APPENDIX E –
STATISTICAL ANALYSES

APPENDIX E.1

BACKGROUND SOIL STATISTICAL INFORMATION

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1a
LIST OF BACKGROUND SOIL SAMPLES
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Sample Location	Sample ID	Date	Start Depth (feet)	End Depth (feet)
BG-01	CUF-BS-BG01-0.0/0.5-20180827	08/27/2018	0	0.5
BG-01	CUF-BS-BG01-1.0/3.0-20180827	08/27/2018	1	3
BG-01	CUF-BS-BG01-6.5/8.5-20180827	08/27/2018	6.5	8.5
BG-01	CUF-BS-BG01-11.5/13.5-20180827	08/27/2018	11.5	13.5
BG-01	CUF-BS-BG01-16.5/18.5-20180827	08/27/2018	16.5	18.5
BG-01	CUF-BS-BG01-21.5/23.5-20180827	08/27/2018	21.5	23.5
BG-02	CUF-BS-BG02-0/0.5-20180822	08/22/2018	0	0.5
BG-02	CUF-BS-BG02-1.5/3.5-20180822	08/22/2018	1.5	3.5
BG-02	CUF-BS-BG02-5.0/7.6-20180822	08/22/2018	5	7.6
BG-03	CUF-BS-BG03-0/0.5-20180822	08/22/2018	0	0.5
BG-03	CUF-BS-BG03-1.2/3.2-20180822	08/22/2018	1.2	3.2
BG-03	CUF-BS-BG03-5.2/7.2-20180822	08/22/2018	5.2	7.2
BG-04	CUF-BS-BG04-0.0/0.5-20180823	08/23/2018	0	0.5
BG-04	CUF-BS-BG04-1.5/3.5-20180823	08/23/2018	1.5	3.5
BG-04	CUF-BS-BG04-6.5/8.5-20180823	08/23/2018	6.5	8.5
BG-04	CUF-BS-BG04-10.0/11.4-20180823	08/23/2018	10	11.4
BG-05	CUF-BS-BG05-0.0/0.5-20181129	11/29/2018	0	0.5
BG-05	CUF-BS-BG05-2.5/4.5-20181129	11/29/2018	2.5	4.5
BG-05	CUF-BS-BG05-6.5/8.5-20181129	11/29/2018	6.5	8.5
BG-05	CUF-BS-BG05-11.5/13.5-20181129	11/29/2018	11.5	13.5
BG-06	CUF-BS-BG06-0.0/0.5-20181204	12/04/2018	0	0.5
BG-06	CUF-BS-BG06-0.5/2.5-20181204	12/04/2018	0.5	2.5
BG-06	CUF-BS-BG06-6.8/8.8-20181204	12/04/2018	6.8	8.8
BG-07	CUF-BS-BG07-0/0.66-20180821	08/21/2018	0	0.66
BG-07	CUF-BS-BG07-1.5/3.5-20180821	08/21/2018	1.5	3.5
BG-07	CUF-BS-BG07-6.1/8.1-20180821	08/21/2018	6.1	8.1
BG-07	CUF-BS-BG07-11.6/13.6-20180821	08/21/2018	11.6	13.6
BG-07	CUF-BS-BG07-15.5/17.5-20180821	08/21/2018	15.5	17.5
BG-08	CUF-BS-BG08-0.0/0.5-20180824	08/24/2018	0	0.5
BG-08	CUF-BS-BG08-0.9/2.9-20180824	08/24/2018	0.9	2.9
BG-08	CUF-BS-BG08-6.5/8.5-20180824	08/24/2018	6.5	8.5
BG-08	CUF-BS-BG08-10.0/12.0-20180824	08/24/2018	10	12
BG-09	CUF-BS-BG09-0.0/0.5-20180823	08/23/2018	0	0.5
BG-09	CUF-BS-BG09-1.5/3.5-20180823	08/23/2018	1.5	3.5
BG-09	CUF-BS-BG09-6.5/8.5-20180823	08/23/2018	6.5	8.5
BG-09	CUF-BS-BG09-11.5/13.5-20180823	08/23/2018	11.5	13.5
BG-09	CUF-BS-BG09-16.5/18.5-20180823	08/23/2018	18.5	18.5
BG-10	CUF-BS-BG10-0.0/0.5-20181205	12/05/2018	0	0.5
BG-10	CUF-BS-BG10-1.0/3.0-20181205	12/05/2018	1	3
BG-10	CUF-BS-BG10-5.6/7.6-20181205	12/05/2018	5.6	7.6
BG-11	CUF-BS-BG11-0.0/0.5-20181206	12/06/2018	0	0.5
BG-11	CUF-BS-BG11-1.0/3.0-20181206	12/06/2018	1	3
BG-11	CUF-BS-BG11-6.5/8.5-20181206	12/06/2018	6.5	8.5
BG-11	CUF-BS-BG11-11.2/13.2-20181206	12/06/2018	11.2	13.2
BG-12	CUF-BS-BG12-0.0/0.5-20181206	12/06/2018	0	0.5
BG-12	CUF-BS-BG12-2.5/4.5-20181206	12/06/2018	2.5	4.5
BG-12	CUF-BS-BG12-6.5/8.5-20181206	12/06/2018	6.5	8.5
BG-12	CUF-BS-BG12-10.6/12.6-20181206	12/06/2018	10.6	12.6
BG-13	CUF-BS-BG13-0.0/0.5-20180828	08/28/2018	0	0.5
BG-13	CUF-BS-BG13-0.75/2.75-20180828	08/28/2018	0.75	2.75
BG-13	CUF-BS-BG13-6.5/8.5-20180828	08/28/2018	6.5	8.5
BG-14	CUF-BS-BG14-0.0/0.5-20180828	08/28/2018	0	0.5
BG-14	CUF-BS-BG14-1.0/3.0-20180828	08/28/2018	1	3
BG-14	CUF-BS-BG14-6.5/8.5-20180828	08/28/2018	6.5	8.5
BG-14	CUF-BS-BG14-10.3/12.3-20180828	08/28/2018	10.3	12.3
BG-15	CUF-BS-BG15-0.0/0.5-20181129	11/29/2018	0	0.5
BG-15	CUF-BS-BG15-1.9/3.9-20181129	11/29/2018	1.9	3.9
BG-15	CUF-BS-BG15-6.5/8.5-20181129	11/29/2018	6.5	8.5
BG-16	CUF-BS-BG16-0.0/0.5-20181203	12/03/2018	0	0.5
BG-16	CUF-BS-BG16-0.8/2.8-20181203	12/03/2018	0.8	2.8
BG-16	CUF-BS-BG16-5.0/6.8-20181203	12/03/2018	5	6.8
BG-17	CUF-BS-BG17-0.0/0.5-20181130	11/30/2018	0	0.5
BG-17	CUF-BS-BG17-0.75/2.75-20181130	11/30/2018	0.75	2.75
BG-17	CUF-BS-BG17-6.0/8.0-20181130	11/30/2018	6	8
BG-17	CUF-BS-BG17-11.25/13.25	11/30/2018	11.25	13.25
BG-17	CUF-BS-BG17-15.0/16.9-20181130	11/30/2018	15	16.9
CUF-1000-ALT	CUF-BS-CUF1000ALTA-13.5/15.0	11/29/2018	13.5	15
CUF-1000-ALT	CUF-BS-CUF1000ALTA-18.0/19.5	11/29/2018	18	19.5

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-01	BG-01	BG-01	BG-01	BG-01	BG-01
Sample Name	CUF-BS-BG01-0.0/0.5-20180827	CUF-BS-BG01-1.0/3.0-20180827	CUF-BS-BG01-6.5/8.5-20180827	CUF-BS-BG01-11.5/13.5-20180827	CUF-BS-BG01-16.5/18.5-20180827	CUF-BS-BG01-21.5/23.5-20180827
Sample Date	08/27/2018	08/27/2018	08/27/2018	08/27/2018	08/27/2018	08/27/2018
Sample Depth (bgs)	0 - 0.5 (ft)	1 - 3 (ft)	6.5 - 8.5 (ft)	11.5 - 13.5 (ft)	16.5 - 18.5 (ft)	21.5 - 23.5 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.816 J	1.86 J	6.19 J	1.36 J	2.53 J	1.52 J
Arsenic	16.3	58.6	77.2	12.5	39.9	22.3
Barium	85.4	37.9	36	42.7	271	40.2
Beryllium	0.708	0.703	0.56	0.462	1.15	0.851
Boron	1.72 J	4.32 J	6.24 J	7.16 J	3.9 J	5.75 J
Cadmium	0.218	0.141	0.204	0.171	0.217	0.345
Calcium	1880 J	1030	312	265	415	395
Chromium	31.1 J	30.6	15.4	11.7	17	12.7
Cobalt	10.8 J	2.1	0.548	0.621	1.84	6.06
Copper	17.3 J	54.1	117	92	189	139
Lead	15.5	13	43.3	11.2	41.5	18.9
Lithium	2.89 J	3.63 J	1.98 J	2.07 J	3.03 J	2.89 J
Mercury	0.0634 J	0.0927 J	0.213	0.0764 J	0.0989 J	0.163
Molybdenum	10.2	66.1	172	17.9	54	28.4
Nickel	14 J	12	3.07	4.5	12	33.3
Selenium	0.449 J	1.02 J	1.27 J	0.492 J	1.31 J	0.842 J
Silver	0.139	0.0531 J	0.0694 J	0.0714 J	0.148	0.0852 J
Thallium	0.258	0.577	0.468	0.748	1.38	1.98
Vanadium	40.7 J	60.6 J	80.2 J	35.6 J	119 J	60.8 J
Zinc	43.8 J	24.7	11.1	9.66	23.8	45.4
Other						
Chloride (mg/kg)	8.6 U	8.18 U	8.56 U	8.89 U	8.93 U	9.31 U
Fluoride (mg/kg)	1.65 J	0.935 U	0.979 U	1.02 U	1.02 U	1.06 U
Sulfate (mg/kg)	12.6 U*	18.8 U*	9.39 U*	9.26 U*	7.77 U*	107
pH (lab) (pH units)	6.2	6	5.1	5	5.2	4.6
Ash (%)						
Ash	1 U	-	-	-	-	-
Field Parameters						
pH, Field (pH units)	6.49	5.16	3.87	4	4.32	3.9
Radiological (pCi/g)						
Radium-226	2.37	6.87	13.2	6.46	4.14	9.96
Radium-228	1.05	1.55	2.5	2.18	1.4	1.74
Radium-226 & 228	3.42	8.42	15.7	8.64	5.54	11.7

Notes:
- \- - not analyzed in this sample.
- J - value is estimated.
- mg/kg - milligram per kilogram.
- pCi/g - picoCurie per gram.
- U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-02	BG-02	BG-02	BG-03	BG-03	BG-03
Sample Name	CUF-BS-BG02-0/0.5-20180822	CUF-BS-BG02-1.5/3.5-20180822	CUF-BS-BG02-5.0/7.6-20180822	CUF-BS-BG03-0/0.5-20180822	CUF-BS-BG03-1.2/3.2-20180822	CUF-BS-BG03-5.2/7.2-20180822
Sample Date	08/22/2018	08/22/2018	08/22/2018	08/22/2018	08/22/2018	08/22/2018
Sample Depth (bgs)	0 - 0.5 (ft)	1.5 - 3.5 (ft)	5 - 7.6 (ft)	0 - 0.5 (ft)	1.2 - 3.2 (ft)	5.2 - 7.2 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.314 J	0.652 J	0.303 J	0.254 J	0.492 J	0.714 J
Arsenic	4.27	7.37	3.67	6.34	15	88.7
Barium	60.7	74.8	50	58	90.2	133
Beryllium	0.663	0.616	0.781	0.44	0.724	1.27
Boron	1.5 J	2.13 J	7 J	2.04 J	2.28 J	2.38 J
Cadmium	0.108 J	0.0547 J	0.0672 J	0.0891 J	0.107 J	0.285
Calcium	1050	1570	131000	1320	674	3980
Chromium	14.5	21.6	16	12.6	19	25.1
Cobalt	7.48	11.7	6.19	7.91	15.3	14.2
Copper	5.51	12	11.2	12.1	22.1	77.2
Lead	12.4	18	6.95	14.6	24.8	41.9
Lithium	3.93 J	8.55 J	11.1 J	5.15 J	9.26 J	14.3 J
Mercury	0.0361 U	0.0525 J	0.0408 J	0.037 U	0.0469 J	0.0368 U
Molybdenum	0.66	1.59	1.09	0.846	2.32	4.43
Nickel	6.84	12.9	18.7	8.02	18.3	44.8
Selenium	0.588 J	0.468 J	0.344 J	0.647 J	0.622 J	1.08 J
Silver	0.0285 J	0.0249 J	0.0353 J	0.0275 J	0.0262 J	0.0624 J
Thallium	0.142	0.261	0.195	0.131	0.232	0.271
Vanadium	19.1	33.8	16.5	22.5	34.7	44.5
Zinc	20.8	30.2	29.2	27	30.8	51.6
Other						
Chloride (mg/kg)	10 U*	8.26 U	8.51 U	10.8 U*	8.01 U	8.84 U
Fluoride (mg/kg)	1.19 J	0.944 U	1.39 J	2.31 J	0.915 U	2.66 J
Sulfate (mg/kg)	22.1 U*	51.8 J	7.95 U*	17 U*	81.5 J	31.5 J
pH (lab) (pH units)	5.5	6.2	8.3	5.9	5.7	7.6
Ash (%)						
Ash	1	-	-	1	-	-
Field Parameters						
pH, Field (pH units)	-	6.08	8.47	-	5.07	6.57
Radiological (pCi/g)						
Radium-226	1.36	0.778	0.498	1.48	1.63	1.39
Radium-228	1.08	1.17	0.76	1.09	0.884	1.3
Radium-226 & 228	2.44	1.95	1.26	2.57	2.51	2.69

Notes:
- \- - not analyzed in this sample.
- J - value is estimated.
- mg/kg - milligram per kilogram.
- pCi/g - picoCurie per gram.
- U - not detected, value is the reporting limit.

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-04	BG-04	BG-04	BG-04	BG-05	BG-05
Sample Name	CUF-BS-BG04-0.0/0.5-20180823	CUF-BS-BG04-1.5/3.5-20180823	CUF-BS-BG04-6.5/8.5-20180823	CUF-BS-BG04-10.0/11.4-20180823	CUF-BS-BG05-0.0/0.5-20181129	CUF-BS-BG05-2.5/4.5-20181129
Sample Date	08/23/2018	08/23/2018	08/23/2018	08/23/2018	11/29/2018	11/29/2018
Sample Depth (bgs)	0 - 0.5 (ft)	1.5 - 3.5 (ft)	6.5 - 8.5 (ft)	10 - 11.4 (ft)	0 - 0.5 (ft)	2.5 - 4.5 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.261 J	0.337 J	0.653 J	0.227 J	0.307 U*	0.241 U*
Arsenic	4.81	13.7 J	22.8 J	7.97 J	5.37 J	5.1 J
Barium	108	342	214	56.6	124	119
Beryllium	0.841	1.83	1.93	1.52	1.02	1.3
Boron	1.42 J	2.01 J	1.16 J	0.998 U	2.28 J	1.82 J
Cadmium	0.125	0.35	0.914 J	0.211 J	0.146	0.0526 J
Calcium	1250	1940	1700	1970	1290 J	723 J
Chromium	22.1	20.1	39.7	20.9	12.1	11.5
Cobalt	11.3	15.9	25	5.48	19.2	13.2
Copper	7.38	10.8	18.5	13.9	10.7	12.4
Lead	17.4	20.8	44.8 J	15.3 J	20	14.8
Lithium	3.95 J	8.28 J	12.1 J	13.2 J	4.35 J	7.21 J
Mercury	0.0347 U	0.0537 J	0.0663 J	0.0537 J	0.0395 U	0.0364 U
Molybdenum	0.694	0.951 J	3.2 J	0.504 J	1.01	1.91
Nickel	8.53	17.6	28.3	16.9	11.1	14.4
Selenium	0.672 J	1.25 J	0.626 J	0.895 J	0.956 J	0.844 J
Silver	0.0397 J	0.0743 J	0.0337 J	0.0957 J	0.0411 J	0.0338 J
Thallium	0.152	0.232	0.314 J	0.245 J	0.17	0.442
Vanadium	20.6	41.4	62.2	26.9	22.1 J	26.3 J
Zinc	22.2	43.5	66.4	58.7	24.9	37.5
Other						
Chloride (mg/kg)	22.5	8.64 U	8.67 U	9.2 U	9.27 U	8.67 U
Fluoride (mg/kg)	7.84 J	0.988 J	1.31 J	2.38 J	2.19 J	0.991 UR
Sulfate (mg/kg)	9.87 U*	10.7 U*	13.7 U*	10.2 U*	11.1 J	24.7 J
pH (lab) (pH units)	7.3	7	6.9	7.3	5.9	6
Ash (%)						
Ash	1 U	-	-	-	3	-
Field Parameters						
pH, Field (pH units)	6.68	6.56	6.87	7.32	6.38	5.23
Radiological (pCi/g)						
Radium-226	1.44	1.91	1.42	1.95	1.15	0.796
Radium-228	1.09	1.85	1.78	1.61	1.03	1.1
Radium-226 & 228	2.53	3.77	3.21	3.55	2.18	1.9

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-05	BG-05	BG-06	BG-06	BG-06	BG-07
Sample Name	CUF-BS-BG05-6.5/8.5-20181129	CUF-BS-BG05-11.5/13.5-20181129	CUF-BS-BG06-0.0/0.5-20181204	CUF-BS-BG06-0.5/2.5-20181204	CUF-BS-BG06-6.8/8.8-20181204	CUF-BS-BG07-0/0.66-20180821
Sample Date	11/29/2018	11/29/2018	12/04/2018	12/04/2018	12/04/2018	08/21/2018
Sample Depth (bgs)	6.5 - 8.5 (ft)	11.5 - 13.5 (ft)	0 - 0.5 (ft)	0.5 - 2.5 (ft)	6.8 - 8.8 (ft)	0 - 0.66 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.333 U*	0.304 U*	0.67 J	0.628 J	0.847 J	0.218 J
Arsenic	7.48 J	8.63 J	15.5	35.7	35.3	4.93
Barium	65.6	80.1	145	121	103	56.4
Beryllium	0.874	1.49	2.13 J	1.93 J	1.78 J	0.554
Boron	3.02 J	3.12 J	7.18 J	7.22 J	4.51 J	1.72 J
Cadmium	0.0457 J	0.101 J	0.402	1.07	0.827	0.0825 J
Calcium	833 J	1070 J	4650	7290	5960	846
Chromium	15.1	20.1	28.2	30.3	35.7	14.8
Cobalt	10.6	11.8	20.4	15.1	23	7.05
Copper	16.8	19.5	16.3	20.3	26	12.2
Lead	9.58	12.1	30.3	125	125	12.7
Lithium	7.83 J	10.8 J	13.4 J	17.3 J	14.1 J	5.22 J
Mercury	0.0426 J	0.0519 J	0.0641	0.0811	0.0511	0.0374 U
Molybdenum	1.53	1.23	1.42	1.32	2.35	0.74 U*
Nickel	16.3	22.7	35.9	41.8	39.6	8.28
Selenium	0.364 J	0.76 J	0.398 J	0.537 J	0.407 J	0.549 J
Silver	0.0206 J	0.0293 J	0.0362 J	0.0582 J	0.0534 J	0.0239 J
Thallium	0.262	0.268	0.286	0.432	0.321	0.138
Vanadium	30.9 J	33.2 J	43	44.5	47.6	23.1
Zinc	30	47.1	92	195	187	30.5
Other						
Chloride (mg/kg)	8.8 U	9.41 U	9.72 U	9.05 U	9.47 U	8.97 U
Fluoride (mg/kg)	1.01 UR	1.08 UR	2.03 U*	2.69	2.19 U*	1.22 U*
Sulfate (mg/kg)	23.5 J	12.7 J	8.33 U	7.76 U	12.9 U*	14.4 U*
pH (lab) (pH units)	5.5	5.5	6.3	7.6	7.7	5.2
Ash (%)						
Ash	-	-	1 U	-	-	1 U
Field Parameters						
pH, Field (pH units)	5.56	5.45	6.25	6.82	6.48	-
Radiological (pCi/g)						
Radium-226	0.201	0.677	0.737	1.81	1.14	0.836
Radium-228	1.42	1.2	1.67	1.56	1.75	1.1
Radium-226 & 228	1.62	1.88	2.41	3.37	2.89	1.94

Notes:
- \- - not analyzed in this sample.
- J - value is estimated.
- mg/kg - milligram per kilogram.
- pCi/g - picoCurie per gram.
- U - not detected, value is the reporting limit.

