

UV Disinfection and Landfill Leachate- a Troublesome Combination

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Pierce County

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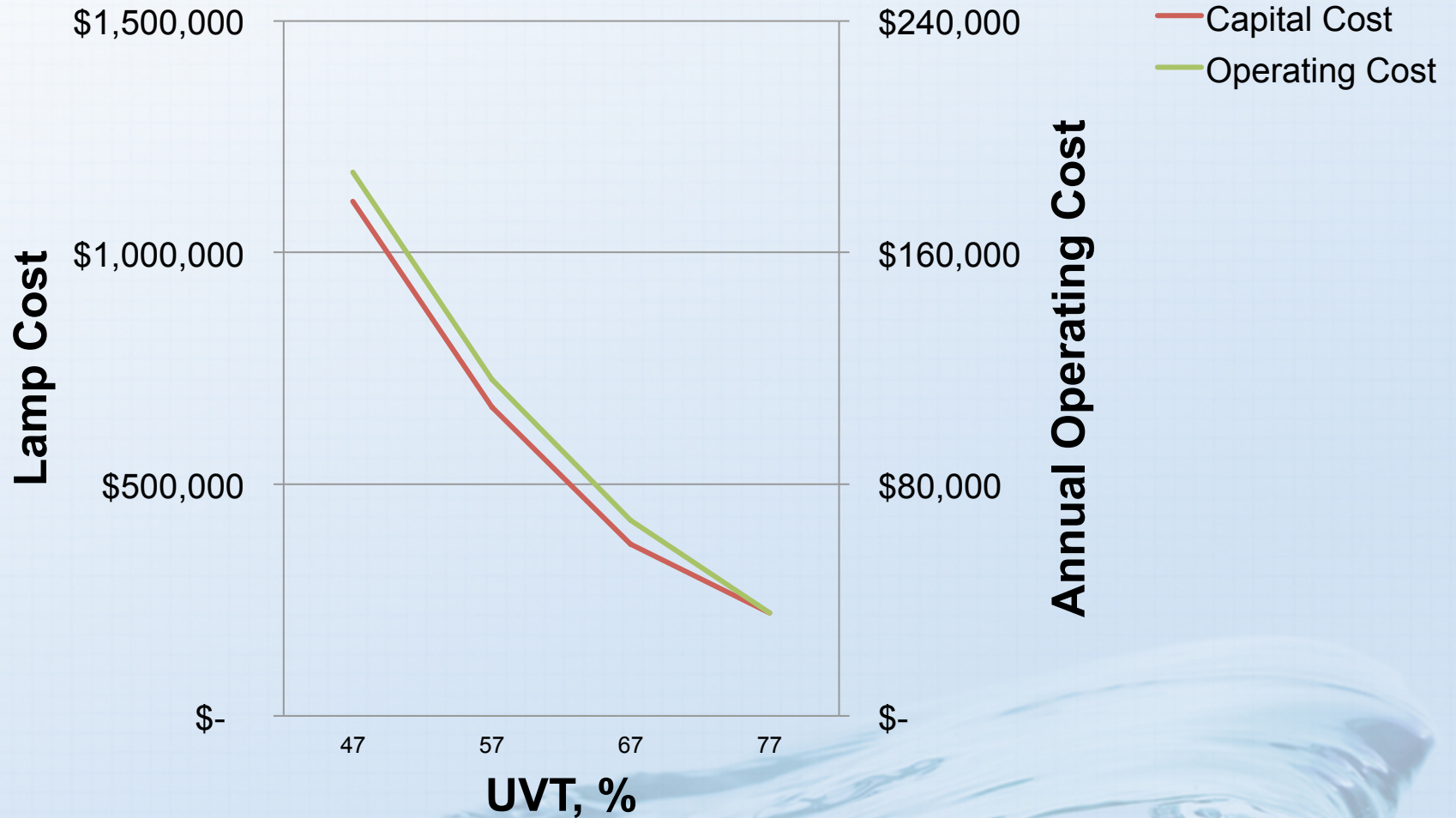
Andrew Salveson, Brian Matson, Karl Hadler, Nitin Goel, Alena Bennett, and Morayo
Noibi


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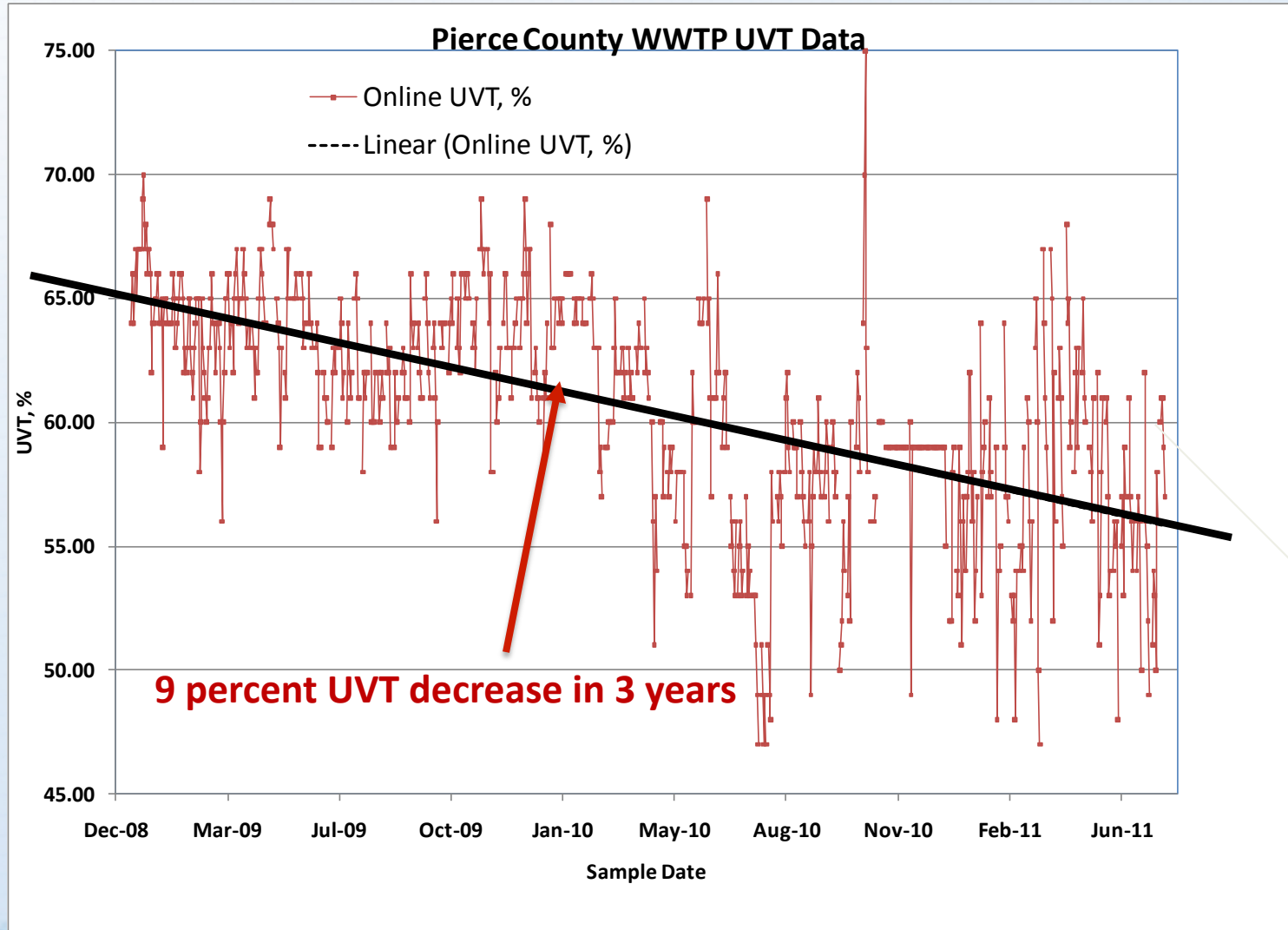
Project Background

- Chambers Creek WWTP undergoing UV disinfection improvements
- New UV System: 57 mgd
- Design UVT: 56%

Why is UVT Important?



Secondary Effluent UVT Trend at the WWTP



What is the suspected culprit of this downward trend?



