EPA 625: Base, Neutral, Acid Semi-volatiles in Municipal and Industrial Waste Water by Solid Phase Extraction

Tom Hall, Fluid Management Systems, Watertown, MA

Overview

- Development of a fully automated extraction system for EPA 8270/625
- Establishment of an extraction procedure capable of implementation of various aqueous matrices
- Participation in ILI SPE Demonstration project for method suitability
- Implementation of platform across other EPA methodologies

Matrices

- DI and Tap
- ASTM 5909 synthetic Waste Water
- TCLP Fluid
- Pond, River and Reservoir surface water
- Real world industrial effluents and influents
- Groundwater

SPE Waste Water Study Participation

- Participated in both Phase I and II
- Submitted data for all matrices in each respective study
- 3rd Party participation using FMS equipment

Comparison of LLE/CLE vs. Automated SPE Methods

LLE/CLE	Automated SPE
Open to laboratory background	Closed system
Uses >360mls solvent	Uses <60mls solvent
Shaking / Continuous process	Filtration process
Forms emulsions requiring centrifuging	No emulsions formed
Little Selectivity	Wide Selectivity (adsorbent)
Requires water removal	In-line water removal
	Fast and Unattended

Comparison of LLE/CLE vs. Automated SPE Methods

LLE/CLE	Automated SPE
No Separation of waste	Separates Aqueous and Organic Waste
More volume to evaporate	<60mls solvent to evaporate
Massive solvent emission	6 times less solvent emission
CLE uses a lot of power	Easily Capture Solvent
Requires lots of solvent for cleaning	Lower solvent costs
	Lower Disposal Costs

Reduced Solvent Usage

FMS TurboTrace® ABN

Real Time Graphical Display of Extraction Steps

Touch Screen Control

Automatic Liquid Level Sensor

SD Card for Storing and Transferring Methods

Six Elution and Wash Solvents

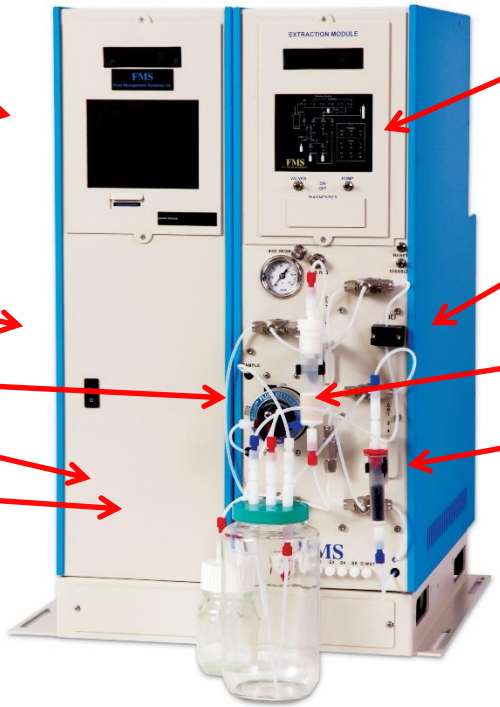
Positive Pressure Pump for precise, consistent delivery of Sample and Solvent

ABN Cartridge

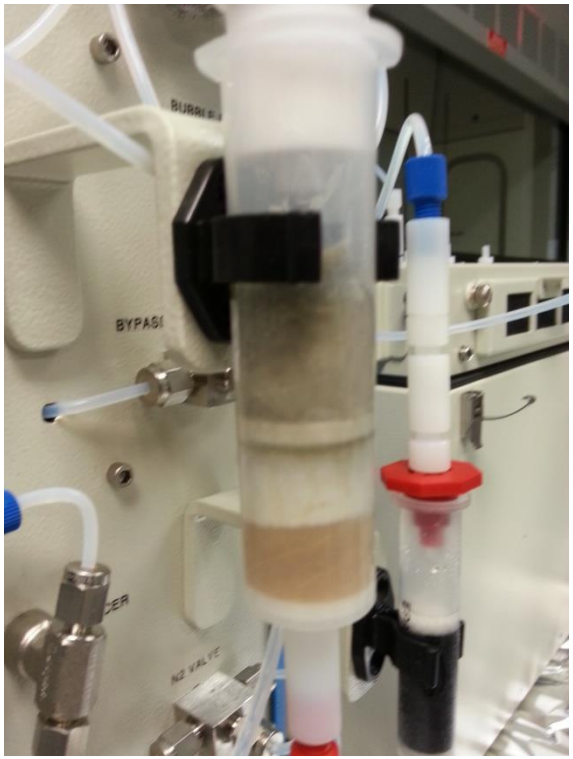
Carbon Cartridge

Sample Size 2 ml to unlimited

Automatic Bottle Rinse



Dual SPE Cartridge Extraction



Direct to Vial Concentration

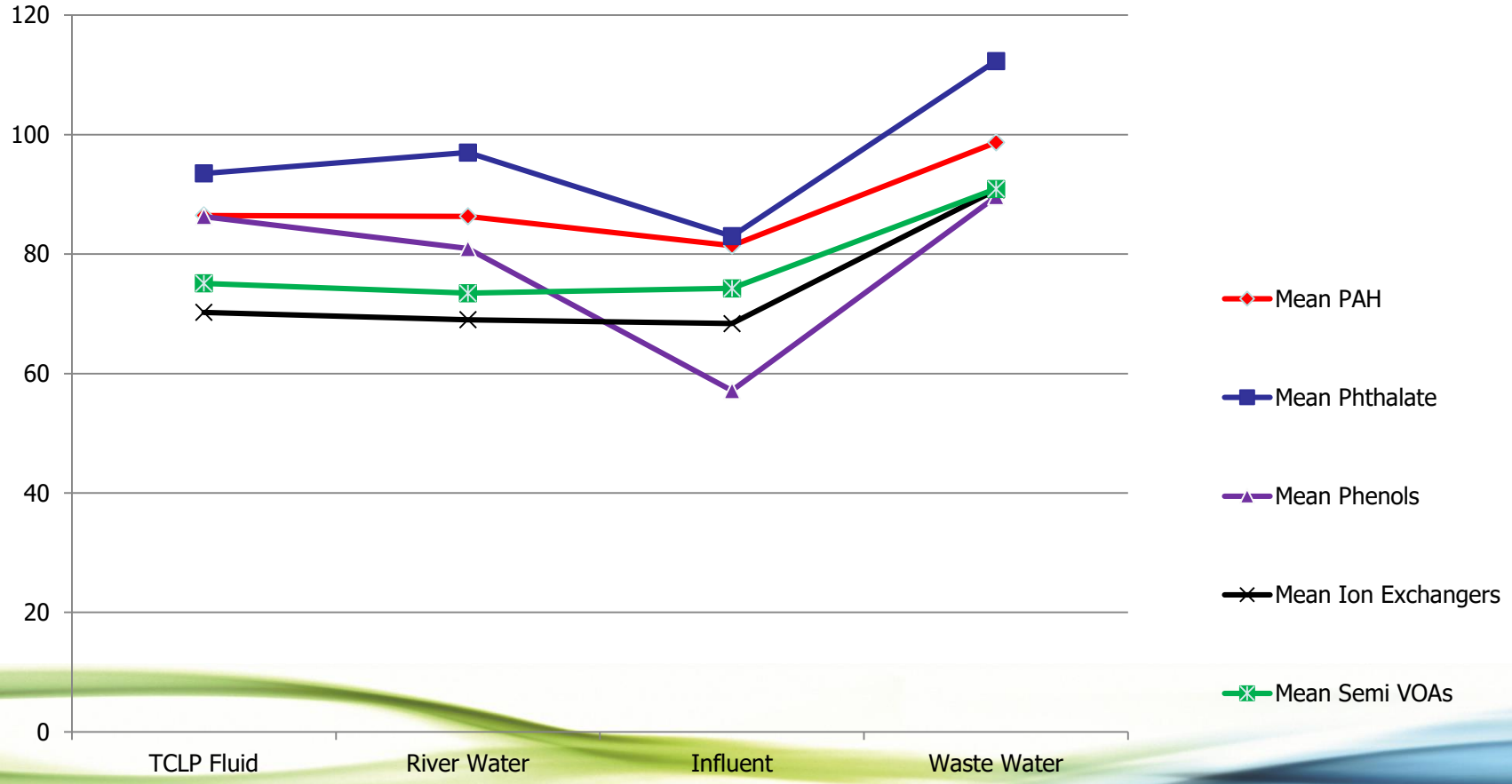
SuperVap Features

- 6 (250ml) and 12 (50ml) position models for extractions.
- Dry bath heating element
- Independent secondary heater for extract nipple (Can be disabled).
- Sensor controlled
- Savable temperature log capability.

