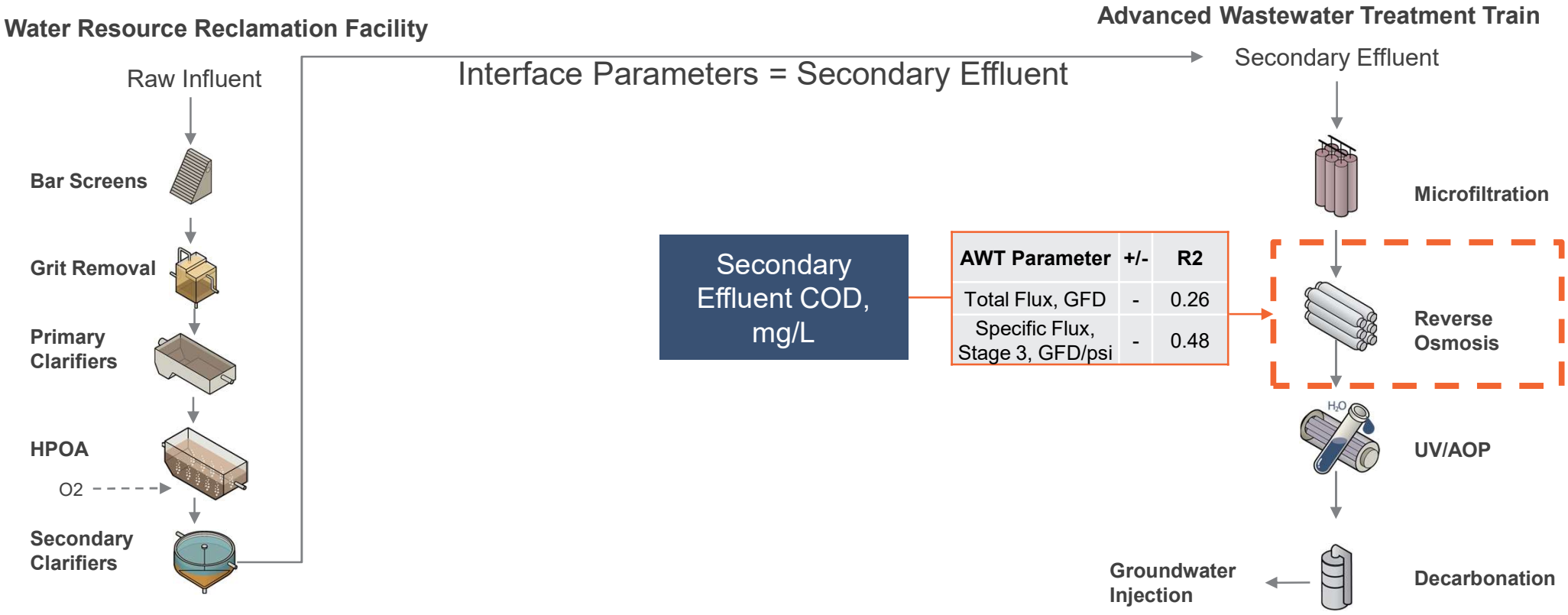
Advanced Wastewater Treatment Train



Utility No. 1 Summary of Results



Utility No. 1 Summary of Results



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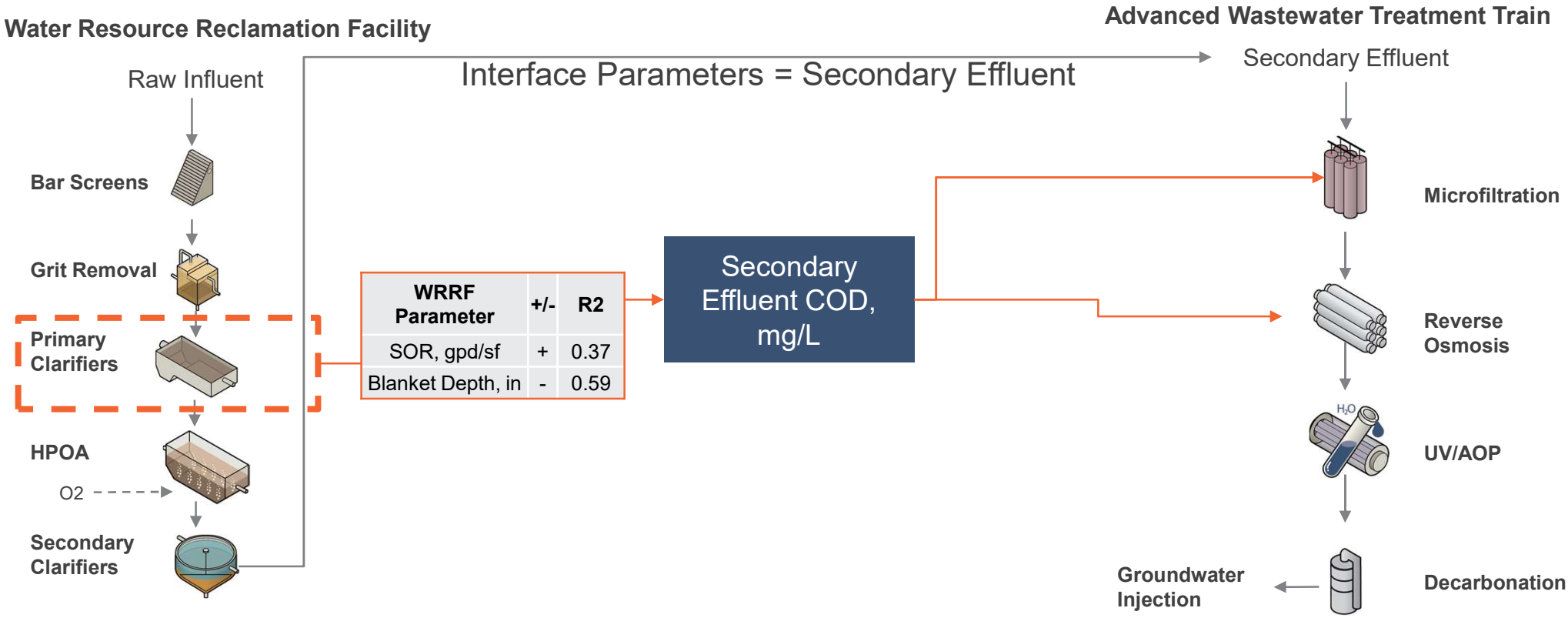

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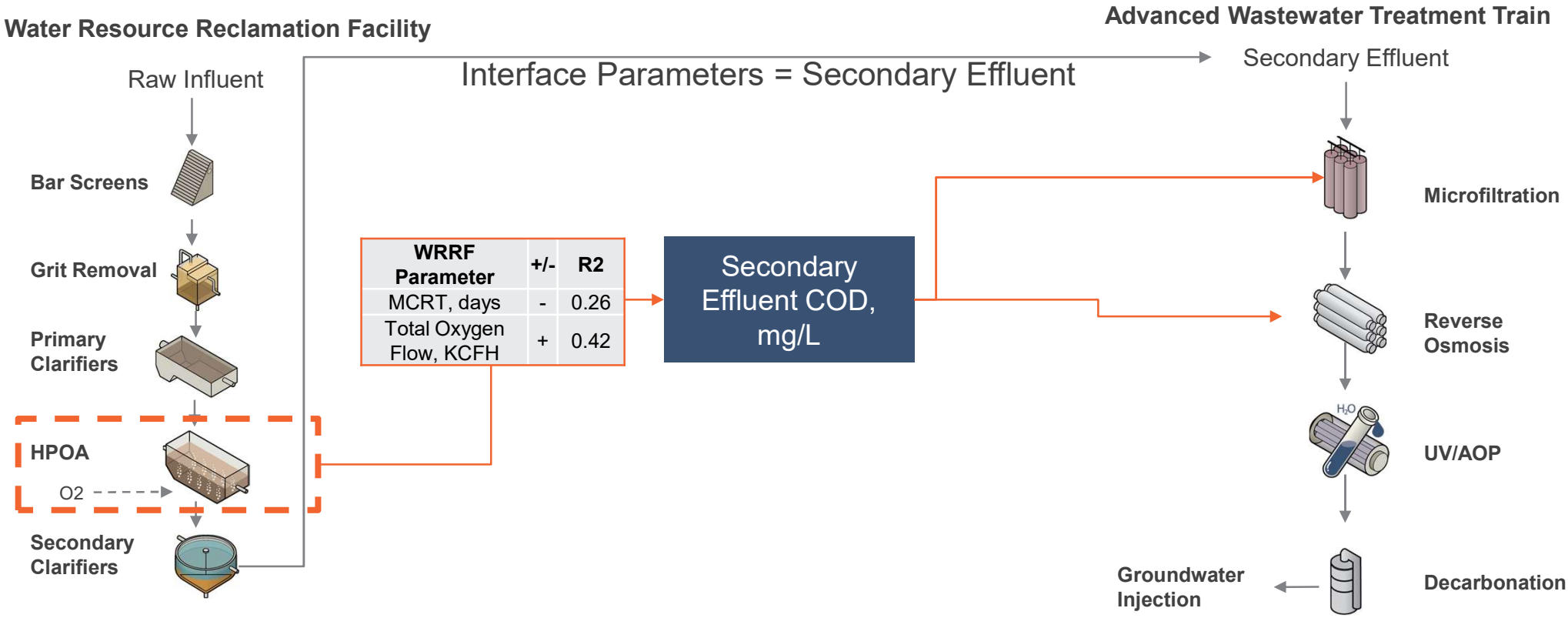
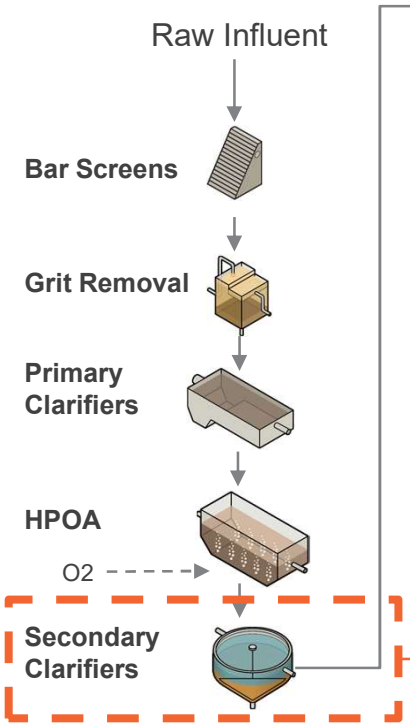


