



Desalination Membrane Selection for Direct Potable Reuse

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Texas Desal – September 29, 2016

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



Implementing Potable Reuse for El Paso

Feasibility
Study

Planning

Pilot
Testing
(2015)

Design

Build





Pilot Testing Overview

Core Treatment Train

Membrane Filtration

- Pall MF
- Evoqua UF

Membrane Desalination

- Hydranautics ESPA2
- Dow NF90
- Hydranautics ESNA1

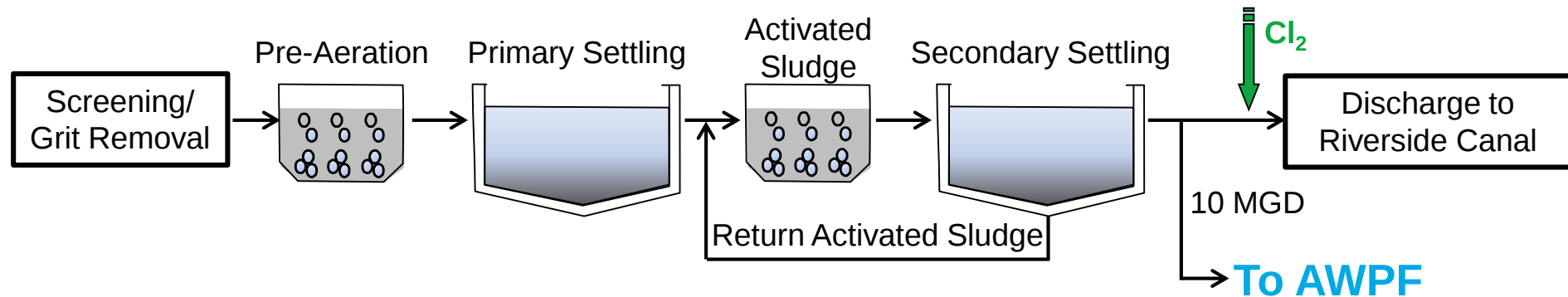
UV-Peroxide Advanced Oxidation

Granular Activated Carbon

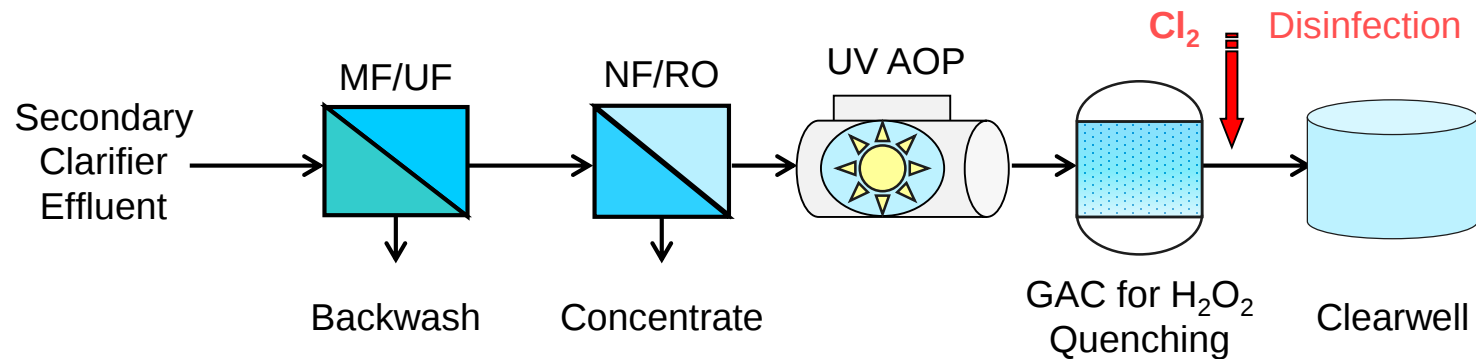
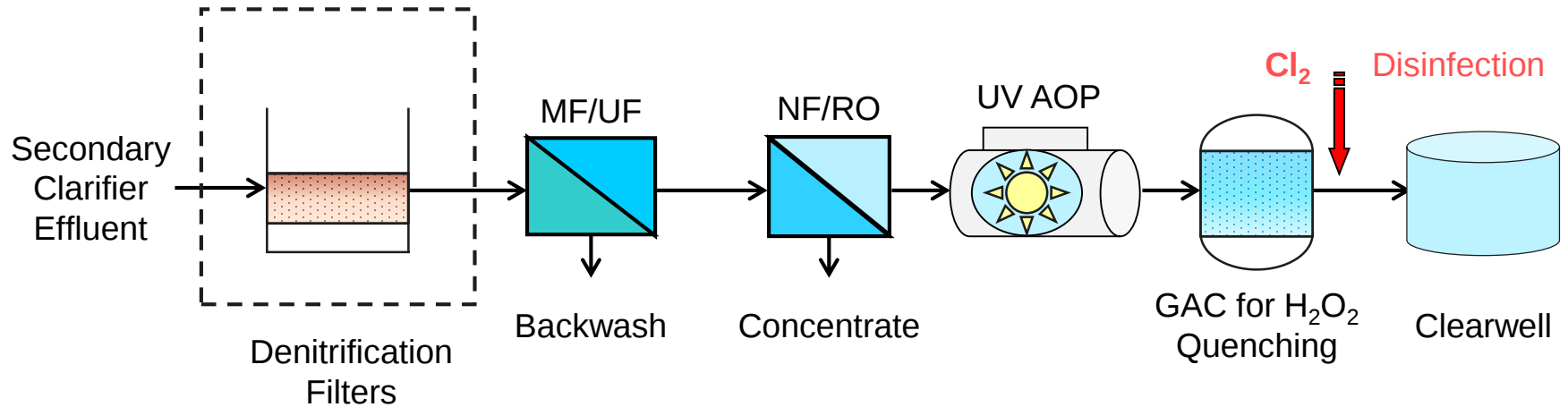
- Catalytic Bituminous (Calgon)
- Catalytic Coconut Shell (Evoqua)
- Non-catalytic Bituminous (Calgon)