Leachate Treatment at the WWTP

	Flow
Average Leachate Flow to WWTP	30,000 gpd (treated at landfill)
Permitted Leachate Flow to WWTP	60,000 gpd
Bypass Leachate Flow to WWTP	Up to 100,000 gpd (mostly untreated)

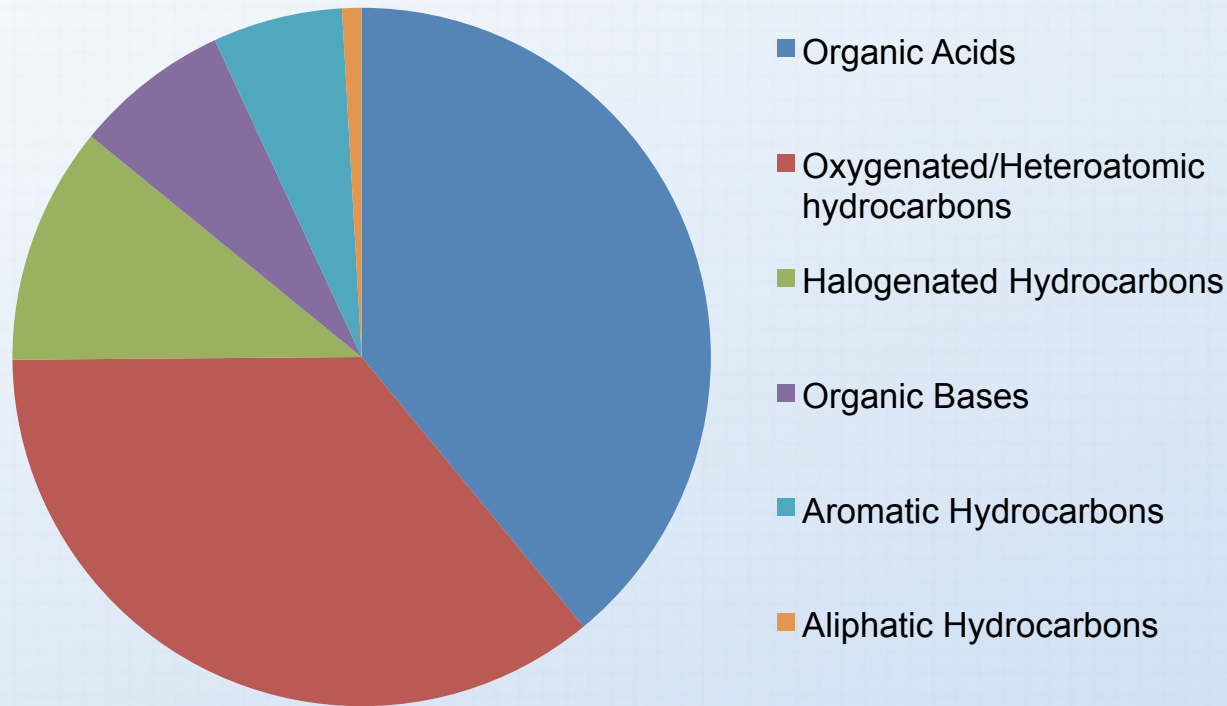
- Carollo was hired to evaluate leachate properties and alternate treatment methods to reduce UVT impacts and secondary effluent

What is the effect of Leachate on Operating and Capital Costs at the WWTP?

	Current Operational Conditions	Conditions without Leachate
Design Conditions		
Ultraviolet Transmission (%)	56	65
Number of Operating Channels	6	6
Number of Operating Banks per Channel	2	2
Total Number of Operating Lamps	768	480
Lamp Cost	\$1,777,200	\$1,110,700
Operating Conditions		
Ultraviolet Transmission (%)	59	68
Total Power Consumed (kW)	134	92
Number of Lamp Changes/year	187	140
Annual Energy Cost (@ \$0.055/kW-hr)	\$58,800	\$40,500
Annual Cost of Lamp Changes (@\$250 per lamp)	\$46,700	\$35,000
Total Annual Energy and Lamp Maintenance Cost	\$105,500	\$75,500

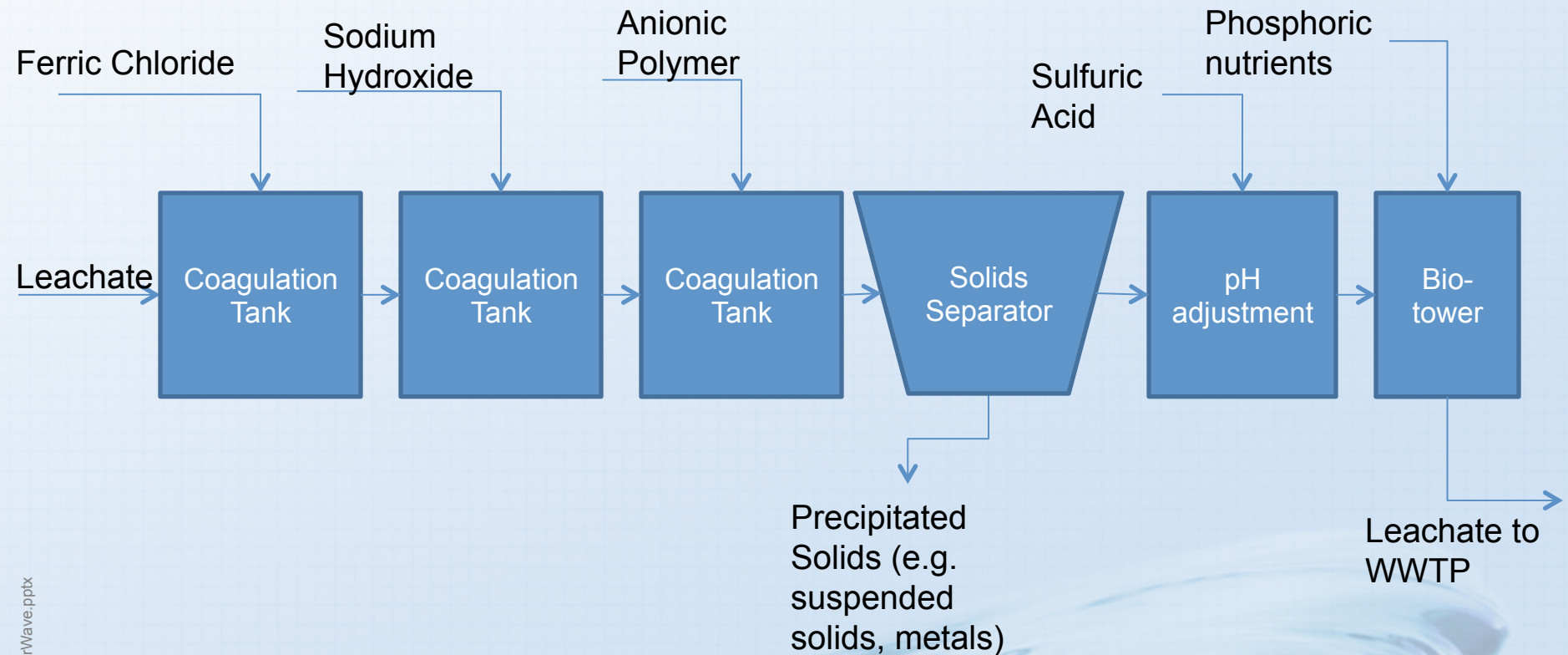
Literature Review

What Constitutes Leachate?

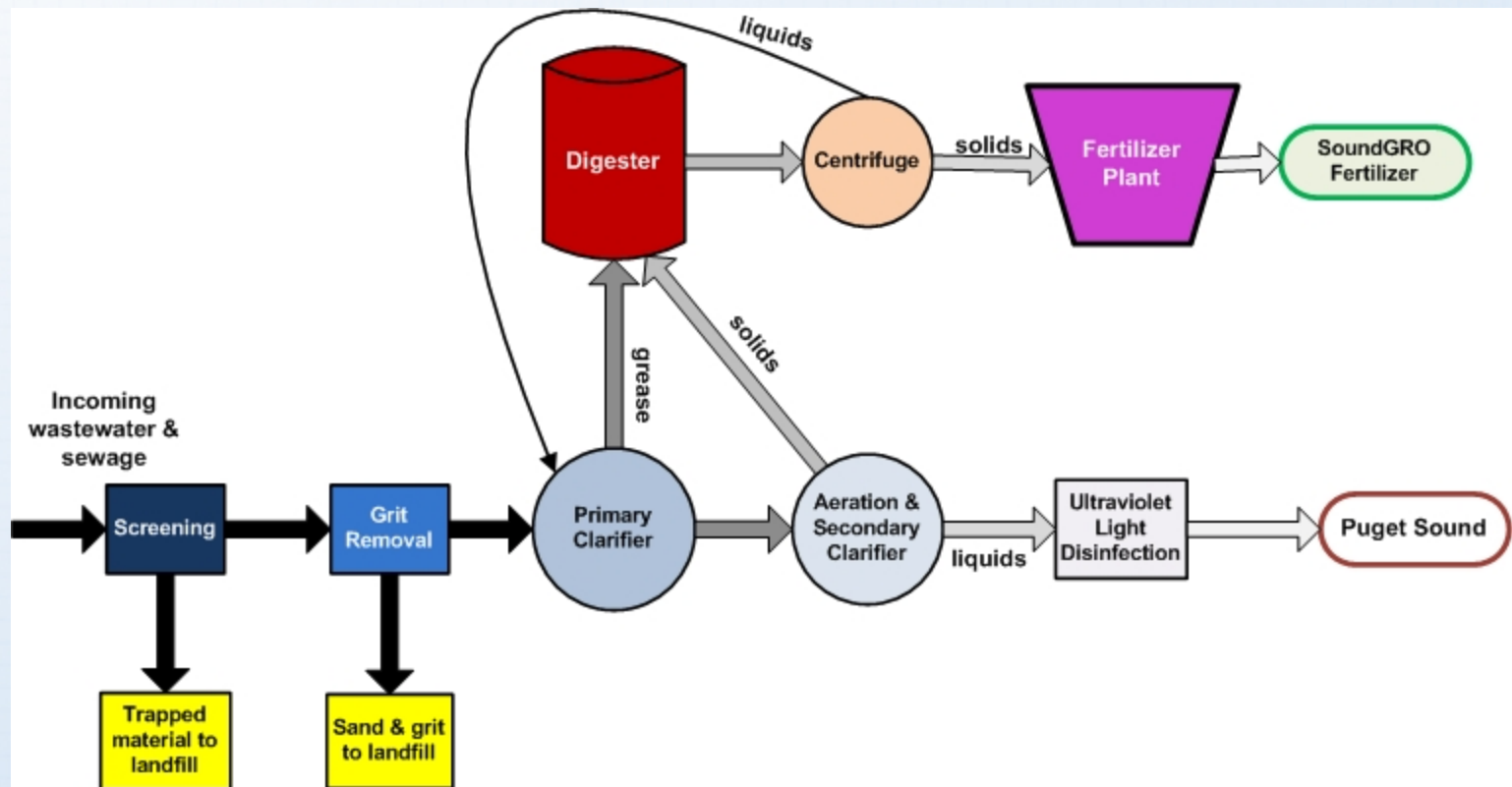


- Leachate organic component: Up to 75% Humic Acids
- Humic Acids are pigmented polymers that absorb light

