

EcoEPI-Follow up– Use of Eco-epidemiology to determine
the likely causes of poor biological quality in rivers
in England and Wales

Virginie Keller
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I. OVERVIEW

This report presents the activities undertaken by the Centre for Ecology and Hydrology (CEH-Wallingford) as part of the EcoEPI Follow-up contract. The role of CEH was to quantify the influence of wastewater inputs based on a national dataset of sewage treatment works (STWs) location and characteristics. Within this project, there were 307 catchments selected across England and Wales, for each catchment a weighted population contribution to the effluent load was derived and existing LF2K-WQX concentration predictions for steroid oestrogens included.

II. APPROACH

The work carried within this study was achieved mainly using the software ArcGIS.

II.1 Overview of the GIS data available

Within the initial study, the 307 sites selected in the project were mapped by Waterborne Environmental (USA), who provided a catchment boundaries shapefile. CEH then provided for each catchment the total number of STWs discharging within the catchment, the total dry weather flow (DWF) discharged in the catchment ($\text{m}^3 \text{d}^{-1}$) and the total population served by STWs within the catchment.

Within a recent project, CEH undertook a national-scale assessment of steroid oestrogen exposure across England and Wales on behalf of the Environment Agency. As part of this study, only those STWs contributing to 95% of the total DWF discharged above the tidal limit were included within the exposure assessment. Due to the time and resource constraints within this follow-up project, it was agreed with Cranfield University that the new variables would be derived using this reduced river network and reduced STW dataset.

II.2 Methodology

II.2.1 Weighted Population contribution

As mentioned previously, only those STWs contributing to 95% of the total DWF discharged above the tidal limit are included in this follow-up project.

The main task within this project was to derive a weighted population contribution to the chemical load for each STW within the catchment. These individual STW contribution were then summed to obtain a variable representative of the total contributing load (CL) to the catchment outlet. The CL accounted for losses due to biodegradation within the water column between the discharge point and the catchment outlet.

Thus three methods were proposed:

- Method 1a: the surrogate of the contributing load CL_1 is based on inverse distance weighing:

$$CL_1 = \sum_{i=1}^n \frac{Pop_i}{L_i}$$

- Where:
- n is the number of STWs within the catchment
 - Pop_i is the population served by STW i .
 - L_i is the distance (km) between STW i and the catchment outlet, if $L_i < 1 \Rightarrow L_i = 1$

Within this method a minimum distance of 1 km was allowed in the calculations. This was because small distances provided a much higher weighted population than the actual population served.

- Method 1b: the surrogate of the contributing load CL_1 is based on inverse distance weighing:

$$CL_1 = \sum_{i=1}^n \frac{Pop_i}{L_i}$$

- Where:
- n is the number of STWs within the catchment
 - Pop_i is the population served by STW i .
 - L_i is the distance (km) between STW i and the catchment outlet.

Within this method there was no lower limit on the distance used, because STW very close to the point of interest might well have a large impact on the ecology of that site (much greater than other STWs in the catchment).

- Method 2: the surrogate of the contributing load CL_2 reflects the calculation of in-stream concentration for a degradable chemical.

$$CL_2 = \sum_{i=1}^n Pop_i \times e^{-1/L_i}$$

- Where:
- n is the number of STWs within the catchment
 - Pop_i is the population served by STW i .
 - L_i is the distance (km) between STW i and the catchment outlet,

The selection of appropriate STWs in each catchment was done within ArcGIS using the “Select by location...” functionality. The distance between STWs and catchment outlet were then calculated using the “closest facility” ArcGIS functionality, which provides the distance between 2 points based upon a user provided network. The actual calculations of CL_1 and CL_2 were done within Excel.

II.2.2 Existing predicted concentrations for steroid oestrogens

In order to assess the risk of fish intersex induced by steroid estrogens, Williams *et al.* (2009) predicted estrone (E_1), estradiol (E_2) and ethinylestradiol (EE_2) concentrations in surface waters across England and Wales, using the LF2000-WQX (LowFlows2000 Water Quality eXtension) model. LF2000-WQX is a mixed deterministic and stochastic model that combines hydrological models and water-quality models to produce spatially explicit statistical distributions of “down-the-

drain” chemicals in surface waters across England and Wales (Williams *et al.*, 2009). The output of the model is a shapefile containing a river network split into reaches of variable length for which the downstream predicted concentrations are provided in terms of a series of statistics: mean, standard deviation and 90th percentile.

Within the present project, for each catchment the closest downstream concentration is supplied. The appropriate reach containing the catchment outlet was selected using the ArcGIS “Select by location...” functionality. As mentioned above, the reaches within the LF2000-WQX model are of variable length and the model assumes the reaches to be well mixed, therefore in reality there might be a difference between the concentration at the point of interest and the value given by the model for the whole reach.