Source Water: Bustamante WWTP



Piloted Treatment Trains



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



Nanofiltration / Reverse Osmosis

NF/RO Pilot System Overview

- 4"-diameter membrane elements:
 - ESPA2-LD
 - NF90-400/34i
 - ESNA1-LF2-LD
 - 2:1 array
 - Recovery: 80%
 - Flux: 11.7 gfd
 - Pretreatment: acid + scale inhibitor
- Removed from pilot testing, due to poor rejection of nitrate and nitrite

Membrane Comparison

- Total Dissolved Solids (TDS) Removal
- Pathogen Barrier
- Emerging Contaminants
- Permeate TOC
- Nutrient Removal (NO_3 , NO_2)
- Energy Consumption

Water Quality Results

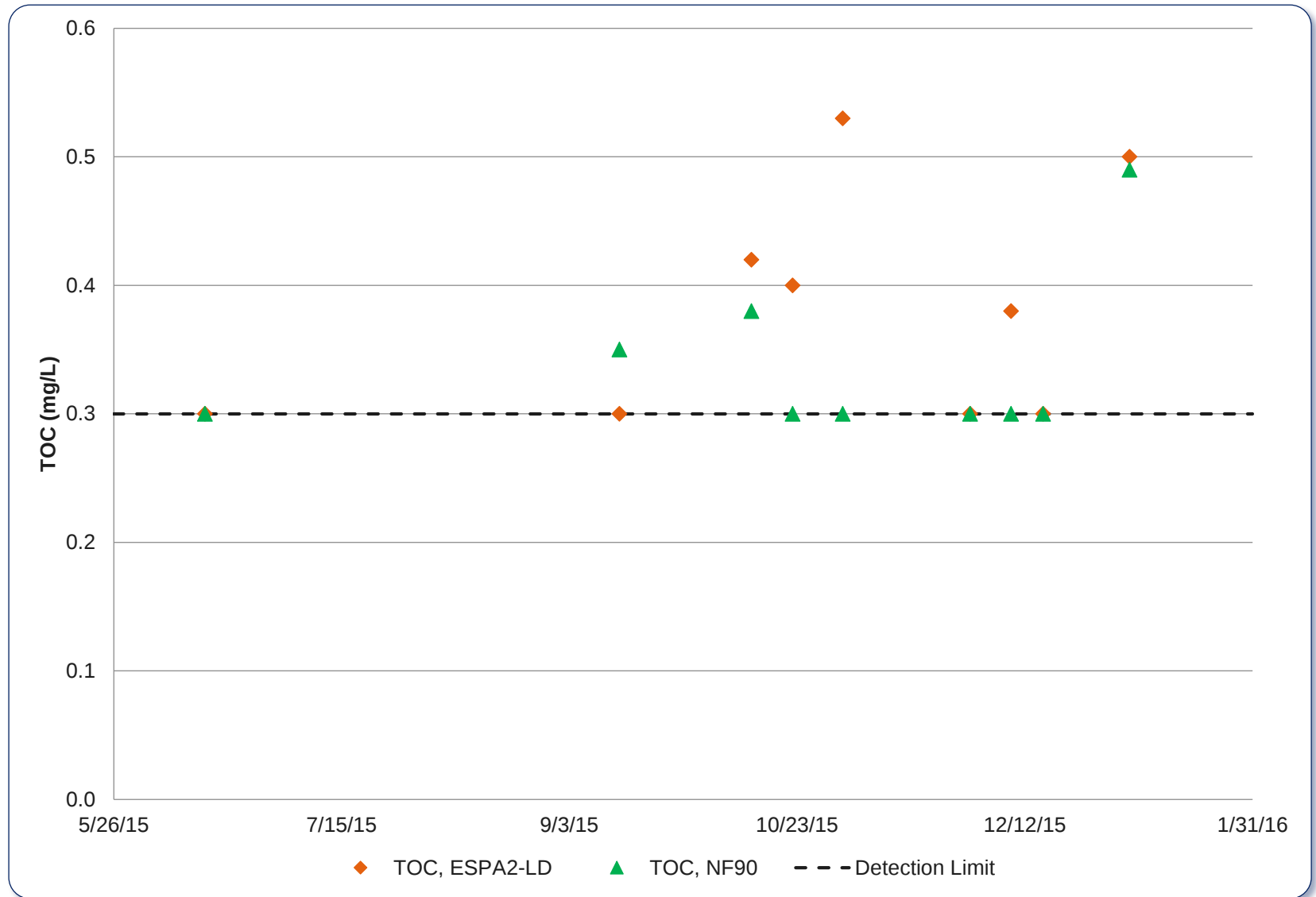
Parameter	Units	NF/RO Feed	Goal	ESPA2-LD (RO)	NF90 (Tight NF)	ESNA1 (Loose NF)
Chloride	mg/L	285	300	24	7.2	61
Nitrate	mg/L as N	12.0	6	2.4	1.3	5.1
Nitrite	mg/L as N	1.06	0.6	0.04	0.06	0.9
Sulfate	mg/L	274	300	7.6	0.9	5.0
TDS	mg/L	1,075	600	84	37	174
TOC	mg/L	7.51	< 1	0.5	0.5	0.9