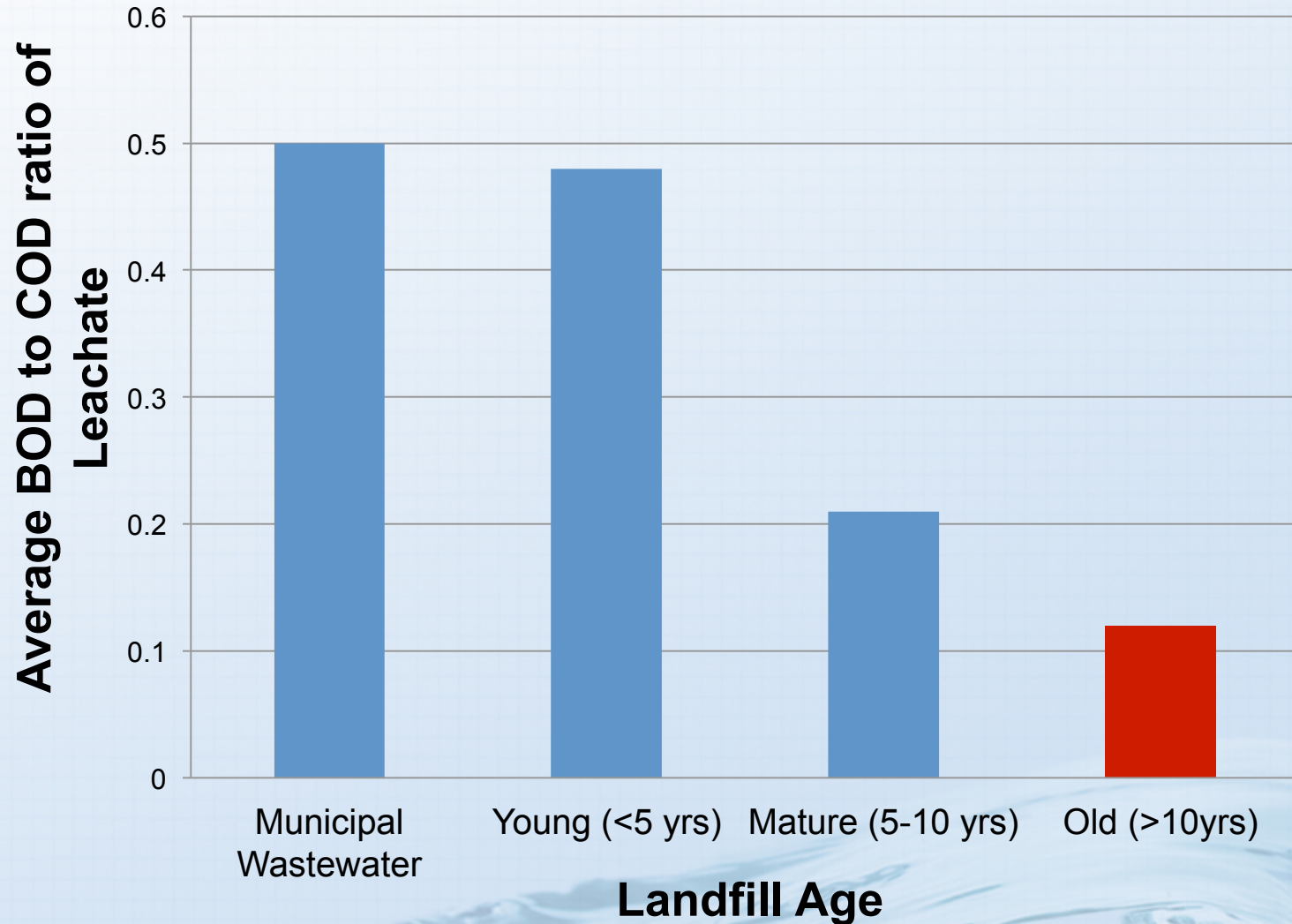
Why aren't the Humic Acids removed at the Landfill's Treatment Plant?



Why aren't the Humic Acids removed at the WWTP?

