Appendix H:
Detailed Results

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APPENDIX H1 – DETAILED DATA SUMMARY: CONCENTRATION

This appendix presents a detailed summary of the data used to prepare the report including summary statistics (i.e., minimum, maximum, mean, and median) for concentration data (Table 1), as well as figures that provide a comparison of influent and effluent results for each parameter. Data included here were validated, as described in Appendix G2. Sampling locations include the inlet and outlets of the east and west bioretention facilities (EBI, EBO, WBI, WBO), the inlet to the wetland complex (WCI), the combined outlet of the wetland complex and the east bioretention facility (WCEBO), and the North Fork of West Hylebos Creek, downstream of the detention facility. Note: the location code for the North Fork West Hylebos Creek site has been shortened here from NFWHC to NWH.

Table 1. Summary of validated nutrient and bacteria data at each sampling location.

		EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
Total Phosphorus (mg/L)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	0.0212	0.369	0.0222	1.05	0.0382	0.0433	0.0364
	Max	0.0483	1.30	0.0444	3.83	0.0977	0.0767	0.107
	Mean	0.0319	0.711	0.0317	2.40	0.0630	0.0606	0.0562
	Median	0.0294	0.691	0.0329	2.48	0.0569	0.0596	0.0528
Total Nitrogen (mg/L)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	0.161	0.445	0.180	1.48	0.382	0.273	0.561
	Max	0.459	2.38	0.476	6.52	0.774	0.517	1.00
	Mean	0.304	1.21	0.299	3.26	0.569	0.423	0.664
	Median	0.296	1.15	0.255	2.89	0.567	0.434	0.616
Ortho-phosphate P (µg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.00429 J	0.284 J	0.00445 J	0.930 J	0.00286 J	0.0134 J	0.0117 J
	Max	0.0211 J	1.01 J	0.0207 J	3.13 J	0.0131 J	0.0343 J	0.0263 J
	Mean	0.0105 J	0.610 J	0.0108 J	1.97 J	0.00664 J	0.0234 J	0.0172 J
	Median	0.0102 J	0.603 J	0.00987 J	2.02 J	0.00508 J	0.0221 J	0.0167 J
Nitrate/nitrite N (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.0526	0.123	0.0539	0.0899	0.0909	0.0400	0.212
	Max	0.166	0.834	0.171	4.25	0.260	0.204	0.403
	Mean	0.0974	0.417	0.0995	1.20	0.154	0.133	0.293
	Median	0.0962	0.379	0.0879	0.851	0.152	0.147	0.294
Ammonia N (mg/L)	FOD	16/17	18/18	17/18	18/18	18/18	18/18	18/18
	Min	0.0020 U	0.0333	0.0020 U	0.147	0.0489	0.0112	0.0028 J
	Max	0.0928	0.22	0.0901	0.687	0.164	0.129	0.0778
	Mean	0.0444 J	0.0777 J	0.0423 J	0.322 J	0.0968	0.0450	0.0219 J
	Median	0.0387	0.0556	0.0388	0.254	0.0962	0.0351	0.0147
Fecal Coliform (CFU/100mL)	FOD	10/10	10/10	10/10	10/10	10/10	10/10	10/10
	Min	9	23	9	1	80	10 J	4
	Max	1,900 J	200 J	1,500 J	410 J	1,100	900 J	410 J
	Mean	348 J	57 J	305 J	66 J	519 J	198 J	101 J
	Median	102 J	45 J	100 J	7	515 J	94	53 J

P – phosphorus; N –nitrogen; CFU – colony forming unit;
FOD – frequency of detection; J – estimated value; U – non-detect

Table 2. Summary of validated data for conventional parameters at each sampling location.

		EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
TSS (mg/L)	FOD	17/17	18/18	18/18	17/18	18/18	18/18	18/18
	Min	1.22	0.84 J	1.68	0.74 J	9.79	2.80	3.33
	Max	14.5	6.24	14.2	14.8	61.2	22.4	27.3
	Mean	5.34	2.32 J	5.70	4.68 J	36.7	10.0	13.3
	Median	4.74	1.95	4.43	2.72	37.2	8.12	12.1
TOC (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	1.10	2.67	1.24 J	6.49	1.59	2.29	3.94
	Max	3.01	13.9	3.16	33.8	7.40	4.44	10.3
	Mean	1.74	6.62	1.86 J	16.3	4.75	3.25	6.15
	Median	1.62	5.95	1.65	14.2	5.04	3.23	5.85
DOC (mg/L)	FOD	17/17	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.71 J	1.18	0.86 J	6.41	1.14	1.66	3.59
	Max	2.81	13.5	3.10	28.1	4.05	4.45	8.69
	Mean	1.54 J	6.53	1.79 J	15.1	2.58	2.97	5.28
	Median	1.54	5.84	1.75 J	14.1	2.57	2.97	4.92
Turbidity (NTU)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	2.38	2.20 J	2.85	2.55	10.5	4.55	4.72
	Max	12.9	9.23	12.5	17.9	56.8	41.1	35.7
	Mean	6.47 J	4.75 J	6.63 J	6.08 J	29.4 J	16.0 J	14.9 J
	Median	6.12	4.40	5.90	4.69 J	27.9	12.5	14.0
Conductivity (µmhos/cm)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	19.1	37.7	19.5	71.7	27.2	37.5	87.1
	Max	223	246	211	376	140	267	272
	Mean	52.6	88.4	53.9	146	51.2	83.2	134
	Median	27.1	69.4	26.7	119	40.1	68.8	125
pH (pH units)	FOD	17/17	18/18	17/17	18/18	18/18	18/18	18/18
	Min	6.50 J	6.45 J	6.48 J	6.37 J	6.58 J	6.53 J	7.06 J
	Max	7.33 J	7.10 J	7.13 J	7.16 J	7.21 J	7.35 J	7.71 J
	Mean	6.96 J	6.81 J	6.90 J	6.72 J	7.00 J	7.02 J	7.45 J
	Median	6.98 J	6.82 J	6.97 J	6.74 J	7.05 J	7.09 J	7.49 J
Hardness (mg $CaCO_3$/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	4.71	7.85	4.89	14.4	10.4	12.6	30.2
	Max	12.7	44.8	12.3	82.0	28.5	36.0	70.1
	Mean	7.34	19.2	7.51	38.7	14.9	20.5	47.9
	Median	7.44	18.0	7.74	33.9	14.5	19.9	46.5

TSS – total suspended solids; TOC – total organic carbon; DOC – dissolved organic carbon;
DO – dissolved oxygen; FOD – frequency of detection; J – estimated value

Table 3. Summary of validated metals data at each sampling location.

		EBI	EBO	WBI	WBO	WCI	WCEBO	NWH
Total Cadmium (µg/L)	FOD	1/18	4/18	1/18	9/18	13/18	3/18	4/18
	Min	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
	Max	0.072 J	0.12 J	0.11 J	0.19 J	0.10 J	0.093 J	0.072 J
	Mean	NC	0.056 J	NC	0.072 J	0.066 J	0.054 J	0.053 J
	Median	NC	0.050 U	NC	0.053 J	0.063 J	0.050 U	0.050 U
Total Copper (µg/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	1.9 J	1.8 J	2.03	2.60	5.77	3.76	2.45
	Max	5.95	8.30	6.55	17.0	15.3	8.11	6.38
	Mean	3.73 J	4.35 J	3.79	6.29	10.2	5.49	3.99
	Median	3.54	4.07	3.52	5.67	10.6	5.21	3.86
Total Lead (µg/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.21 J	0.20 J	0.25 J	0.30 J	1.27	0.44 J	0.557
	Max	1.52	0.823	1.46	2.08	6.23	2.30	3.88
	Mean	0.683 J	0.45 J	0.672 J	0.961 J	3.69	1.22 J	1.61
	Median	0.624	0.43 J	0.607	0.858	3.58	1.29	1.52
Total Zinc (µg/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	17.1	3.62	18.9	6.08	41.9	34.3	16.7
	Max	38.4	6.34	35.1	16.2	97.3	67.7	44.8
	Mean	26.8	4.89	26.7	9.26	65.4	44.3	26.9
	Median	26.2	4.78	26.1	8.28	63.8	40.5	26.0
Dissolved Cadmium (µg/L)	FOD	0/18	0/18	1/18	5/18	0/18	2/18	0/18
	Min	NC	NC	0.050 U	0.050 U	NC	0.050 U	NC
	Max	0.050 U	0.050 U	0.070 J	0.150 J	0.050 U	0.064 J	0.050 U
	Mean	NC	NC	NC	0.058 J	NC	NC	NC
	Median	NC	NC	NC	0.050 U	NC	NC	NC
Dissolved Copper (µg/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	0.94 J	1.6 J	0.99 J	2.08 J	2.05 J	2.62 J	1.7 J
	Max	4.27 J	7.09 J	4.80 J	14.1 J	5.36 J	5.94 J	5.52 J
	Mean	2.51 J	3.91 J	2.59 J	5.71 J	3.34 J	3.47 J	2.64 J
	Median	2.26 J	3.81 J	2.23 J	5.31 J	3.20 J	3.27 J	2.46 J
Dissolved Lead (µg/L)	FOD	3/18	16/18	2/18	18/18	14/18	17/18	18/18
	Min	0.10 U	0.10 U	0.10 U	0.12 J	0.10 U	0.10 U	0.13 J
	Max	0.11 J	0.560 J	0.11 J	1.14 J	0.37 J	0.683 J	0.34 J
	Mean	0.10 J	0.25 J	NC	0.641 J	0.15 J	0.19 J	0.22 J
	Median	0.10 U	0.23 J	NC	0.663 J	0.12 J	0.16 J	0.21 J
Dissolved Zinc (µg/L)	FOD	18/18	18/18	18/18	18/18	18/18	18/18	18/18
	Min	13.0 J	2.2 J	12.4 J	4.96 J	21.0 J	28.2 J	12.3 J
	Max	27.2 J	4.86 J	27.1 J	13.9 J	47.0 J	54.0 J	25.3 J
	Mean	19.9 J	3.46 J	20.1 J	7.79 J	28.0 J	33.2 J	15.4 J
	Median	18.9 J	3.51 J	19.0 J	7.43 J	27.0 J	30.8 J	14.8 J

FOD – frequency of detection; NC – not calculated due to low sample number; U – not-detect; J – estimated value

Table 4. Summary of validated organic contaminant data at each sampling location.

		EBI		EBO		WBI		WBO		WCI		WCEBO		NWH	
Total PAHs (µg/L)	FOD	11/17		5/18		11/17		4/18		18/18		13/18		12/18	
	Min	0.0078	J	0.0070	J	0.0094	U	0.0056	J	0.046	J	0.0094	U	0.0094	U
	Max	0.0967	J	0.0451	J	0.113	J	0.024	U	0.641	J	0.238	J	0.078	J
	Mean	0.0283	J	0.014	J	0.0299	J	0.012	J	0.303	J	0.054	J	0.022	J
	Median	0.0158	J	0.0094	U	0.0146	J	0.0094	U	0.287	J	0.030	J	0.018	J
Total PCBs (pg/L)	FOD	15/15		15/15		13/13		13/13		15/15		15/15		15/15	
	Min	203	J	7.89	J	199	J	1.73	J	27.0	J	70.4	J	224	J
	Max	6,200	J	1,230	J	2,440	J	665	J	3,910	J	1,890	J	3,220	J
	Mean	919	J	230	J	733	J	178	J	1,610	J	525	J	970	J
	Median	551	J	111	J	529	J	112	J	1,290	J	406	J	541	J

FOD – frequency of detection; U – not-detect; J – estimated value

Figures of Results by Facility and by Location

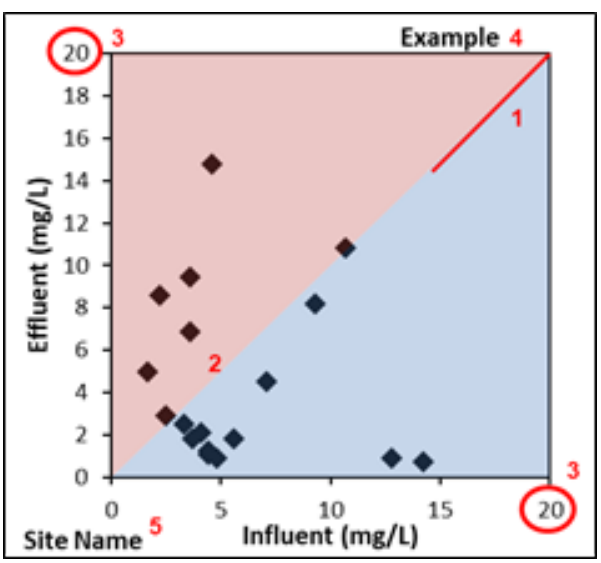
This section includes figures that summarize concentration results for each facility, including field measurements. Each page includes five figures that summarize results for a single parameter; box plots display the distribution of results for each site and four scatter plots compare influent and effluent concentrations. The example figures below provide explanations for the two figure types.

Scatter Plot Explanation:
These figures plot effluent versus influent concentrations for each sampling event at a given facility. Features of the plots are noted with red numbers and explained below.

1 – The middle line between the red and blue shading represents no change between influent and effluent concentrations, or a 1 to 1 ratio.
2 – Data points within the red shaded area represent samples with effluent concentrations that were higher than influent concentrations (> 1 to 1 ratio). Data points in the blue shaded area represent samplings with effluent concentrations that were lower than influent concentrations (< 1 to 1 ratio).
3 – Where possible, the x and y concentration scales and units are the same for each parameter across facilities to facilitate comparison. Exceptions are identified with red axis labels.
4 – Name of parameter
5 – Facility name:

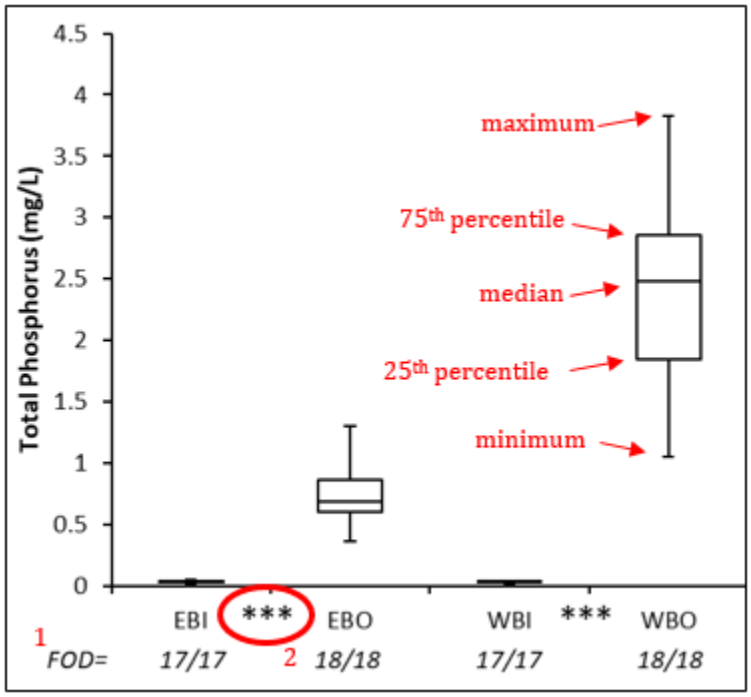
- East Bioretention (EB) = EBI vs. EBO
- West Bioretention (WB) = WBI vs. WBO
- Wetland Complex (WC*) = WCI vs. WCEBO
- Whole System* = WCI vs. NWH

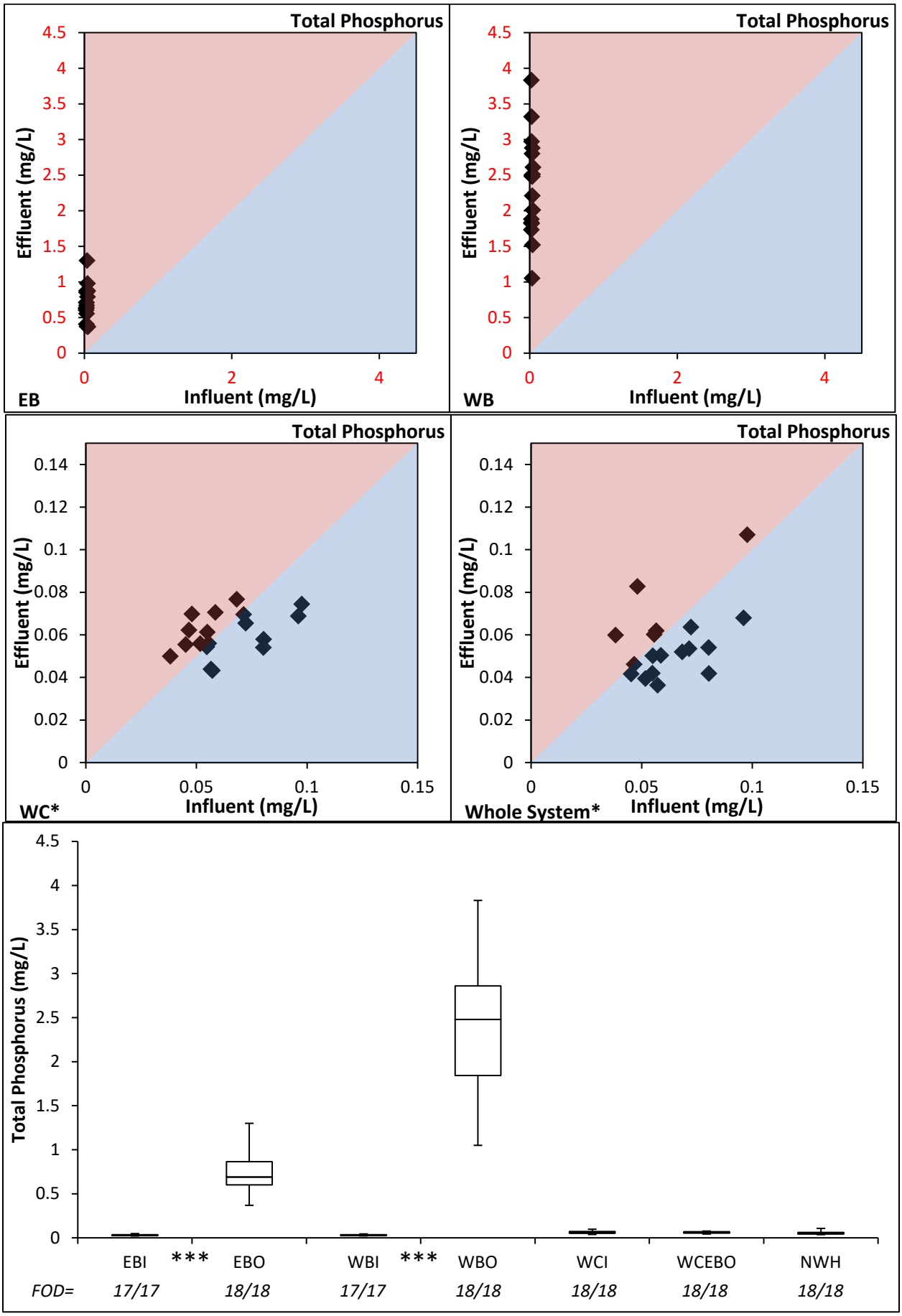
*These comparisons are not entirely representative of influent and effluent flows for these systems, but provide approximate estimates as described in Appendix A.
Note: Figures with several non-detect results include red lines indicating the method detection limit.



Box Plot Explanation:
Box plots illustrate the distribution of results for each site as indicated in the example figure below. Features of the plots are noted with red numbers and explained below.

1 – Frequency of detection (FOD): non-detects are included at the method detection limit (MDL) value.
2 – The asterisks indicate statistically significant differences between influent and effluent concentrations (i.e., EBI vs. EBO, WBI vs. WBO, WCI vs. WCEBO): *** = p<0.001, ** = p<0.01, * = p<0.05. See Appendix E for statistical methods descriptions.

