Update on Pilot Testing of the Advanced Water Purification Facility in El Paso, TX

Gilbert Trejo & Daniel Olson

Presented at the Multi-State Salinity Coalition Summit

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LESS SALT. MORE WATER.
MSSC
Multi-State Salinity Coalition

EL PASO WATER UTILITIES PUBLIC SERVICE BOARD

Agenda

1. Project Background
2. Source Water Quality
3. Pilot Testing Results
   - Nitrogen
   - Pathogens
   - CECs
4. Lessons Learned
5. Summary and Next Steps

Background

- El Paso, TX
- Population: 600,000+
- Semi-arid climate typical of Southwest U.S.
- Rio Grande over-allocated in drought year
- Non-Potable Reuse since 1956
- Indirect Potable Reuse since 1985
- Now embarking on DPR

H2O TOGETHER

WORKING TOGETHER = WATER FOREVER

Sustainable water is totally doable. Working together, we can balance these resources to make sure we have water for today and tomorrow.

The River	Groundwater	Desalination
Water Reuse	Conservation	Future Resources[1]

[1] Future resources will include importation from water rights landholdings and from other identified sources

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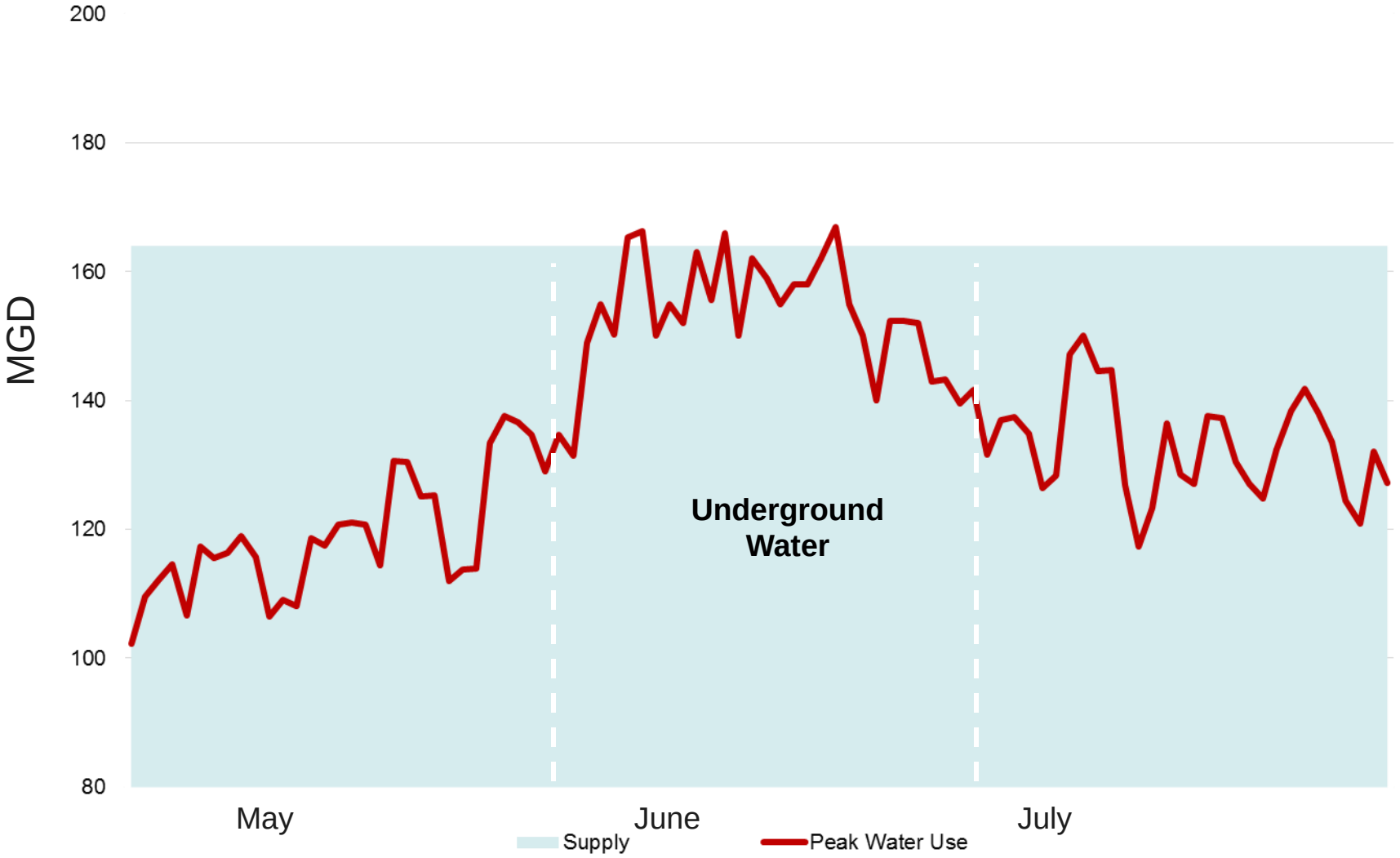
Drought Year Without River Water



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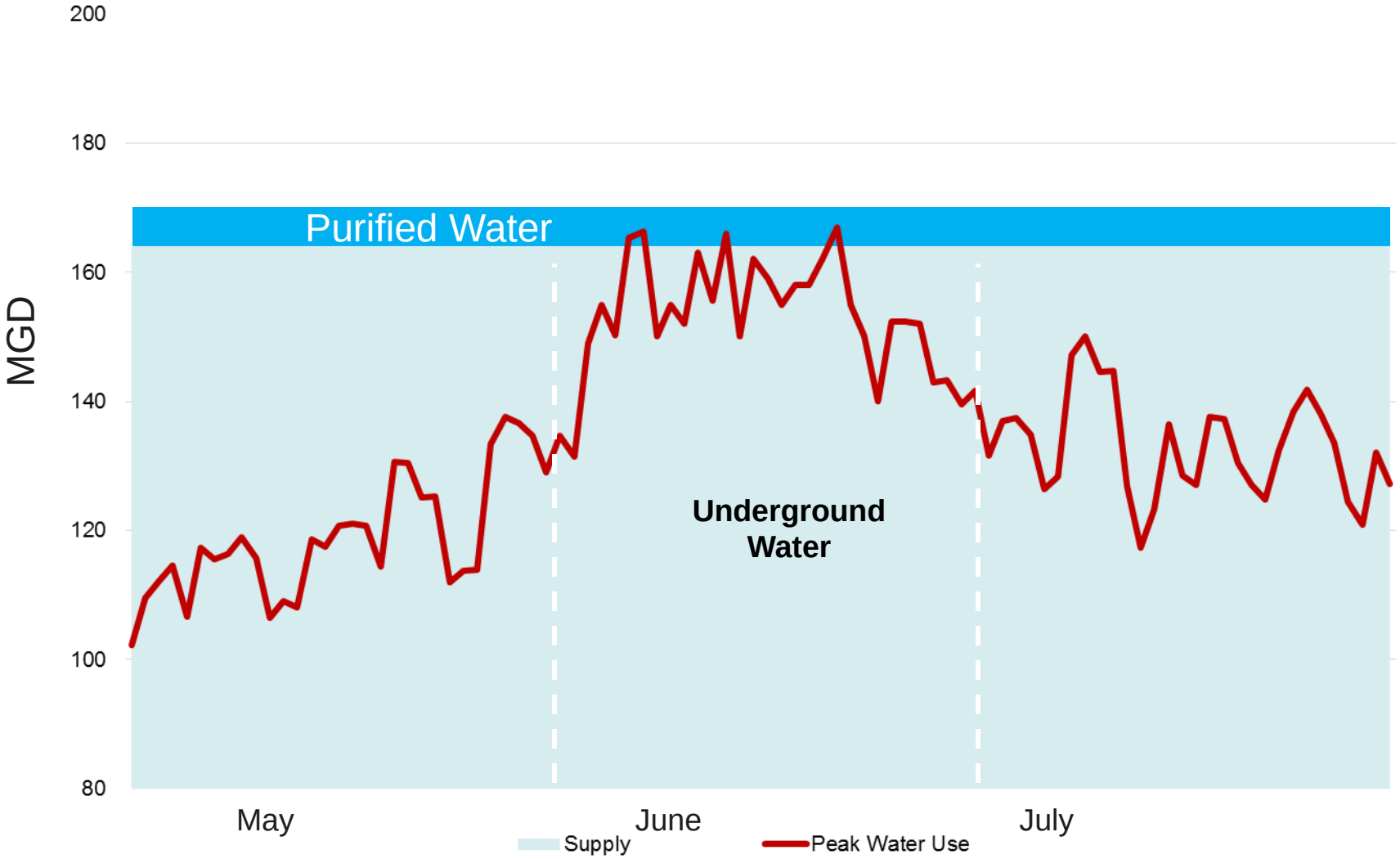
Drought Year Without River Water