EPA 625/8270 Procedure

- Fully automates all processes, not manual steps
- Capable of delivering up to to 3 independent fractions (or combine as 1)
- Can elute direct to FMS SuperVap evaporator
- Automated organic solvent rinse of sample bottle
- Can elute either cartridge independently or in parallel
- Modular and Expandable
- Direct to GC Vial extracts

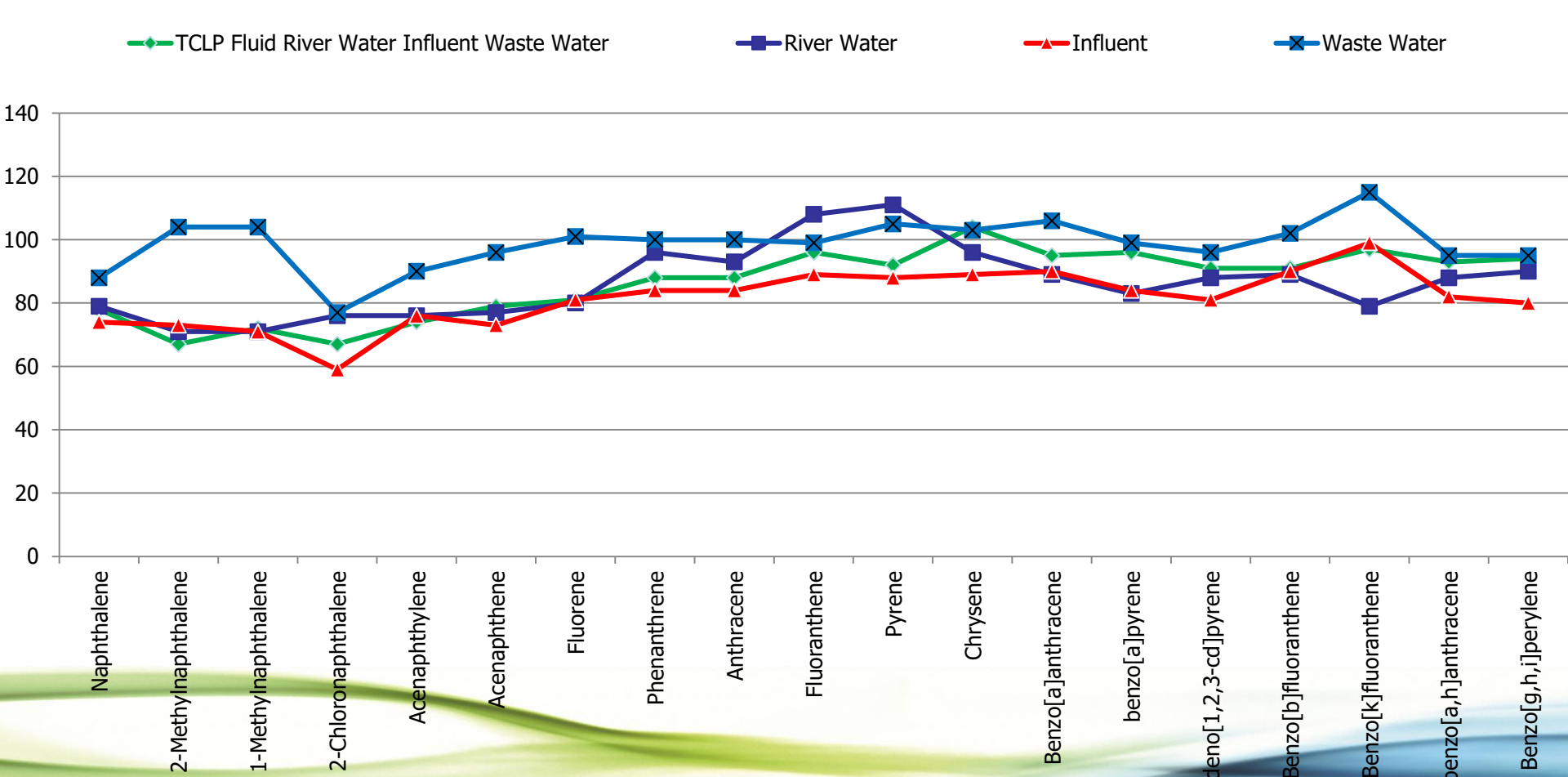
Recoveries by Analyte Class



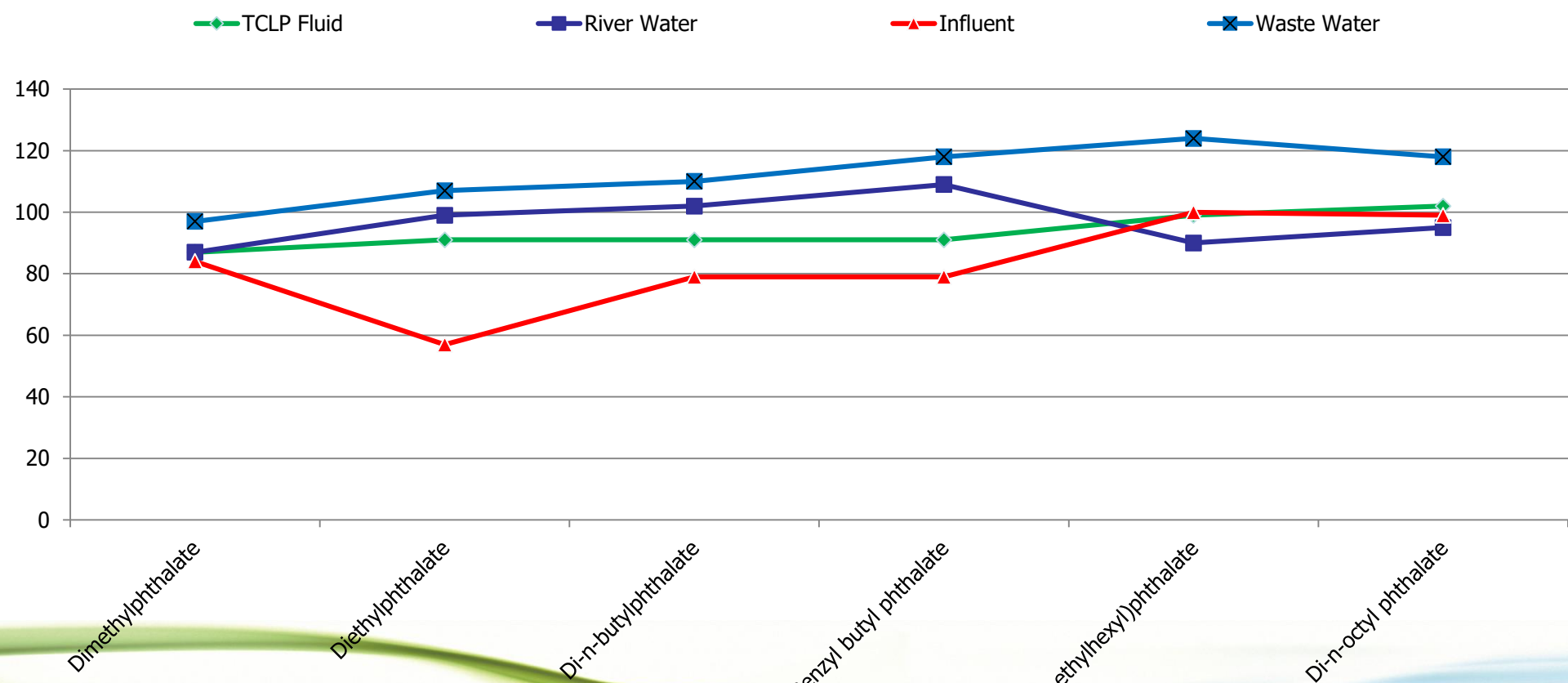
Data

Recoveries for Individual Compounds with specific Analyte Classes

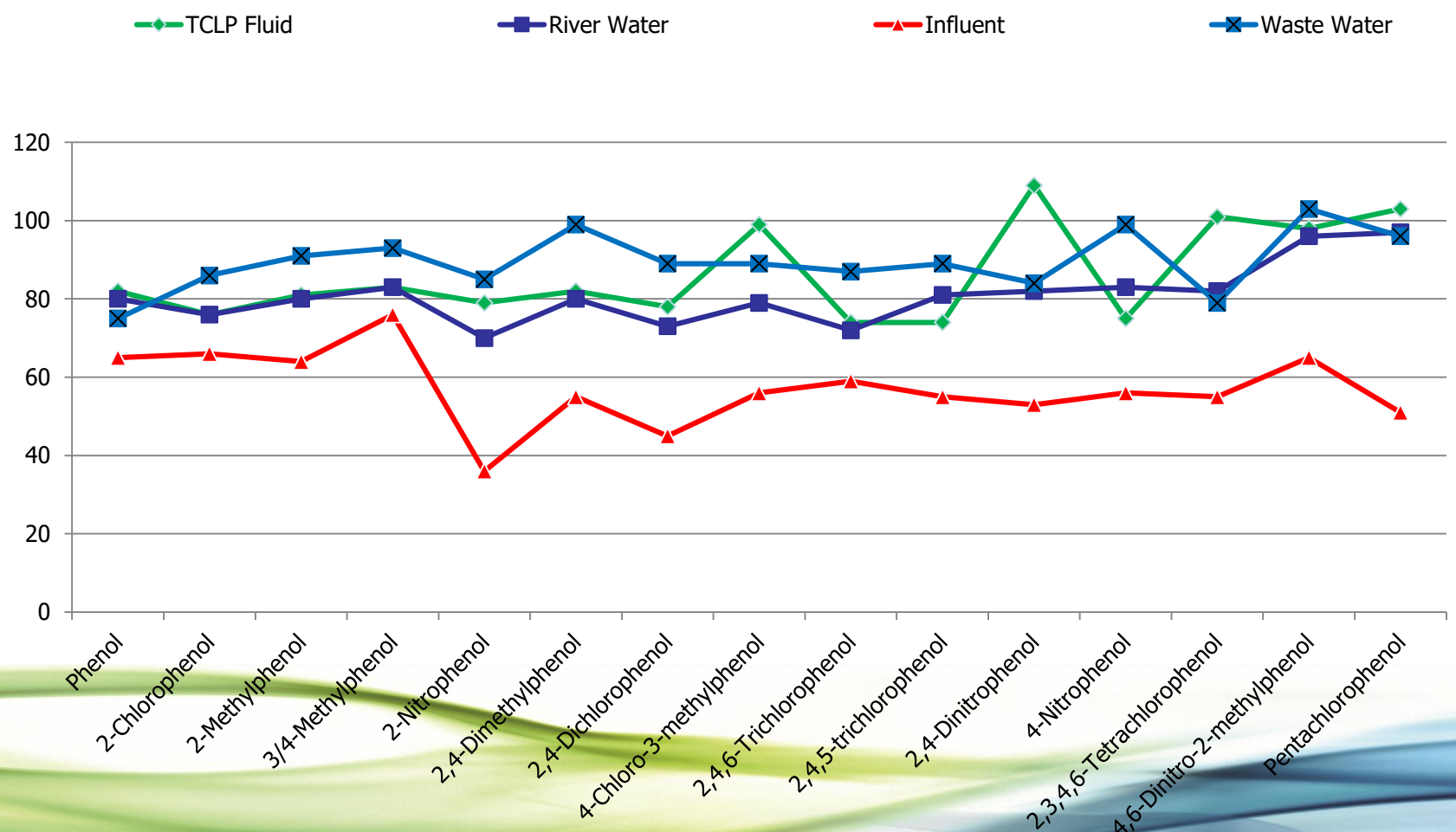
PAHs