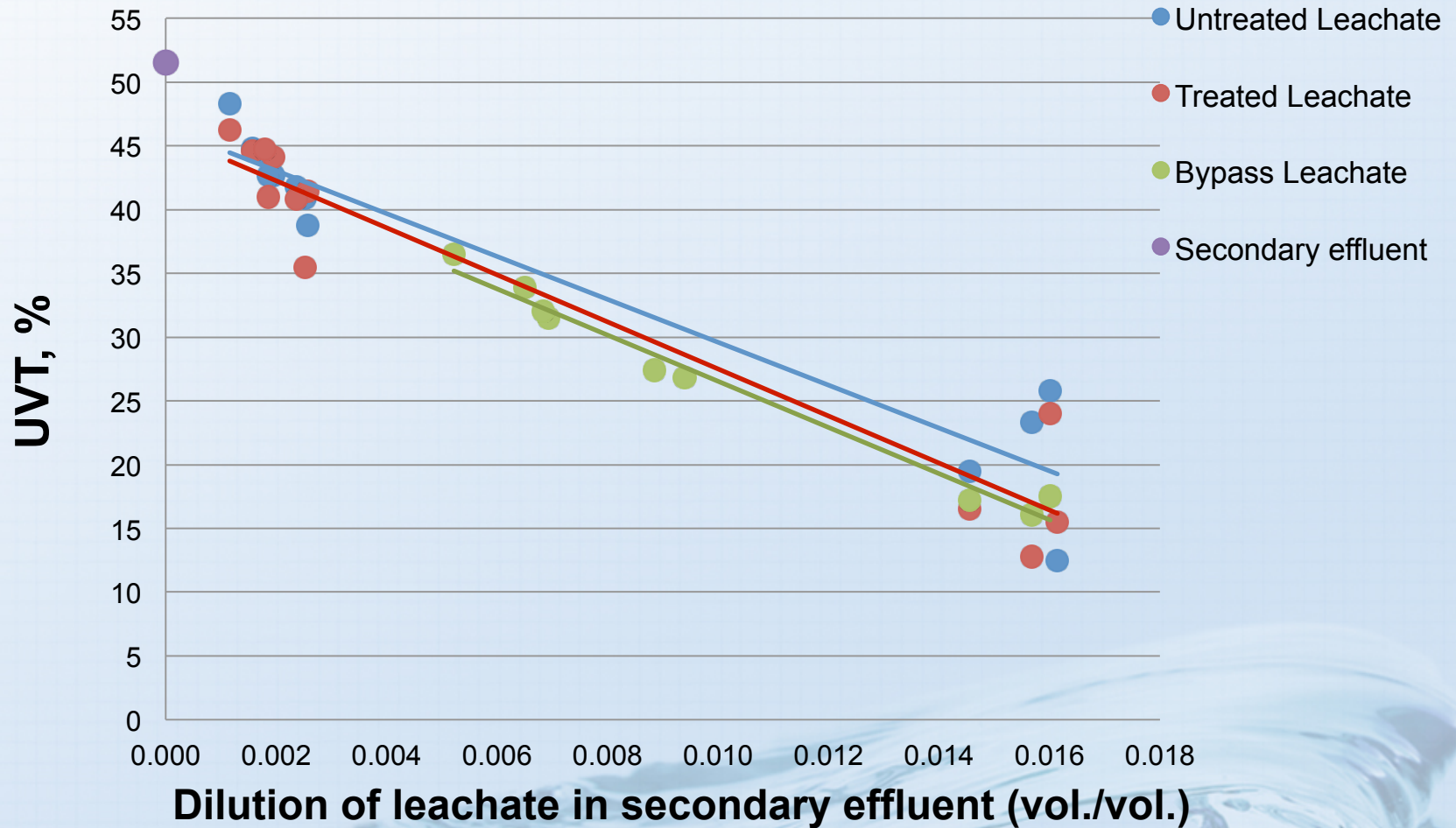


Landfill Leachate Biodegradability

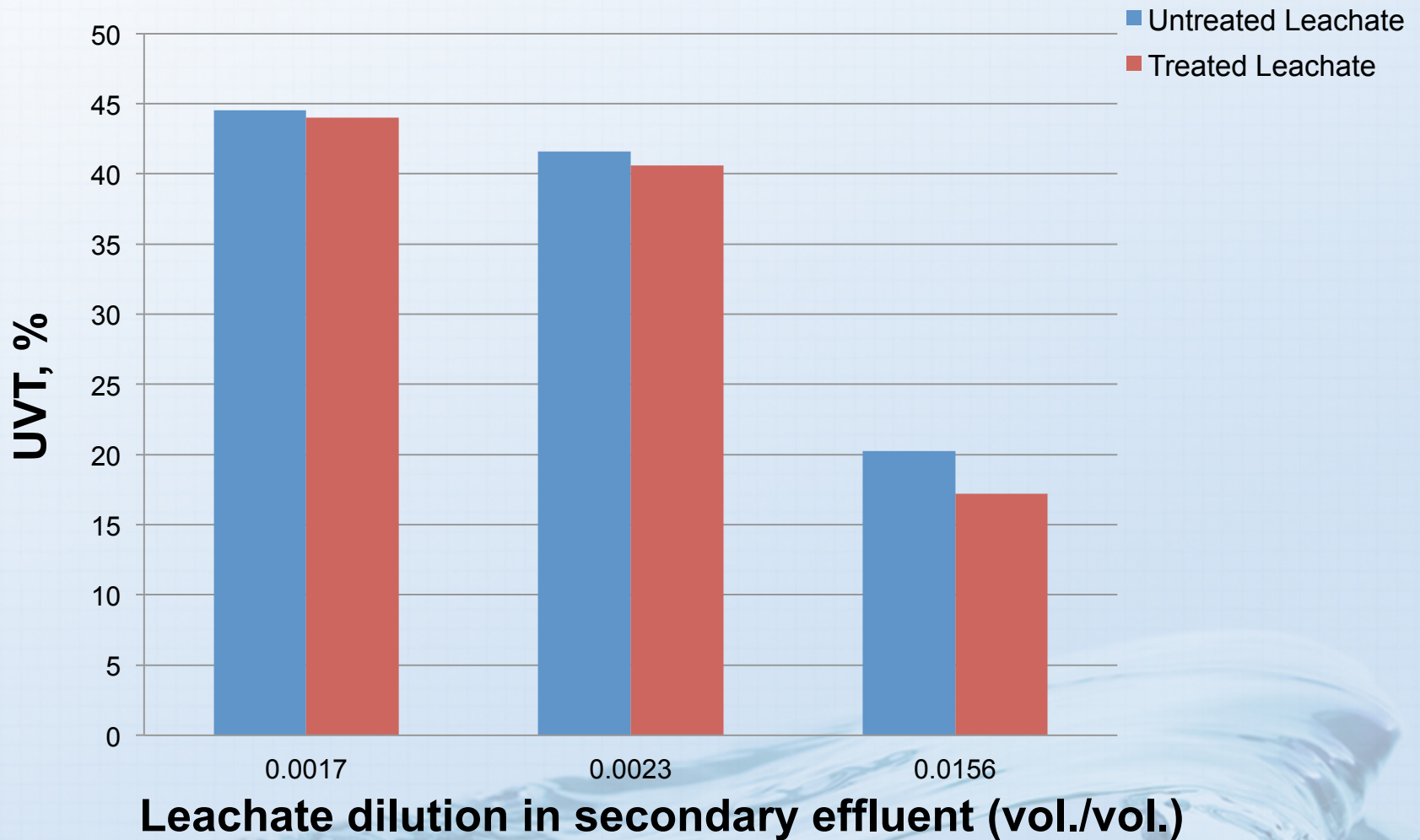


Leachate Impact Assessment

How does Leachate Affect the WWTP UVT?



How does Leachate Treatment at the Landfill Affect WWTP UVT?



Literature Review- Alternate Leachate Treatment Methods

Landfill Leachate Treatment Methods

Advanced Oxidation Processes

- Ozonation
- TiO_2 Photo-Catalytic Oxidation
- H_2O_2 - O_3 Treatment
- Ferrate

Physical Treatment Processes

- Powdered Activated Carbon
- Reverse Osmosis
- Nano-Filtration

How do the Treatment Methods Compare?

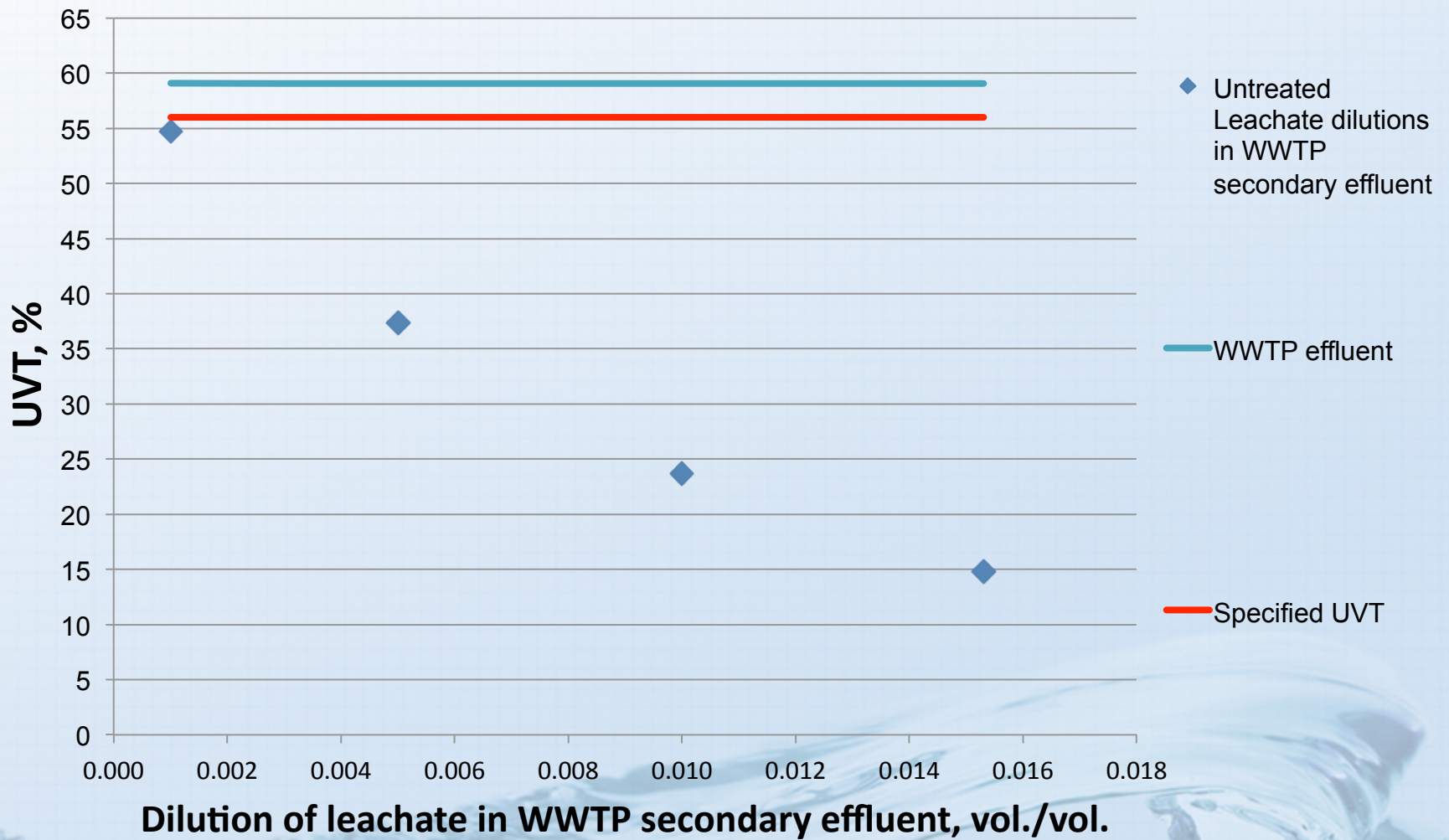
Technology/ Application	Ozone	TiO ₂ - Photo- catalysis	Peroxide	Ferrate	PACT® Adsorption	Membranes
Full-scale applications	Yes	No	No	No	Yes	Yes
Dose	0.2g /gCOD	6g /gCOD	0.7g H ₂ O ₂ /gCOD and 0.05g Fe ⁺² / gCOD	0.7g Fe ⁺⁶ / gCOD	NA	120 Bar
Change in Biodegradability	400% increase	57% increase	63% increase	200% increase	ND- Final values are non-detects	72% increase
Color Removal	90%	90%	ND	ND	Observed visually	Observed visually
UVT Increase	30% (Dose: 0.6g/gCOD)	ND	ND	ND	ND	89% increase
COD Removal	60%	70% (Dose: 7g/gCOD)	Up to 50%	70% (Dose: 0.7g/gCOD)	97%	99%
Byproducts/Residue	No	No	No	Yes	Yes	Yes, recycled to Landfill, or incinerated.

How do the Treatment Methods Compare?