III. RESULTS

An Excel document named ‘WEI_WS_95DWF_Followup’ was generated, based on the “WEI_WS_100DWF” shapefile delivered within the original EcoEpi project. The new worksheet contains the following fields, where the new fields are presented in bold:

- HydroID: field provided by Waterborne.
- Name: Unique catchment Id (provided by Waterborne).
- Shape_Leng: catchment perimeter (provided by Waterborne).
- Shape_Area: Catchment area (provided by Waterborne).
- Nb_STW: Number of STWs discharging within the catchment.
- TotDWF_M3D: Total DWF discharged into the catchment, in m³d⁻¹.
- Tot_RES: Total population served by STWs in the catchment.
- **95%_DWF**: DWF discharged in the catchment by those STWs contributing to 95% of the total DWF discharged above the tidal limit, in m³d⁻¹.
- **95%_Res**: Population served in the catchment by those STWs contributing to 95% of the total DWF discharged above the tidal limit.
- **95%_Nb_STW**: Number of STWs in the catchment that contribute to 95% of the total DWF discharged above the tidal limit.
- **CL1a**: Surrogate of the contributing load as defined by Method 1a.
- **CL1b**: Surrogate of the contributing load as defined by Method 1b.
- **CL2**: Surrogate of the contributing load as defined by Method 2.
- **EE2_Mean**: Predicted mean concentration for ethinylestradiol in ng/L.
- **EE2_SD**: Predicted standard deviation for ethinylestradiol in ng/L.
- **EE2_90th**: Predicted 90th percentile (concentration exceeded 10% of the time) for ethinylestradiol in ng/L.
- **E2_Mean**: Predicted mean concentration for estradiol in ng/L.
- **E2_SD**: Predicted standard deviation for estradiol in ng/L.
- **E2_90th**: Predicted 90th percentile (concentration exceeded 10% of the time) for estradiol in ng/L.
- **E1_Mean**: Predicted mean concentration for estrone in ng/L.
- **E1_SD**: Predicted standard deviation for estrone in ng/L.
- **E1_90th**: Predicted 90th percentile (concentration exceeded 10% of the time) for estrone in ng/L.

Some of the new contents (“Name” + some fields in bold) of the attribute table are presented in Appendix 1: only the mean concentrations for each steroid estrogen are presented in the table to save space (all data are in the spreadsheet).

Amongst the 307 catchments, there were five for which no STW data were available within the previous analysis when 100% of DWF was included, details of these are provided in the previous report. Amongst the remaining 298 catchments, there were five catchments for which the catchment outline as defined by Waterborne Environmental (USA) using the DEM data provided by CEH were wrong. These errors are most likely due to issues within the DEM dataset. The problematic catchments are presented in Appendix 2; for these 5 catchments, CL values could not be derived as the river network did not match the catchment outline.

IV. REFERENCES

Williams, RJ, Keller, VD, Johnson, AC, Young, AR, Holmes, MG, Wells, C, Gross-Sorokin, M, Benstead, R, 2009. A national risk assessment for intersex in fish arising from steroid estrogens. *Environ Toxicol Chem* 28:220-230.

Appendix 1:
Contents of the attribute table of the shapefile WEI_WS_100DWF

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
00034302	185400	779785	43	21433	21433	758773	0.0446	0.1381	1.4455
00052182	36310	148408	16	14356	14356	135098	0.0146	0.046	0.6699
00060200	6580	22835	5	753	753	22099	0.0049	0.0151	0.1709
00260000	0	0	0	0	0	0	0	0	0
04465220	25800	111618	1	87888	87888	50789	0.3506	1.2578	9.3421
04766040	8710	34782	2	21758	188738	13070	0.1242	0.4513	3.3948
04778460	188550	738368	32	16607	16607	722144	0.1478	0.4765	4.168
04788950	141910	566506	14	23807	23807	543390	0.1978	0.713	5.5398
04791460	115800	461314	13	20364	20364	441430	0.1847	0.6792	5.2723
04800980	22000	79872	3	62172	70497	35225	0.1886	0.6986	5.8425
04805580	0	0	0	0	0	0	0	0	0
05217440	3420	14144	1	14144	19644	3527	0.3131	1.1707	18.282
07429100	0	0	0	0	0	0	0	0	0
07687380	5050	17645	3	9646	9646	11214	0.0915	0.3229	2.5168
07687720	870	4035	1	522	522	3545	0.05	0.1722	1.3306
08017430	24560	89389	4	9016	9016	80960	0.1065	0.3498	3.2516
08019230	21650	76264	2	13304	22662	64129	0.1681	0.5805	4.4961
08023080	0	0	0	0	0	0	0	0	0
08100050	950	4311	1	430	430	3902	0.0148	0.0501	0.8401
08100160	950	4311	1	498	498	3841	0.0148	0.0501	0.8401
08102620	0	0	0	0	0	0	0	0	0
09563180	3380	14566	5	542	542	14034	0.0311	0.0894	0.941