TCLP Fluid River Water Influent Waste Water
River Water
Influent
Waste Water
140
120
100
80
60
40
20
0
Naphthalene
2-Methylnaphthalene
1-Methylnaphthalene
2-Chloronaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Chrysene
Benzo[a]anthracene
benzo[a]pyrene
Indeno[1,2,3-cd]pyrene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Dibenzo[a,h]anthracene
Benzo[g,h,i]perylene

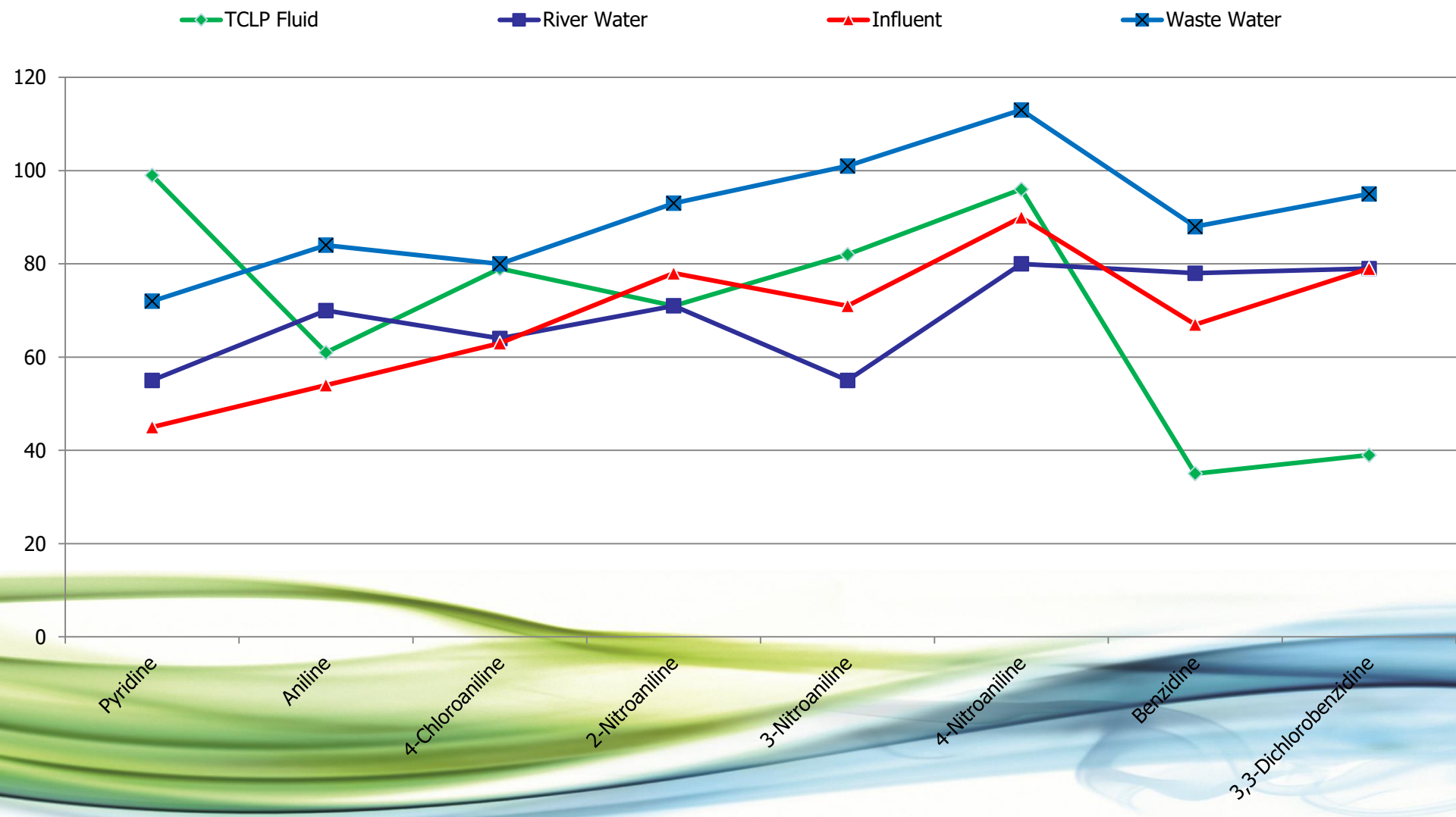
Phthalates


TCLP Fluid
River Water
Influent
Waste Water
140
120
100
80
60
40
20
0
Dimethylphthalate
Diethylphthalate
Di-n-butylphthalate
Benzyl butyl phthalate
Bis(2-ethylhexyl)phthalate
Di-n-octyl phthalate

