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Determining the Fatty Acid Composition in Wastewater Treatment Plant Using Gas Chromatography Mass Spectrum (GC-MS) and Fluorescence Spectroscopy Excitation Emission (EEM)

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COLLEGE OF ENGINEERING

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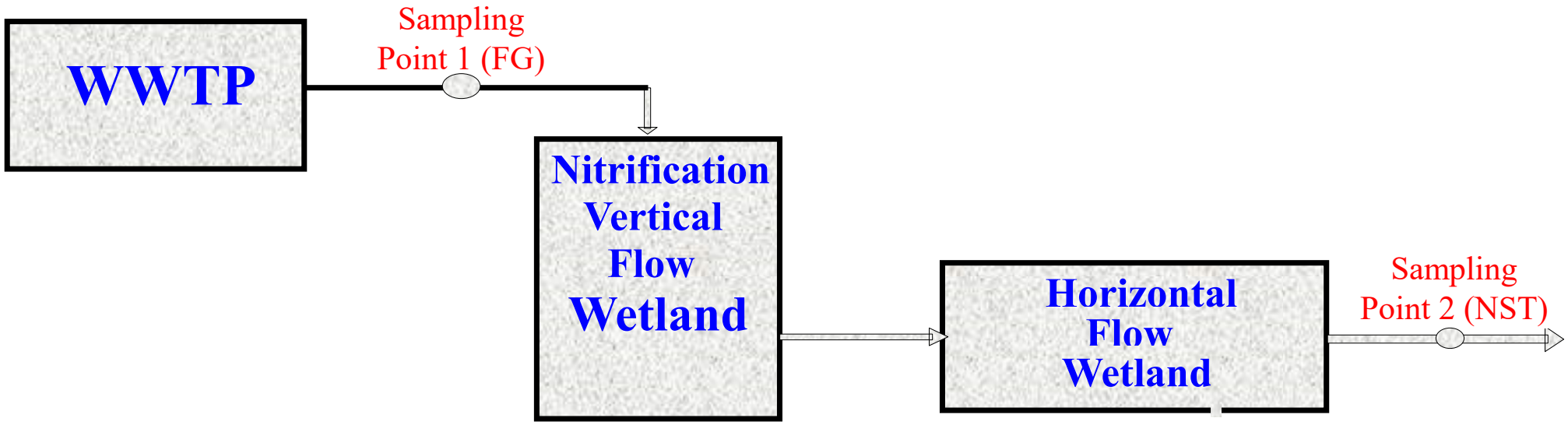
Former sewage lagoons are converted into a valuable resource that provides wildlife habitat and recreational opportunities as it cools and cleans water that is discharged into the Tualatin River.

The objective of this work was to characterize and compare the WWTP (sample point 1) and the horizontal flow wetland (sample point 2) effluents. We used conventional wastewater analyses, TSS, BOD, mass and fluorescent spectrometry, and sequence analyses to characterize the wastewater samples.



Schematic of the Forest Grove Wastewater Treatment facility includes a conventional wastewater treatment plant that is capable of operating to remove phosphorous, a vertical wetland designed to transform ammonia to nitrate, and an engineered wetland for cooling.

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We propose to use a variety of techniques
to characterize dissolved and particulate effluent organic matter from the two sampling points to ascertain if the BOD and TSS in the effluent of the WWTP (sample point 1) remains in the water through the two wetlands to exit the system at sample point 2.

A variety of types of organic matter flow into and are treated by the WWTP. However, some organic matter remains in the WWTP effluent.

Remaining organic matter, e.g. fatty acids (FAs) are play critical roles in biological systems and can lead to buildups which can cause blockages and ineffective wastewater treatment.

