Evaluating The Impacts Of Leachate Co-treatment On A Full-scale Municipal Wastewater Treatment Plant In Canada

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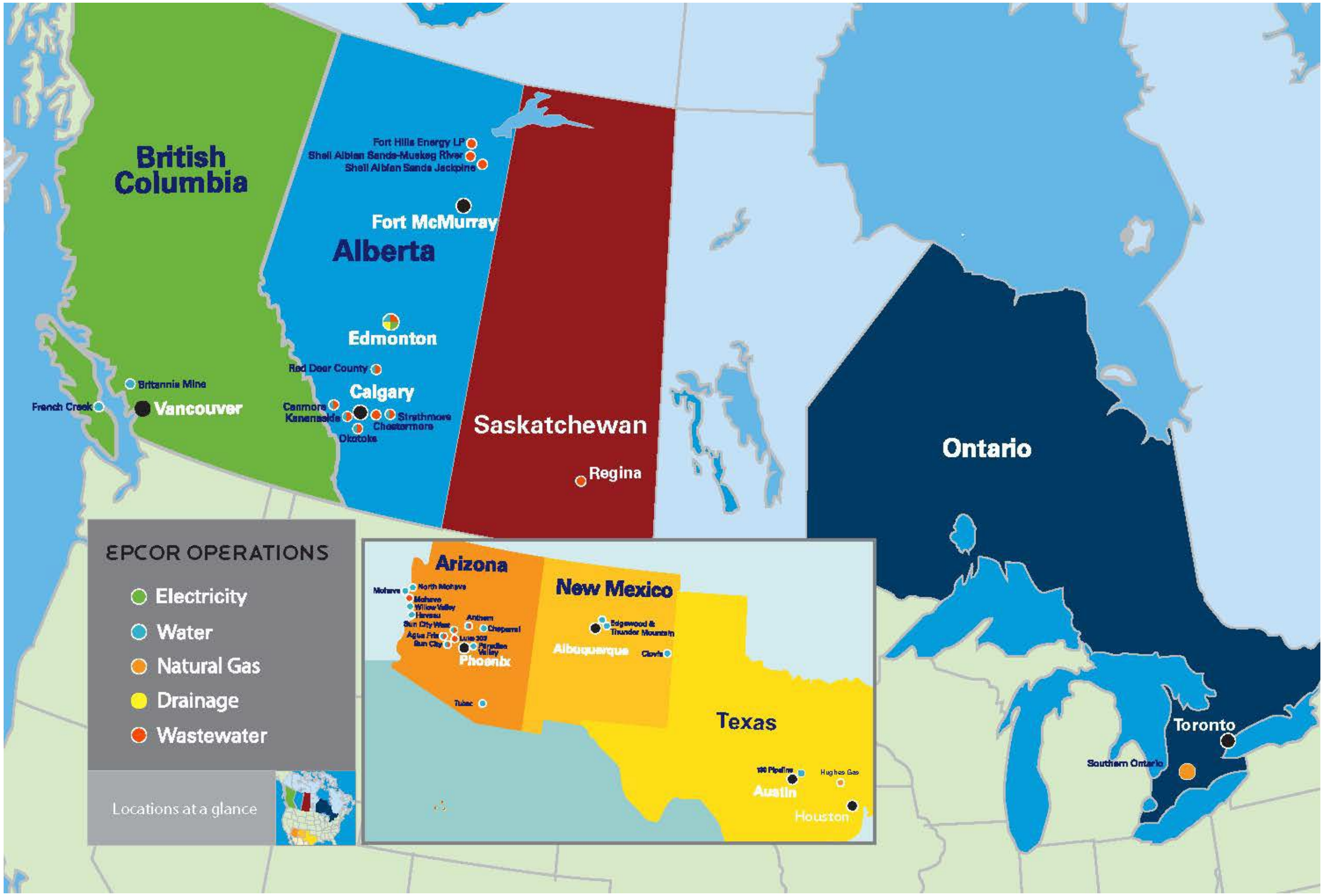
About EPCOR

- Owner & Operator of Water, Wastewater, Drainage, Electrical & Natural Gas Utilities
- 100+ year history
- About 1.9 million served
- Municipal and Industrial markets
- 3,500 employees
- Operations in Canada & U.S

