

Biosolids

Class A Biosolids Analysis

Biosolids Beneficial Use Strategy

Biosolids Analysis

During the wastewater treatment process, residual solids are removed from wastewater and conveyed to the Residuals Treatment Facility for further treatment. The residual solids undergo anaerobic digestion in which microorganisms break down biodegradable material in the absence of oxygen and produce biogas. The residual solids are then dewatered and heated at a very high temperature to create Class A biosolids.

In 2022, in support of the biosolids management program under our core area wastewater service, the CRD collected and submitted samples of Class A biosolids being produced at the Residual Treatment Facility for high resolution analysis of a wide range of contaminants, including contaminants of emerging concern.

The classes of contaminants include:

- Pesticides
- Dioxins
- Polybrominated diphenyl ethers (PBDEs)
- Polychlorinated Biphenyls (PCBs)
- Pharmaceuticals and Personal Care Products (PPCPs)
- Per and poly fluorinated alkyl substances (PFAS)
- Volatile and Semi-volatile Organic Compounds (VOCs and SCOCs)

The results indicate low, detectable concentrations of several contaminants, typical of low-industrialized urban communities.

Note: there are no standards for these compounds in the BC Organic Matter Recycling Regulation. These compounds are considered in the provincial and federal regulatory frameworks but standards have not been developed at this time. The provincial government reviews available scientific information and updates the regulations on a regular basis.

Table 1: Pharmaceuticals and Personal Care Products (PPCP)

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
Bisphenol A	ng/g	1820	1740
Furosemide	ng/g	30.1	26.8
Gemfibrozil	ng/g	8.50	5.16
Glipizide	ng/g	ND	ND
Glyburidea	ng/g	ND	ND
Hydrochlorothiazide	ng/g	ND	ND
2-Hydroxy-ibuprofen	ng/g	ND	78.7
Ibuprofen	ng/g	103	278
Naproxen	ng/g	16.8	12.9
Triclocarban	ng/g	161	151
Triclosan	ng/g	1870	1300
Warfarin	ng/g	ND	ND
Acetaminophen	ng/g	106	74.6
Azithromycin	ng/g	280	224
Caffeine	ng/g	64.4	44.6
Carbadox	ng/g	9.83	ND
Carbamazepine	ng/g	162	194
Cefotaxime	ng/g	ND	ND
Ciprofloxacin	ng/g	3030	2610
Clarithromycin	ng/g	14.0	19.5
Clinafloxacin	ng/g	ND	3.74
Cloxacillin	ng/g	ND	ND
Dehydronifedipine	ng/g	ND	ND
Diphenhydramine	ng/g	1890	1670
Diltiazem	ng/g	5.45	4.71
Digoxin	ng/g	ND	ND
Digoxigenin	ng/g	ND	ND
Enrofloxacin	ng/g	12.4	7.89
Erythromycin-H2O	ng/g	ND	ND
Flumequine	ng/g	ND	ND
Fluoxetine	ng/g	480	438
Lincomycin	ng/g	16.1	15.7
Lomefloxacin	ng/g	ND	ND
Miconazole	ng/g	561	400
Norfloxacin	ng/g	84.1	70.1
Norgestimate	ng/g	ND	ND
Ofloxacin	ng/g	315	274
Ormetoprim	ng/g	ND	ND
Oxacillin	ng/g	ND	ND
Oxolinic Acid	ng/g	ND	ND
Penicillin G	ng/g	ND	ND
Penicillin V	ng/g	ND	ND
Roxithromycin	ng/g	6.29	8.60
Sarafloxacin	ng/g	ND	ND
Sulfachloropyridazine	ng/g	ND	ND
Sulfadiazine	ng/g	ND	ND
Sulfadimethoxine	ng/g	ND	ND
Sulfamerazine	ng/g	ND	ND
Sulfamethazine	ng/g	ND	ND
Sulfamethizole	ng/g	13.7	ND
Sulfamethoxazole	ng/g	ND	ND
Sulfanilamide	ng/g	32.2	31.9
Sulfathiazole	ng/g	ND	ND
Thiabendazole	ng/g	44.5	32.8
Trimethoprim	ng/g	1.70	1.65
Tylosin	ng/g	ND	ND
Virginiamycin M1	ng/g	ND	ND
1,7-Dimethylxanthine	ng/g	99.4	75.5
ND - Below detection limit			