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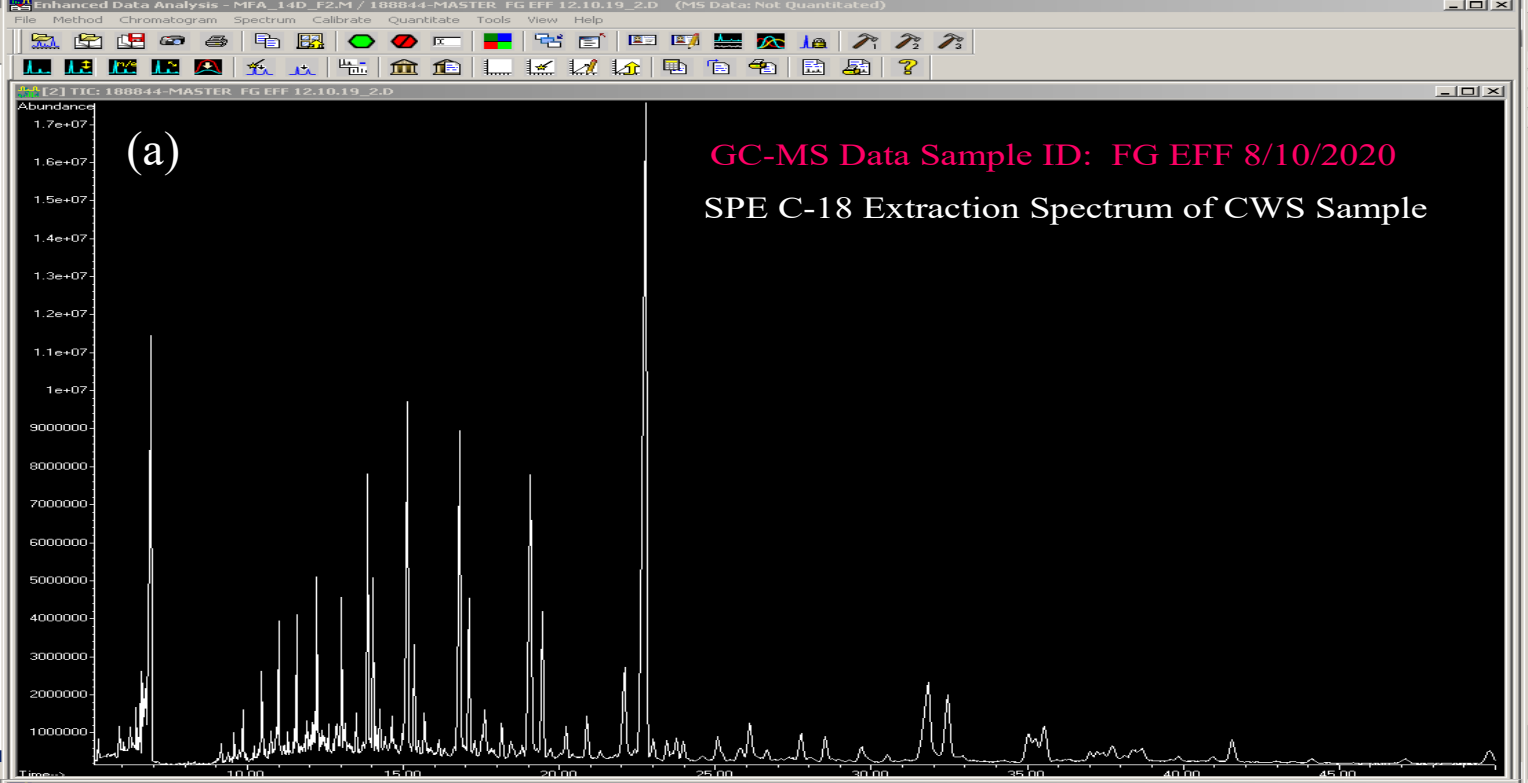
GC-MS, solid phase extraction, and
acid derivatization method were used for the fatty acids analysis of FG and NST effluents from the waste water treatment plant.

GC-MS analytical methods for the fatty acids included three steps:

- Extraction of the fatty acids from the sample matrix,
- Derivatization of the fatty acids,
- Injection onto GC–MS