Utility No. 1 Summary of Results

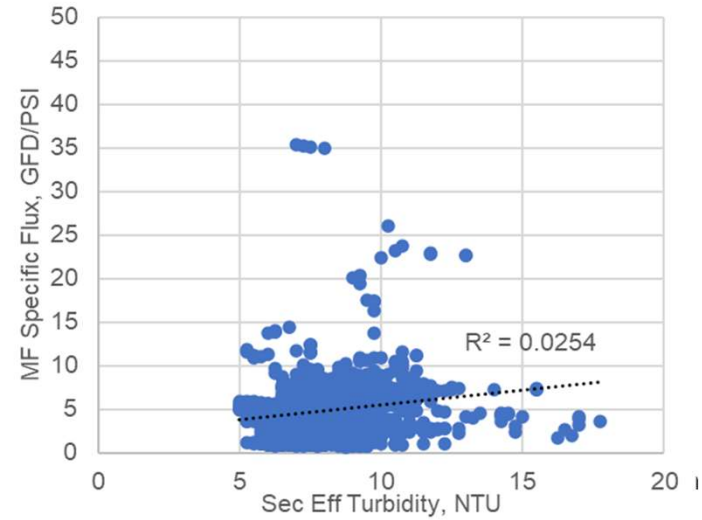
Water Resource Reclamation Facility

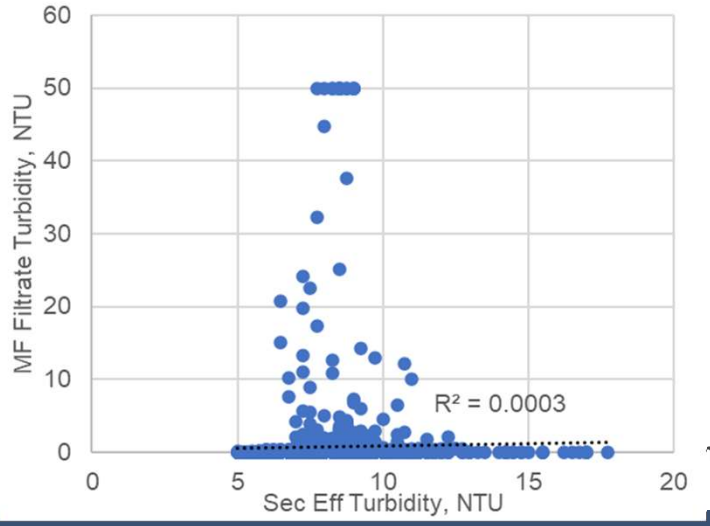


Interface Parameters = Secondary Effl

WRRF Parameter	+/-	R2
SLR, lb/sf/d	+	0.28
Influent COD, mg/L	-	0.85

Secondary Effluent Turbidity, mg/L

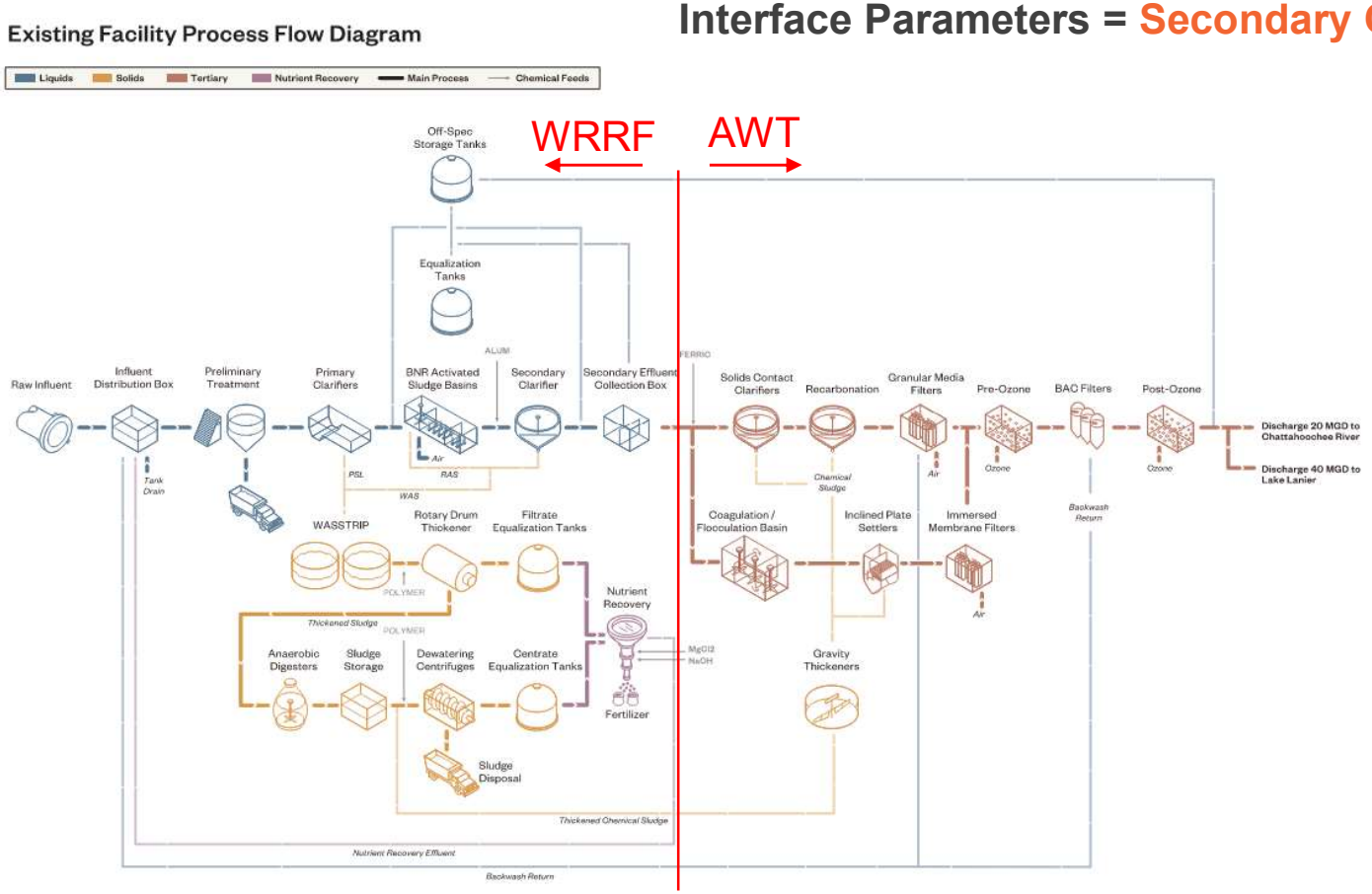




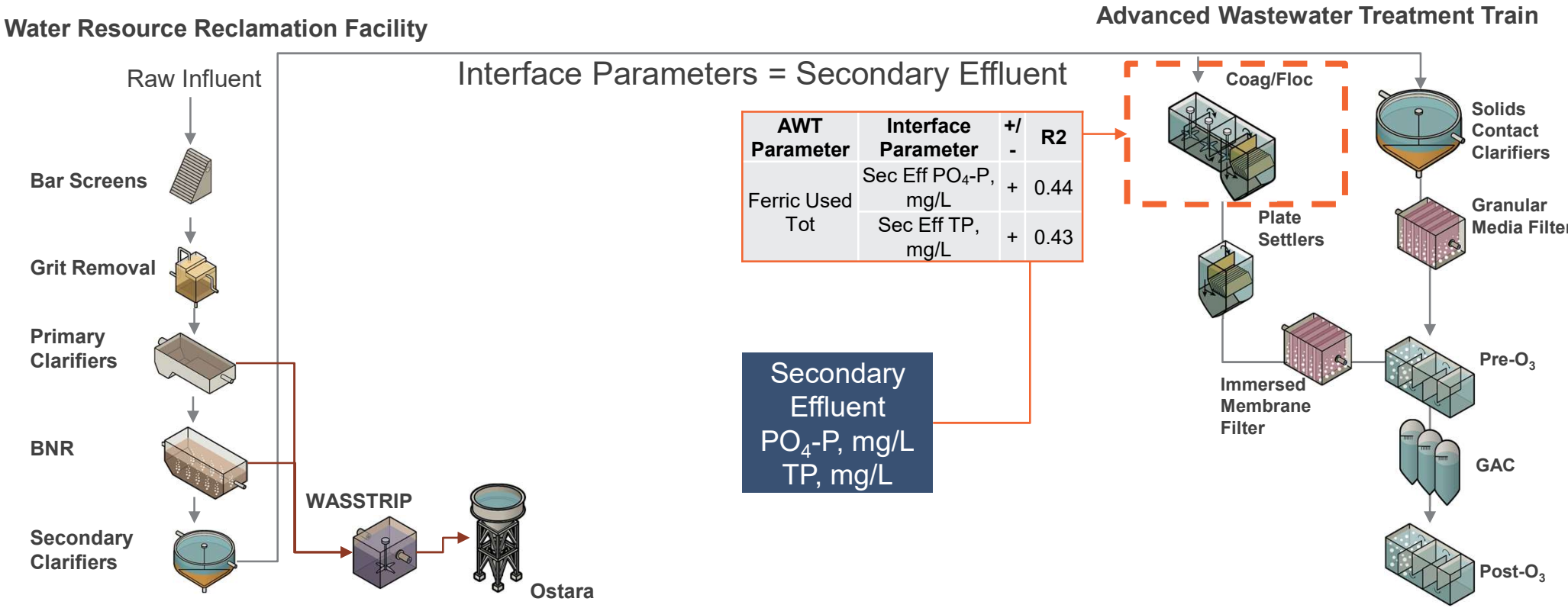