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Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
Total Phosphorus (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
***
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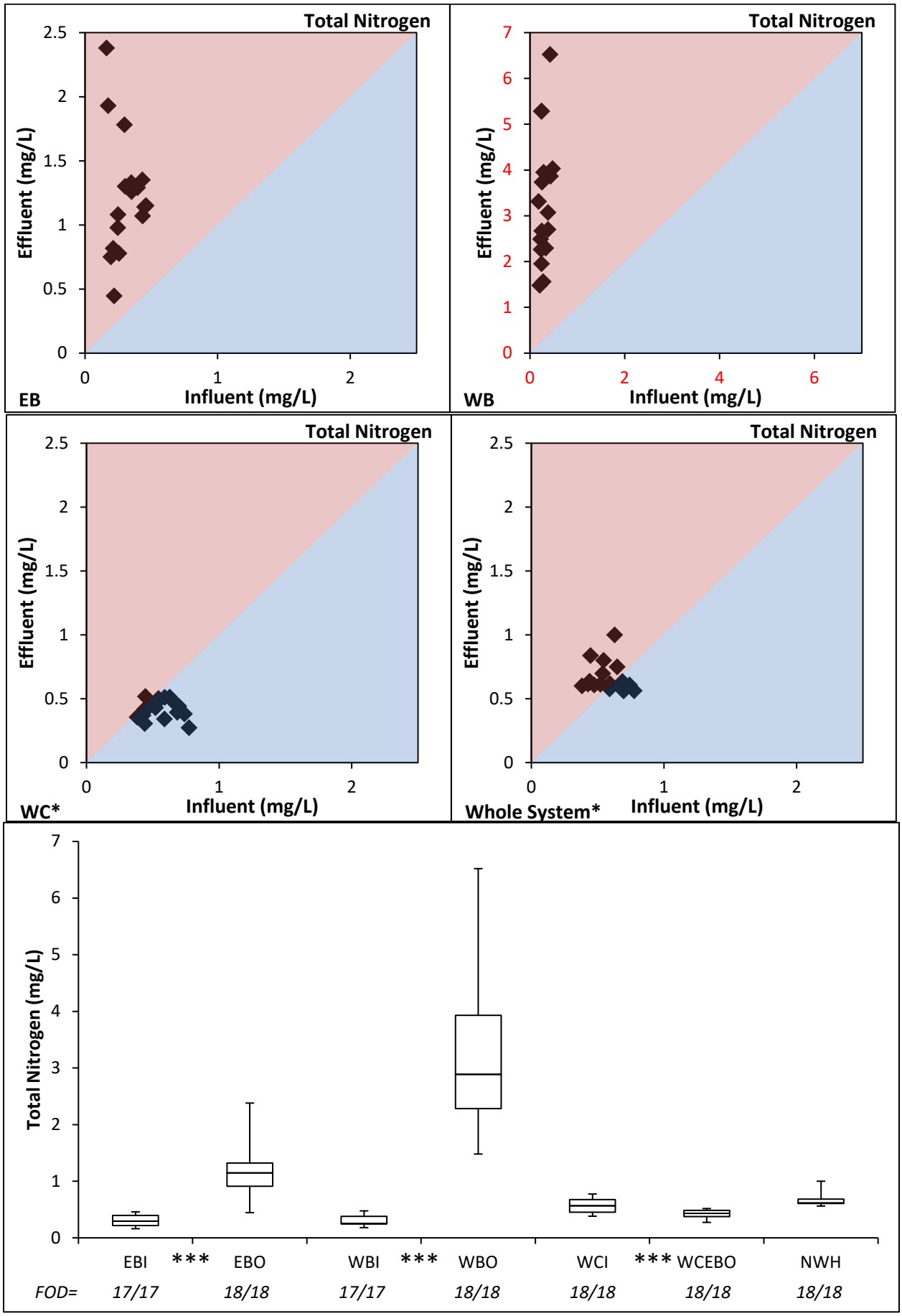
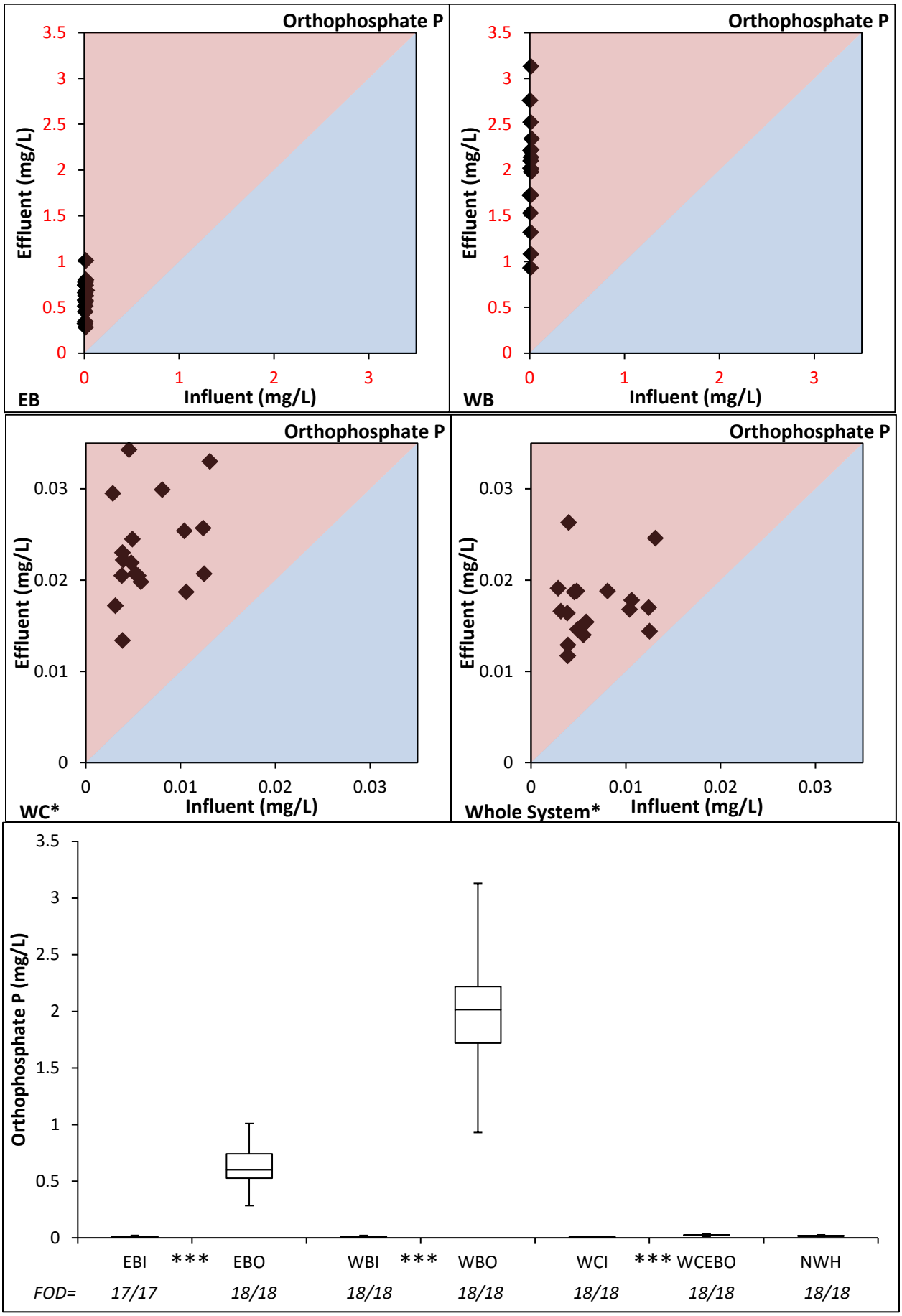
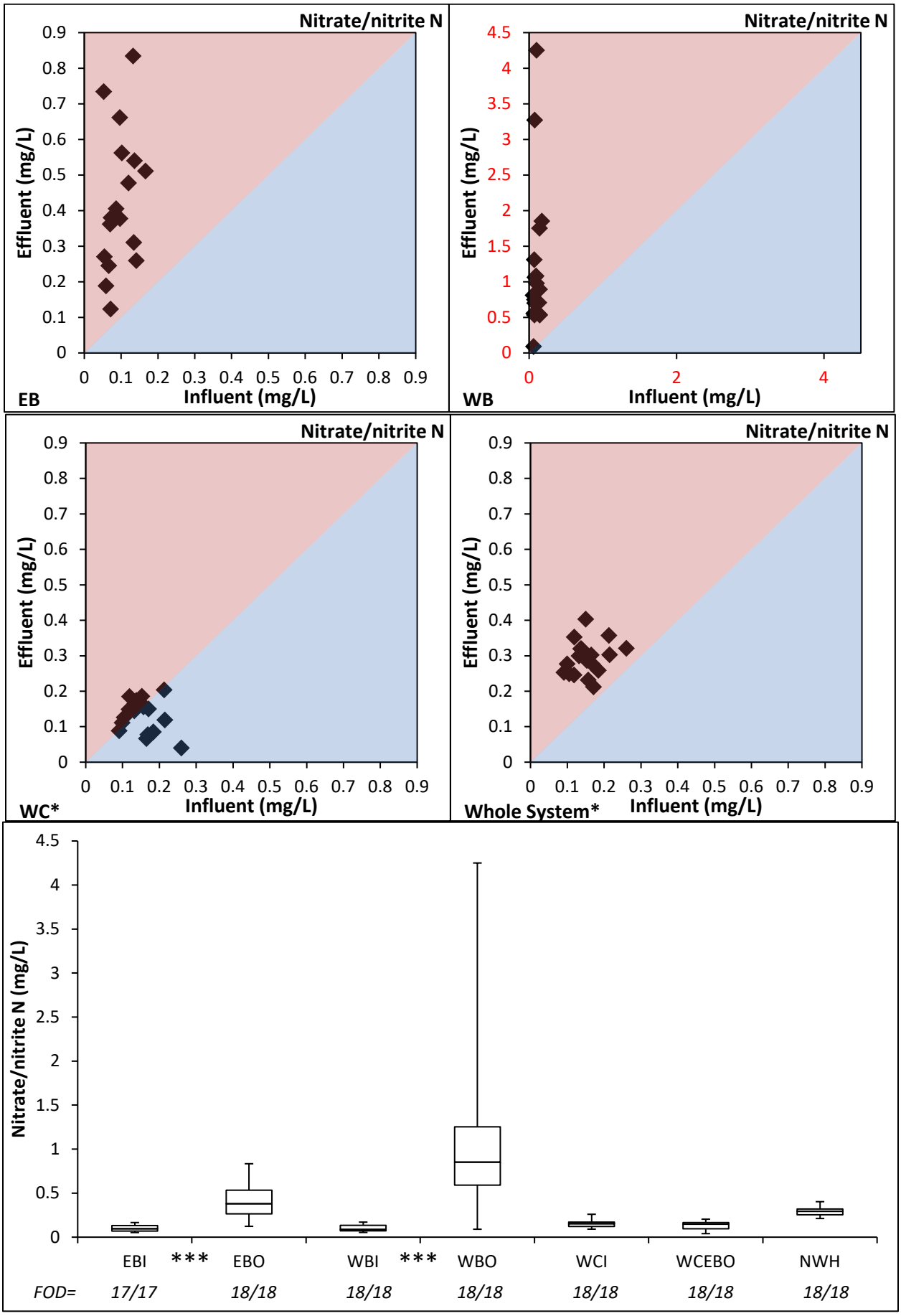
17/17
18/18
17/17
18/18
18/18
18/18
18/18


Total Nitrogen
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
Total Nitrogen (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18


Orthophosphate P
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
Orthophosphate P (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
FOD=
17/17
18/18
18/18
18/18
18/18
18/18
18/18


Nitrate/nitrite N
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
Nitrate/nitrite N (mg/L)
EBI
***
EBO
WBI
***
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
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18/18
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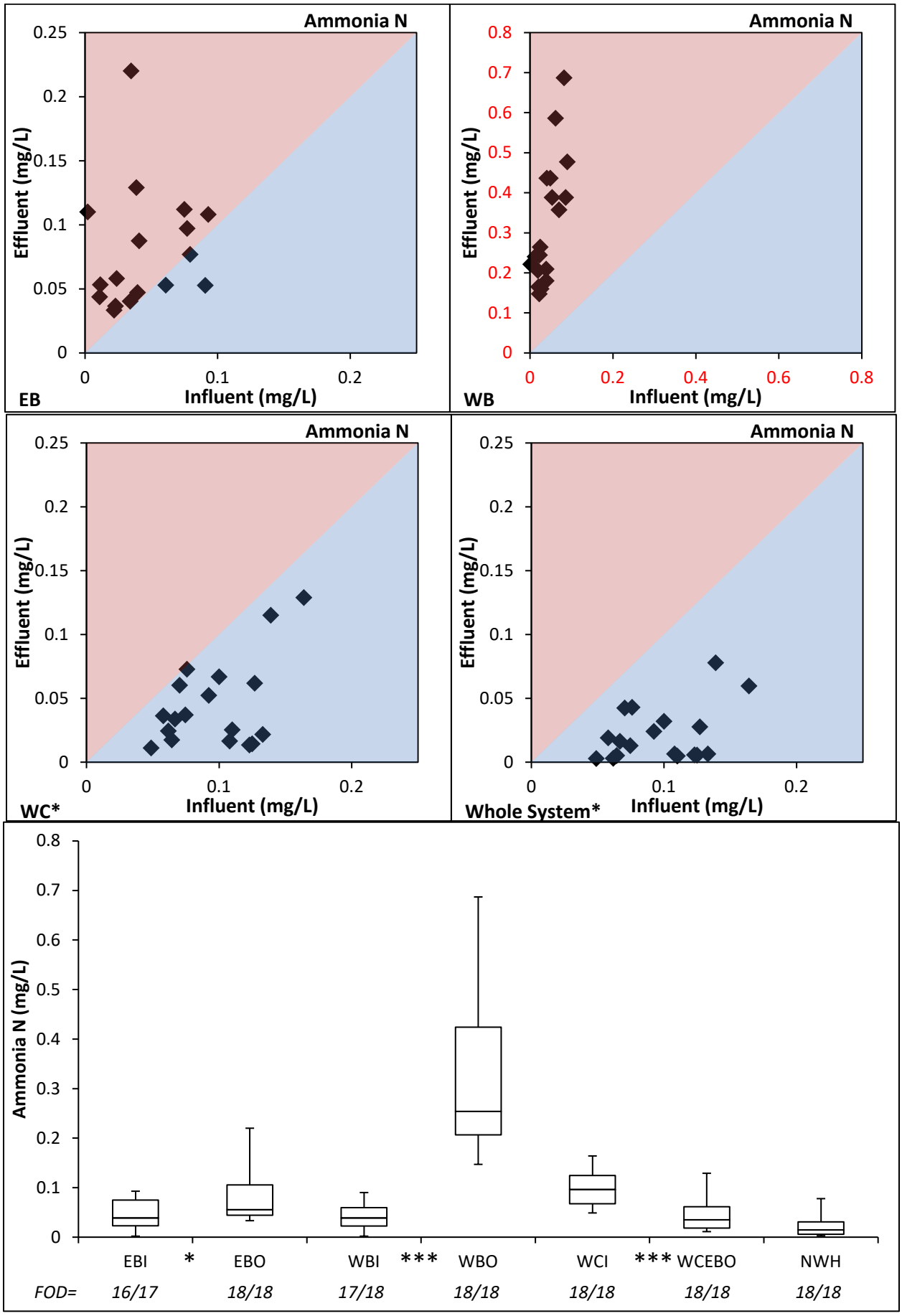
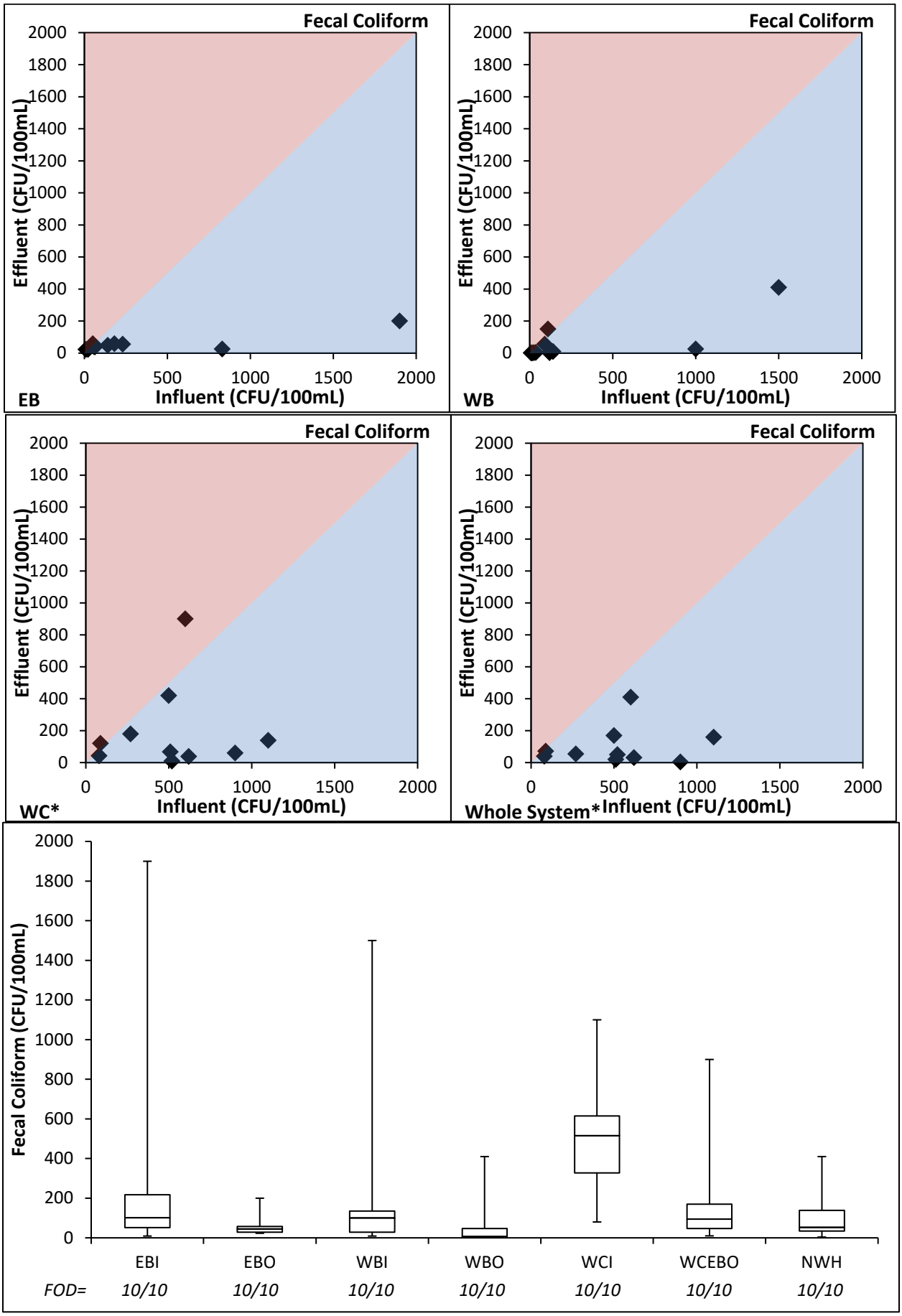
18/18
18/18


Ammonia N
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
Ammonia N (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
*
***
***
FOD=
16/17
18/18
17/18
18/18
18/18
18/18
18/18


Fecal Coliform
Effluent (CFU/100mL)
Influent (CFU/100mL)
EB
WB
WC*
Whole System*
Fecal Coliform (CFU/100mL)
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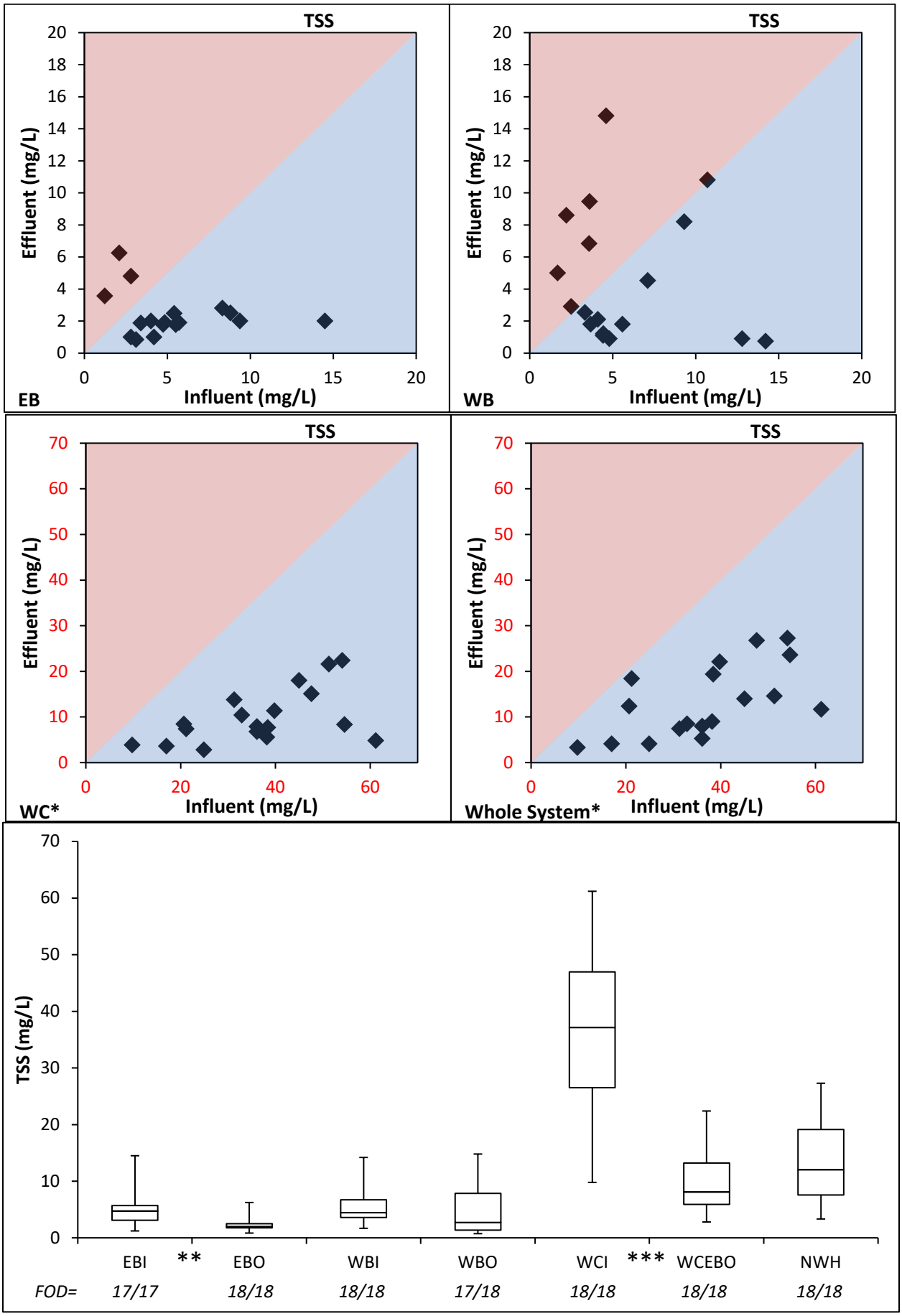
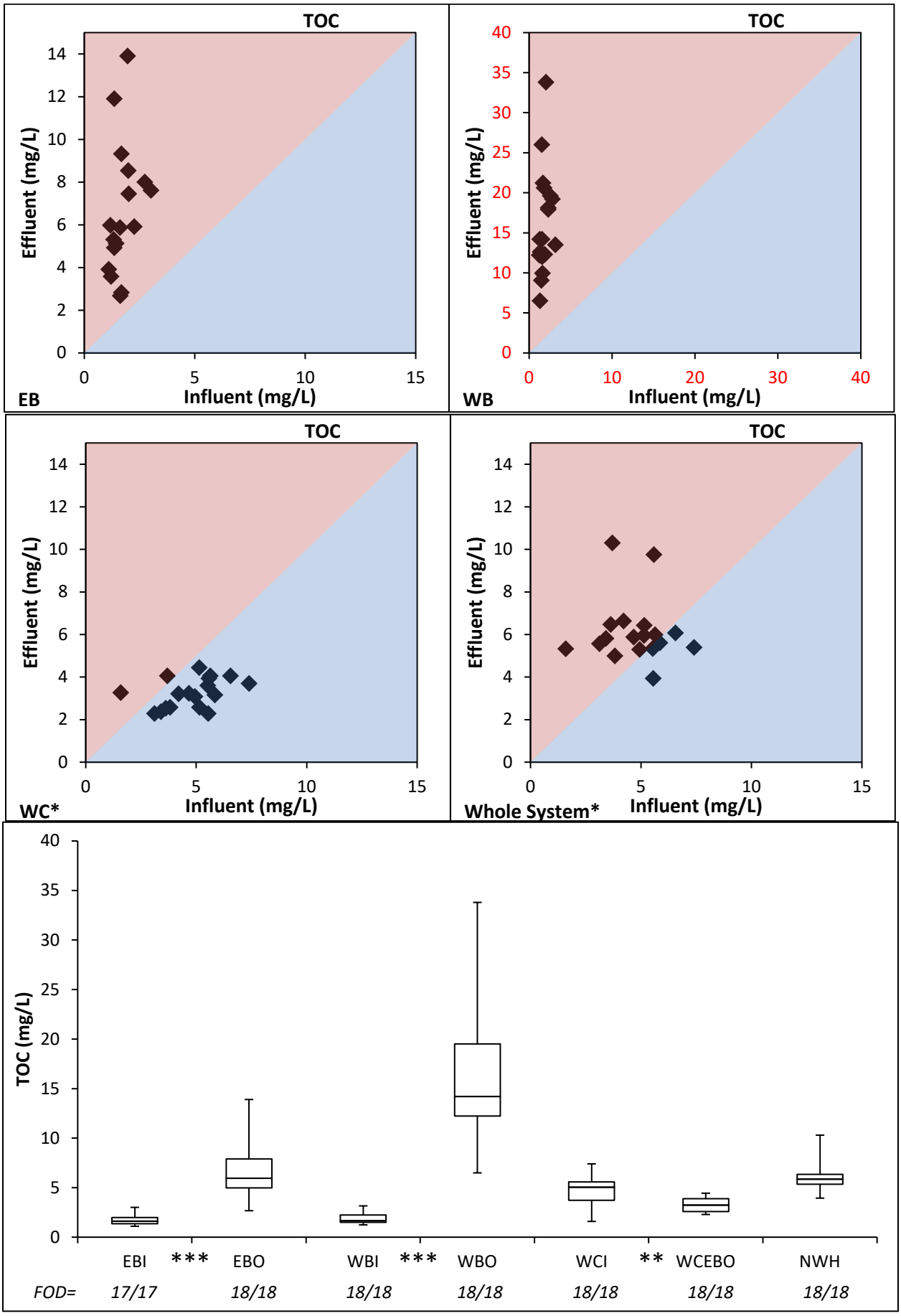
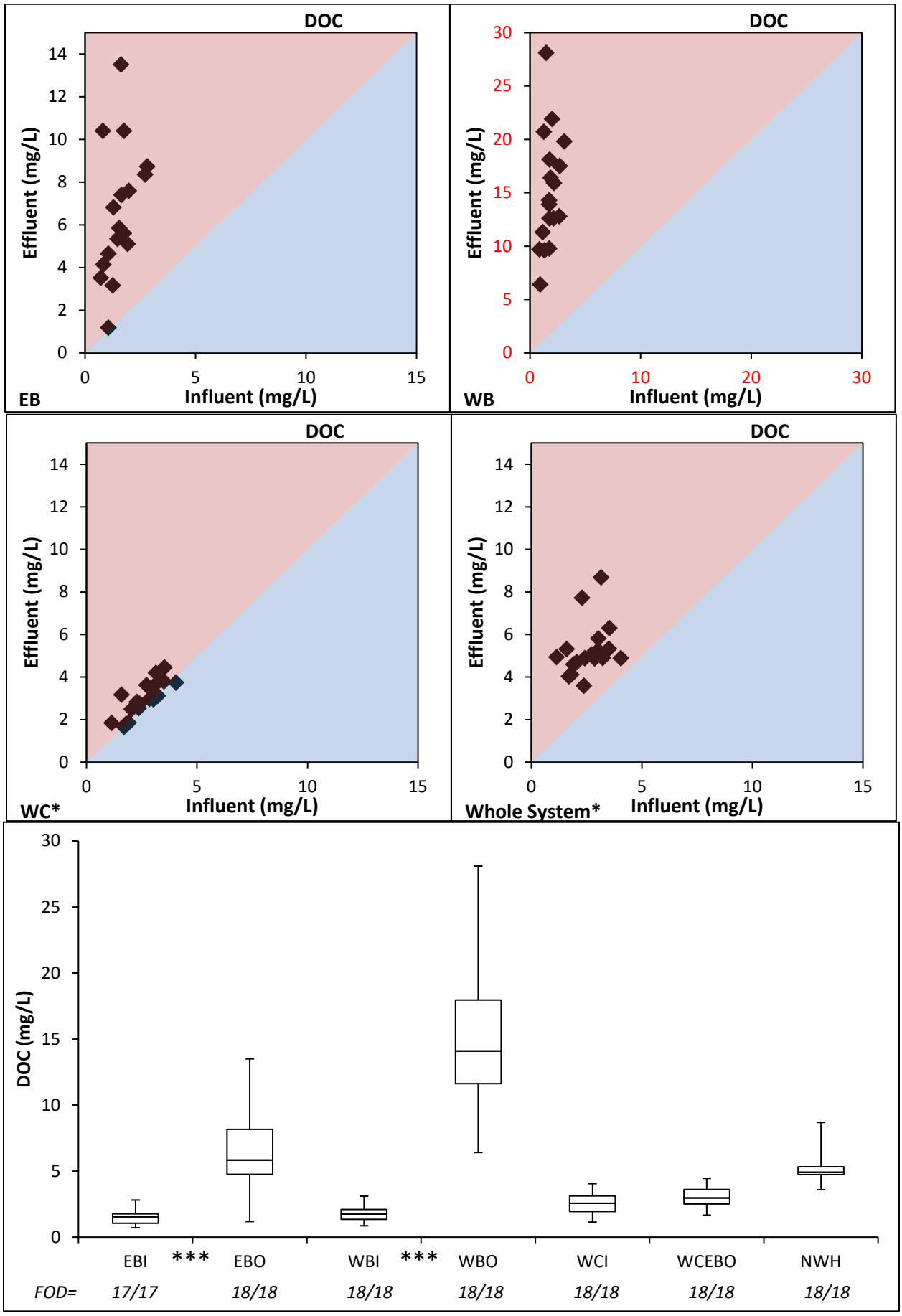
WBI
WBO
WCI
WCEBO
NWH
FOD=
10/10