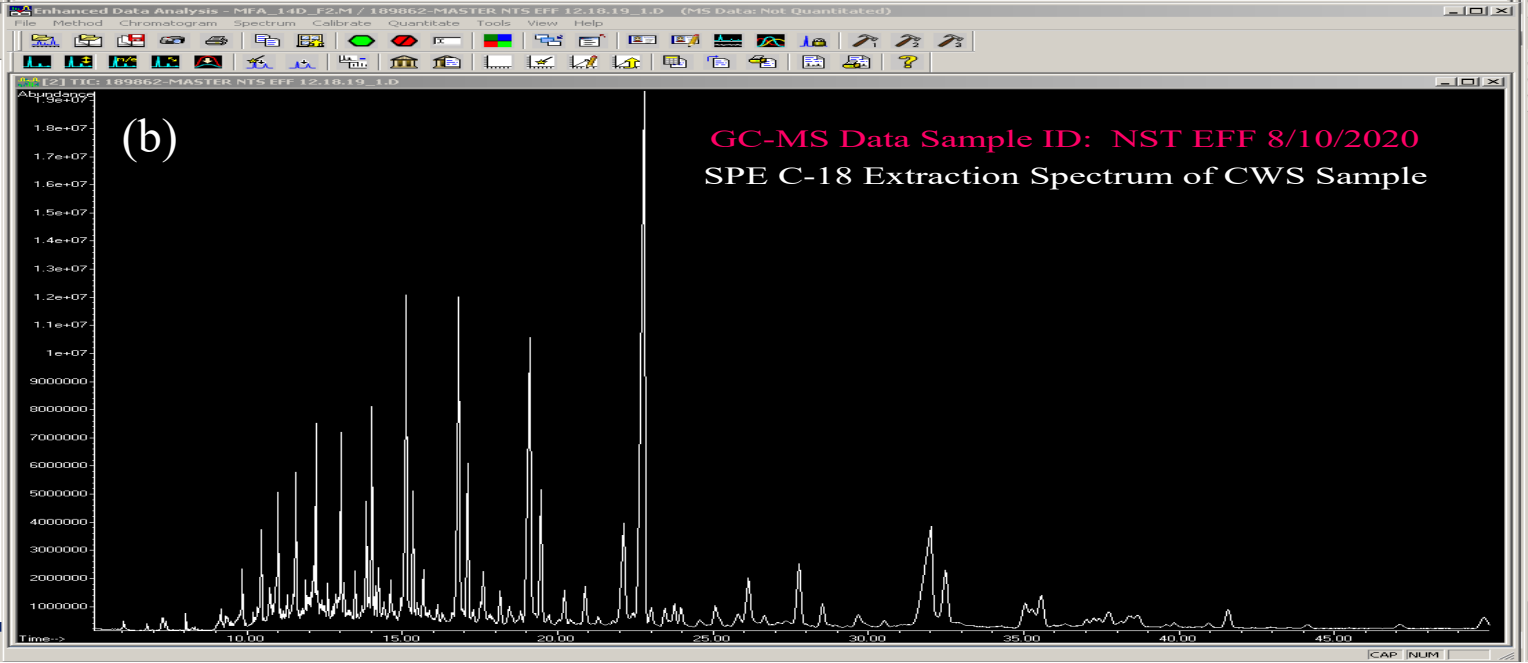


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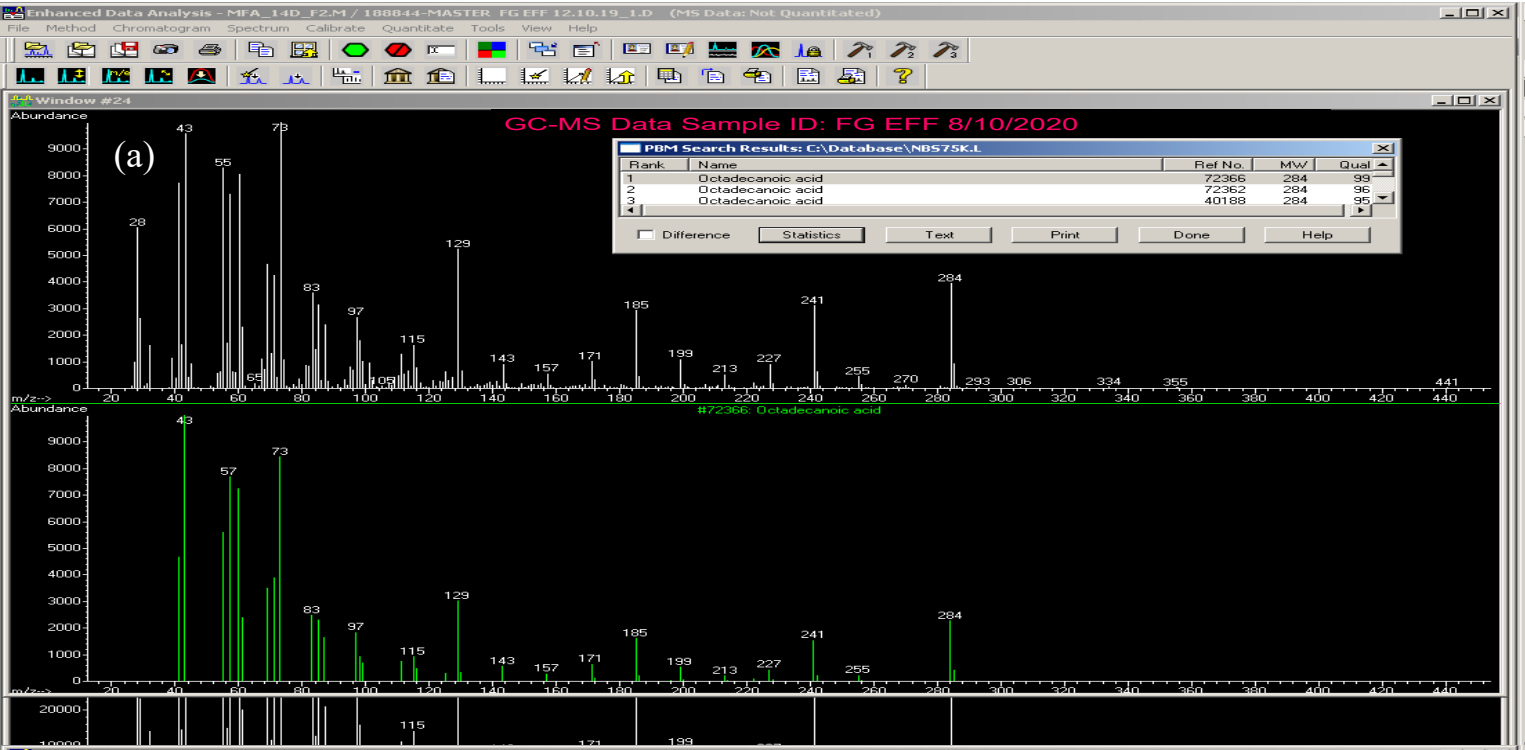
Figure 1: GC-MS spectrum of fatty acids after SPE and acid derivatization (a) FG Effluent and (b) NST Effluent samples.