EPCOR Operations



The Leachate Goldilocks Effect

Carbon and VFA Loading

Microbial activity and BNR

Cost

BOD/COD

Toxicity

Main Objectives

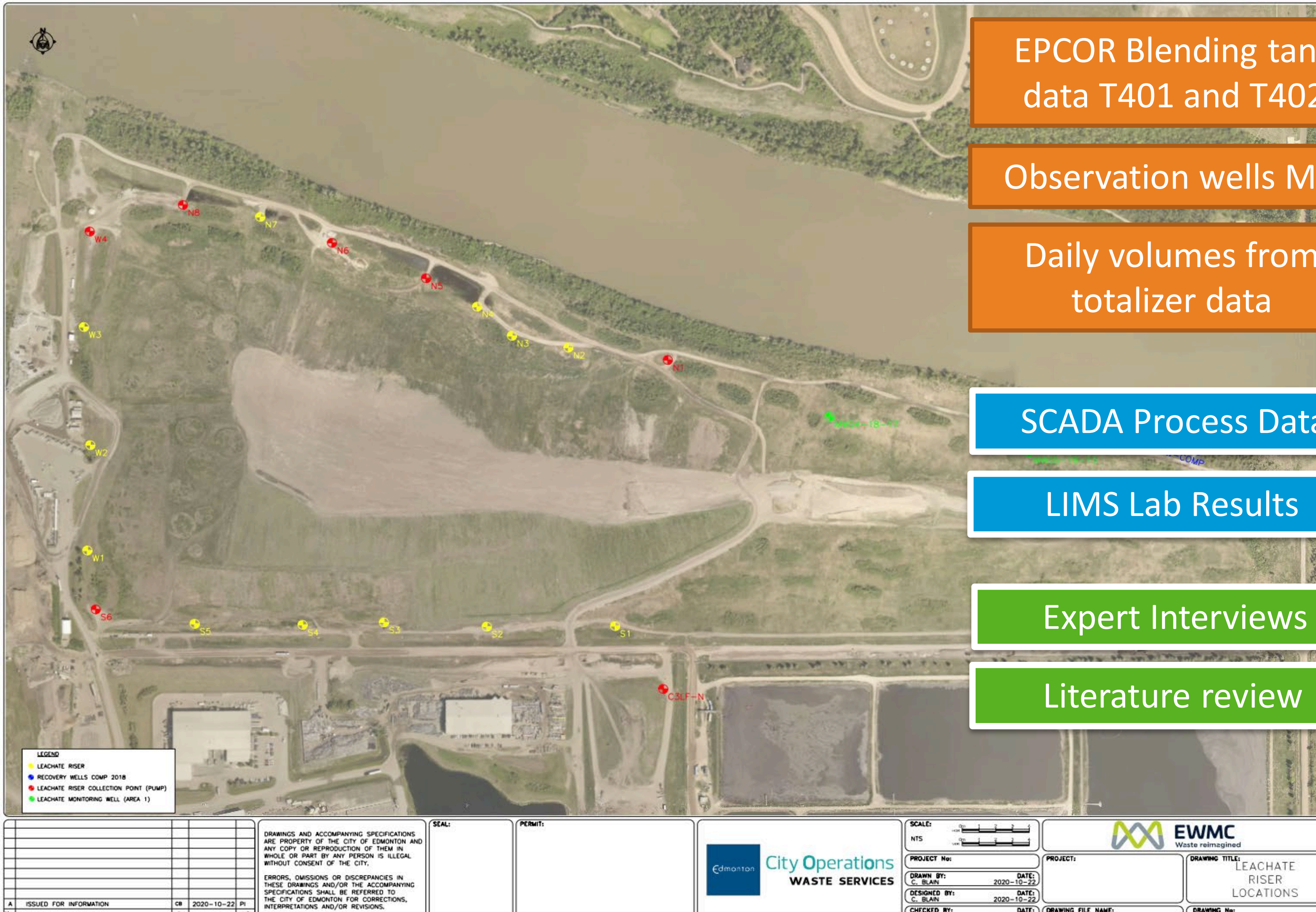
Leachate Characterization

Impacts on Process

Volumes Leachate Contribution

Leachate Characterization

Data sources - Leachate



EPCOR Blending tank data T401 and T402

Observation wells MH

Daily volumes from totalizer data

SCADA Process Data

LIMS Lab Results

Expert Interviews

Literature review

Timelines

Understanding leachate volumes, properties and impacts on process

Leachate co-treatment started May 21, 2019

Leachate co-treatment ended December, 2020

Initial assessment completed Feb 2021

Second assessment September 2021

Paper Published Nov 2021

Identifying volumes at which we see positive or negative impacts

INTERMEDIATE LEACHATE

Landfill age 1 - 5 years
pH 6.5 - 7.5
BOD/COD 0.1 - 0.3
COD 3 - 15 g/L
TOC/COD 0.3 - 0.5
5 - 30% VFA + humic and fulvic acids
SUVA Index 10 - 30 L/cm. g C

Aerobic, acidic phase | **Anaerobic, methanogenic phase**

YOUNG LEACHATE

Landfill age < 1 year
pH < 6.5
BOD/COD > 0.3
COD > 20 g/L
TOC/COD < 0.3
NH3-N < 400 mg/L
Kjeldahl-N 0.1 - 2 g/L
80% VFA concentrations
SUVA Index < 10 L/cm. g C