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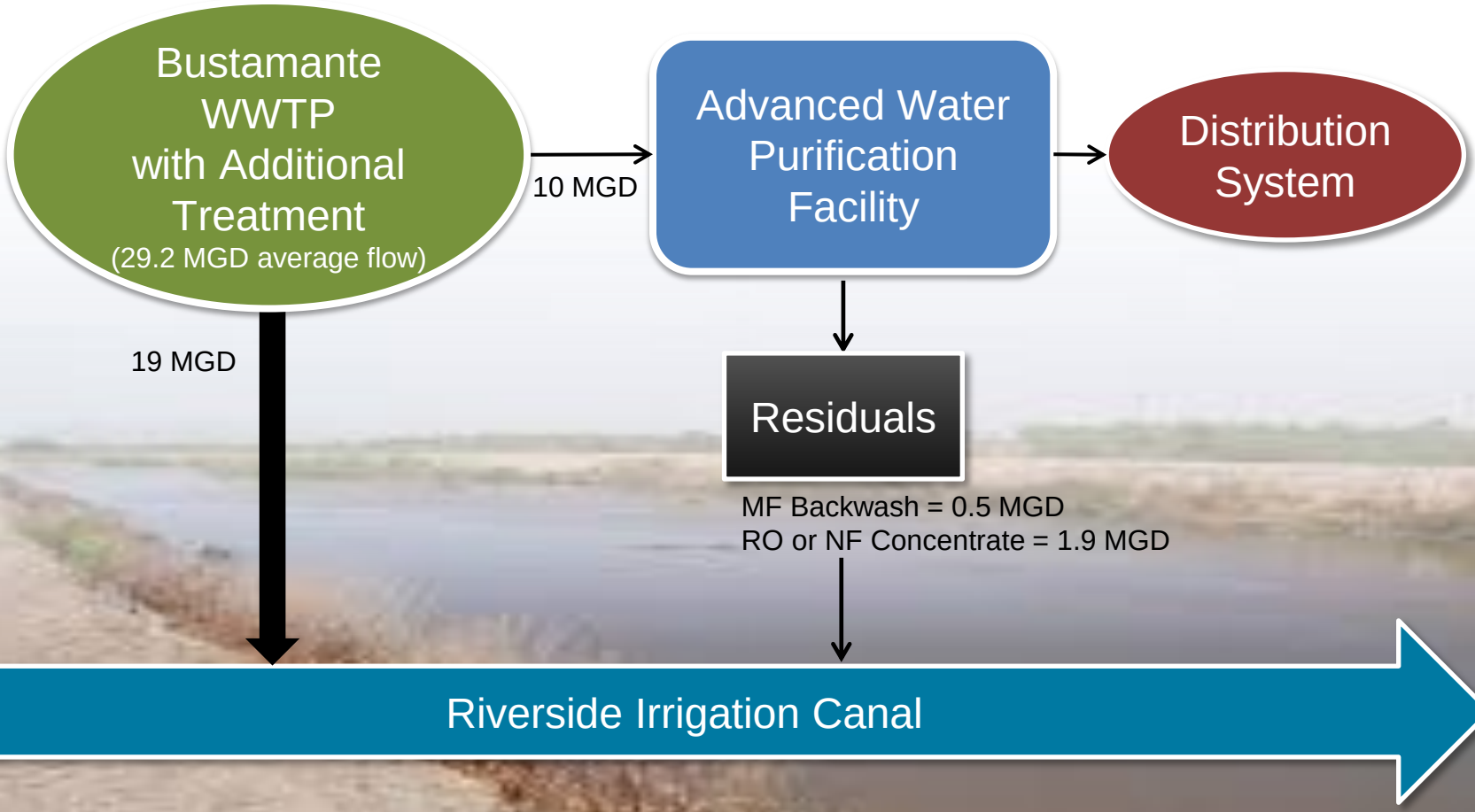
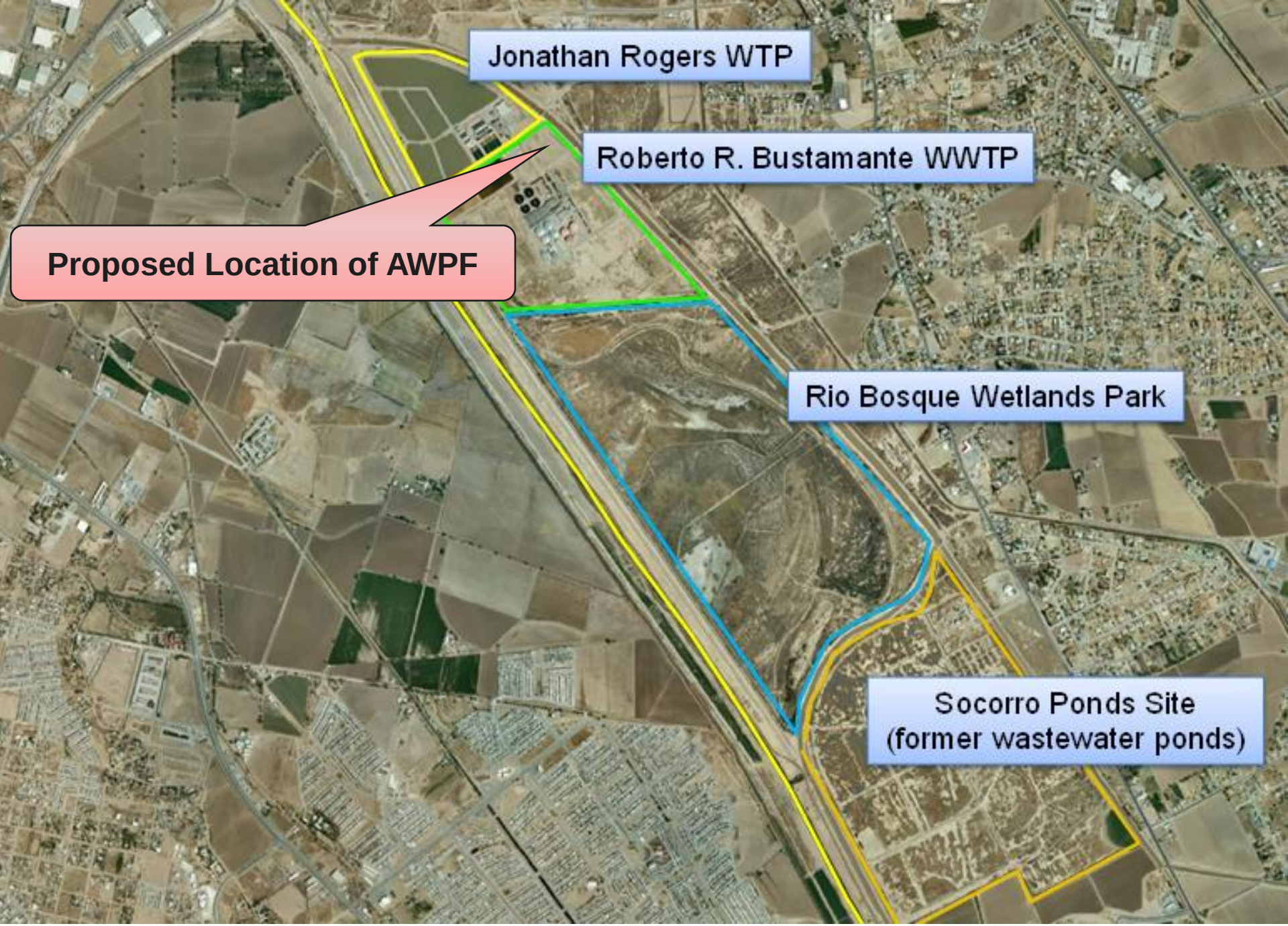
Advanced Water Purification Facility Concept