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
10325060	590	2536	1	488	488	2092	0.0287	0.099	0.7725
10680080	0	0	0	0	0	0	0.1978	0.713	5.5398
10927160	5870	25724	5	732	732	22029	0.0435	0.1224	1.1393
10929340	5480	22749	5	1307	1307	21481	0.0435	0.1224	1.1393
11053760	3450	13933	1	4381	4381	10174	0.0814	0.2764	2.1333
11559580	240	1124	1	52	52	1073	0.003	0.0088	0.1598
13598380	9291	37195	10	645	645	36557	0.0072	0.0194	0.3039
13608780	8351	33382	9	1031	1031	32371	0.0073	0.0226	0.3556
13612980	6260	25075	5	1159	1159	23949	0.0067	0.0215	0.3347
13624310	1280	5101	2	314	314	4797	0.0026	0.0077	0.0688
20671100	550	2161	1	2161	2183	787	0.0341	0.1217	0.9797
22241560	18640	78578	3	23304	23304	61078	0.167	0.5581	4.5189
22686160	10080	45104	1	45104	214781	386	0.1811	0.6452	4.9949
23416980	0	0	0	0	0	0	0	0	0
23529780	0	0	0	0	0	0	0	0	0
23967980	0	0	0	0	0	0	0	0	0
26944180	27360	112719	10	9043	9043	104104	0.0465	0.1641	1.3147
26947700	25460	104791	8	58702	239175	34618	0.0614	0.226	1.735
26948480	9210	33466	7	1619	1619	31889	0.0164	0.0515	0.461
26949580	5970	18837	5	850	850	18007	0.0144	0.046	0.4161
26955600	990	4252	2	458	458	3817	0.0138	0.0467	0.4519
27044180	1340	5438	1	1001	1001	4523	0.0093	0.0306	0.2548
27045180	1340	5438	1	4028	4028	2593	0.0164	0.0594	0.4653
28208180	3240	14629	2	1127	1127	13544	0.0318	0.1052	0.88
28431400	0	0	0	0	0	0	0	0	0

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
29991100	3960	16385	3	1152	1152	15302	0.0255	0.0799	0.9278
3	50631	176416	17	5836	5836	170707	0.0107	0.036	0.3412
33231280	0	0	0	0	0	0	0.0038	0.012	0.1076
3533	0	0	0	0	0	0	0	0.0726	1.4596
36748340	942840	3556160	76	60728	60728	3496943	0.1511	0.4434	4.3037
36751680	816580	3137351	56	49740	49740	3088241	0.1526	0.4595	4.4047
36753920	813160	3122847	55	70094	70094	3055155	0.1588	0.4939	4.6611
36754350	776330	3016099	47	120445	120445	2917296	0.1969	0.6171	5.7829
36761800	726730	2889406	43	64864	64864	2825409	0.198	0.6356	5.8576
36768280	165000	671336	14	17928	17928	653757	0.1137	0.3566	3.5647
36770430	165000	671336	14	27163	32074	645835	0.1465	0.4733	4.6976
36784280	73560	304488	1	190305	190305	162981	0.2282	0.8754	6.5006
36786080	0	0	0	0	0	0	0	0	0
37644330	17380	74517	1	74517	112905	16377	0.3148	1.1529	8.6674
38471380	94430	371210	20	7139	7139	364149	0.116	0.3541	3.8311
38473020	29700	116566	5	4647	4647	112018	0.1557	0.495	6.4869
38474920	63600	249433	14	6812	6812	242751	0.1348	0.4005	3.6914
38475950	63600	249433	14	10543	10543	239413	0.1348	0.4005	3.6914
38478690	49760	196464	9	8938	8938	187756	0.188	0.6083	5.333
38482980	28360	105884	2	83139	85585	51248	0.2615	0.9275	7.5017
42486650	0	0	0	0	0	0	0	0	0
44510300	0	0	0	0	0	0	0	0	0
45212350	45350	180184	7	16015	16015	165130	0.2036	0.6985	5.5966
45213020	45350	180184	7	19850	19850	161973	0.2036	0.6985	5.5966
45217250	19310	65704	4	18600	18600	51106	0.1594	0.5546	4.3719

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
45300029	59717	190669	8	68738	68738	140334	0.2199	0.7886	10.1337
45300033	31059	99335	7	5767	5767	93740	0.1695	0.6117	5.4437
45300050	31059	99335	7	2347	2347	28803	0.1695	0.6117	5.4437
45400013	77440	204561	15	1597	1597	75862	0.1025	0.3665	4.7037
46257100	165920	604726	13	129875	129875	490906	0.1792	0.628	5.0371
46265220	10820	48913	4	6821	6821	42592	0.1186	0.4142	3.3115
46265950	2700	11984	1	8208	8208	6041	0.0784	0.2735	2.2429
46266590	0	0	0	0	0	0	0	0	0
47043180	0	0	0	0	0	0	0	0	0
47511500	11460	31884	2	1760	1760	30173	0.045	0.1451	1.4611
47511900	11460	31884	2	2004	2004	29943	0.0581	0.1936	1.9147
47513300	11460	31884	2	5781	5781	26712	0.0581	0.1936	1.9147
47514350	10160	26119	1	13191	13191	15762	0.0561	0.2056	1.6123
47517980	0	0	0	0	0	0	0	0	0
47519100	0	0	0	0	0	0	0	0	0
47601380	0	0	0	0	0	0	0	0	0
48939020	17100	72541	5	28656	30993	52024	0.109	0.376	3.0232
48940560	2600	7429	2	805	805	6667	0.0471	0.1586	1.8752
48940950	2600	7429	2	805	805	6667	0.0471	0.1586	1.8752
48941980	0	0	0	0	0	0	0.1158	0.4278	6.966
48942750	0	0	0	0	0	0	0	0	0
49099020	1910	4237	1	4237	8474	573	0.1756	0.6684	5.0063
49100488	65256	221281	24	4880	4880	216465	0.0184	0.0582	0.761
49200090	13040	16631	4	1184	1184	15493	0.0109	0.0373	0.3451
49221140	6010	27181	2	4641	4641	22933	0.1699	0.6078	4.7281