Data are average values

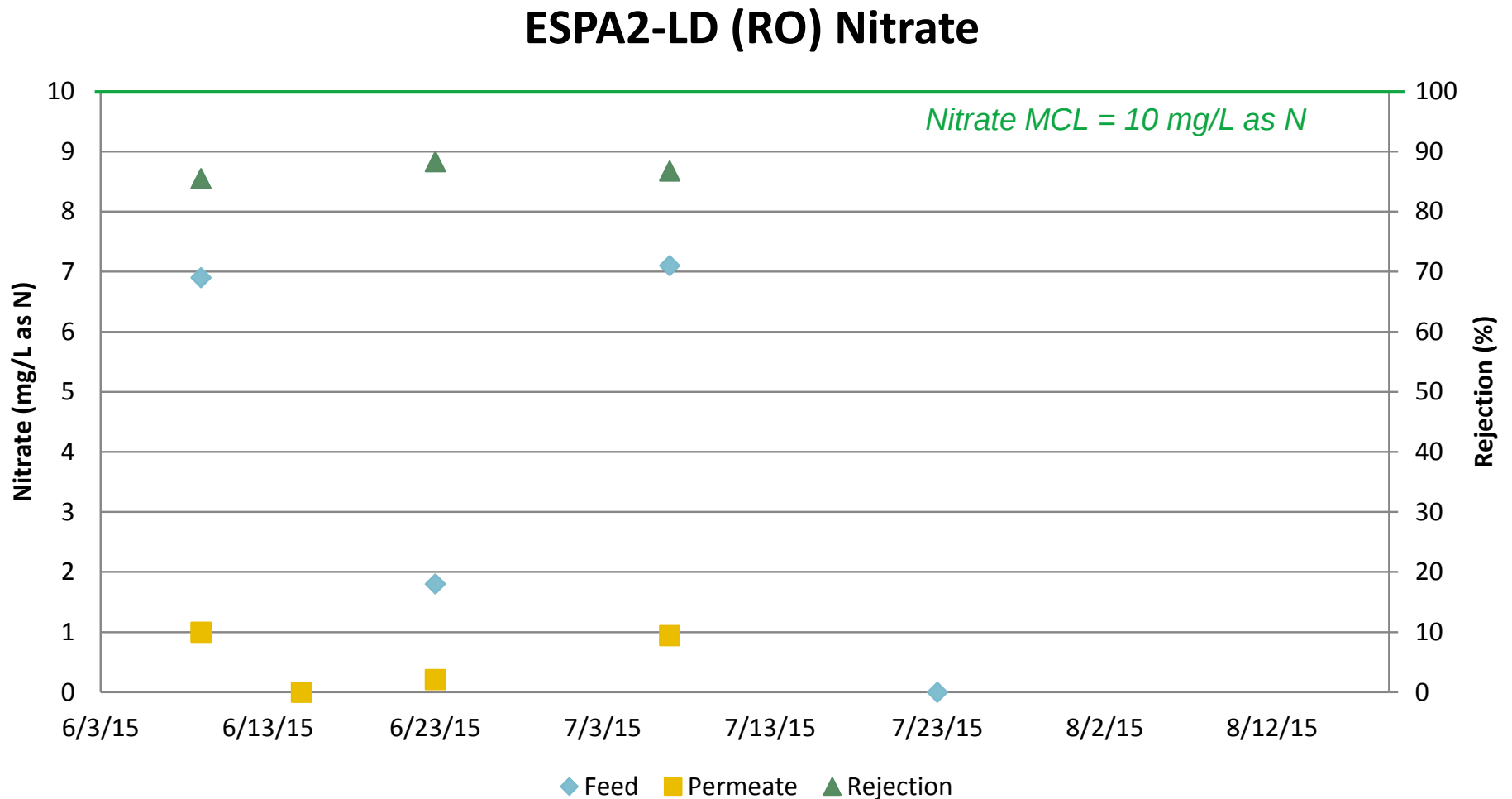
ND: Not Detected

TBD: To Be Determined

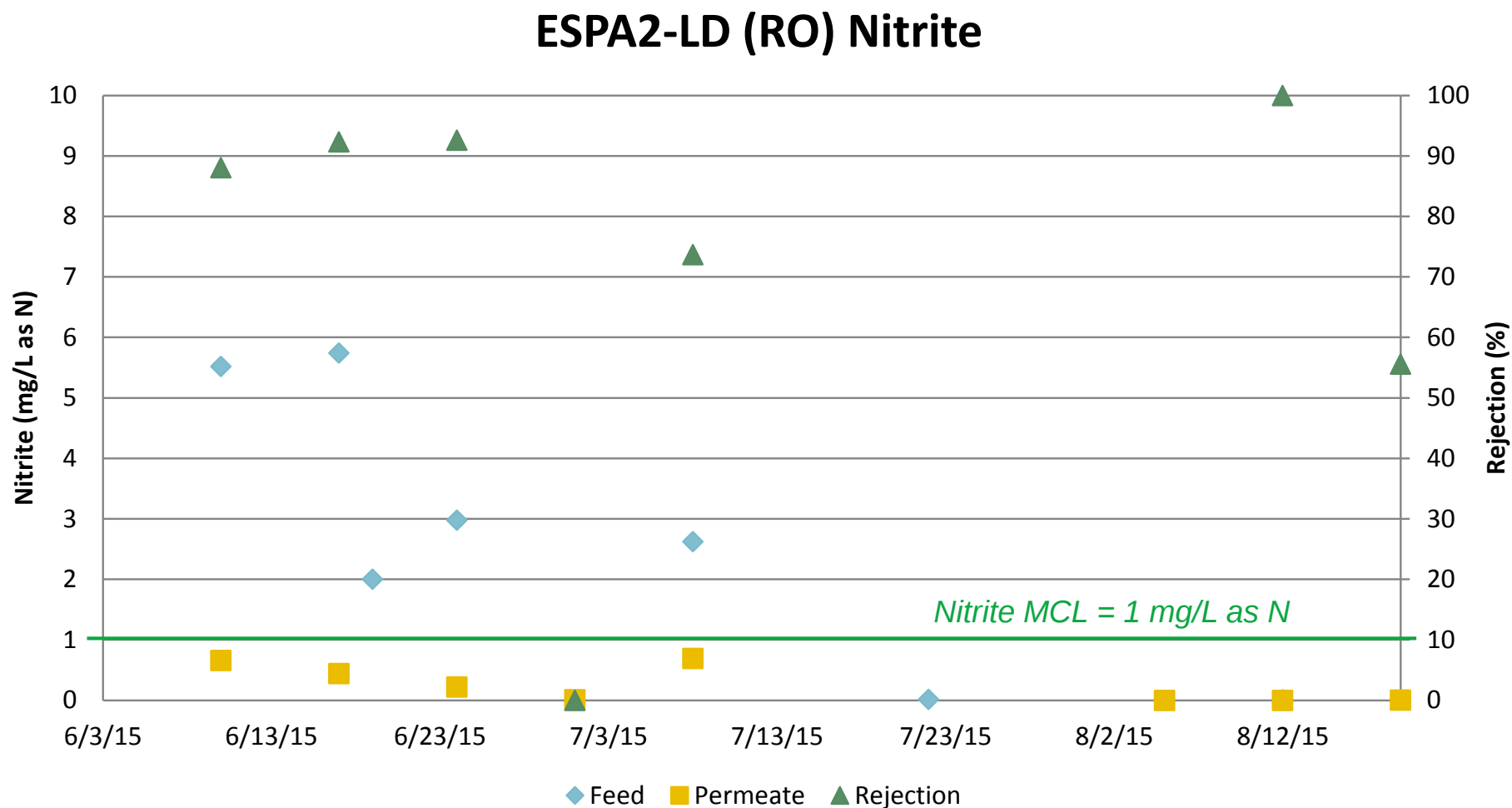
NF/RO Permeate TOC



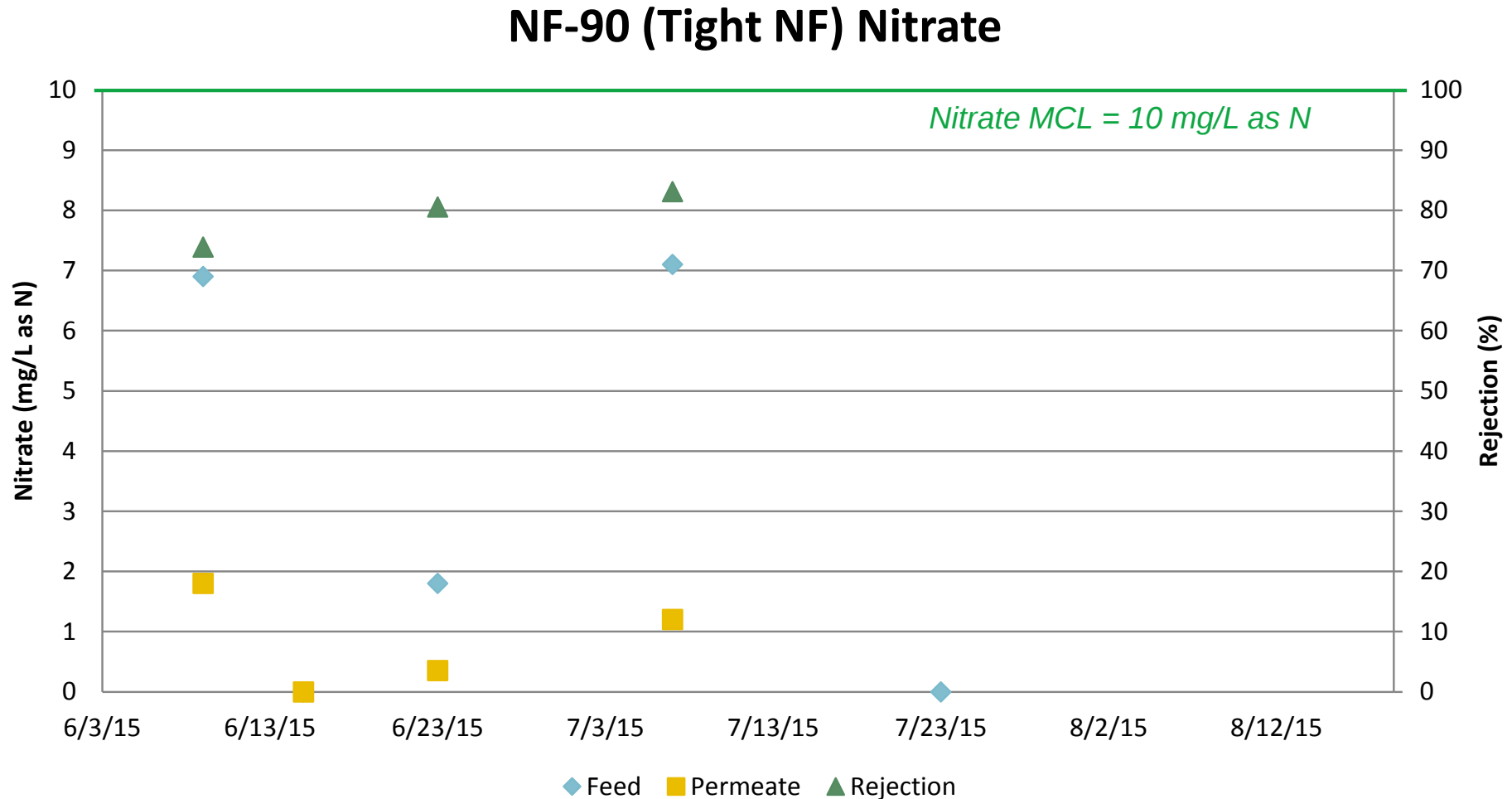
ESPA2-LD (RO) – Nitrate



ESPA2-LD (RO) – Nitrite

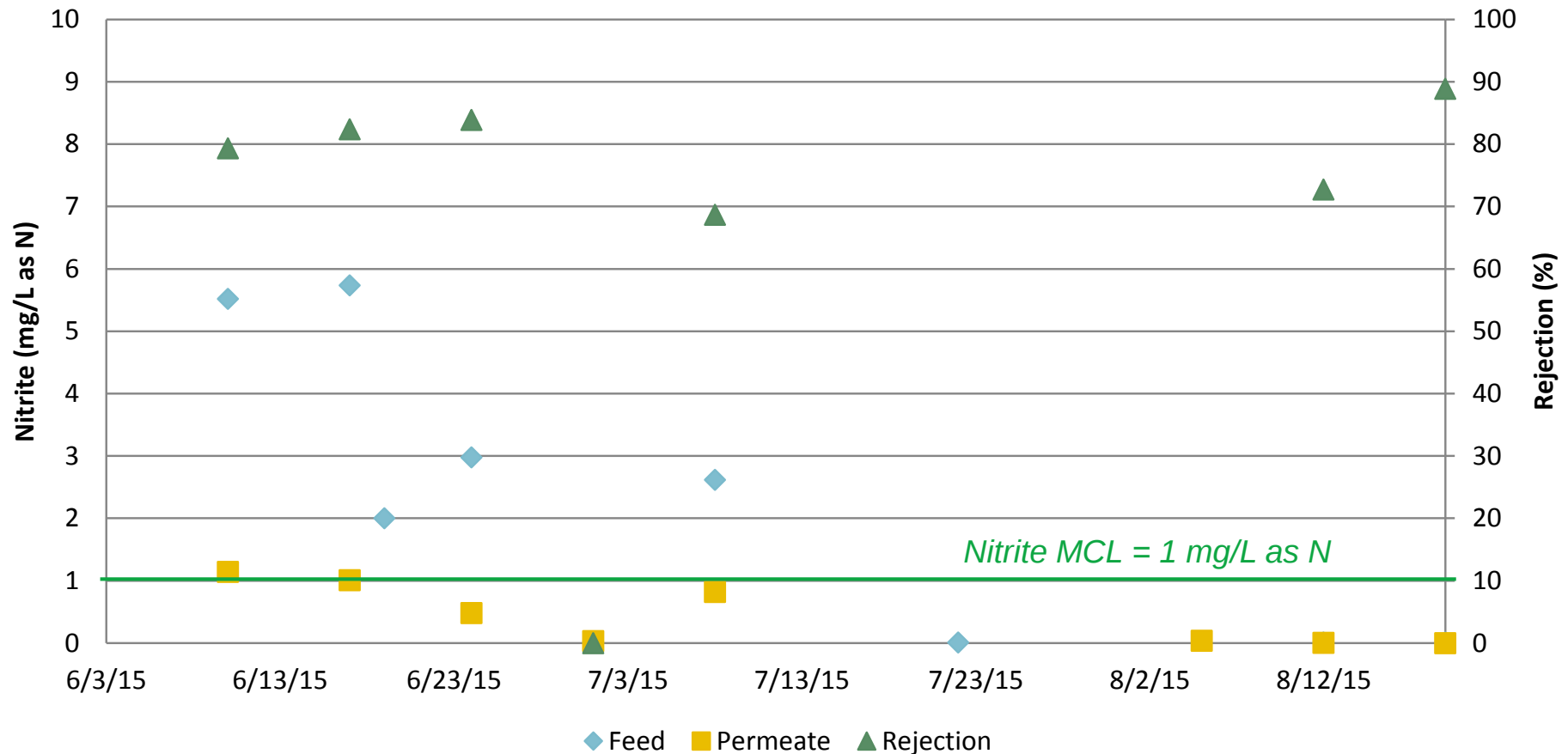


NF-90 (Tight NF) – Nitrate