Lower Valley, El Paso, Texas

Project Status

- Feasibility assessment
- Concept development
- Pilot testing
- Preliminary design
- Detailed design
- Construction

Advanced Water Purification Facility (AWPF)

Project Status

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- ✓ Feasibility assessment
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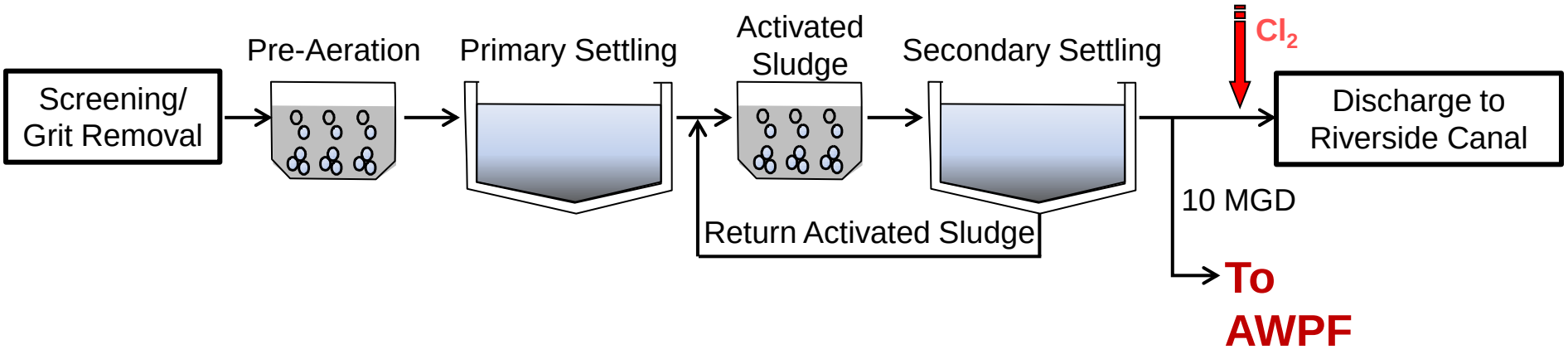
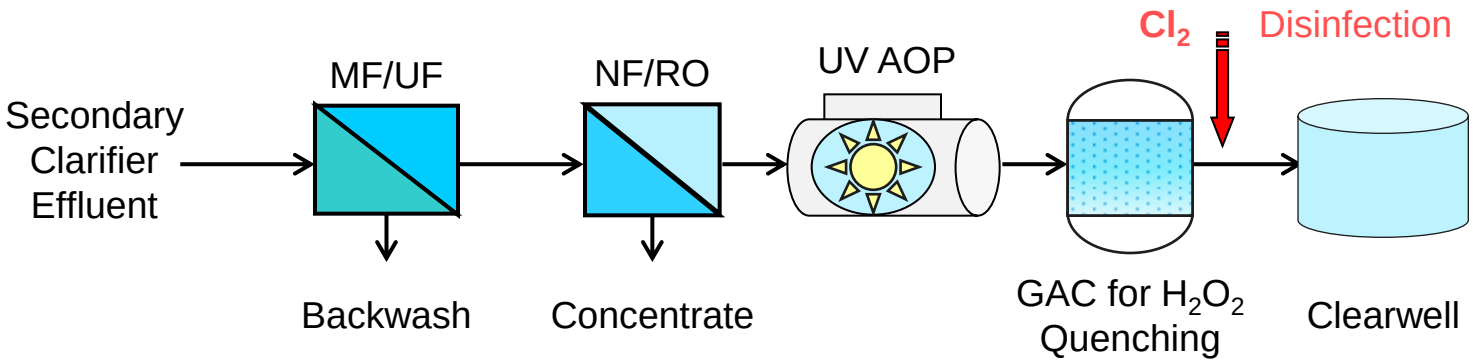
Advanced Water Purification Facility (AWPF)

Source Water: Bustamante WWTP



AWPF Process Schematic



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Pilot Tent Exterior

Pilot Tent Interior

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Pilot Testing Overview

Membrane Filtration

- Pall MF
- Evoqua UF

Membrane Desalination

- Hydranautics ESPA2
- Dow NF90
- Hydranautics ESNA1

UV-Peroxide Advanced Oxidation

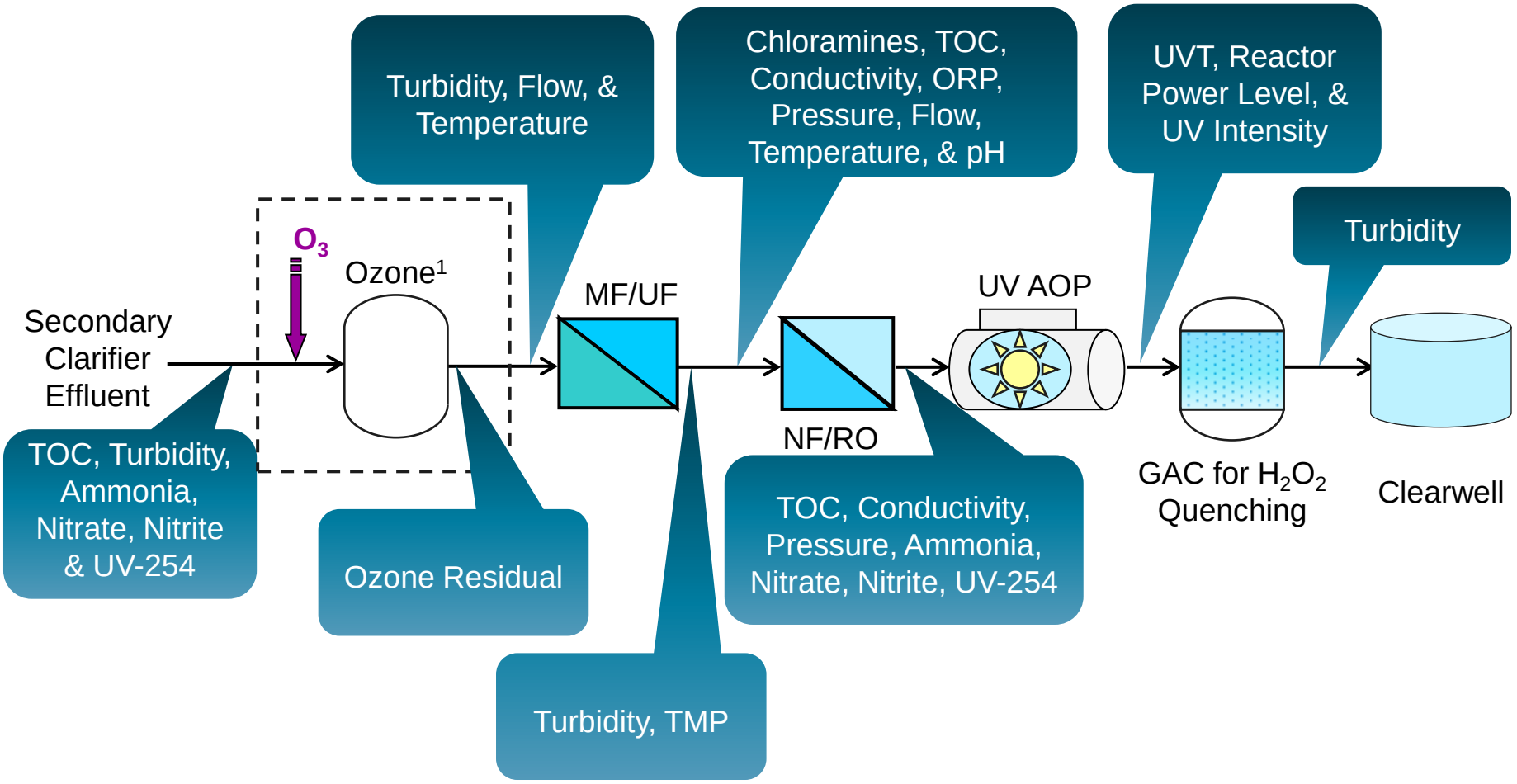
Granular Activated Carbon

- Catalytic Bituminous (Calgon)
- Catalytic Coconut Shell (Evoqua)
- Non-catalytic Bituminous (Calgon)

Pilot Testing Overview, cont'd.