TSS
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
TSS (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
**
***
FOD=
17/17
18/18
18/18
17/18
18/18
18/18
18/18


TOC
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
TOC (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
***
**
FOD=
17/17
18/18
18/18
18/18
18/18
18/18
18/18


DOC
Effluent (mg/L)
Influent (mg/L)
EB
WB
WC*
Whole System*
DOC (mg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
***
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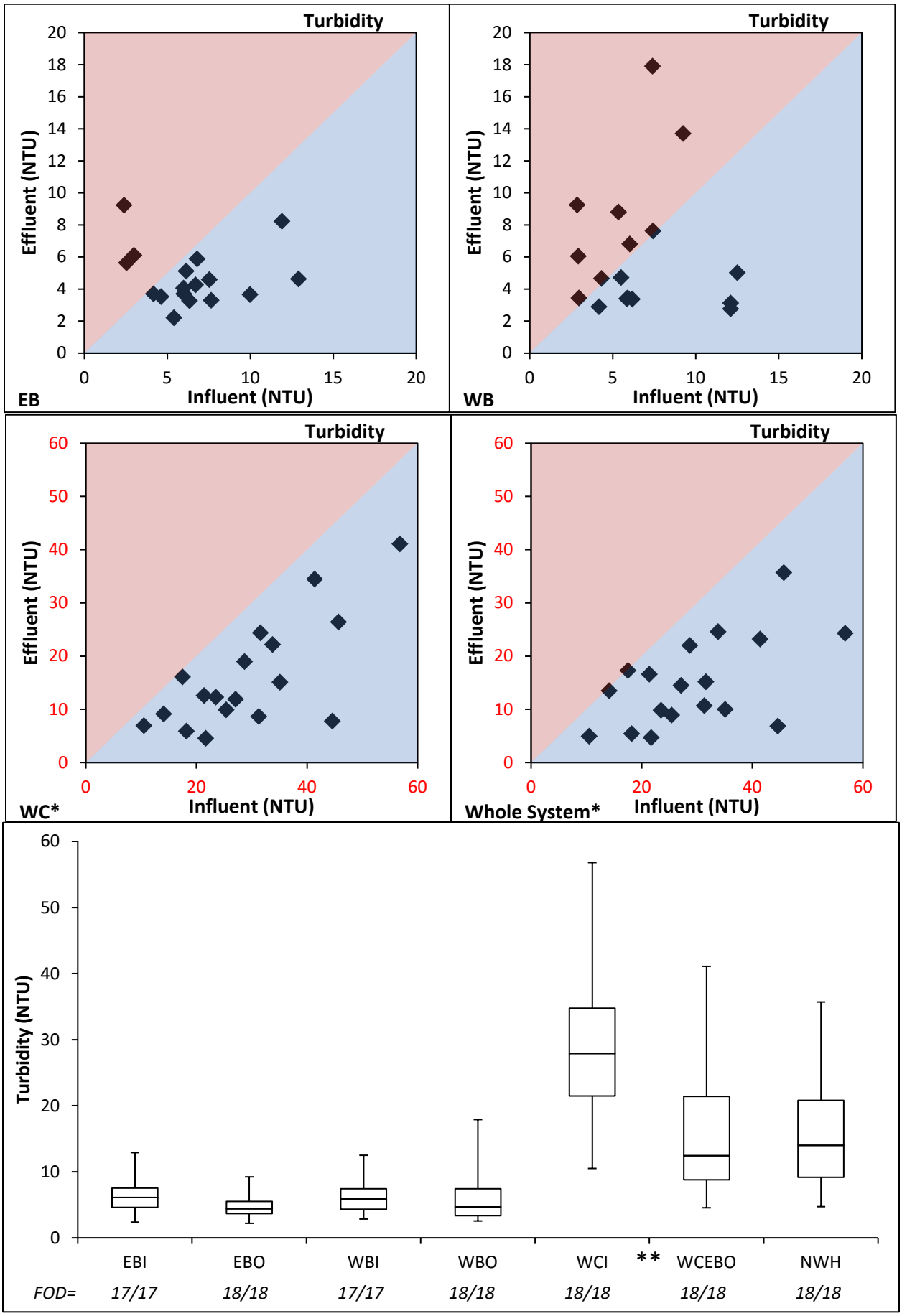
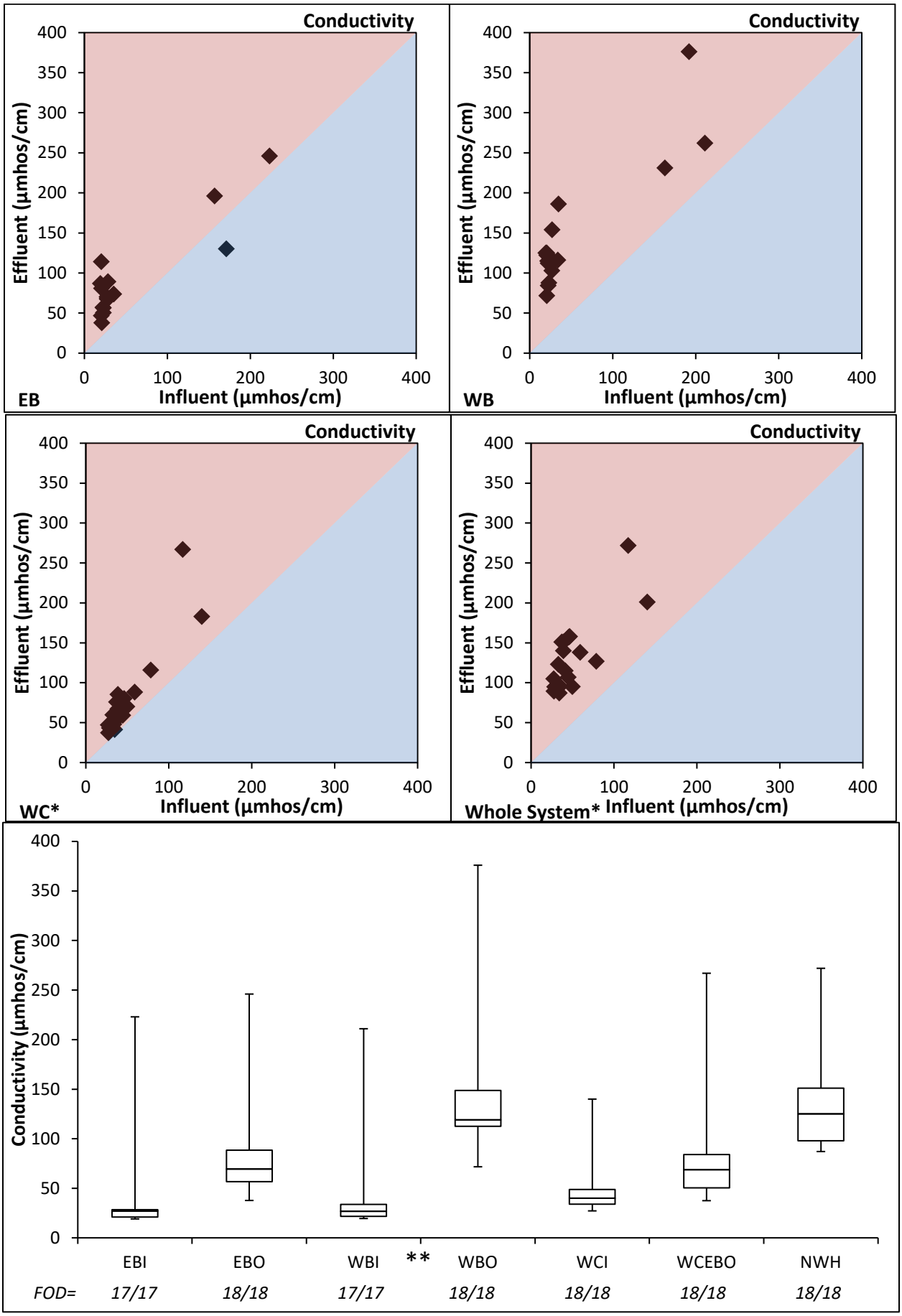
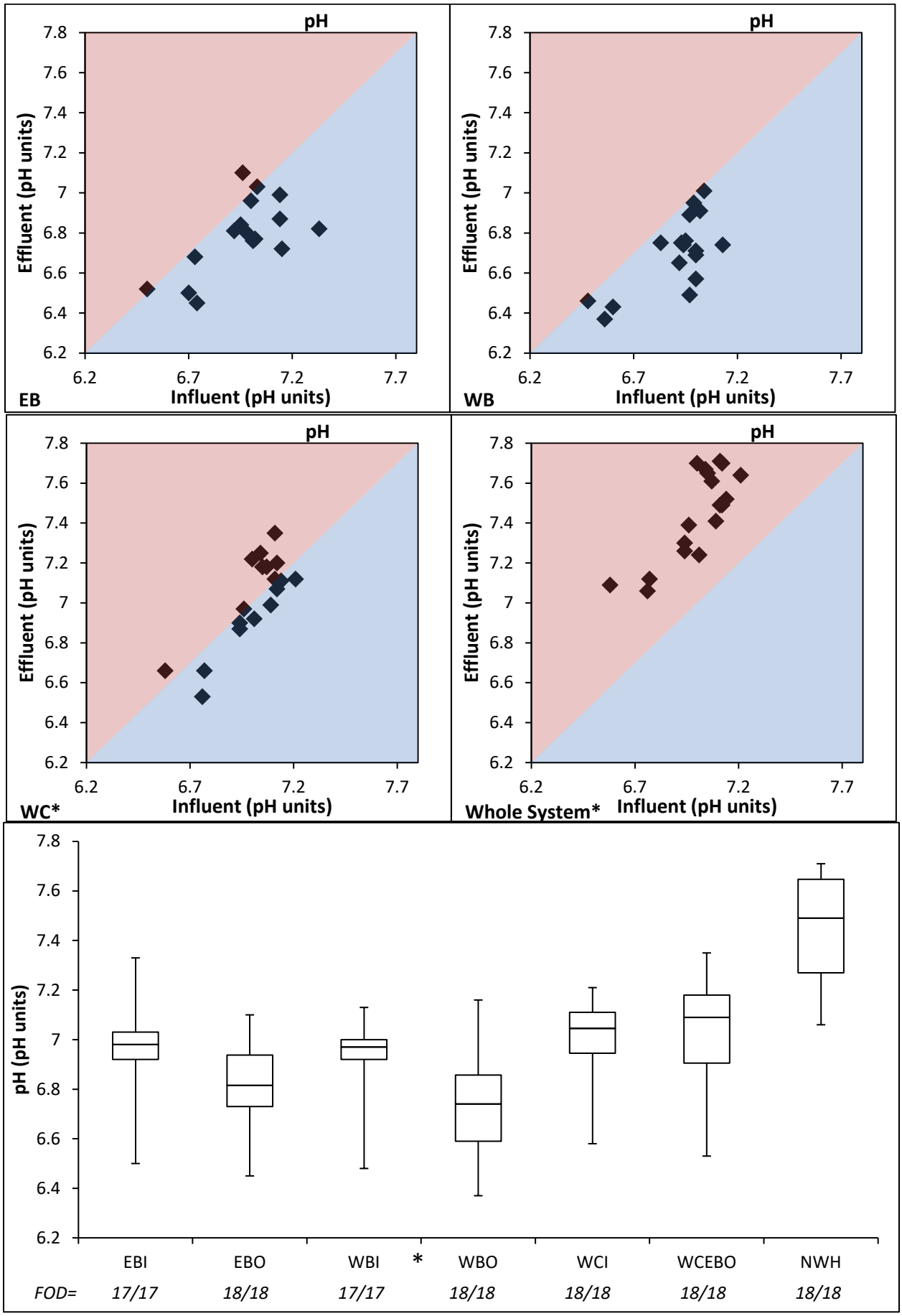
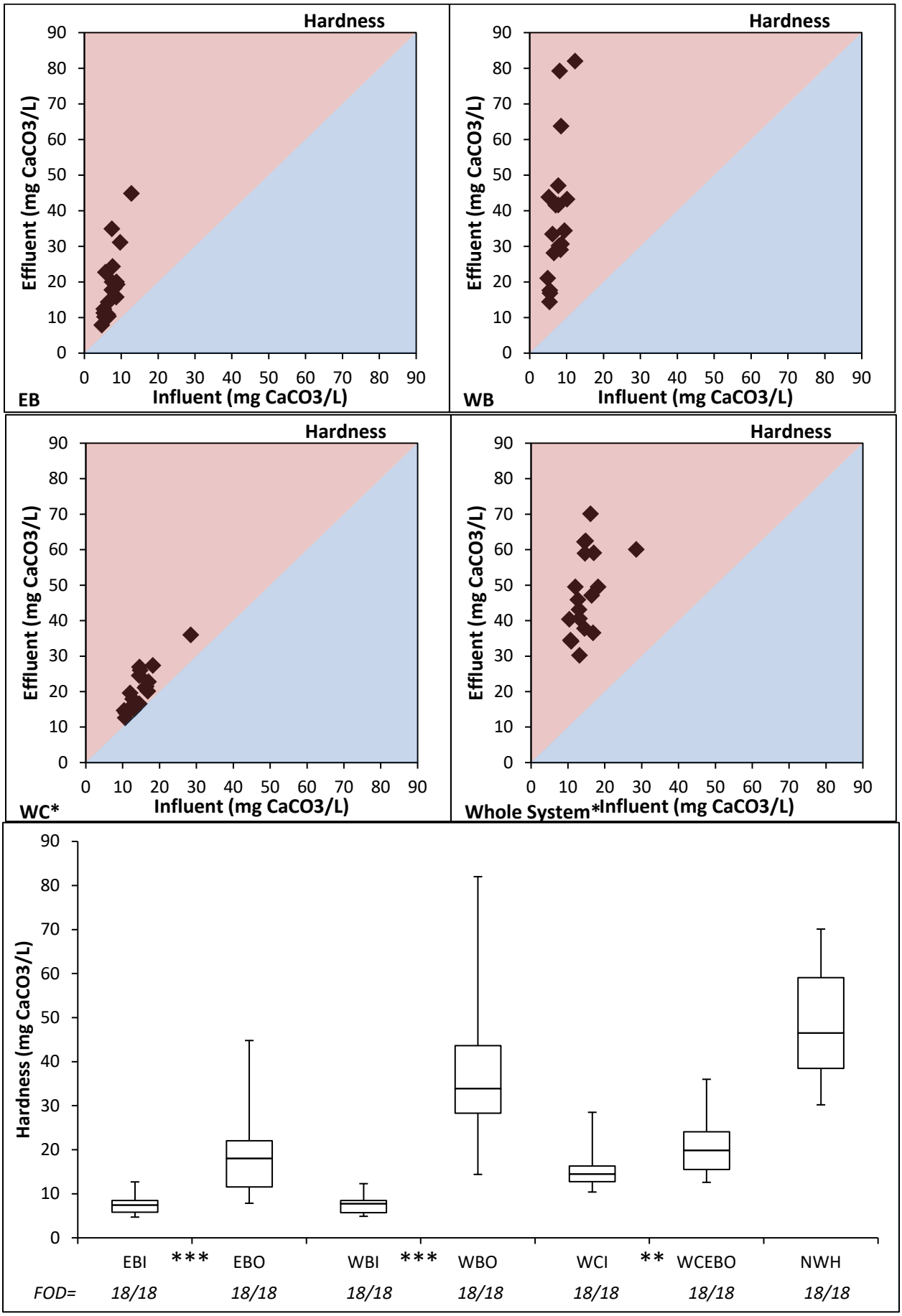
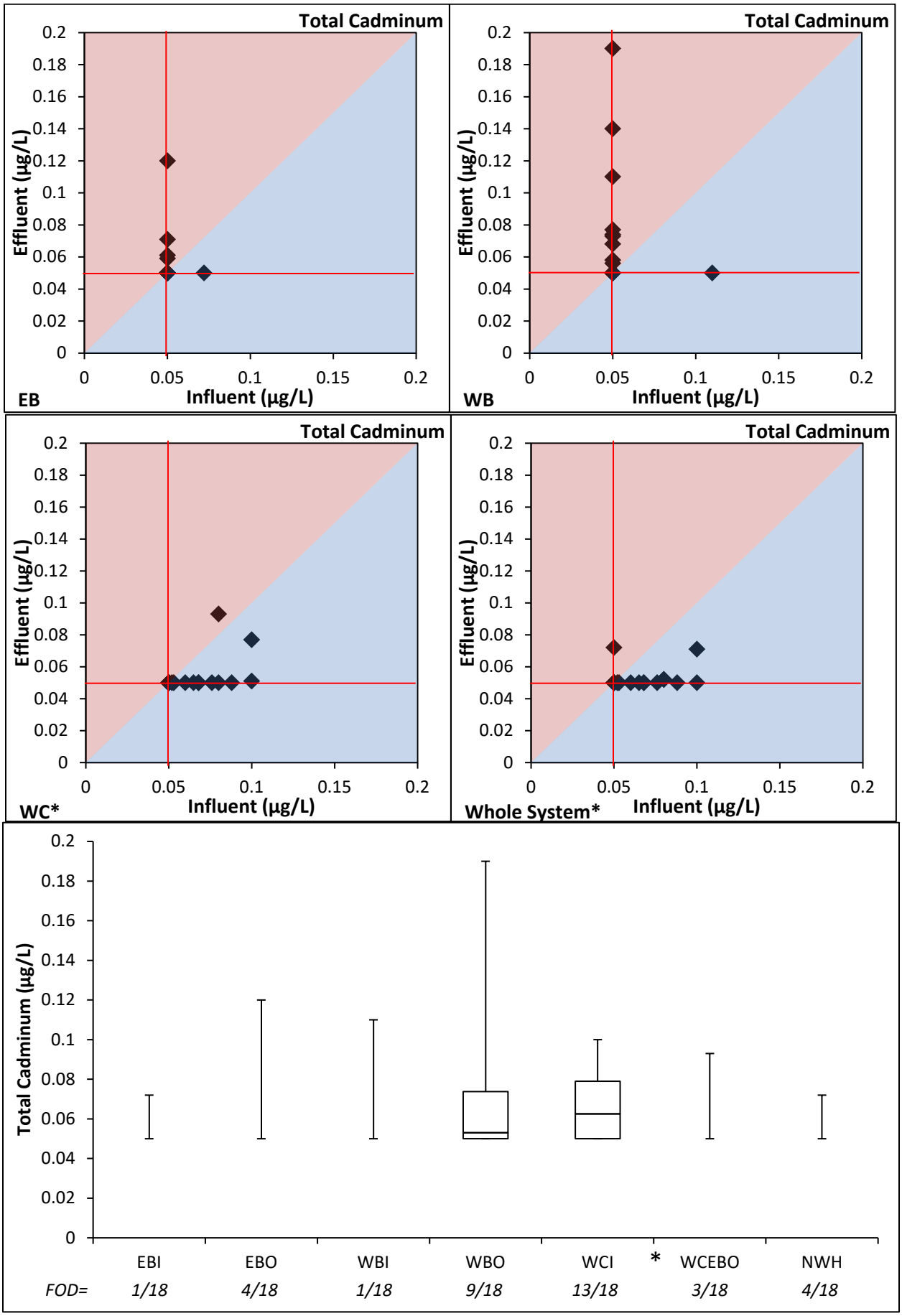
17/17
18/18
18/18
18/18
18/18
18/18
18/18

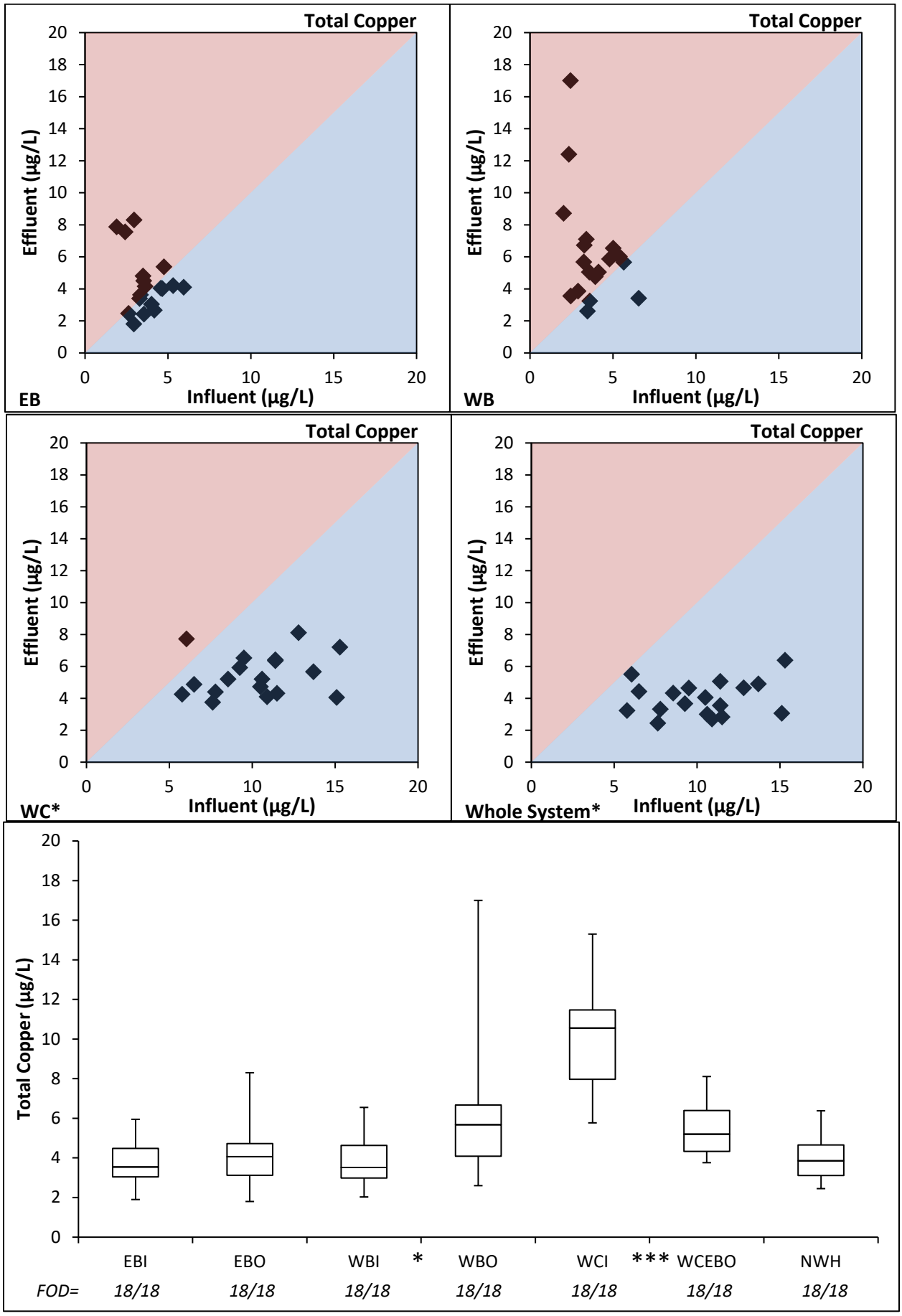

Turbidity
Effluent (NTU)
Influent (NTU)
EB
WB
WC*
Whole System*
Turbidity (NTU)
EBI
EBO
WBI
WBO
WCI
**
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