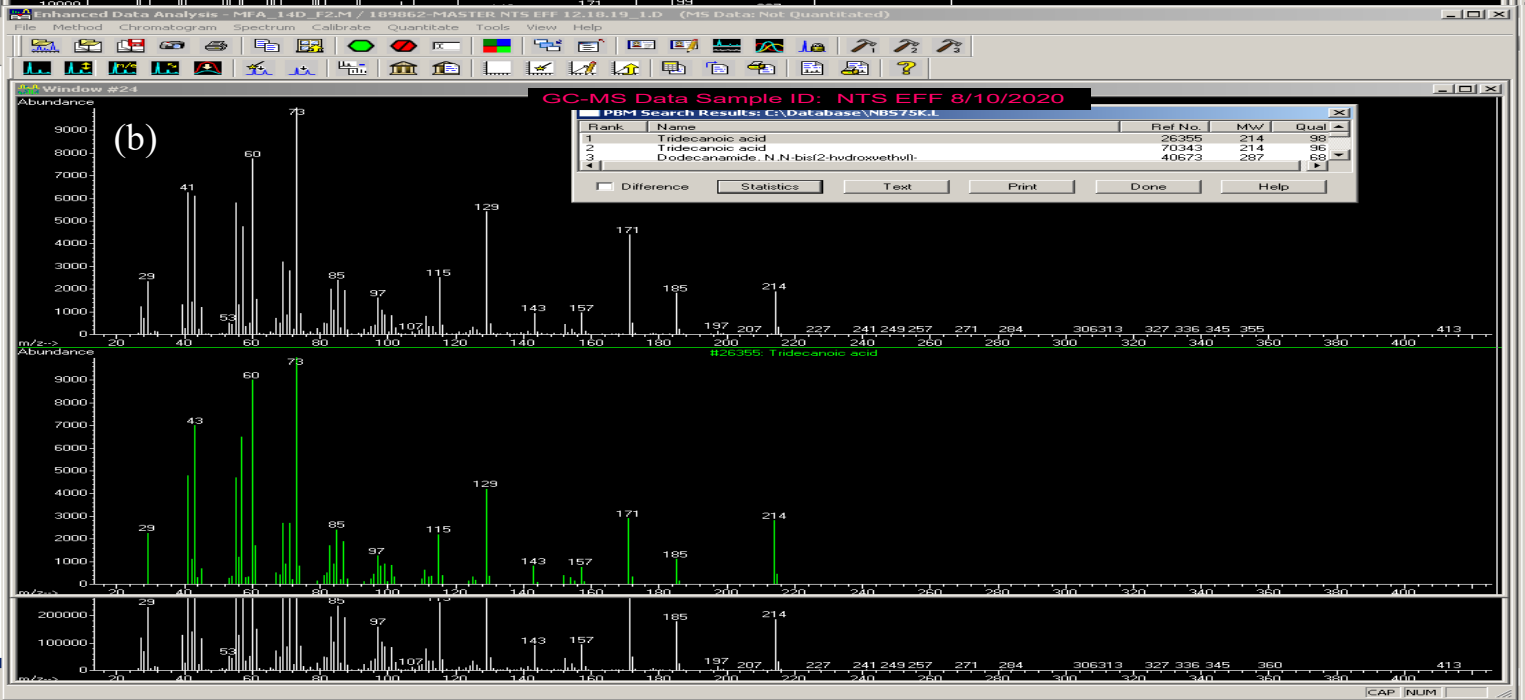


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Figure 2: Example of identification of (a) Octadecanoic acid in FG Effluent and (b) Tridecanoic acid in NST Effluent with 99% and 98% quality match, respectively.

Structural formula of fatty acids that were identified using GC-MS analysis of FG and NST Effluent samples.

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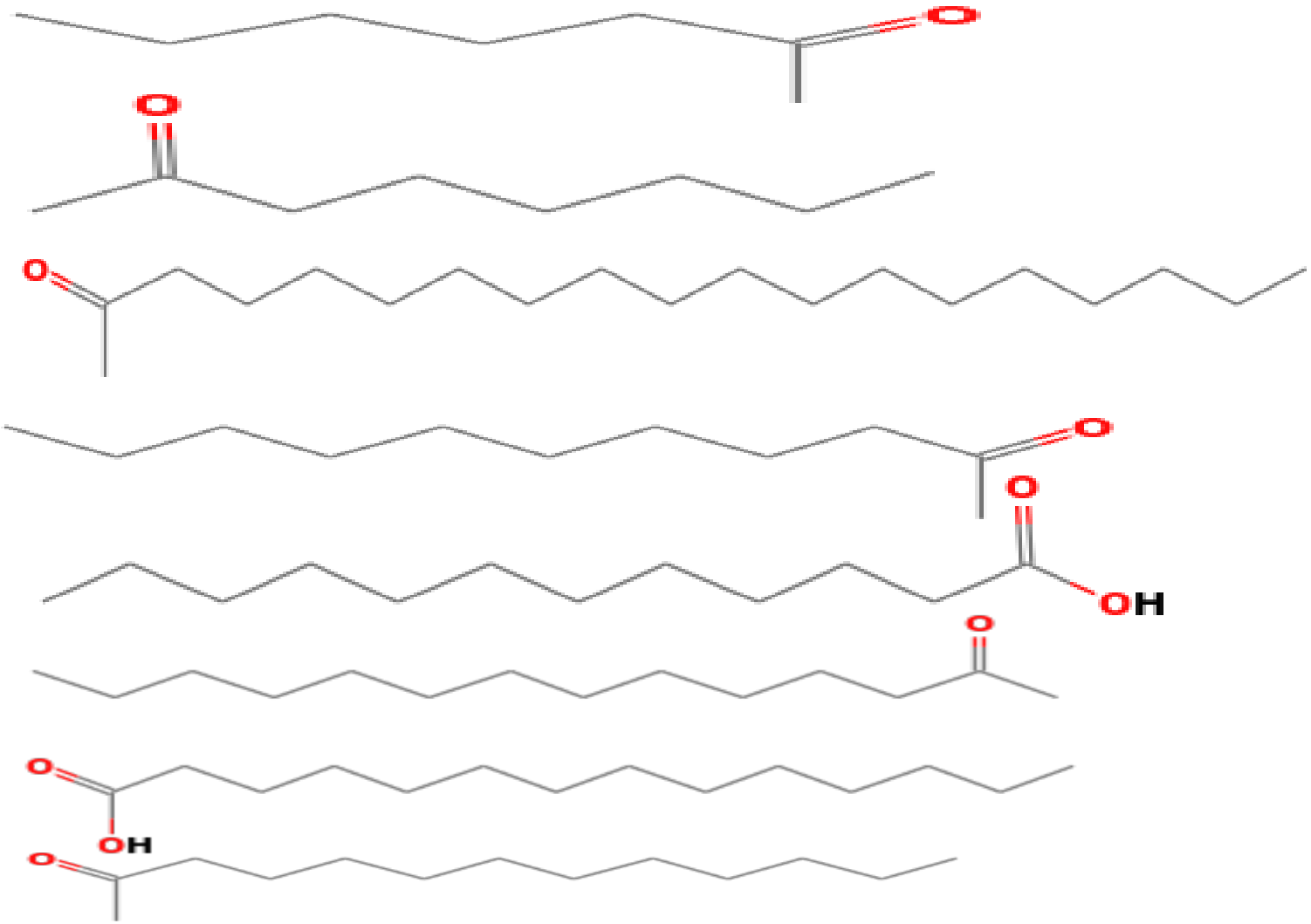
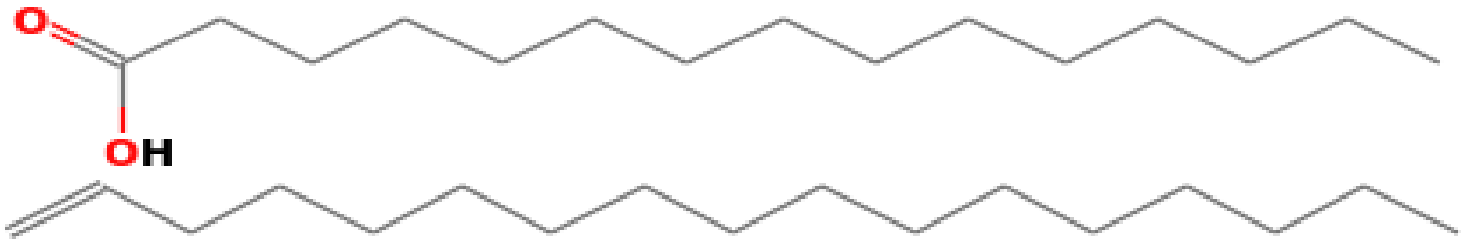
1. 2-Heptanone
2. 2-Octanone
3. 2-Nonadecanone
4. 2-Undecanone
5. 2-Tetradecanone
6. n-Tetradecanoic Acid
7. Dodecanoic Acid
8. 2-Tridecanone