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-07	BG-07	BG-07	BG-07	BG-08	BG-08
Sample Name	CUF-BS-BG07-1.5/3.5-20180821	CUF-BS-BG07-6.1/8.1-20180821	CUF-BS-BG07-11.6/13.6-20180821	CUF-BS-BG07-15.5/17.5-20180821	CUF-BS-BG08-0.0/0.5-20180824	CUF-BS-BG08-0.9/2.9-20180824
Sample Date	08/21/2018	08/21/2018	08/21/2018	08/21/2018	08/24/2018	08/24/2018
Sample Depth (bgs)	1.5 - 3.5 (ft)	6.1 - 8.1 (ft)	11.6 - 13.6 (ft)	15.5 - 17.5 (ft)	0 - 0.5 (ft)	0.9 - 2.9 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.208 J	0.194 J	0.284 J	0.238 J	0.247 J	0.183 J
Arsenic	4.04	5.74	9.86	7.94	5.75	5.22
Barium	26.3	58.1	73.6	88	75.9	100
Beryllium	0.298	0.611	1.37	2.82	0.68	0.789
Boron	1.16 J	1.42 J	1.57 J	1.89 J	2.13 J	2.4 J
Cadmium	0.0277 J	0.0392 J	0.0717 J	0.0854 J	0.199	0.201
Calcium	225	854	2190	3870	2610	1740
Chromium	11.6	16.7	21.5	18.4	18.9	17.7
Cobalt	5.44	2.03	3.28	18.7	9.91	9.93
Copper	6.42	10.5	16.1	15.7	8.71	9.61
Lead	7.58	10.2	15.6	12.7	16.5	12.2
Lithium	3.62 J	4.66 J	6.43 J	11.7 J	4.74 J	7.56 J
Mercury	0.0393 J	0.0334 U	0.0564 J	0.0578 J	0.0363 U	0.0359 U
Molybdenum	1.57 U*	1.24 U*	1.31 U*	0.924 U*	0.499 J	0.561 J
Nickel	7.09	9.76	16.7	22.1	11.5	11.8
Selenium	0.241 J	0.306 J	0.507 J	0.799 J	0.348 J	0.367 J
Silver	0.0167 U	0.016 U	0.0192 J	0.0181 U	0.0417 J	0.0521 J
Thallium	0.162	0.224	0.319	0.313	0.132	0.159
Vanadium	17.5	24.2	38	30.5	30.3 J	30.8 J
Zinc	34.4	25.6	45	48.7	32.4	32.2
Other						
Chloride (mg/kg)	8.03 U	8.74 U*	9.54 U	9.39 U	17.6 U*	8.69 U
Fluoride (mg/kg)	0.917 UR	0.9 UR	1.09 UR	1.73 U*	1.93 J	2.4 J
Sulfate (mg/kg)	46.3 J	6.75 UJ	13.3 U*	9.04 U*	27.9 U*	11.1 U*
pH (lab) (pH units)	4.7	4.8	5.1	6.9	7.4	7.7
Ash (%)						
Ash	-	-	-	-	1	-
Field Parameters						
pH, Field (pH units)	4.15	4.55	4.84	5.68	7.05	7.19
Radiological (pCi/g)						
Radium-226	0.284	0.206	0.425	0.907	1.3	1.37
Radium-228	0.297	0.904	1.43	1.39	1.03	1.12
Radium-226 & 228	0.581	1.11	1.85	2.3	2.33	2.49

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-08	BG-08	BG-09	BG-09	BG-09	BG-09
Sample Name	CUF-BS-BG08-6.5/8.5-20180824	CUF-BS-BG08-10.0/12.0-20180824	CUF-BS-BG09-0.0/0.5-20180823	CUF-BS-BG09-1.5/3.5-20180823	CUF-BS-BG09-6.5/8.5-20180823	CUF-BS-BG09-11.5/13.5-20180823
Sample Date	08/24/2018	08/24/2018	08/23/2018	08/23/2018	08/23/2018	08/23/2018
Sample Depth (bgs)	6.5 - 8.5 (ft)	10 - 12 (ft)	0 - 0.5 (ft)	1.5 - 3.5 (ft)	6.5 - 8.5 (ft)	11.5 - 13.5 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.358 J	0.258 J	0.228 J	0.332 J	0.782 J	0.819 J
Arsenic	13.5	11.4	4.78 J	7.59 J	22.8 J	17.8 J
Barium	191	144	73.8	52.7	33.9	45.9
Beryllium	1.17	1.03	0.67	0.418	1.04	0.888
Boron	2.85 J	3.13 J	1.19 J	1.42 J	2.07 J	1.78 J
Cadmium	0.952	1.01	0.0658 J	0.0371 J	0.0354 J	0.0416 J
Calcium	2270	3000	999	836 J	446	552
Chromium	25.5	26.6	11.8	19.8 J	17.5	26.9
Cobalt	23	16.1	9.09	10.3 J	4.78	3.75
Copper	15.7	23.4	5.9	9.18 J	15	15.4
Lead	20.4	17.5	13.4 J	12.9 J	18.2 J	19.3 J
Lithium	26.9 J	31 J	4.44 J	7.02 J	8.89 J	10.2 J
Mercury	0.0349 U	0.0391 J	0.0357 U	0.0638 J	0.0925 J	0.114 J
Molybdenum	1.08	1.13	0.612 J	1.29 J	3.65 J	3.62 J
Nickel	26.8	34.3	8.37	9.53 J	17.9	18.7
Selenium	0.281 J	0.251 J	0.717 J	0.318 J	0.261 J	0.358 J
Silver	0.0806 J	0.0996 J	0.0252 J	0.0289 J	0.0388 J	0.0348 J
Thallium	0.238	0.294	0.136 J	0.171 J	0.364 J	0.361 J
Vanadium	55.2 J	41.4 J	19.7	29.5 J	34.6	49.5
Zinc	72.1	87.2	20.5	22.8 J	27.5	27.3
Other						
Chloride (mg/kg)	8.35 U	8.99 U	8.27 U	7.97 U	9.58 U	9.51 U
Fluoride (mg/kg)	2.3 J	2.55 J	2.74 J	0.911 UR	1.1 UR	1.09 UR
Sulfate (mg/kg)	12.5 U*	15.3 U*	8.68 U*	16.6 U*	8.21 U	11.5 U*
pH (lab) (pH units)	7.6	7.6	6.7	6	5.6	5.9
Ash (%)						
Ash	-	-	1	-	-	-
Field Parameters						
pH, Field (pH units)	7.33	7.2	5.79	5.45	4.06	4.46
Radiological (pCi/g)						
Radium-226	1.76	2.13	1.39	1.4	1.93	2.36
Radium-228	1.9	1.21	1.37	1.07	1.28	2.14
Radium-226 & 228	3.66	3.34	2.76	2.47	3.21	4.5

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-09	BG-10	BG-10	BG-10	BG-11	BG-11
Sample Name	CUF-BS-BG09-16.5/18.5-20180823	CUF-BS-BG10-0.0/0.5-20181205	CUF-BS-BG10-1.0/3.0-20181205	CUF-BS-BG10-5.6/7.6-20181205	CUF-BS-BG11-0.0/0.5-20181206	CUF-BS-BG11-1.0/3.0-20181206
Sample Date	08/23/2018	12/05/2018	12/05/2018	12/05/2018	12/06/2018	12/06/2018
Sample Depth (bgs)	18.5 - 18.5 (ft)	0 - 0.5 (ft)	1 - 3 (ft)	5.6 - 7.6 (ft)	0 - 0.5 (ft)	1 - 3 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.707 J	0.59 J	0.397 J	0.486 J	0.346 J	0.626 J
Arsenic	19.9 J	15.4	12.3	20.4	5.83	8.52
Barium	58.5	72	92.5	82.4	70.7	37.5
Beryllium	5.59	0.728	0.498	1.09	0.575	0.426
Boron	1.59 J	3.74 J	2.34 J	1.83 J	3.74 U*	6.02 U*
Cadmium	0.0786 J	0.226	0.216	0.229	0.135 J	0.11 J
Calcium	1370	7730	1690	1770	1430	932
Chromium	35.4	26.6	20.8	26.5	34.3 J	23 J
Cobalt	6.99	14.2	13.8	18.2	6.93	1.69
Copper	19.3	15.3	16.9	12.8	6.48	12.8
Lead	27.1 J	21.6	15.3	18.1	12.1 J	7.5 J
Lithium	14.4 J	6.67 J	9.59 J	6.1 J	4.26 J	5.47 J
Mercury	0.131 J	0.0342 J	0.0453	0.0266 J	0.0251 J	0.0881
Molybdenum	2.97 J	3.2	1.87	2.27	0.893	2.02
Nickel	19.5	18.3	17.2	19.3	9.73	16.8
Selenium	2.41 J	0.632 J	0.374 J	0.337 J	0.903	0.652
Silver	0.0671 J	0.0404 J	0.038 J	0.0382 J	0.0594 U*	0.363
Thallium	0.466 J	0.237	0.249	0.248	0.145	0.193
Vanadium	61	40.8 J	44.2 J	49.1 J	30.3	47.6
Zinc	49.6	50	45.6	40.4	32.7	73
Other						
Chloride (mg/kg)	10.1 U	9.22 U	8.73 U	8.69 U	9.28 U	9.17 U
Fluoride (mg/kg)	1.16 UR	3.08 J	0.998 UJ	0.993 UJ	1.68 J	1.05 UR
Sulfate (mg/kg)	8.68 U	10.6 U*	51.3 J	34.9 J	7.96 UJ	17.7 J
pH (lab) (pH units)	6.8	8.2	6.4	5.9	6.5	5.9
Ash (%)						
Ash	-	1 U	-	-	1 U	-
Field Parameters						
pH, Field (pH units)	4.99	7.24	6.13	5.6	6.2	5.8
Radiological (pCi/g)						
Radium-226	2.2	0.729	1.31	0.852	1.08	1.15
Radium-228	1.89	0.993	1.14	1.6	0.694	1.61
Radium-226 & 228	4.08	1.72	2.45	2.45	1.77	2.76

Notes:
- \- not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-11	BG-11	BG-12	BG-12	BG-12	BG-12
Sample Name	CUF-BS-BG11-6.5/8.5-20181206	CUF-BS-BG11-11.2/13.2-20181206	CUF-BS-BG12-0.0/0.5-20181206	CUF-BS-BG12-2.5/4.5-20181206	CUF-BS-BG12-6.5/8.5-20181206	CUF-BS-BG12-10.6/12.6-20181206
Sample Date	12/06/2018	12/06/2018	12/06/2018	12/06/2018	12/06/2018	12/06/2018
Sample Depth (bgs)	6.5 - 8.5 (ft)	11.2 - 13.2 (ft)	0 - 0.5 (ft)	2.5 - 4.5 (ft)	6.5 - 8.5 (ft)	10.6 - 12.6 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.787 J	0.707 J	0.436 J	0.23 J	0.324 J	0.299 J
Arsenic	12.5	9.06	7.4	3.92	5.92	6.53
Barium	37.6	29.5	84.2	135	67.2	75.3
Beryllium	0.757	0.608	0.484	0.806	0.294	0.347
Boron	4.55 U*	3.23 U*	5.47 U*	2.77 U*	2.74 U*	2.17 U*
Cadmium	0.296	0.356	0.119 J	0.0629 J	0.065 J	0.0716 J
Calcium	1380	1030	1710	446	424	444
Chromium	25.6 J	18.8 J	19.2 J	16.2 J	20 J	17 J
Cobalt	6.11	22.9	6.23	8.84	4.26	4.06
Copper	22.8	15.6	10.8	7.3	7.43	8.88
Lead	9.17 J	7.68 J	11.6 J	9.53 J	8.79 J	9.6 J
Lithium	5.97 J	4.63 J	4.24 J	4.61 J	6.85 J	6.79 J
Mercury	0.105	0.0617	0.0399 J	0.0198 J	0.0525	0.0487
Molybdenum	2.12	2.39	1.67	0.744	1.64	1.82
Nickel	24.8	20.8	10.2	10.7	12.9	13.1
Selenium	1.07	0.973	0.928	1.32	0.653	0.688
Silver	0.136	0.0871 U*	0.0395 U*	0.049 U*	0.0586 U*	0.0549 U*
Thallium	0.286	0.31	0.164	0.169	0.221	0.212
Vanadium	60.9	41.9	32.1	22.6	33.2	33.2
Zinc	157	115	32.4	24.3	30.6	32.5
Other						
Chloride (mg/kg)	9.46 U	9.06 U	9.4 U	8.35 U	8.64 U	8.6 U
Fluoride (mg/kg)	1.08 UR	1.04 UR	1.49 J	0.954 UR	0.987 UR	0.983 UR
Sulfate (mg/kg)	12 J	8.05 U*	8.08 U*	37.8 J	33.5 J	19.9 J
pH (lab) (pH units)	5.8	5.9	6.7	5.5	5.3	5.5
Ash (%)						
Ash	-	-	1 U	-	-	-
Field Parameters						
pH, Field (pH units)	6.03	5.63	6.7	5.13	5.69	5.02
Radiological (pCi/g)						
Radium-226	1.48	1.02	1.12	0.872	0.937	0.812
Radium-228	2.25	1.09	1.09	0.938	0.381	0.917
Radium-226 & 228	3.73	2.11	2.21	1.81	1.32	1.73

Notes:

- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-13	BG-13	BG-13	BG-14	BG-14	BG-14
Sample Name	CUF-BS-BG13-0.0/0.5-20180828	CUF-BS-BG13-0.75/2.75-20180828	CUF-BS-BG13-6.5/8.5-20180828	CUF-BS-BG14-0.0/0.5-20180828	CUF-BS-BG14-1.0/3.0-20180828	CUF-BS-BG14-6.5/8.5-20180828
Sample Date	08/28/2018	08/28/2018	08/28/2018	08/28/2018	08/28/2018	08/28/2018
Sample Depth (bgs)	0 - 0.5 (ft)	0.75 - 2.75 (ft)	6.5 - 8.5 (ft)	0 - 0.5 (ft)	1 - 3 (ft)	6.5 - 8.5 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.529 J	0.738 J	0.643 J	0.7 J	1.32 J	0.979 J
Arsenic	8.96	10.3	4.88	16.5	24.6	17.4
Barium	87.2 J	146	101	121	138	151
Beryllium	1.33 J	1.94	1.31	1.29	1.82	1.55
Boron	6.25 J	5.55 J	8.74 J	4.1 J	2.64 J	2.41 J
Cadmium	0.387	0.549	0.298	0.245	0.307	0.647
Calcium	6780	5770	5830	4660	3730	2680
Chromium	23.2	31.6	23.8	34.3	38.4	39.1
Cobalt	22.3	13.4	13.3	18.1	17.5	26.3
Copper	16.1	18.3	12.7	15.3	16.3	19.2
Lead	26.7	23.2	16.3	19.5	27.8	45.5
Lithium	7.71 J	17 J	13.9 J	8.07 J	6.68 J	6.45 J
Mercury	0.0526 J	0.0502 J	0.0391 U	0.0425 J	0.0716 J	0.0521 J
Molybdenum	1.18 J	1.21	0.609 J	4.7	25.3	26.2
Nickel	37.7	42.8	37.8	27.5	28.9	27.1
Selenium	0.462 J	0.63 J	0.277 J	0.581 J	0.972 J	0.678 J
Silver	0.0281 J	0.0374 J	0.0217 J	0.0349 J	0.0379 J	0.0233 J
Thallium	0.245	0.324	0.238	0.245	0.323	0.321
Vanadium	40.2 J	52.3 J	34.8 J	49.3 J	50.4 J	52.4 J
Zinc	53.7	75.1	61.1	50.4	51	53.7
Other						
Chloride (mg/kg)	8.62 U	9.46 U	9.02 U	8.61 U	9.01 U	8.49 U
Fluoride (mg/kg)	3.02	3.8	2.45	3.1	2.75	2.5
Sulfate (mg/kg)	8.77 U*	8.1 U	7.73 U	20.3 U*	19.6 U*	8.39 U*
pH (lab) (pH units)	7	7.7	7.9	7.2	7.3	7.1
Ash (%)						
Ash	1 U	-	-	1 U	-	-
Field Parameters						
pH, Field (pH units)	7.38	7.17	8.17	7.1	7.41	6.75
Radiological (pCi/g)						
Radium-226	0.864	0.606	0.902	0.909	0.853	1.52
Radium-228	1.32	1.36	1.83	1.03	1.32	1.66
Radium-226 & 228	2.19	1.96	2.73	1.94	2.17	3.18

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-14	BG-15	BG-15	BG-15	BG-16	BG-16
Sample Name	CUF-BS-BG14-10.3/12.3-20180828	CUF-BS-BG15-0.0/0.5-20181129	CUF-BS-BG15-1.9/3.9-20181129	CUF-BS-BG15-6.5/8.5-20181129	CUF-BS-BG16-0.0/0.5-20181203	CUF-BS-BG16-0.8/2.8-20181203
Sample Date	08/28/2018	11/29/2018	11/29/2018	11/29/2018	12/03/2018	12/03/2018
Sample Depth (bgs)	10.3 - 12.3 (ft)	0 - 0.5 (ft)	1.9 - 3.9 (ft)	6.5 - 8.5 (ft)	0 - 0.5 (ft)	0.8 - 2.8 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.695 J	0.259 U*	0.357 U*	0.335 U*	1.34 J	0.911 J
Arsenic	15.5	5.5 J	7.42 J	8 J	53.8	79.4
Barium	104	78.6	60.2	264	227	570
Beryllium	1.45	0.808	0.438	1.89	2.05 J	2.15 J
Boron	3.21 J	1.64 J	1.6 J	2.26 J	4.97 J	4.78 J
Cadmium	0.285	0.0958 J	0.0409 J	0.148 J	0.347	0.361
Calcium	7580	969 J	578 J	5360 J	3200	3220
Chromium	34	15.6	16.9	23.8	30.6	33.4
Cobalt	21.8	11.7	15.6	13.6	45	27.6
Copper	15.7	7.41	11.1	18.8	64.3	112
Lead	26.1	14.5	19.2	21.6	20	21.4
Lithium	7.79 J	4.63 J	7.8 J	12.2 J	7.17 J	5.54 J
Mercury	0.0597 J	0.0374 U	0.0647 J	0.117 J	0.0856	0.0859
Molybdenum	3.53	1.04	1.88	0.887	34.5	24.6
Nickel	26.2	9.29	9.47	25.5	218	272
Selenium	0.515 J	0.733 J	0.414 J	0.837 J	2.01	2.91
Silver	0.0337 J	0.0259 J	0.0185 U	0.0288 J	0.0585 J	0.0333 J
Thallium	0.252	0.158	0.304	0.22	1.77	1.49
Vanadium	48.7 J	23.5 J	30.8 J	30.5 J	74.5	76.4
Zinc	54.1	25.8	29	38.3	352	256
Other						
Chloride (mg/kg)	8.64 U	9.17 U	8.7 U	9.32 U	9.16 U	10.3 U
Fluoride (mg/kg)	3.34	1.86 J	0.994 UR	4.03 J	1.05 U	1.18 U
Sulfate (mg/kg)	7.4 U	11.6 J	29 J	7.99 UJ	36.5	33.2
pH (lab) (pH units)	7.9	5.7	5.1	7.5	6.5	6
Ash (%)						
Ash	-	1	-	-	1 U	-
Field Parameters						
pH, Field (pH units)	8.13	5.56	4.79	7.34	5.87	5.45
Radiological (pCi/g)						
Radium-226	0.962	1.41	1.02	0.646	9.68	9.57
Radium-228	1.62	1.32	1.33	1.72	1.53	1.49
Radium-226 & 228	2.58	2.73	2.35	2.37	11.2	11.1