NF-90 (Tight NF) – Nitrite

NF-90 (Tight NF) Nitrite



CEC Testing

Testing for ~**100** 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

Pilot CEC Results

ESPA2 Testing:

- Six sampling events, total of 16 data sets
- 13 CECs detected in UV AOP influent
- Large majority were non-detect

NF90 Testing:

- 2 CECs detected in permeate sample

Chemical Name	Units	Detection Limit	RO Permeate
4-nonylphenol	ng/L	100	660
4-tert-Octylphenol	ng/L	50	400
Acesulfame-K	ng/L	20	150
Atenolol	ng/L	5	8
Carbamazepine	ng/L	5	8.9
DEET	ng/L	10	13
Diclofenac	ng/L	5	6.2
Iohexal	ng/L	10	28
Iopromide	ng/L	5	6.9
Sucralose	ng/L	100	1400
TCEP	ng/L	10	19
Triclocarban	ng/L	5	33
Triclosan	ng/L	10	55

RO Permeate, October 20th

Chemical Name	Units	Detection Limit	NF Permeate
4-nonylphenol	ng/L	100	340
4-tert-Octylphenol	ng/L	50	ND
Acesulfame-K	ng/L	20	ND
Atenolol	ng/L	5	ND
Carbamazepine	ng/L	5	ND
DEET	ng/L	10	11
Diclofenac	ng/L	5	ND
Iohexal	ng/L	10	ND
Iopromide	ng/L	5	ND
Sucralose	ng/L	100	260
TCEP	ng/L	10	ND
Triclocarban	ng/L	5	ND
Triclosan	ng/L	10	ND