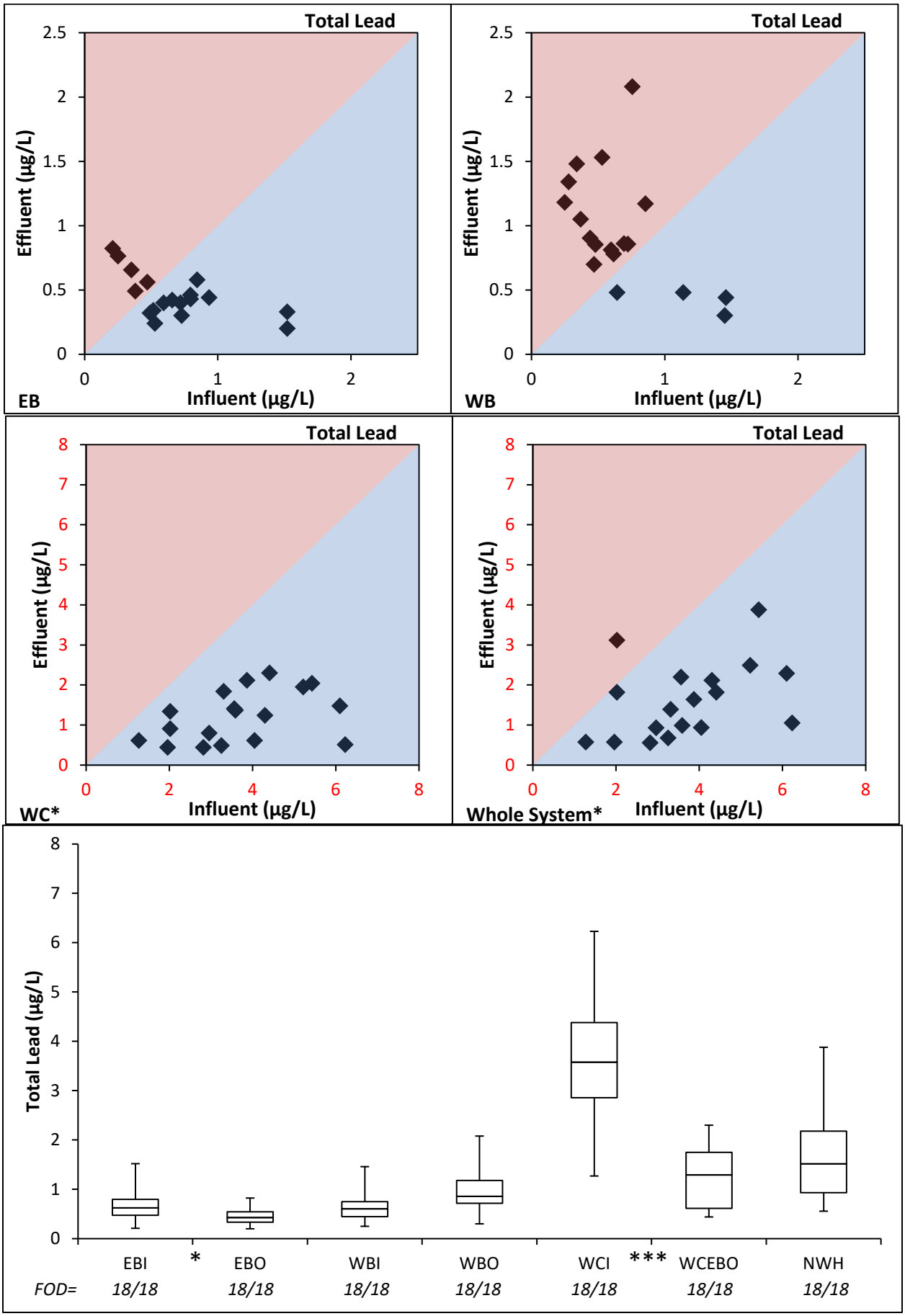

Conductivity
Effluent (µmhos/cm)
Influent (µmhos/cm)
EB
WB
WC*
Whole System*
Conductivity (µmhos/cm)
EBI
EBO
WBI
**
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

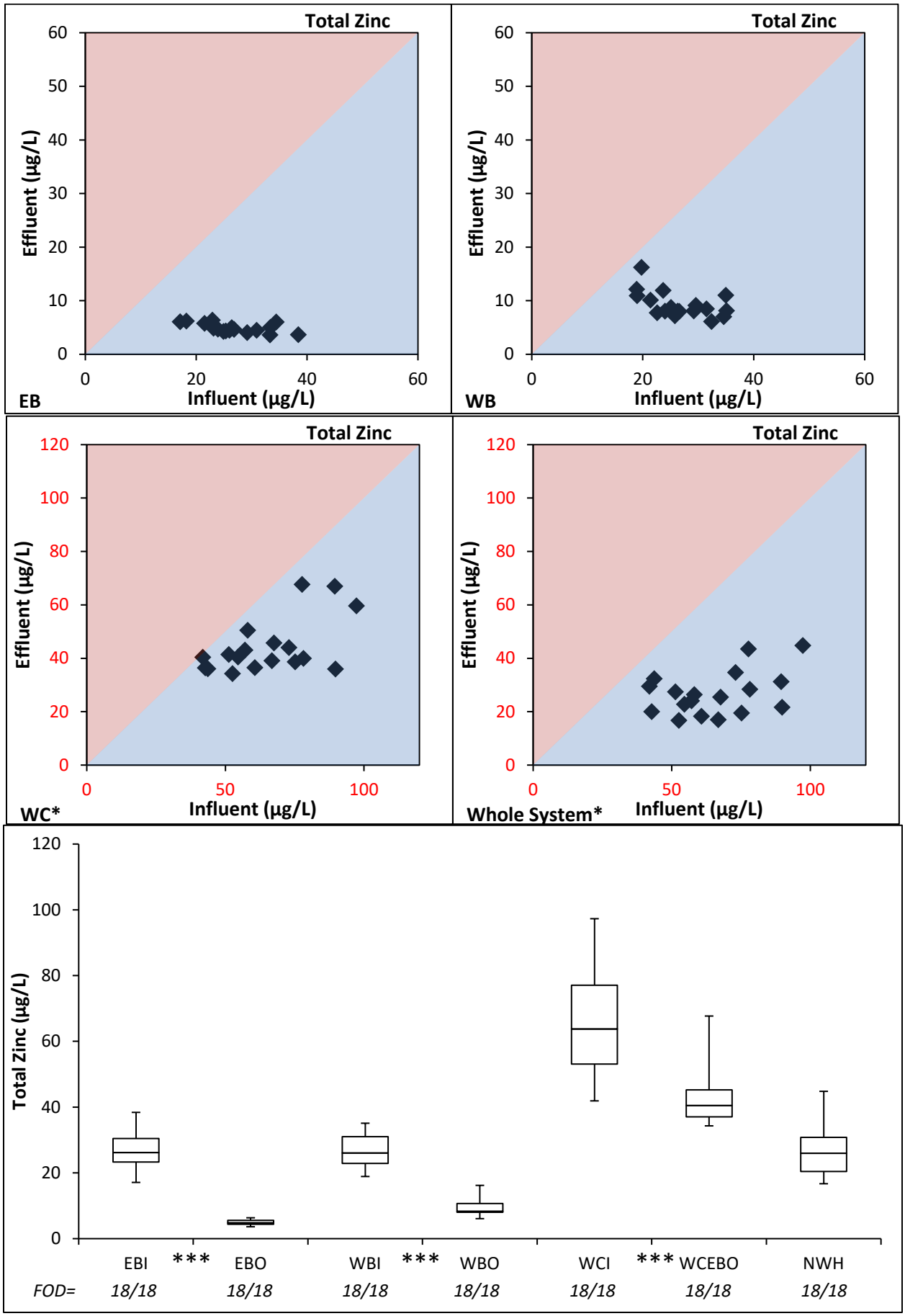

pH
Effluent (pH units)
Influent (pH units)
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6.2
6.7
7.2
7.7
EB
WB
WC*
Whole System*
pH (pH units)
EBI
EBO
WBI
*
WBO
WCI
WCEBO
NWH
FOD=
17/17
18/18
17/17
18/18
18/18
18/18
18/18

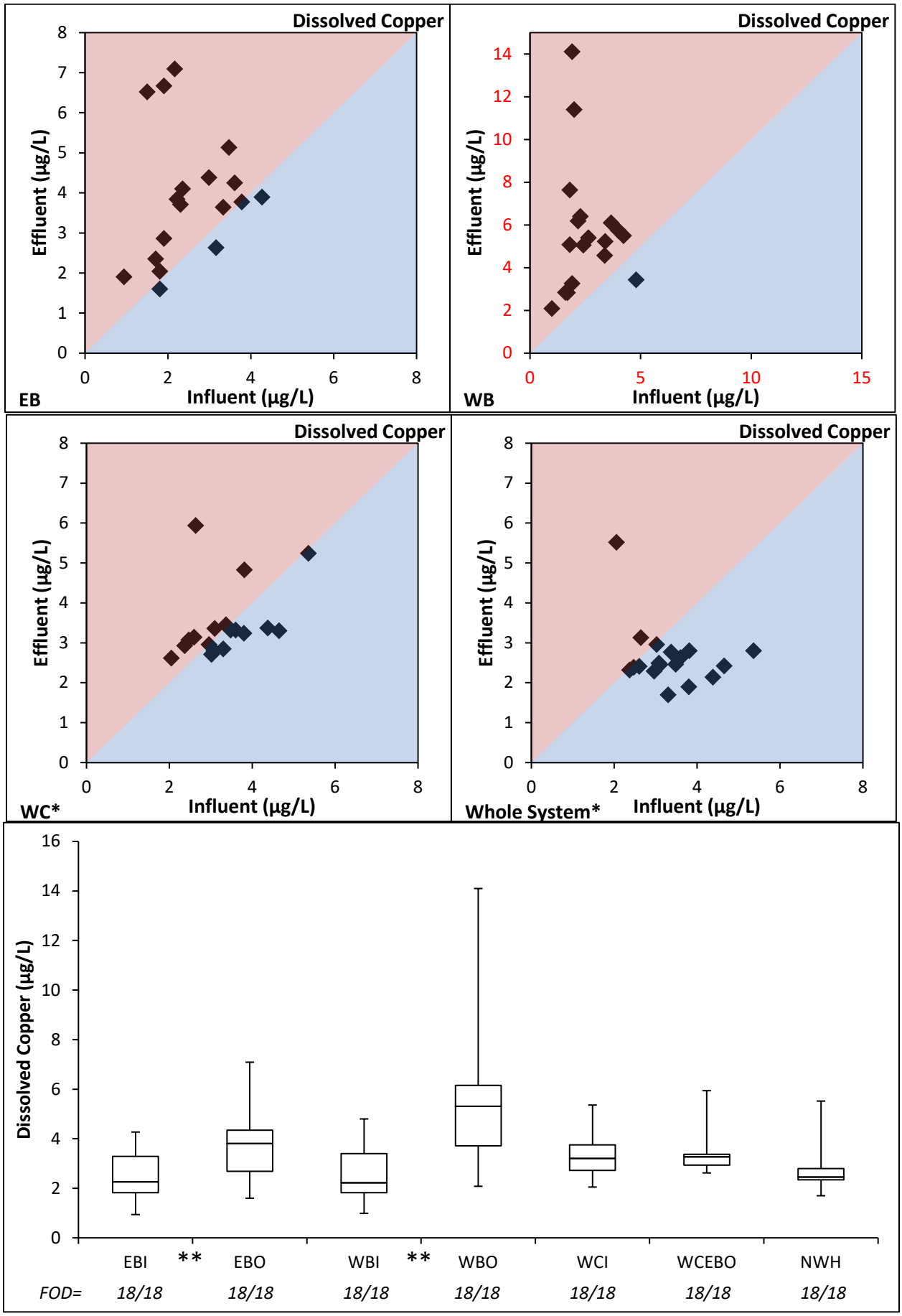

Hardness
Effluent (mg CaCO3/L)
Influent (mg CaCO3/L)
EB
WB
WC*
Whole System*
Hardness (mg CaCO3/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
***
**
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18

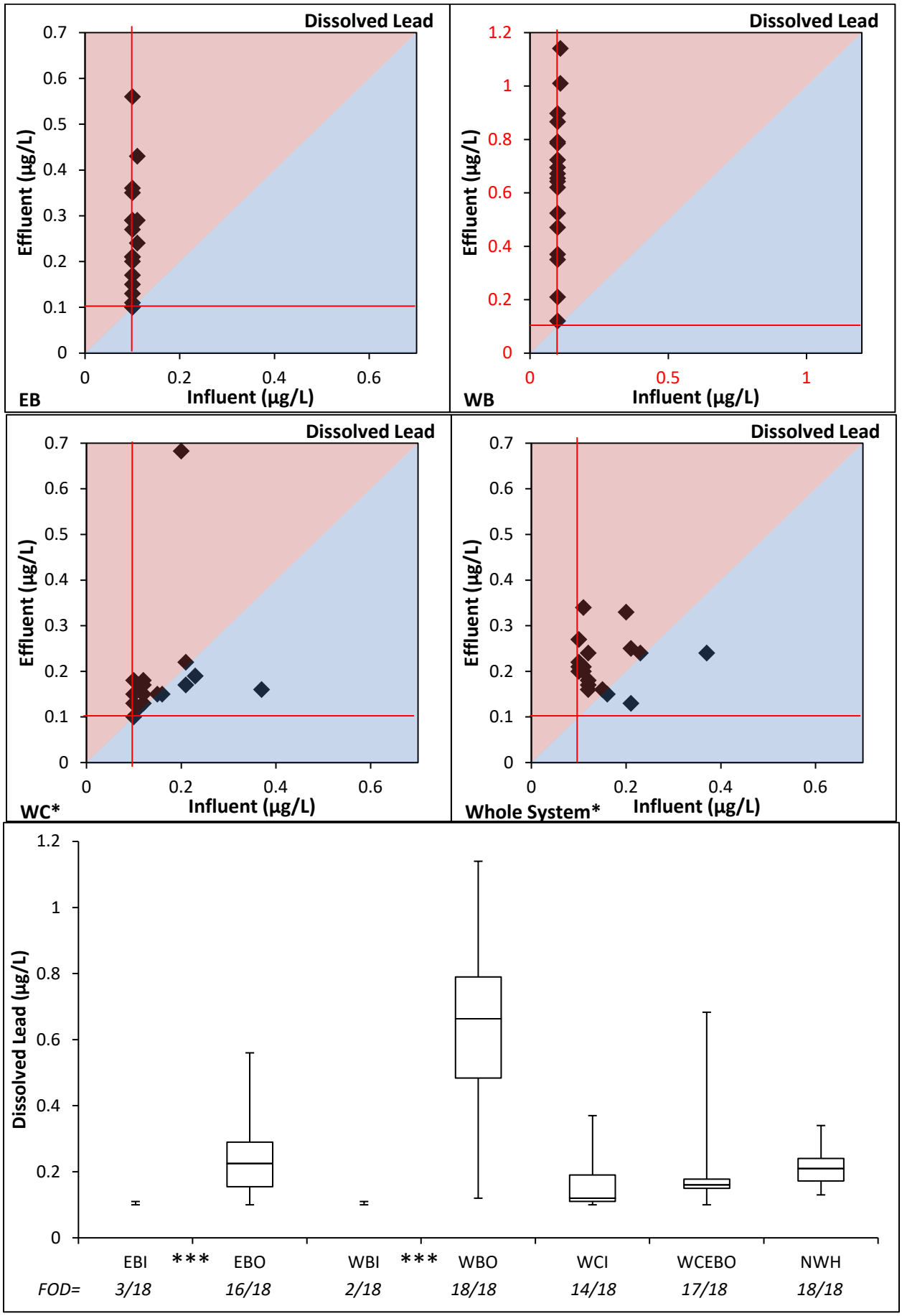

Total Cadminum
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Cadminum (µg/L)
EBI
EBO
WBI
WBO
WCI
*
WCEBO
NWH
FOD=
1/18
4/18
1/18
9/18
13/18
3/18
4/18

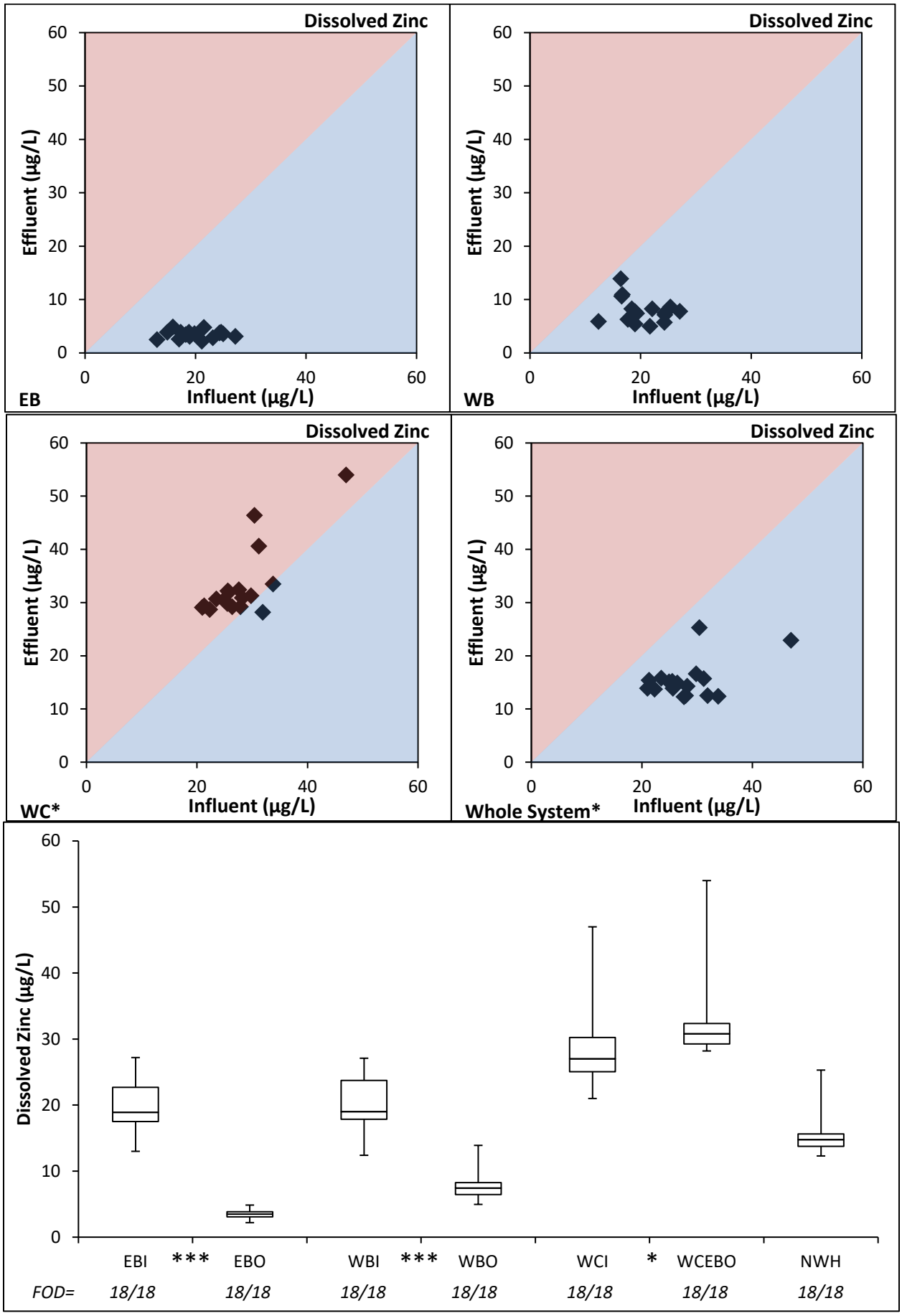

Total Copper
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Copper (µg/L)
EBI
EBO
WBI
*
WBO
WCI
*** WCEBO
NWH
FOD=
18/18

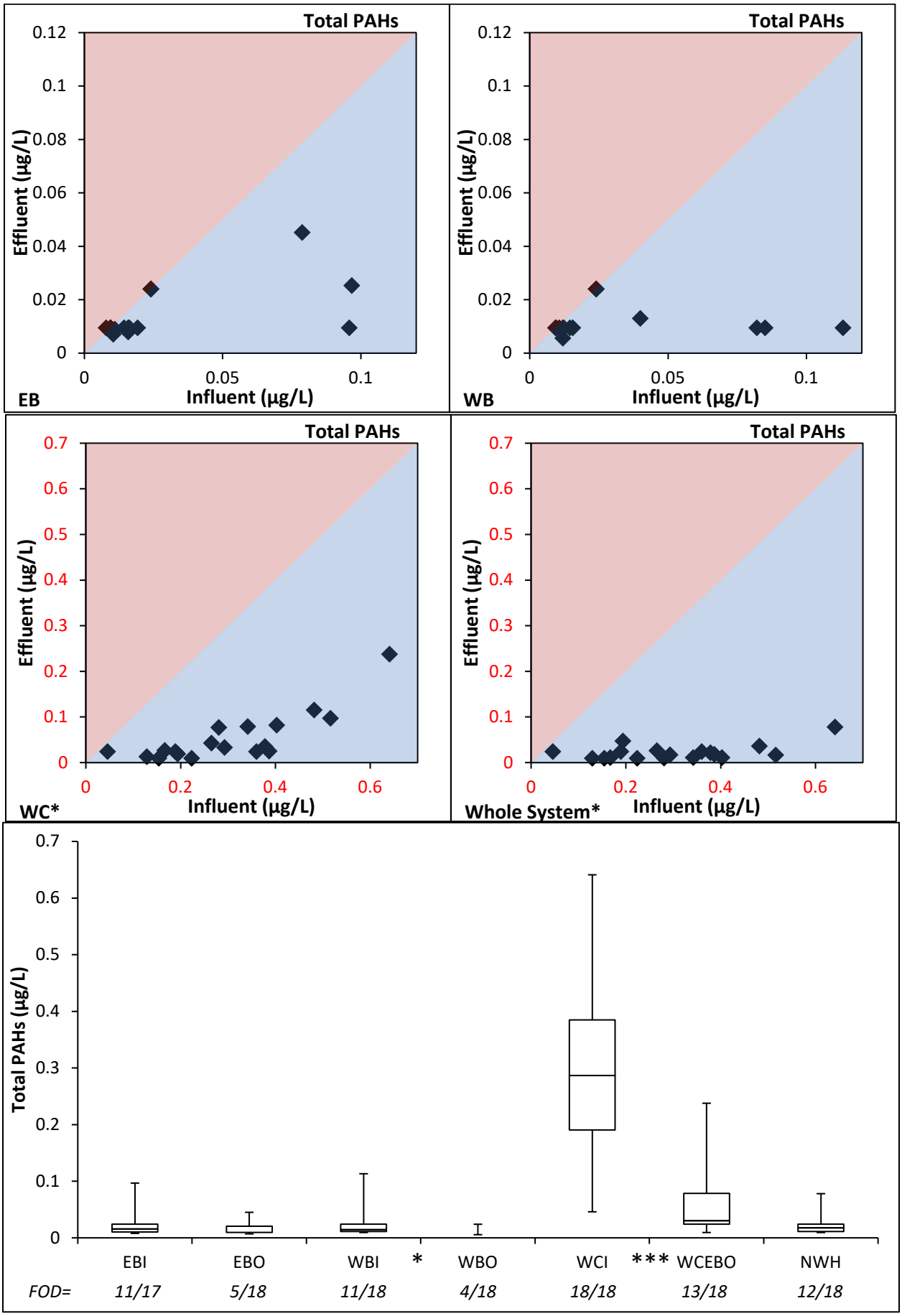

Total Lead
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Lead (µg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
*
***
FOD=
18/18