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	BG-16	BG-17	BG-17	BG-17	BG-17	BG-17
Sample Name	CUF-BS-BG16-5.0/6.8-20181203	CUF-BS-BG17-0.0/0.5-20181130	CUF-BS-BG17-0.75/2.75-20181130	CUF-BS-BG17-6.0/8.0-20181130	CUF-BS-BG17-11.25/13.25	CUF-BS-BG17-15.0/16.9-20181130
Sample Date	12/03/2018	11/30/2018	11/30/2018	11/30/2018	11/30/2018	11/30/2018
Sample Depth (bgs)	5 - 6.8 (ft)	0 - 0.5 (ft)	0.75 - 2.75 (ft)	6 - 8 (ft)	11.25 - 13.25 (ft)	15 - 16.9 (ft)
Inorganic Compounds (mg/kg)						
Antimony	0.674 J	0.319 U*	0.262 U*	0.326 U*	0.378 U*	0.451 U*
Arsenic	70.7	5.83 J	4.95 J	13.3 J	17.9 J	30.4 J
Barium	127	101	107	637	91.3	81.1
Beryllium	2.57 J	0.741	1.18	1.01	1.67	1.53
Boron	3.45 J	2.29 J	2.71 J	1.55 J	1.93 J	2.24 J
Cadmium	0.218	0.178	0.116 J	0.423	0.352	0.309
Calcium	1240	2870 J	3780 J	3240 J	4760 J	4200 J
Chromium	38.6	12.8	18.1	14.7	20.7	25.5
Cobalt	77.6	9.04	7.25	33	12.7	30.7
Copper	83	11.4	13.8	10.4	19	16.4
Lead	10.5	14.7	15.4	11.6	17.8	18.2
Lithium	3.64 J	4.88 J	7.67 J	5.89 J	9.3 J	9.04 J
Mercury	0.0359 J	0.0521 J	0.0397 J	0.0396 J	0.063 J	0.0579 J
Molybdenum	17.7	1.47	1.47	2.51	1.61	3.57
Nickel	398	12.2	13.6	20.8	23.7	31.8
Selenium	0.759	0.755 J	1.15 J	0.682 J	0.868 J	0.893 J
Silver	0.026 J	0.0422 J	0.0695 J	0.0558 J	0.0694 J	0.052 J
Thallium	1.21	0.196	0.204	0.2	0.194	0.556
Vanadium	67.9	23.3 J	24 J	25.4 J	43.2 J	35.5 J
Zinc	692	33.8	35.7	37.6	66.2	54.1
Other						
Chloride (mg/kg)	10.7 U	10 U	9.42 U	8.59 U	9.21 U	9.1 U
Fluoride (mg/kg)	1.23 U	2.48 U*	2.81 U*	2.03 U*	2.91 U*	2.52 U*
Sulfate (mg/kg)	14.4 U*	28.5 J	8.65 U*	7.37 UJ	7.9 UJ	7.8 UJ
pH (lab) (pH units)	5.8	6.2	6.9	7	7.6	7.6
Ash (%)						
Ash	-	1 U	-	-	-	-
Field Parameters						
pH, Field (pH units)	5.58	6.98	5.07	6.49	7.61	6.83
Radiological (pCi/g)						
Radium-226	7.59	1.42	1.04	1.07	1.03	0.712
Radium-228	0.563	0.982	1.07	0.837	1.08	1.02
Radium-226 & 228	8.15	2.4	2.11	1.91	2.11	1.73

Notes:
- - not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

TABLE 1b
SUMMARY OF BACKGROUND SOIL QUALITY DATA
CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

Location Name	CUF-1000-ALT	CUF-1000-ALT
Sample Name	CUF-BS-CUF1000ALTA-13.5/15.0	CUF-BS-CUF1000ALTA-18.0/19.5
Sample Date	11/29/2018	11/29/2018
Sample Depth (bgs)	13.5 - 15 (ft)	18 - 19.5 (ft)
Inorganic Compounds (mg/kg)		
Antimony	0.314	0.284
Arsenic	88.3	33.4
Barium	66.6	108
Beryllium	0.718	1.65
Boron	11	23.8
Cadmium	0.091 J	0.0545 J
Calcium	320000	125000
Chromium	11.7	23.1
Cobalt	3.88	5.16
Copper	6.06	14
Lead	30.7	16.2
Lithium	4.76	17.2
Mercury	0.0827 J	0.0937 J
Molybdenum	1.41 U*	1.3 U*
Nickel	9.76	17.4
Selenium	0.566	0.8
Silver	0.016 J	0.0201 J
Thallium	0.733	0.38
Vanadium	14.2	26.9
Zinc	15	37.9
Other		
Chloride (mg/kg)	8.66 U	9.43 U
Fluoride (mg/kg)	11.3 J	6.25 J
Sulfate (mg/kg)	10.7 J	8.08 UJ
pH (lab) (pH units)	7.8	7.5
Ash (%)		
Ash	-	-
Field Parameters		
pH, Field (pH units)	-	-
Radiological (pCi/g)		
Radium-226	4.31	2.14
Radium-228	0.181	0.992
Radium-226 & 228	4.49	3.13

Notes:

- \- not analyzed in this sample.
J - value is estimated.
mg/kg - milligram per kilogram.
pCi/g - picoCurie per gram.
U - not detected, value is the reporting limit.

Source: Haley & Aldrich, Inc. 2021. Report on Risk-Based Closure Approach for the Main Ash Pond, TVA Cumberland Fossil Plant. January. Included as Attachment C within Stantec, 2021a.

Table 2
Background Soil Data Statistical Evaluation
Cumberland Fossil Plant
Tennessee Valley Authority

Variable	Units	Frequency of Detection	Percent Detects	Range of Non-Detects	KM Mean	KM Variance	KM Standard Deviation	KM Coefficient of Variation	50th Percentile	95th Percentile	Maximum Detect	Outlier Presence*	Outlier Removed	Distribution	BTV	Method
Antimony	mg/Kg	56 / 68	82%	0.241 : 0.451	0.632	0.643	0.802	1.268	0.388	1.464	6.19	Yes	No	Lognormal	1.9	95% KM UTL (Lognormal)
Arsenic	mg/Kg	68 / 68	100%	NA	18.83	437.8	20.92	1.111	10.85	74.93	88.7	Yes	No	Distribution Free	88	95% UTL
Barium	mg/Kg	68 / 68	100%	NA	113	10939	104.6	0.925	84.8	268.6	637	Yes	No	Lognormal	310	95% Lognormal UTL
Beryllium	mg/Kg	68 / 68	100%	NA	1.165	0.635	0.797	0.684	0.949	2.143	5.59	Yes	No	Gamma	2.8	95% WH Approx. Gamma UTL
Boron	mg/Kg	59 / 68	87%	0.998 : 6.02	3.367	10.32	3.213	0.954	2.405	7.206	23.8	Yes	No	Distribution Free	11	95% UTL
Cadmium	mg/Kg	68 / 68	100%	NA	0.243	0.0582	0.241	0.994	0.175	0.884	1.07	Yes	No	Gamma	0.79	95% WH Approx. Gamma UTL
Calcium	mg/Kg	68 / 68	100%	NA	10718	1.9E+09	43707	4.078	1705	7678	320000	Yes	No	Distribution Free	130,000	95% UTL
Chromium	mg/Kg	68 / 68	100%	NA	22.41	61.79	7.861	0.351	20.75	37.46	39.7	No	No	Normal	38	95% UTL
Cobalt	mg/Kg	68 / 68	100%	NA	13.51	135.3	11.63	0.861	11.5	29.62	77.6	Yes	No	Gamma	41	95% WH Approx. Gamma UTL
Copper	mg/Kg	68 / 68	100%	NA	25.63	1158	34.03	1.328	15.35	105	189	Yes	No	Distribution Free	140	95% UTL
Lead	mg/Kg	68 / 68	100%	NA	21.49	410.4	20.26	0.943	16.4	44.28	125	Yes	No	Distribution Free	130	95% UTL
Lithium	mg/Kg	68 / 68	100%	NA	8.244	27.54	5.248	0.637	6.935	17.13	31	Yes	No	Gamma	20	95% WH Approx. Gamma UTL
Mercury	mg/Kg	54 / 68	79%	0.0334 : 0.0395	0.0584	0.00119	0.0345	0.591	0.0521	0.116	0.213	Yes	No	Lognormal	0.15	95% KM UTL (Lognormal)
Molybdenum	mg/Kg	61 / 68	90%	0.74 : 1.57	8.402	543.4	23.31	2.774	1.6	32.37	172	Yes	No	Distribution Free	66	95% UTL
Nickel	mg/Kg	68 / 68	100%	NA	31.28	3638	60.32	1.928	17.5	44.1	398	Yes	No	Lognormal	94	95% Lognormal UTL
Selenium	mg/Kg	68 / 68	100%	NA	0.744	0.218	0.467	0.628	0.653	1.317	2.91	Yes	No	Gamma	1.7	95% WH Approx. Gamma UTL
Silver	mg/Kg	58 / 68	85%	0.016 : 0.0871	0.0498	0.00227	0.0477	0.958	0.0385	0.123	0.363	Yes	No	Distribution Free	0.15	95% UTL
Thallium	mg/Kg	68 / 68	100%	NA	0.371	0.136	0.369	0.995	0.251	1.321	1.98	Yes	No	Distribution Free	1.8	95% UTL
Vanadium	mg/Kg	68 / 68	100%	NA	39.88	322.7	17.96	0.45	35.15	72.19	119	Yes	No	Gamma	79	95% WH Approx. Gamma UTL
Zinc	mg/Kg	68 / 68	100%	NA	64.91	9113	95.46	1.471	38.1	192.2	692	Yes	No	Distribution Free	350	95% UTL
Radium-226	pCi/g	66 / 68	97%	0.201 : 0.206	2.081	6.54	2.557	1.229	1.225	8.877	13.2	Yes	No	Distribution Free	10	95% UTL
Radium-228	pCi/g	64 / 68	94%	0.181 : 0.563	1.282	0.213	0.462	0.36	1.245	2.056	2.5	No	No	Gamma	2.5	Maximum Detect
Chloride	mg/Kg	1 / 68	1%	7.97 : 17.6	8.184	3.059	1.749	0.214	9.015	10.56	22.5	NA	No	NA	23	Maximum Detect
Fluoride	mg/Kg	30 / 51	59%	0.915 : 2.91	2.191	3.465	1.861	0.85	2.19	5.14	11.3	Yes	No	Lognormal	6.2	95% KM UTL (Lognormal)
Sulfate	mg/Kg	22 / 68	32%	6.75 : 27.9	15.73	330.4	18.18	1.155	11.8	49.55	107	Yes	No	Gamma	48	95% HW Approx. Gamma KM UTL

Notes:

* - Tested at 5% significance level.
BTV - Background Threshold Value.
KM - Kaplan-Meier Method.
NA - Not Available.
pCi/g - picoCurie per gram.
UTLs - Upper Tolerance Limits.
Var - Variance.
WH - Wilson Hilferty Transformation.

BTV values and statistics were calculated using ProUCL v. 5.1.002. The number of significant figures provided in ProUCL's general statistics output (Appendix B to the Report) were retained in this table (Columns "KM Mean" through "95th Percentile") for general statistical parameters. However, the BTV values in the last column have been rounded to two significant figures.

APPENDIX E.2

STATISTICAL ANALYSIS OF CCR MATERIAL CHARACTERISTICS DATA

Appendix E.2 - Statistical Analysis of CCR Material Characteristics Data

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

Revision Log

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022 TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023 TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Appendix E.2 - Statistical Analysis of CCR Material Characteristics Data was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

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Abbreviations

CASRN	Chemical Abstracts Service Registry Number
CCR	Coal Combustion Residuals
CCR Parameters	Constituents listed in Appendices III and IV of 40 CFR 257 and five inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04
CCR Rule	Title 40, Code of Federal Regulations, Part 257
CUF Plant	Cumberland Fossil Plant
EAR	Environmental Assessment Report
ft bgs	feet below ground surface
IQR	Interquartile Range
NA	Not Available
%	Percent
SPLP	Synthetic Precipitate Leaching Procedure
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to document the statistical analyses performed on data collected to characterize coal combustion residual (CCR) materials to support evaluations conducted for the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. The CCR material characterization samples were collected between December 2018 and June 2020 within the CCR management units at the CUF Plant. Further details regarding the CCR material sampling and laboratory data results are presented in the CUF Plant *CCR Material Characteristics Sampling and Analysis Report* (Appendix G.3).

For the Environmental Investigation, CCR material and pore water samples were collected for characterization related to the leachability of constituents listed in Appendices III and IV of 40 CFR 257 and five additional inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04 (CCR Parameters) from material within three CUF Plant CCR management units: the Gypsum Storage Area, Dry Ash Stack Area, and Stilling Pond (including Retention Pond). The Synthetic Precipitate Leaching Procedure (SPLP) was used to characterize leachability of CCR Parameters in CCR material. Temporary well/boring locations and the number of samples collected in each CUF Plant CCR management unit are presented in Table E.2-1. Table E.2-2 presents the list of CCR parameters evaluated in this statistical evaluation.

Table E.2-1 – CCR Material Characteristics Sample Locations - CUF Plant

CUF Plant CCR Management Unit	Temporary Well/Boring Location	Number of Samples	
		CCR Material/SPLP	Pore Water
Gypsum Storage Area	CUF-TW01; CUF-TW02; CUF-TW03; CUF-TW04; CUF-TW05; CUF-TW06	50	3
Dry Ash Stack	CUF-TW07; CUF-TW08; CUF-TW09	52	3
Stilling Pond (including Retention Pond)	ALT-2; ALT-7B; B-1; ‘B-2, B-2A’; ‘B-3, B-3A, B-3B, ALT-5’; B-4	8	0

Table E.2-2 – CCR Parameters Evaluated in Statistical Analysis

CCR Parameter	CASRN
CCR Rule Appendix III Parameters	
Boron	7440-42-8
Calcium	7440-70-2
Chloride	16887-00-6
Fluoride[1] (also Appendix IV)	16984-48-8
pH	NA
Sulfate	14808-79-8
Total Dissolved Solids	NA
CCR Rule Appendix IV Parameters	
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Cadmium	7440-43-9
Chromium	7440-47-3
Cobalt	7440-48-4
Lead	7439-92-1
Lithium	7439-93-2
Mercury	7439-97-6
Molybdenum	7439-98-7
Radium-226+228	13982-63-3/ 15262-20-1
Selenium	7782-49-2
Thallium	7440-28-0
Additional TDEC Appendix I Parameters	
Copper	7440-50-8
Nickel	7440-02-0
Silver	7440-22-4
Vanadium	7440-62-2
Zinc	7440-66-6

Notes:
CASRN: Chemical Abstracts Service Registry Number; CCR Rule - Title 40, Code of Federal Regulations, Part 257; NA – Not Available; TDEC - Tennessee Department of Environment and Conservation
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV CCR parameter. In this table, and in the results figures and tables for this report, fluoride has been grouped with the Appendix III CCR parameters only to avoid duplication.

The following sections present the methods and results used to evaluate the CCR material and pore water data, including: 1) general exploratory data analysis (summary statistics, data plots and outlier screening), 2) a regression analysis to evaluate correlation between SPLP results to CCR Parameter concentrations in CCR material, and 3) a comparison of SPLP results to pore water concentrations.

2.0 METHODS

The statistical evaluation was conducted in three parts: 1) exploratory data analysis, 2) regression analysis, and 3) comparison of SPLP results to CCR Parameter concentrations in pore water.

2.1 EXPLORATORY DATA ANALYSIS

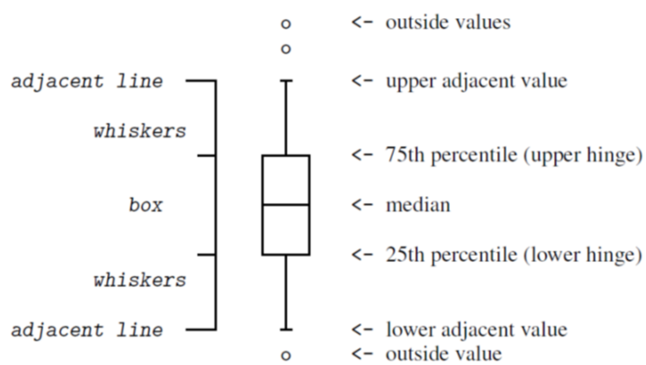
Exploratory data analysis is the initial step of statistical analysis. It utilizes simple summary statistics (e.g. mean, median, standard deviation and percentiles) and graphical representations to identify characteristics of an analytical dataset, such as the center of the data (mean, median), variation, distribution, patterns, presence of outliers, and randomness.

2.1.1 Summary Statistics

Summary statistics were calculated for CCR material, SPLP, and pore water for each CCR Parameter grouped by CUF Plant CCR management unit. Summary statistics include information such as the total numbers of available samples, the frequencies of detection, ranges of reporting limits, minimum and maximum detected concentrations, mean concentrations, standard deviations, median concentrations, and the 95th percentile concentrations. Summary statistics tables are presented in Attachment E.2-A.

2.1.2 Exploratory Data Plots

Box plots were constructed of CCR Parameter concentrations in CCR material to support a visual review of the data. Box plots were used to identify the center of the data, distribution, variability, and to visually identify potential outliers. The diagram below graphically depicts the basics of the construction of the box plots (StataCorp LLC 2017).



The box portion of the plot is the interquartile range (IQR), which represents the middle 50 percent (%) of data, with the bottom of the box being the 25th percentile and the top of the box being the 75th percentile. The line inside the box is the median concentration. The top of the upper "whisker" represents the first observed concentration above the 75th percentile, whereas the bottom of the lower "whisker" represents the first observed concentration below the 25th percentile (upper adjacent value and lower adjacent value, respectively). Values that lie outside of the adjacent values represent outside (potential outliers) concentrations (i.e. concentrations at the upper and lower ends of the distribution of the data). The method detection limit was used as the reported value in order to construct the box plot when analytical results were reported as non-detects.

Side-by-side box plots were constructed for the CCR materials data and aggregated by temporary well/boring location and CUF Plant CCR management unit. These box plots were useful in identifying differences in CCR Parameter concentrations between each CUF Plant CCR management unit and are especially useful for visually identifying potential outliers.

An additional set of box plots was also prepared to specifically review CCR parameter concentrations in CCR material in the Gypsum Storage Area, aggregated by depth. CCR material samples collected from TW-01, TW-03, and TW-05 were collected in both a layer of gypsum (approximately 0 to 26 feet below ground surface [ft bgs]) and in a layer of ash (greater than 26 ft bgs). Box plots are presented in Attachment E.2-B.

2.1.3 Outlier Screening

Outliers are data points that are abnormally high or low as compared to other measurements and may represent anomalous data or data errors. Outliers may also represent natural variation of CCR Parameter concentrations in environmental systems. Screening for outliers is an important step because outliers can bias statistical estimates, statistical testing results, and inferences.

Outlier values were initially screened visually using side-by-side box plots. If suspected visual outliers were identified, then Tukey's procedure was used to identify extreme outliers (Tukey 1977). This method relies on the interquartile range (IQR), which is defined as the 75th percentile value minus the 25th percentile value. Values were identified as potential outliers as follows:

- **Lower extreme outliers** are less than the 25th percentile minus 3 x IQR
- **Upper extreme outliers** are greater than the 75th percentile plus 3 x IQR.

Finally, when the potential outlier(s) were identified visually and by Tukey's procedure, then statistical testing for outliers (Dixon or Rosner's Test) was conducted to determine if the data points were statistically significant outliers.

Following confirmation of the outliers as statistically significant, a desktop evaluation was conducted to verify that the data points were not errors (e.g., laboratory or transcriptional error). Field forms, data validation reports, and other variables in the dataset that could influence analytical results were also evaluated. If a verifiable error was discovered, the outlier was removed and, if possible, replaced with a corrected value.

In the absence of a verifiable error, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability). If an outlier was identified as suitable for removal from further statistical analysis, a clear and defensible rationale based on multiple lines of evidence was provided. In addition, values that were identified as outliers and removed from further evaluation in the present statistical analysis were retained in the historical database and will be reevaluated for inclusion or exclusion in future statistical analyses of this dataset. The results of the outlier screening for the CUF Plant CCR material dataset are provided in Section 3.1.

