March 2016 – Biosolids/ Sludge Data Summary

The following data was collected from Melbourne Water's Eastern and Western Treatments Plants over many years. Various compounds and parameters were tested over this time but those of most interest to the EPA and the public are shown here. This data should be used to give an indication of the average concentrations of pollutants in biosolids and sludge and how these may change as the material changes from fresh to old. Old biosolids are classified as being older than 3 years at the time of testing. All tests were conducted on dried biosolids by NATA accredited laboratories.

The term 'Count' gives the total number of samples included in this analysis. The statistical parameter 'Min' indicates the minimum value observed across all the samples analyzed. Note that sometimes the lowest non-detection value is used instead of the minimum. Conversely the term 'Max' indicates the maximum value observed across all samples. The term 'St Dev' is the standard deviation of the sample set. The '95% CI' is the Upper 95% confidence interval calculated using the student T table (conservative) which gives the value at which we are 95% confident that this is the highest possible value of the average of the dataset. All values are given to three significant figures where appropriate.

Metals

Metal concentrations are in milligrams per kilogram of dry biosolid or sludge material from the Eastern Treatment Plant (ETP) or the Western Treatment Plant (WTP) of Melbourne Water. Where metal concentrations were below the detection limit, the value at this limit was used for calculations. This may increase the average concentration slightly.

ETP Metals (mg/kg)												
Material Type	Biosolids Old						Biosolids Fresh					
Compound	Count	Min	Max	St Dev	Average	95% CI	Count	Min	Max	St Dev	Average	95% CI
Arsenic	552	1	25	2.764	5.32	5.56	137	<1	9	1.524	5.46	5.72
Cadmium	583	0.1	19	3.177	4.43	4.69	137	1	9	1.641	4.20	4.48
Chromium	503	13	610	66.46	114	120	137	5	290	45.88	136	144
Copper	577	6	4200	247.86	258	278	137	6	805	175.87	387	416
Lead	592	<5	12000	554.00	132	177	137	6	239	38.53	80.4	86.9
Mercury	571	<0.05	8.9	0.7650	0.893	0.96	137	0.09	2.3	0.3980	1.17	1.24
Nickel	577	<5	150	22.78	44.4	46.3	137	2	200	34.18	66.0	71.9
Selenium	405	<0.5	13	1.354	2.52	2.66	122	<1	12	1.903	3.07	3.42
Thallium	28	0.16	5	2.011	3.97	4.75	12	<5	5	N/A	5.00	N/A
Zinc	577	8	4700	353.63	431	460	137	8	1400	340.20	570	628

WTP Metals (mg/kg)												
Material Type	**Biosolids Old**						**Biosolids Fresh**					
Compound	**Count**	**Min**	**Max**	**St Dev**	**Average**	**95% CI**	**Count**	**Min**	**Max**	**St Dev**	**Average**	**95% CI**
Arsenic	175	7	109	13.16	18.3	20.3	220	5	13	1.499	8.44	8.64
Cadmium	185	1.7	107	12.76	12.2	14.0	220	1.1	6.7	1.068	2.78	2.92
Chromium	192	<1	2900	444.89	552	616	222	<1	410	62.54	157	166
Copper	185	95.5	1870	318.61	679	725	220	280	2480	188.56	625	651
Lead	175	57	1510	310.16	364	411	220	32	160	24.85	71.2	74.5
Mercury	175	0.2	19.9	3.018	3.90	4.35	220	0.2	5.1	0.5851	1.66	1.73
Nickel	185	33	589	73.66	111	122	220	42	180	18.14	75.1	77.6
Selenium	182	1	9	2.192	4.46	4.79	225	<1	9	1.569	5.3	5.47
Thallium	24	<0.01	0.6	0.1598	0.15	0.214	86	<0.01	8	1.423	4.60	4.91
Zinc	185	270	4590	690.32	1270	1373	220	460	1980	230.05	993	1024

Organic Compounds

The table below is the concentration of EPA priority organic chemicals at Melbourne Water's ETP and WTP. The column 'count detected' indicates the number of samples with results above a detection limit but not necessarily above guideline values. Detection limits vary depending on the laboratory conducting the testing. The other count parameters indicate the number of samples below the laboratory detection limit and below the value given.

Organic Compounds (mg/kg)												
Plant	**ETP**						**WTP**					
Compound	**Count**	**Min**	**Max**	**Count <0.01**	**Count <0.1**	**Count Detected**	**Count**	**Min**	**Max**	**Count <0.01**	**Count <0.1**	**Count Detected**
Aldrin	535	<0.0005	0.24	128	493	2	281	<0.01	0.3	144	273	5
Chlordane (cis)	403	<0.0005	0.031	109	342	20	272	<0.01	NA	159	269	0
Chlordane (trans)	403	<0.0005	0.1	107	341	21	272	<0.01	0.02	141	248	19
DDD	533	<0.0005	0.089	125	398	4	282	<0.01	0.29	131	254	25
DDE	535	<0.0005	0.066	48	321	83	283	<0.01	0.1	47	141	136
DDT	509	<0.0005	0.76	126	333	3	281	<0.01	NA	147	276	0
Dieldrin	536	<0.0005	0.12	56	341	154	283	<0.01	0.21	29	75	196
Heptachlor	533	<0.0005	NA	129	492	0	281	<0.01	0.03	139	271	7
Heptachlor epoxide	533	<0.0005	NA	129	492	0	281	<0.01	NA	146	278	0
Hexachlorobenzene	633	<0.0005	0.049	123	474	6	281	<0.01	0.12	141	272	6
Lindane	638	<0.0005	NA	123	478	0	281	<0.01	NA	146	278	0
PCBs	528	<0.0001	0.18	64	456	3	264	<0.01	5.98	2	155	11

Calorific Value and Nutrients

The calorific value of a sample gives an indication of the amount of heat released during combustion. Nitrogen and phosphorus are the two major nutrients in soil and their concentrations are necessary for reuse purposes.