Utility No. 2

60 MGD Facility

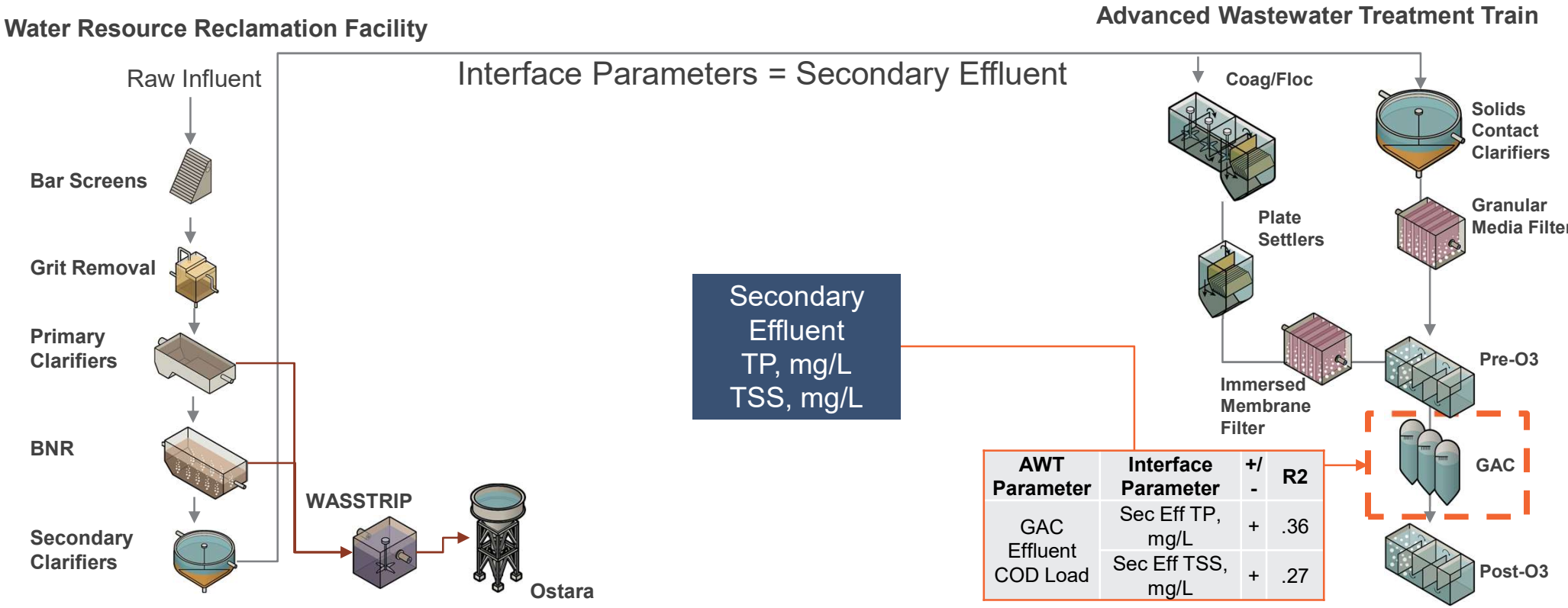
Interface Parameters = Secondary Clarifier Effluent



Utility No. 2 Summary of Results



Utility No. 2 Summary of Results



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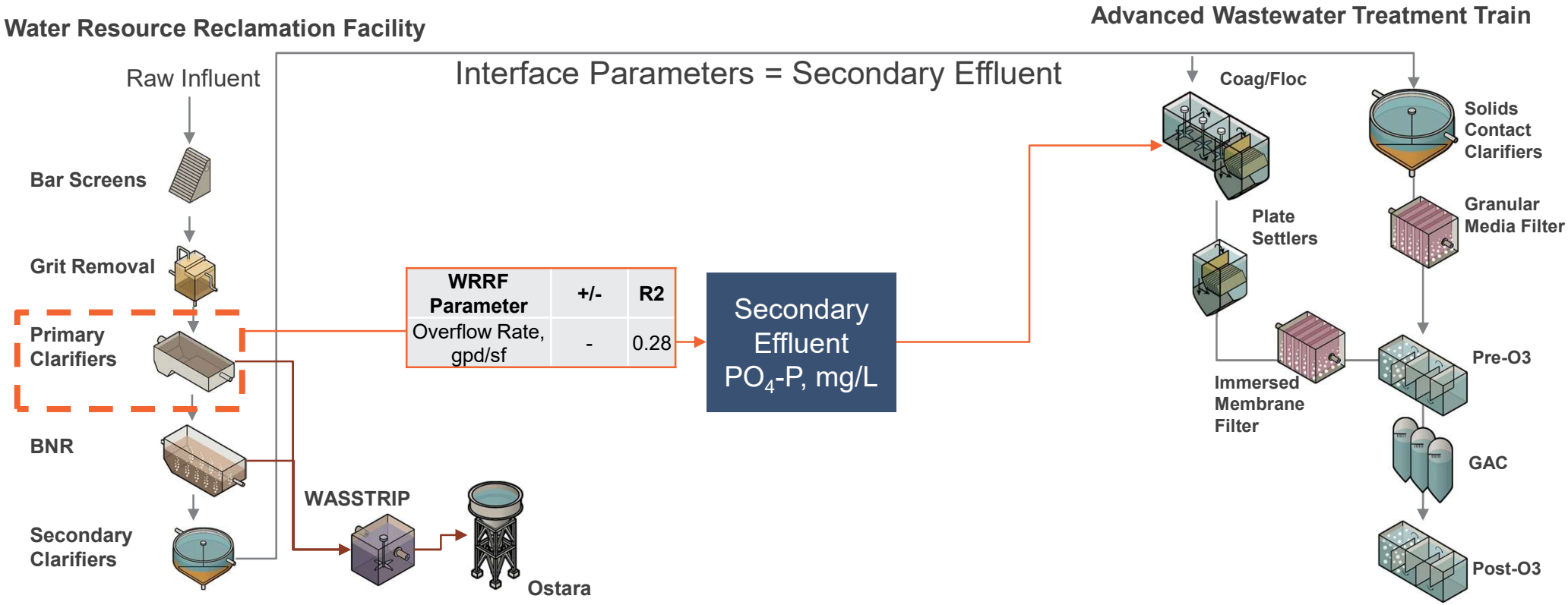
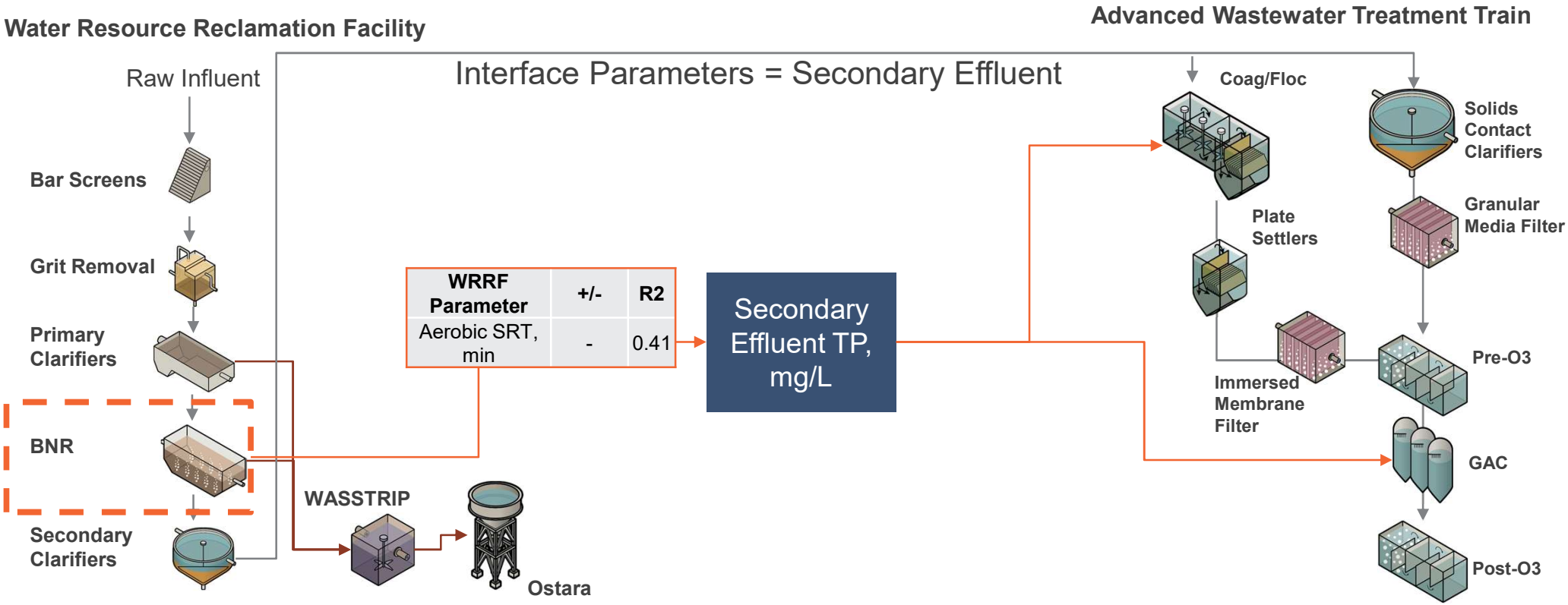
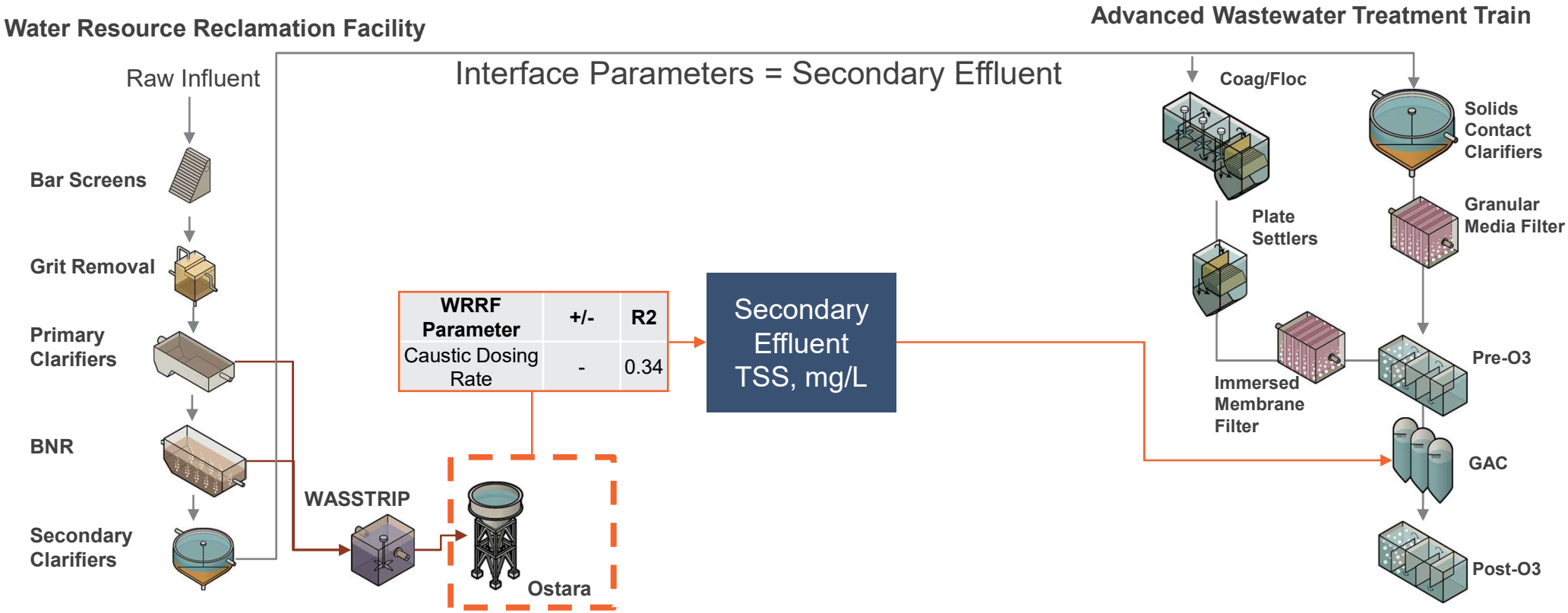