2.2 REGRESSION ANALYSIS

The linear relationship between the concentrations of CCR Parameters in SPLP results and concentrations in CCR material was evaluated using regression analysis. Scatter plots were constructed to compare SPLP and CCR material results for the CCR Parameters. Using linear regression, the Pearson's correlation coefficient was estimated, and a regression line was fit to the data and added to the scatter plots. As part of the analysis, the SPLP results for the CCR Parameters were compared to the range of pore water concentrations from the Gypsum Storage Area and Dry Ash Stack. Analyses were conducted on data where CCR parameters were detected in greater than 50% of the samples in both the SPLP and CCR material datasets. Scatter plots, regression results, and range of pore water concentrations are presented in Attachment E.2-C.

3.0 RESULTS AND DISCUSSION

3.1 SUMMARY STATISTICS, EXPLORATORY DATA PLOTS, AND OUTLIER SCREENING

Summary statistics tables are presented in Attachment E.2-A, and box plots are presented in Attachment E.2-B.

There were no outliers identified as suitable for removal from further statistical analysis in the CCR material or SPLP data sets. The pore water dataset was not screened for outliers due to the small size of the data set.

3.2 REGRESSION ANALYSIS

The purpose of the regression analysis was to evaluate whether the total concentrations of metals in CCR material could be used as a reliable predictor of leachable concentrations as represented by SPLP concentrations. Scatter plots, regression results, and range of pore water concentrations are presented in Attachment E.2-C. The correlation coefficient is a numerical measure that measures the strength of association between two variables (in this case, between total concentration and SPLP results for CCR material). Correlation coefficients range from zero to one; a high correlation coefficient (closer to one) demonstrates a strong relationship between the two variables, whereas a low correlation coefficient (closer to zero) demonstrates a weak relationship. The slope of the regression line indicates the direction of correlation. A positive slope indicates that SPLP concentrations increase as CCR Parameter concentrations in CCR material increase. Conversely, a negative slope indicates that as CCR Parameter concentrations increase, the SPLP concentrations decrease.

The statistical relationships between SPLP concentrations and CCR material concentrations were inconsistent and highly variable. One would expect SPLP concentrations to increase with increasing

CCR constituent concentrations in CCR material (e.g. regression line with a positive slope). However, this relationship was inconsistent between different CCR constituents and between CUF Plant CCR management units. In some cases, even when there was a statistically significant correlation (e.g., boron), the wide range of variability around the regression line limits the predictive value of the relationship. The results indicate that the total concentrations of metals in CCR material is not a reliable predictor of the magnitude of the potentially leached concentrations measured using SPLP.

In addition, the CCR constituent concentrations in SPLP generally underestimated CCR constituent concentrations measured in pore water.

The results indicate that direct measurement of pore water concentrations is the most accurate way of characterizing potential leachability from CCR materials.

4.0 REFERENCES

StataCorp. (2017). Stata Graphics Reference Manual Stata: Release 15. Statistical Software. College Station, Texas: StataCorp LLC.

Tukey, J.W. (1977). *Exploratory Data Analysis*. Reading, Massachusetts: Addison-Wesley. 1977.

ATTACHMENT E.2–A
SUMMARY STATISTICS

Summary Statistics - CCR Material Characteristics Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
CCR Rule Appendix III Parameters										
Boron	Dry Ash Stack	52/52	--	0%	31.5	798	352	194	368	625
	Gypsum Storage Area	33/50	(1.80 - 2.11)	34.0%	2.17	876	196	240	6.32	607
	Stilling Pond (Including Retention Pond)	8/8	--	0%	121	227	171	34.9	172	217
Calcium	Dry Ash Stack	52/52	--	0%	6,430	49,400	21,000	9,970	19,200	39,100
	Gypsum Storage Area	50/50	--	0%	12,400	276,000	144,000	113,000	194,000	273,000
	Stilling Pond (Including Retention Pond)	8/8	--	0%	6,780	37,500	18,000	10,400	14,900	33,200
Chloride	Dry Ash Stack	52/52	--	0%	8.23	640	180	168	137	600
	Gypsum Storage Area	28/50	(5.15 - 6.03)	44.0%	6.41	495	64.2	108	11.8	286
	Stilling Pond (Including Retention Pond)	7/8	(5.51 - 5.51)	12.5%	43.2	287	132	85.2	145	259
Fluoride	Dry Ash Stack	24/52	(0.727 - 2.42)	53.9%	0.881	8.35	2.07	1.86	1.28	5.00
	Gypsum Storage Area	46/50	(0.918 - 0.993)	8.00%	1.13	45.0	14.0	13.1	9.76	39.9
	Stilling Pond (Including Retention Pond)	8/8	--	0%	0.987	4.53	2.07	1.14	1.92	3.79
pH (field)	Dry Ash Stack	1/1	--	0%	10.7	10.7	--	--	10.7	10.7
	Gypsum Storage Area	12/12	--	0%	6.51	10.8	8.85	1.65	9.36	10.6
	Stilling Pond (Including Retention Pond)	--	--	--	--	--	--	--	--	--
pH (lab)	Dry Ash Stack	52/52	--	0%	5.10	11.3	9.42	1.49	10.0	10.8
	Gypsum Storage Area	50/50	--	0%	7.20	11.5	8.56	1.22	7.80	10.9
	Stilling Pond (Including Retention Pond)	8/8	--	0%	8.00	9.80	8.43	0.609	8.15	9.45
Sulfate	Dry Ash Stack	52/52	--	0%	584	20,100	4,150	4,420	2,760	13,800
	Gypsum Storage Area	50/50	--	0%	617	22,300	13,000	8,920	18,800	21,800
	Stilling Pond (Including Retention Pond)	8/8	--	0%	460	1,150	854	250	857	1,130
CCR Rule Appendix IV Parameters										
Antimony	Dry Ash Stack	49/52	(0.434 - 0.565)	5.77%	0.385	8.06	3.85	2.01	4.13	6.92
	Gypsum Storage Area	44/50	(0.0829 - 0.0908)	12.0%	0.0914	5.73	2.03	2.17	0.480	5.43
	Stilling Pond (Including Retention Pond)	8/8	--	0%	1.30	2.95	2.18	0.526	2.28	2.81
Arsenic	Dry Ash Stack	52/52	--	0%	3.27	72.9	34.5	18.0	38.7	59.1
	Gypsum Storage Area	50/50	--	0%	0.287	67.2	22.0	24.0	3.98	60.2
	Stilling Pond (Including Retention Pond)	8/8	--	0%	40.7	92.7	62.0	19.2	59.5	91.0
Barium	Dry Ash Stack	52/52	--	0%	26.8	847	253	180	225	514
	Gypsum Storage Area	50/50	--	0%	8.33	1,190	261	297	126	827
	Stilling Pond (Including Retention Pond)	8/8	--	0%	295	404	364	37.9	369	402
Beryllium	Dry Ash Stack	52/52	--	0%	0.568	4.94	2.55	1.10	2.74	4.00
	Gypsum Storage Area	46/50	(0.0678 - 0.128)	8.00%	0.0275	5.11	1.30	1.53	0.241	4.08
	Stilling Pond (Including Retention Pond)	8/8	--	0%	2.17	5.27	3.38	1.02	3.31	4.82

Summary Statistics - CCR Material Characteristics Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Cadmium	Dry Ash Stack	52/52	--	0%	0.150	7.32	3.04	1.73	3.20	5.64
	Gypsum Storage Area	50/50	--	0%	0.135	3.90	1.41	1.21	1.02	3.38
	Stilling Pond (Including Retention Pond)	8/8	--	0%	0.553	2.41	1.48	0.535	1.51	2.18
Chromium	Dry Ash Stack	52/52	--	0%	7.81	106	58.2	26.0	69.7	86.4
	Gypsum Storage Area	50/50	--	0%	1.29	102	36.7	34.8	18.2	94.4
	Stilling Pond (Including Retention Pond)	8/8	--	0%	33.0	72.9	58.7	12.4	61.6	70.6
Cobalt	Dry Ash Stack	52/52	--	0%	1.39	13.0	5.91	2.39	6.55	8.58
	Gypsum Storage Area	50/50	--	0%	0.0442	10.9	3.61	4.10	0.938	10.3
	Stilling Pond (Including Retention Pond)	8/8	--	0%	7.65	18.2	11.7	3.33	11.5	16.6
Fluoride	Dry Ash Stack	24/52	(0.727 - 2.42)	53.9%	0.881	8.35	2.07	1.86	1.28	5.00
	Gypsum Storage Area	46/50	(0.918 - 0.993)	8.00%	1.13	45.0	14.0	13.1	9.76	39.9
	Stilling Pond (Including Retention Pond)	8/8	--	0%	0.987	4.53	2.07	1.14	1.92	3.79
Lead	Dry Ash Stack	52/52	--	0%	4.18	186	49.6	39.1	37.1	118
	Gypsum Storage Area	47/50	(0.422 - 0.646)	6%	0.324	42.7	14.1	13.3	6.74	33.9
	Stilling Pond (Including Retention Pond)	8/8	--	0%	13.1	37.0	25.5	6.99	25.7	34.8
Lithium	Dry Ash Stack	52/52	--	0%	2.16	20.0	10.5	3.49	10.4	15.2
	Gypsum Storage Area	49/50	(0.413 - 0.413)	2.00%	0.491	16.5	6.04	4.56	5.96	14.0
	Stilling Pond (Including Retention Pond)	8/8	--	0%	10.0	32.2	18.7	7.90	17.0	30.4
Mercury	Dry Ash Stack	21/52	(0.0148 - 0.0212)	59.6%	0.0239	0.260	0.0379	0.0470	0.0202	0.119
	Gypsum Storage Area	33/50	(0.0169 - 0.0235)	34.0%	0.0223	4.19	0.488	0.821	0.159	2.21
	Stilling Pond (Including Retention Pond)	3/8	(0.0268 - 0.0337)	62.5%	0.0433	0.0535	0.0352	0.0111	0.0331	0.0525
Molybdenum	Dry Ash Stack	52/52	--	0%	4.27	124	35.8	25.2	30.5	77.4
	Gypsum Storage Area	49/50	(0.481 - 0.481)	2.00%	0.277	38.2	7.15	7.79	2.82	18.4
	Stilling Pond (Including Retention Pond)	8/8	--	0%	6.61	23.4	11.6	6.06	9.10	21.6
Radium-226+228	Dry Ash Stack	52/52	--	0%	0.811	14.7	9.74	2.44	10.1	13.7
	Gypsum Storage Area	42/50	(0.000 - 0.306)	16.0%	0.271	10.3	3.85	3.70	1.97	9.50
	Stilling Pond (Including Retention Pond)	2/2	--	0%	6.59	7.67	7.13	0.583	7.13	7.66
Selenium	Dry Ash Stack	52/52	--	0%	0.221	13.7	5.34	3.40	5.50	10.7
	Gypsum Storage Area	50/50	--	0%	1.27	27.7	5.77	5.28	3.71	16.4
	Stilling Pond (Including Retention Pond)	8/8	--	0%	2.80	16.2	6.67	4.31	5.12	13.7
Thallium	Dry Ash Stack	52/52	--	0%	0.128	9.06	4.70	2.62	5.37	8.39
	Gypsum Storage Area	39/50	(0.0338 - 0.0374)	22.0%	0.0425	8.11	2.54	2.95	0.179	7.42
	Stilling Pond (Including Retention Pond)	8/8	--	0%	3.04	5.18	4.36	0.724	4.43	5.17

Summary Statistics - CCR Material Characteristics Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
TDEC Appendix I Parameters										
Copper	Dry Ash Stack	52/52	--	0%	4.44	38.9	21.9	9.17	24.2	33.0
	Gypsum Storage Area	50/50	--	0%	0.583	35.8	13.7	12.8	7.86	33.9
	Stilling Pond (Including Retention Pond)	8/8	--	0%	24.4	54.1	37.9	10.2	36.6	51.9
Nickel	Dry Ash Stack	52/52	--	0%	4.97	46.1	22.9	9.01	24.3	32.9
	Gypsum Storage Area	50/50	--	0%	0.377	37.6	13.9	14.3	6.45	36.7
	Stilling Pond (Including Retention Pond)	8/8	--	0%	27.1	45.5	37.7	7.60	39.8	45.4
Silver	Dry Ash Stack	42/52	(0.0155 - 0.145)	19.2%	0.0167	0.190	0.0919	0.0518	0.110	0.163
	Gypsum Storage Area	27/50	(0.0361 - 0.276)	46.0%	0.0478	2.19	0.222	0.485	0.0572	1.37
	Stilling Pond (Including Retention Pond)	8/8	--	0%	0.0542	0.141	0.0978	0.0279	0.0981	0.134
Vanadium	Dry Ash Stack	52/52	--	0%	23.3	386	179	96.4	182	329
	Gypsum Storage Area	50/50	--	0%	1.12	349	101	118	14.5	297
	Stilling Pond (Including Retention Pond)	8/8	--	0%	102	235	171	40.4	165	227
Zinc	Dry Ash Stack	49/52	(12.4 - 14.8)	5.77%	19.1	215	110	52.2	120	189
	Gypsum Storage Area	50/50	--	0%	7.69	142	70.7	48.7	75.5	137
	Stilling Pond (Including Retention Pond)	8/8	--	0%	47.8	784	187	243	109	556
Additional Parameters										
Iron	Dry Ash Stack	52/52	--	0%	7,320	40,300	24,300	8,150	25,800	37,100
	Gypsum Storage Area	50/50	--	0%	181	40,400	14,800	15,900	4,070	39,400
	Stilling Pond (Including Retention Pond)	8/8	--	0%	20,700	35,000	27,600	5,020	27,300	34,200
Manganese	Dry Ash Stack	52/52	--	0%	20.8	254	130	63.2	123	230
	Gypsum Storage Area	50/50	--	0%	4.50	803	111	130	59.8	232
	Stilling Pond (Including Retention Pond)	8/8	--	0%	99.7	286	168	58.9	148	256
TOC	Dry Ash Stack	52/52	--	0%	1,900	464,000	18,900	63,500	7,550	31,300
	Gypsum Storage Area	39/50	(1,000 - 1,170)	22.0%	1,100	43,500	5,430	7,920	3,050	17,500
	Stilling Pond (Including Retention Pond)	8/8	--	0%	4,000	57,000	16,700	17,100	13,800	43,600

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

TOC - Total Organic Carbon

"--" - Not Applicable

% - Percent

Except for pH & Radium 226 + 228, all units milligrams per kilogram (mg/kg)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per gram (pCi/g)

All non-detects reported at the method detection limit

For Parameters with non-detects, the mean, standard deviation and background threshold values utilize Kaplan-Meier estimates (KM)

Summary Statistics - CCR Material Characteristics - Synthetic Precipitate Leaching Procedure (SPLP) Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
CCR Rule Appendix III Parameters										
Boron	Dry Ash Stack	52/52	--	0%	138	2,990	1,600	800	1,420	2,750
	Gypsum Storage Area	31/50	(30.3 - 315)	38.0%	30	5,110	1,020	1,250	769	3,700
	Stilling Pond (Including Retention Pond)	8/8	--	0%	1,270	2,710	1,730	451	1,650	2,430
Calcium	Dry Ash Stack	52/52	--	0%	19,500	561,000	101,000	99,000	73,000	278,000
	Gypsum Storage Area	50/50	--	0%	34,000	651,000	369,000	249,000	537,000	620,000
	Stilling Pond (Including Retention Pond)	8/8	--	0%	18,600	48,800	31,300	10,000	31,800	45,400
CCR Rule Appendix IV Parameters										
Antimony	Dry Ash Stack	46/52	(1.12 - 1.12)	11.5%	1.18	14.7	8.13	3.73	8.75	13.1
	Gypsum Storage Area	22/50	(0.378 - 1.43)	56.0%	1.61	22.5	3.81	4.84	0.378	12.1
	Stilling Pond (Including Retention Pond)	8/8	--	0%	6.09	19.0	11.9	4.11	11.9	17.5
Arsenic	Dry Ash Stack	51/52	(0.323 - 0.323)	1.92%	0.423	13.5	7.55	3.53	7.95	12.9
	Gypsum Storage Area	41/50	(0.323 - 1.07)	18.0%	0.345	18.7	4.55	5.05	1.98	15.5
	Stilling Pond (Including Retention Pond)	8/8	--	0%	11.1	85.0	40.2	30.4	25.6	84.8
Barium	Dry Ash Stack	52/52	--	0%	9.81	389	74.4	70.1	62.7	164
	Gypsum Storage Area	50/50	--	0%	10.7	143	43.1	36.8	20.4	112
	Stilling Pond (Including Retention Pond)	8/8	--	0%	44.5	109	77.9	23.7	78.7	106
Beryllium	Dry Ash Stack	1/52	(0.0570 - 0.0570)	98.1%	0.119	0.119	0.0582	0.00851	0.0570	0.0570
	Gypsum Storage Area	2/50	(0.155 - 0.155)	96.0%	0.168	0.699	0.166	0.0761	0.155	0.155
	Stilling Pond (Including Retention Pond)	0/8	(0.182 - 0.182)	100%	--	--	--	--	0.182	0.182
Cadmium	Dry Ash Stack	15/52	(0.125 - 0.125)	71.2%	0.127	54.0	1.30	7.41	0.125	0.777
	Gypsum Storage Area	30/50	(0.125 - 0.125)	40.0%	0.133	2.38	0.399	0.447	0.181	1.26
	Stilling Pond (Including Retention Pond)	0/8	(0.217 - 0.282)	100%	--	--	--	--	0.217	0.268
Chromium	Dry Ash Stack	46/52	(0.975 - 2.65)	11.5%	1.02	43.6	5.33	6.43	3.51	13.4
	Gypsum Storage Area	31/50	(1.53 - 1.53)	38.0%	1.55	7.11	2.18	1.23	1.69	4.86
	Stilling Pond (Including Retention Pond)	6/8	(1.53 - 1.53)	25.0%	1.84	7.17	3.49	2.02	2.76	6.78
Cobalt	Dry Ash Stack	20/52	(0.075 - 0.075)	61.5%	0.0800	7.39	0.462	1.23	0.0750	2.80
	Gypsum Storage Area	29/50	(0.075 - 1.10)	42.0%	0.0930	5.52	0.290	0.757	0.204	0.603
	Stilling Pond (Including Retention Pond)	0/8	(0.134 - 0.277)	100%	--	--	--	--	0.134	0.274
Lead	Dry Ash Stack	19/52	(0.0940 - 0.436)	63.5%	0.0960	2.54	0.361	0.651	0.0940	2.32
	Gypsum Storage Area	4/50	(0.128 - 0.831)	92.0%	0.175	5.90	0.276	0.829	0.128	0.639
	Stilling Pond (Including Retention Pond)	1/8	(0.128 - 0.744)	87.5%	1.32	1.32	0.277	0.394	0.402	1.12
Lithium	Dry Ash Stack	52/52	--	0%	5.02	91.9	37.5	24.6	35.6	83.0
	Gypsum Storage Area	27/50	(3.14 - 3.14)	46.0%	3.15	24.6	6.59	5.01	3.57	17.3
	Stilling Pond (Including Retention Pond)	6/8	(3.39 - 3.39)	25.0%	4.13	12.5	5.39	2.78	4.56	10.0