Table 2: Per- and polyfluoroalkyl substances (PFAS)

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
11C1-PF3OUdS	ng/g	ND	ND
3:3 FTCA	ng/g	ND	ND
4:2 FTS	ng/g	ND	ND
5:3 FTCA	ng/g	26.0	26.4
6:2 FTS	ng/g	ND	ND
7:3 FTCA	ng/g	15.6	17.0
8:2 FTS	ng/g	ND	ND
9C1-PF3ONS	ng/g	ND	ND
ADONA	ng/g	ND	ND
EtFOSAA	ng/g	8.19	9.24
HFPO-DA	ng/g	ND	ND
MeFOSAA	ng/g	12.0	12.6
N-EtFOSA	ng/g	ND	ND
N-EtFOSE	ng/g	8.00	6.72
NFDHA	ng/g	ND	ND
N-MeFOSA	ng/g	NDR (1.21)	NDR (0.347)
N-MeFOSE	ng/g	12.4	12.0
PFBA	ng/g	ND	ND
PFBS	ng/g	ND	ND
PFDA	ng/g	1.80	1.89
PFDoA	ng/g	1.20	1.49
PFDoS	ng/g	ND	ND
PFDS	ng/g	ND	ND
PFEESA	ng/g	ND	ND
PFHpA	ng/g	NDR (1.19)	NDR (1.27)
PFHpS	ng/g	ND	ND
PFHxA	ng/g	2.07	2.06
PFHxS	ng/g	NDR (11.8)	NDR (11.3)
PFMBA	ng/g	ND	ND
PFMPA	ng/g	ND	ND
PFNA	ng/g	ND	ND
PFNS	ng/g	ND	ND
PFOA	ng/g	0.846	1.11
PFOS	ng/g	6.12	5.25
PFOSA	ng/g	0.76	0.778
PFPeA	ng/g	1.42	1.61
PFPeS	ng/g	ND	ND
PFTeDA	ng/g	ND	0.599
PFTrDA	ng/g	ND	ND
PFUnA	ng/g	0.739	0.869
ND - Below detection limit			
NDR- Detected, but not quantifiable. Estimated maximum concentration reported in parenthesis			

Table 3: Polychlorinated Biphenyls (PCBs)

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
Total Monochloro Biphenyls	pg/g	320	276
Total Dichloro Biphenyls	pg/g	4460	4110
Total Trichloro Biphenyls	pg/g	5610	5740
Total Tetrachloro Biphenyls	pg/g	11200	10700
Total Pentachloro Biphenyls	pg/g	11900	10800
Total Hexochloro Biphenyls	pg/g	8530	8180
Total Heptochloro Biphenyls	pg/g	3540	3380
Total Octochloro Biphenyls	pg/g	840	837
Total Nonochloro Biphenyls	pg/g	258	260
Decachloro Biphenyl	pg/g	164	171
Total PCBs	pg/g	46800	44500

Table 4: Dioxins & Furans

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
2,3,7,8-TCDD	pg/g	0.590	0.200
1,2,3,7,8-PECDD	pg/g	0.724	0.628
1,2,3,4,7,8-HxCDD	pg/g	0.839	0.935
1,2,3,6,7,8-HxCDD	pg/g	6.62	6.63
1,2,3,7,8,9-HxCDD	pg/g	3.73	3.65
1,2,3,4,6,7,8-HPCDD	pg/g	134	144
OCDD	pg/g	818	923
2,3,7,8-TCDF	pg/g	2.71	2.70
1,2,3,7,8-PECDF	pg/g	0.675	0.431
2,3,4,7,8-PECDF	pg/g	0.796	0.695
1,2,3,4,7,8-HxCDF	pg/g	1.13	1.16
1,2,3,6,7,8-HxCDF	pg/g	0.979	0.999
1,2,3,7,8,9-HxCDF	pg/g	0.225	0.142
2,3,4,6,7,8-HxCDF	pg/g	0.852	0.873
1,2,3,4,6,7,8-HPCDF	pg/g	9.82	11.3
1,2,3,4,7,8,9-HPCDF	pg/g	0.841	0.840
OCDF	pg/g	17.3	21.1
TOTAL TETRA-DIOXINS	pg/g	32.9	24.9
TOTAL PENTA-DIOXINS	pg/g	43.2	38.2
TOTAL HEXA-DIOXINS	pg/g	64.4	61.1
TOTAL HEPTA-DIOXINS	pg/g	258	278
TOTAL TETRA-FURANS	pg/g	16.7	17.4
TOTAL PENTA-FURANS	pg/g	15.0	14.4
TOTAL HEXA-FURANS	pg/g	15.8	18.1
TOTAL HEPTA-FURANS	pg/g	24.2	28.4
TOTAL TEQ		4.72	4.30
TEQ - Toxicity Equivalency Quotient			