Utility No. 2 Summary of Results



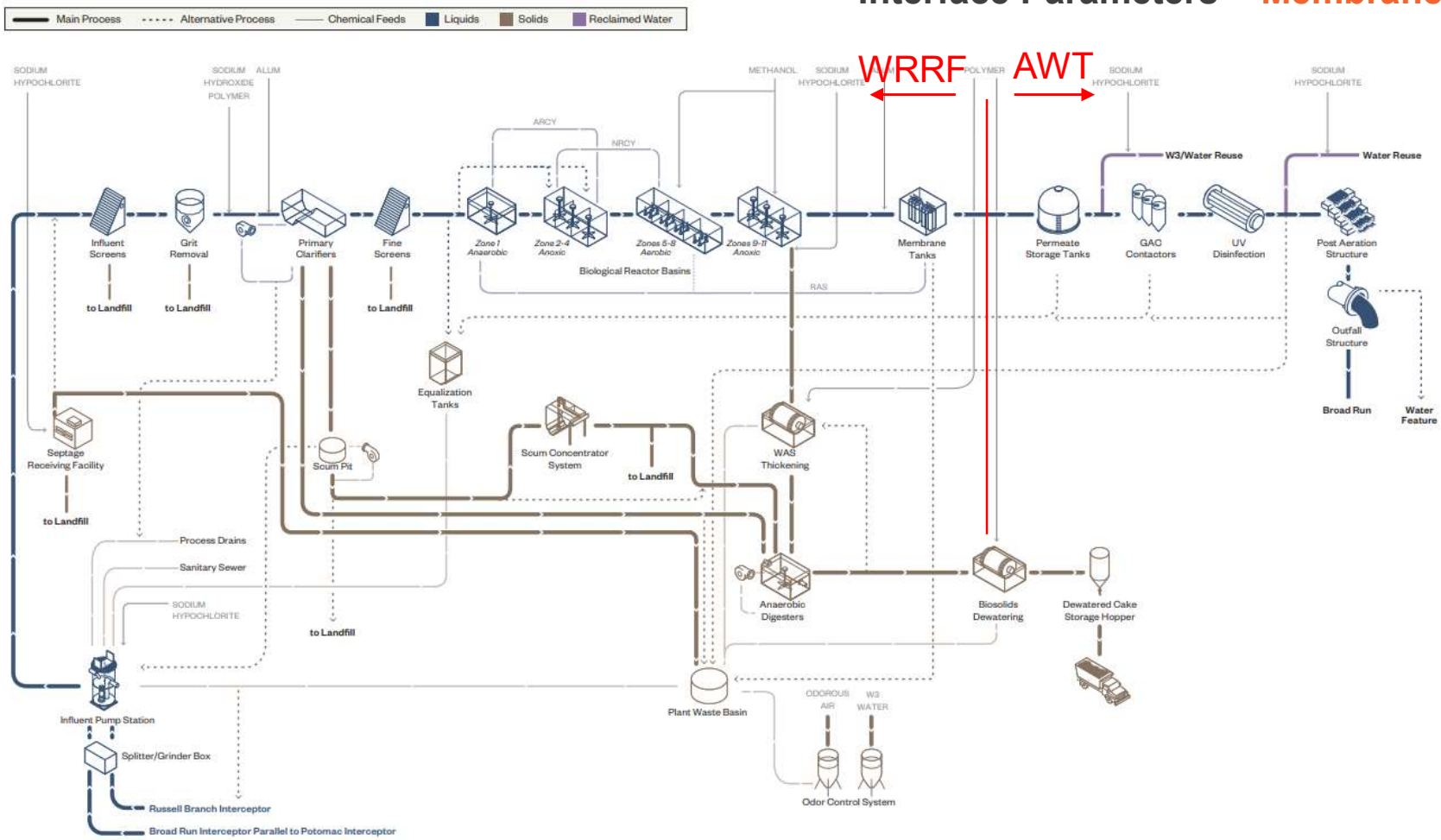
Utility No. 2 Summary of Results



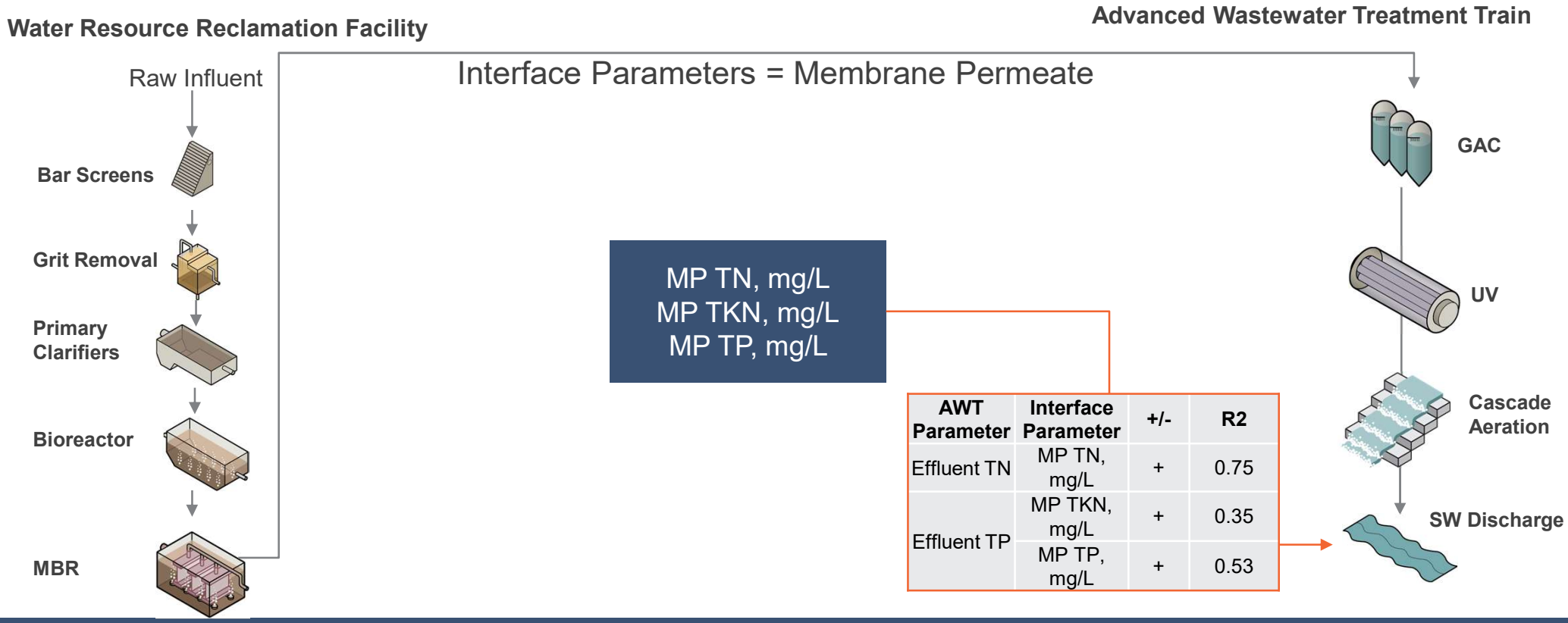
Utility No. 3

11.5 MGD Facility

Interface Parameters = Membrane Permeate

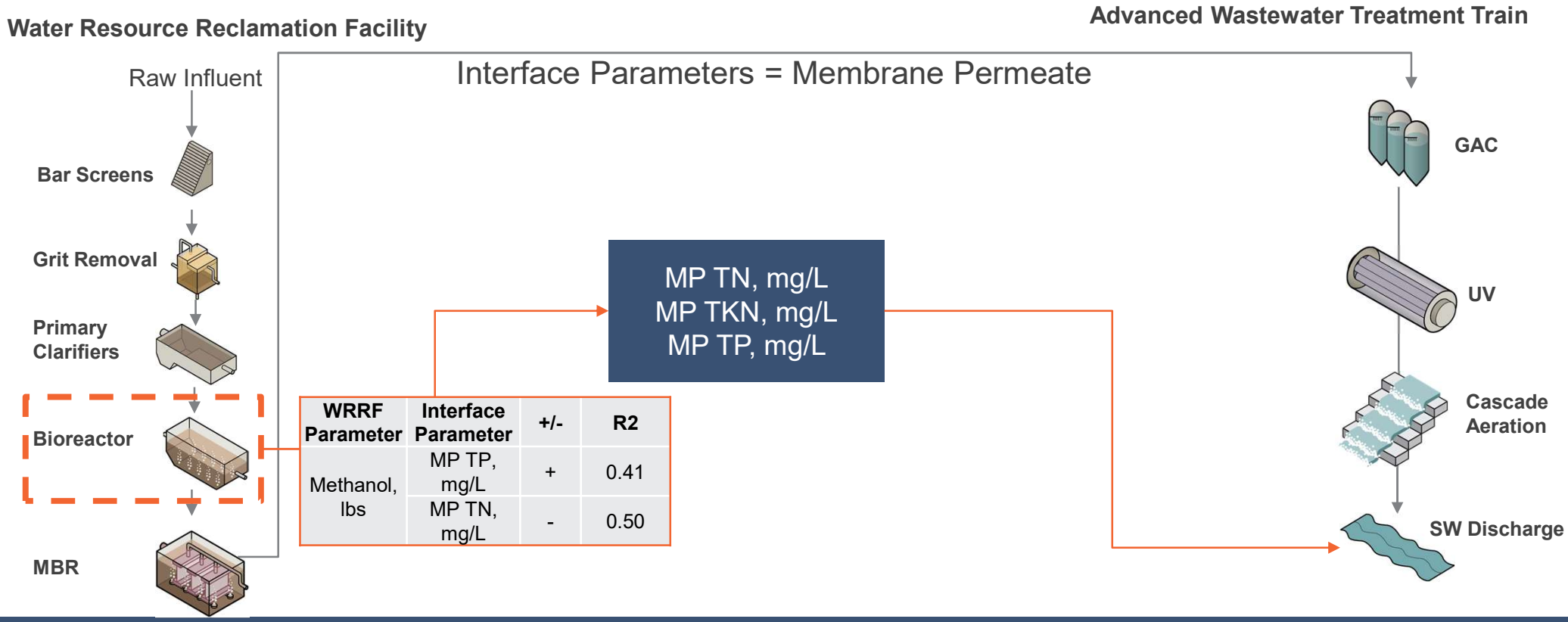


Utility No. 3 Summary of Results



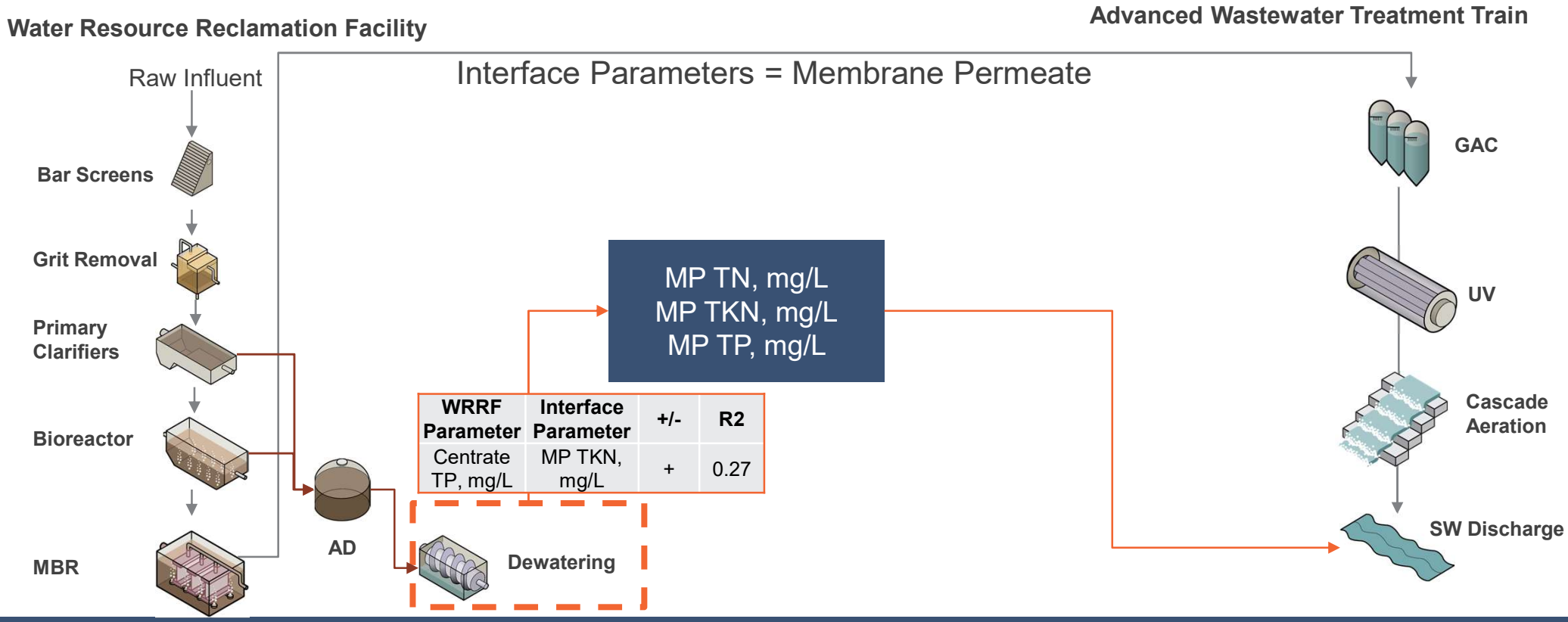
AWT Parameter	Interface Parameter	+/-	R2
Effluent TN	MP TN, mg/L	+	0.75
Effluent TP	MP TKN, mg/L	+	0.35
	MP TP, mg/L	+	0.53

Utility No. 3 Summary of Results



WRRF Parameter	Interface Parameter	+/-	R2
Methanol, lbs	MP TP, mg/L	+	0.41
	MP TN, mg/L	-	0.50