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
49258050	5250	23669	1	13603	13603	13322	0.5903	2.2452	16.792
49300215	0	0	0	0	0	0	0.0178	0.0643	0.7795
49301153	0	0	0	0	0	0	0	0	0
49301429	30297	121886	4	32435	32435	94296	0.1574	0.5621	5.2349
49301545	275416	844747	11	178904	269312	685960	0.1793	0.6615	5.3039
49301578	244146	742797	10	112891	112891	640316	0.1679	0.6148	4.9832
49301624	347852	1109924	23	40039	40039	1070714	0.1699	0.6155	5.2082
49301640	0	0	0	0	0	0	0	0	0
49302181	0	0	0	0	0	0	0.1755	0.6478	5.1884
49400263	0	0	0	0	0	0	0.0914	0.3254	3.227
49400347	0	0	0	0	0	0	0.1456	0.5246	4.5565
49400395	637236	1858787	29	84212	84212	1777282	0.1274	0.4392	4.2666
49400406	263449	1043982	11	71003	71003	976194	0.146	0.5175	4.5063
49400411	46149	462233	9	74535	74535	394564	0.0914	0.3254	3.227
49400433	46149	462233	9	23175	23175	439672	0.0914	0.3254	3.227
49400438	670756	1982598	36	41159	41159	1944331	0.1282	0.3969	4.0857
49400676	46149	462233	9	304345	304345	261571	0.0914	0.3254	3.227
49400722	33593	109146	6	47755	47755	72642	0.0478	0.1716	2.8061
49400723	9893	29300	5	1654	1654	27696	0.014	0.0463	0.7115
49400739	46019	146475	8	28817	28817	122185	0.0464	0.1639	2.7219
49400828	910	2115	1	229	229	1898	0.0021	0.0069	0.1393
49401050	2110	9748	1	5701	5701	5432	0.1673	0.6203	4.7322
49500105	10025	38151	1	8478	8478	30549	0.3492	1.3355	21.297
49500159	0	0	0	0	0	0	0.1001	0.3507	3.9264
49500338	321153	654828	14	33657	33657	622282	0.0968	0.3378	3.8085

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
49500343	373787	814805	18	40998	40998	777287	0.1099	0.3716	4.1127
49500479	0	0	0	0	0	0	0.0994	0.3529	3.8828
49500601	77957	151791	5	10772	10772	141409	0.0563	0.2	1.8349
49500607	258004	476375	11	50142	50142	429668	0.0821	0.2921	2.6279
49500617	77957	151791	5	10772	10772	141409	0.0563	0.2	1.8349
49500857	33100	37703	1	6273	6273	31924	0.0909	0.3412	2.5892
49600142	25894	75355	16	1526	1526	73851	0.0096	0.0274	0.4106
49690300	122250	402227	17	22389	22389	380597	0.1413	0.4772	3.8948
49695250	41660	156779	16	5299	5299	151592	0.0425	0.1326	1.4083
49700156	37043	79491	8	4130	4130	75536	0.0201	0.0662	0.6369
49700252	821	2204	1	125	125	2083	0.0007	0.0023	0.0198
49703460	14390	58459	4	8258	8258	51291	0.0204	0.069	0.8815
49704500	9380	36834	3	1529	1529	35347	0.0124	0.0394	0.3817
49800093	14220	47237	4	5599	5599	41972	0.1813	0.6692	10.894
49800100	29761	105088	9	3913	3913	101287	0.1019	0.3715	4.5261
49800103	18544	63489	5	10433	10433	54504	0.1911	0.7125	11.7241
50014900	0	0	0	0	0	0	0	0	0
50304820	3510	15962	2	7257	7257	10364	0.1757	0.6373	4.9251
50450129	858	3095	3	143	143	2955	0.0027	0.0086	0.0993
50584150	0	0	0	0	0	0	0	0	0
50896050	16170	54074	7	4585	4585	49713	0.1037	0.3472	3.3328
50896350	16170	54074	7	5728	5728	48725	0.1037	0.3472	3.3328
50896620	13210	40581	5	3540	3540	37196	0.094	0.3173	3.1771
50897770	13210	40581	5	6622	6622	34524	0.094	0.3173	3.1771
50899450	1230	4413	1	770	770	3706	0.0477	0.17	1.3483