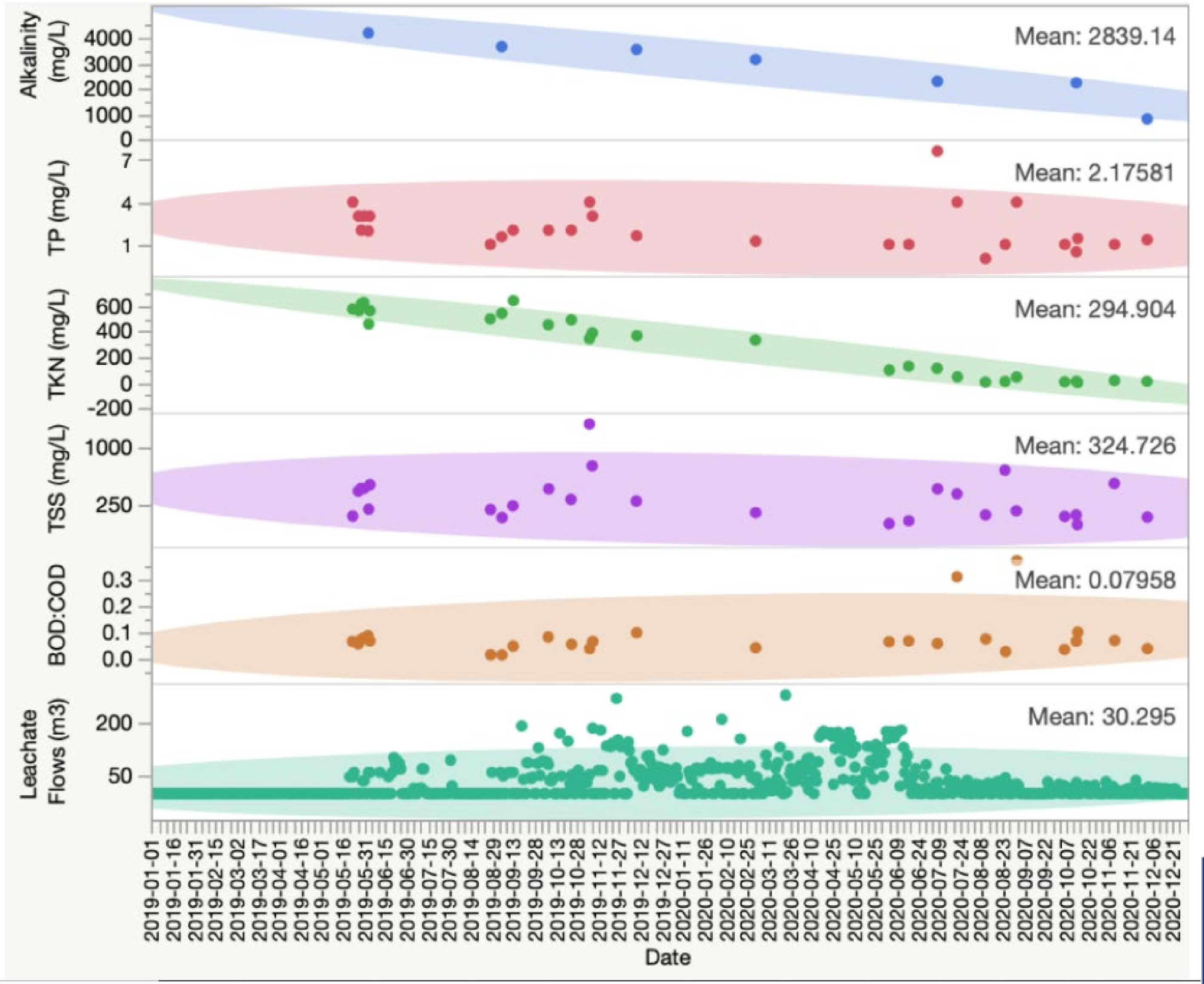
✓ Biological Treatment

STABILIZED LEACHATE

Landfill age > 5 year
pH > 7.5
BOD/COD < 0.1
COD < 2 g/L
TOC/COD > 0.5
NH3-N 3–5 g/L
Hydrophobic humic and fulvic acids
SUVA Index > 30L/cm. g C
Recalcitrants remain

✓ Physico-chemical Treatment

Leachate properties over time



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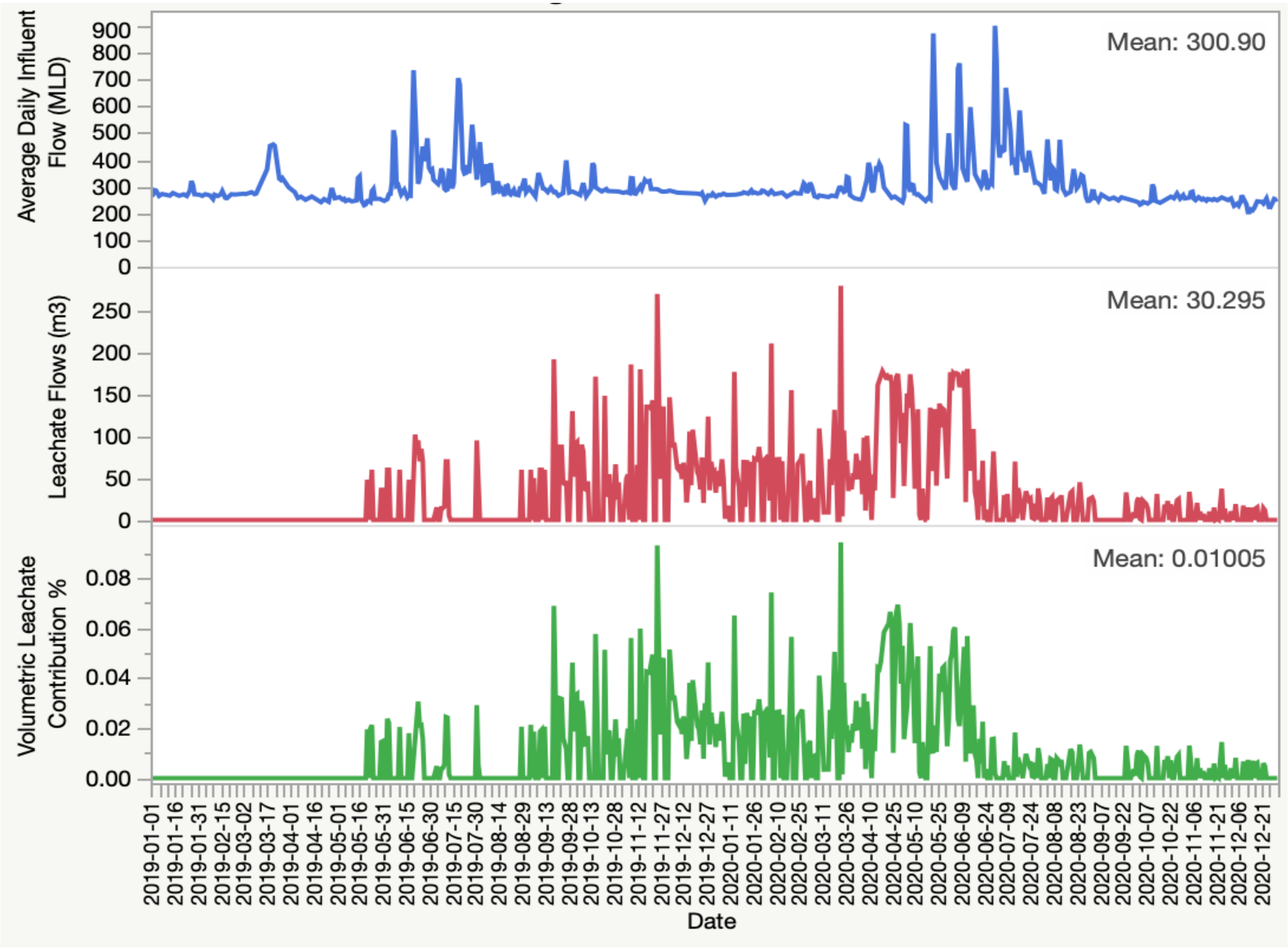
Volumetric leachate ratios (VLR%)