NF (Tight) Permeate, December 16th

Energy Consumption

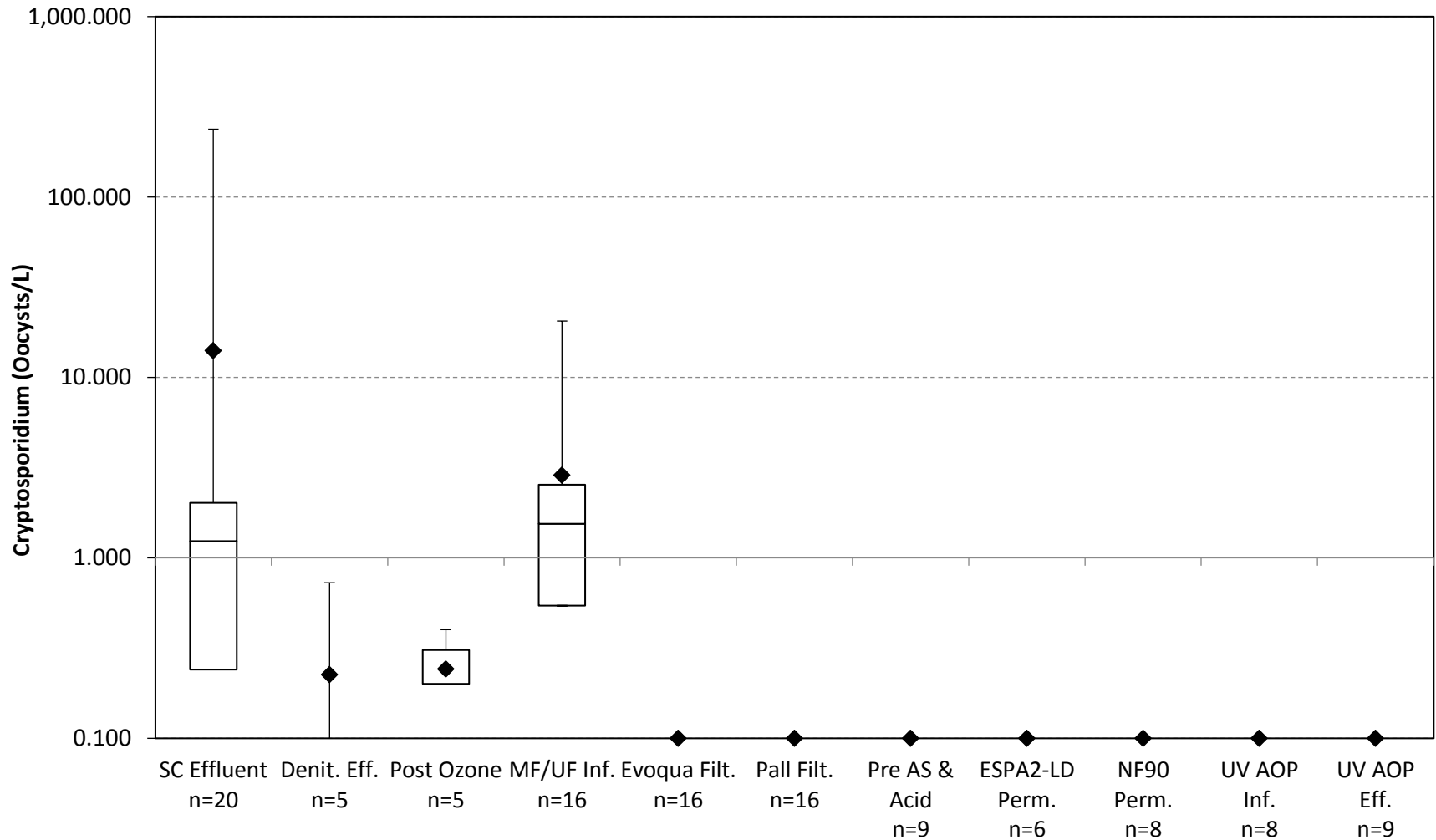
Parameter	ESPA2-LD (RO)	NF90 (Tight NF)	Units
System ΔP (average)	133	102	psi
Permeate Flow	12	12	gpm
Specific Energy	0.25	0.32	kWh/m ³