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
50901140	0	0	0	0	0	0	0.0752	0.2843	2.1223
51113100	0	0	0	0	0	0	0.1586	0.5624	5.4872
51214030	2780	11413	2	2974	2974	8815	0.166	0.5948	4.6967
51705250	6200	22988	1	7793	7793	16379	0.0551	0.2045	1.6086
51705550	6200	22988	1	12293	12293	13467	0.0551	0.2045	1.6086
51729450	0	0	0	0	0	0	0.0162	0.0514	0.4648
52762070	0	0	0	0	0	0	0	0	0
530	0	0	0	0	0	0	0.0009	0.0032	0.0536
53784050	910	4178	1	4178	5497	1121	0.0499	0.1876	1.3873
538	0	0	0	0	0	0	0.0009	0.0032	0.0536
54509300	36170	103723	7	36170	36170	103723	0.022	0.0665	0.7382
54521950	0	0	0	0	0	0	0.0162	0.0514	0.4648
54536180	0	0	0	0	0	0	0	0	0
54537900	0	0	0	0	0	0	0	0	0
54758250	0	0	0	0	0	0	0	0	0
55724900	14990	47507	1	42799	42799	19298	0.1389	0.482	3.9343
56082180	11600	31441	4	11600	11600	31441	0.0249	0.0789	0.9174
56088780	9700	23791	2	5318	5318	19030	0.0362	0.1329	1.2478
56090180	0	0	0	0	0	0	0	0	0
58470100	7010	22587	2	851	851	21752	0.0585	0.1795	2.0233
58472140	7010	22587	2	6200	6200	17276	0.0988	0.3482	3.6114
58639195	0	0	0	0	0	0	0	0	0
59000500	544120	2158549	25	61147	61147	2098496	0.2676	0.8815	7.7471
59008980	462400	1824762	10	207220	207220	1630374	0.3166	1.127	8.9058
59018780	0	0	0	0	0	0	0.1897	0.6122	5.7738

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
59392220	43290	172811	9	6962	6962	166007	0.1503	0.4854	4.2365
59393340	43290	172811	9	19791	20724	156541	0.1503	0.4854	4.2365
59394420	40490	159859	7	23517	23517	139028	0.1663	0.5772	4.5522
59714780	1650	7434	1	865	865	6617	0.0357	0.1151	0.9823
60010867	110	540	1	397	397	259	0	0	0
60250424	40036	122329	27	4771	4771	117665	0.043	0.1343	1.9208
60864380	13060	55431	3	3274	3274	52254	0.121	0.39	6.7868
61642420	16980	76338	3	4355	4355	72106	0.1263	0.4105	3.5695
61643350	16980	76338	3	7755	7755	68972	0.1263	0.4105	3.5695
61644950	16980	76338	3	19386	19386	59345	0.1263	0.4105	3.5695
61646060	3800	17478	2	4571	4571	13606	0.0689	0.2435	1.9377
61648150	0	0	0	0	0	0	0	0	0
70220119	3318	10554	7	1057	1057	9564	0.0069	0.024	0.3311
70220159	3033	9899	6	1797	1797	8306	0.0066	0.0232	0.314
70220164	3033	9899	6	6177	8270	5271	0.0066	0.0232	0.314
70230122	804	3941	5	711	711	3302	0.0085	0.0288	0.2427
70230903	0	0	0	0	0	0	0.0085	0.0288	0.2427
70256300	78040	313168	9	32877	32877	284243	0.1306	0.4283	4.9368
70257450	59690	242791	8	9977	9977	233059	0.176	0.5638	5.4954
70257580	1430	6308	1	377	377	5942	0.0089	0.0291	0.2396
70261360	1430	6308	1	902	902	5467	0.0348	0.1237	0.9554
70420116	5882	21161	6	1815	1815	19444	0.0161	0.0562	0.57
70540110	17493	52503	23	2364	2364	50201	0.011	0.0364	0.473
70720104	3788	8432	2	713	713	7751	0.0029	0.0105	0.0784
71363300	3400	7585	2	982	982	6664	0.0333	0.1125	1.5483