- Pipe Loop Testing (distribution system pipe segments)
- Bench-Scale Testing
  - Coagulant Alternatives
  - 7-Day Simulated Distribution System (SDS) Testing with Free Chlorine to determine DBP potential
- Extensive Lab and Field Sampling
- Online Monitoring (Process Analyzers)
  - Nutrients (ChemScan)
  - Total Organic Carbon (GE)
  - Turbidity (Hach)
  - Free & Total Chlorine (Hach)
  - UV-254 Transmittance (RealTech)
  - Ozone Residual (ATI)
  - pH, ORP, Conductivity, Temperature at several locations

Pilot-Scale Online Monitoring




ChemScan
Sievers M5310 C
On-Line TOC Analyzer
Sievers M5310 C
On-Line TOC Analyzer

Pilot Plant Sampling Locations

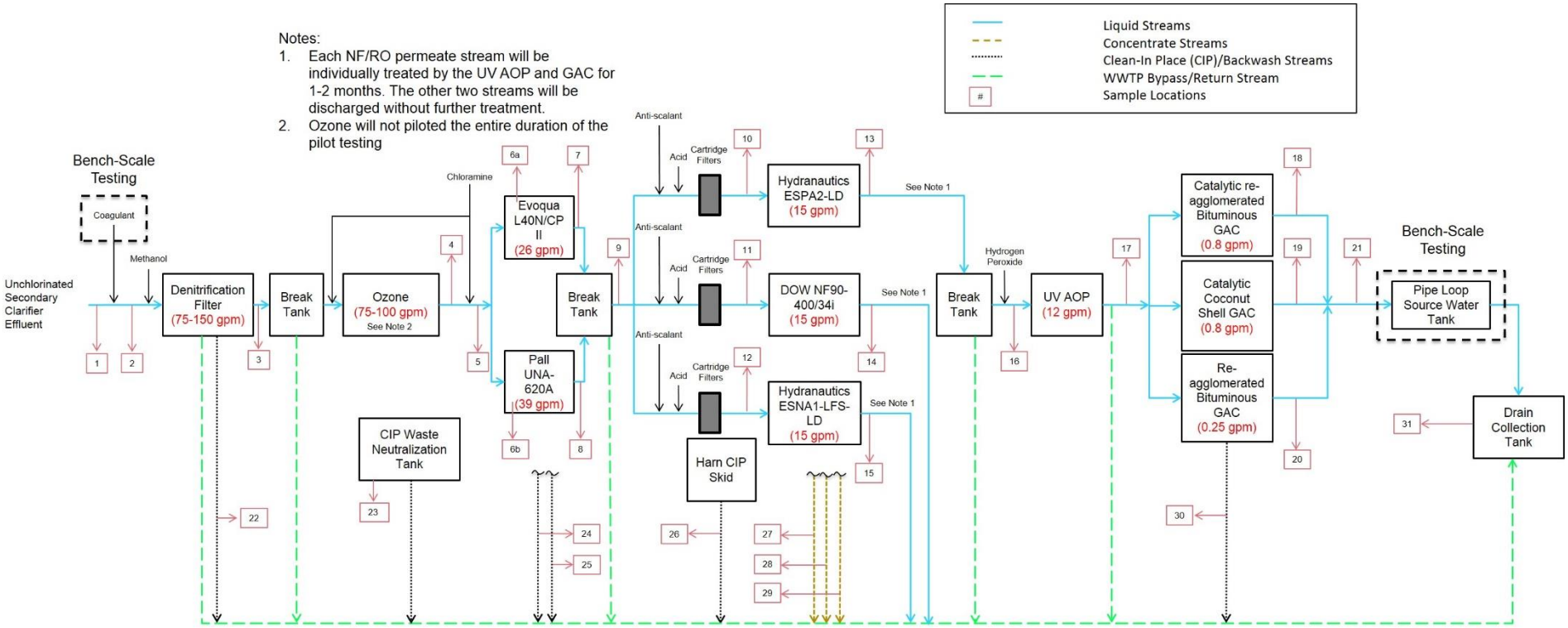


Figure 3-3. Pilot Test Process Schematic

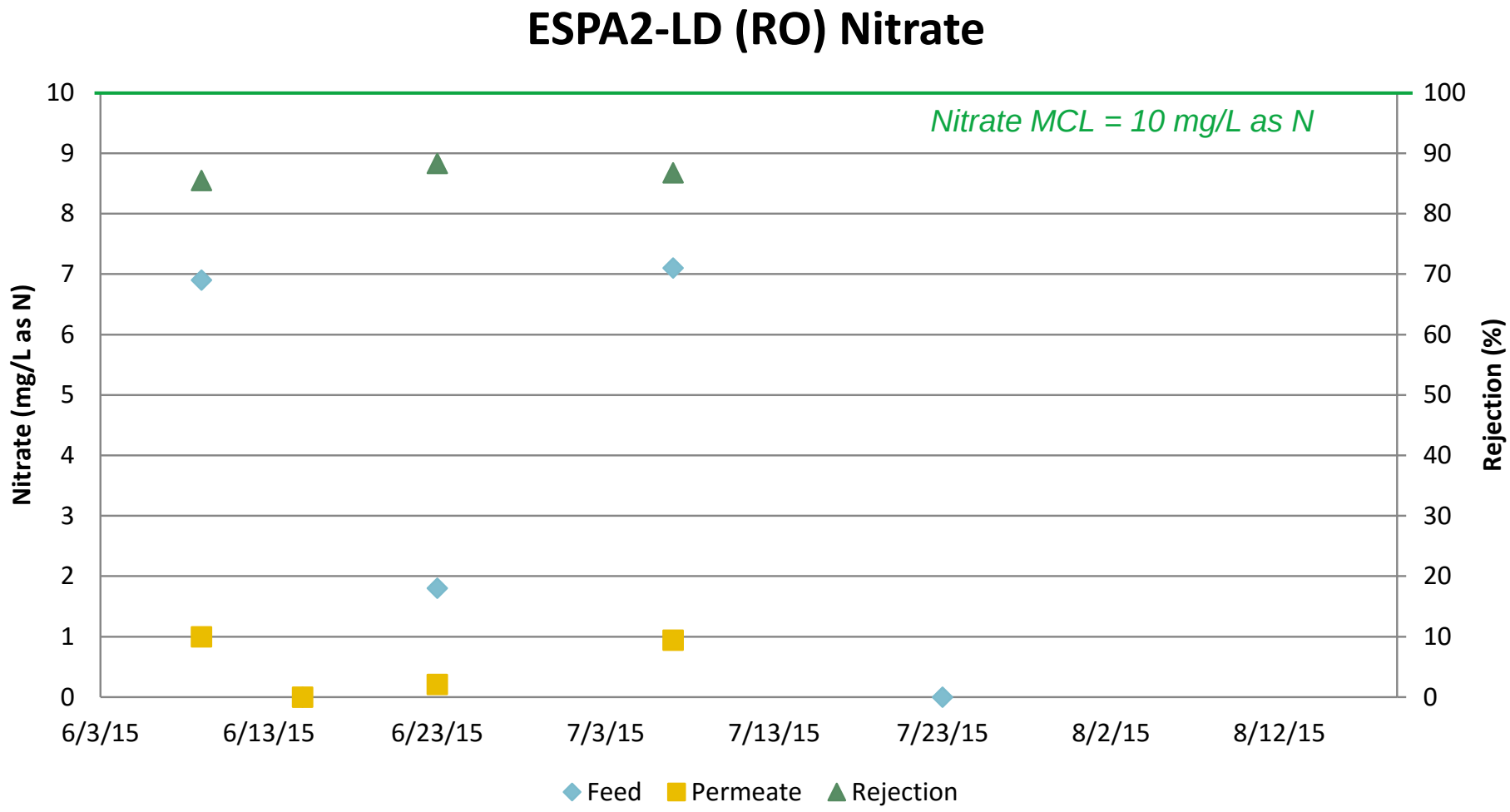
Source Water Quality

Parameter	Units	Average	Min.	Max.
Temperature	°C	27.4	17.5	33.5
pH	S.U.	6.8	6.6	7.1
Alkalinity (as $CaCO_3$)	mg/L	99	29	244
Turbidity	NTU	3.3	1.0	30
Total Organic Carbon	mg/L	10.6	9.3	14.5
Total Dissolved Solids	mg/L	1,100	566	1,250
Ammonia (as N)	mg/L	3.2	0.3	35.0
Nitrate (as N)	mg/L	14.2	0.5	33.0
Nitrite (as N)	mg/L	0.6	0.07	5.9
Orthophosphate (as P)	mg/L	3.1	0.4	7.0
Sulfate	mg/L	238	97	543