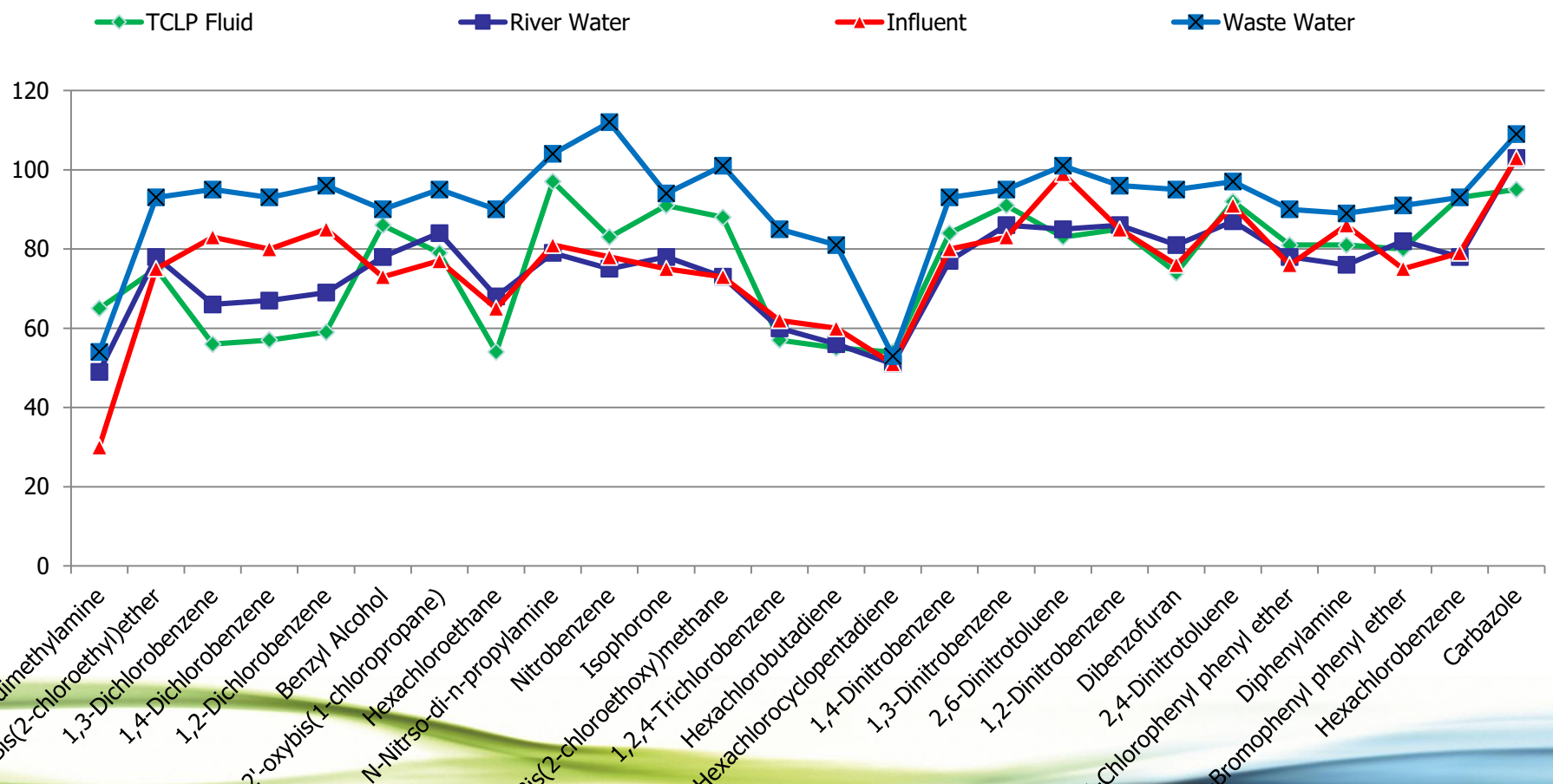
Phenols


TCLP Fluid
River Water
Influent
Waste Water
120
100
80
60
40
20
0
Phenol
2-Chlorophenol
2-Methylphenol
3/4-Methylphenol
2-Nitrophenol
2,4-Dimethylphenol
2,4-Dichlorophenol
4-Chloro-3-methylphenol
2,4,6-Trichlorophenol
2,4,5-trichlorophenol
2,4-Dinitrophenol
4-Nitrophenol
2,3,4,6-Tetrachlorophenol
4,6-Dinitro-2-methylphenol
Pentachlorophenol

Ion Exchangers



Semi-Volatiles



Method Validation

Proficiency Data for Laboratory Validation

IDC/IPR Data

Entry Identifier	IDC #1		IDC #2		IDC #3		IDC #4		EPA Limit
	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	
1,4-Dichlorobenzene-d4	20	100	20	100	20	100	20	100	
N-Nitrosodimethylamine-d6	20.75	83	21.11	84	20.22	81	20.33	81	
N-Nitrosodimethylamine	24.69	99	25.47	102	24.91	100	25.29	101	
Pyridine	24.44	98	26.04	104	25.45	102	25.75	103	
Phenol-d6	21.07	84	21.23	85	20.37	81	20.93	84	
Phenol	26.78	107	28.03	112	27.56	110	27.34	109	5-112
Aniline	25.37	101	27.59	110	26.23	105	26.26	105	
Bis(2-chloroethyl)ether-d8	19.3	77	19.77	79	19.67	79	18.69	75	
Bis(2-chloroethyl)ether	24.32	97	26.18	105	24.99	100	25.97	104	12-158
2-Chlorophenol-d4	19.6	78	20.05	80	19.52	78	19.48	78	
2-Chlorophenol	24.77	99	26.31	105	26.24	105	25.97	104	23-134
1,3-Dichlorobenzene	21.13	85	21.19	85	21.01	84	20.32	81	D-172
1,4-Dichlorobenzene	21.32	85	22.1	88	21.82	87	20.19	81	20-124
1,2-Dichlorobenzene	21.55	86	21.84	87	21.87	87	20.49	82	32-129
Benzyl Alcohol	28.6	114	29.15	117	29.16	117	28.71	115	
2,2'-oxybis(1-chloropropane)	27.13	109	27.65	111	26.77	107	26.68	107	36-166
2-Methylphenol	25.96	104	27.49	110	26.31	105	26.76	107	
4-Methylphenol-d8	20.95	84	21.18	85	21.74	87	21.63	87	

IDC/IPR Data

	IDC #1		IDC #2		IDC #3		IDC #4		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit
3/4-Methylphenol	26.59	106	27.33	109	26.7	107	27.02	108	
Hexachloroethane	22.29	89	21.84	87	22.07	88	20.52	82	40-113
N-Nitrso-di-n-propylamine	26.88	108	26.89	108	27.43	110	26.8	107	D-230
Naphthalene-d8	20	100	20	100	20	100	20	100	
Nirtrobenzene	26.71	107	27.95	112	27.76	111	27.09	108	35-180
Nitrobenzene-d5	21.06	84	21.14	85	21.02	84	20.55	82	
2-Nitrophenol-d4	23.84	95	23.04	92	23.64	95	23.14	93	
Isophorone	27.63	111	28.14	113	29.13	117	27.89	112	21-196
2-Nitrophenol	28.05	112	29.36	117	29.97	120	28.35	113	29-182
2,4-Dimethylphenol	26.91	108	28.22	113	27.32	109	26.28	105	32-119
Bis(2-chloroethoxy)methane	27.1	108	29.2	117	29.36	117	28.2	113	33-184
2,4-Dichlorophenol-d3	20.56	82	21.03	84	20.97	84	21.37	85	
2,4-Dichlorophenol	27.14	109	28.35	113	27.39	110	27.27	109	39-135
1,2,4-Trichlorobenzene	21.7	87	21.57	86	21.78	87	20.81	83	44-142
Naphthalene	22.63	91	23.53	94	23.66	95	22.69	91	21-133
4-Chloroaniline-d4	20.76	83	21.9	88	20.05	80	21.24	85	
4-Chloroaniline	25.48	102	27.21	109	25.49	102	25.69	103	
Hexachlorobutadiene	20.55	82	21.81	87	21.73	87	20.53	82	24-116
Acenaphthene-d10	20	100	20	100	20	100	20	100	
2-Methylnaphthalene	23.73	95	23.87	95	24.17	97	23.29	93	