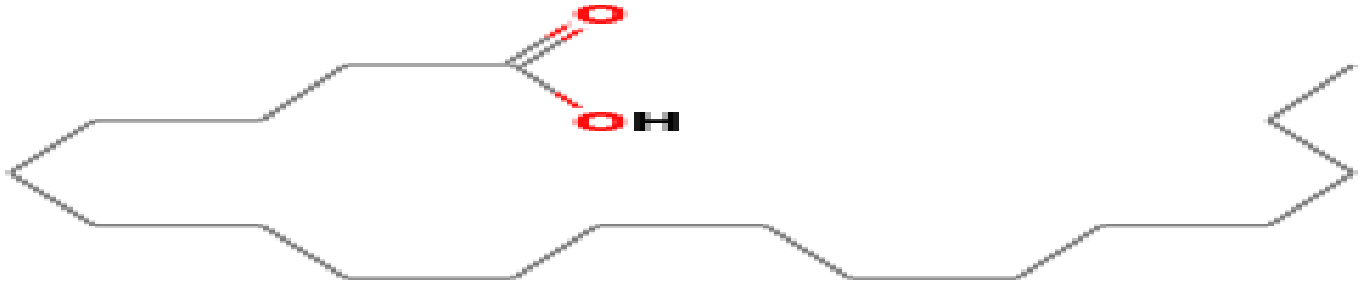
9. Pentadecanoic acid



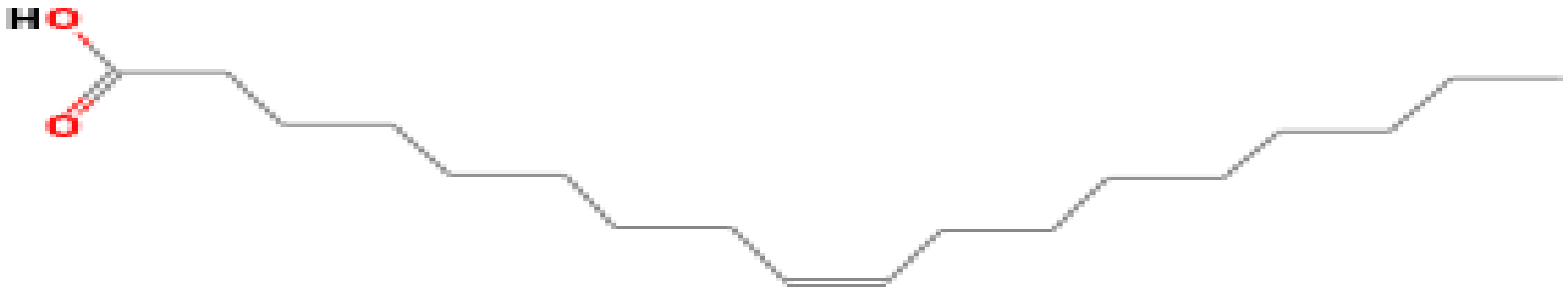
10. 1-Heptadecene

11. Octadecanal

12. Octadecanoic acid

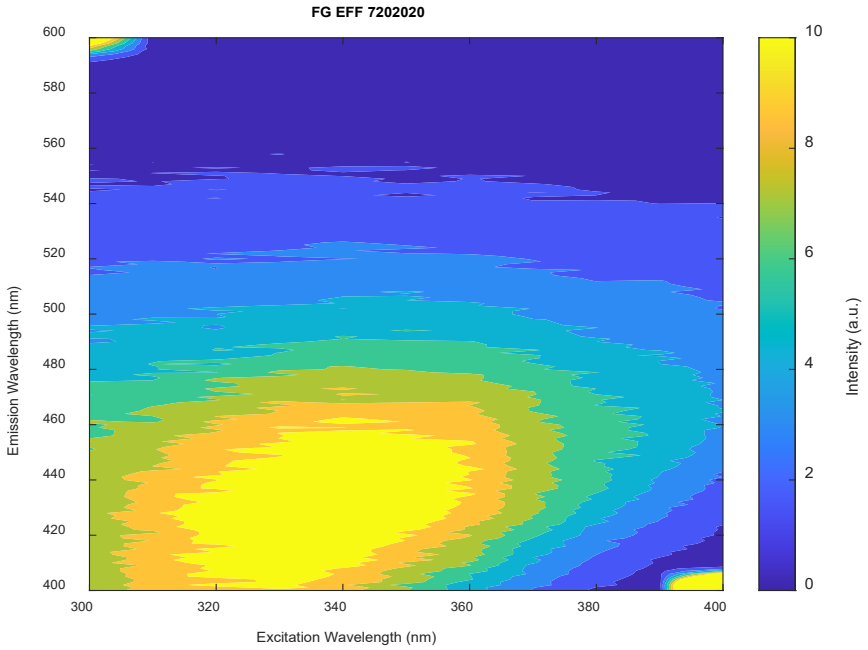


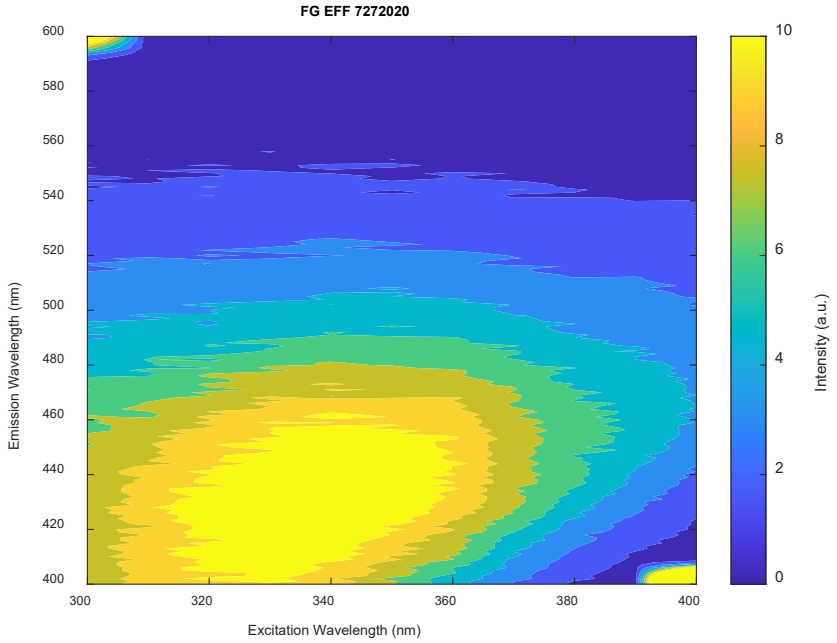
13. Oleic acid

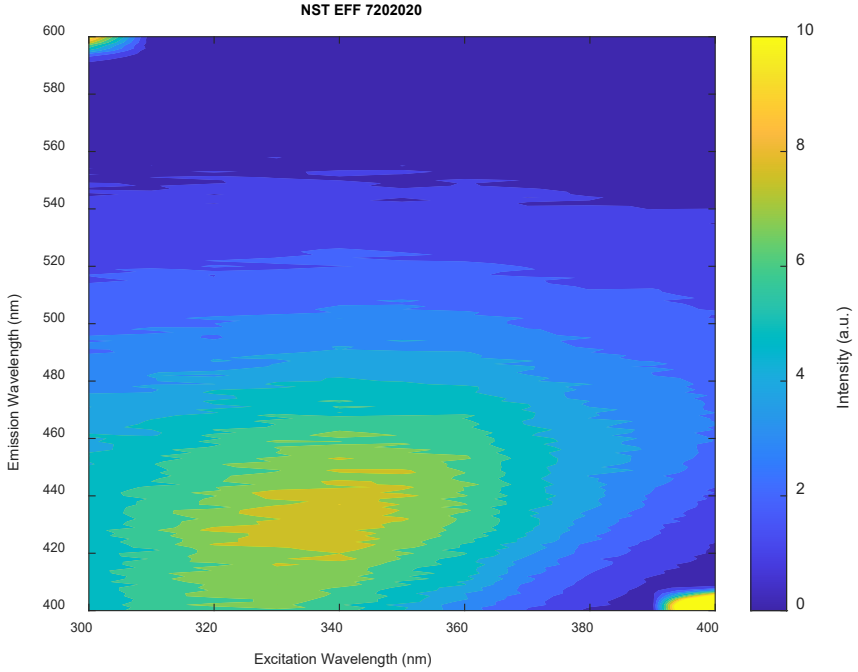


14. 2-Dodecanone

Chemicals	Formula	MW	FG Effluent Conc. (ug/L)	NST Effluent Conc. (ug/L)	Removal %	COD Calculated	
						FG EFF (mg/L)	NST EFF (mg/L)
2-Heptanone	2-$C_7H_{14}O$	114	198.5	154.3	22.3	0.557	0.433
2-Octanone	2-$C_8H_{16}O$	128	209.4	145.6	30.4	1.204	0.838
2-Undecanone	2-$C_{11}H_{22}O$	170	200.6	153.4	23.5	0.661	0.505
2-Tridecanone	$C_{13}H_{26}O$	198	110.8	107.6	2.9	0.341	0.331
Dodecanoic Acid	$C_{12}H_{24}O_2$	200	106.3	100.6	5.3	0.298	0.282
2-Dodecanone	$C_{12}H_{24}O$	184	259.5	193.5	25.4	0.767	0.572
2-Tetradecanone	$C_{14}H_{28}O$	212	245.8	208.5	15.1	0.761	0.645
Tetradecanoic Acid	$C_{14}H_{28}O_2$	228	155.8	134.7	13.5	0.437	0.378
Pentadecanoic Acid	$C_{15}H_{30}O_2$	242	256.1	186.4	27.4	0.728	0.530
1-Heptadecene	$C_{17}H_{34}$	238	245.1	167.4	31.7	0.840	0.574
Octadecanal	$C_{18}H_{36}O$	268	208.8	178.3	14.6	0.648	0.554
Octadecanoic Acid	$C_{18}H_{36}O_2$	284	114.4	104.6	8.54	0.623	0.532
Oleic Acid	$C_{18}H_{34}O_2$	282	237.9	195.4	17.8	0.329	0.301
2-Nonadecanone	2-$C_{19}H_{38}O$	282	207.9	148.7	26.3	0.661	0.473
					Total	**8.855**	**6.948**