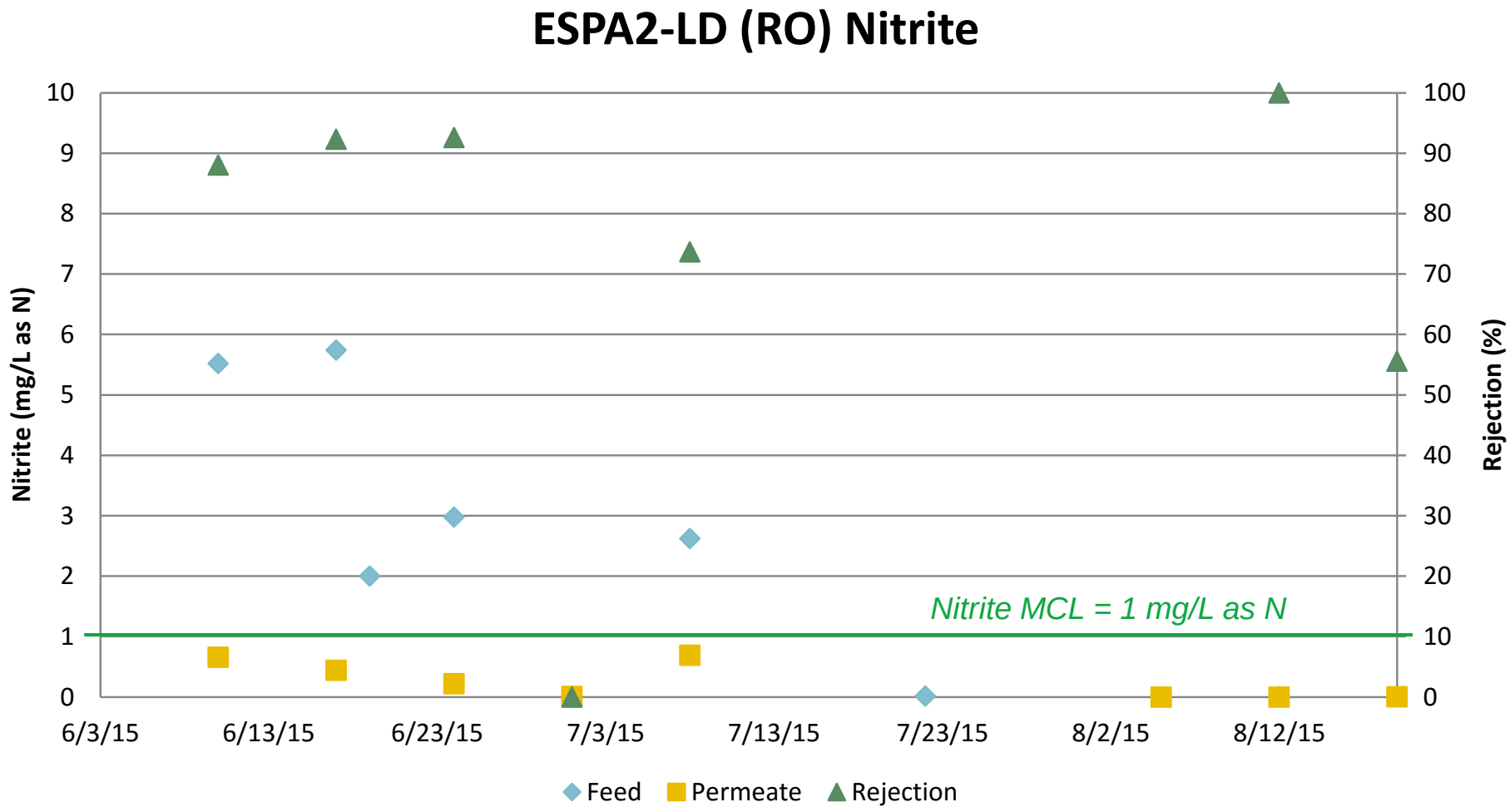
Nitrogen

Imagine the result

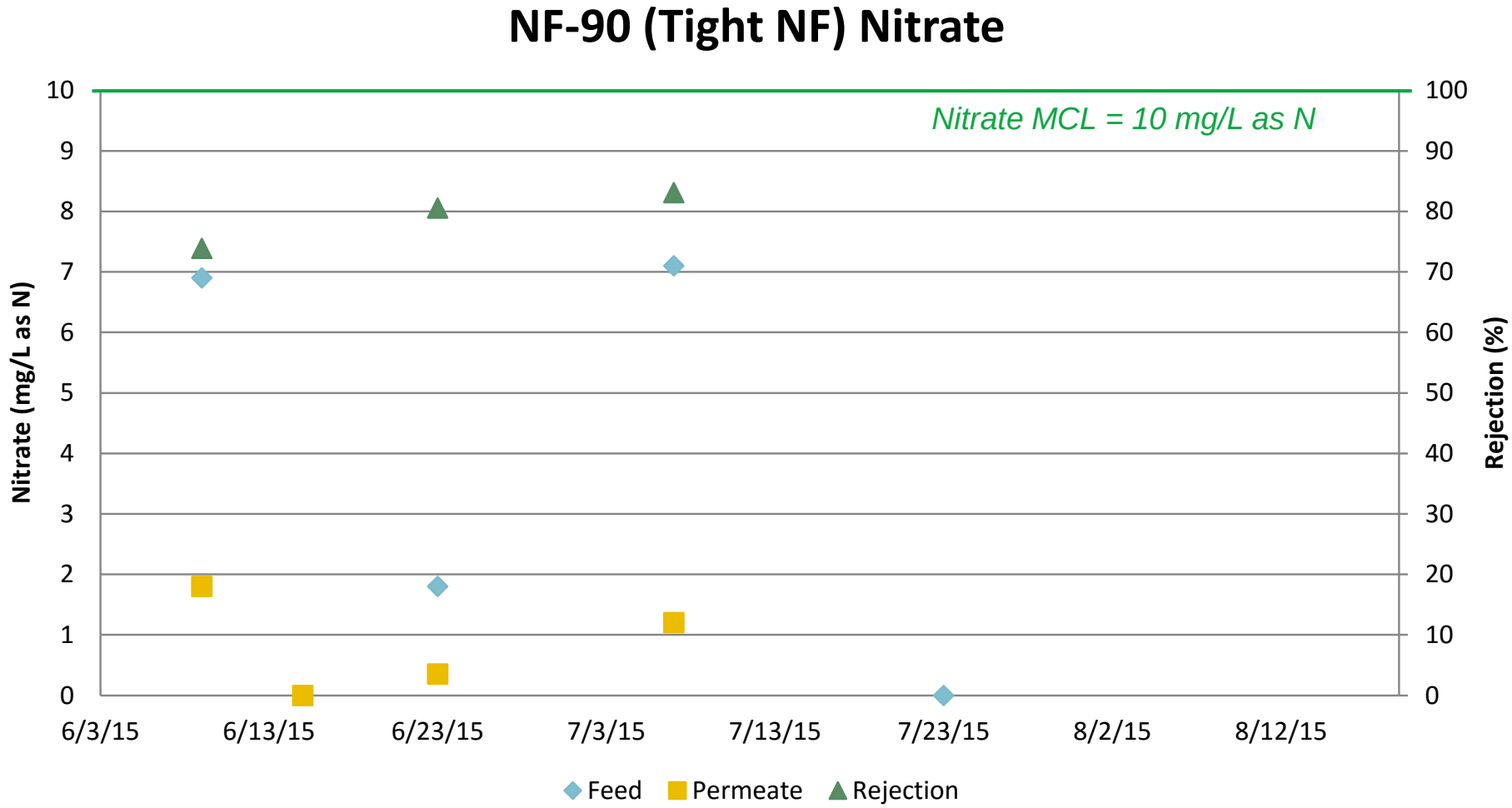
ESPA2-LD (RO) – Nitrate



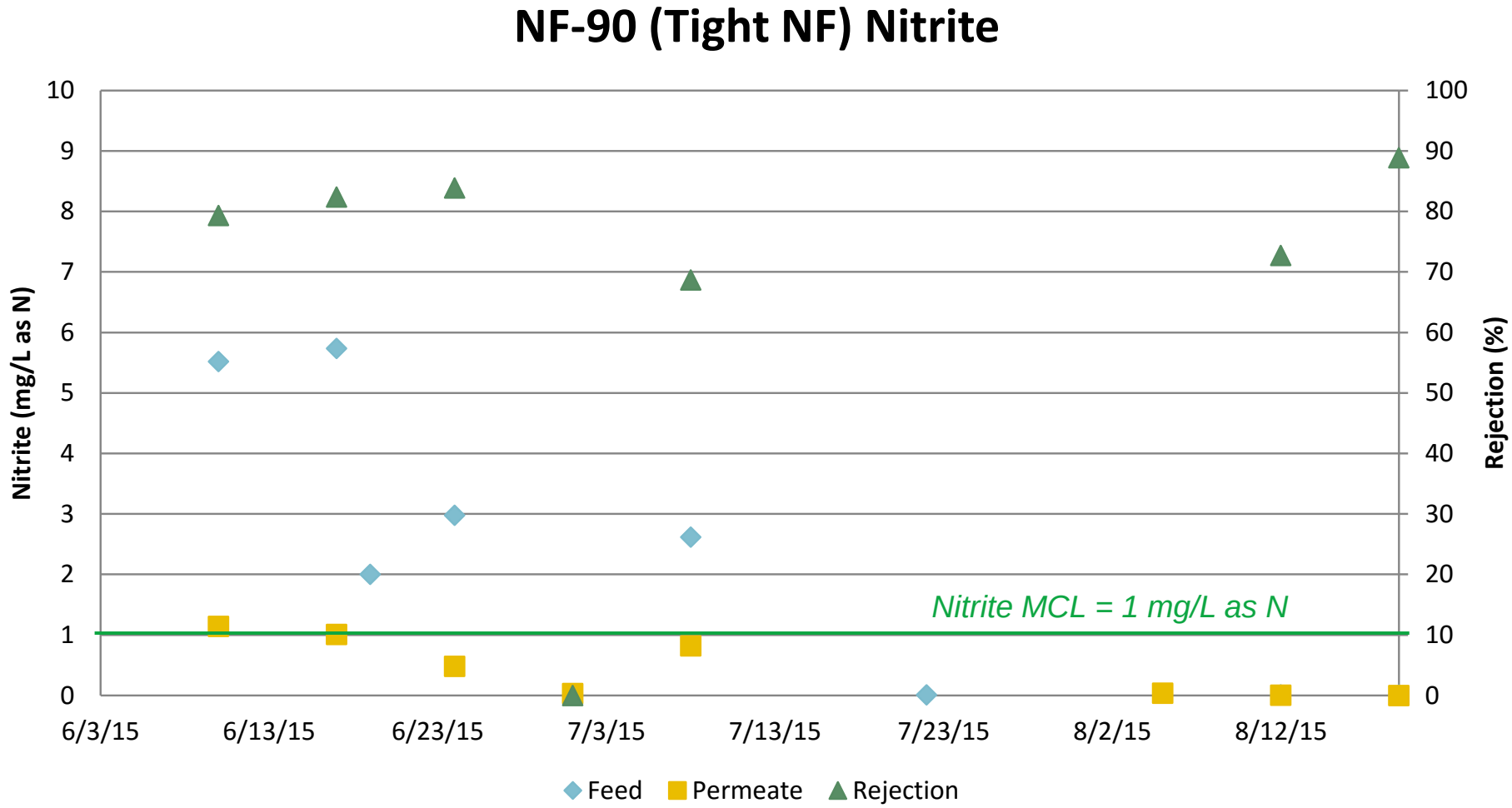
ESPA2-LD (RO) – Nitrite



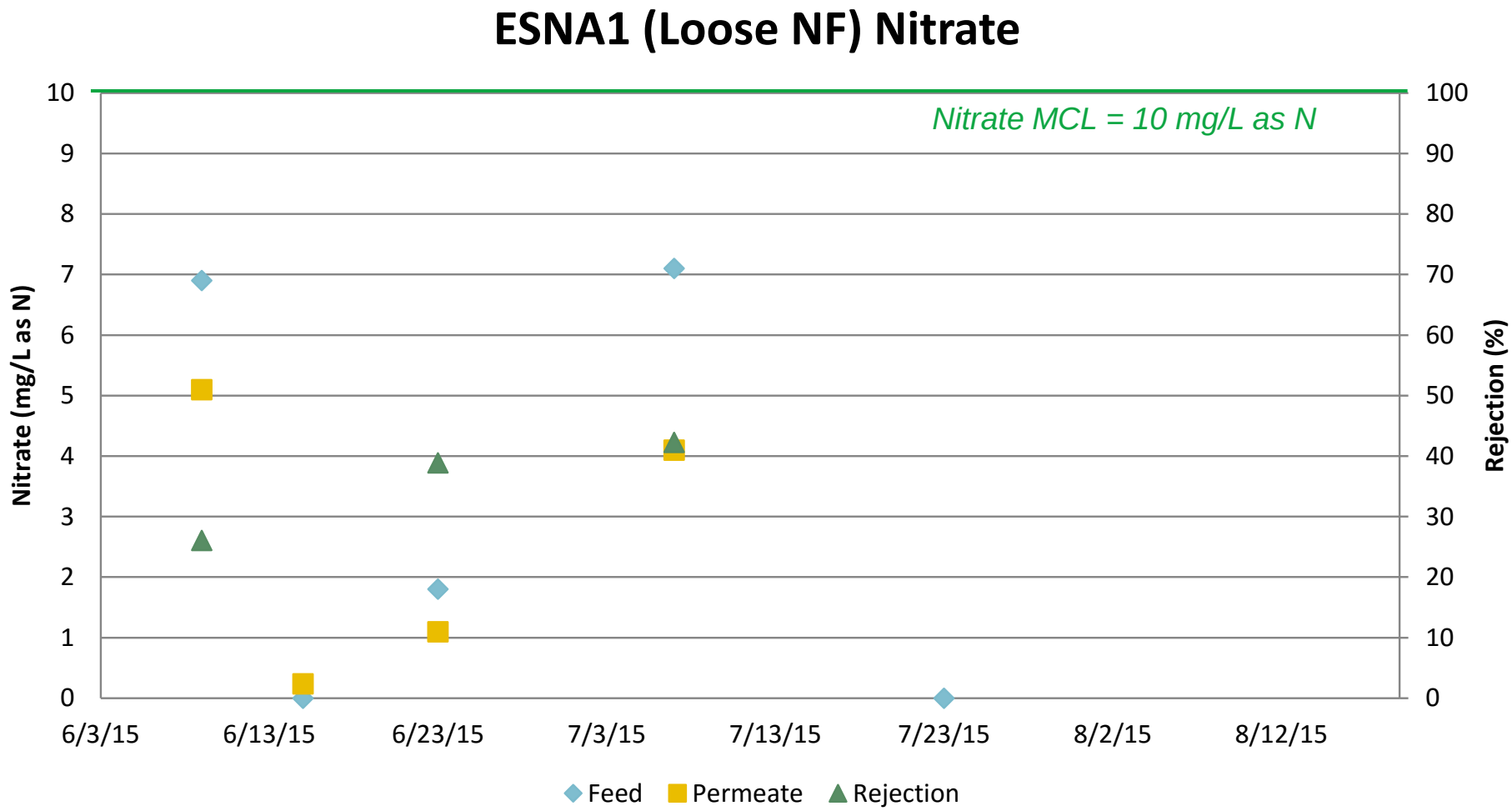