Utility No. 3 Summary of Results

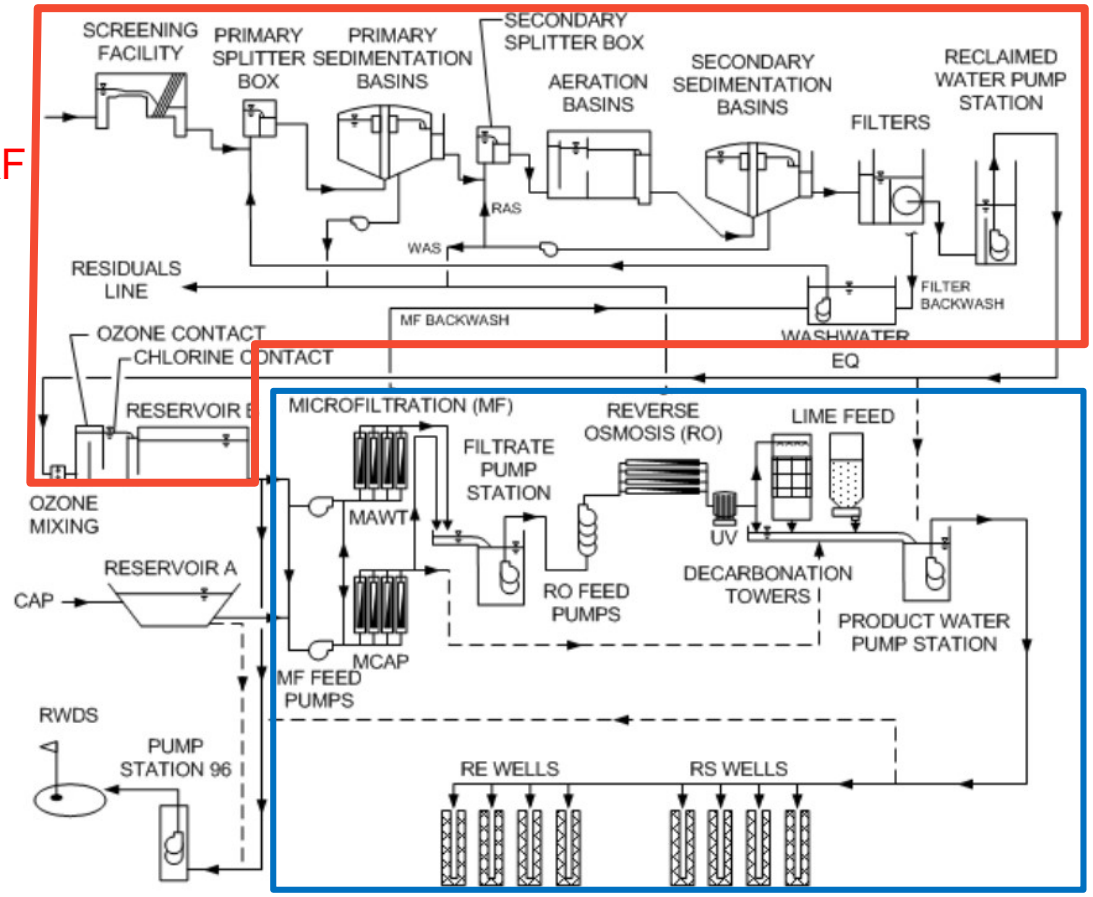


Utility No. 3

20 MGD Facility

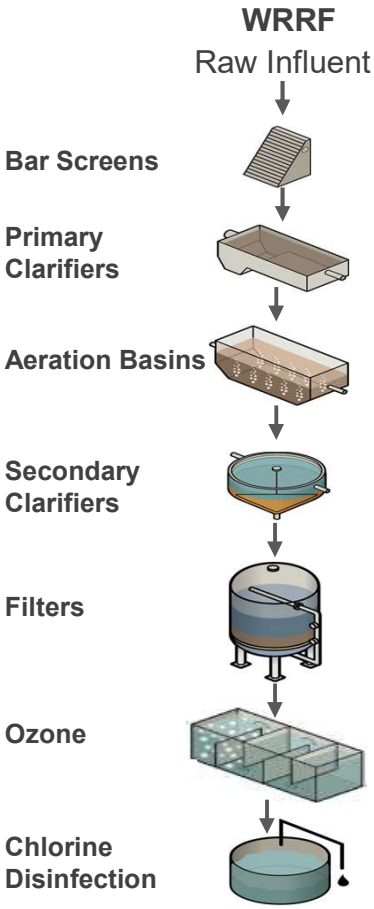
Interface Parameters = Ozone Effluent

WRRF



AWT

Utility No. 4 Summary of Results

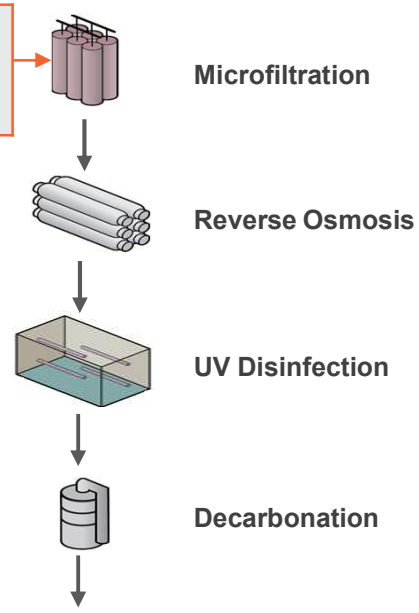


Interface Parameters

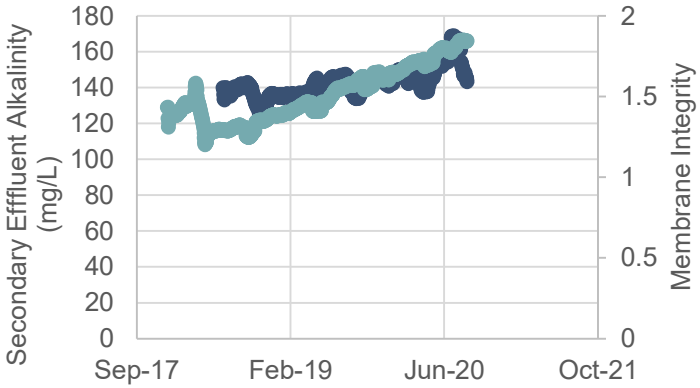
AWT Parameter	Interface Parameter	+/-	R2
Membrane Integrity	Alkalinity	+	0.50