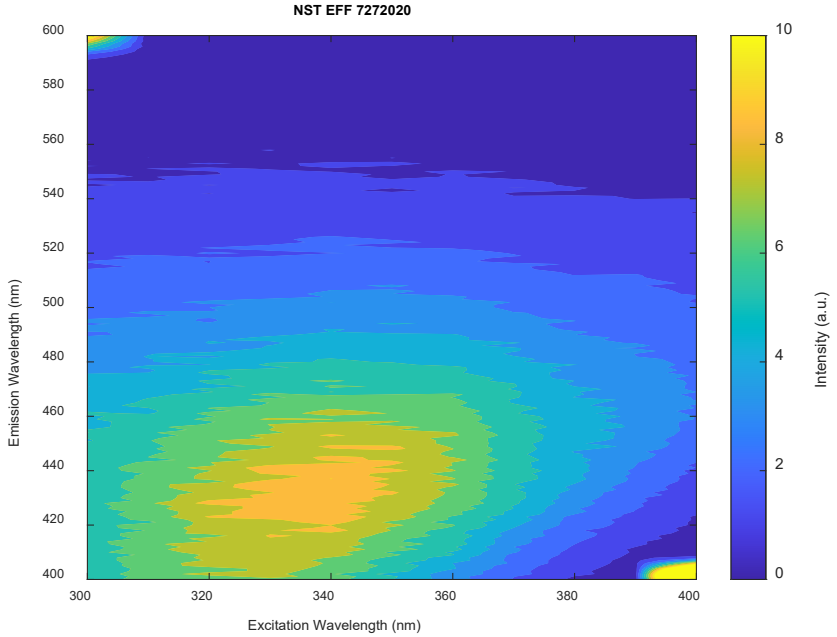


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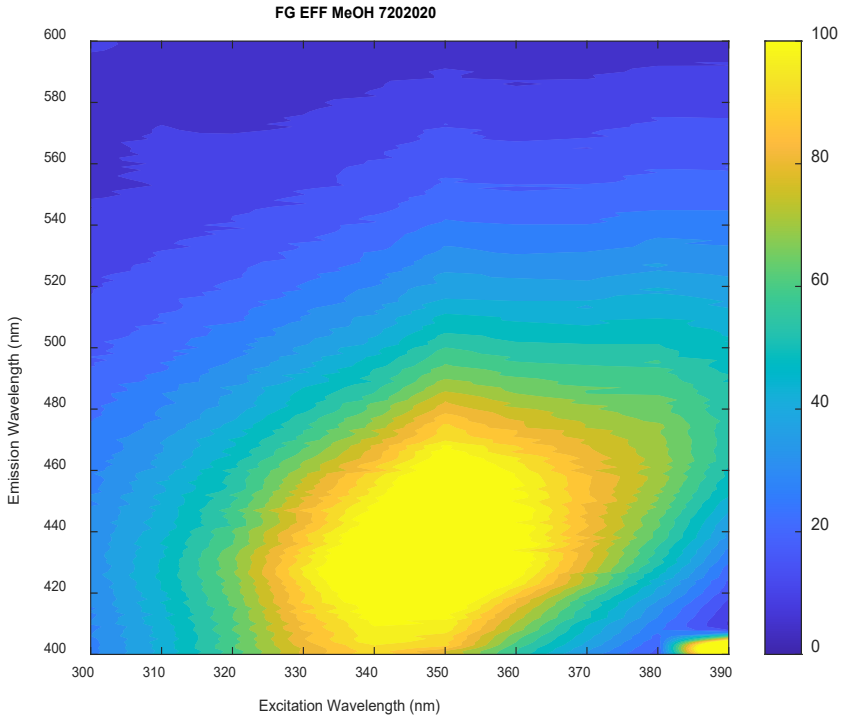
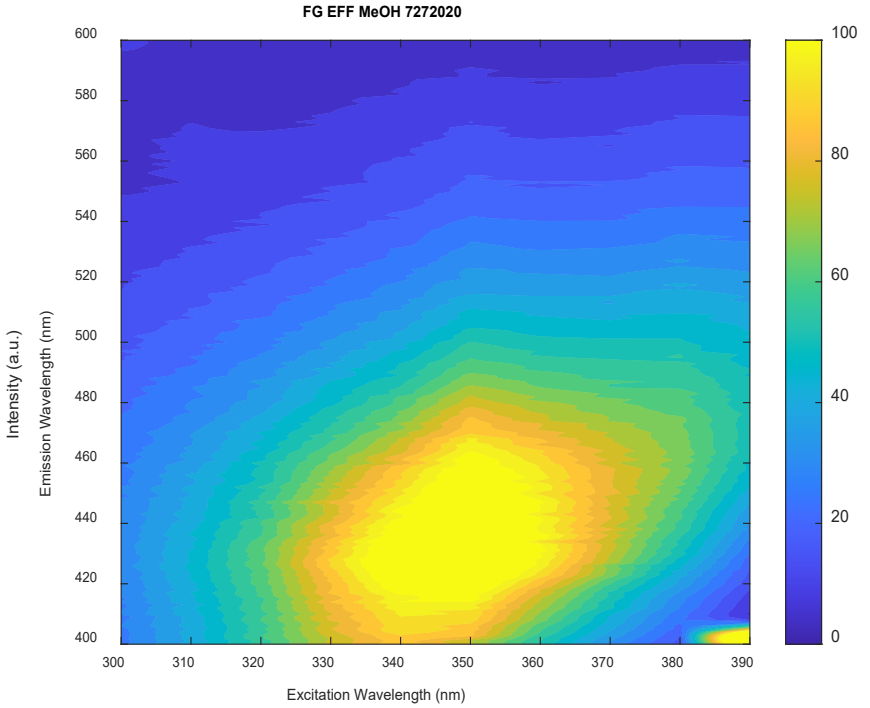
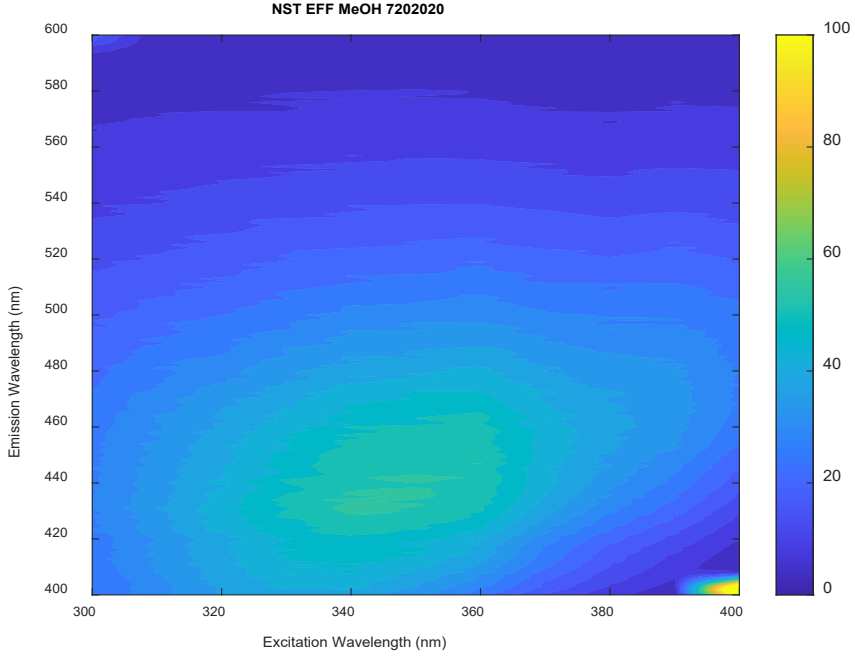
Figure 4: Excitation Emission matrix (EEM) fluorescence spectrum of FG and NST effluent samples. These Figures showing fluorescent organic compounds directly measured in bulk water samples.