Summary Statistics - CCR Material Characteristics - Synthetic Precipitate Leaching Procedure (SPLP) Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Mercury	Dry Ash Stack	0/52	(0.0653 - 0.101)	100%	--	--	--	--	0.0653	0.101
	Gypsum Storage Area	2/50	(0.101 - 0.101)	96.0%	0.106	0.127	0.102	0.00369	0.101	0.101
	Stilling Pond (Including Retention Pond)	0/8	(0.130 - 0.130)	100%	--	--	--	--	0.130	0.130
Molybdenum	Dry Ash Stack	51/52	(0.474 - 0.474)	1.92%	5.60	1,490	245	289	138	870
	Gypsum Storage Area	46/50	(0.610 - 3.54)	8.00%	0.650	1,380	55.0	200	5.12	216
	Stilling Pond (Including Retention Pond)	8/8	--	0%	34.6	635	181	205	92.2	522
Radium-226+228	Dry Ash Stack	35/52	(0.00681 - 0.274)	32.7%	0.106	0.936	0.268	0.214	0.265	0.627
	Gypsum Storage Area	39/50	(0.0024 - 0.362)	22.0%	0.15	0.684	0.312	0.172	0.308	0.567
	Retention Pond and Stilling Pond	1/2	(0.362 - 0.362)	50.0%	0.508	0.508	0.435	0.0732	0.435	0.501
Selenium	Dry Ash Stack	49/52	(0.813 - 0.813)	5.77%	1.19	31.2	12.7	7.71	12.2	28.2
	Gypsum Storage Area	49/50	(2.62 - 2.62)	2.00%	3.16	132	12.5	18.6	7.52	26.5
	Stilling Pond (Including Retention Pond)	8/8	--	0%	3.72	59.9	31.1	23.7	25.7	59.2
Thallium	Dry Ash Stack	41/52	(0.063 - 0.271)	21.2%	0.0910	2.75	0.589	0.610	0.327	1.81
	Gypsum Storage Area	16/50	(0.128 - 0.856)	68.0%	0.156	5.43	0.378	0.793	0.128	1.33
	Stilling Pond (Including Retention Pond)	0/8	(0.148 - 0.655)	100%	--	--	--	--	0.347	0.642
TDEC Appendix I Parameters										
Copper	Dry Ash Stack	13/52	(1.30 - 1.30)	75.0%	1.34	21.2	2.28	3.27	1.30	7.18
	Gypsum Storage Area	42/50	(0.627 - 5.54)	16.0%	0.653	287	10.6	41.1	1.03	43.4
	Stilling Pond (Including Retention Pond)	7/8	(0.627 - 0.627)	12.5%	0.774	2.89	1.40	0.695	1.33	2.54
Nickel	Dry Ash Stack	26/52	(0.312 - 0.312)	50.0%	0.317	14.1	1.05	2.21	0.315	4.75
	Gypsum Storage Area	35/50	(0.312 - 0.312)	30.0%	0.328	26.4	1.65	3.71	0.550	3.67
	Stilling Pond (Including Retention Pond)	8/8	--	0%	0.356	2.32	1.00	0.684	0.801	2.10
Silver	Dry Ash Stack	0/52	(0.121 - 0.121)	100%	--	--	--	--	0.121	0.121
	Gypsum Storage Area	13/50	(0.121 - 0.121)	74.0%	0.129	3.15	0.266	0.495	0.121	1.12
	Stilling Pond (Including Retention Pond)	0/8	(0.177 - 0.177)	100%	--	--	--	--	0.177	0.177
Vanadium	Dry Ash Stack	52/52	--	0%	1.79	427	177	121	173	386
	Gypsum Storage Area	46/50	(1.67 - 2.92)	8.00%	1.11	281	65.3	78.1	2.73	197
	Stilling Pond (Including Retention Pond)	8/8	--	0%	43.6	360	197	93.1	199	321
Zinc	Dry Ash Stack	19/52	(2.42 - 13)	63.5%	2.54	210	11.8	30.6	2.42	37.9
	Gypsum Storage Area	4/50	(3.22 - 11.4)	92.0%	5.71	68.2	4.92	9.21	3.22	10.7
	Stilling Pond (Including Retention Pond)	7/8	(3.22 - 3.22)	12.5%	6.53	13.3	8.22	2.70	8.31	12.0

Summary Statistics - CCR Material Characteristics - Synthetic Precipitate Leaching Procedure (SPLP) Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Additional Parameters										
Iron	Dry Ash Stack	27/52	(14.1 - 14.1)	48.1%	14.6	1160	80.6	175	14.9	319
	Gypsum Storage Area	17/50	(14.1 - 14.1)	66.0%	14.4	461	33.9	71.5	14.1	124
	Stilling Pond (Including Retention Pond)	2/8	(30.3 - 177)	75.0%	226	579	123	184	88.8	456
Manganese	Dry Ash Stack	16/52	(1.35 - 1.35)	69.2%	1.67	50.5	5.44	9.53	1.35	21.9
	Gypsum Storage Area	30/50	(1.35 - 1.35)	40.0%	1.36	1160	30.7	162	2.04	32.0
	Stilling Pond (Including Retention Pond)	6/8	(0.866 - 0.866)	25.0%	0.933	12.7	3.44	3.99	1.29	10.7

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

For Parameters with non-detects, the mean, standard deviation and background threshold values utilize Kaplan-Meier estimates (KM)

Except for pH & Radium 226 + 228, all units micrograms per liter (ug/L)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per liter (pCi/L)

Summary Statistics - CCR Material Characteristics - Pore Water - Total Metals Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects				
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile	
CCR Rule Appendix III Parameters											
Boron	Dry Ash Stack	3/3	--	0%	10,300	18,700	14,500	4,200	14,400	18,300	
	Gypsum Storage Area	3/3	--	0%	3,530	13,200	9,810	5,440	12,700	13,200	
Calcium	Dry Ash Stack	3/3	--	0%	356,000	396,000	370,000	22,500	358,000	392,000	
	Gypsum Storage Area	3/3	--	0%	349,000	900,000	608,000	277,000	575,000	868,000	
Chloride	Dry Ash Stack	3/3	--	0%	104,000	282,000	207,000	92,400	236,000	277,000	
	Gypsum Storage Area	3/3	--	0%	17,200	781,000	290,000	426,000	73,200	710,000	
Fluoride	Dry Ash Stack	3/3	--	0%	71.2	173	105	58.6	71.7	163	
	Gypsum Storage Area	3/3	--	0%	198	3810	1510	2000	506	3480	
pH (field)	Dry Ash Stack	3/3	--	0%	9.79	10.5	10.1	0.345	10.1	10.4	
	Gypsum Storage Area	3/3	--	0%	8.52	10.9	9.66	1.19	9.56	10.8	
Sulfate	Dry Ash Stack	3/3	--	0%	657,000	1,270,000	1,030,000	327,000	1,160,000	1,260,000	
	Gypsum Storage Area	3/3	--	0%	1,100,000	1,850,000	1,540,000	392,000	1,670,000	1,830,000	
CCR Rule Appendix IV Parameters											
Antimony	Dry Ash Stack	1/3	(3.07 - 4.70)	66.7%	6.19	6.19	4.11	1.47	4.70	6.04	
	Gypsum Storage Area	2/3	(1.46 - 1.46)	33.3%	3.92	11.2	5.53	4.14	3.92	10.5	
Arsenic	Dry Ash Stack	3/3	--	0%	18.7	71	39.4	27.8	28.6	66.8	
	Gypsum Storage Area	3/3	--	0%	17.1	23.9	20.9	3.46	21.6	23.7	
Barium	Dry Ash Stack	3/3	--	0%	73.2	167	113	48.4	99.6	160	
	Gypsum Storage Area	3/3	--	0%	45.5	141	91.6	47.8	88.4	136	
Beryllium	Dry Ash Stack	0/3	(0.233 - 0.509)	100%	--	--	--	--	0.302	0.488	
	Gypsum Storage Area	0/3	(0.155 - 0.456)	100%	--	--	--	--	0.155	0.426	
Cadmium	Dry Ash Stack	3/3	--	0%	0.983	8.66	3.78	4.24	1.69	7.96	
	Gypsum Storage Area	3/3	--	0%	0.210	1.80	0.803	0.868	0.400	1.66	

Summary Statistics - CCR Material Characteristics - Pore Water - Total Metals Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Chromium	Dry Ash Stack	0/3	(3.91 - 4.41)	100%	--	--	--	--	4.09	4.38
	Gypsum Storage Area	0/3	(1.53 - 2.29)	100%	--	--	--	--	1.53	2.21
Cobalt	Dry Ash Stack	3/3	--	0%	0.387	0.530	0.470	0.0741	0.492	0.526
	Gypsum Storage Area	2/3	(0.0750 - 0.0750)	33.3%	0.152	0.527	0.251	0.197	0.152	0.490
Fluoride	Dry Ash Stack	3/3	--	0%	71.2	173	105	58.6	71.7	163
	Gypsum Storage Area	3/3	--	0%	198	3810	1510	2000	506	3480
Lead	Dry Ash Stack	0/3	(1.08 - 1.38)	100%	--	--	--	--	1.18	1.36
	Gypsum Storage Area	0/3	(0.176 - 0.355)	100%	--	--	--	--	0.182	0.338
Lithium	Dry Ash Stack	2/3	(21.2 - 21.2)	33.3%	69.7	675	255	297	69.7	615
	Gypsum Storage Area	2/3	(17.8 - 17.8)	33.3%	80.8	129	75.9	45.5	80.8	124
Mercury	Dry Ash Stack	0/3	(0.101 - 0.101)	100%	--	--	--	--	0.101	0.101
	Gypsum Storage Area	0/3	(0.101 - 0.101)	100%	--	--	--	--	0.101	0.101
Molybdenum	Dry Ash Stack	3/3	--	0%	3,950	37,100	16,000	18,400	6,860	34,100
	Gypsum Storage Area	3/3	--	0%	485	8,990	3,590	4,690	1,300	8,220
Radium-226+228	Dry Ash Stack	0/3	(0.080 - .356)	100%	--	--	--	--	0.157	0.355
	Gypsum Storage Area	2/3	(0.155 - 0.155)	33.3%	0.157	0.356	0.223	0.0943	0.157	0.257
Selenium	Dry Ash Stack	2/3	(2.62 - 2.62)	33.3%	7.21	546	185	255	7.21	492
	Gypsum Storage Area	3/3	--	0%	13.5	68.7	45.5	28.6	54.2	67.3
Thallium	Dry Ash Stack	0/3	(0.203 - 0.687)	100%	--	--	--	--	0.370	0.655
	Gypsum Storage Area	1/3	(0.577 - 0.834)	66.7%	2.21	2.21	1.12	0.770	0.834	2.07
TDEC Appendix I Parameters										
Copper	Dry Ash Stack	0/3	(1.57 - 2.63)	100%	--	--	--	--	2.06	2.57
	Gypsum Storage Area	0/3	(0.627 - 1.15)	100%	--	--	--	--	0.895	1.13
Nickel	Dry Ash Stack	3/3	--	0%	3.06	4.33	3.90	0.728	4.31	4.33
	Gypsum Storage Area	3/3	--	0%	0.803	5.75	2.83	2.59	1.93	5.37
Silver	Dry Ash Stack	0/3	(0.121 - 0.121)	100%	--	--	--	--	0.121	0.121
	Gypsum Storage Area	0/3	(0.121 - 0.121)	100%	--	--	--	--	0.121	0.121
Vanadium	Dry Ash Stack	3/3	--	0%	19.8	983	368	534	101	895
	Gypsum Storage Area	3/3	--	0%	94.7	426	263	166	267	410
Zinc	Dry Ash Stack	3/3	--	0%	5.29	6.81	6.04	0.760	6.02	6.73
	Gypsum Storage Area	1/3	(3.22 - 3.22)	66.7%	3.22	3.22	3.22	0	3.22	3.22

Summary Statistics - CCR Material Characteristics - Pore Water - Total Metals Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Additional Water Quality Parameters										
Iron	Dry Ash Stack	3/3	--	0%	359	598	453	127	403	579
	Gypsum Storage Area	3/3	--	0%	30.4	125	89.5	51.5	113	124
Manganese	Dry Ash Stack	3/3	--	0%	5.01	15.8	8.98	5.93	6.14	14.8
	Gypsum Storage Area	3/3	--	0%	3.13	198	75.4	107	25.2	181
TDS	Dry Ash Stack	3/3	--	0%	1,770,000	2,630,000	2,120,000	450,000	1,970,000	2,560,000
	Gypsum Storage Area	3/3	--	0%	2,000,000	3,340,000	2,820,000	721,000	3,130,000	3,320,000
TOC	Dry Ash Stack	3/3	--	0%	8,180	61,800	27,700	29,600	13,200	56,900
	Gypsum Storage Area	3/3	--	0%	3,530	85,900	33,300	45,700	10,500	78,400

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

TDS: Total Dissolved Solids

TOC: Total Organic Carbon

% - Percent

"--" - Not Applicable

For Parameters with non-detects, the mean, standard deviation and background threshold values utilize Kaplan-Meier estimates (KM)

Except for pH & Radium 226 + 228, all units micrograms per liter (ug/L)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per liter (pCi/L)

All non-detects reported at the laboratory detection limit

Summary Statistics - CCR Material Characteristics - Pore Water - Dissolved Metals Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	CCR Management Unit	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
CCR Rule Appendix III Parameters										
Boron	Dry Ash Stack	3/3	--	0%	10,700	19,500	14,867	4,419	14,400	18,990
	Gypsum Storage Area	3/3	--	0%	3,900	13,100	9,700	5,048	12,100	13,000
Calcium	Dry Ash Stack	3/3	--	0%	357,000	402,000	372,333	25,697	358,000	397,600
	Gypsum Storage Area	3/3	--	0%	397,000	840,000	601,667	223,411	568,000	812,800
pH (field)	Dry Ash Stack	3/3	--	0%	9.79	10.5	10.1	0.345	10.1	10.4
	Gypsum Storage Area	3/3	--	0%	8.52	10.9	9.66	1.19	9.56	10.8
CCR Rule Appendix IV Parameters										
Antimony	Dry Ash Stack	2/3	(3 - 3)	33.3%	4.8	5.67	4.49	1.112	4.80	5.583
	Gypsum Storage Area	2/3	(1.22 - 1.22)	33.3%	3.46	10.7	5.127	4.046	3.46	9.976
Arsenic	Dry Ash Stack	3/3	--	0%	17.6	68.9	38.27	27.06	28.3	64.84
	Gypsum Storage Area	3/3	--	0%	16	24.2	21.03	4.407	22.9	24.07
Barium	Dry Ash Stack	3/3	--	0%	64.2	180	111.5	60.72	90.4	171
	Gypsum Storage Area	3/3	--	0%	44.6	129	89.57	42.47	95.1	125.6
Beryllium	Dry Ash Stack	0/3	(0.155 - 0.219)	100%	--	--	--	--	0.193	0.216
	Gypsum Storage Area	0/3	(0.155 - 0.299)	100%	--	--	--	--	0.212	0.29
Cadmium	Dry Ash Stack	3/3	--	0%	0.869	8.59	3.676	4.27	1.57	7.888
	Gypsum Storage Area	3/3	--	0%	0.144	1.96	0.804	1.004	0.309	1.795
Chromium	Dry Ash Stack	0/3	(2.41 - 3.18)	100%	--	--	--	--	2.41	3.103
	Gypsum Storage Area	0/3	(1.53 - 2.16)	100%	--	--	--	--	1.53	2.097
Cobalt	Dry Ash Stack	3/3	--	0%	0.222	0.322	0.266	0.0512	0.253	0.315
	Gypsum Storage Area	2/3	(0.075 - 0.075)	33.3%	0.145	0.45	0.223	0.163	0.145	0.420
Lead	Dry Ash Stack	1/3	(0.128 - 0.128)	67%	0.151	0.151	0.136	0.0108	0.128	0.149
	Gypsum Storage Area	0/3	(0.128 - 0.128)	100%	--	--	--	--	0.128	0.128
Lithium	Dry Ash Stack	3/3	--	0.0%	19.6	679	256.2	367	69.9	618.1
	Gypsum Storage Area	2/3	(16.8 - 16.8)	33.3%	92.7	122	77.17	44.33	92.7	119.1
Mercury	Dry Ash Stack	0/3	(0.101 - 0.101)	100%	--	--	--	--	0.101	0.101
	Gypsum Storage Area	0/3	(0.101 - 0.101)	100%	--	--	--	--	0.101	0.101
Molybdenum	Dry Ash Stack	3/3	--	0%	3,890	37,400	16,050	18,549	6,860	34,346
	Gypsum Storage Area	3/3	--	0%	470	10,400	4,033	5,527	1,230	9,483
Selenium	Dry Ash Stack	2/3	(2.62 - 2.62)	33.3%	6.36	549	186	256.7	6.36	494.7
	Gypsum Storage Area	3/3	--	0%	12.5	75.3	43.27	31.42	42	71.97
Thallium	Dry Ash Stack	2/3	(0.128 - 0.128)	33%	0.158	0.251	0.179	0.0524	0.158	0.242
	Gypsum Storage Area	1/3	(0.706 - 1.73)	66.7%	2.02	2.02	1.144	0.619	1.73	1.991

Summary Statistics - CCR Material Characteristics - Pore Water - Dissolved Metals Cumberland Fossil Plant - Cumberland City, Tennessee										
Parameter	**CCR Management Unit**	**Frequency of Detection**	**Range of Reporting Limits**	**% Non Detect**	**Statistics using Detected Data Only**		**Statistics using all Detects & Non-Detects**			
					Minimum Detect	**Maximum Detect**	**Mean**	**Standard Deviation**	**50th Percentile**	**95th Percentile**
TDEC Appendix I Parameters										
Copper	Dry Ash Stack	0/3	(1.12 - 1.36)	100%	--	--	--	--	1.23	1.347
	Gypsum Storage Area	0/3	(0.627 - 1.05)	100%	--	--	--	--	0.627	1.01
Nickel	Dry Ash Stack	3/3	--	0%	2.48	3.88	3.32	0.741	3.6	3.852
	Gypsum Storage Area	1/3	(0.724 - 1.86)	67%	6.79	6.79	2.746	2.86	1.86	6.297
Silver	Dry Ash Stack	0/3	(0.121 - 0.121)	100%	--	--	--	--	0.121	0.121
	Gypsum Storage Area	0/3	(0.121 - 0.121)	100%	--	--	--	--	0.121	0.121
Vanadium	Dry Ash Stack	3/3	--	0%	14.8	948	352.5	517.3	94.6	862.7
	Gypsum Storage Area	3/3	--	0%	89.8	464	271.3	187.4	260	443.6
Zinc	Dry Ash Stack	0/3	(3.22 - 3.22)	100%	--	--	--	--	3.22	3.22
	Gypsum Storage Area	0/3	(3.22 - 3.22)	100.0%	--	--	--	--	3.22	3.22
Additional Water Quality Parameters										
Iron	Dry Ash Stack	2/3	(14.1 - 14.1)	33%	28.7	29.2	24	7.003	28.7	29.15
	Gypsum Storage Area	1/3	(14.1 - 14.1)	67%	37.2	37.2	21.8	10.89	14.1	34.89
Manganese	Dry Ash Stack	2/3	(1.35 - 1.35)	33%	1.4	12.4	5.05	5.197	1.4	11.3
	Gypsum Storage Area	2/3	(1.35 - 1.35)	33%	20.2	194	71.85	86.72	20.2	176.6

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

For Parameters with non-detects, the mean, standard deviation and background threshold values utilize Kaplan-Meier estimates (KM)

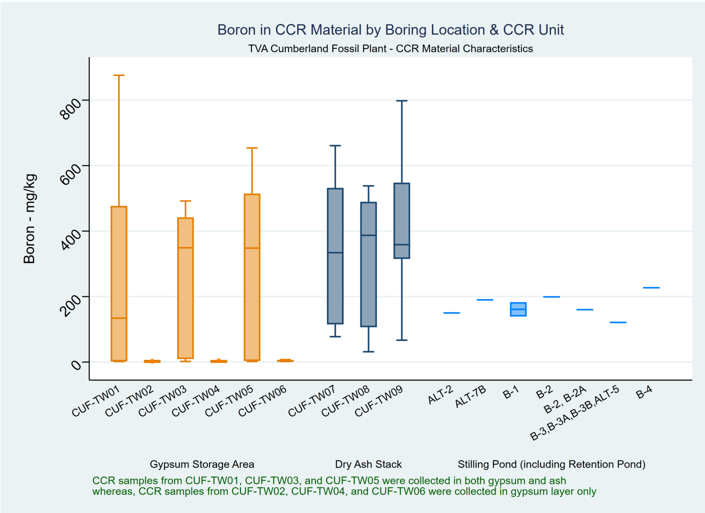
Except for pH , all units micrograms per liter (ug/L)

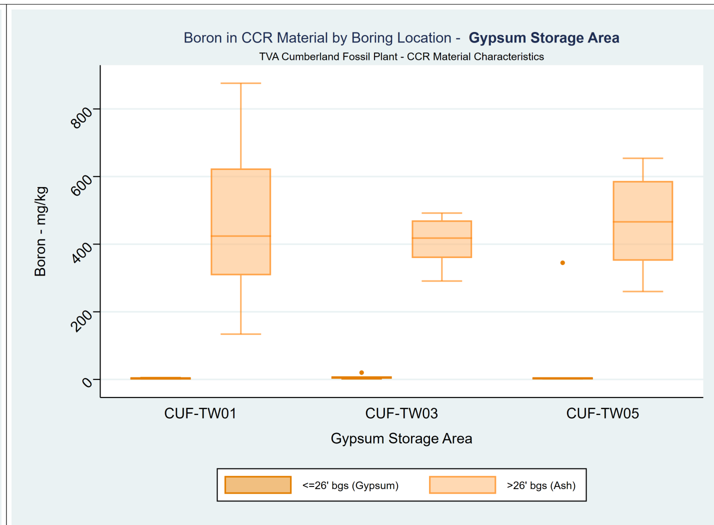
Units for pH are Standard Units (S.U.)