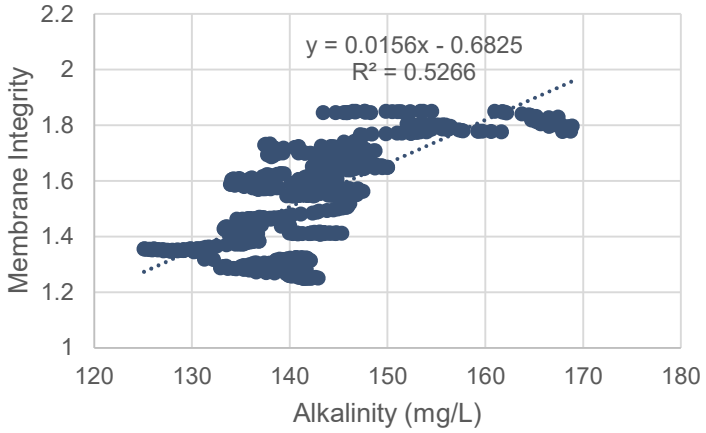
Secondary Effluent Alkalinity, mg/L

AWT



Utility No. 4 Summary of Results



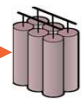


Interface Parameters

AWT Parameter	Interface Parameter	+/-	R2
Membrane Integrity	Alkalinity	+	0.50

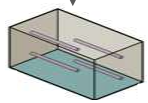
Secondary Effluent Alkalinity, mg/L

AWT



Microfiltration

Reverse Osmosis

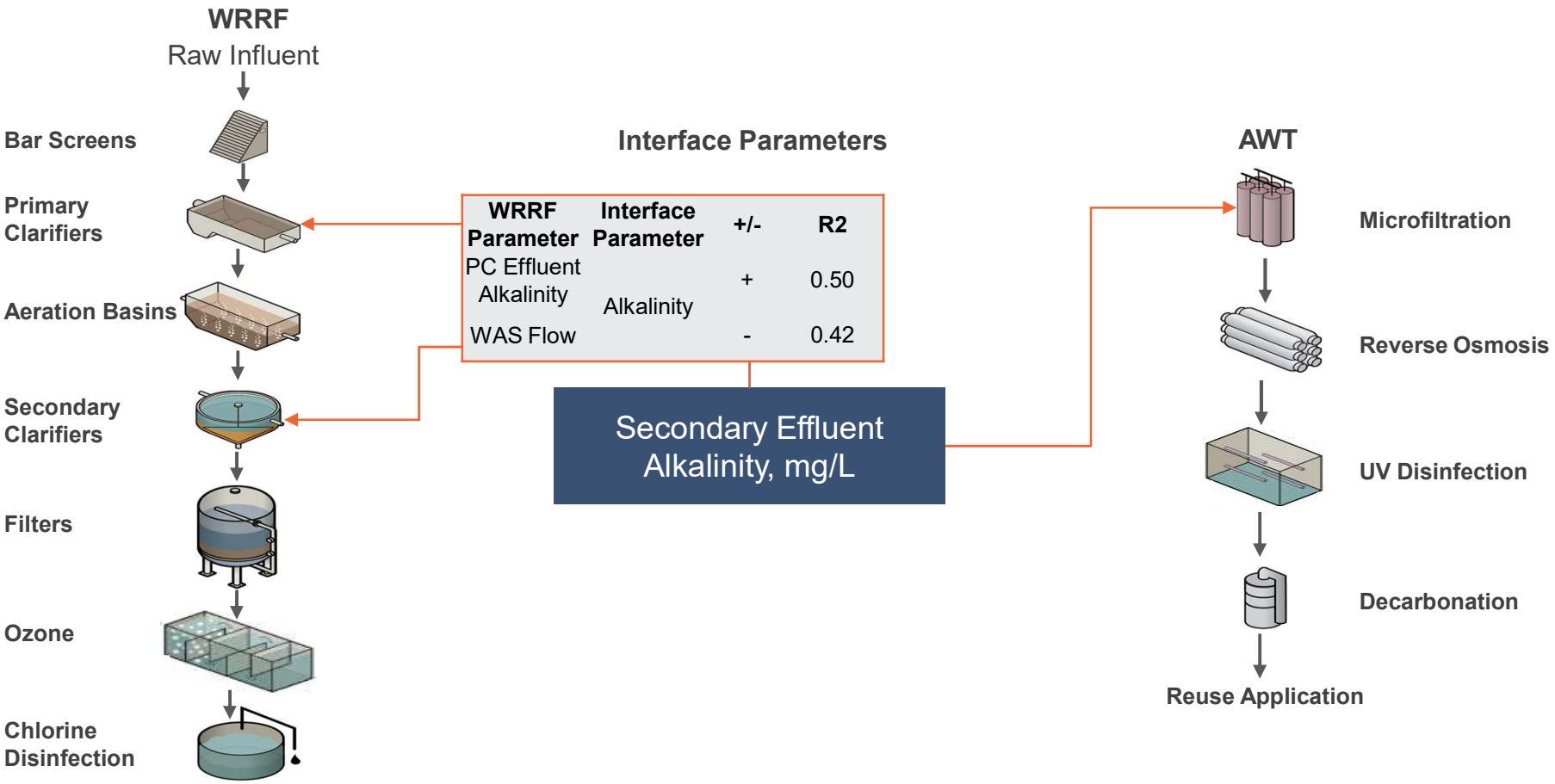


UV Disinfection

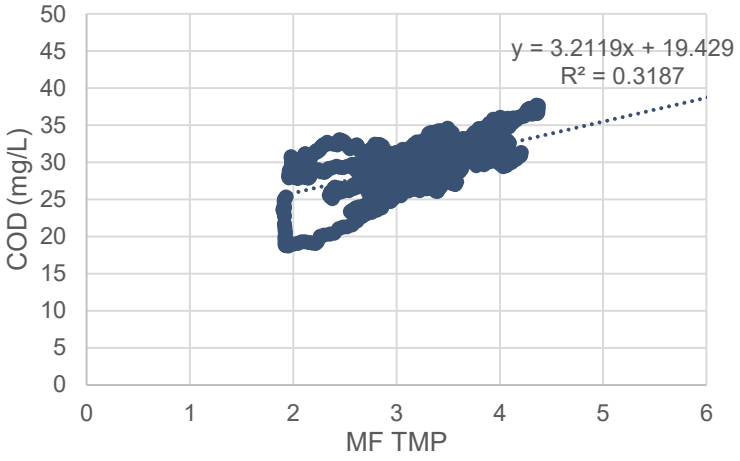
Decarbonation