IDC/IPR Data

	IDC #1		IDC #2		IDC #3		IDC #4		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit
1-Methylnaphthalene	23.33	93	23.12	92	24.37	97	23.46	94	
4-Chloro-3-methylphenol	28.55	114	29.94	120	30.63	123	28.77	115	22-147
Hexachlorocyclopendadiene	21.87	87	22.14	89	22.03	88	20.55	82	
2,4,6-trichlorophenol	25.9	104	27.01	108	30	120	28.24	113	37-144
2,4,5-Trichlorophenol	27.47	110	26.86	107	29.38	118	28.89	116	
2-Chloronaphthalene	23.16	93	23.69	95	24.38	98	23.38	94	60-118
2-Nitroaniline	30.05	120	30.91	124	32.64	131	31.4	126	
1,4-Dinitrobenzene	32.72	131	33.68	135	35.76	143	34.63	139	
Dimethylphthalate-d6	19.42	78	19.77	79	21.57	86	20.63	83	
Dimethylphthalate	26.03	104	25.79	103	28.38	112	26.87	107	D-112
1,3-Dinitrobenzene	28.16	113	29.11	116	29.95	120	30.35	121	
Acenaphthylene-d8	17.81	71	18.31	73	19.72	79	18.74	75	
Acenaphthylene	23.51	94	23.71	95	25.11	100	24.24	97	33-145
2,6-Dinitrotoluene	28.46	114	28.78	115	30.64	123	30.38	122	50-158
1,2-Dinitrobenzene	26.02	104	27.77	111	29.21	117	28.86	115	
Acenaphthene	23.4	94	23.36	93	24.55	98	23.23	93	47-145
3-Nitroaniline	25.73	103	26.93	108	27.36	109	27	108	
2,4-Dinitrophenol	27.14	109	29.52	118	30.94	124	30.93	124	D-191
Dibenzofuran	23.43	94	23.7	95	24.81	99	24.16	97	
2,4-Dinitrotoluene	31.85	127	32.86	131	35.06	140	33.97	136	39-139
4-Nitrophenol-d4	25.73	103	25.43	102	28.2	113	25.06	100	
4-Nitrophenol	24.13	97	23.77	95	24.23	97	23.29	93	D-132

IDC/IPR Data

Entry Identifier	IDC #1		IDC #2		IDC #3		IDC #4		EPA Limit
	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	
2,3,4,6-Tetrachlorophenol	28	112	29.36	117	31.24	125	29.17	117	
2,3,5,6-Tetrachlorophenol	29.6	118	29.26	117	32.17	129	31.82	127	
Fluorene-d10	18.96	76	18.06	72	18.19	73	17.55	70	
Fluorene	23.32	93	23.83	95	25.13	101	25.01	100	59-121
4-Chlorophenyl phenyl ether	22.1	88	22.11	88	24.34	97	23.41	94	25-158
Diethylphthalate	26.23	105	26.62	106	29.25	114	27.23	109	D-114
4-Nitroaniline	22.62	90	22.24	89	28.2	113	21.16	85	
Phenanthrene-d10	20	100	20	100	20	100	20	100	
4,6-Dinitro-2-methylphenol-d2	13.41	54	13.85	55	14.41	58	15.09	60	
4,6-Dinitro-2-methylphenol	27.15	109	28.13	113	28.54	114	29.74	119	D-181
Diphenylamine	22.39	90	22.22	89	24.11	96	24.56	98	
Azobenzene	25.33	101	26.85	107	26.32	105	27.48	110	
4-Bromophenyl phenyl ether	22.54	90	23.28	93	23.75	95	24.09	96	53-127
Hexachlorobenzene	20.46	82	21.09	84	21.96	88	22.21	89	D-152
Pentachlorophenol	27.19	109	27.83	111	29.47	118	28.81	115	14-176
Phenanthrene	23.17	93	24	96	24.6	98	24.9	100	54-120
Anthracene-d10	21.28	85	21.4	86	20.79	83	21.2	85	
Anthracene	24.76	99	25.31	101	25.87	103	25.82	103	27-133
Carbazole	28.52	114	28.93	116	30.79	123	30.7	123	
Di-n-butylphthalate	25.12	100	26.82	107	27.43	110	26.16	105	1-118
Fluoranthene	26.21	105	26.85	107	27.73	111	27.48	110	26-137
Pyrene	25.28	101	26.27	105	26.97	108	26.97	108	52-115
Benzyl butyl phthalate	28.78	115	29.41	118	30.4	122	30.71	123	D-152

IDC/IPR Data

	IDC #1		IDC #2		IDC #3		IDC #4		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit
Benzidine	17.25	69	17.25	69	13.16	53	6.18	25	
Chrysene-d12	20	100	20	100	20	100	20	100	
Benzo[a]anthracene	24.19	97	24.17	97	23.65	95	22.69	91	33-143
Chrysene	24.06	96	24.75	99	23.97	96	22.77	91	17-168
Bis(2-ethylhexyl)adipate	27.2	109	27.51	110	26.97	108	26.19	105	
3,3-Dichlorobenzidine	10.85	43	12.86	51	9.16	37	9.41	38	D-262
Bis(2-ethylhexyl)phthalate	24.16	97	25.11	100	23.56	94	23.25	93	8-158
Di-n-octyl phthalate	26.81	107	27.02	108	26.64	107	25.43	102	4-146
Perylene-d12	20	100	20	100	20	100	20	100	
Benzo[a]pyrene-d12	4.7	19	4.43	18	4.51	18	4.53	18	
Benzo[a]pyrene	25.13	101	24.45	98	24.41	98	23.83	95	17-163
Benzo[b]Fluoranthene	26.83	107	26.34	105	26.06	104	26.24	105	24-159
Benzo[k]fluoranthene	25.53	102	25.93	104	25.29	101	24.78	99	11-162
Indeno[1,2,3-cd]pyrene	7.28	29	25.76	103	24.12	96	26.37	105	D-171
Dibenz[a,h]anthracene	29.79	119	29.54	118	27.91	112	29.57	118	D-227
Benzo[g,h,i]perylene	26.84	107	26.77	107	26.25	105	26.44	106	D-219

FMS
Fluid Management Systems

MDL

	MDL #1		MDL #2		MDL #3		MDL #4		MDL #5		MDL #6		MDL #7		MDL #8			STD		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit	DEV	MDL	EPA
1,4-Dichlorobenzene-d4	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	
N-Nitrosodimethylamine-d6	2.66	53	3.23	65	3.07	61	3.83	77	3.71	74	3.46	69	2.77	55	3.36	67		0.365455	1.10	
N-Nitrosodimethylamine	2.69	54	3.27	65	3.18	64	4.18	84	4.16	83	3.7	74	3.49	70	3.83	77		0.399404	1.20	
Pyridine	3.05	61	3.17	63	3.33	67	4.14	83	4.55	91	4.09	82	3.87	77	4.51	90		0.536732	1.61	
Phenol-d6	2.15	43	2.62	52	2.76	55	3.25	65	3.18	64	3.38	68	2.39	48	2.59	52		0.383642	1.15	
Phenol	2.72	54	3.18	64	3.32	66	4.02	80	3.93	79	4.14	83	3.52	70	3.76	75	5-112	0.365051	1.09	1.5
Aniline	2.52	50	2.72	54	2.81	56	3.66	73	3.58	72	3.54	71	3.48	70	3.67	73		0.406794	1.22	
Bis(2-chloroethyl)ether-d8	2.74	55	3.16	63	3.25	65	4	80	3.95	79	3.87	77	2.92	58	3.28	66		0.438102	1.31	
Bis(2-chloroethyl)ether	2.9	58	3.29	66	3.47	69	4.23	85	3.99	80	4.39	88	3.63	73	3.93	79	12-158	0.401734	1.20	5.7
2-Chlorophenol-d4	2.62	52	3.02	60	3.15	63	3.62	72	3.63	73	3.62	72	2.71	54	3.07	61		0.366151	1.10	
2-Chlorophenol	2.82	56	3.21	64	3.35	67	4.21	84	4.04	81	4.1	82	3.4	68	3.82	76	23-134	0.407256	1.22	3.3
1,3-Dichlorobenzene	2.33	47	2.87	57	2.82	56	3.51	70	3.36	67	3.47	69	2.8	56	3.33	67	D-172	0.320565	0.96	1.9
1,4-Dichlorobenzene	2.5	50	2.84	57	2.88	58	3.51	70	3.53	71	3.56	71	2.92	58	3.5	70	20-124	0.346046	1.04	4.4
1,2-Dichlorobenzene	2.46	49	2.95	59	3.02	60	3.73	75	4	80	3.66	73	3.09	62	3.58	72	32-129	0.409134	1.23	1.9
Benzyl Alcohol	2.25	45	2.28	46	2.88	58	3.54	71	4.28	86	3.4	68	2.72	54	4.07	81		0.727255	2.18	
2,2'-oxybis(1-chloropropane)	2.1	42	2.33	47	1.89	38	3.99	80	3.6	72	1.89	38	3.55	71	3.84	77	36-166	0.936318	2.81	5.7
2-Methylphenol	2.75	55	3.21	64	3.06	61	4.12	82	4.62	92	3.85	77	3.51	70	3.97	79		0.544111	1.63	
4-Methylphenol-d8	2.34	47	2.83	57	2.97	59	3.68	74	3.85	77	3.47	69	2.56	51	3.04	61		0.474482	1.42	
3/4-Methylphenol	2.56	51	3.02	60	3.18	64	3.64	73	4.32	86	3.6	72	3.49	70	3.84	77		0.428325	1.28	
Hexachloroethane	2.21	44	2.56	51	2.78	56	3.42	68	3.53	71	3.05	61	2.74	55	3.33	67	40-113	0.377334	1.13	1.6
N-Nitrso-di-n-propylamine	3.47	69	3.75	75	4.03	81	4.74	95	5.14	103	4.69	94	3.66	73	4.13	83	D-230	0.55752	1.67	
Naphthalene-d8	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	
Nirtrobenzene	2.66	53	3.17	63	3.29	66	4.05	81	4.3	86	4.31	86	3.7	74	3.8	76	35-180	0.454522	1.36	1.9
Nitrobenzene-d5	2.37	47	3	60	2.92	58	3.58	72	3.9	78	3.83	77	2.73	55	3.15	63		0.465669	1.40	
2-Nitrophenol-d4	1.79	36	2.28	46	2.47	49	2.99	60	3.08	62	3.05	61	2.68	54	2.98	60		0.31686	0.95	
Isophorone	2.66	53	3.14	63	3.21	64	4.05	81	4.2	84	4.12	82	3.62	72	3.92	78	21-196	0.435677	1.31	
2-Nitrophenol	2.08	42	2.54	51	2.9	58	3.19	64	3.45	69	3.44	69	3.4	68	3.73	75	29-182	0.399535	1.20	2.6
2,4-Dimethylphenol	1.92	38	2.42	48	1.76	35	3.89	78	3.38	68	2.22	44	3.6	72	3.73	75	32-119	0.847722	2.54	2.7
Bis(2-chloroethoxy)methane	2.79	56	3.3	66	3.42	68	4.29	86	4.33	87	4.47	89	3.76	75	4.01	80	33-184	0.460579	1.38	5.3
2,4-Dichlorophenol-d3	1.9	38	2.2	44	2.65	53	3.06	61	3.14	63	3.21	64	2.31	46	2.53	51		0.410505	1.23	
2,4-Dichlorophenol	2.38	48	3.14	63	2.86	57	3.63	73	3.57	71	3.44	69	3.15	63	3.66	73	39-135	0.304193	0.91	2.7
1,2,4-Trichlorobenzene	2.45	49	2.95	59	2.95	59	3.65	73	3.5	70	3.68	74	3.09	62	3.46	69	44-142	0.320669	0.96	1.9
Naphthalene	2.81	56	3.23	65	3.23	65	3.96	79	3.89	78	3.91	78	3.5	70	3.8	76	21-133	0.321188	0.96	1.6