Table 5: Pesticides

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
1,3-Dichlorobenzene	ng/g	ND	ND
1,4-Dichlorobenzene	ng/g	58	50.3
1,2-Dichlorobenzene	ng/g	3.01	2.13
1,3,5-Trichlorobenzene	ng/g	0.182	0.157
1,2,4-Trichlorobenzene	ng/g	0.650	0.509
1,2,3-Trichlorobenzene	ng/g	0.131	0.116
1,2,4,5-/1,2,3,5-Tetrachlorobenzene	ng/g	0.154	0.121
1,2,3,4-Tetrachlorobenzene	ng/g	0.165	0.203
Pentachlorobenzene	ng/g	0.547	0.463
Hexachlorobutadiene	ng/g	0.247	0.057
Hexachlorobenzene	ng/g	1.34	1.11
HCH, alpha	ng/g	ND	ND
HCH, beta	ng/g	ND	NDR (0.010)
HCH, gamma	ng/g	ND	ND
HCH, delta	ng/g	ND	ND
Heptachlor	ng/g	ND	ND
Aldrin	ng/g	NDR (0.008)	ND
Octachlorostyrene	ng/g	NDR (0.021)	0.023
Chlordane, oxy-	ng/g	NDR (0.017)	0.021
Chlordane, gamma (trans)	ng/g	0.639	0.722
Chlordane, alpha (cis)	ng/g	0.660	0.695
Nonachlor, trans-	ng/g	0.433	0.482
Nonachlor, cis-	ng/g	0.145	0.156
2,4'-DDD	ng/g	36.6	28.6
4,4'-DDD	ng/g	0.294	0.310
2,4'-DDE	ng/g	0.192	0.158
4,4'-DDE	ng/g	7.55	6.86
2,4'-DDT	ng/g	ND	ND
4,4'-DDT	ng/g	ND	ND
Mirex	ng/g	0.025	0.026
Heptachlor Epoxide	ng/g	NDR (0.071)	NDR (0.167)
alpha-Endosulphan	ng/g	NDR (0.025)	ND
Dieldrin	ng/g	1.84	2.21
Endrin	ng/g	ND	ND
beta-Endosulphan	ng/g	NDR (0.074)	0.053
Endosulphan Sulphate	ng/g	ND	ND
Endrin Aldehyde	ng/g	NQ	NQ
Endrin Ketone	ng/g	ND	ND
Methoxychlor	ng/g	NDR (1.06)	0.522
ND - Below detection limit			
NQ - Data not quantifiable			
NDR- Detected, but not quantifiable. Estimated maximum concentration reported in parenthesis			

Table 6: Semi-Volatile Organic Compounds (SVOCs)