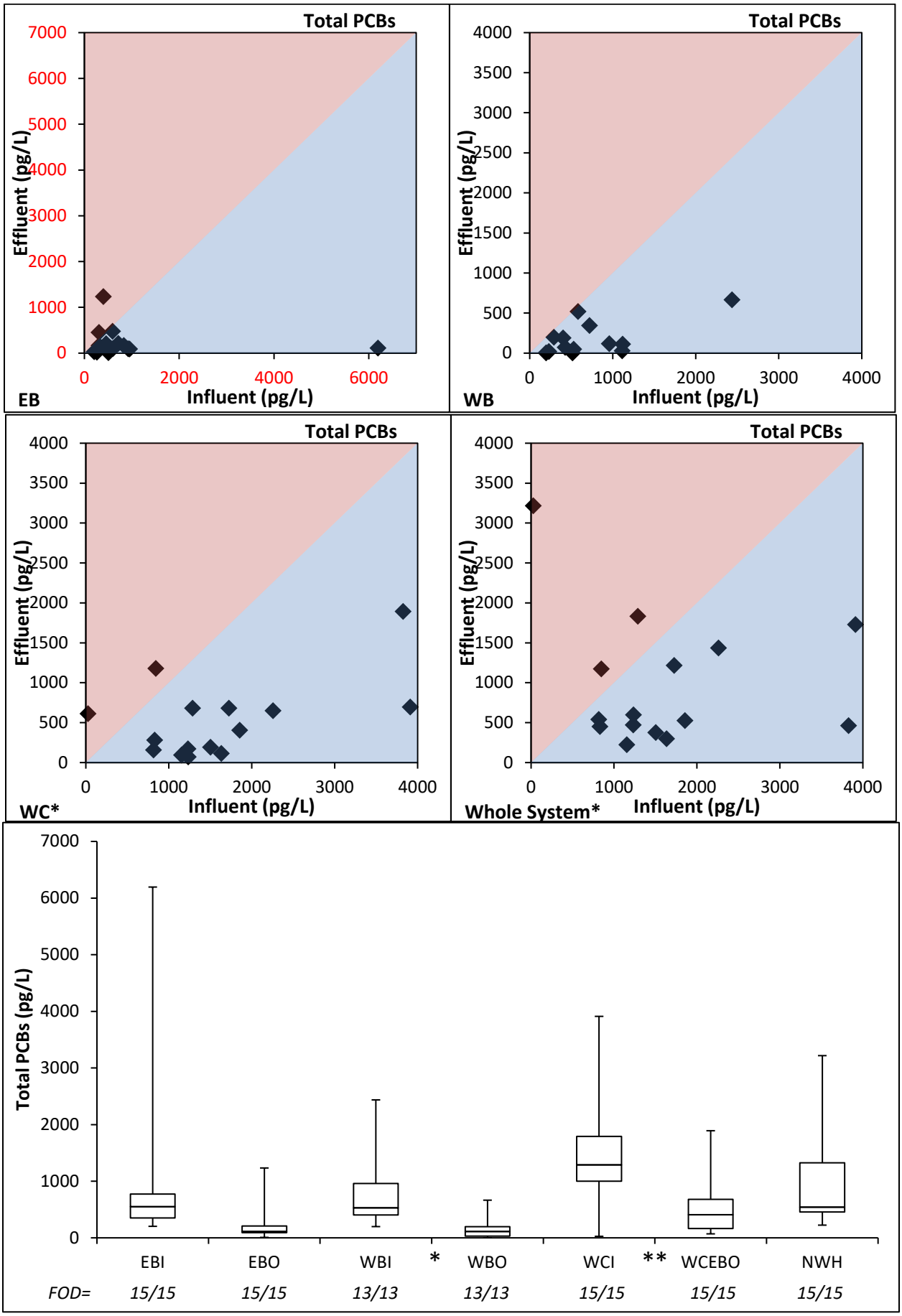

Total Zinc
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total Zinc (µg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
FOD=
18/18


Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
EB
Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
WB
Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
WC*
Dissolved Copper
Effluent (µg/L)
Influent (µg/L)
Whole System*
Dissolved Copper (µg/L)
EBI
**
EBO
WBI
**
WBO
WCI
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18


Dissolved Lead
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Dissolved Lead (µg/L)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
***
***
FOD=
3/18
16/18
2/18
18/18
14/18
17/18
18/18


Dissolved Zinc
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Dissolved Zinc (µg/L)
EBI
***
EBO
WBI
***
WBO
WCI
*
WCEBO
NWH
FOD=
18/18
18/18
18/18
18/18
18/18
18/18
18/18


Total PAHs
Effluent (µg/L)
Influent (µg/L)
EB
WB
WC*
Whole System*
Total PAHs (µg/L)
EBI
EBO
WBI
*
WBO
WCI
***
WCEBO
NWH
FOD=
11/17
5/18
11/18
4/18
18/18
13/18
12/18


Total PCBs
Effluent (pg/L)
Influent (pg/L)
EB
WB
WC*
Whole System*
Total PCBs (pg/L)
EBI
EBO
WBI
*
WBO
WCI
**
WCEBO
NWH
FOD=
15/15
15/15
13/13
13/13
15/15
15/15
15/15

APPENDIX H2 – DETAILED DATA SUMMARY: LOADING ESTIMATES

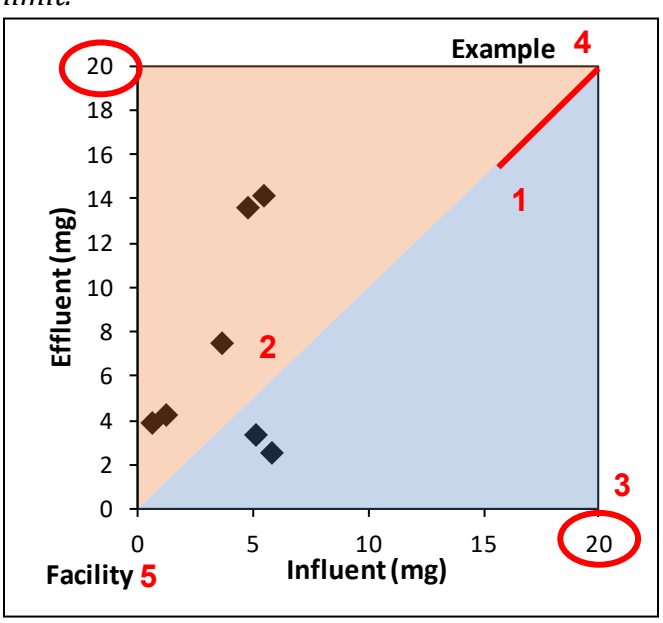
This section summarizes loadings estimates using figures similar to those summarizing concentration data in Section H1. However, there were only five storms where loadings could be reliably calculated for samples across all sites. The box plot display the distribution of loadings results for these five storms. The scatter plots compare influent and effluent loadings, including all sample pairs for which loadings could be reliably calculated at each facility. The format of these figure types are generally similar to those above with some notable exceptions underlined below.

Scatter Plot Explanation:
These figures plot effluent versus influent loadings for each sampling event with reliable loadings at a given facility. Features of the plots are noted with red numbers and explained below.

1 – The middle line between the red and blue shading represents no change between influent and effluent loadings, or a 1 to 1 ratio.
2 – Data points in the red shading illustrate sampling events where loadings were higher in the effluent than the influent (> 1 to 1 ratio). Data points in the blue shading illustrate sampling events where loadings were lower in the effluent than the influent (< 1 to 1 ratio).
3 – Where possible, the x and y scales and units are the same for each parameter across the facilities to facilitate comparison. Exceptions are identified with red axis labels.
4 – Name of parameter
5 – Facility name:

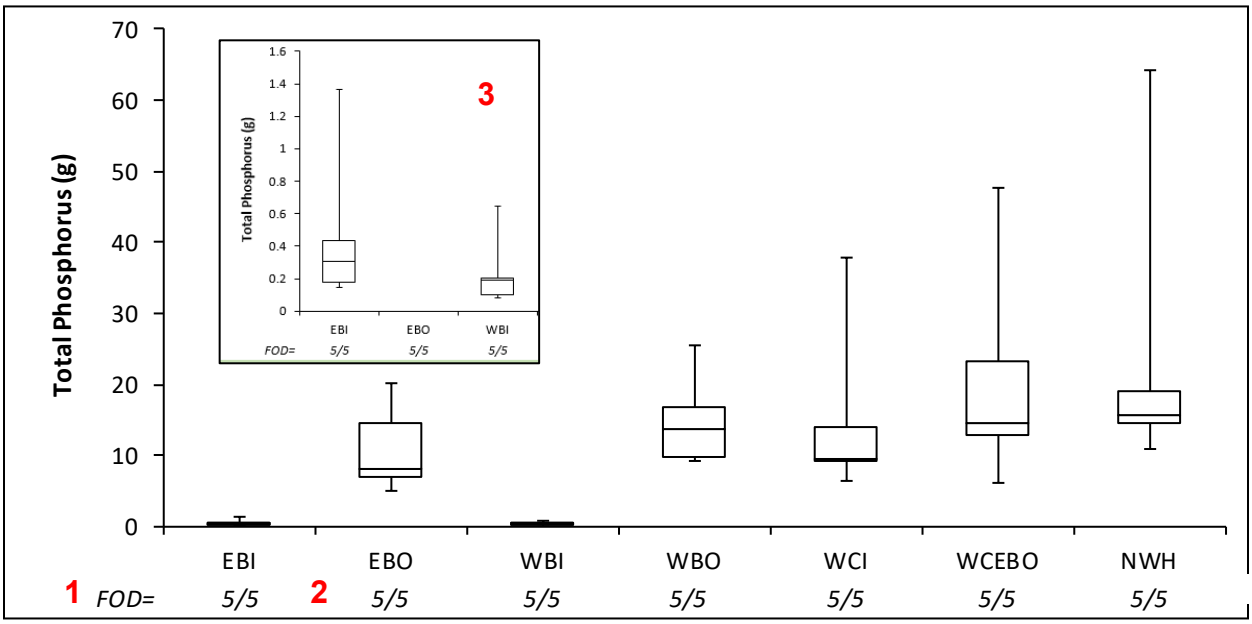
- East Bioretention (EB) = EBI vs. EBO
- West Bioretention (WB) = WBI vs. WBO
- Wetland Complex (WC) = WCI vs. WCEBO - EBO
- Whole System = WCI + EBI + WBI vs. WCEBO + WBO

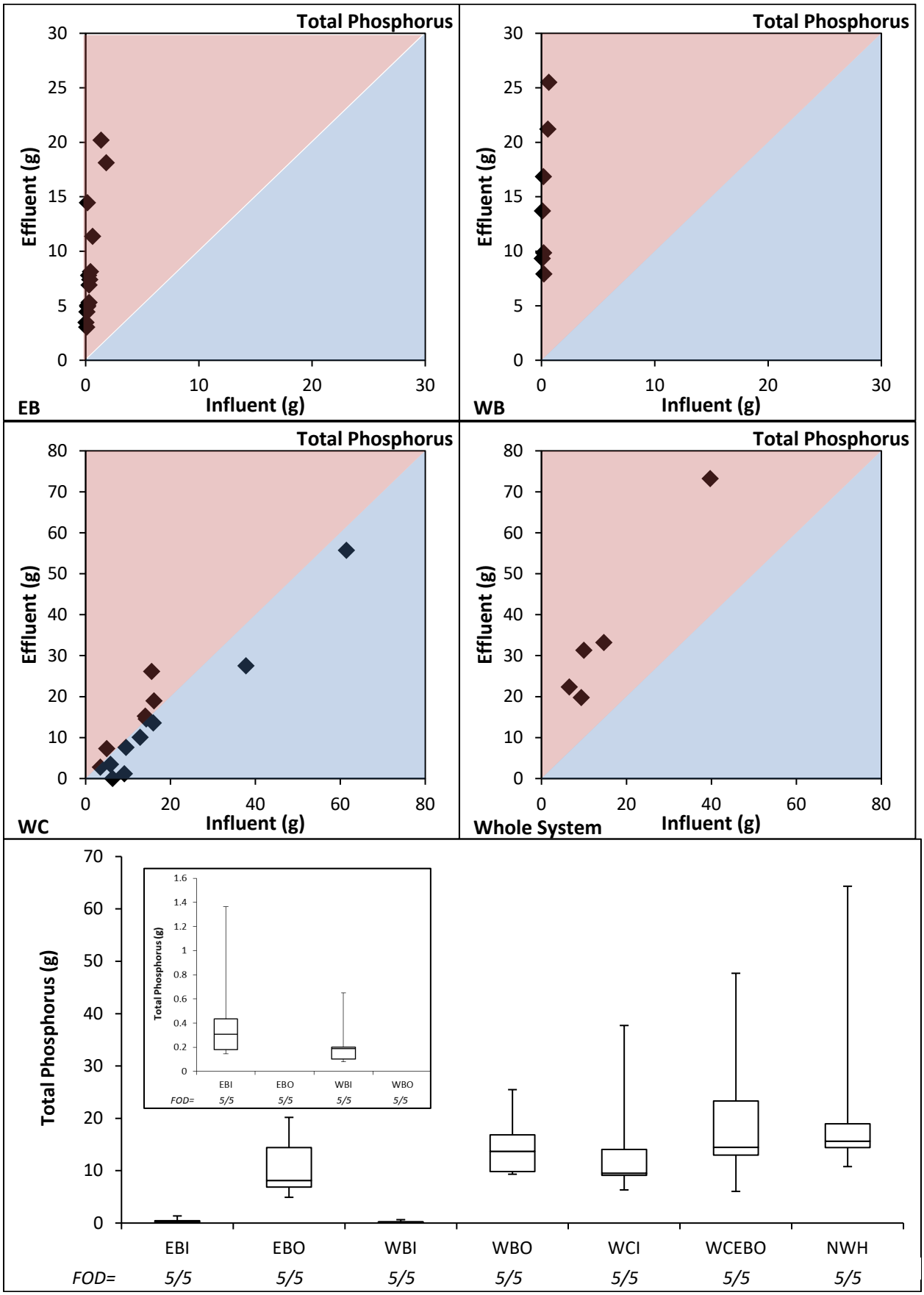
Note: Figures with several non-detect results include red lines indicating the method detection limit.

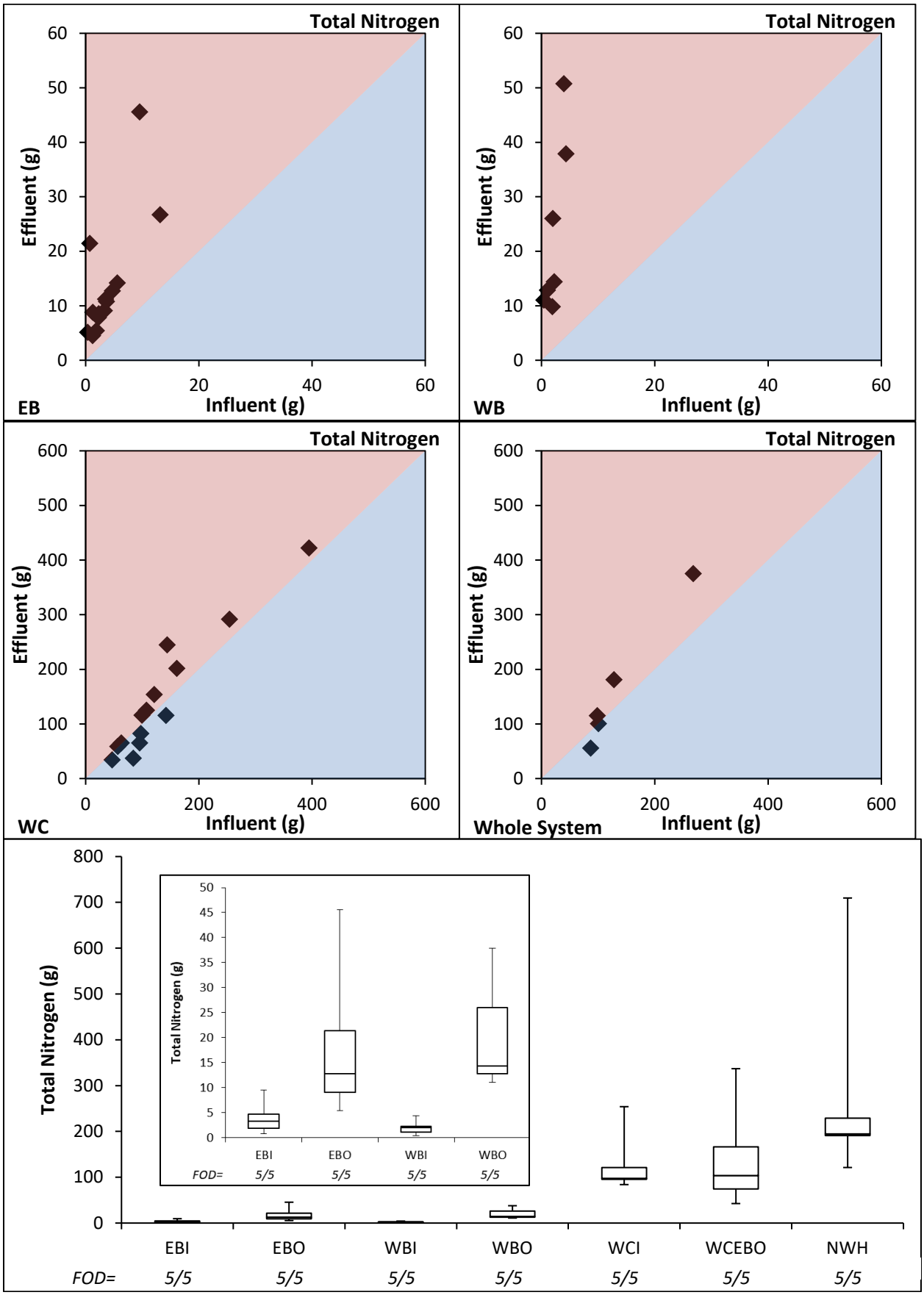


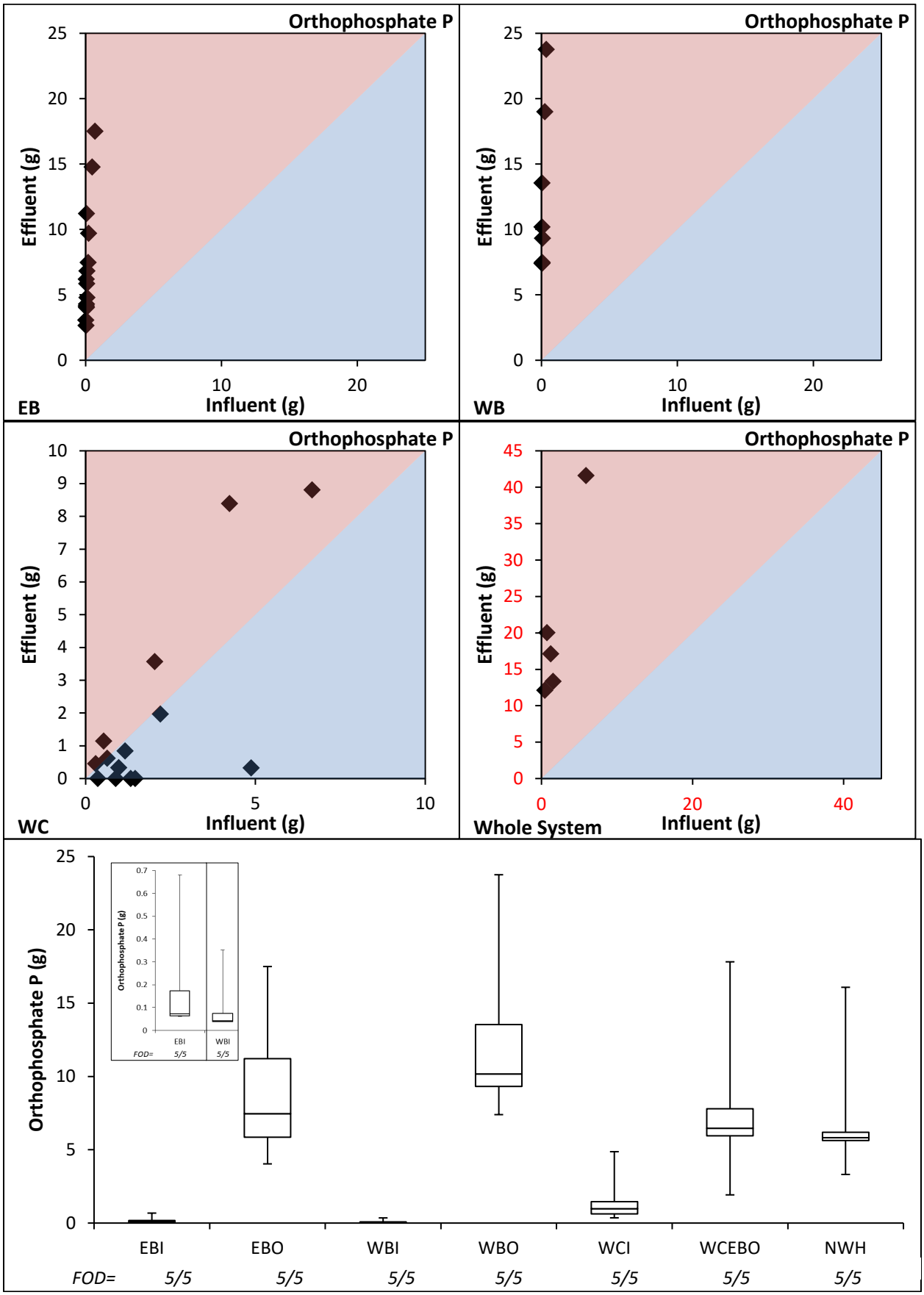
Box Plot Explanation:
These figures plot the distribution of results for each site as indicated in the example figure below. Although there are more results for some facilities than others (as seen with the scatter plots), the box plots include only the storms for which reliable loadings could be calculated across all sites (n=5).