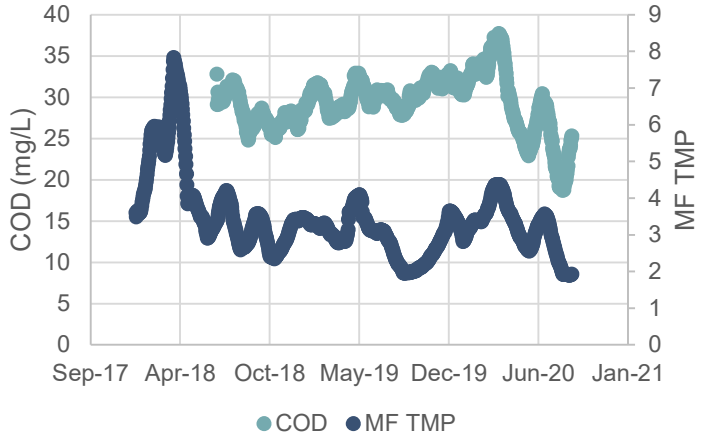
Reuse Application

Utility No. 4 Summary of Results



Utility No. 4 Summary of Results



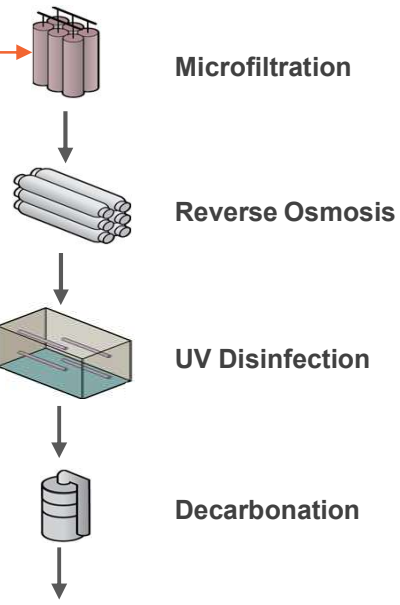


Interface Parameters

AWT Parameter	Interface Parameter	+/-	R2
MF TMP	COD	+	0.32

Secondary Effluent COD, mg/L

AWT



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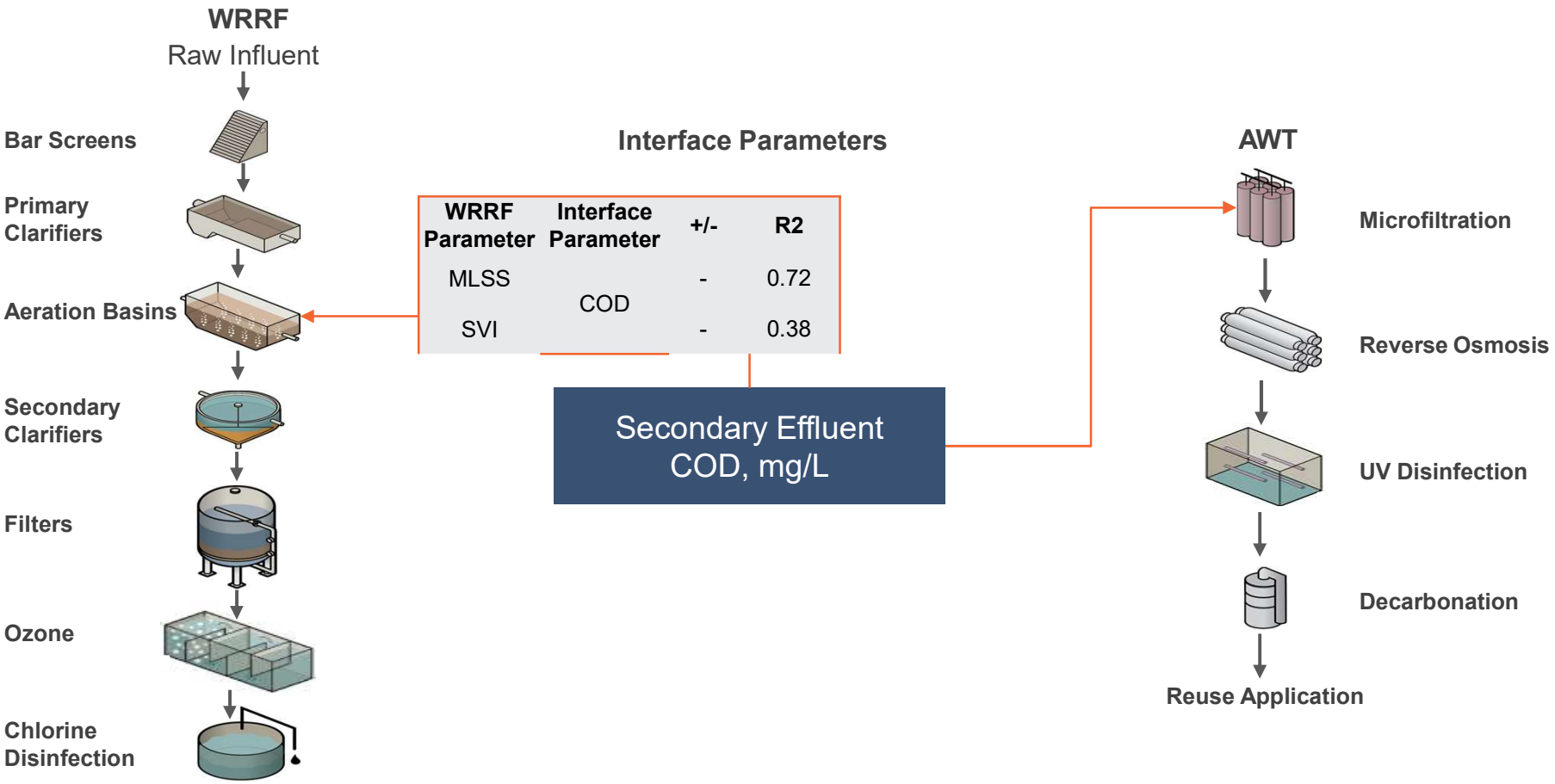

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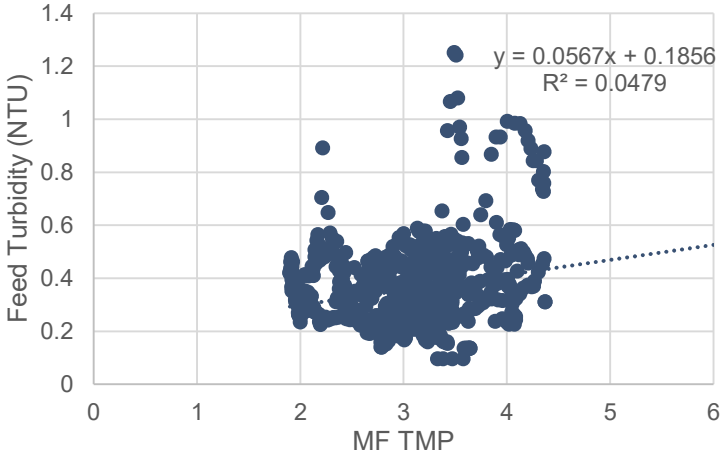
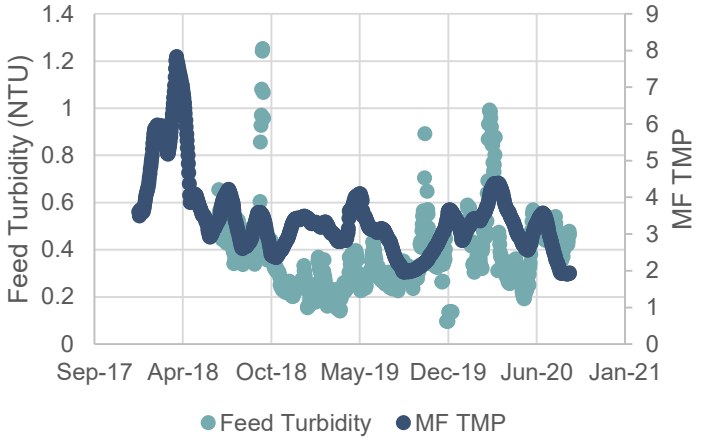