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
71363900	2380	2910	1	573	573	2390	0.0336	0.1152	0.9489
72770190	13790	54749	1	7832	7832	47451	0.1988	0.7171	5.5602
73020127	3601	14205	13	432	432	13783	0.0037	0.0111	0.1397
73030120	675	2576	2	285	285	2309	0.0052	0.0181	0.1449
81930120	1705	8810	2	1070	1070	7807	0.0159	0.0541	0.5499
81950522	1770	5473	3	921	921	4626	0.0207	0.0746	0.6836
82310103	17698	43392	1	8802	8802	35426	0.0846	0.3134	2.3273
82310132	17698	43392	1	43392	114189	3123	0.1662	0.6366	4.6287
82310160	0	0	0	0	0	0	0	0	0
82310451	0	0	0	0	0	0	0	0	0
877	0	0	0	0	0	0	0	0	0
88000584	0	0	0	0	0	0	0	0	0
88000613	1689	6749	1	553	553	6218	0.0143	0.0476	0.3894
88000790	0	0	0	0	0	0	0	0	0
88000793	8435	31015	2	5453	5453	26035	0.3751	1.3138	13.3078
88002749	18049	63234	1	52695	52695	27481	0.2184	0.8223	13.6484
88003464	0	0	0	0	0	0	0.0388	0.1233	1.0642
88003465	0	0	0	0	0	0	0.0108	0.037	0.297
88003466	12770	31338	3	3883	3883	27806	0.0077	0.0263	0.2117
88003816	0	0	0	0	0	0	0	0	0
88003818	0	0	0	0	0	0	0	0	0
88003828	0	0	0	0	0	0	0.0083	0.0273	0.2425
88003839	0	0	0	0	0	0	0	0	0
88003949	0	0	0	0	0	0	0.0003	0.0013	0.0233
88003969	656	2804	2	734	734	2162	0.0014	0.0055	0.0889

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
88003988	0	0	0	0	0	0	0.0013	0.0046	0.0788
88003993	0	0	0	0	0	0	0	0	0
88004016	923	3088	3	455	455	2676	0.0015	0.0052	0.0569
88004372	0	0	0	0	0	0	0	0	0
88004374	0	0	0	0	0	0	0	0	0
88004392	0	0	0	0	0	0	0	0	0
88004397	18362	31072	1	9561	9561	22842	0.0157	0.0573	0.447
88004418	297	840	2	242	242	631	0	0	0.0012
88004421	0	0	0	0	0	0	0	0	0
88004458	0	0	0	0	0	0	0.0054	0.0187	0.1508
88004467	0	0	0	0	0	0	0	0	0
88004587	0	0	0	0	0	0	0	0	0
88004940	0	0	0	0	0	0	0	0	0
88004959	0	0	0	0	0	0	0	0	0
88004974	35	61	1	61	64	22	0.0006	0.0023	0.0389
88005131	0	0	0	0	0	0	0	0	0
88005153	0	0	0	0	0	0	0.004	0.014	0.3545
88005173	3185	12350	2	12079	57410	375	0.047	0.1761	1.3994
88005180	3185	12350	2	1306	1306	11112	0.0087	0.0305	0.2525
88005536	0	0	0	0	0	0	0.0007	0.0026	0.0223
88005544	0	0	0	0	0	0	0.0007	0.0026	0.0223
88005545	89	105	1	35	35	75	0.0007	0.0026	0.0223
88005547	0	0	0	0	0	0	0.0007	0.0026	0.0226
88005549	0	0	0	0	0	0	0.0007	0.0026	0.0226
88005570	116	554	1	60	60	497	0.0007	0.0026	0.0223

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
88005573	2303	7875	3	5168	5168	4161	0.0031	0.0117	0.0888
88005585	0	0	0	0	0	0	0	0	0
88005586	0	0	0	0	0	0	0	0	0
88005616	2534	8393	6	897	897	7546	0.002	0.0077	0.0639
88005618	0	0	0	0	0	0	0	0	0
88005667	224	600	2	118	118	493	0.0005	0.0018	0.0334
88005728	408	1024	4	449	4190	580	0.0022	0.0078	0.1015
88005740	7331	23728	23	1688	1688	22136	0.0041	0.0148	0.1525
88005786	241	654	3	233	233	476	0.0018	0.0063	0.1068
88005816	2135	7044	9	925	925	6197	0.01	0.0354	0.4549
88006220	3082	8948	10	564	564	8409	0.0025	0.0084	0.1083
88006264	5943	17561	4	42	42	3784	0.0356	0.1308	1.0504
88006317	0	0	0	0	0	0	0	0	0
88006319	0	0	0	0	0	0	0	0	0
88006329	92	216	1	45	45	176	0.0007	0.0026	0.0454
88006338	0	0	0	0	0	0	0	0	0
88006340	0	0	0	0	0	0	0	0	0
88006362	0	0	0	0	0	0	0	0	0
88006367	0	0	0	0	0	0	0.0007	0.0021	0.0384
88006369	188	506	1	40	40	468	0.0009	0.0033	0.0565
88006381	387	930	2	36	36	895	0.0011	0.0033	0.0573
88006382	13378	39344	30	1038	1038	38327	0.0042	0.015	0.162
88006392	0	0	0	0	0	0	0	0	0
88006424	961	2280	3	244	244	2051	0.0012	0.0042	0.0797
88006451	0	0	0	0	0	0	0.0086	0.0314	0.4432