NF-90 (Tight NF) – Nitrate



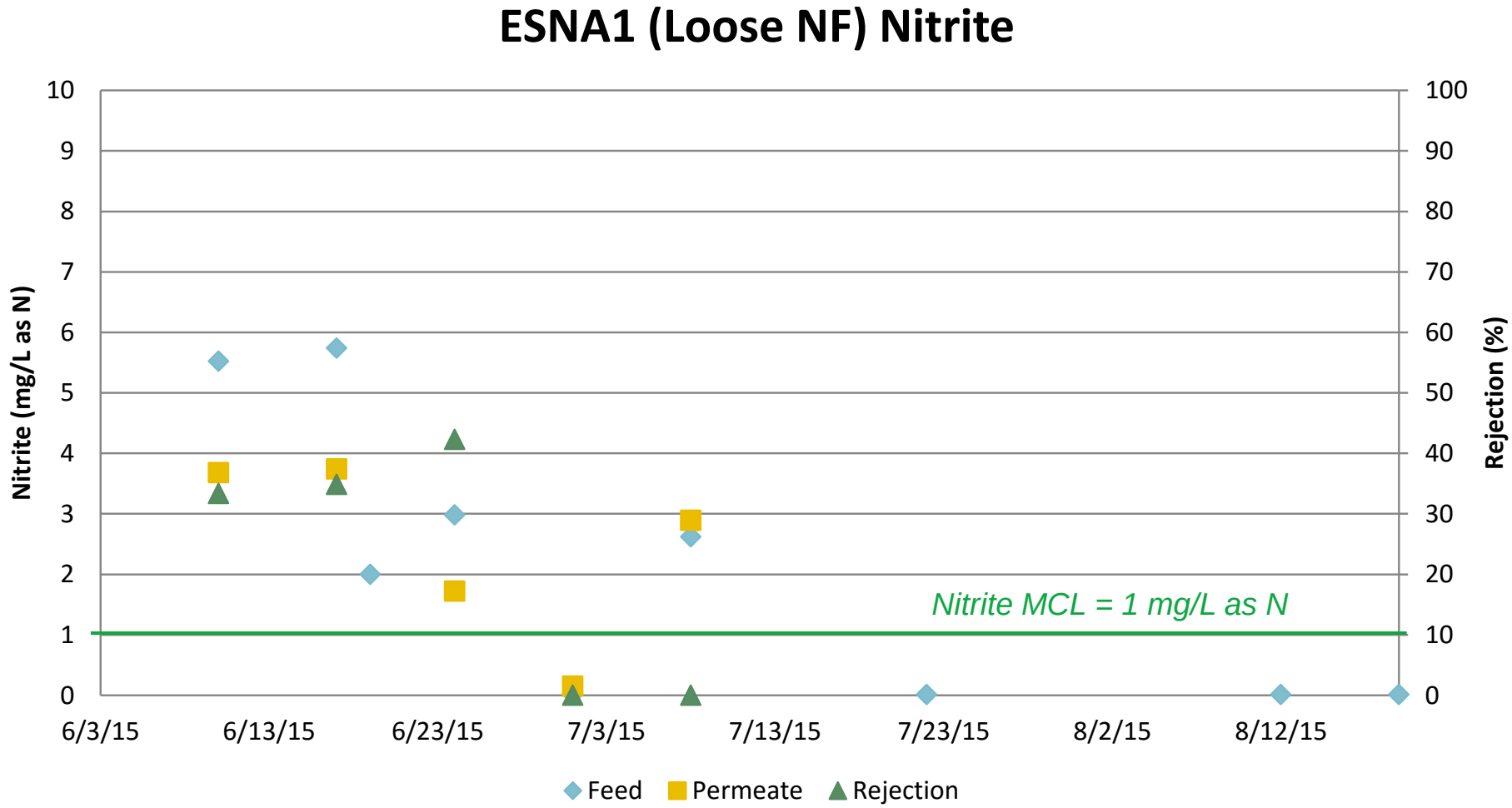
NF-90 (Tight NF) – Nitrite



ESNA1 (Loose NF) – Nitrate

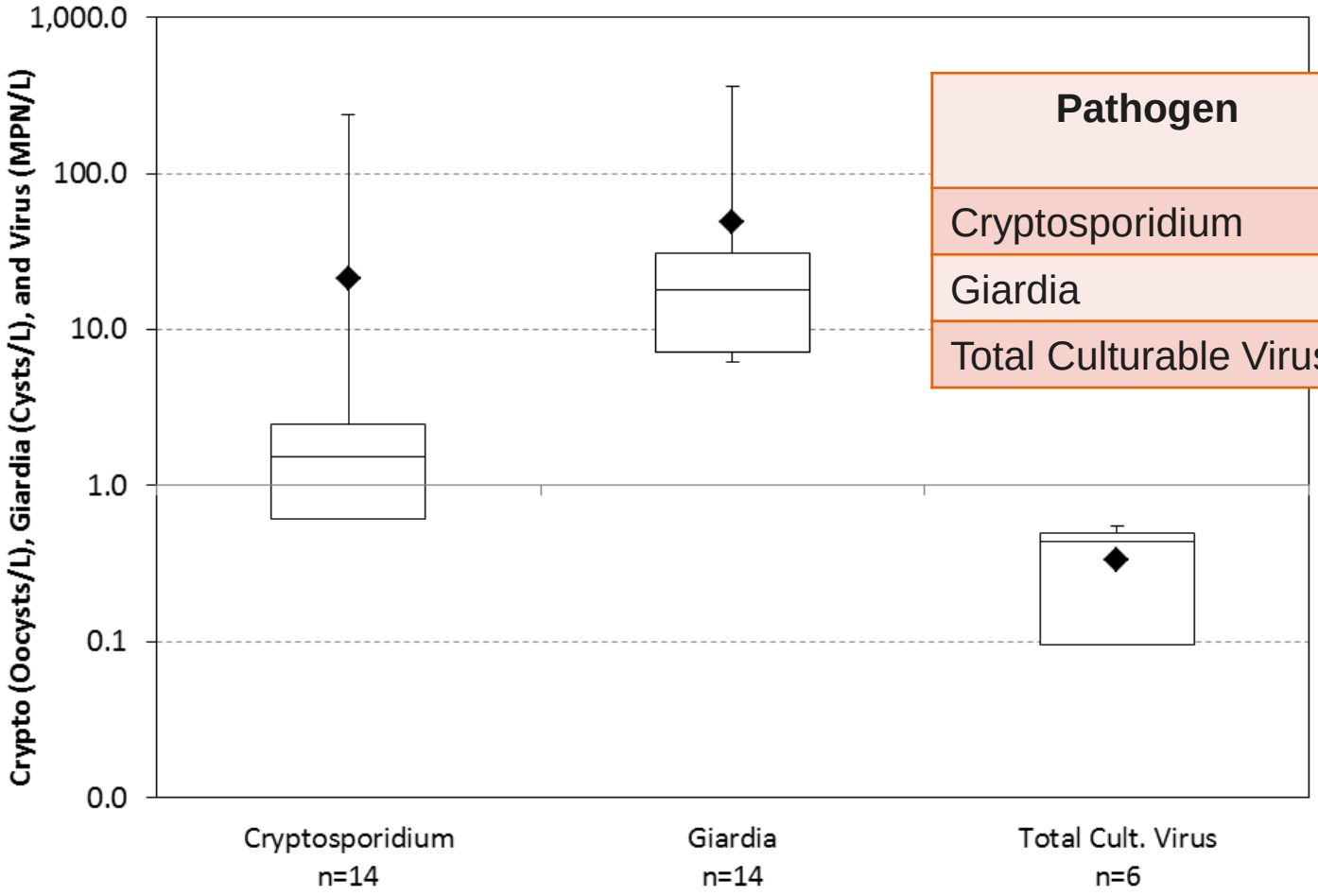


ESNA1 (Loose NF) – Nitrite

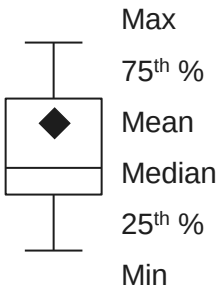


Pathogens

Unchlorinated Secondary Clarifier Effluent Pathogen Concentrations (2014-15)



Pathogen	Maximum Concentration
Cryptosporidium	238 Oocysts/L
Giardia	358 Cysts/L
Total Culturable Virus	0.46 MPN/L