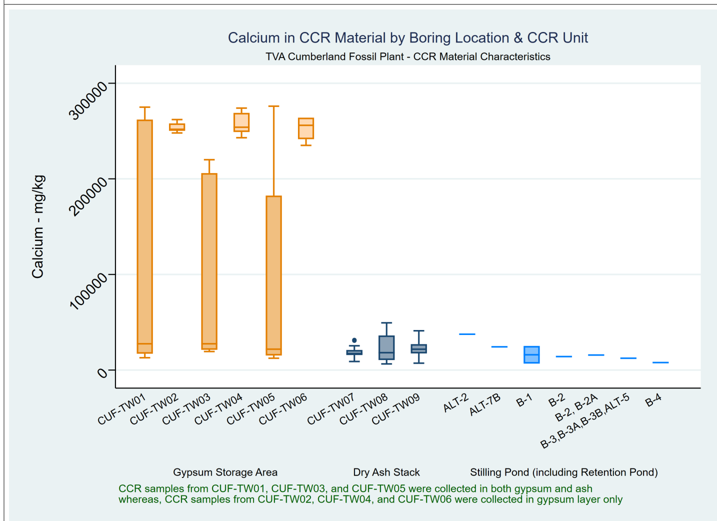
All non-detects reported at the laboratory detection limit

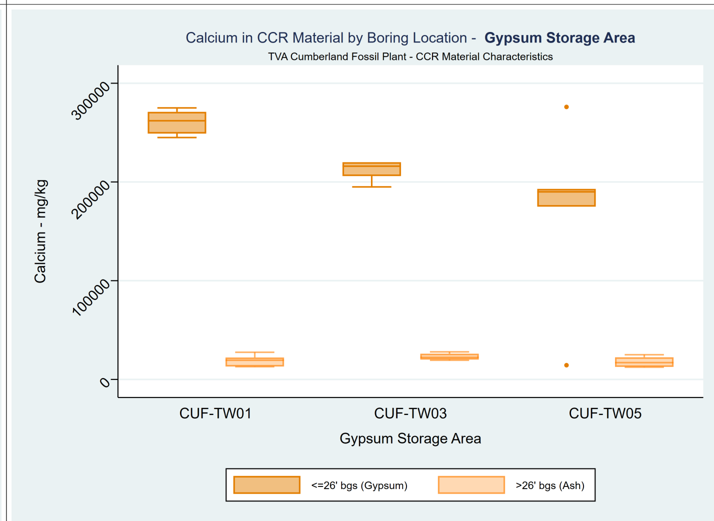
ATTACHMENT E.2-B
BOX PLOTS

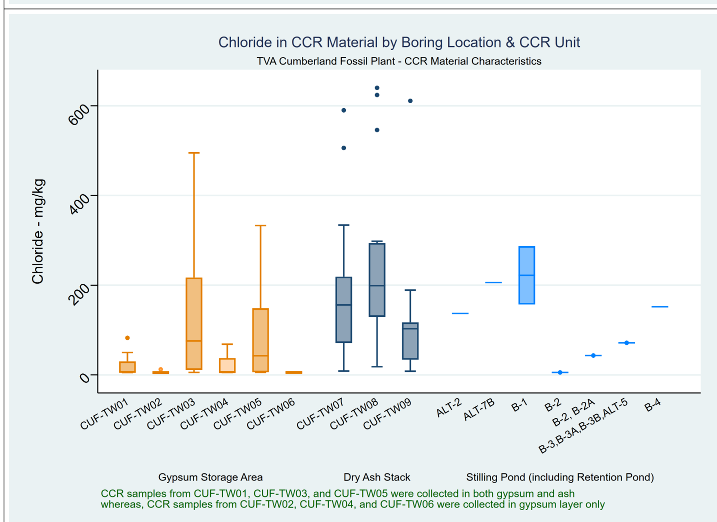
Box Plots
CCR Rule Appendix III Parameters
CCR Material Characteristics Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

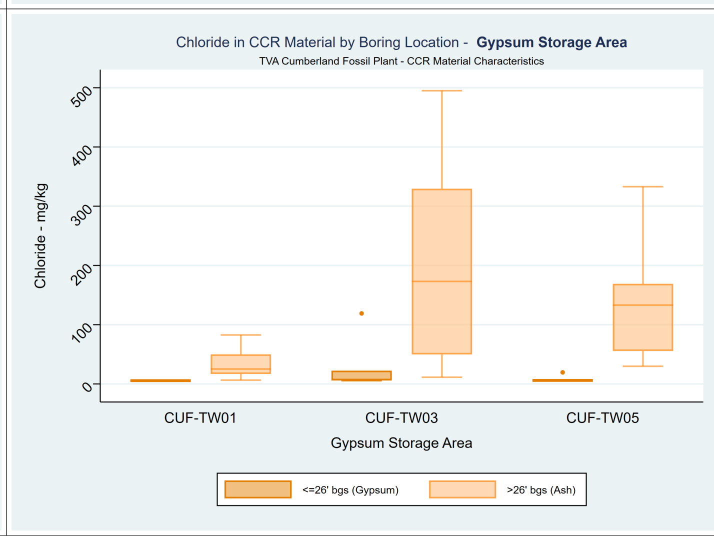


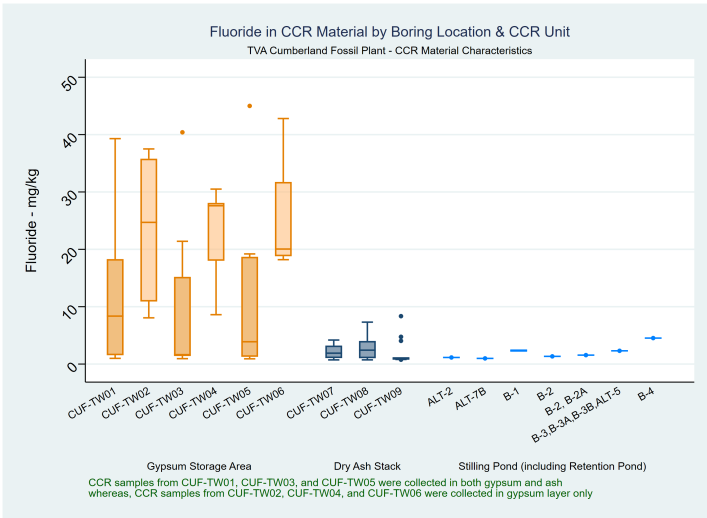


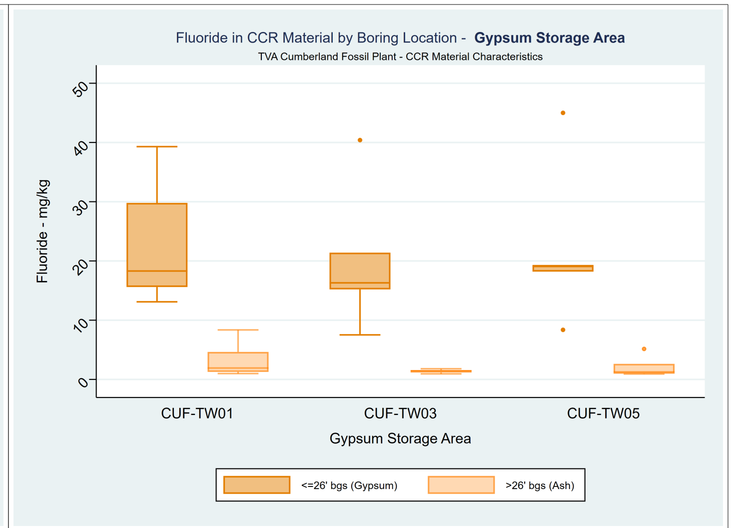


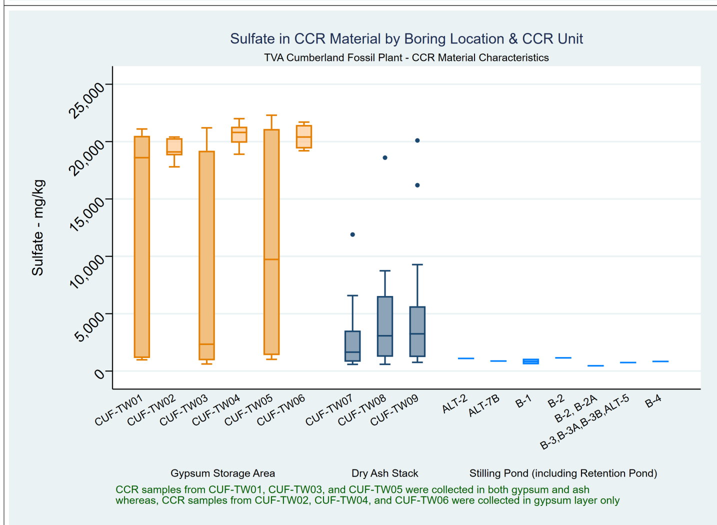


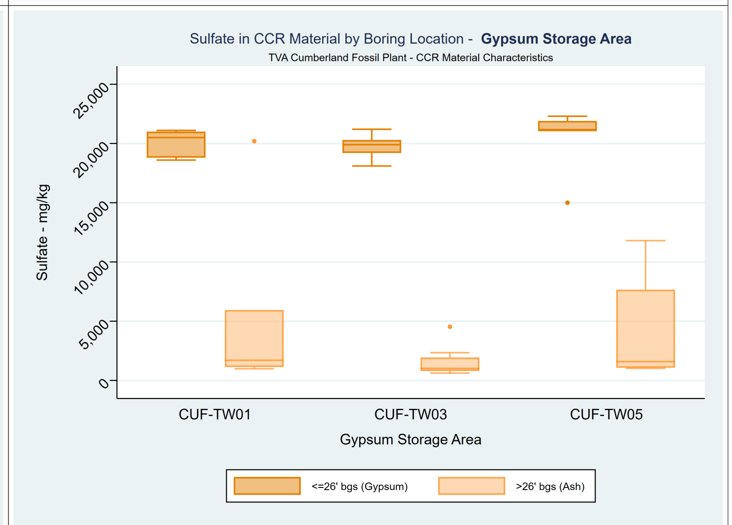


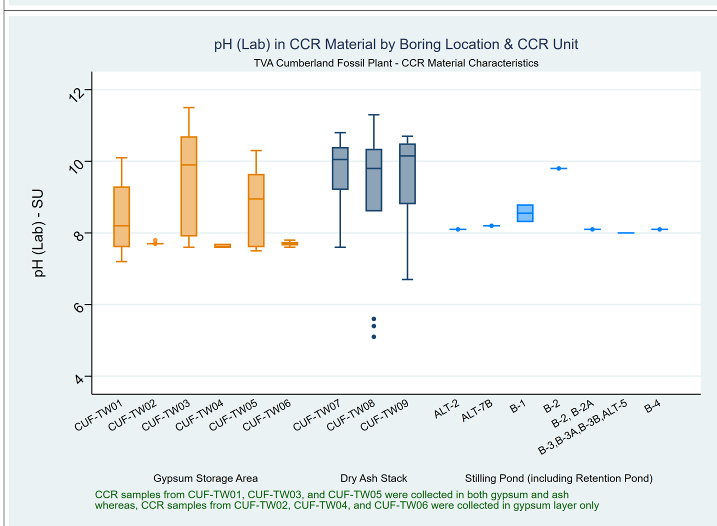


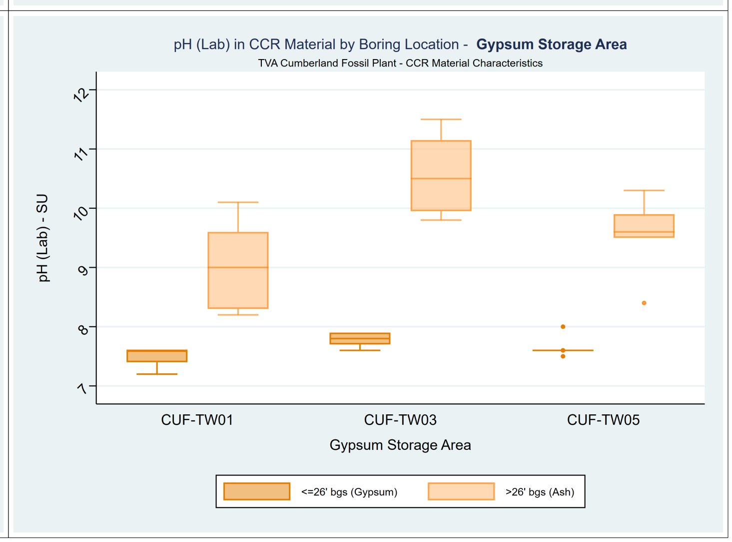

Fluoride in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Fluoride - mg/kg
0
10
20
30
40
50
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only


Fluoride in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Fluoride - mg/kg
0
10
20
30
40
50
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

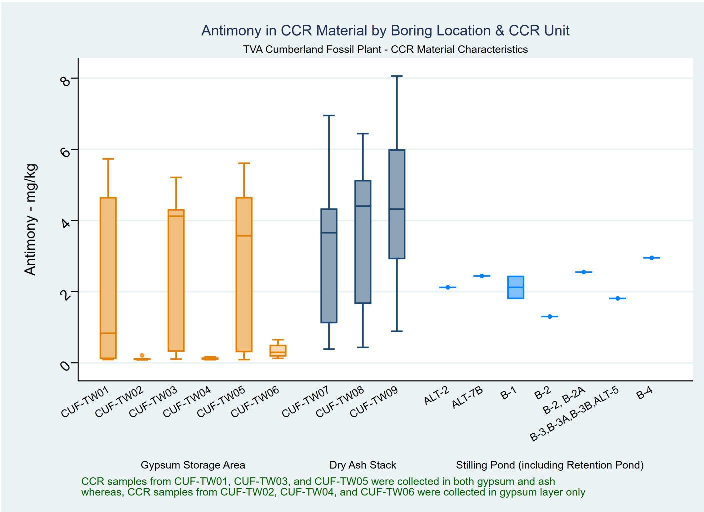

Sulfate in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Sulfate - mg/kg
0
5,000
10,000
15,000
20,000
25,000
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

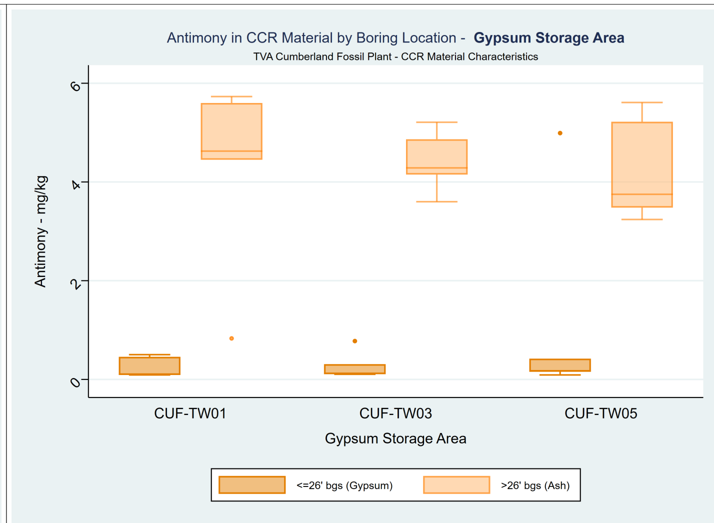

Sulfate in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Sulfate - mg/kg
0
5,000
10,000
15,000
20,000
25,000
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

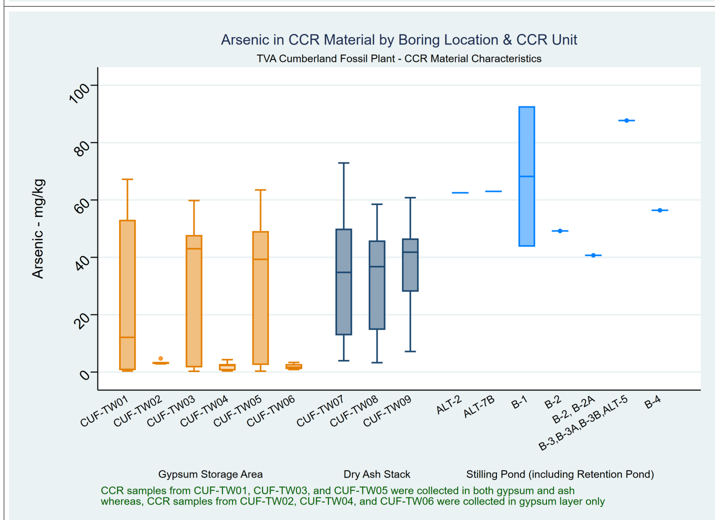

pH (Lab) in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
pH (Lab) - SU
4
6
8
10
12
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

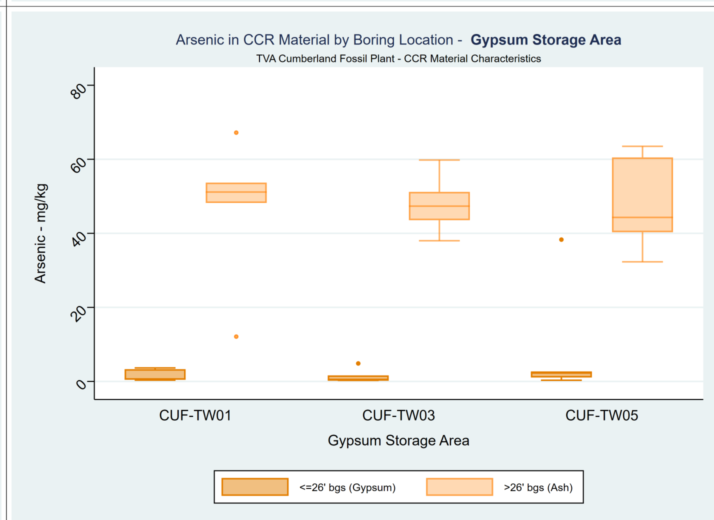

pH (Lab) in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
pH (Lab) - SU
7
8
9
10
11
12
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

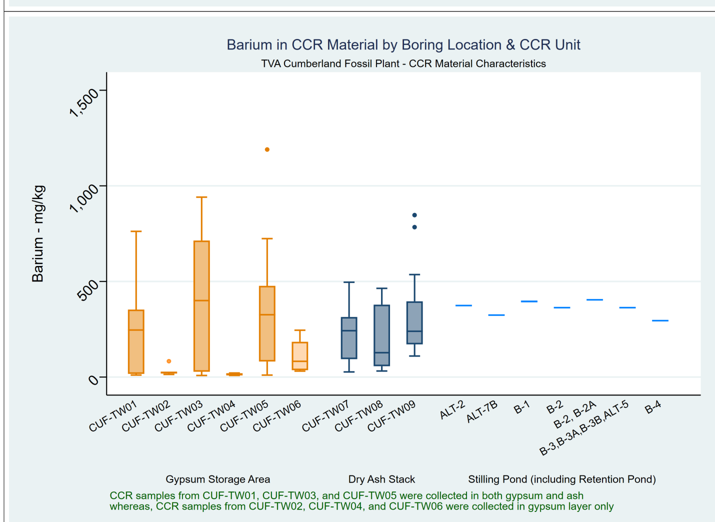
Box Plots
CCR Rule Appendix IV Parameters
CCR Material Characteristics Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