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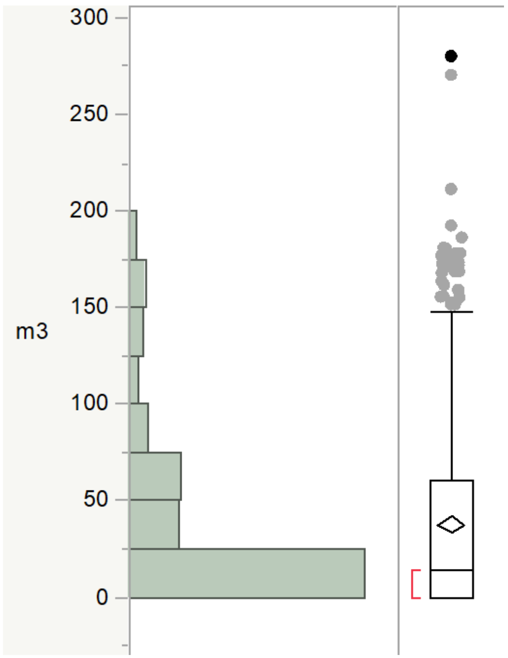
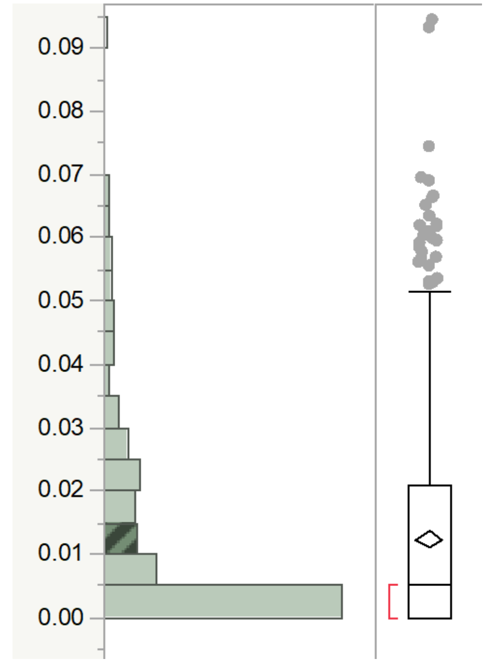
Volumes and volumetric contributions





100%	**Max**	**270 m^3**
75.0%	Quartile	60 m^3
50.0%	**Median**	**14 m^3**
25.0%	Quartile	0

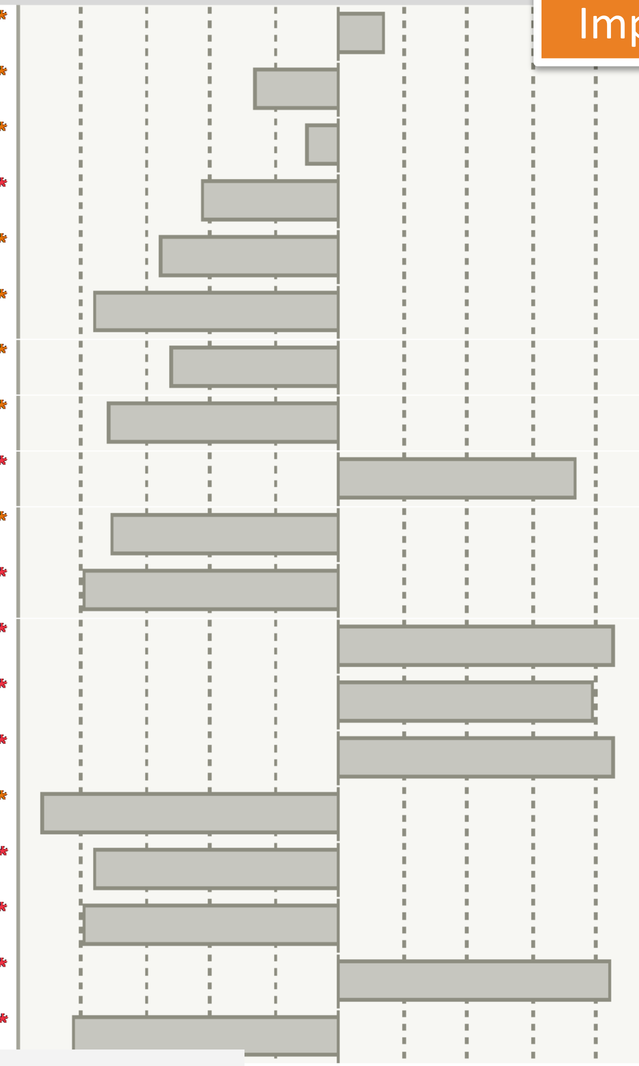
100%	**Max**	**0.09 %**
75.0%	Quartile	0.02 %
50.0%	**Median**	**0.01 %**
25.0%	Quartile	0

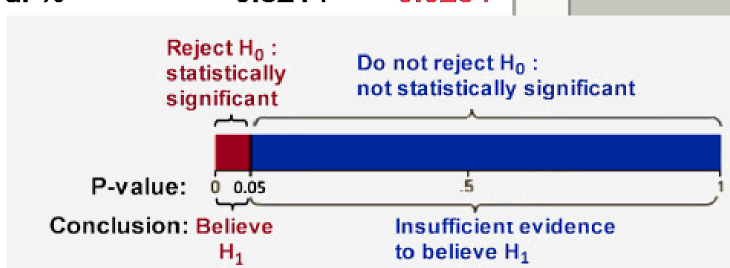
Leachate impact on process?