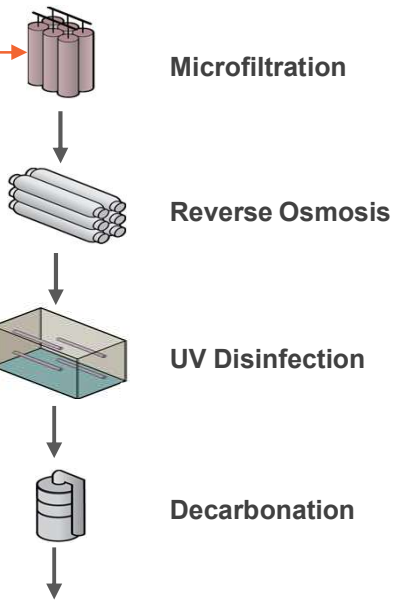


Interface Parameters

AWT Parameter	Interface Parameter	+/-	R2
MF TMP	Turbidity	+	0.05

Secondary Effluent Turbidity, NTU

AWT



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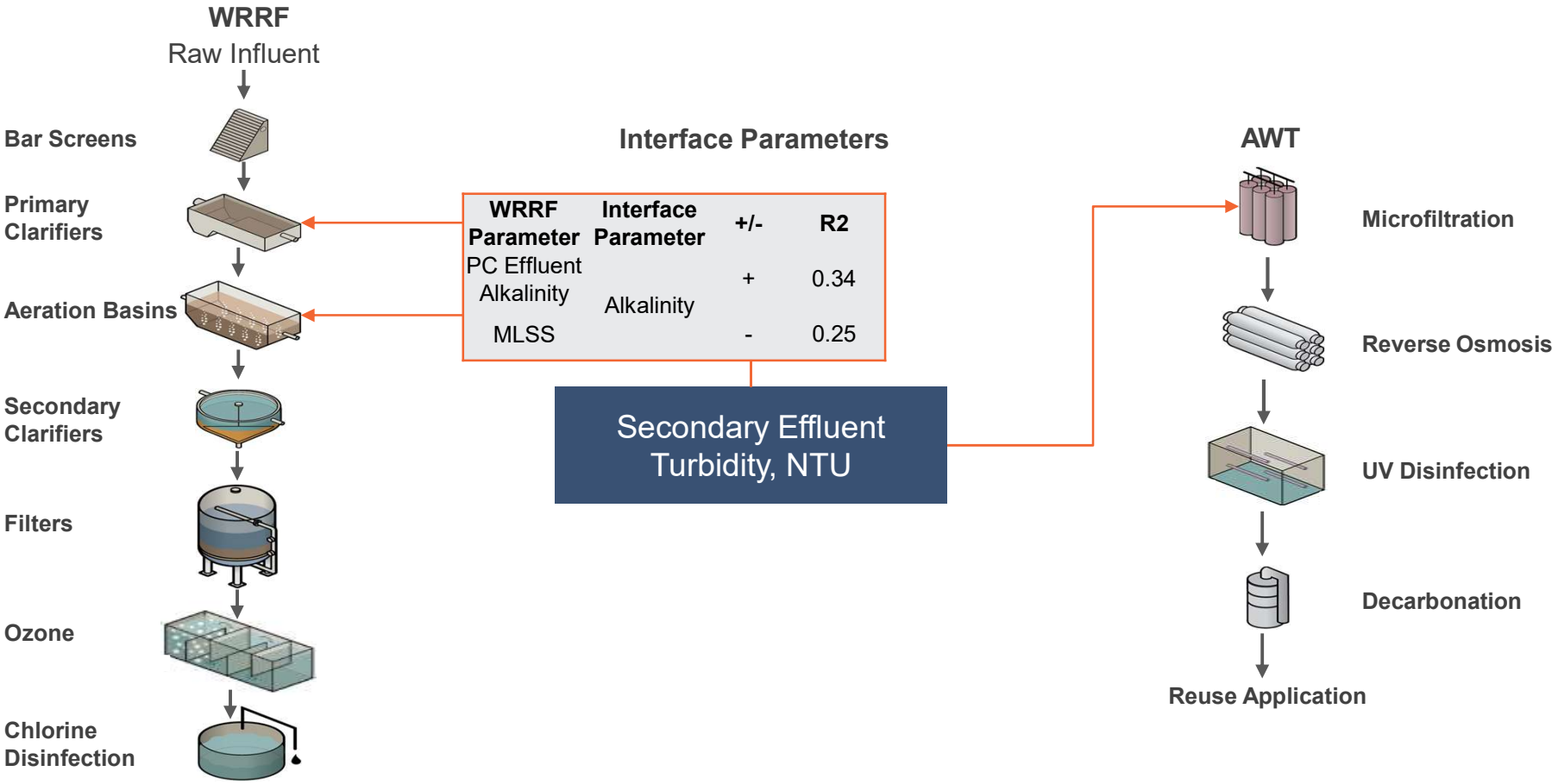

Next Steps

1. Performing direct comparison between WRRF and AWT parameters (eliminating interface parameter step)
2. Evaluating and removing multi-collinearity effects between independent variables
   - **Multi-collinearity produces less reliable probabilities**
   - **Statistical inferences from a model will multi-collinearity may be not dependable**
3. Performing multi-linear regression analyses to develop predictive models for AWT performance

Thank You!

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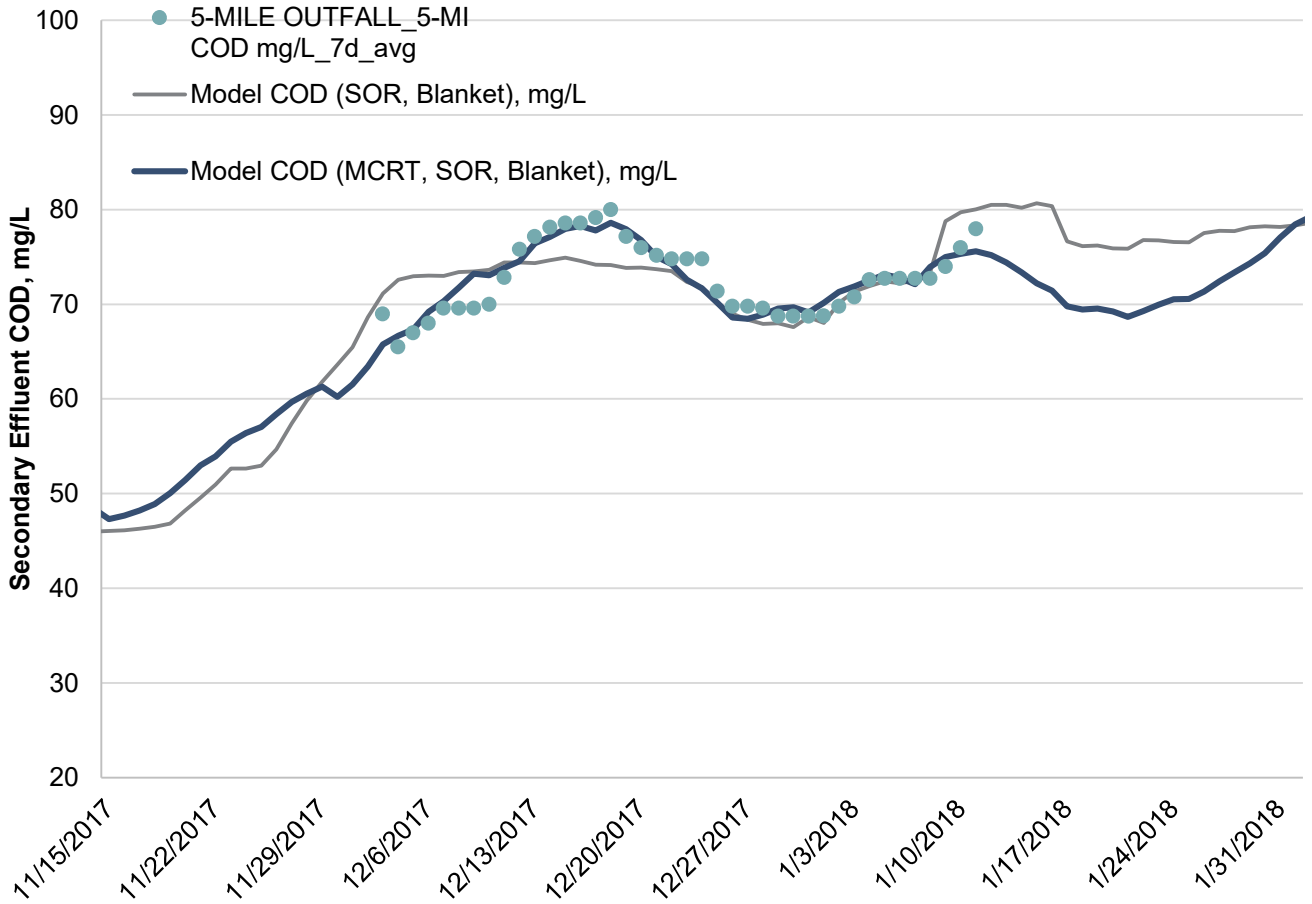
WRRF Recommendations

- Development of MLR analyses may be developed to estimate WRRF effluent quality that impacts downstream AWT performance
- Comparisons across utilities will be performed to identify similarities or if trends are site specific
- Recommendations to improve performance of key WRRF parameters will be developed
  - **Monitoring**
  - **WRRF control/upgrades**
  - **AWT upgrades/controls**



Slide 42

WT1 Walker, Troy, 7/24/2021