Preliminary Assessment of Pathogen Removal Requirements for AWPF

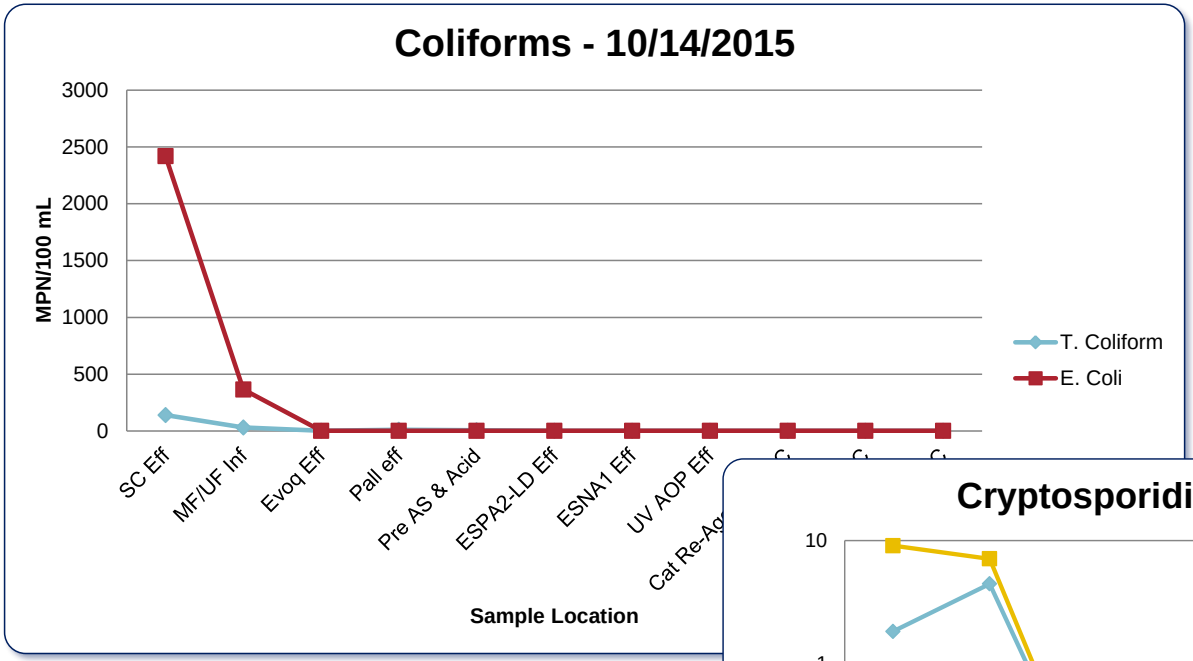
	Crypto	*Giardia*	Viruses
Maximum concentration to date in unchlorinated secondary clarifier effluent	238 #/L	358 #/L	0.46 #/L
Purified water goal	$< 3.0 \times 10^{-5}$ #/L	$< 7.0 \times 10^{-6}$ #/L	$< 2.2 \times 10^{-7}$ #/L
Projected Inactivation / Removal Requirement	**7**	**8**	**6.5**

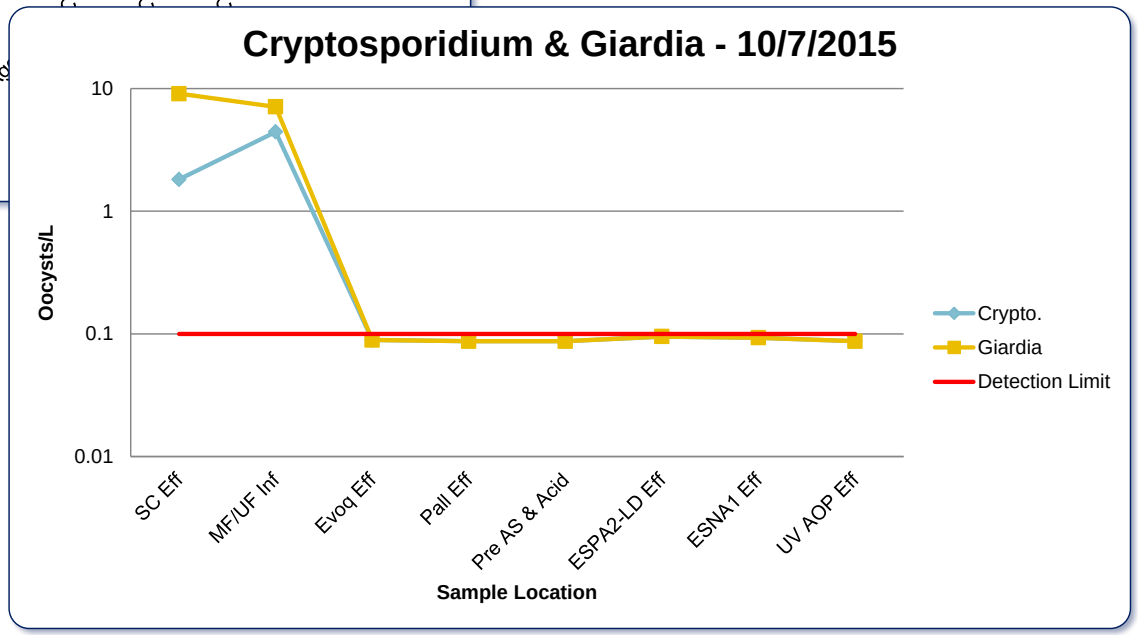
Pathogen Removal Requirements and Preliminary Results

Unit Process	Anticipated Log Removal / Inactivation Credits		
	Crypto	*Giardia*	Viruses
Pretreatment	0	0	0
MF/UF	4	4	0-1
NF/RO	0-2	0-2	0-2
UV AOP	4-6	4-6	4-6
GAC	0	0	0
Cl_2	0	3	4
Total	8-12	11-15	8-13
Projected Requirement	**7**	**8**	**6.5**

Anticipated removal requirements achieved through AWPF unit processes without WWTP chlorination

Pathogen Removal through Treatment Train





Virus Concentrations are Non-Detect in UV AOP Effluent

Parameter	Units	6/10/15	7/8/15
Adenovirus	GC/L	Non-detect	Non-detect
Total Culturable Virus	MPN/L	< 0.0036	< 0.053
Enterovirus	GC/L	Non-detect	Non-detect
Norovirus GIA	GC/L	Non-detect	Non-detect
Norovirus GIB	GC/L	Non-detect	Non-detect
Norovirus GII	GC/L	Non-detect	Non-detect
Rotavirus	GC/L	Non-detect	Non-detect

- Viruses are non-detect in UV AOP effluent samples
- Chlorine disinfection for full-scale treatment train will provide additional pathogen barrier

Chemical Microconstituents

CEC Testing

Testing for **97** chemicals of emerging concern (CECs):

- Source water
- Each NF/RO Permeate stream
- UV AOP Influent
- UV AOP Effluent
- Each GAC Effluent stream

Examples: caffeine, ibuprofen, estradiol, sucralose, triclosan, BPA, atrazine

UV AOP Pilot Testing Results

ESPA2 Testing:

- Six sampling events, total of 16 data sets
- 13 CECs detected in UV AOP influent
- 84 CECs not detected in membrane permeate
- **Large majority were non-detect!**

NF90 Testing:

- **Only 2 CECs detected in permeate sample!**

Chemical Name	Units	Detection Limit	UV AOP Influent	UV AOP Effluent	% Removal
4-nonylphenol	ng/L	100	660	230	65%
4-tert-Octylphenol	ng/L	50	400	120	70%
Acesulfame-K	ng/L	20	150	ND	-
Atenolol	ng/L	5	8	ND	-
Carbamazepine	ng/L	5	8.9	ND	-
DEET	ng/L	10	13	ND	-
Diclofenac	ng/L	5	6.2	ND	-
Iohexal	ng/L	10	28	ND	-
Iopromide	ng/L	5	6.9	ND	-
Sucralose	ng/L	100	1400	220	84%
TCEP	ng/L	10	19	ND	-
Triclocarban	ng/L	5	33	ND	-
Triclosan	ng/L	10	55	ND	-

ESPA2 Permeate through UV AOP

Lessons Learned

- Chloramine residual improves MF/UF performance
- Sample conditioning important for reliable monitoring
- Added benefits of GAC for peroxide quenching (AOP)
- Source water quality led to higher-than-expected flux for membrane filtration units
- NOx effectively removed with NF/RO membranes

Summary & Next Steps

- AWPF pilot treatment train meets primary and secondary drinking water standards
- Nitrogen removal with NF/RO membranes
- CECs very effectively removed by NF/RO membranes
- Near-complete removal of organics with UV-AOP/GAC
- Next Steps:
  - Wrap up pilot testing and permit project for design
  - Continue source water quality monitoring (24 months)
  - Design and construct full-scale AWPF

Acknowledgements

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