Reference	Volumetric ratio	Impacts observed when exceeded
Brennan et al., 2016	2%	Nitrification impacted when young leachate added; shock loads detrimental
Brennan et al., 2017b	4% for intermediate	Hydraulic loading-based NH_3-N acceptance limit not suitable for young leachate. Instantaneous loading should be avoided.
EPA Ireland, 2014	4%	Nitrification inhibition
Dereli et al, 2020	Plant-dependent	Shock loading should be avoided
Song et al., 2020	2%	TP removal reduced due to denitrifiers outcompeting PAOs
Bolyard et al., 2019	**0.1%**	UVT% drops below 65%
Masoner et al. 2020	1%	No difference in CEC concentrations when co-treating
Bolyard & Reihart, 2017	1%	Meets a TN limit of 3 mg/L only when bDON removal equals TN (no recalcitrant ON); at 0.01% UVT% and TN still impacted
Yuan et al., 2016	2.5%	Denitrifiers outcompete PAOs – replicating Winnipeg plant
Ye et al., 2014	**0.03%**	Impacts observed on TN removal (75 m^3/d at 88 MLD)
Ranjan et al., 2016	20%	Biomass decay minimized at 6d HRT and 30d SRT
Danley-Thomson et al., 2020	5-10%	15-20% resulted in nitrite build up, but improved TP removal; shock loads detrimental
Booth et al., 1996	**0.2%**	2% BOD loading of Waterloo WWTP (carbon removal plant)
Zhao et al., 2013	3-5%	UVT < 60%
Ferraz et al., 2016	2%	No effects, BOD:COD = 0.5
Ferraz et al., 2014	2%	Non-biodegradable organic matter contributed to FE

Process Impacts

Variable	by Variable	Spearman ρ	Prob>|ρ|
VRL %	BOD FE	0.1388	0.0002*
VRL %	N2O FE	-0.2549	<.0001*
VRL %	BOD Removal %	-0.1019	0.0058*
VRL %	COD Removal %	-0.4170	0.0426*
Leachate COD	UVT %	-0.5469	0.0032*
Leachate COD	NH3-N Removal %	-0.7569	<.0001*
Leachate COD	BOD Removal %	-0.5160	0.0059*
Leachate COD	TKN Removal %	-0.7121	<.0001*
Leachate N-TKN	BOD:COD FE	0.7381	0.0366*
Leachate N-TKN	UVT %	-0.6980	<.0001*
Leachate NH3	NH3 Removal %	-0.7857	0.0362*
Leachate Sulfate	NH3 Removal %	0.8571	0.0137*
Leachate Calcium	UVT %	0.7857	0.0362*
Leachate Iron	UVT %	0.8571	0.0137*
Leachate Lead	cBOD Removal %	-0.9190	0.0034*
Leachate Lead	TKN Removal %	-0.7568	0.0489*
Leachate Lead	TP Removal %	-0.7928	0.0334*
Leachate Phenols	VRL %	0.8469	0.0162*
Leachate F2	NH3-N Removal %	-0.8214	0.0234*