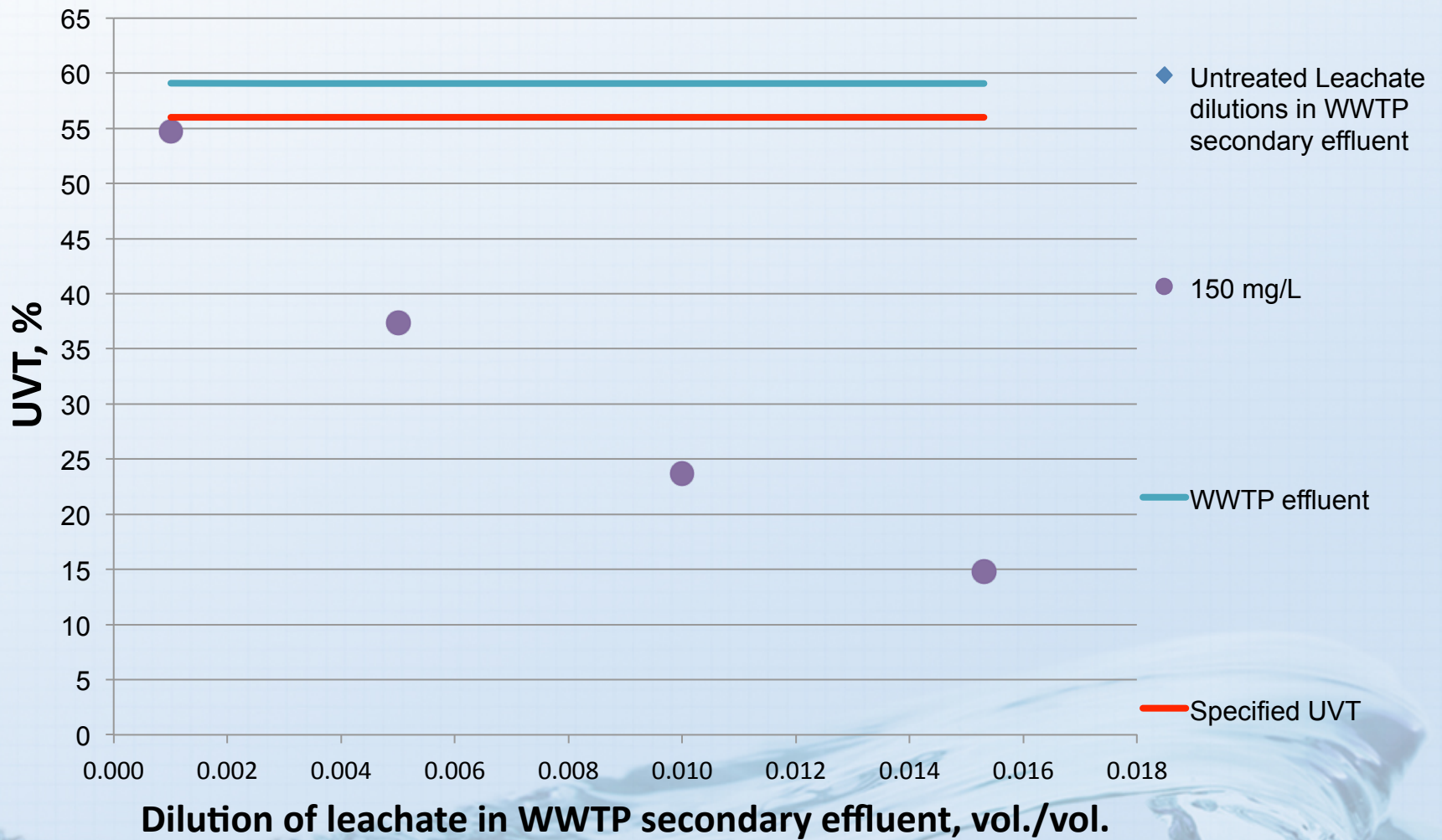
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Results of Benchtop Tests