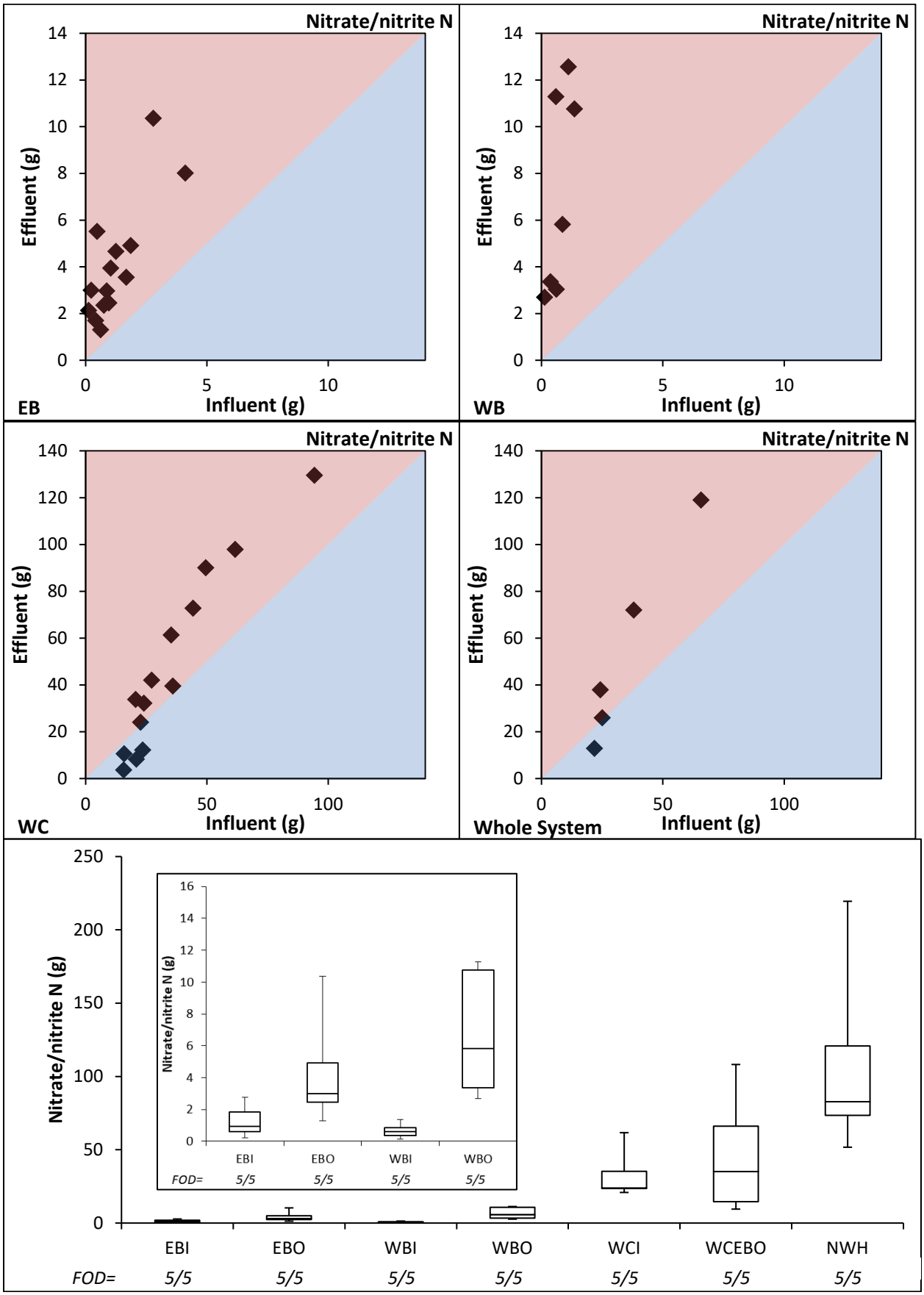
1 – Frequency of detection (FOD): non-detects are included at the method detection limit (MDL) value.
2 – Statistical differences were not calculated for loadings.
3 – Loadings often differed by orders of magnitude between the bioretention facilities and the wetland complex. Inset figures were included to illustrate the lower magnitude of loadings at the bioretention facilities.

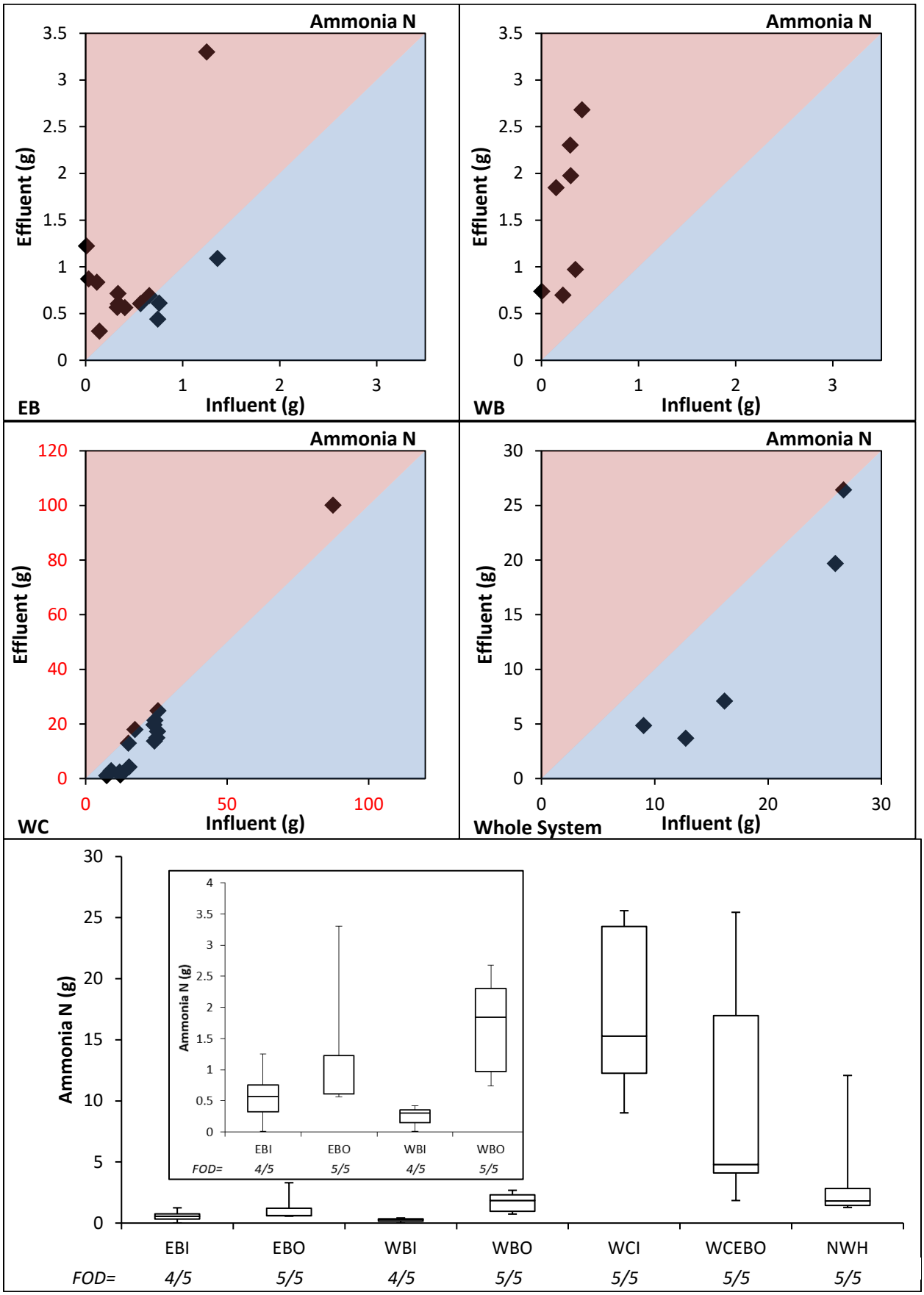


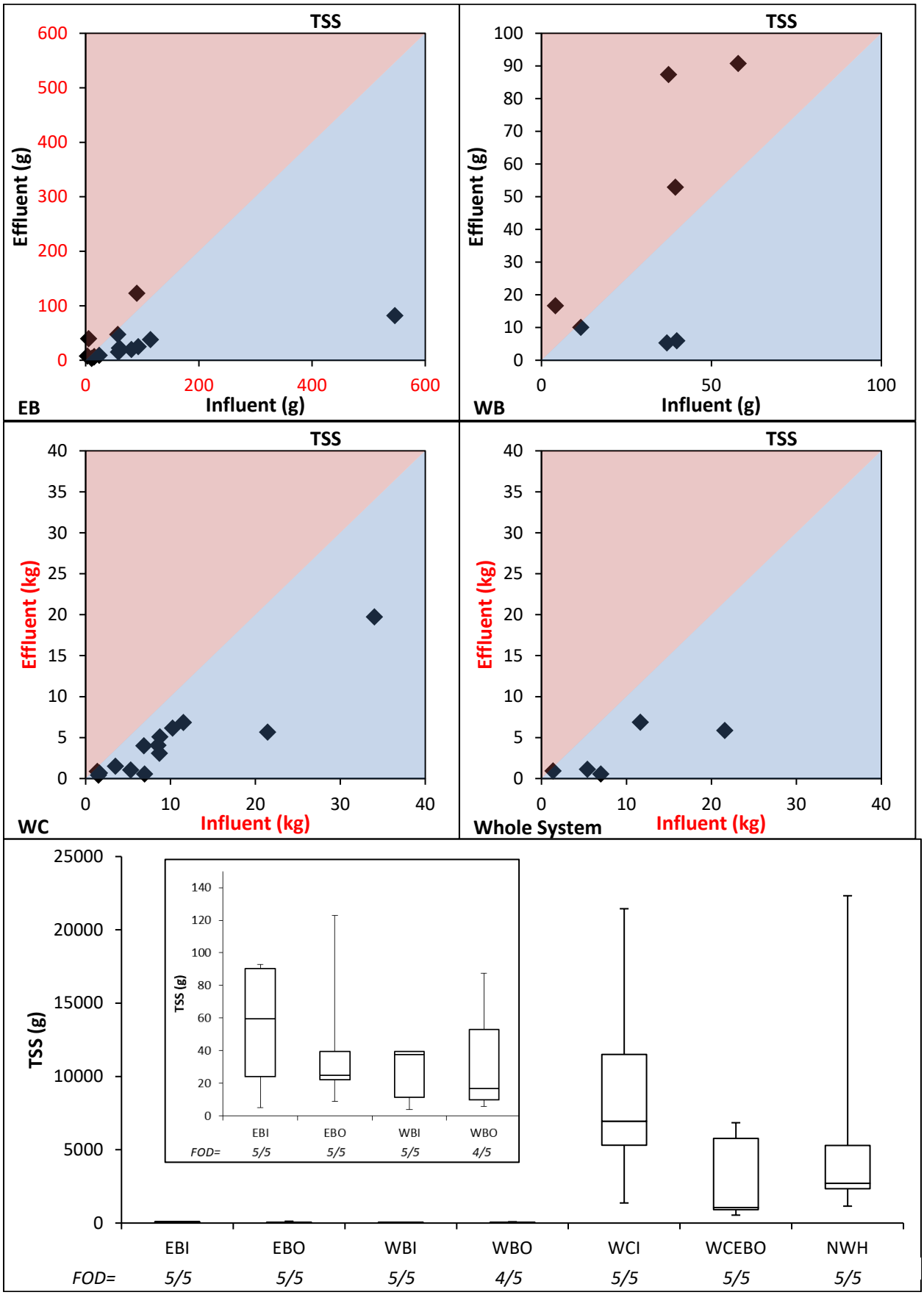

Total Phosphorus
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
Total Phosphorus (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

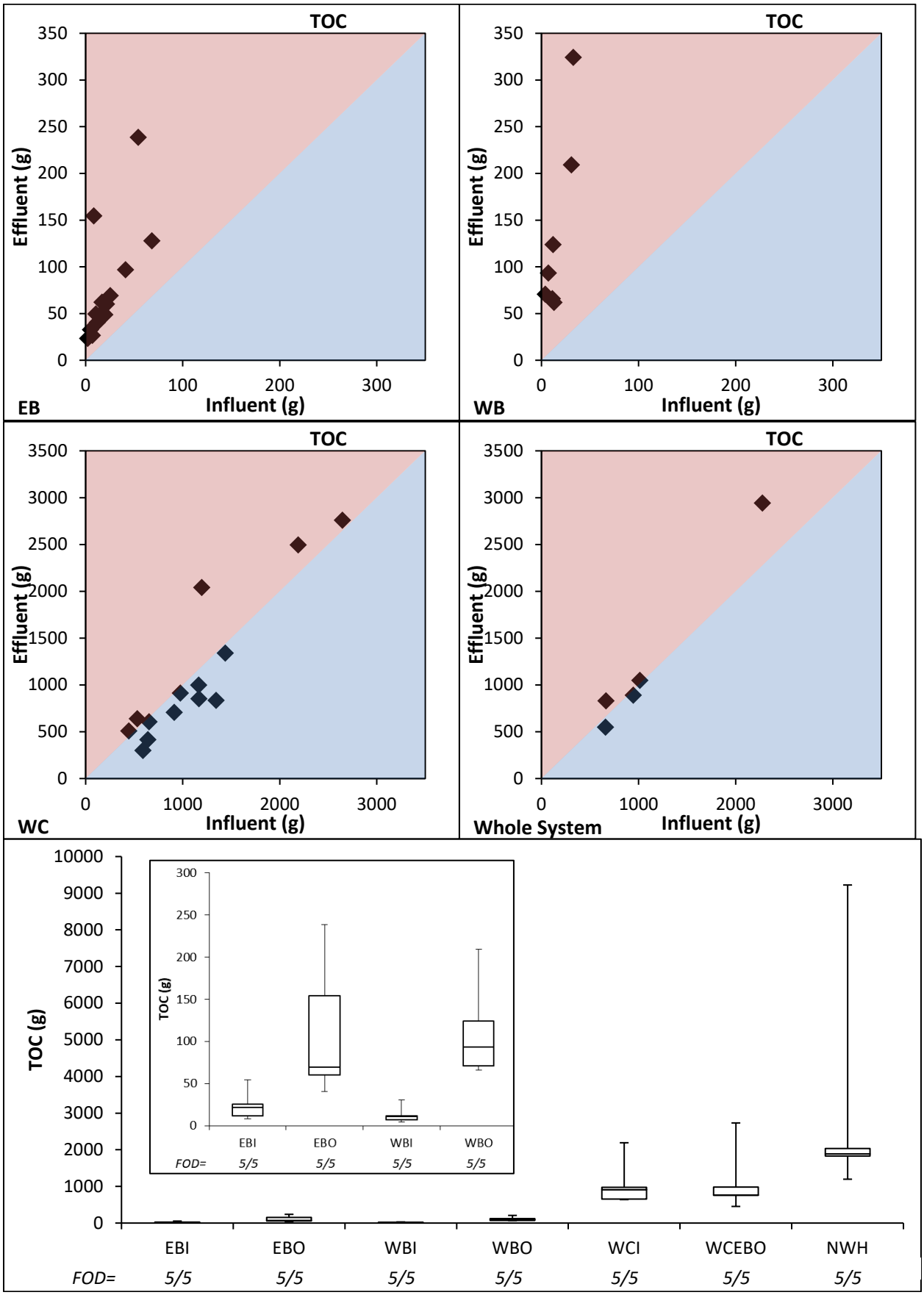

Total Nitrogen
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
Total Nitrogen (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

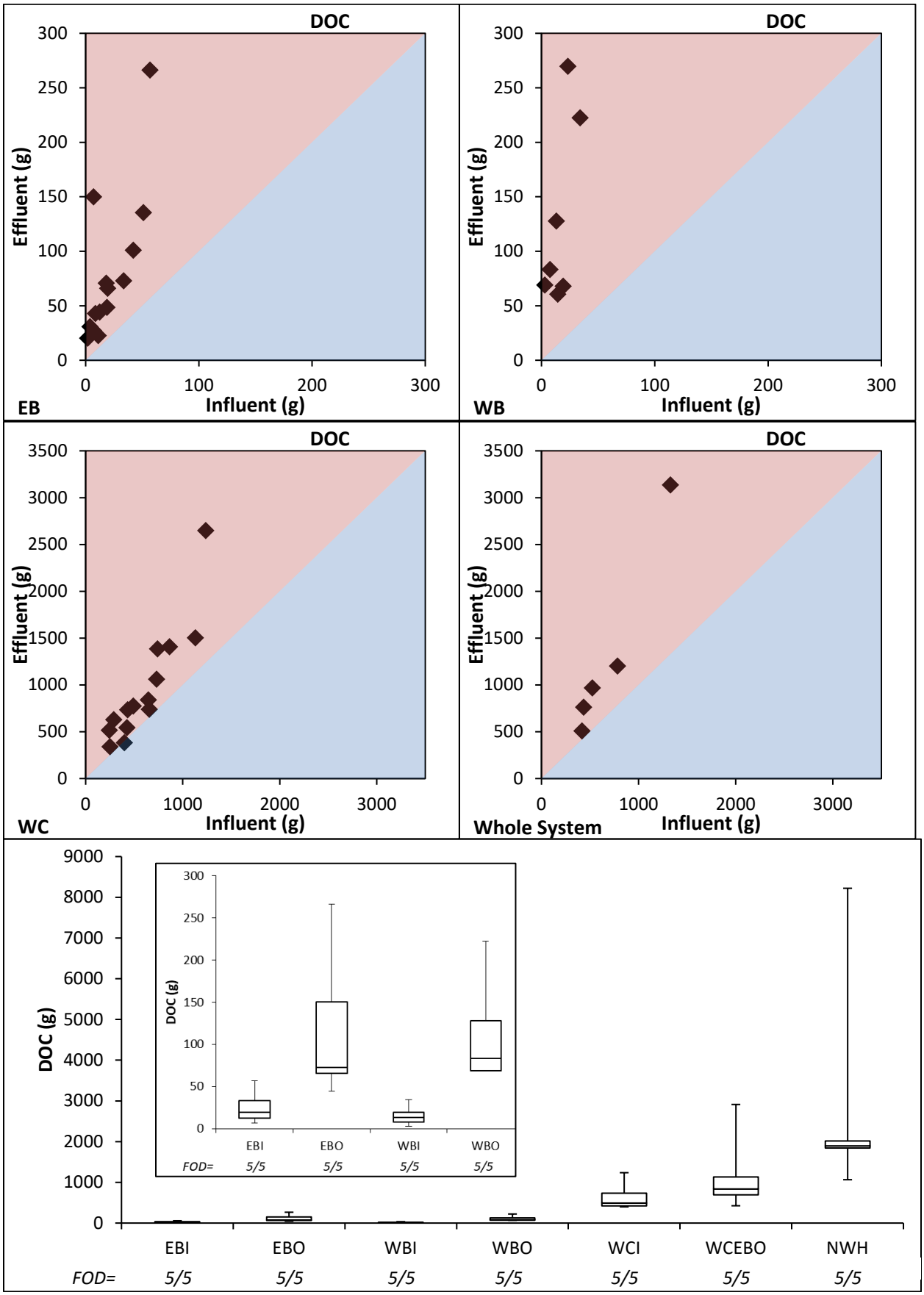

Orthophosphate P
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
Orthophosphate P (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

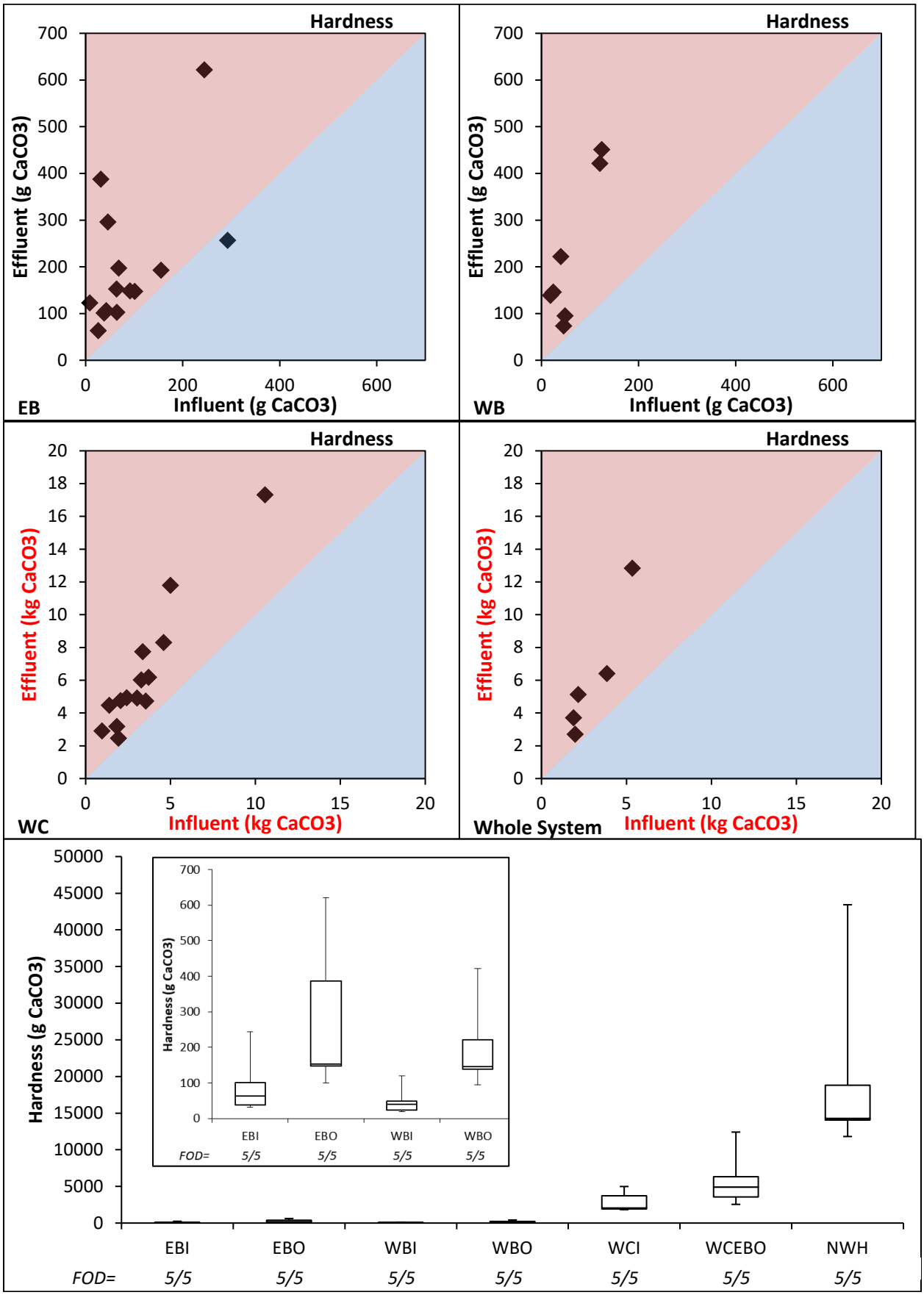

Nitrate/nitrite N
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
Nitrate/nitrite N (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