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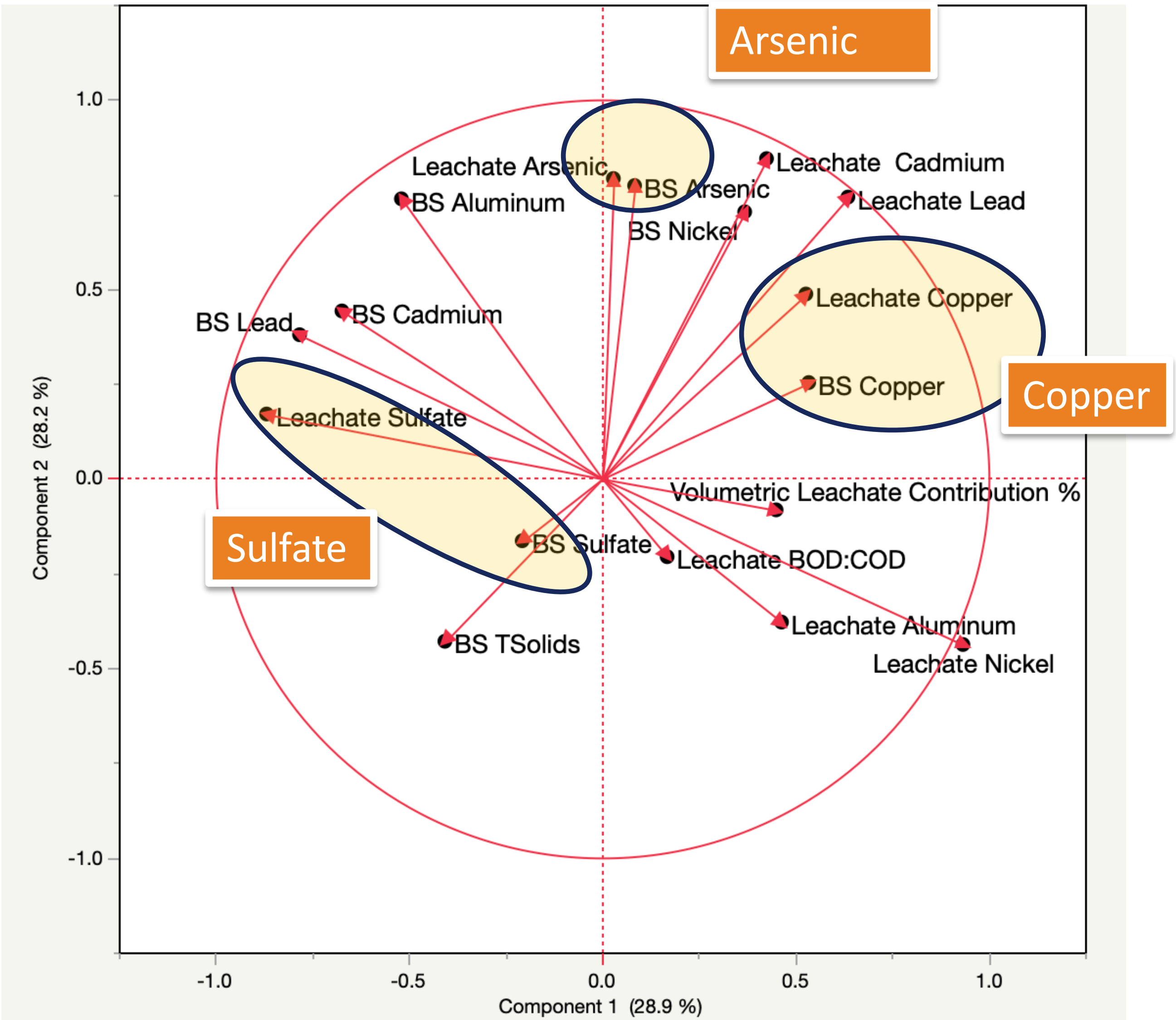
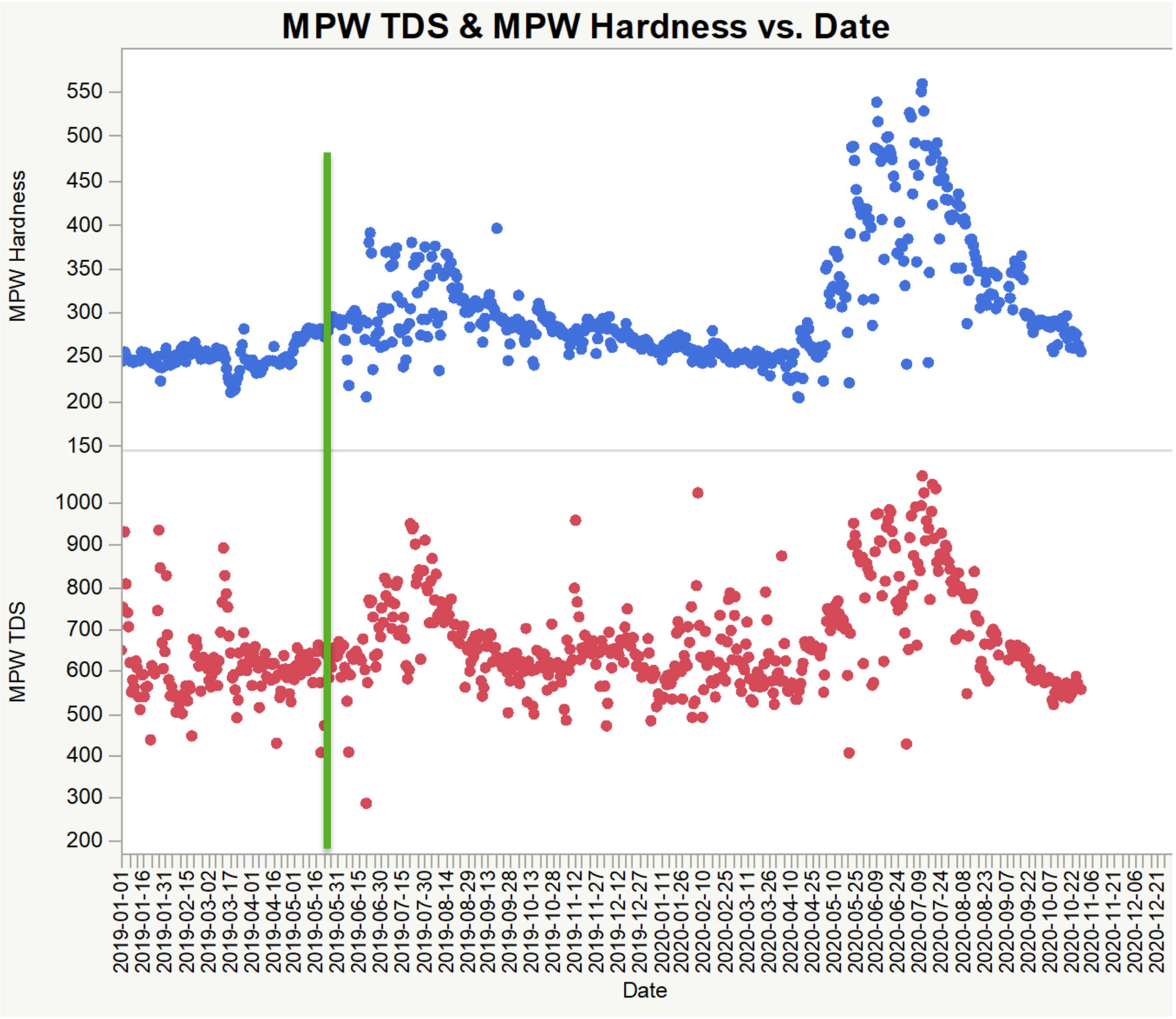
Impacts on Biosolids