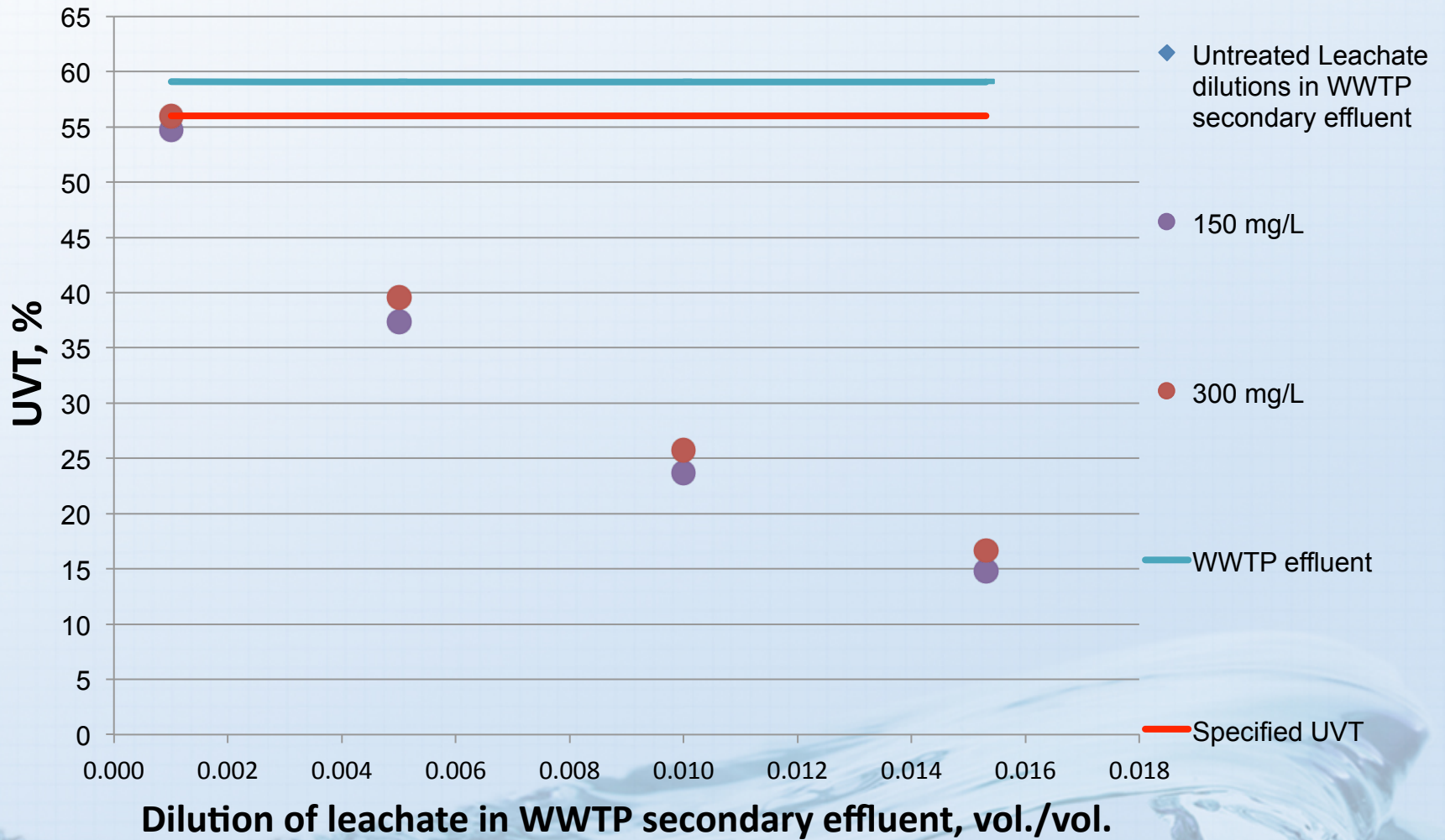
Ozone Benchtop Test Results



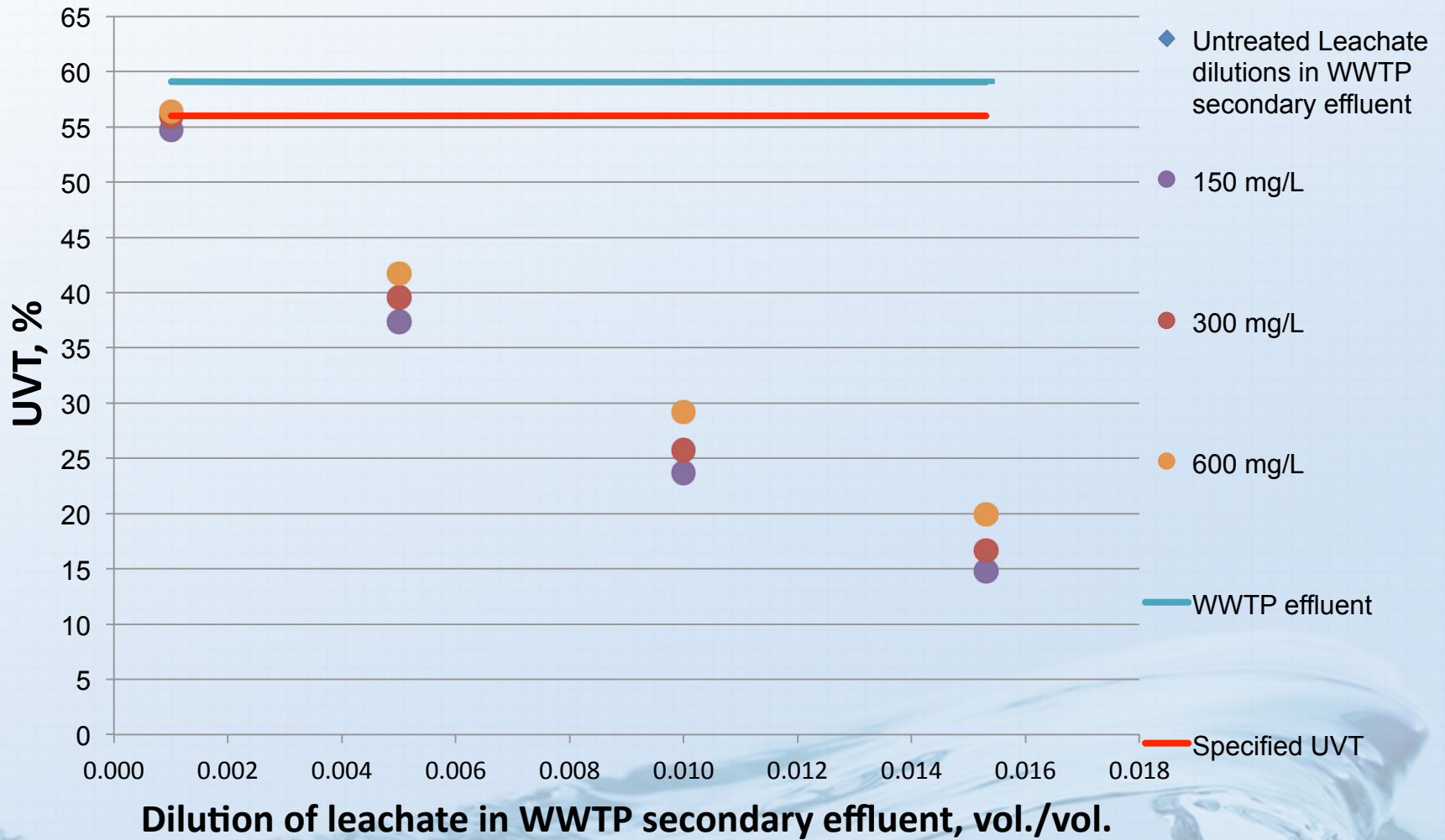
Ozone Benchtop Test Results



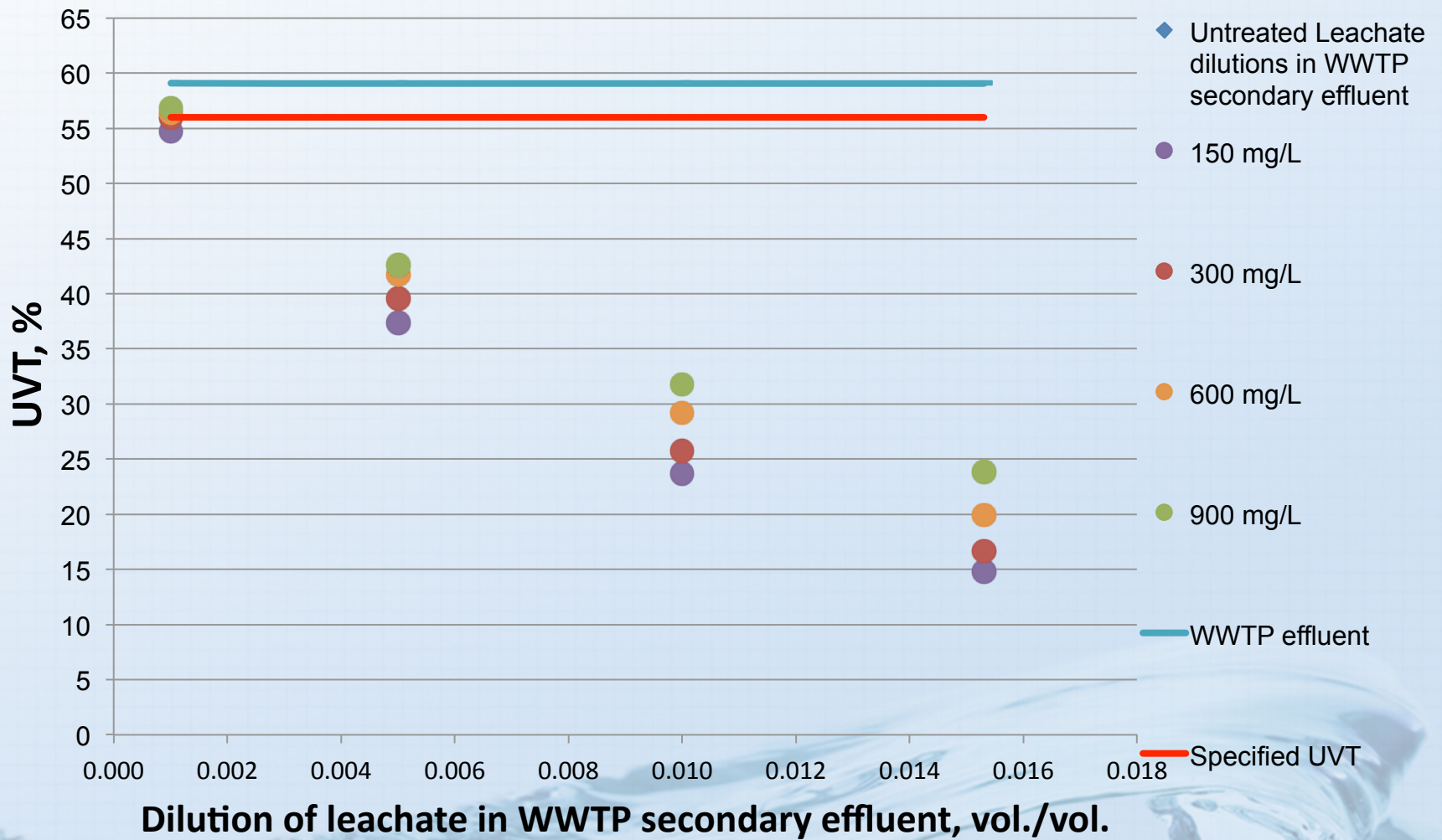
Ozone Benchtop Test Results



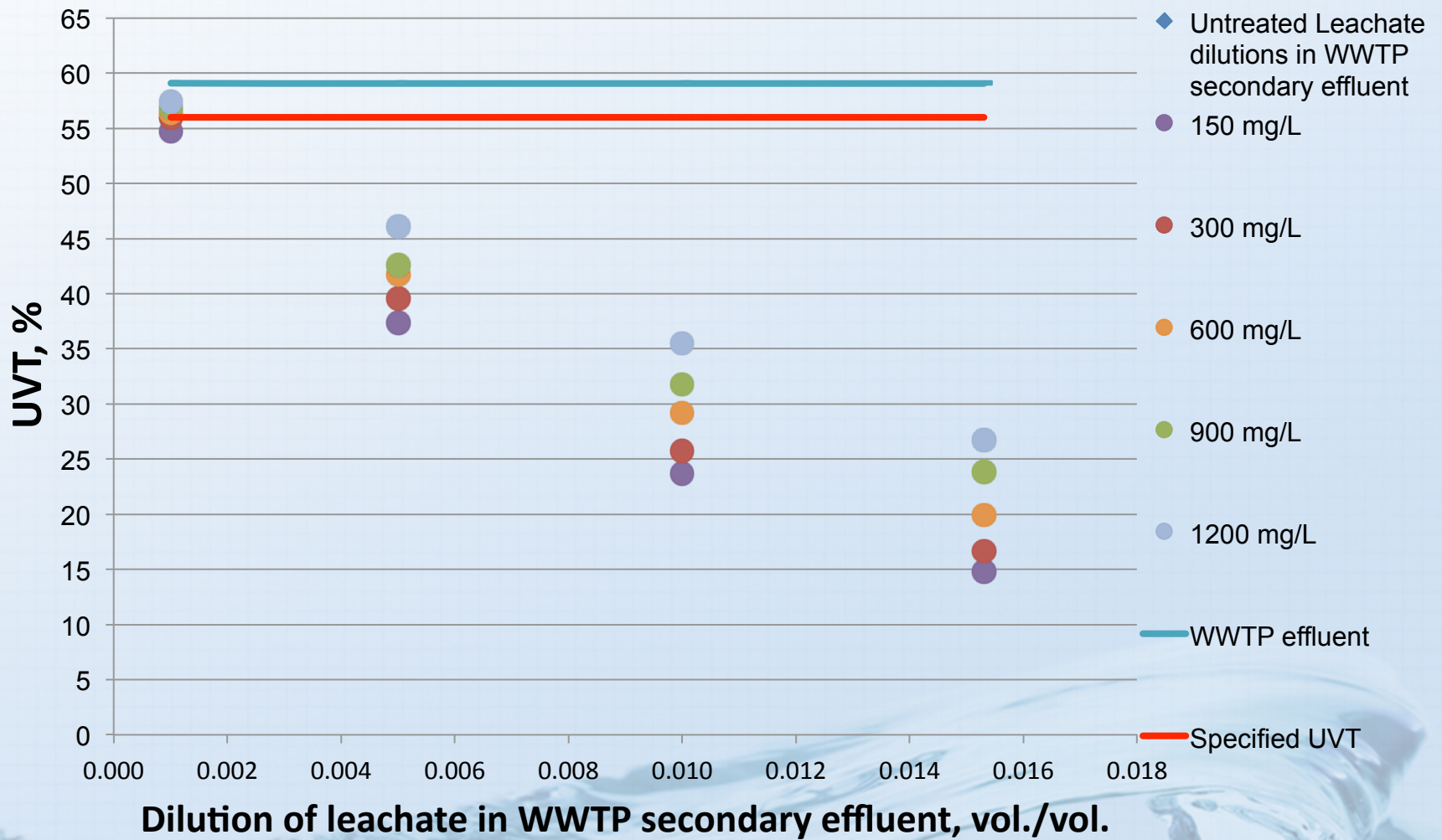
Ozone Benchtop Test Results



Ozone Benchtop Test Results



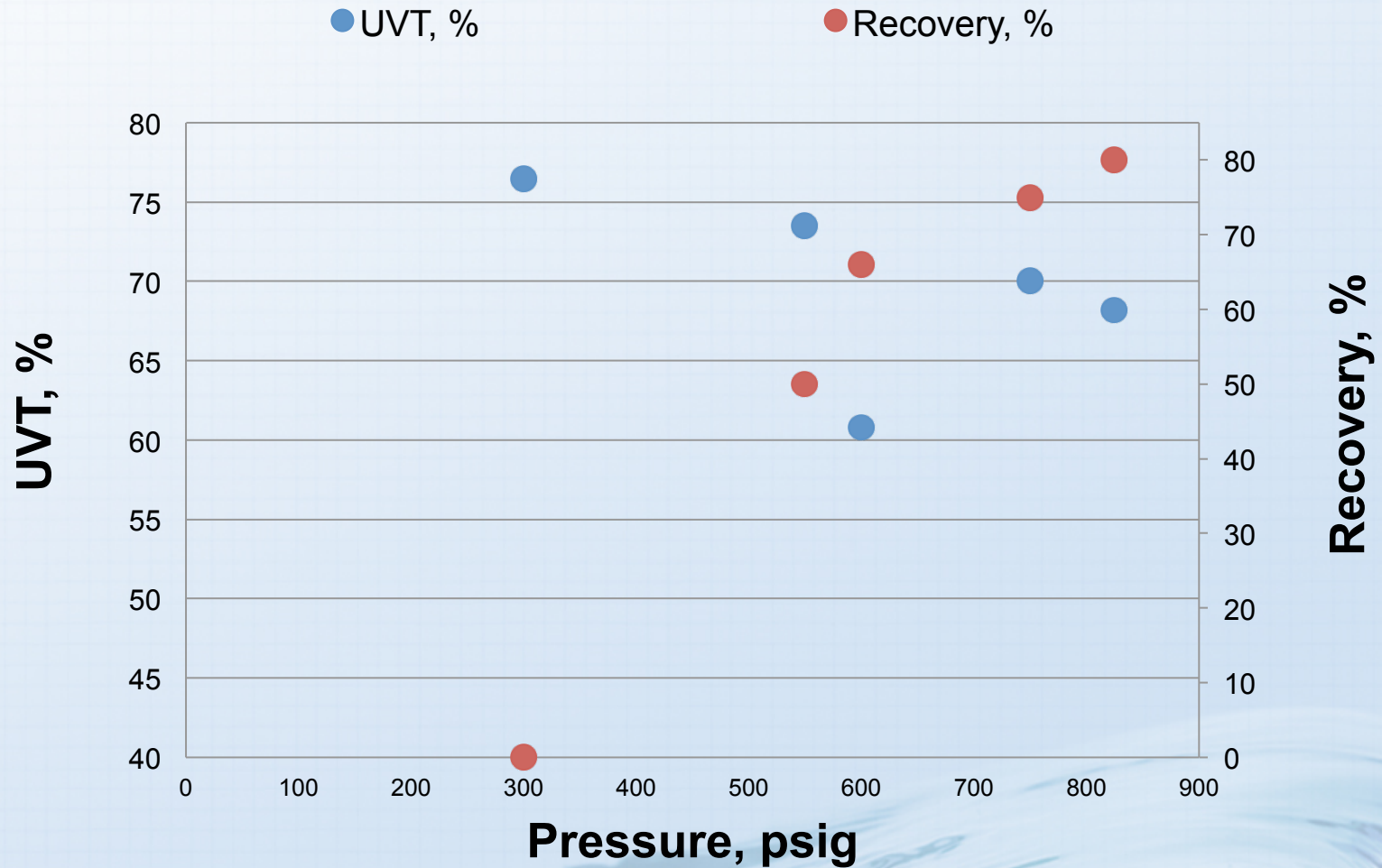
Ozone Benchtop Test Results



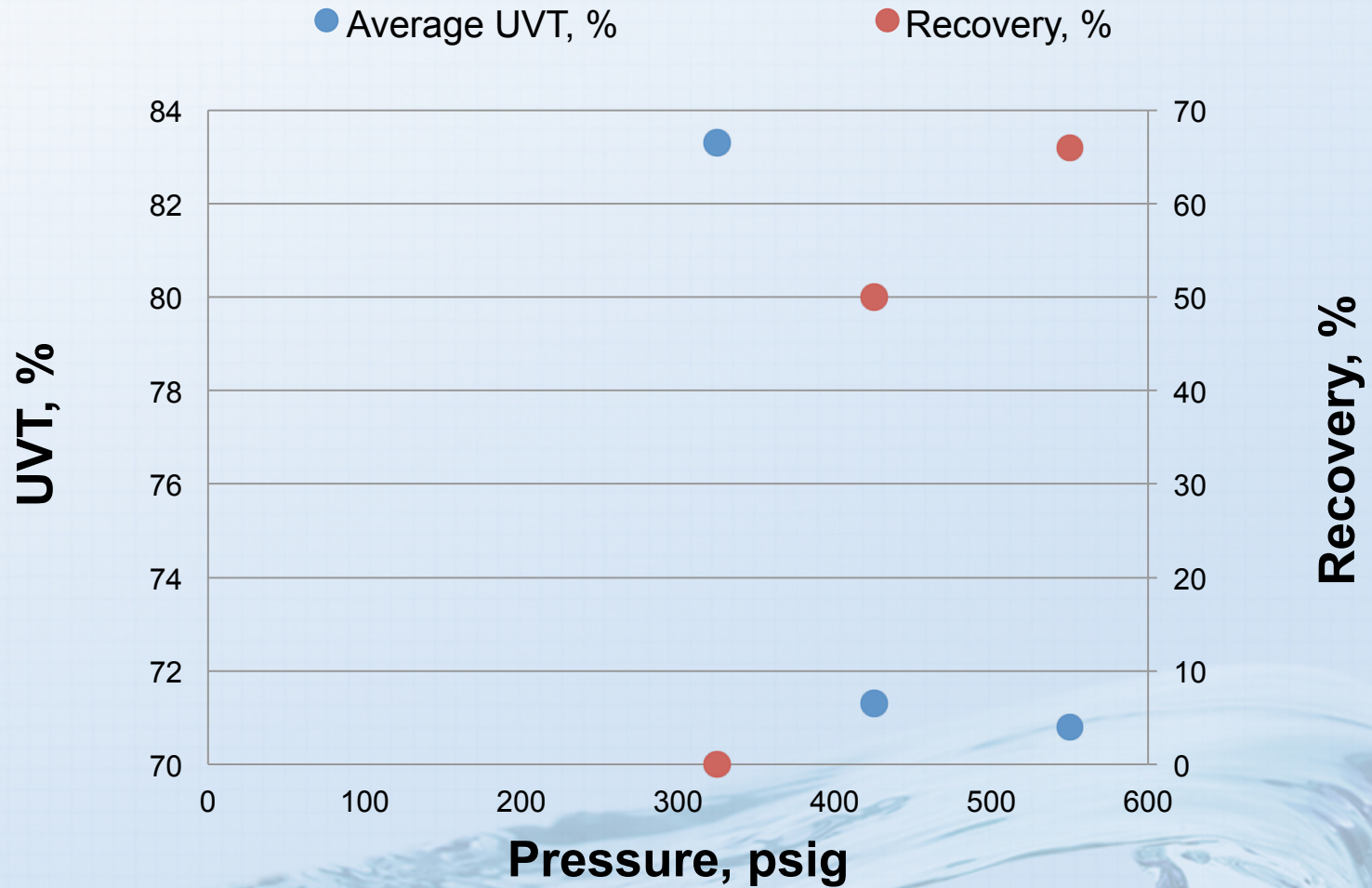
Ozone Benchtop Test Samples



Membrane Benchtop Test Results- Reverse Osmosis

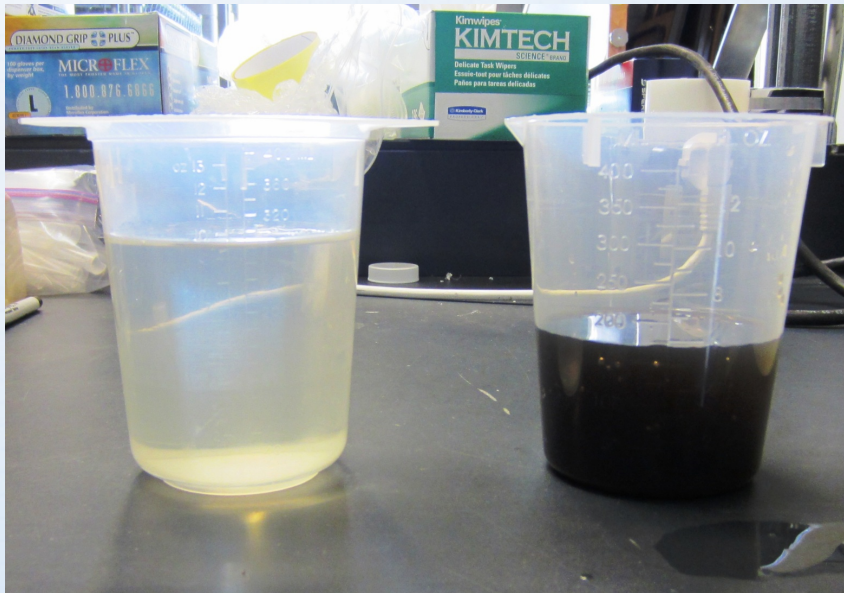


Membrane Benchtop Test Results- Nanofiltration



Membrane Benchtop Test Samples

**Secondary effluent and
untreated leachate**

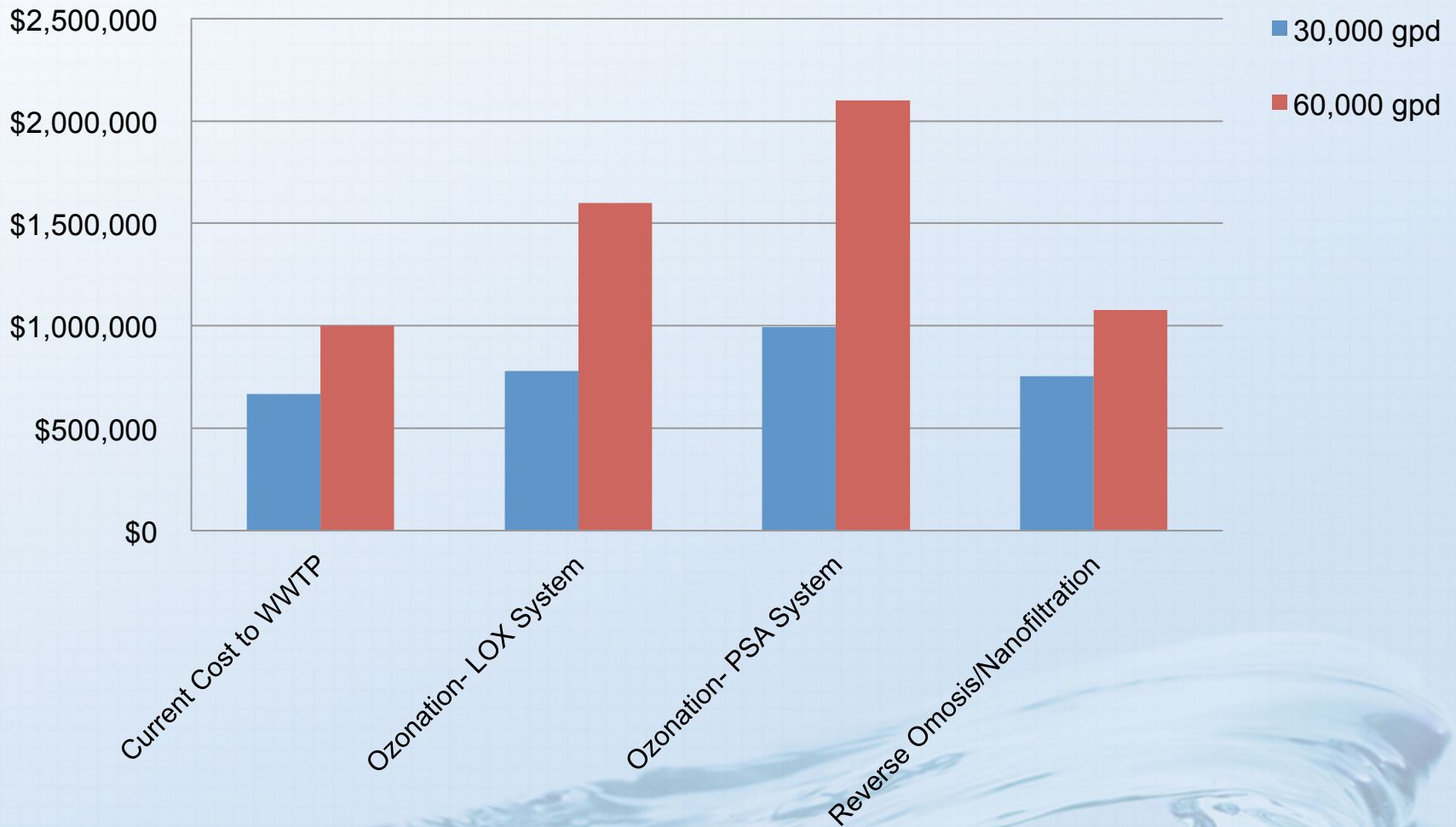