Fluid Management Systems

MDL

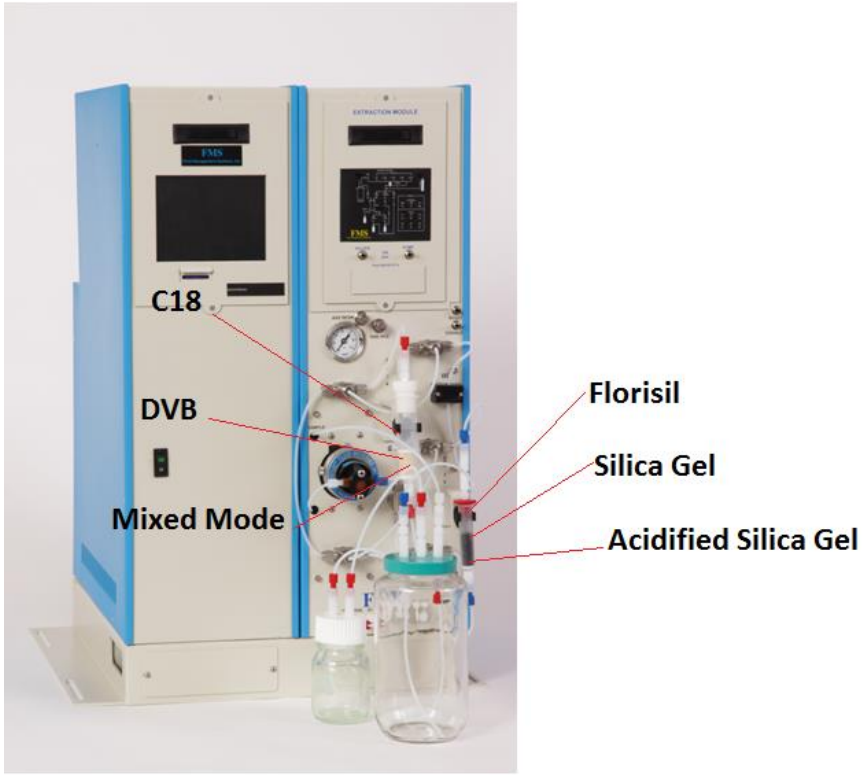
	MDL #1		MDL #2		MDL #3		MDL #4		MDL #5		MDL #6		MDL #7		MDL #8			STD		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit	DEV	MDL	EPA
4-Chloroaniline-d4	1.83	37	2.07	41	2.14	43	2.59	52	2.86	57	2.76	55	2.14	43	2.5	50		0.321907	0.97	
4-Chloroaniline	1.94	39	2.25	45	2.46	49	3.17	63	2.93	59	3.2	64	2.97	59	2.88	58		0.355327	1.07	
Hexachlorobutadiene	2.04	41	2.52	50	2.67	53	3.31	66	3.22	64	3.38	68	2.85	57	3.24	65	24-116	0.342331	1.03	0.9
Acenaphthene-d10	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	
2-Methylnaphthalene	2.98	60	3.46	69	3.34	67	4.14	83	4.21	84	4.42	88	3.06	61	3.62	72		0.509542	1.53	
1-Methylnaphthalene	2.95	59	3.43	69	3.39	68	4.18	84	4.12	82	4.31	86	3.09	62	3.6	72		0.469589	1.41	
4-Chloro-3-methylphenol	2.53	51	2.69	54	2.88	58	3.33	67	3.3	66	3.74	75	2.85	57	3.29	66	22-147	0.364457	1.09	3
Hexachlorocyclopendadiene	1.21	24	1.62	32	1.64	33	2.1	42	2.19	44	2.2	44	2.05	41	2.4	48		0.293509	0.88	
2,4,6-trichlorophenol	2.54	51	2.99	60	2.83	57	3.5	70	3.69	74	3.75	75	2.85	57	3.25	65	37-144	0.389095	1.17	2.7
2,4,5-Trichlorophenol	2.26	45	2.5	50	2.61	52	3.42	68	3.4	68	3.27	65	2.41	48	3.24	65		0.449794	1.35	
2-Chloronaphthalene	2.77	55	3.24	65	3.14	63	3.92	78	3.85	77	3.79	76	3.01	60	3.41	68	60-118	0.370945	1.11	1.9
2-Nitroaniline	2.07	41	1.88	38	2.28	46	2.65	53	2.77	55	2.44	49	2.52	50	2.85	57		0.329892	0.99	
1,4-Dinitrobenzene	1.8	36	1.93	39	2.05	41	2.65	53	2.77	55	2.64	53	2.89	58	2.76	55		0.37792	1.13	
Dimethylphthalate-d6	2.82	56	3.41	68	3.38	68	3.85	77	4.08	82	3.88	78	2.94	59	2.96	59		0.452953	1.36	
Dimethylphthalate	3.25	65	3.76	75	3.78	76	4.32	86	4.67	93	4.39	88	3.62	72	3.8	76	D-112	0.403585	1.21	1.6
1,3-Dinitrobenzene	2.01	40	2.24	45	2.33	47	2.64	53	2.94	59	3.09	62	2.94	59	2.91	58		0.331246	0.99	
Acenaphthylene-d8	2.59	52	3.15	63	3.09	62	3.65	73	3.78	76	3.58	72	2.56	51	2.77	55		0.46328	1.39	
Acenaphthylene	3.09	62	3.55	71	3.44	69	4.28	86	4.09	82	4.29	86	3.15	63	3.6	72	33-145	0.447863	1.34	3.5
2,6-Dinitrotoluene	2.87	57	3.34	67	3.4	68	4.01	80	4.1	82	4.12	82	3.65	73	3.57	71	50-158	0.331533	0.99	1.9
1,2-Dinitrobenzene	2.6	52	2.81	56	3.3	66	3.69	74	4.05	81	3.73	75	3.38	68	3.33	67		0.396779	1.19	
Acenaphthene	3.11	62	3.55	71	3.41	68	4.06	81	4.01	80	4.17	83	3.18	64	3.67	73	47-145	0.369974	1.11	1.9
3-Nitroaniline	2.21	44	2.24	45	2.09	42	2.33	47	2.29	46	2.31	46	2.47	49	1.84	37		0.203786	0.61	
2,4-Dinitrophenol	1.65	33	1.79	36	1.75	35	1.53	31	1.98	40	1.97	39	2.04	41	1.07	21	D-191	0.340525	1.02	24
Dibenzofuran	2.91	58	3.46	69	3.28	66	3.89	78	3.92	78	4.06	81	3.11	62	3.55	71		0.356371	1.07	
2,4-Dinitrotoluene	2.29	46	2.95	59	3.03	61	3.51	70	3.69	74	3.45	69	3.53	71	3.24	65	39-139	0.276207	0.83	5.7
4-Nitrophenol-d4	1.35	27	1.61	32	1.77	35	1.94	39	1.83	37	2.03	41	1.77	35	2.09	42		0.167204	0.50	
4-Nitrophenol	1.68	34	1.75	35	1.69	34	1.82	36	1.97	39	1.81	36	1.53	31	1.49	30	D-132	0.168989	0.51	2.4
2,3,4,6-Tetrachlorophenol	2.86	57	3.24	65	3.24	65	3.62	72	4.04	81	3.88	78	3.44	69	3.47	69		0.306509	0.92	
2,3,5,6-Tetrachlorophenol	2.48	50	2.97	59	3.17	63	3.36	67	3.8	76	3.65	73	3.23	65	3.17	63		0.292908	0.88	
Fluorene-d10	0.11	2	0.14	3	0.13	3	0.15	3	0.15	3	0.15	3	2.79	56	3.06	61		1.359245	4.08	
Fluorene	3.05	61	3.65	73	3.45	69	4.12	82	4.3	86	4.32	86	3.29	66	3.6	72	59-121	0.421404	1.26	1.9
4-Chlorophenyl phenyl ether	3.12	62	3.7	74	3.45	69	4.14	83	4.24	85	4.29	86	3.19	64	3.51	70	25-158	0.435332	1.31	4.2
Diethylphthalate	3.38	68	3.79	76	3.7	74	4.3	86	4.72	94	4.34	87	3.79	76	3.6	72	D-114	0.41912	1.26	1.9
4-Nitroaniline	1.58	32	1.43	29	n.d. < 1.42	28	1.5	30	1.63	33	1.97	39	1.93	39	1.98	40		0.24996	0.75	
Phenanthrene-d10	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	