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
88006456	0	0	0	0	0	0	0	0	0
88006466	0	0	0	0	0	0	0	0	0
88006469	0	0	0	0	0	0	0.0045	0.016	0.1702
88006473	0	0	0	0	0	0	0.0045	0.016	0.1702
88020376	0	0	0	0	0	0	0.0042	0.0158	0.126
A1260166	10274	33703	7	3102	3102	30786	0.0259	0.0873	0.8046
ANCOC	6856	24285	11	1261	1261	23063	0.0553	0.171	2.8804
BUR120	2752	14290	7	885	885	13435	0.0143	0.0463	0.4536
E0000362	59619	248453	26	8145	8145	240513	0.057	0.1749	2.0156
E0000364	59619	248453	26	8959	8959	239771	0.057	0.1749	2.0156
E0000397	44454	182683	14	15991	15991	167967	0.0854	0.2784	3.0538
E0000421	0	0	0	0	0	0	0.2254	0.8466	6.4317
E0000807	10737	45024	5	2061	2061	43016	0.0528	0.1565	1.5611
E0001255	40093	129218	4	22589	22589	110132	0.0725	0.2505	2.0751
E0001553	2317	9568	7	1069	1069	8582	0.02	0.0644	0.548
E0001569	0	0	0	0	0	0	0.1917	0.7143	5.6915
E0001639	0	0	0	0	0	0	0.1917	0.7143	5.6915
E1008100	26675	88528	5	33062	33062	61847	0.0486	0.1671	1.562
F0002075	3343	13699	2	714	714	13004	0.0433	0.1351	2.2497
F0002886	9948	37916	7	1559	1559	36402	0.0161	0.0517	0.6395
G0003796	6122	20206	2	1499	1499	18764	0.0074	0.0252	0.251
NENE550W	134908	536074	2	9470	9470	526699	0.1528	0.4427	4.0196
PCHR0016	29464	100576	6	2862	2862	97763	0.0531	0.1555	1.2819
PCNR0025	590234	2410489	88	44638	44638	2366731	0.0407	0.1517	1.2061
PKER0025	92840	294800	12	42475	42475	256378	0.0552	0.1947	1.5534

Name	Sewage Treatment Works (STW) information			Weighted Population			Mean Concentrations (ng/L)		
	95%_DWF	95%_Res	95%_Nb_STW	CL1a	CL1b	CL2	EE2	E2	E1
PLER0057	0	0	0	0	0	0	0.1879	0.6143	4.536
PLER0076	25000	135021	2	5827	5827	129319	0.2957	0.9514	7.0921
PMLR0022	91702	434664	9	38964	38964	400010	0.1804	0.5735	4.7725
PTAR0022	36592	139103	8	3170	3170	135973	0.0864	0.2522	2.4651
PUTR0107	59443	230379	8	9013	9013	221563	0.0659	0.2055	1.806
WELL420C	27257	104901	23	2782	2782	102170	0.0569	0.1569	1.68
WITHM	0	0	0	0	0	0	0	0.2055	2.1344
Y0004402	1315	5882	3	550	550	5357	0.0129	0.0441	0.3722
Y0004418	1315	5882	3	919	919	5034	0.0129	0.0441	0.3722
Z1010706	125185	435806	51	48619	48619	389879	0.0649	0.2089	1.9404

**Appendix 2:
Catchments where the boundary derived from the DEM do not
comply with the digitised river network (1:50,000)**

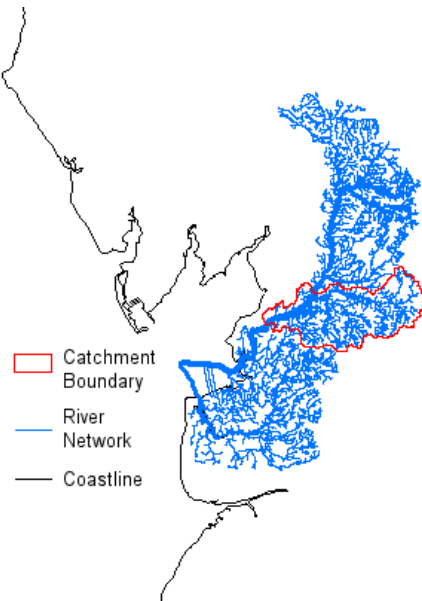


Figure 2. 1. Catchment 88003988 in the North West (EA region).