**Secondary effluent and
treated leachate**

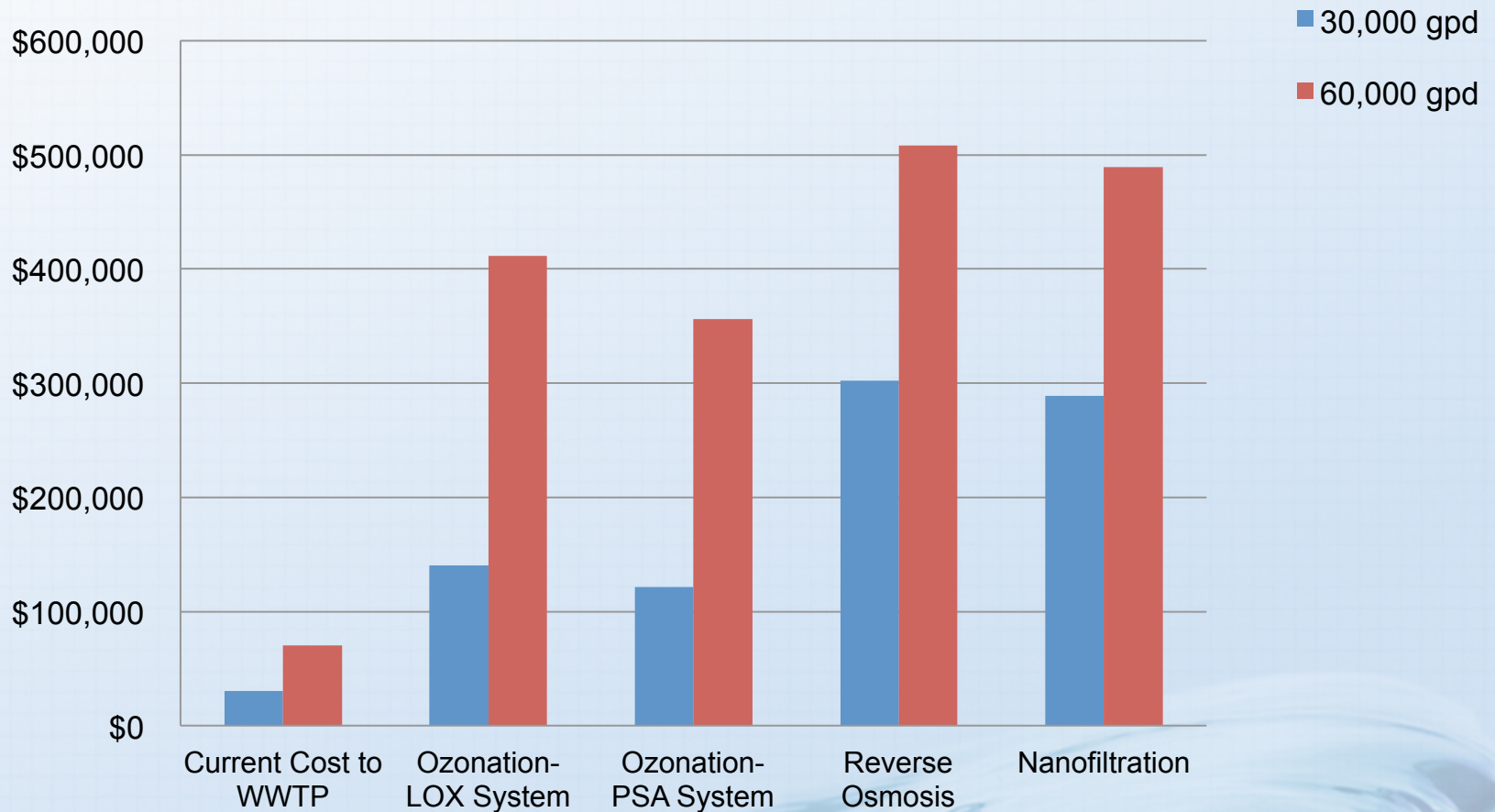


Planning Level Cost Analysis

Equipment Costs of Tested Technologies



Annual Operating Costs of Tested Technologies



Summary and Conclusion

Conclusions

- Leachate discharge reduces the WWTP UVT by up to 9%, regardless of landfill treatment
- Lower UVT results in approximately:
 - \$666,000 of additional UV equipment cost;
 - \$30,000/yr of additional energy and lamp maintenance cost
- Current treatment at the landfill is not effective in removing or reducing humic acids- the low UVT and non-biodegradable component of leachate

Conclusions

- Benchtop testing of Ozone, RO and NF technologies have shown that these technologies can substantially increase leachate UVT
- Leachate pre-treatment cost via Ozone, RO and NF >> NPV of treatment at current conditions
- If low (<56%) plant UVT levels continue, the newly installed UV equipment will not provide a sufficient dose to achieve disinfection
- Providing leachate pre-treatment may be required for WWTP to meet NPDES permit requirements

Next Steps

- Set up of pretreatment regulation based on cost impacts of reduced UVT
- Carollo and Pierce County worked together to model reduction in UVT impact, based on volume of leachate received

Questions?

Contact:

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Acknowledgements

- Pierce County
- Rochem
- APTWater

Ozone bench-top test