note: these Figures are plotted at a minimal intensity range of 0 -10 a.u.







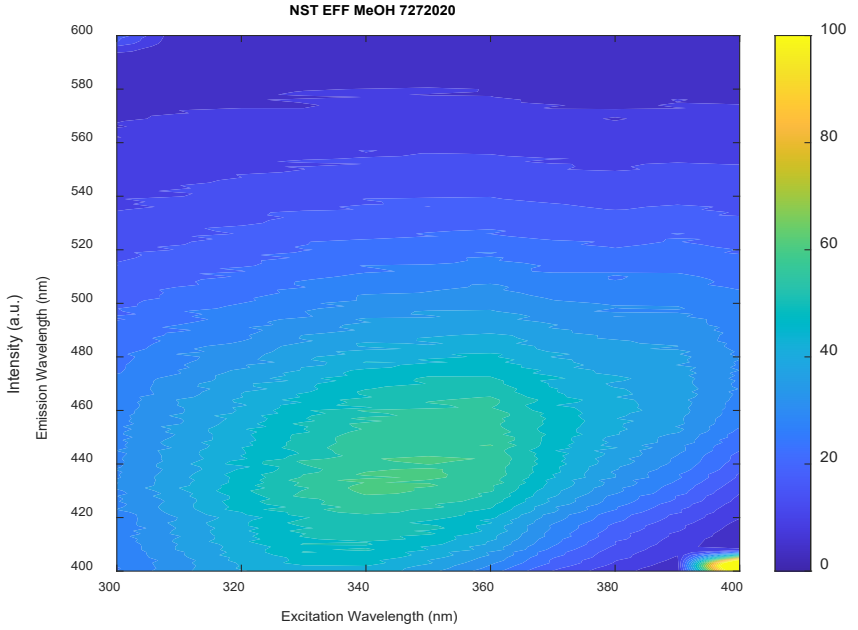


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Figure 5: Excitation Emission matrix (EEM) fluorescence spectrum of FG and NST effluent samples of SPE extraction with methanol. These Figures showing higher fluorescent intensity in SPE extracted with methanol compared to Figure 4 which EEM of the original samples.

note: These Figures are plotted at high intensity range of **0-100 a.u**.

Summary

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- Fourteen fatty acid compounds were detected in both FG and NST effluent samples with SPE extraction and GC-MS analysis.
- There was a reduction of about 10 - 30% in fatty acids concentrations in NST compared to FG effluent samples.
- Calculated COD of the fatty acids accounts only for 18% of the total COD concentrations which directly measured in the bulk water samples.
- Reduction in the intensity of the fluorescent excitation-emission in NST effluent samples compared to FG effluent samples, most likely is related to bioavailability of those fluorescent organic compounds during wastewater treatment.