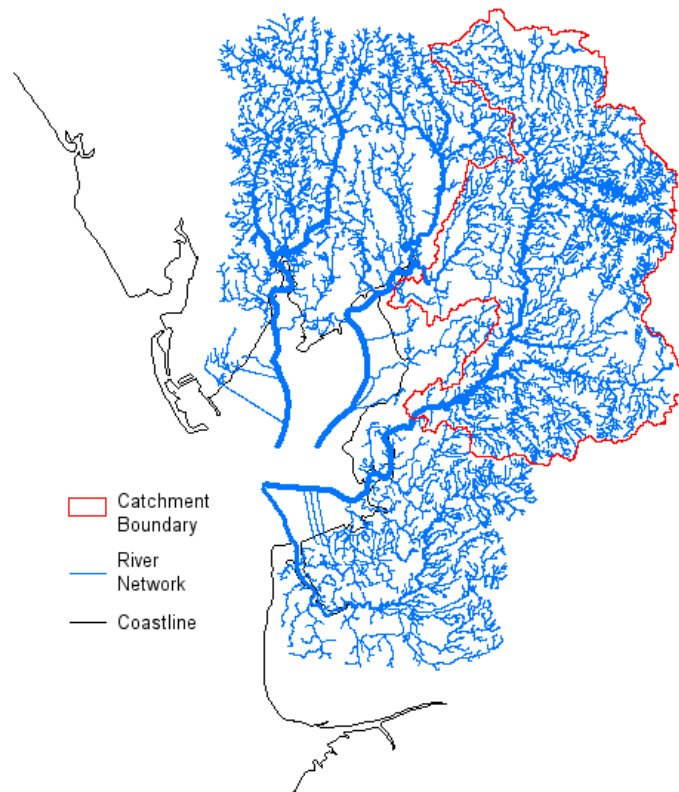


Figure 2. 2. Catchment 88020376 in the North West region(EA region).

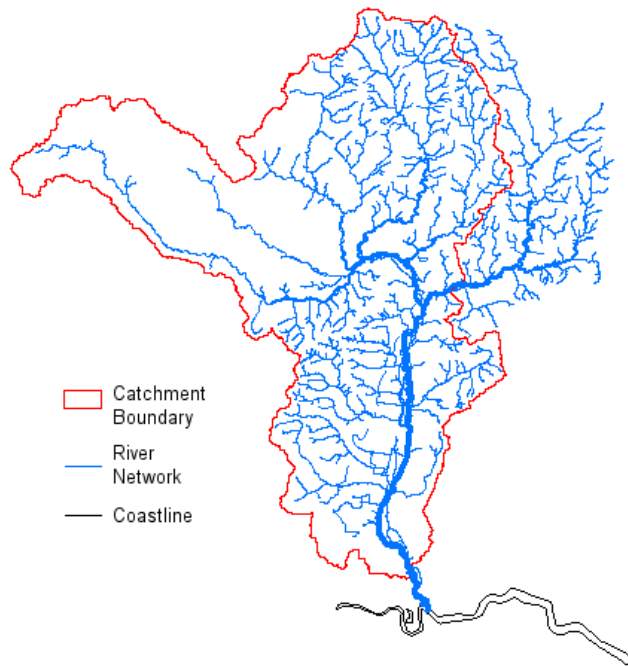


Figure 2. 3. Catchment PLER0057 in the Thames region (EA region).

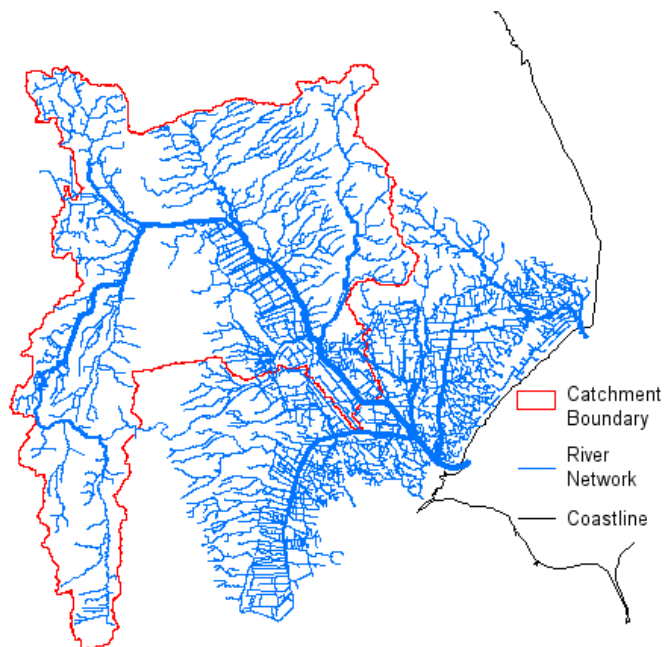


Figure 2. 4. Catchment WITHAM in the Anglian region (EA region).

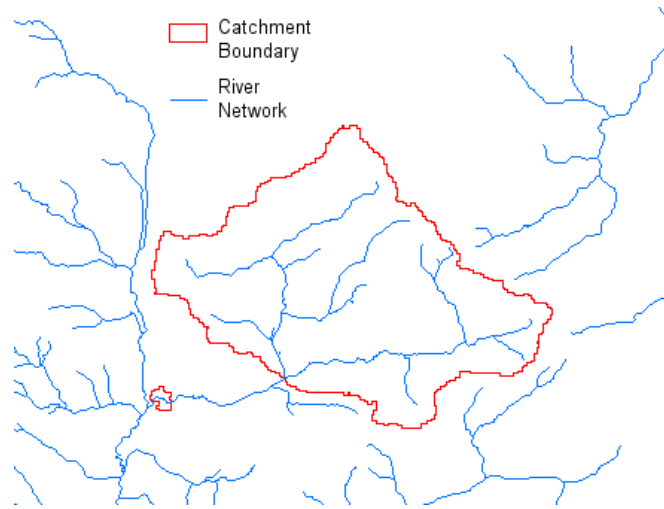


Figure 2. 5. Catchment 51113100 in the Midlands region (EA region).