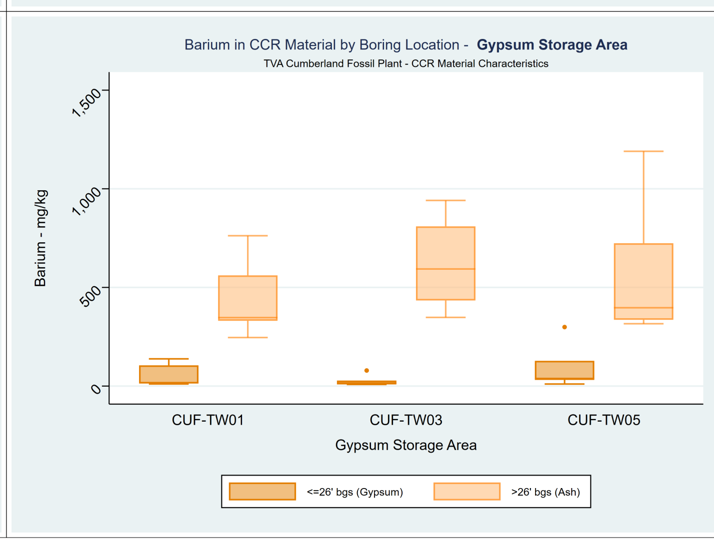


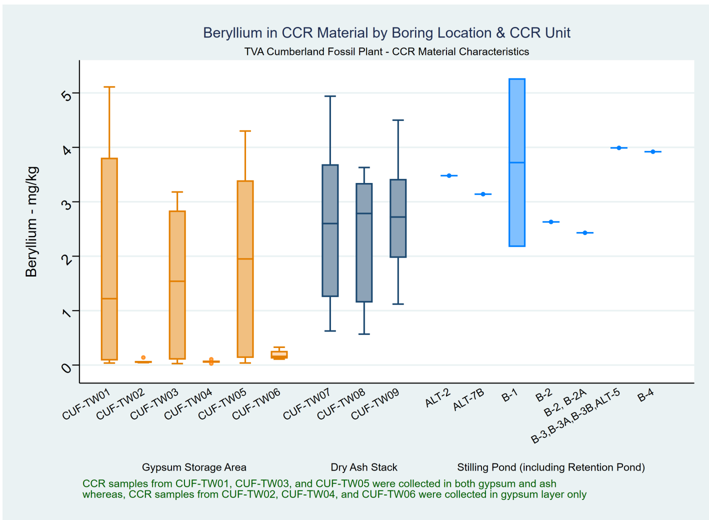


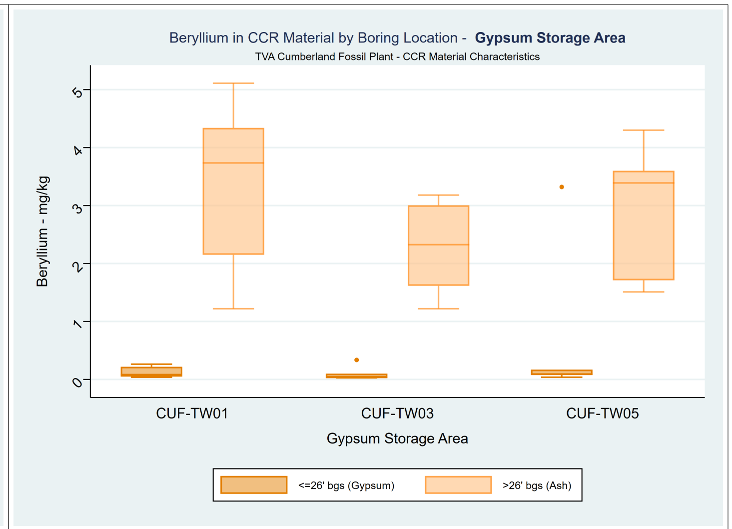


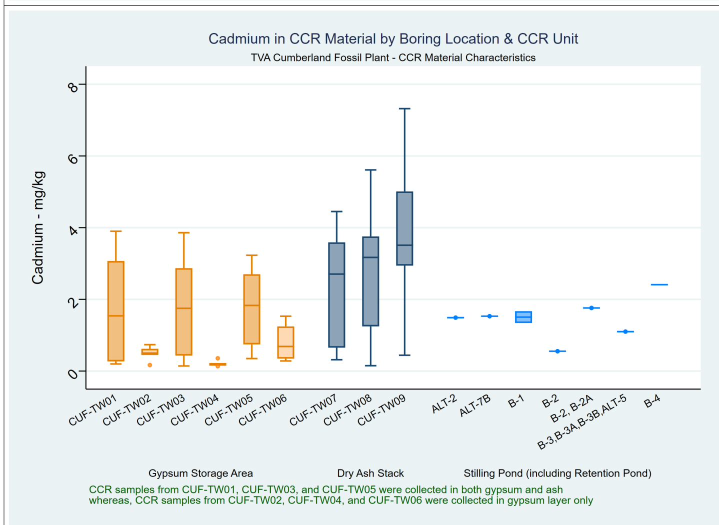


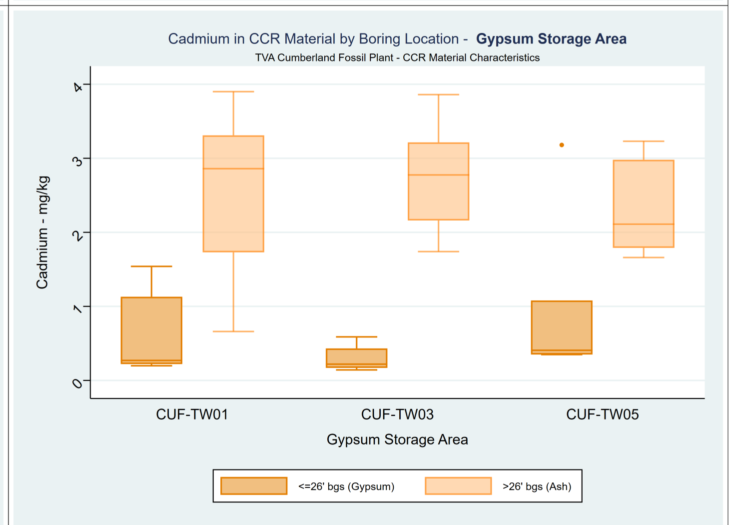


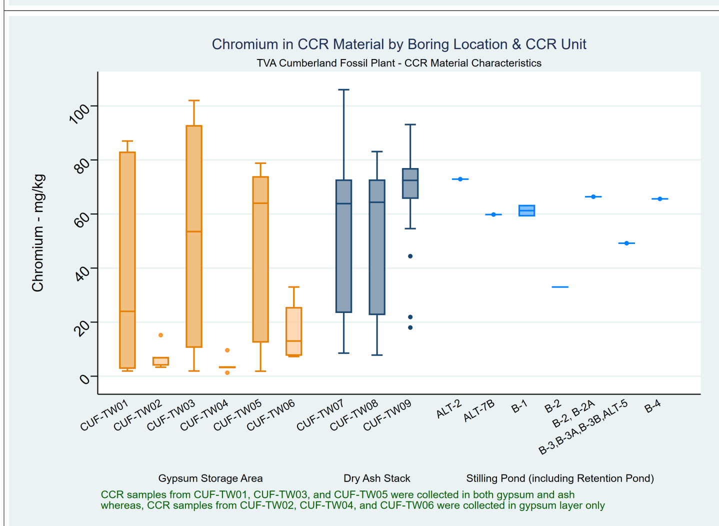


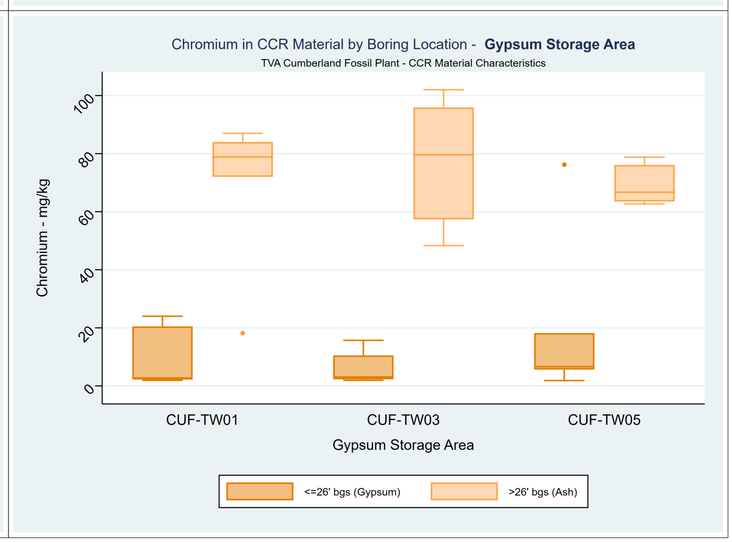

Beryllium in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Beryllium - mg/kg
0
1
2
3
4
5
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

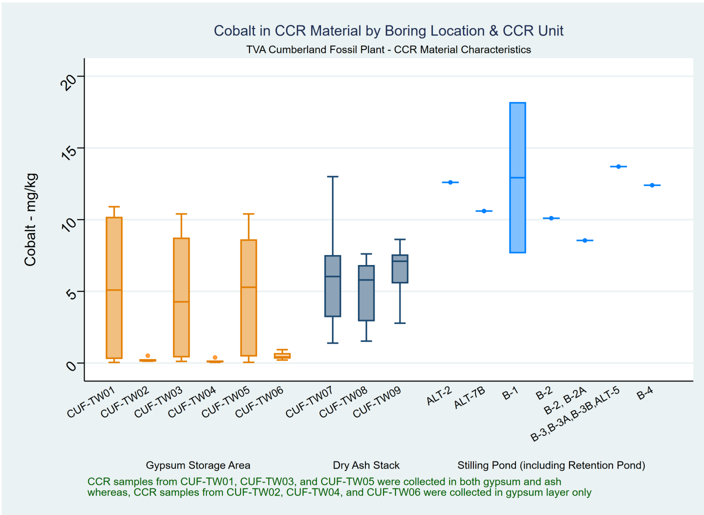

Beryllium in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Beryllium - mg/kg
0
1
2
3
4
5
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

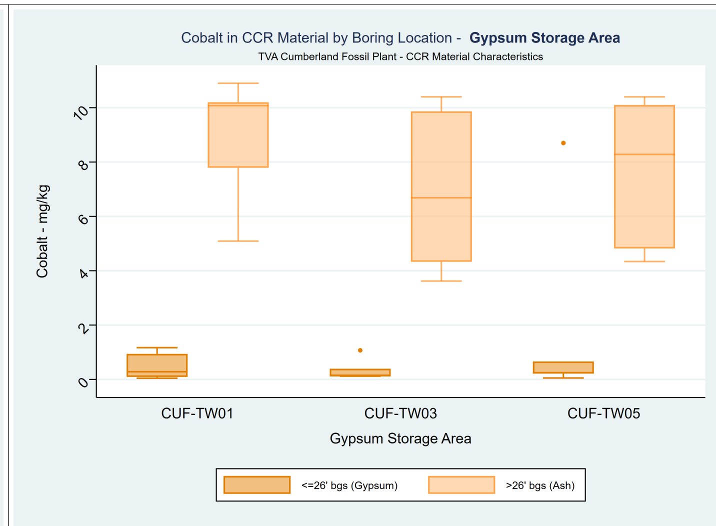

Cadmium in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Cadmium - mg/kg
0
2
4
6
8
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

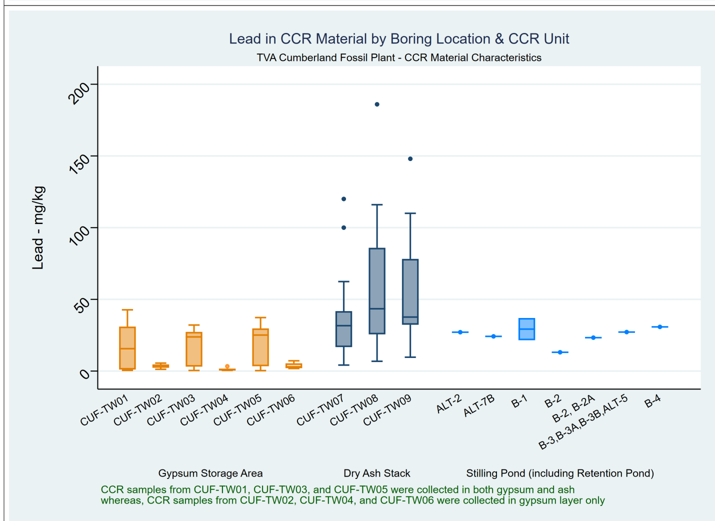

Cadmium in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Cadmium - mg/kg
0
1
2
3
4
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

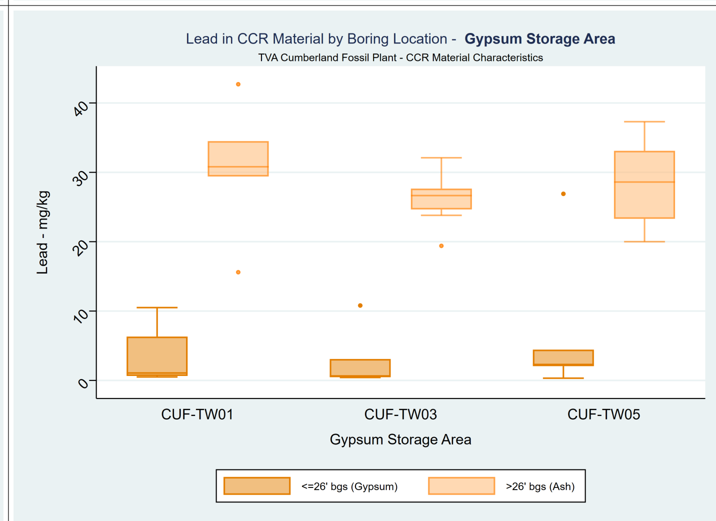

Chromium in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Chromium - mg/kg
0
20
40
60
80
100
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

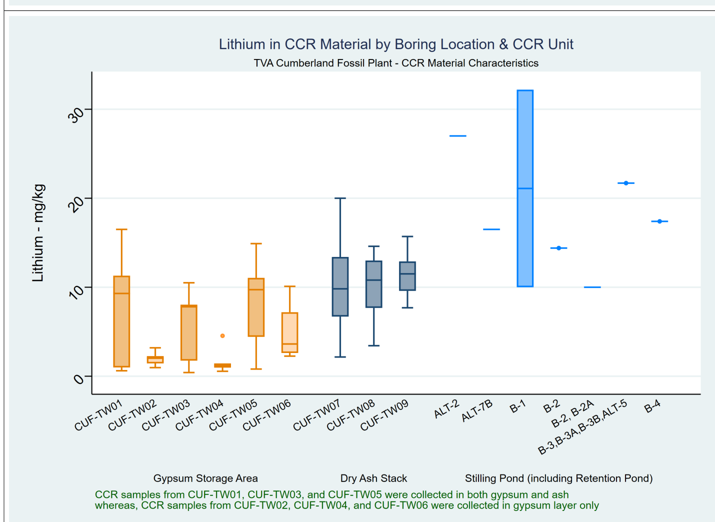

Chromium in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Chromium - mg/kg
0
20
40
60
80
100
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

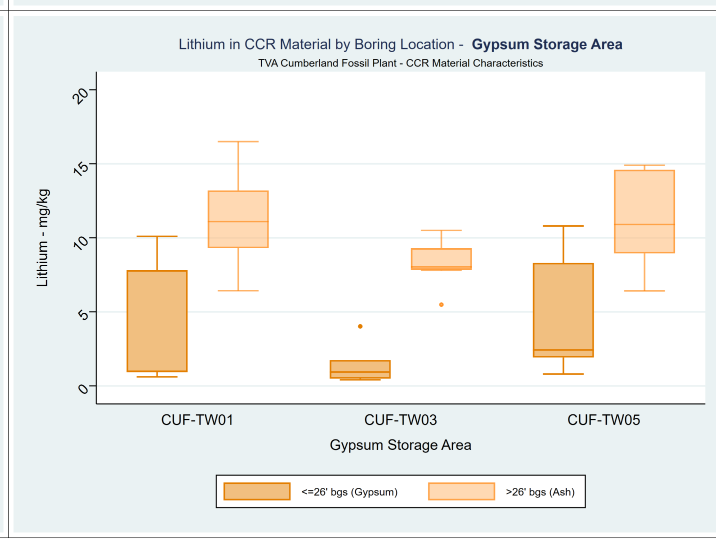

Cobalt in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Cobalt - mg/kg
0
5
10
15
20
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

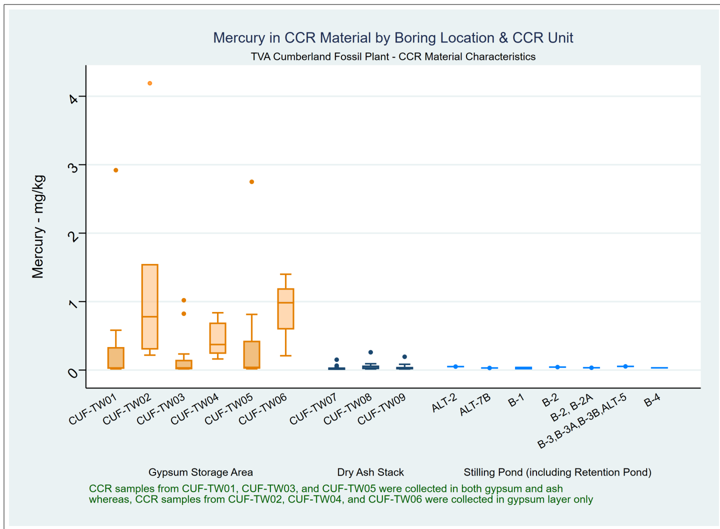

Cobalt in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Cobalt - mg/kg
0
2
4
6
8
10
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

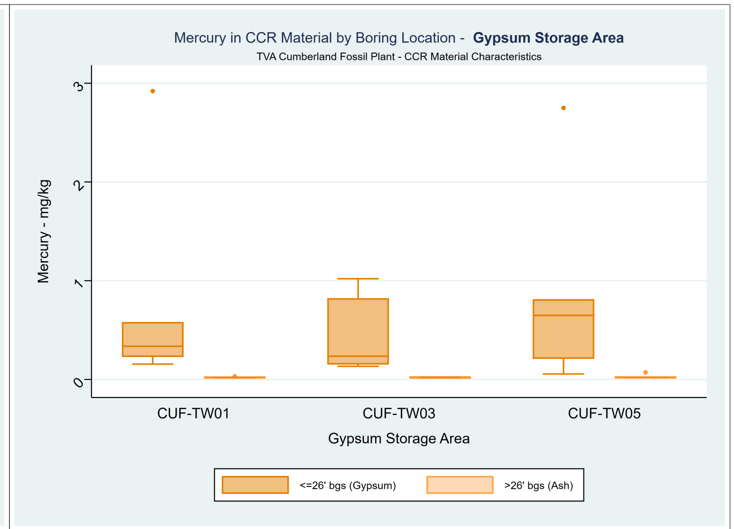

Lead in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Lead - mg/kg
0
50
100
150
200
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

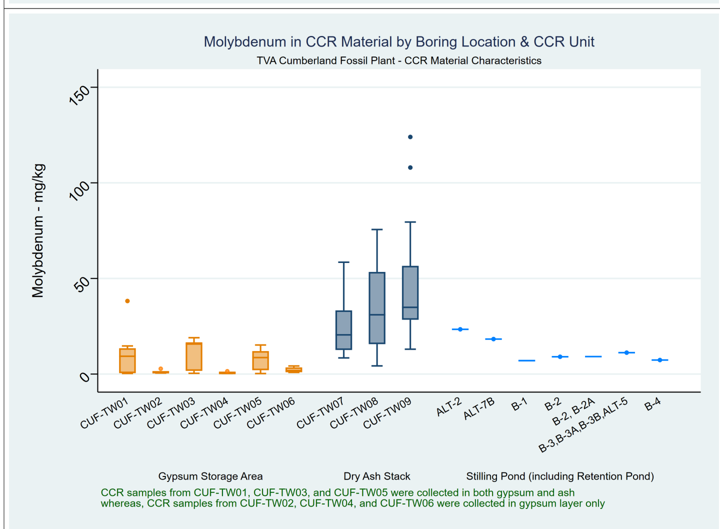

Lead in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Lead - mg/kg
0
10
20
30
40
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