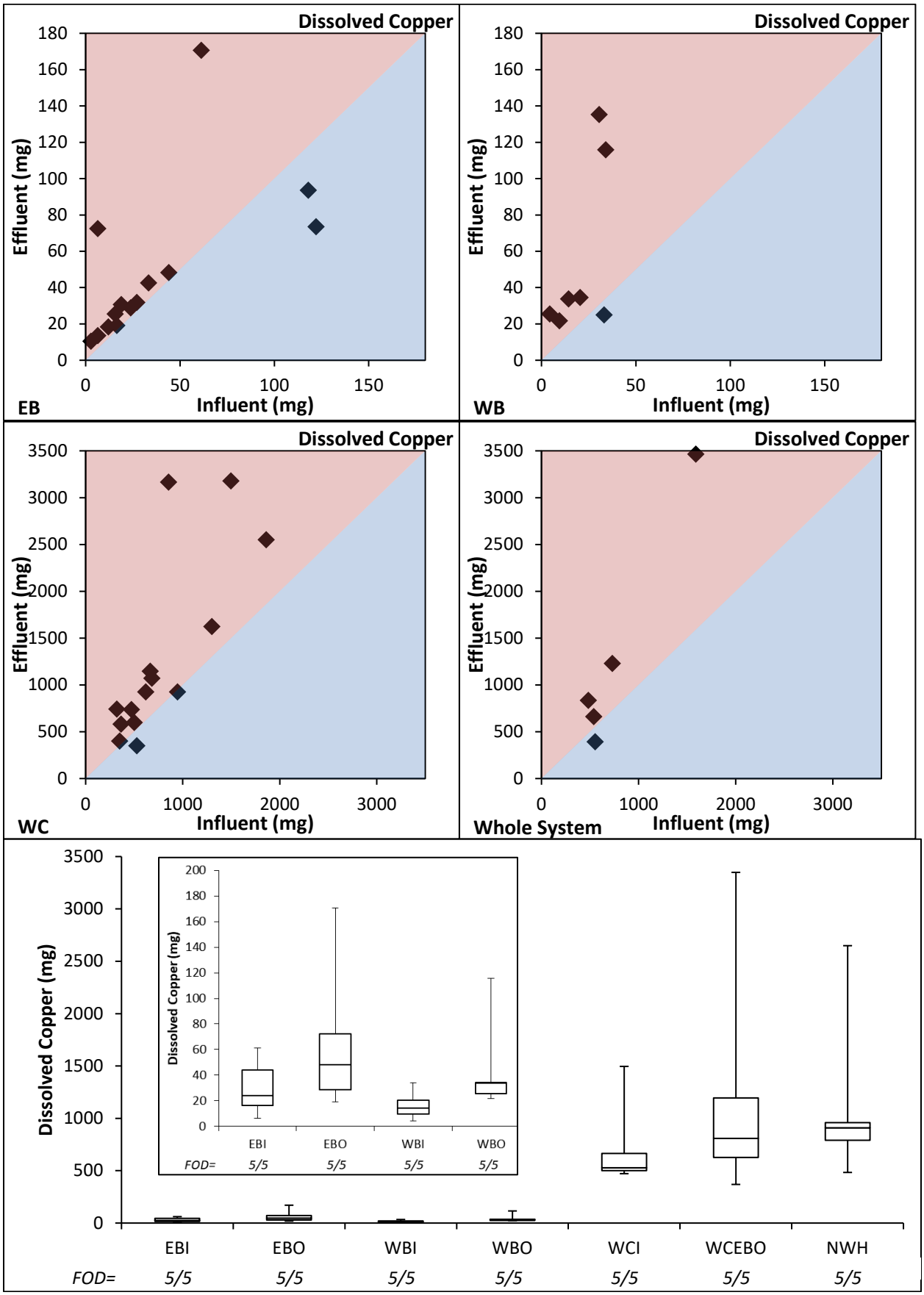

Ammonia N
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
Ammonia N (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
4/5
5/5
4/5
5/5
5/5
5/5
5/5

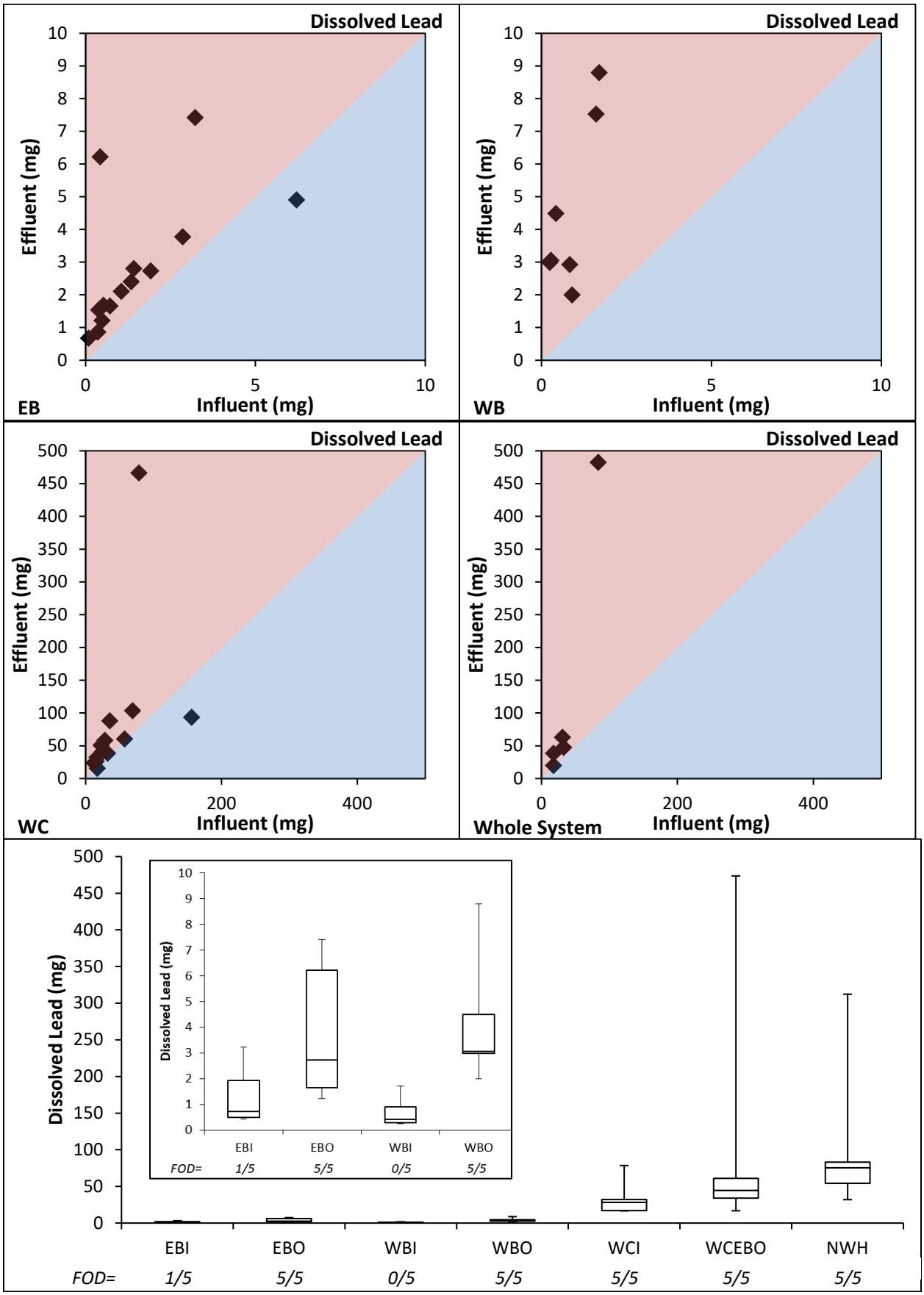

TSS
Effluent (g)
Influent (g)
EB
WB
Effluent (kg)
Influent (kg)
WC
Whole System
TSS (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5
5/5
5/5
4/5
5/5
5/5
5/5

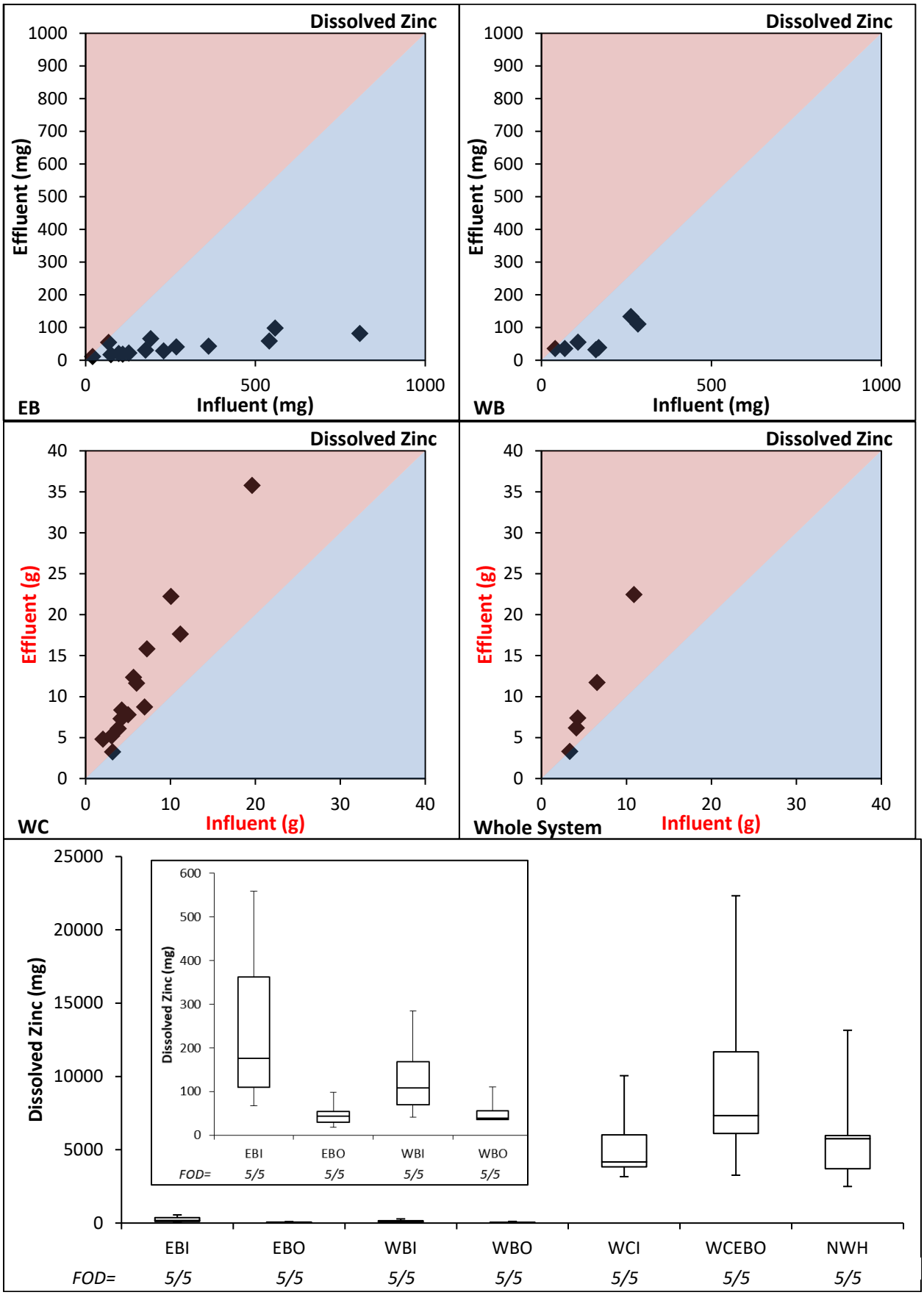

TOC
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
TOC (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

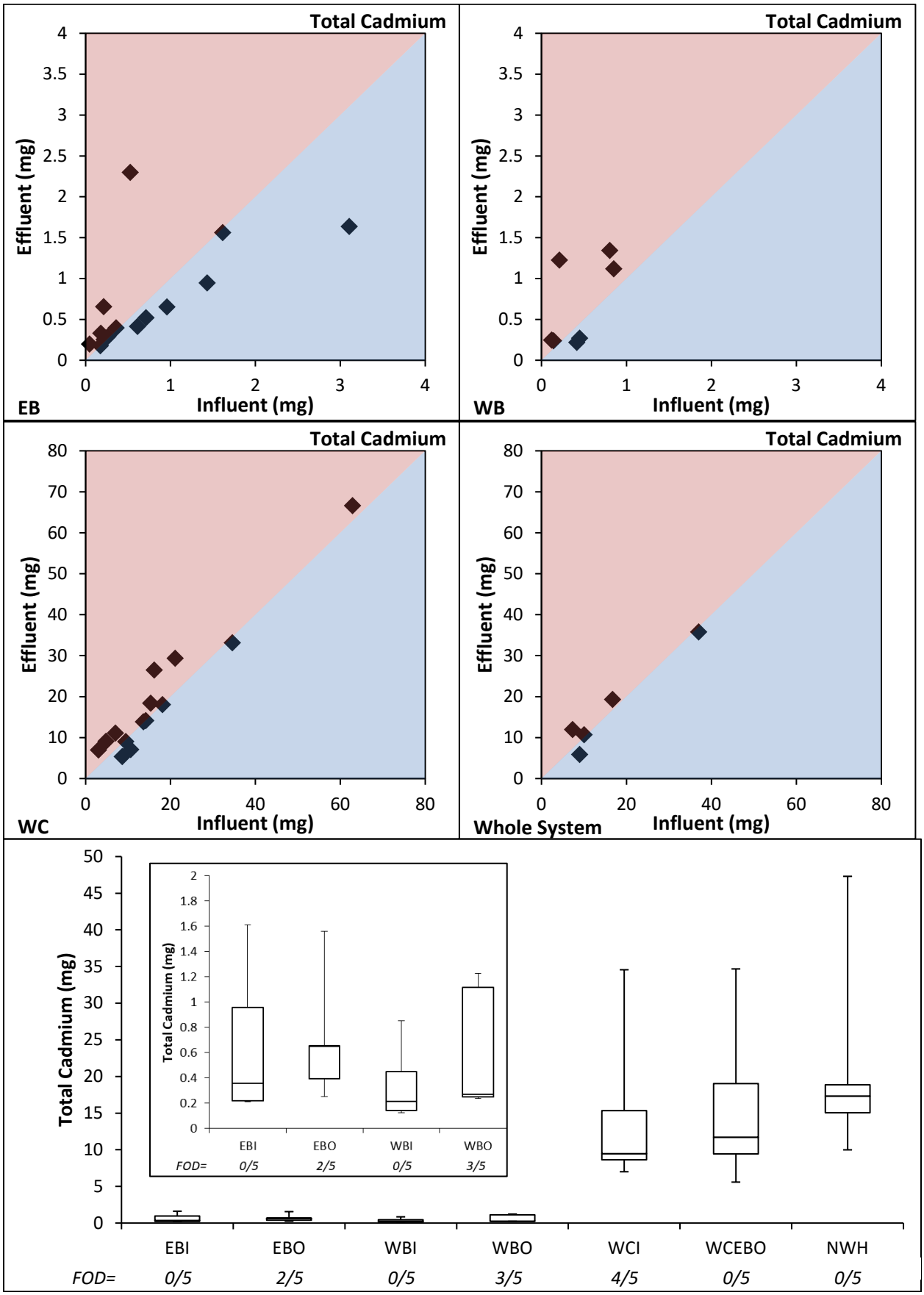

DOC
Effluent (g)
Influent (g)
EB
WB
WC
Whole System
DOC (g)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

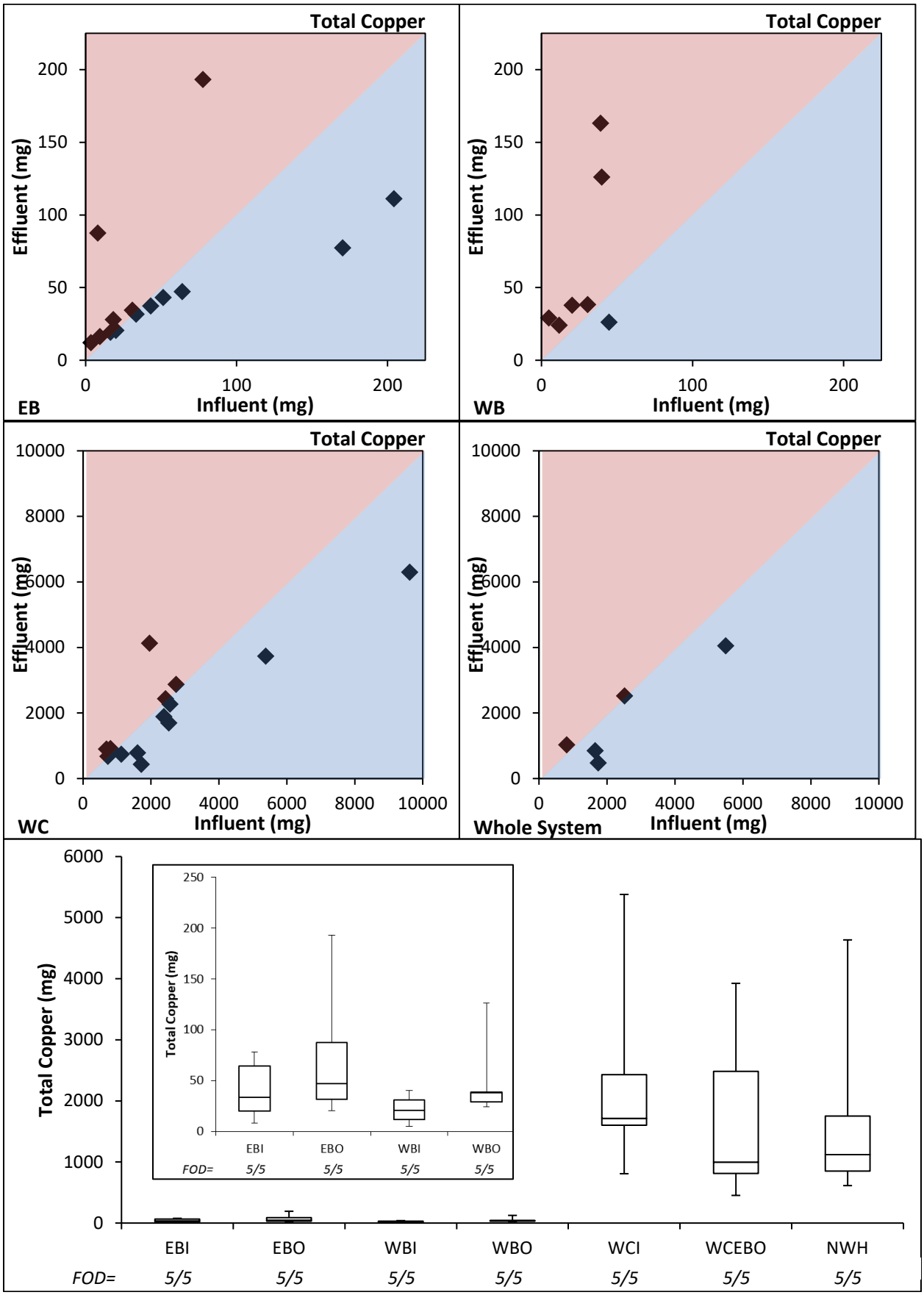

Hardness
Effluent (g CaCO3)
Influent (g CaCO3)
EB
Hardness
Effluent (g CaCO3)
Influent (g CaCO3)
WB
Hardness
Effluent (kg CaCO3)
Influent (kg CaCO3)
WC
Hardness
Effluent (kg CaCO3)
Influent (kg CaCO3)
Whole System
Hardness (g CaCO3)
EBI
EBO
WBI
WBO
FOD=
5/5
WCI
WCEBO
NWH

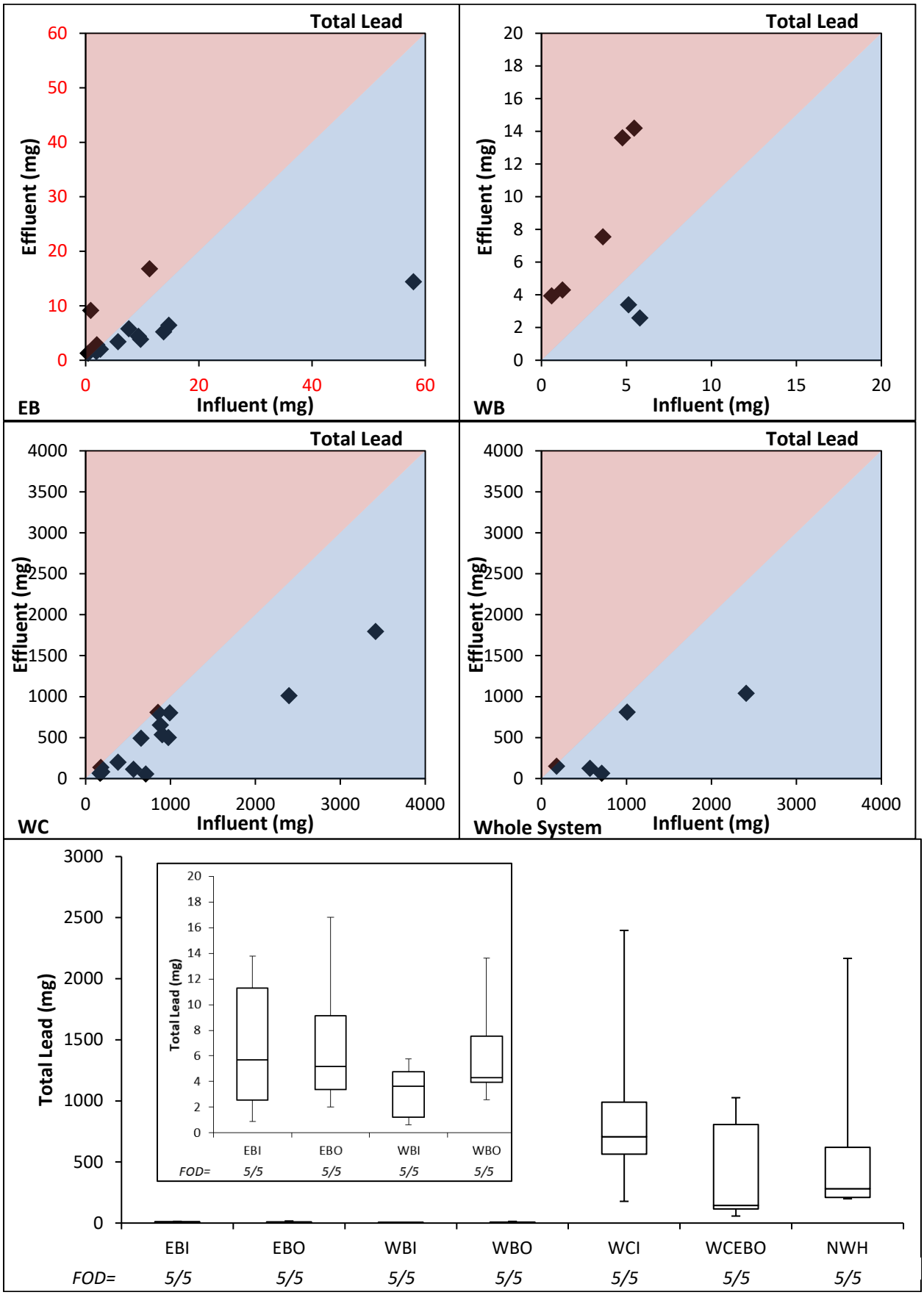

Dissolved Copper
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Dissolved Copper (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

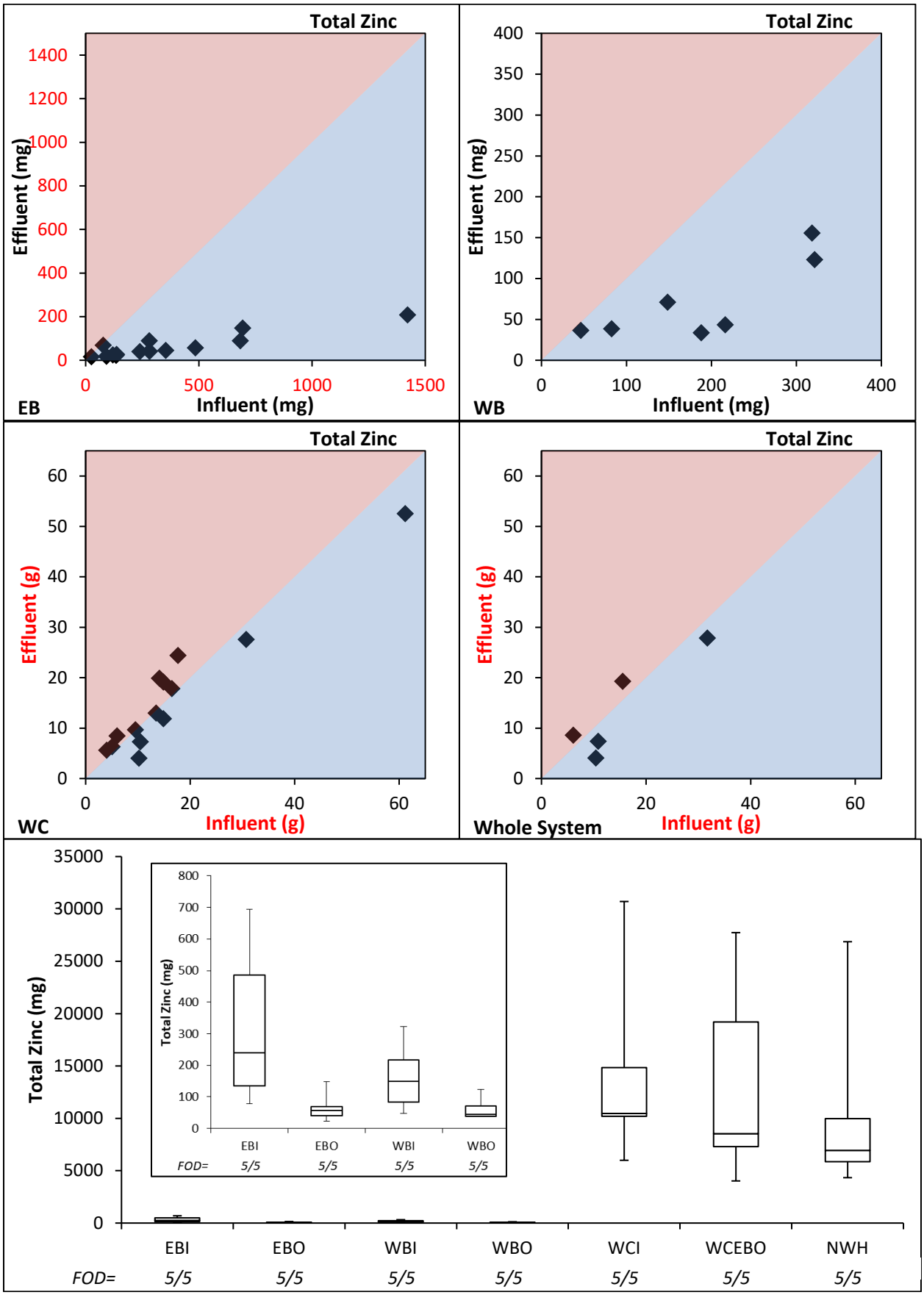

Dissolved Lead
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Dissolved Lead (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
1/5
5/5
0/5
5/5
5/5
5/5
5/5