Data are average values
ND: Not Detected
TBD: To Be Determined

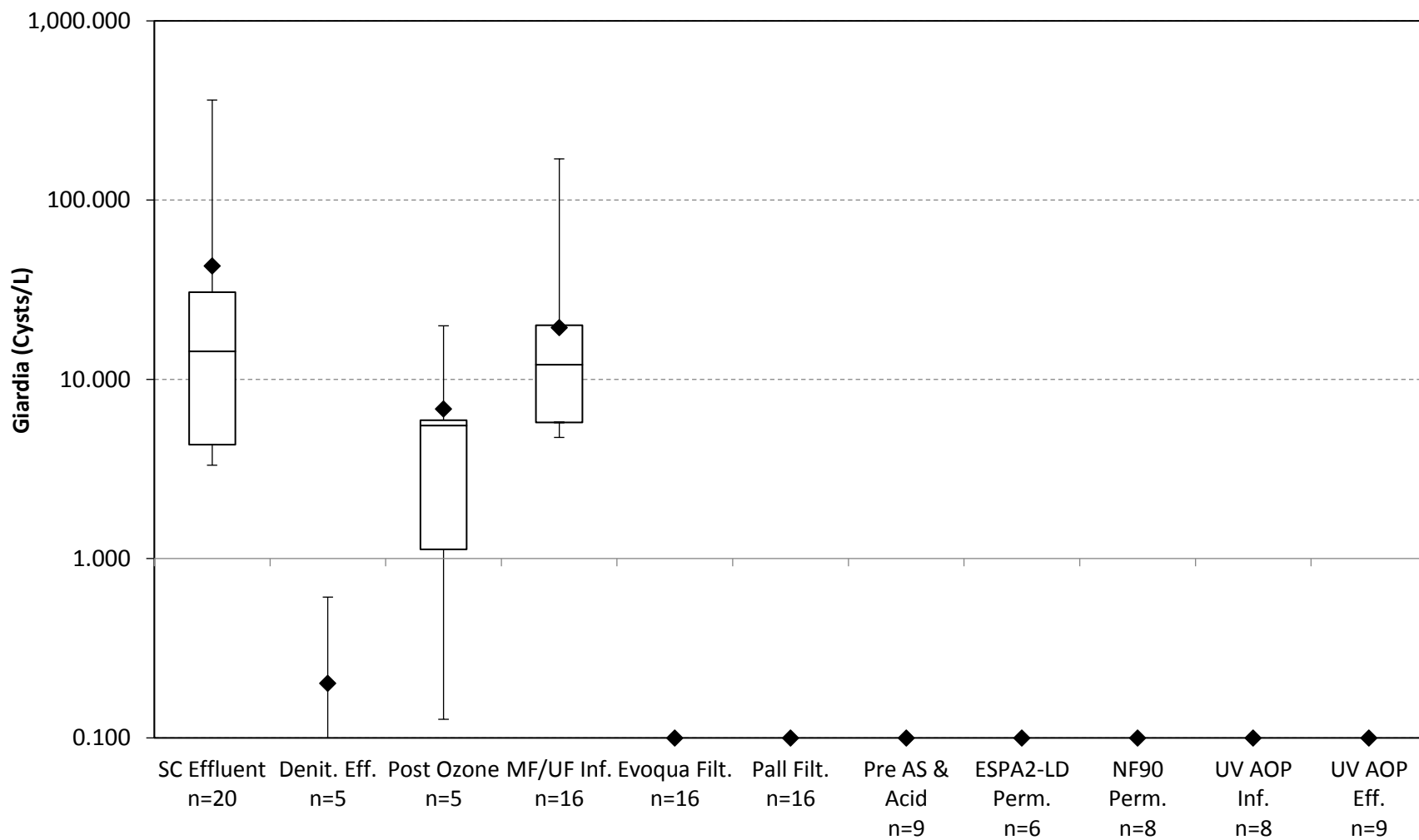


Pathogen Results

Cryptosporidium



Giardia



Total Culturable Virus (MPN/L)

Date	Secondary Clarifier Effluent	UV AOP Effluent
6/10/2015	0.25	ND
7/8/2015	0.46	ND
8/6/2015	0.403	ND
9/14/2015	0.09	ND
10/7/2015	0.575	ND
10/28/2015	0.48	ND
11/30/2015	0.4	ND
12/28/2015	0.299	ND

Membrane Comparison, Recap



Total Dissolved Solids (TDS) Removal



Pathogen Barrier



Emerging Contaminants



Permeate TOC



Nutrient Removal (NO_3 , NO_2)



Energy Consumption

Independent Advisory Panel



Public Outreach Campaign



Regulatory Coordination



TEXAS COMMISSION
ON ENVIRONMENTAL QUALITY

UTEP Involvement



EPWU Resources



El Paso's latest innovative solution:
Advanced Water Purification

YOU ARE INVITED...

to tour the Advanced Water Purification Pilot Facility. We are pilot testing a process that will transform used water into fresh, purified drinking water. Upon regulatory approval, we will build a full-scale facility that will produce a new local water supply that is safe and reliable, drought-proof and sustainable.

Tours are free, but registration is required. Call: (915) 594-5680 or visit epwu.org/purifiedwater for more information.



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