FMS
Fluid Management Systems

MDL

	MDL #1		MDL #2		MDL #3		MDL #4		MDL #5		MDL #6		MDL #7		MDL #8			STD		
Entry Identifier	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	ug/L	% Rec	EPA Limit	DEV	MDL	EPA
4,6-Dinitro-2-methylphenol-d2	2.25	45	2.41	48	n.d. < 2.52	50	2.6	52	2.76	55	2.88	58	1.48	30	1.52	30		0.62083	1.86	
4,6-Dinitro-2-methylphenol	2.52	50	2.59	52	2.73	55	2.73	55	3.23	65	3.22	64	2.98	60	2.77	55	D-181	0.254343	0.76	42
Diphenylamine	2.87	57	3.36	67	3.37	67	3.74	75	4.24	85	3.77	75	3.46	69	3.4	68		0.322852	0.97	1.9
Azobenzene	3.34	67	3.79	76	3.84	77	4.16	83	4.5	90	4.28	86	3.74	75	3.91	78		0.286498	0.86	
4-Bromophenyl phenyl ether	2.85	57	3.33	67	3.3	66	3.7	74	3.86	77	3.95	79	3.31	66	3.44	69	53-127	0.276578	0.83	
Hexachlorobenzene	3.08	62	3.3	66	3.24	65	3.6	72	3.87	77	3.66	73	3.38	68	3.21	64	D-152	0.248452	0.74	1.9
Pentachlorophenol	1.94	39	1.91	38	2.11	42	2.26	45	2.3	46	2.03	41	2.28	46	2.29	46	14-176	0.153994	0.46	3.6
Phenanthrene	3.83	77	4.02	80	3.98	80	4.31	86	4.65	93	4.49	90	4.02	80	3.99	80	54-120	0.275525	0.83	5.4
Anthracene-d10	2.99	60	3.45	69	3.44	69	3.61	72	3.93	79	3.76	75	3.41	68	3.15	63		0.255725	0.77	1.9
Anthracene	3.73	75	3.89	78	3.86	77	4.24	85	4.64	93	4.49	90	4	80	4.2	84	27-133	0.297233	0.89	
Carbazole	3.71	74	3.75	75	3.76	75	4.05	81	4.69	94	4.11	82	4.45	89	4.13	83		0.342533	1.03	
Di-n-butylphthalate	3.93	79	4.02	80	4.15	83	3.98	80	5.15	103	4.54	91	4.46	89	4.05	81	1-118	0.420827	1.26	2.5
Fluoranthene	4.01	80	3.95	79	4.17	83	4.04	81	4.95	99	4.49	90	4.78	96	4.27	85	26-137	0.377201	1.13	2.2
Pyrene	4.14	83	3.95	79	4.13	83	4.16	83	4.88	98	4.56	91	4.65	93	4.4	88	52-115	0.329343	0.99	1.9
Benzyl butyl phthalate	4.5	90	4.11	82	4.28	86	4.37	87	5.2	104	5	100	5.01	100	4.28	86	D-152	0.444512	1.33	2.5
Benzidine	0.29	6	0.08	2	0.07	1	0.07	1	0.09	2	0.06	1	1.42	28	0.86	17		0.544776	1.63	44
Chrysene-d12	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	
Benzo[a]anthracene	3.83	77	3.82	76	3.79	76	3.81	76	4.43	89	4.23	85	4.26	85	3.73	75	33-143	0.285832	0.86	7.8
Chrysene	4	80	4.04	81	3.96	79	4.04	81	4.77	95	4.43	89	4.86	97	4.05	81	17-168	0.379549	1.14	2.5
Bis(2-ethylhexyl)adipate	3.37	67	3.47	69	3.65	73	3.52	70	4.18	84	3.81	76	4.08	82	3.41	68		0.303284	0.91	
3,3-Dichlorobenzidine	1.09	22	1	20	0.89	18	0.84	17	0.89	18	0.87	17	1.34	27	1.23	25	D-262	0.197773	0.59	16.5
Bis(2-ethylhexyl)phthalate	3.64	73	4.53	91	4.03	81	3.67	73	4.43	89	4.35	87	3.86	77	3.79	76	8-158	0.34146	1.02	2.5
Di-n-octyl phthalate	3.28	66	3.54	71	3.61	72	3.54	71	4.17	83	3.83	77	3.86	77	3.5	70	4-146	0.244774	0.73	2.5
Perylene-d12	20	100	20	100	20	100	20	100	20	100	20	100	20	100	20	100		0	0.00	
Benzo[a]pyrene-d12	3.26	65	4.09	82	3.54	71	3.13	63	3.63	73	3.44	69	0.79	16	0.62	12		1.425546	4.27	
Benzo[a]pyrene	3.67	73	3.45	69	3.68	74	3.53	71	4.11	82	3.92	78	4.54	91	3.7	74	17-163	0.379109	1.14	2.5
Benzo[b]Fluoranthene	3.8	76	3.64	73	3.73	75	3.73	75	4.2	84	4.19	84	4.69	94	3.59	72	24-159	0.405821	1.22	4.8
Benzo[k]fluoranthene	4.08	82	3.91	78	4.15	83	3.99	80	4.58	92	4.5	90	4.77	95	4.08	82	11-162	0.330742	0.99	2.5
Indeno[1,2,3-cd]pyrene	3.16	63	4.07	81	4.29	86	3.3	66	3.84	77	3.64	73	3.76	75	2.93	59	D-171	0.458984	1.38	3.7
Dibenz[a,h]anthracene	3.43	69	3.26	65	3.37	67	2.88	58	3.74	75	3.79	76	3.62	72	3.16	63	D-227	0.332802	1.00	2.5
Benzo[g,h,i]perylene	3.7	74	3.45	69	3.43	69	3.22	64	3.69	74	3.65	73	4.27	85	3.05	61	D-219	0.393731	1.18	4.1