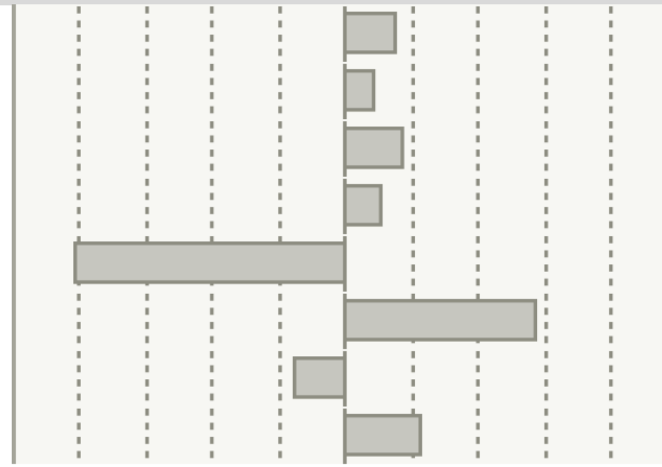


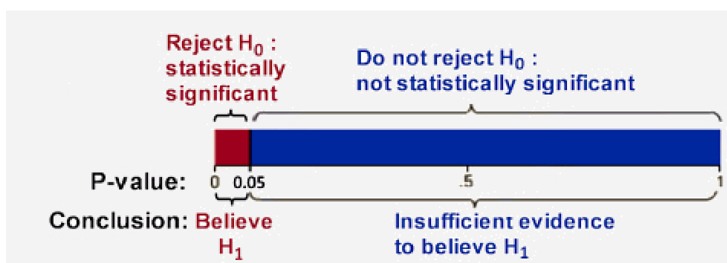
Impacts on Membrane Filtration



Impacts on Membrane Filtration

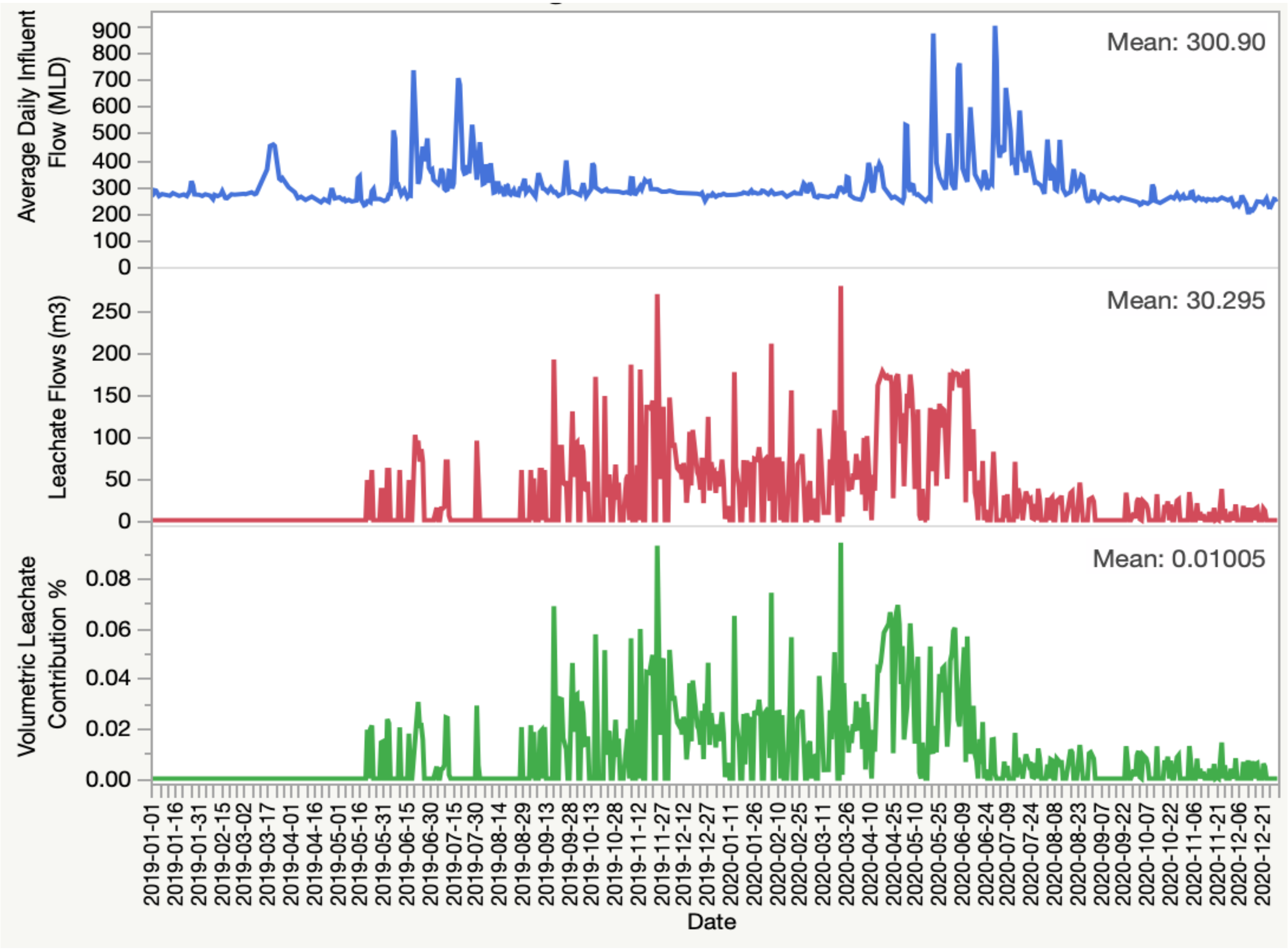
Variable	by Variable	Spearman ρ	Prob>|ρ|
MPW TDS	TSS FE	0.1520	<.0001*
MPW TDS	VR Leachate %	0.0915	0.0186*
MPW Hardness	TSS FE	0.1771	<.0001*
MPW Hardness	VR Leachate %	0.1073	0.0057*
MPW Hardness	Leachate pH	-0.8117	0.0499*
MPW Hardness	MPW TDS	0.5770	<.0001*
MPW Cl-	TSS FE	-0.1471	0.0001*
MPW Cl-	VR Leachate %	0.2225	<.0001*





At what volumes was leachate detrimental to process?