ETP calorific value and nutrients																
Material Type		**Biosolids Old**					**Biosolids Fresh**					**Digested Sludge**				
Parameter	**Unit**	**Count**	**Min**	**Max**	**St Dev**	**Average**	**Count**	**Min**	**Max**	**St Dev**	**Average**	**Count**	**Min**	**Max**	**St Dev**	**Average**
Gross Dry Calorific Value	MJ/kg	12	0.19	2.75	2.02	1.33	12	2.08	14.5	13.4	10.6	15	9.1	15.55	2.07	12.0
Nitrogen	mg/kg	89	2060	20000	7867	7210	126	1050	85400	17230	14100	18	31200	79000	11958	45056
Phosphorus	mg/kg	156	360	16000	7818	7320	124	2010	67800	18850	16450	9	22000	74000	19044	40911

WTP calorific value and nutrients																
Material Type		Biosolids Old					Biosolids Fresh					Digested Sludge				
Parameter	Unit	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average
Gross Dry Calorific Value	MJ/kg	84	3	16.9	10.2	9.62	30	7	13.6	11.8	11.1	13	9.1	15.55	2.07	12.0
Nitrogen	mg/kg	81	3400	33000	16710	15700	162	280	44000	24610	23300	23	31200	79000	11950	45050
Phosphorus	mg/kg	105	1200	18500	9227	8420	162	4600	13000	8183	7890	15	22000	74000	19050	40900

Proximate and Ultimate Analysis

Results from the proximate and ultimate analysis tests for various organic components of biosolids and sludge is in the tables below. Where no tests were conducted on any of the samples for a particular parameter, the count is zero. This may be due to the test being illogical for the material in question. Units for each result are listed in the 'units' column.

ETP Proximate and Ultimate Analysis																
Material Type		Biosolids Old					Biosolids Fresh					Digested Sludge				
Parameter	Unit	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average
Ash Yield	%	24	78.6	92.8	3.47	85.9	12	36.8	85.2	16.1	52.9	15	32.9	58.4	8.48	44.7
Chlorine	mg/kg	4	600	1100	244.95	800	9	700	2000	486	1290	2	7900	8000	70.71	7950
Fixed Carbon	mg/kg	4	6000	29000	11750	16500	7	17000	91000	32313	66850	14	6	12.2	1.92	8.90
Hydrogen	mg/kg	4	4000	13000	4654.7	8500	12	10000	46000	11943	34500	15	33000	49000	6116	41850
Moisture	% w/w	819	4.6	68.4	9.1	28.6	133	11.3	77	11.4	31.85	19	11.6	98	24.8	75.9
Silica	mg/kg	4	751000	806000	30900	778750	4	414000	736000	166595	556250	2	272000	281000	6364	276500
Sulphur	mg/kg	8	700	3200	1007	1737.5	18	1700	15000	4501	9622	20	5300	11700	1864	9870
Volatile matter	mg/kg						3	412000	478000	35791	437000					

WTP Proximate and Ultimate Analysis																
Material Type		Biosolids Old					Biosolids Fresh					Digested Sludge				
Parameter	Unit	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average	Count	Min	Max	St Dev	Average
Ash Yield	%	136	36.1	91.9	9.34	59.7	30	46.6	68	5.14	54.0	15	32.9	58.4	8.5	44.7
Chlorine	mg/kg	22	1300	6300	1166	2321	2	4400	4700	212.1	4550	2	7900	8000	70.71	7950
Fixed Carbon	mg/kg	26	2.29	12	2.76	8.05	3	5.2	126000	72743	42000	14	6	12.2	1.92	8.90
Hydrogen	mg/kg	22	21000	35000	4593.8	26850	3	17000	33000	8963	27350	15	33000	49000	6116	41850
Moisture	%	207	1.3	72.4	15.0	29.7	249	4	59	13.4	21.4	19	11.6	98	24.75	75.9
Silica	mg/kg	3	580	860	144	700	7	810	520000	196133	75211	2	272000	281000	6364	276500
Sulphur	mg/kg	78	2700	15900	3054	8154	196	5600	18000	2296	10987	20	5300	11700	1864	9870

Physicochemical Properties

Physicochemical parameters are the physical chemical properties of biosolids and sludge. These parameters given an indication of the biosolid's geotechnical and soil like properties.

ETP Physicochemical Properties						
Material Type		Biosolids Old				
Parameter	Unit	Count	Min	Max	St Dev	Average
Electrical Conductivity	uS/cm	57	620	2900	540	1390
Organic Matter	%	112	12	75	10.9	33.7
Permeability	m/sec	50	1.00 E-11	3.00 E-9	4.46 E-10	2.09 E-10

WTP Physicochemical Properties											
Material Type		Biosolids Old					Biosolids Fresh				
Parameter	Unit	Count	Min	Max	95% CI	Average	Count	Min	Max	95% CI	Average
Electrical Conductivity	uS/cm	17	2400	7500	4932	4180	7	2700	4810	4610	3850
Organic Matter	%	7	21.5	38.8	37.3	31.4	7	24.9	41	39.8	33.3
Permeability	m/sec	7	1.75 E-5	6.00 E-5	4.48 E-5	3.00 E-5	6	2.00 E-11	4.35 E-4	2.67 E-4	7.38 E-5