Parameter	Units	CRD Biosolids- 2022-11-23	CRD Biosolids - 2022-12-15
		23/11/2022	15/12/2022
N-Nitrosodimethylamine	ug/g	<200	<2000
2-chloronaphthalene	ug/g	<2.0	<20
Aniline	ug/g	<6.0	<60
1,2-dichlorobenzene	ug/g	<2.0	<20
1,3-dichlorobenzene	ug/g	<2.0	<20
1,4-dichlorobenzene	ug/g	<2.0	<20
Hexachlorobenzene	ug/g	<4.0	<40
1,2,4-trichlorobenzene	ug/g	<4.0	<40
2-chlorophenol	ug/g	<2.0	<20
4-chloro-3-methylphenol	ug/g	<2.0	<20
m,p-Cresol	ug/g	15	<40
o-Cresol	ug/g	<4.0	<40
2,4-dichlorophenol	ug/g	<2.0	<20
2,4-dimethylphenol	ug/g	<2.0	<20
2,4-dinitrophenol	ug/g	<20	<200
4,6-dinitro-2-methylphenol	ug/g	<10	<100
2-nitrophenol	ug/g	<10	<100
4-nitrophenol	ug/g	<10	<100
Pentachlorophenol	ug/g	<4.0	<40
Phenol	ug/g	<4.0	<40
2,4,5-trichlorophenol	ug/g	<2.0	<20
2,4,6-trichlorophenol	ug/g	<2.0	<20
Butyl benzyl phthalate	ug/g	<4.0	<40
Bis(2-chloroethoxy)methane	ug/g	<2.0	<20
Bis(2-chloroisopropyl)ether	ug/g	<2.0	<20
Bis(2-ethylhexyl)phthalate	ug/g	31	<100
4-bromophenyl phenyl ether	ug/g	<2.0	<20
p-Chloroaniline	ug/g	<4.0	<40
4-chlorophenyl phenyl ether	ug/g	<2.0	<20
3,3'-Dichlorobenzidine	ug/g	<10	<100
Diethyl phthalate	ug/g	<4.0	<40
Di-n-butyl phthalate	ug/g	<4.0	<40
Di-n-octyl phthalate	ug/g	<10	<100
2,4-Dinitrotoluene	ug/g	<2.0	<20
2,6-Dinitrotoluene	ug/g	<2.0	<20
Dimethyl phthalate	ug/g	<4.0	<40
Biphenyl	ug/g	<2.0	<20
Bis(2-chloroethyl)ether	ug/g	<4.0	<40
Hexachlorobutadiene	ug/g	<2.0	<20
Hexachlorocyclopentadiene	ug/g	<10	<100
Hexachloroethane	ug/g	<2.0	<20
Isophorone	ug/g	<2.0	<20
Nitrobenzene	ug/g	<2.0	<20
Nitrosodiphenylamine/Diphenylamine	ug/g	<4.0	<40
N-nitroso-di-n-propylamine	ug/g	<2.0	<20
Low Molecular Weight PAH's	mg/kg	6.4	7.0
High Molecular Weight PAH's	mg/kg	2.4	2.0
Total PAH	mg/kg	8.8	9.0
Naphthalene	mg/kg	0.74	0.69
1-Methylnaphthalene	mg/kg	0.75	0.70
2-Methylnaphthalene	mg/kg	2.1	1.9
Acenaphthylene	mg/kg	0.019	0.023
Acenaphthene	mg/kg	0.67	0.65
Fluorene	mg/kg	0.55	0.53
Phenanthrene	mg/kg	1.3	1.3
Anthracene	mg/kg	0.30	0.44
Fluoranthene	mg/kg	0.79	0.97
Pyrene	mg/kg	0.64	0.74
Benzo(a)anthracene	mg/kg	<0.10	0.30
Chrysene	mg/kg	<0.10	<0.20

Table 6: Semi-Volatile Organic Compounds (SVOCs) (Continued)

Parameter	Units	CRD Biosolids- 2022-11-23	CRD Biosolids - 2022-12-15
		23/11/2022	15/12/2022
Benzo(b)fluoranthene	mg/kg	<0.10	<0.20
Benzo(k)fluoranthene	mg/kg	0.21	<0.20
Benzo(a)pyrene	mg/kg	0.66	<0.20
Indeno(1,2,3-cd)pyrene	mg/kg	0.14	<0.20
Dibenz(a,h)anthracene	mg/kg	<0.10	<0.20
Benzo(g,h,i)perylene	mg/kg	<0.25	<0.50

Table 6: Volatile Organic Compounds (VOCs)