Volumetric leachate ratios (VLR%)

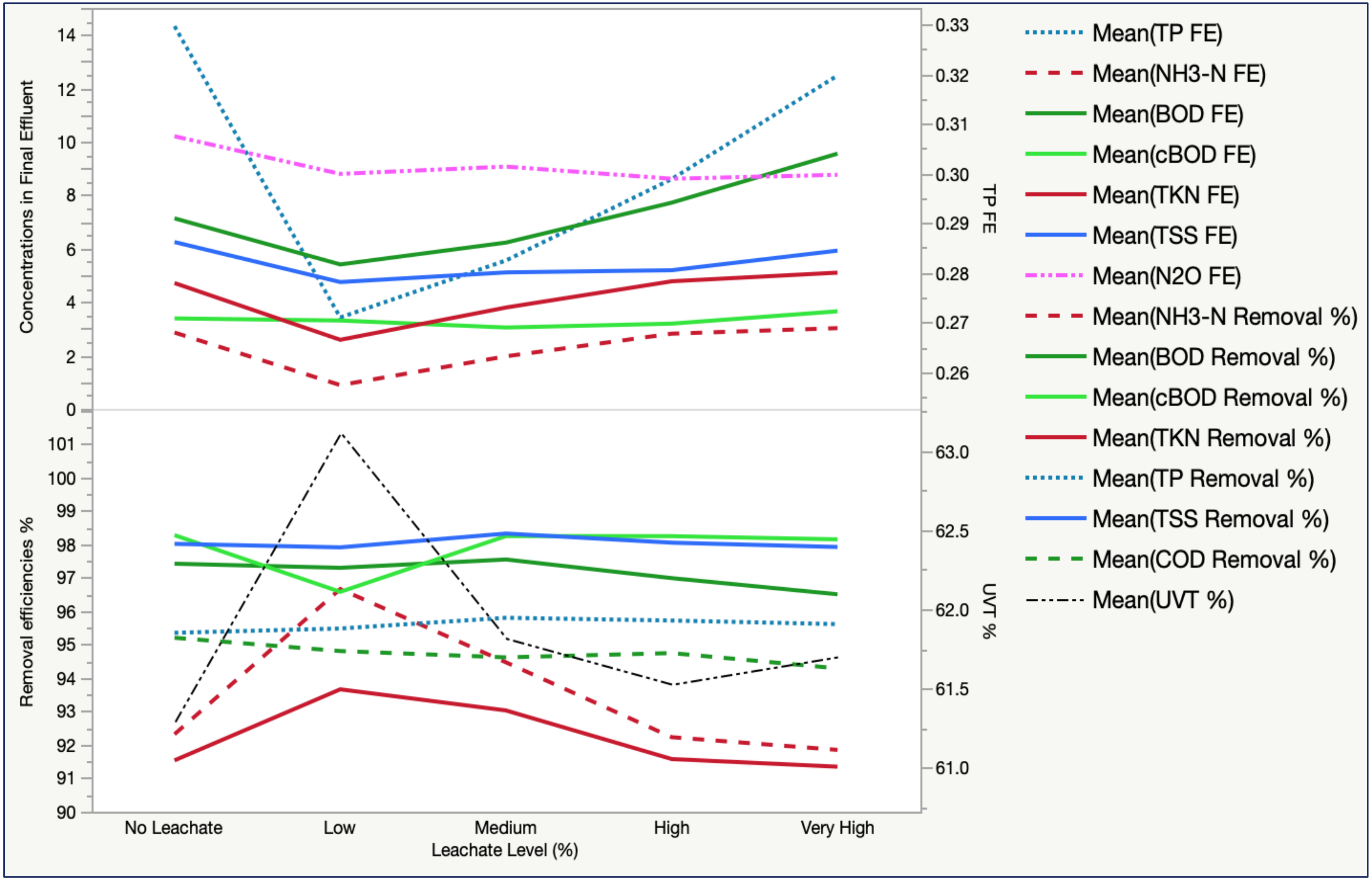


Identifying Volumetric Leachate Ratio Clusters

K-Mean Clusters

Clusters defined	N	Average Leachate Flows (m3/day)	Leachate level code	VLR% Range
*	398	0.0	No leachate	No leachate flow
1	10	4.0	Low	0 < VLR % ≤ 0.001
3	170	64.2	Medium	0.001 < VLR % ≤ 0.02
4	122	151.9	High	0.02 < VLR % ≤ 0.05
2	31	253.5	Very high	0.05 < VLR % ≤ 0.2

The Leachate Goldilocks Effect



Conclusions

- Removals are optimized at low to medium leachate addition levels, which corresponds with a VLR% of 0.001 – 0.02% (corresponding with 4 – 64 m^3/day).

- Parameters like TP, BOD and UVT% in final effluent deteriorated significantly at leachate volumes higher than 152 m^3/day.

Questions?

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