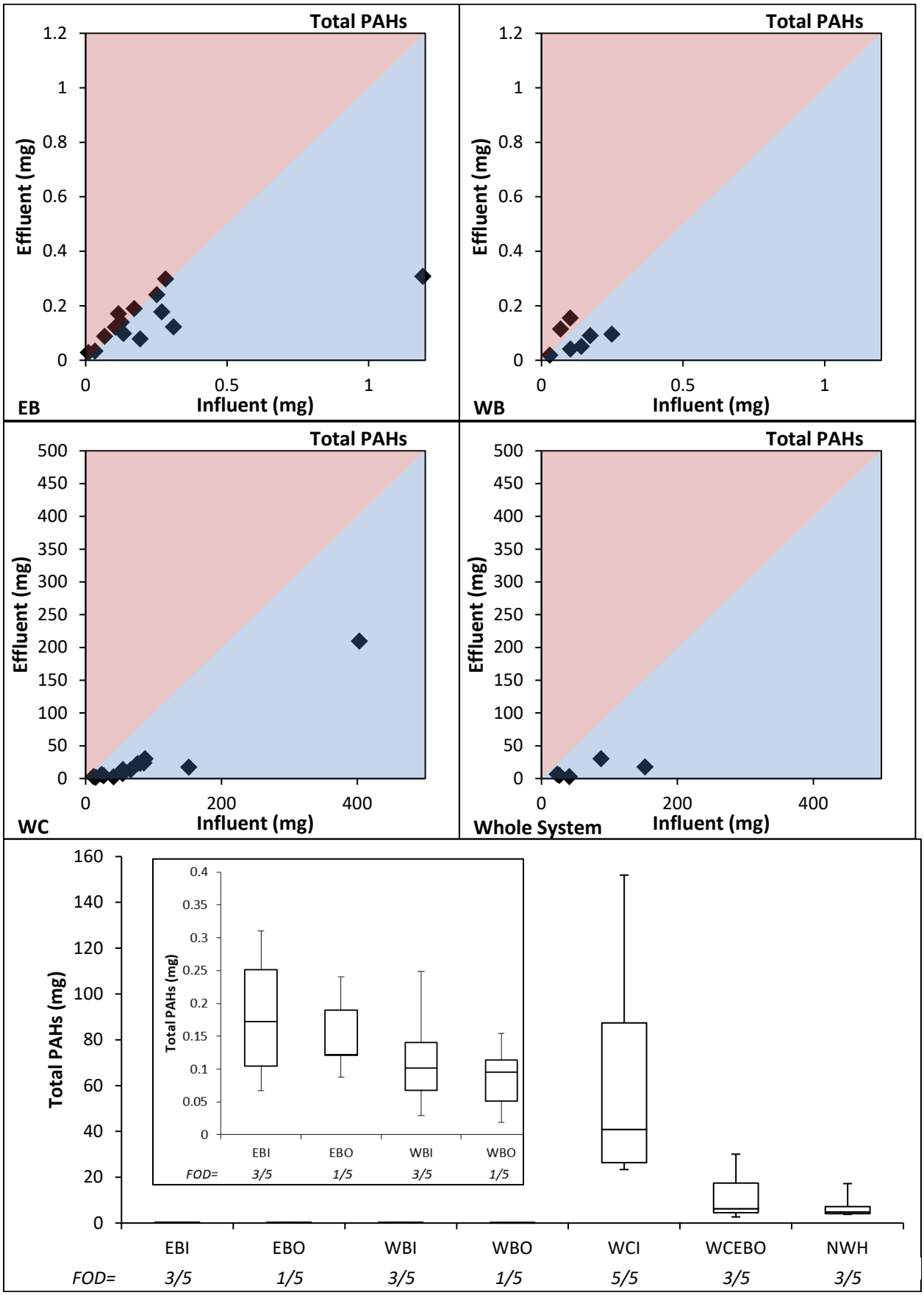

Dissolved Zinc
Effluent (mg)
Influent (mg)
EB
Dissolved Zinc
Effluent (mg)
Influent (mg)
WB
Dissolved Zinc
Effluent (g)
Influent (g)
WC
Dissolved Zinc
Effluent (g)
Influent (g)
Whole System
Dissolved Zinc (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

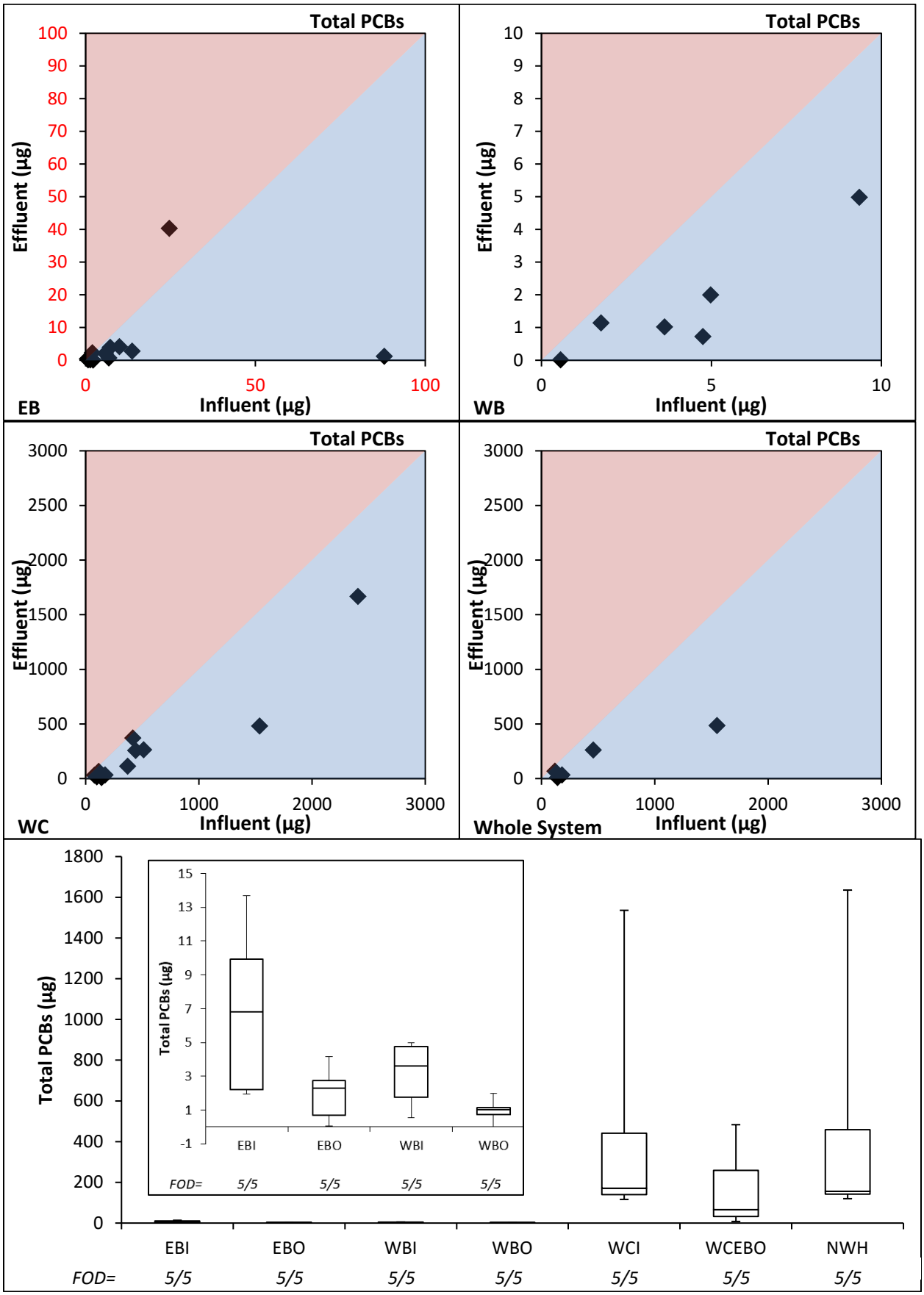

Total Cadmium
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Total Cadmium (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
0/5
2/5
0/5
3/5
4/5
0/5
0/5


Total Copper
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Total Copper (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5


Total Lead
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Total Lead (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5


Total Zinc
Effluent (mg)
Influent (mg)
EB
Total Zinc
Effluent (mg)
Influent (mg)
WB
Total Zinc
Effluent (g)
Influent (g)
WC
Total Zinc
Effluent (g)
Influent (g)
Whole System
Total Zinc (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5


Total PAHs
Effluent (mg)
Influent (mg)
EB
WB
WC
Whole System
Total PAHs (mg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
3/5
1/5
3/5
1/5
5/5
3/5
3/5


Total PCBs
Effluent (µg)
Influent (µg)
EB
WB
WC
Whole System
Total PCBs (µg)
EBI
EBO
WBI
WBO
WCI
WCEBO
NWH
FOD=
5/5

APPENDIX H3 – TOXICITY TEST RESULTS

Toxicity tests using *Daphnia pulex* (48-hour acute test) and *Ceriodaphnia dubia* (7-day chronic test) were conducted on samples from each location for six storm events as summarized in Table 5. Water hardness differed greatly between the standard control and the environmental samples for each event. Low hardness can impact survival and reproduction of daphnia; therefore an additional low hardness (typically ~10 mg/L) control sample was added after the initial series of toxicity testing for Storm #1.

D. pulex survival was poor in all low hardness control samples. However, most environmental samples were not acutely toxic to *D. pulex*, despite hardness levels that were often lower than the low hardness control samples. Influent samples at EBI and WBI were occasionally acutely toxic to *D. pulex*, but effluent samples were not. Water quality data may help explain the observed differences between influent and effluent toxicity to *D. pulex*. Effluent samples at EBO and WBO consistently had lower total PAH and dissolved zinc concentrations than influent samples at EBI and WBI. While dissolved copper and lead concentrations were commonly higher in the bioretention effluent samples, hardness and DOC concentrations were also much higher than in influent samples, which would help mitigate metals toxicity.

C. dubia reproduction was almost always higher in the environmental samples compared to the standard control, with occasional statistical differences in mean reproduction between influent and effluent sample pairs. Overall, the environmental samples were not toxic to *C. dubia* compared to controls.

Due to logistical constraints, toxicity tests were not always conducted within the recommended sample hold times. This may have impacted toxicity results, as chemical degradation during storage may have reduced the toxic potential of the stormwater.

Table 5. Summary of toxicity test results and water quality parameters.

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
03/09/16 (Event #1)	Standard Control	100	100	17.4	62 / 39	--	--	--	--	--
	EBI	90	100	22.7	6.5	1.05	1.8 J	0.10 UJ	18.2 J	0.011 J
	EBO	100	100	22.6	10	1.18	1.6 J	0.11 J	3.44 J	0.0089 J
	WBI	100	100	20.2	6.2	1.77	1.9 J	0.10 UJ	17.7 J	0.011 J
	WBO	100	80	28.4	33	12.6	3.26 J	0.524 J	6.29 J	0.0089 J
	WCI	75	100	25.1	11	1.91	3.02 J	0.10 UJ	24.9 J	0.293 J
	WCEBO	95	100	20.2*	13	1.86	2.71 J	0.13 J	30.5 J	0.0334 J
	NFH	100	100	24.9	35	4.6	2.96 J	0.20 J	15.1 J	0.017 J

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
10/20/16 (Event #3)	Standard Control	100	90	27.1	93.5 / 40.3	--	--	--	--	--
	Low Hard. Control [a]	0	100	31.1	10.3 / 10.4	--	--	--	--	--
	EBI	10	100	31.8	5.68	0.8	2.16 J	0.10 UJ	14.9 J	0.0143 J
	EBO	100*	100	34.7	22.7	10.4	7.09 J	0.35 J	3.88 J	0.0094 U
	WBI	70	100	29.2	7.73	1.46	1.9 J	0.10 UJ	16.4 J	0.0107 J
	WBO	100	100	41.8*	47.0	28.1	14.1 J	0.785 J	13.9 J	0.0094 U
	WCI	95	100	30.6	10.4	2.29	2.64 J	0.11 J	22.3 J	0.265 J
	WCEBO	100	100	35.1*	14.7	2.83	5.94 J	0.17 J	28.7 J	0.0430 J
	NFH	95	100	35.1	40.4	7.72	3.13 J	0.34 J	13.7 J	0.0259 J
10/31/16 (Event #5)	Standard Control	100	100	30.5	97.4 / 42.4	--	--	--	--	--
	Low Hard. Control [a]	50	90	25.8	9.7 / 11.3	--	--	--	--	--
	EBI	100	100	31.9	7.42	1.62	1.5 J	0.10 UJ	15.9 J	0.0158 J
	EBO	100	90	34.6*	34.9	13.5	6.52 J	0.56 J	4.86 J	0.0079 J
	WBI	90	100	32.1	7.74	1.25	1.8 J	0.10 UJ	16.6 J	0.012 J
	WBO	100	100	33.1	41.6	20.7	7.63 J	0.897 J	10.6 J	0.0056 J
	WCI	95	100	30.4	13.1	3.03	3.37 J	0.23 J	29.8 J	0.167 J
	WCEBO	100	100	30.9	15.2	2.96	3.45 J	0.19 J	31.3 J	0.0268 J
	NFH	100	100	30.7	40.6	5.82	2.77 J	0.24 J	16.6 J	0.011 J
01/17/17 (Event #7)	Standard Control	95	--	--	131	--	--	--	--	--
	Low Hard. Control [a]	--	100	31.0	36.0	--	--	--	--	--
	EBI	100	90	34.6	8.6	1.25	1.7 J	0.10 UJ	21.1 J	0.0958 J
	EBO	100	90	35.0	16	3.16	2.35 J	0.10 UJ	2.2 J	0.0094 U
	WBI	100	100	37.7	8.5	1.32	1.7 J	0.10 UJ	21.7 J	0.113 J
	WBO	100	100	41.5	64	9.6	2.83 J	0.12 J	4.96 J	0.0094 U
	WCI	95	100	39.2	17	1.8	2.96 J	0.11 J	31.2 J	0.641 J
	WCEBO	100	100	38.9	20	1.8	2.96 J	0.12 J	40.6 J	0.238 J
	NFH	100	100	38.1†	37	4.12	2.29 J	0.21 J	15.7 J	0.0780 J

Storm Date	Sample Type	*Daphnia pulex*	*Ceriodaphnia dubia*		Hardness[b]	DOC	Diss. Copper	Diss. Lead	Diss. Zinc	Total PAHs
		Mean % Survival	Mean % Survival	Mean Reproduction	(mg $CaCO_3$/L)	(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
03/07/17 (Event #10)	Standard Control	60	100	33.7	103 / 39.5	--	--	--	--	--
	Low Hard. Control [a]	0	100	33.2	11.3 / 9.74	--	--	--	--	--
	EBI	30	100	35.5	5.26	1.54	2.22 J	0.11 J	18.8 J	0.0158 J
	EBO	100*	100	40.2	12.4	5.85	3.84 J	0.29 J	3.41 J	0.0094 U
	WBI	5	100	35.4	5.21	1.77	2.17 J	0.11 J	18.4 J	0.012 J
	WBO	100*	100	32.1	43.8	18.1	6.18 J	1.14 J	8.26 J	0.0094 U
	WCI	85	100	34.9	16.4	3.23	3.1 J	0.12 J	21.3 J	0.403 J
	WCEBO	100	100	45.3*	21.5	3.12	3.36 J	0.15 J	29.4 J	0.0820 J
	NFH	100	100	49.0	47.1	4.9	2.45 J	0.24 J	15.4 J	0.011 J
04/19/17 (Event #17)	Standard Control	100	--	--	134	--	--	--	--	--
	Low Hard. Control [a]	0	--	--	10.7	--	--	--	--	--
	EBI	65	--	--	8.88	2.71	3.33 J	0.10 UJ	24.6 J	0.024 U
	EBO	100*	--	--	19.3	8.35	3.64 J	0.21 J	3.84 J	0.024 U
	WBI	75	--	--	9.41	3.1	3.40 J	0.10 UJ	25.4 J	0.024 U
	WBO	90	--	--	34.4	19.8	5.22 J	0.695 J	8.57 J	0.024 U
	WCI	95	--	--	14.8	3.53	3.60 J	0.12 J	27.6 J	0.189 J
	WCEBO	95	--	--	26.0	4.45	3.32 J	0.18 J	32.4 J	0.024 U
	NFH	100	--	--	62.5	6.3	2.63 J	0.18 J	12.3 J	0.024 U
04/23/17 (Event #18)	Standard Control	100	--	--	134	--	--	--	--	--
	Low Hard. Control [a]	5	--	--	10.7	--	--	--	--	--
	EBI	100	--	--	8.66	2.81	3.78 J	0.11 J	25.0 J	0.024 U
	EBO	100	--	--	20.0	8.73	3.77 J	0.24 J	3.57 J	0.024 U
	WBI	95	--	--	8.62	2.68	3.38 J	0.10 UJ	24.4 J	0.024 U
	WBO	100	--	--	30.6	17.5	4.57 J	0.642 J	7.47 J	0.024 U
	WCI	100	--	--	17.0	3.51	4.65 J	0.15 J	27.9 J	0.360 J
	WCEBO	100	--	--	22.8	3.8	3.30 J	0.15 J	29.2 J	0.024 U
	NFH	100	--	--	59.1	5.33	2.42 J	0.16 J	12.5 J	0.024 U

* Statistically significant result compared to inlet response ($p<0.05$; Appendix E).
† Statistically significant result at NFH compared to control response ($p< 0.05$; Appendix E).
-- not analyzed; J – estimated value; U – non-detect value;
[a] Low hardness controls were added after the first storm
[b] There are two hardness and alkalinity results for control samples; the first represents results for the *D. pulex* test and the second represents results for *C. dubia* test.
Shaded cells indicate unacceptable quality based on <90% control survival.

APPENDIX H4 – PCB PATTERNS FOR INDIVIDUAL SAMPLING LOCATIONS

Total polychlorinated biphenyl (PCB) concentrations generally decreased between influent and effluent. On average, homolog patterns were fairly similar between the bioretention influent (i.e., EBI and WBI), as well as between the wetland complex influent and the effluent (i.e., WCI and WCEBO). The hexa-PCBs were the most prevalent homolog, representing about a third of the total on average, followed by penta-PCBs which comprised about one quarter of the total on average (Figure 1).

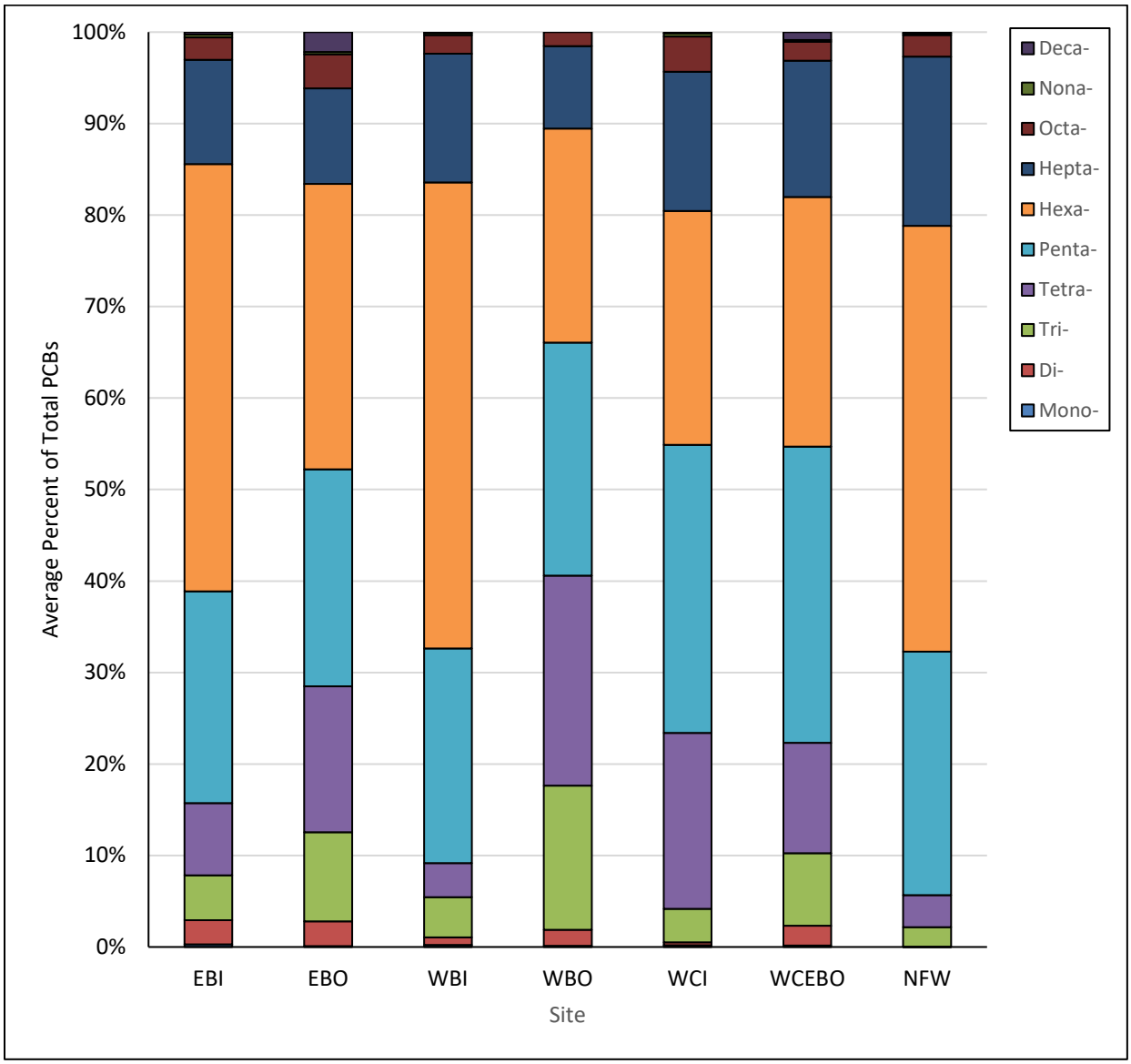


Figure 1. Homolog Patterns – Average Percent of Total PCB Concentrations (n=10)