Parameter	Units	CRD Biosolids- 2022-11-23	CRD Biosolids - 2022-12-15
		23/11/2022	15/12/2022
1,1,1,2-tetrachloroethane	mg/kg	<0.020	<0.066
1,1,1-trichloroethane	mg/kg	<0.53	<0.066
1,1,2,2-tetrachloroethane	mg/kg	<0.97	<0.066
1,1,2-trichloroethane	mg/kg	<0.53	<0.066
1,1-dichloroethane	mg/kg	<0.66	<0.082
1,1-dichloroethene	mg/kg	<0.026	<0.082
1,1-dichloropropene	mg/kg	<400	<49
1,2,3-trichlorobenzene	mg/kg	2.3	<0.099
1,2,3-trichloropropane	mg/kg	1.1	<0.099
1,2,4-trichlorobenzene	mg/kg	0.89	<0.099
1,2,4-trimethylbenzene	mg/kg	11	1.1
1,2-dibromo-3-chloropropane	mg/kg	<26	<3.3
1,2-dibromoethane	mg/kg	<0.53	<0.066
1,2-dichlorobenzene	mg/kg	<0.53	<0.066
1,2-dichloroethane	mg/kg	<0.53	<0.066
1,2-dichloropropane	mg/kg	<0.53	<0.066
1,3,5-trimethylbenzene	mg/kg	<5.3	<0.66
1,3-dichlorobenzene	mg/kg	<0.53	<0.066
1,3-dichloropropane	mg/kg	<400	<49
1,4-dichlorobenzene	mg/kg	0.56	<0.066
2-chlorotoluene	mg/kg	<400	<49
2-Butanone (MEK)	mg/kg	<400	<49
4-chlorotoluene	mg/kg	<400	<49
4-Methyl-2-pentanone (MIBK)	mg/kg	<13	<1.6
Acetone	mg/kg	130	<17
Benzene	mg/kg	7.5	0.61
Bromobenzene	mg/kg	<5.3	<0.66
Bromodichloromethane	mg/kg	<1.3	<0.16
Bromoform	mg/kg	<1.3	<0.16
Bromomethane	mg/kg	<7.9	<0.99
Carbon tetrachloride	mg/kg	<0.53	<0.066
Chlorobenzene	mg/kg	<0.53	<0.066
Dibromochloromethane	mg/kg	<0.050	<0.16
Chloroethane	mg/kg	<2.6	<0.33
Chloroform	mg/kg	0.69	<0.066
Chloromethane	mg/kg	0.12	<0.16
cis-1,2-dichloroethene	mg/kg	<0.79	<0.099
cis-1,3-dichloropropene	mg/kg	<0.53	<0.066
Dibromomethane	mg/kg	<5.3	<0.66
Dichlorodifluoromethane	mg/kg	<5.3	<0.66
Ethylbenzene	mg/kg	0.69	0.062
Hexachlorobutadiene	mg/kg	<5.3	<0.66
Isopropylbenzene	mg/kg	<5.3	<0.66
Methyl-tert-butylether (MTBE)	mg/kg	<2.6	<0.33
n-Butylbenzene	mg/kg	<400	<49

Table 6: Volatile Organic Compounds (VOCs) (Continued)

Parameter	Units	CRD Biosolids- 2022-11-23	CRD Biosolids - 2022-12-15
		23/11/2022	15/12/2022
n-Propylbenzene	mg/kg	<400	<49
p-Isopropyltoluene	mg/kg	<400	<49
sec-Butylbenzene	mg/kg	<400	<49
tert-Butylbenzene	mg/kg	<400	<49
Styrene	mg/kg	3.1	0.18
Tetrachloroethene	mg/kg	<0.26	<0.033
Toluene	mg/kg	32	1.5
trans-1,2-dichloroethene	mg/kg	<0.79	<0.099
trans-1,3-dichloropropene	mg/kg	<0.53	<0.066
Trichloroethene	mg/kg	<0.009	<0.030
Trichlorofluoromethane	mg/kg	<5.3	<0.66
Vinyl chloride	mg/kg	<1.1	<0.13
m & p-Xylene	mg/kg	35	2.7
o-Xylene	mg/kg	<1.1	<0.13
Xylenes (Total)	mg/kg	35	2.7
Extractable (MeOH) 2-Hexanone	mg/kg	<260	<33
Extractable (MeOH) Acrylonitrile	mg/kg	<53	<6.6
Extractable (MeOH) Carbon disulfide	mg/kg	<400	<49
Extractable (MeOH) Ethyl ether	mg/kg	<260	<33
Extractable (MeOH) Tetrahydrofuran	mg/kg	<400	<49
Extractable (MeOH) Vinyl Acetate	mg/kg	<400	<49