Expanded Methodology



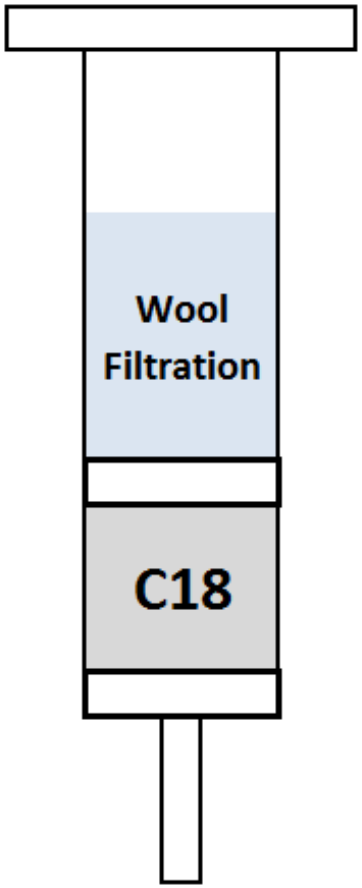
EPA Methods (examples)

- EPA 8082
- EPA 8081
- EPA 1694
- EPA 1664
- EPA 1613
- EPA 8151
- EPA 1614
- EPA 8310
- EPA 8290
- EPA 8330
- EPA 8141

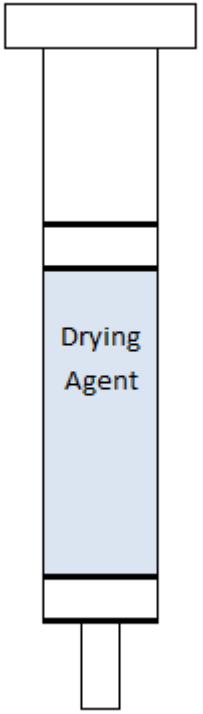
- Any EPA 500 series SPE method

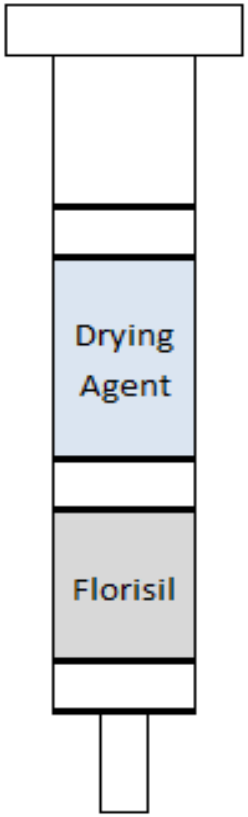
Examples

Extraction Cartridge



Clean-up Cartridge





Examples

Validated Protocols with inline drying/cleaning

PAH's with drying and/or Silica Gel clean-up

Organochlorine Pesticides with drying and/or Florisil

Organophosphorus Pesticides with Drying

Typical mid level OCP Recoveries

Analyte	LCS #1	LCS #2	LCS #3	LCS #4	Mean Rec	RSD
α-BHC	102.5%	106.8%	106.3%	107.9%	106%	2.2%
γ-BHC (Lindane)	102.1%	105.9%	105.5%	107.0%	105%	2.0%
β-BHC	96.3%	98.0%	100.9%	100.0%	99%	2.1%
δ-BHC	107.7%	110.6%	113.0%	111.8%	111%	2.1%
Heptachlor	86.1%	106.4%	107.2%	101.6%	100%	9.8%
Aldrin	68.7%	80.2%	79.6%	77.0%	76%	6.9%
Heptachlor Epoxide	99.5%	100.0%	102.1%	103.6%	101%	1.9%
γ-Chlordane	95.5%	88.7%	92.8%	91.3%	92%	3.1%
Endosulfan I	93.2%	93.4%	96.8%	96.2%	95%	2.0%
α-Chlordane	98.9%	97.2%	100.7%	101.8%	100%	2.0%
4,4'-DDE	91.8%	92.3%	97.1%	94.5%	94%	2.6%
Dieldrin	101.2%	99.3%	103.0%	104.3%	102%	2.1%
Endrin	108.2%	107.6%	112.9%	113.3%	111%	2.7%
4,4'-DDD	104.6%	97.2%	105.5%	104.3%	103%	3.7%
Endosulfan II	102.5%	97.7%	102.7%	104.1%	102%	2.7%
Endrin Aldehyde	85.4%	77.6%	89.4%	84.1%	84%	5.8%
4,4'-DDT	105.2%	97.5%	106.9%	105.9%	104%	4.1%
Endosulfan Sulfate	104.3%	99.1%	104.5%	106.2%	104%	3.0%
Methoxychlor	104.8%	90.9%	101.2%	103.4%	100%	6.3%
Endrin Ketone	102.7%	93.1%	101.6%	101.8%	100%	4.5%
Surrogate						
TCMX	66%	73%	75%	75%	72.3%	5.7%
PCB-209	88%	69%	74%	84%	78.7%	11.2%

Typical mid level OPP Recoveries

Compound	Position #1	Position #2	Mean Rec	RSD	Compound	Position #1	Position #2	Mean Rec	RSD
Alachlor	4.72	4.61	93.3%	2.4%	Mevinphos	4.57	4.38	89.5%	4.2%
Ametryn	4.46	4.5	89.6%	-0.9%	MGK 264	4.13	3.59	77.2%	14.0%
Atraton	4.59	4.26	88.5%	7.5%	Molinate	4.24	3.97	82.1%	6.6%
Atrazine	4.49	4.42	89.1%	1.6%	Napropamide	4.49	4.28	87.7%	4.8%
Bromacil	4.18	5.07	92.5%	-19.2%	Norflurazon	4.74	4.67	94.1%	1.5%
Butachlor	4.08	4.09	81.7%	-0.2%	Pebulate	4.07	3.52	75.9%	14.5%
Butylate	3.62	3.54	71.6%	2.2%	Prometon	4.16	4.3	84.6%	-3.3%
Carboxin	4.3	3.64	79.4%	16.6%	Prometryn	4.4	4.57	89.7%	-3.8%
Chlorophram	4.61	4.17	87.8%	10.0%	Pronamide+*	4.46	4.36	88.2%	2.3%
Cycloate	4.11	3.9	80.1%	5.2%	Propazine	4.72	4.55	92.7%	3.7%
Dichlorvos	4.23	3.91	81.4%	7.9%	Simazine	4.2	4.24	84.4%	-0.9%
Diphenamid	4.13	4.55	86.8%	-9.7%	Simetryn	4.79	4.73	95.2%	1.3%
Disulfoton*	4.03	3.32	73.5%	19.3%	Stirofos	4.33	4.4	87.3%	-1.6%
EPTC	3.74	3.41	71.5%	9.2%	Tebuthiuron	4.36	4.18	85.4%	4.2%
Ethoprop	4.64	4.44	90.8%	4.4%	Terbacil	4.81	5.33	101.4%	-10.3%
Fenamiphos	4.21	5.07	92.8%	-18.5%	Terbufos+*	3.58	3.51	70.9%	2.0%
Fenarimol	5.27	4.82	100.9%	8.9%	Terbutryn	4.43	4.82	92.5%	-8.4%
Fluridone	5.51	5.06	105.7%	8.5%	Triademefon	5.69	4.82	105.1%	16.6%
Hexazinone	4.86	4.69	95.5%	3.6%	Tricyclazole	5.25	4.95	102.0%	5.9%
Methyl Paraoxon	5.35	5.56	109.1%	-3.8%	Vernolate	3.69	3.529	72.2%	4.5%
Metolachlor	4.5	4.41	89.1%	2.0%					

Typical mid level PAH Recoveries

Compound	LCS	LCSD	RPD
Naphthalene	92.0%	86.0%	-6.7%
2-Methylnaphthalene	93.6%	86.8%	-7.5%
Acenaphthylene	97.8%	85.2%	-13.8%
Acenaphthene	96.3%	107.2%	10.7%
Fluorene	101.6%	109.6%	7.6%
Phenanthrene	97.6%	106.8%	9.0%
Anthracene	107.2%	109.6%	2.2%
Fluoranthene	108.0%	106.8%	-1.1%
Pyrene	110.0%	108.4%	-1.5%
Benzo[a]anthracene	110.0%	108.0%	-1.8%
Chrysene	108.8%	108.4%	-0.4%
Benzo[b]fluoranthene	109.2%	106.8%	-2.2%
Benzo[k]fluoranthene	108.8%	106.4%	-2.2%
Benzo[a]pyrene	110.0%	108.0%	-1.8%
Indeno[1,2,3-c,d]pyrene	98.0%	94.4%	-3.7%
Dibenzo[a,h]anthracene	101.6%	105.2%	3.5%
Benzo[g,h,i]perylene	109.6%	106.4%	-3.0%

Summation

- Fully Automated 625/8270 extractions
- Expandable to meet any SPE method
- Capable of performing in line extract drying and/or Cartridge extract clean-ups
- In-line evaporation with direct to GC vial tubes.

FMS
Fluid Management Systems

Questions?