Table 8: Polybrominated Diphenyl Ethers (PBDEs)

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
2,4-DiBDE	pg/g	54.2	41.2
2,4'-DiBDE	pg/g	93.8	71.1
2,6-DiBDE	pg/g	ND	ND
3,3'-DiBDE	pg/g	NQ	NQ
3,4-DiBDE	pg/g	47.9	38.8
3,4'-DiBDE	pg/g	NQ	NQ
4,4'-DiBDE	pg/g	147	145
2,2',4-TriBDE	pg/g	1530	1280
2,3',4-TriBDE	pg/g	NQ	NQ
2,4,4'-TriBDE	pg/g	3020	2620
2,4,6-TriBDE	pg/g	ND	ND
2,4',6-TriBDE	pg/g	13.5	11.7
2',3,4-TriBDE	pg/g	NQ	NQ
3,3',4-TriBDE	pg/g	31.5	26.4
3,4,4'-TriBDE	pg/g	46.5	41
2,2',4,4'-TeBDE	pg/g	130000	106000
2,2',4,5'-TeBDE	pg/g	4170	3680
2,2',4,6'-TeBDE	pg/g	538	464
2,3',4,4'-TeBDE	pg/g	2730	2510
2,3',4',6-TeBDE	pg/g	392	383
2,4,4',6-TeBDE	pg/g	183	163
3,3',4,4'-TeBDE	pg/g	11.8	NDR (8.42)
3,3',4,5'-TeBDE	pg/g	78.3	NDR (48.7)
2,2',3,4,4'-PeBDE	pg/g	5850	5360
2,2',4,4',5-PeBDE	pg/g	107000	102000
2,2',4,4',6-PeBDE	pg/g	27800	25000
2,3,3',4,4'-PeBDE	pg/g	ND	ND
2,3,4,5,6-PeBDE	pg/g	ND	ND
2,3',4,4',6-PeBDE	pg/g	310	328
2,3',4,5,5'-PeBDE	pg/g	NQ	NQ
3,3',4,4',5-PeBDE	pg/g	ND	ND
2,2',3,3',4,4'-HxBDE	pg/g	NDR (87.3)	NDR (74.4)
2,2',3,4,4',5'-HxBDE	pg/g	1780	1320
2,2',3,4,4',6'-HxBDE	pg/g	528	508

Table 8: Polybrominated Diphenyl Ethers (PBDEs) (Continued)

Parameter	Units	CRD Biosolids-2022-10-28	CRD Biosolids-2022-11-23
		28/10/2022	23/11/2022
2,2',4,4',5,5'-HxBDE	pg/g	13600	12300
2,2',4,4',5,6'-HxBDE	pg/g	10300	9370
2,2',4,4',6,6'-HxBDE	pg/g	537	679
2,3,4,4',5,6-HxBDE	pg/g	NQ	NQ
2,2',3,4,4',5,6-HpBDE	pg/g	ND	ND
2,2',3,4,4',5',6-HpBDE	pg/g	2950	2360
2,3,3',4,4',5,6-HpBDE	pg/g	ND	ND
2,2',3,4,4',5,5',6-OcBDE	pg/g	3820	2820
2,2',3,3',4,4',5,5',6-NoBDE	pg/g	NDR (15600)	NDR (16400)
2,2',3,3',4,4',5,6,6'-NoBDE	pg/g	NDR (38000)	NDR (36100)
2,2',3,3',4,5,5',6,6'-NoBDE	pg/g	NDR (27400)	NDR (25300)
2,2',3,3',4,4',5,5',6,6'-DeBDE	pg/g	394000	447000
ND - Below detection limit			
NQ - Data not quantifiable			
NDR- Detected, but not quantifiable. Estimated maximum concentration reported in parenthesis			