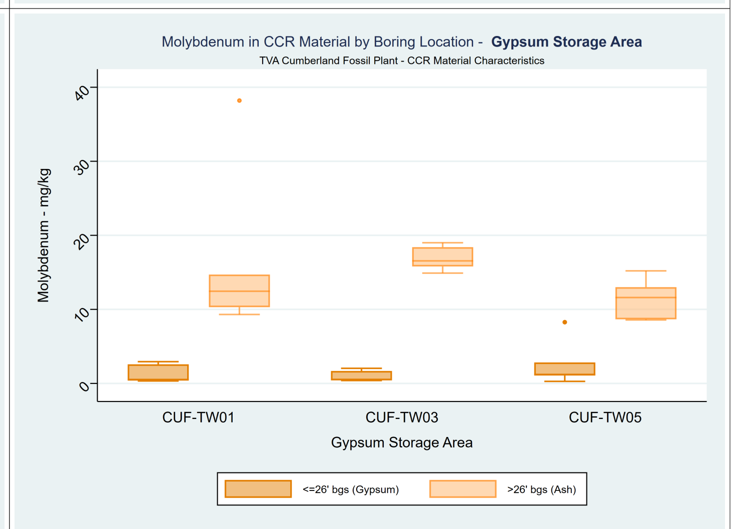

Lithium in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Lithium - mg/kg
0
10
20
30
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

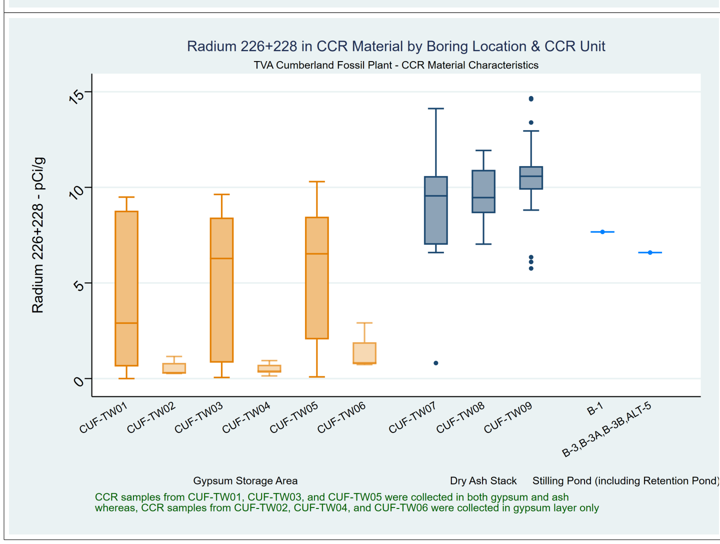

Lithium in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Lithium - mg/kg
0
5
10
15
20
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

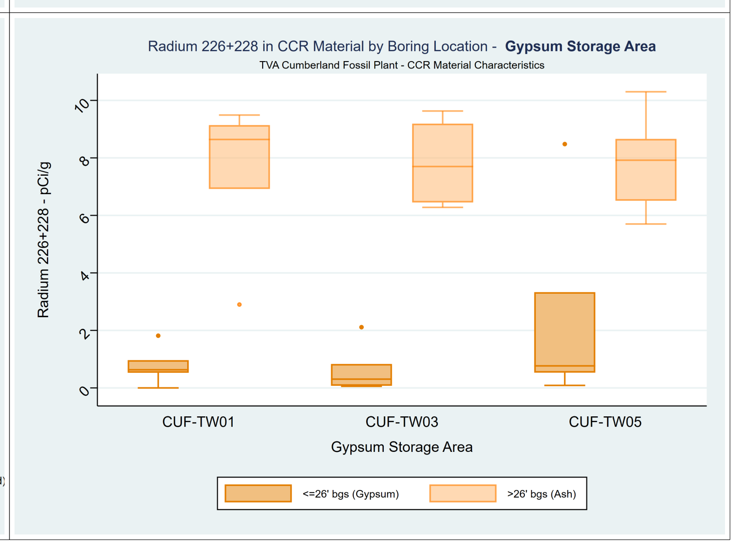

Mercury in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Mercury - mg/kg
0
1
2
3
4
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

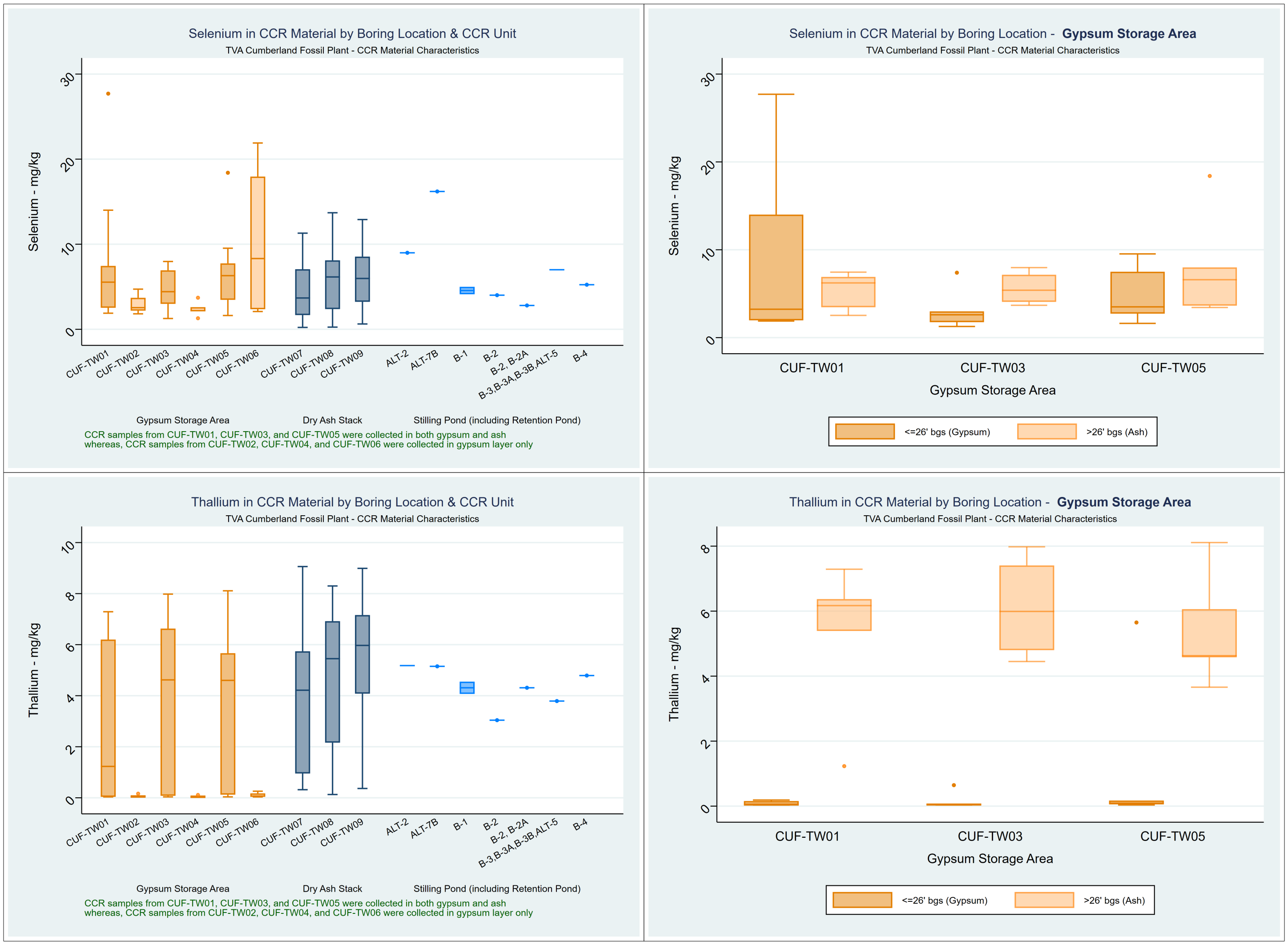

Mercury in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Mercury - mg/kg
0
1
2
3
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)


Molybdenum in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Molybdenum - mg/kg
0
50
100
150
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

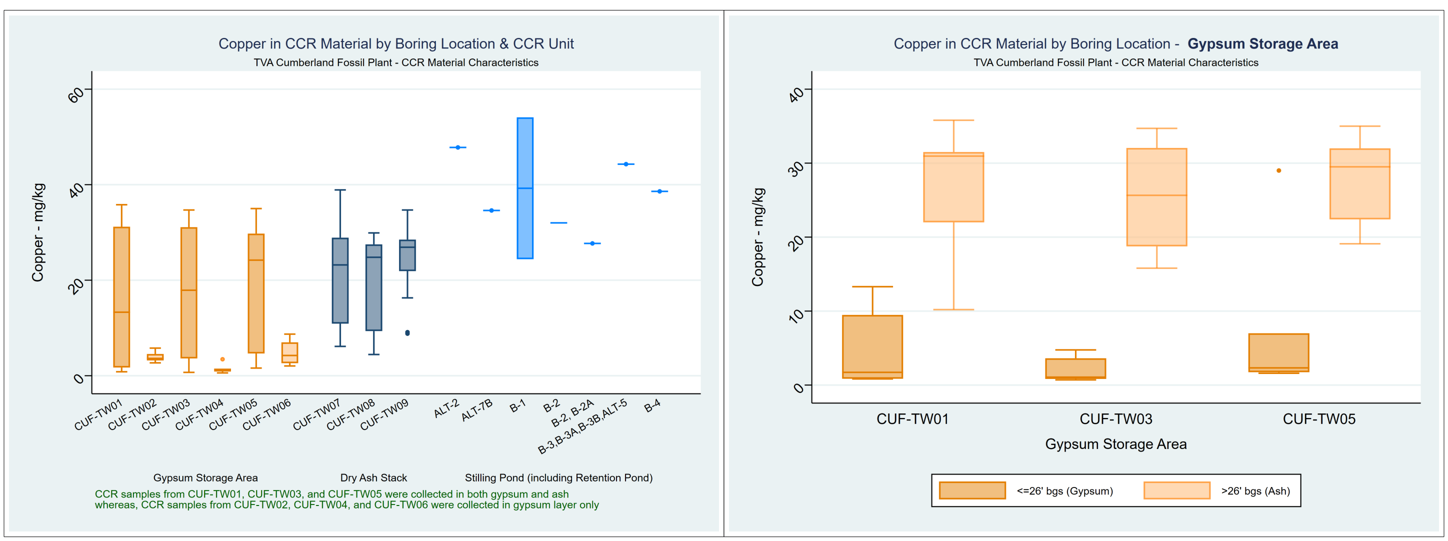

Molybdenum in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Molybdenum - mg/kg
0
10
20
30
40
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

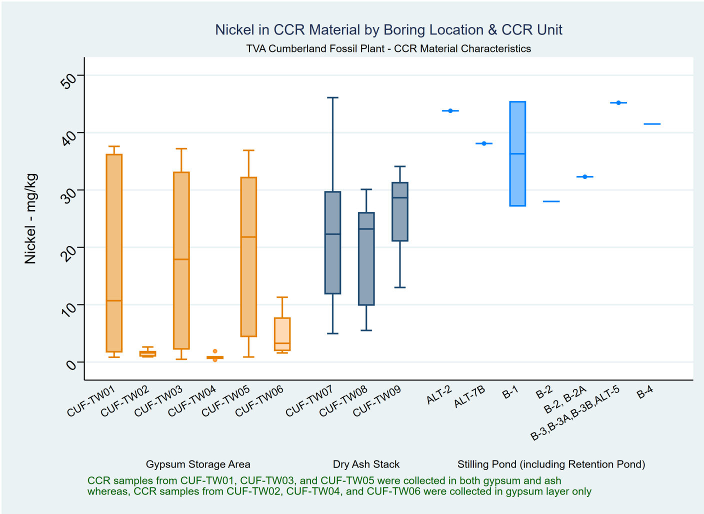

Radium 226+228 in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Radium 226+228 - pCi/g
0
5
10
15
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
B-1
B-3,B-3A,B-3B,ALT-5
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

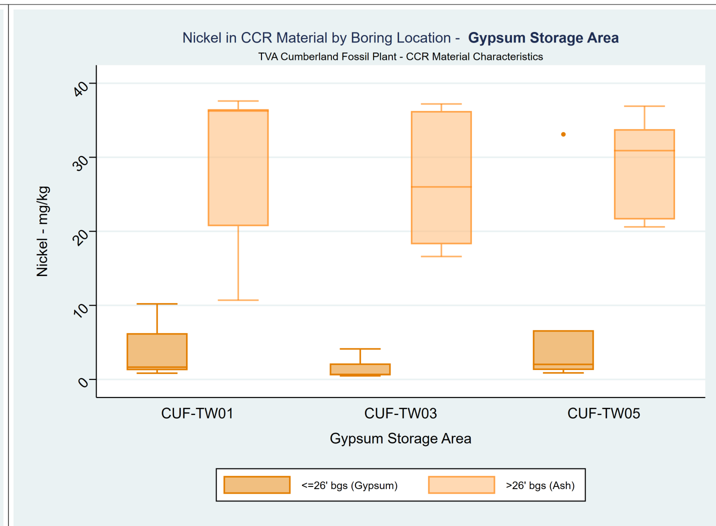

Radium 226+228 in CCR Material by Boring Location - Gypsum Storage Area
TVA Cumberland Fossil Plant - CCR Material Characteristics
Radium 226+228 - pCi/g
0
2
4
6
8
10
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

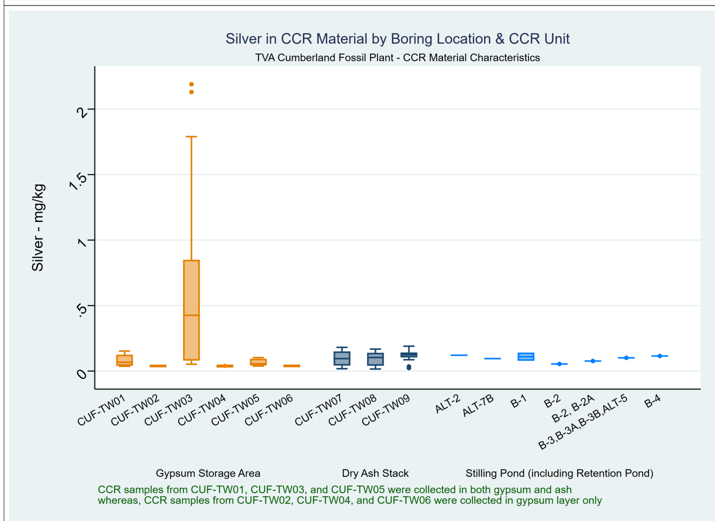


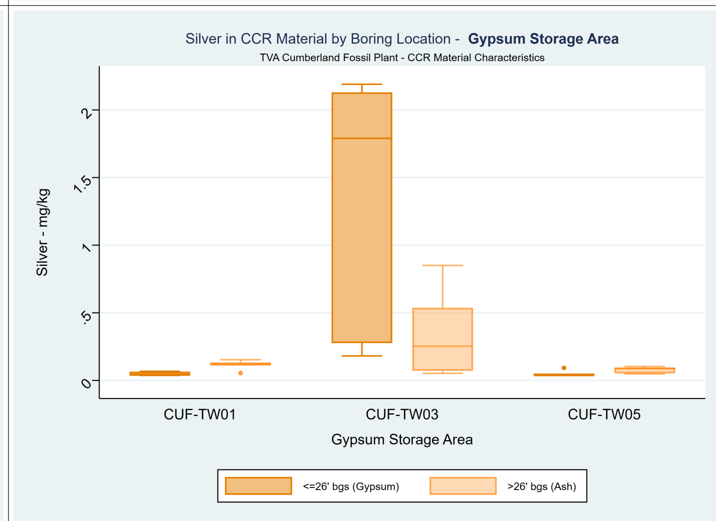
Box Plots
TDEC Appendix I Parameters
CCR Material Characteristics Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

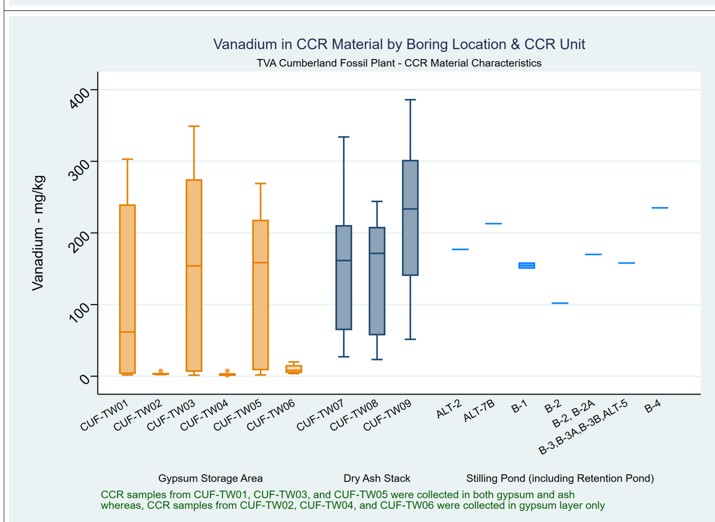


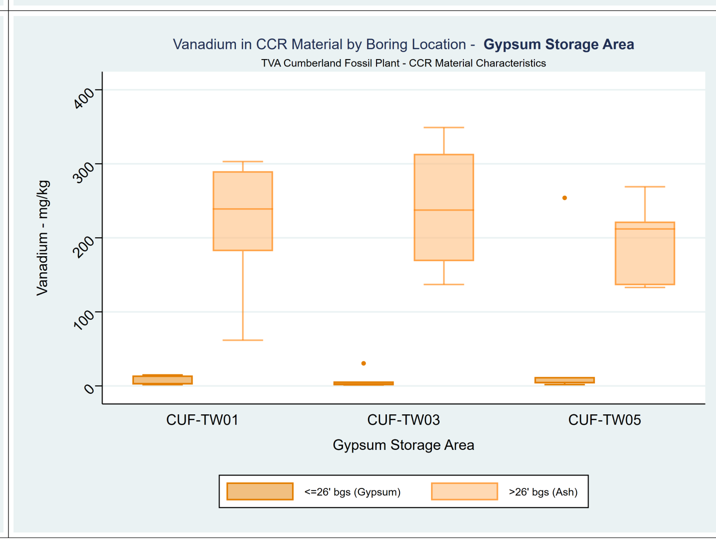

Nickel in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Nickel - mg/kg
0
10
20
30
40
50
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

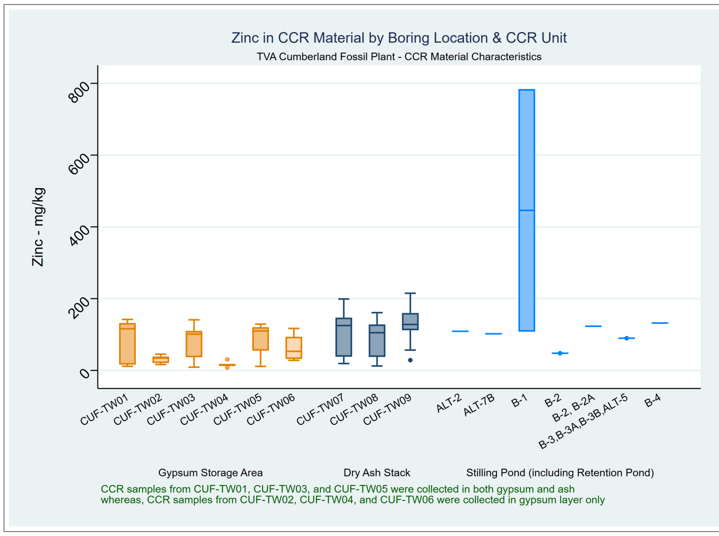

Nickel in CCR Material by Boring Location - **Gypsum Storage Area**
TVA Cumberland Fossil Plant - CCR Material Characteristics
Nickel - mg/kg
0
10
20
30
40
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)


Silver in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Silver - mg/kg
0
.5
1
1.5
2
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

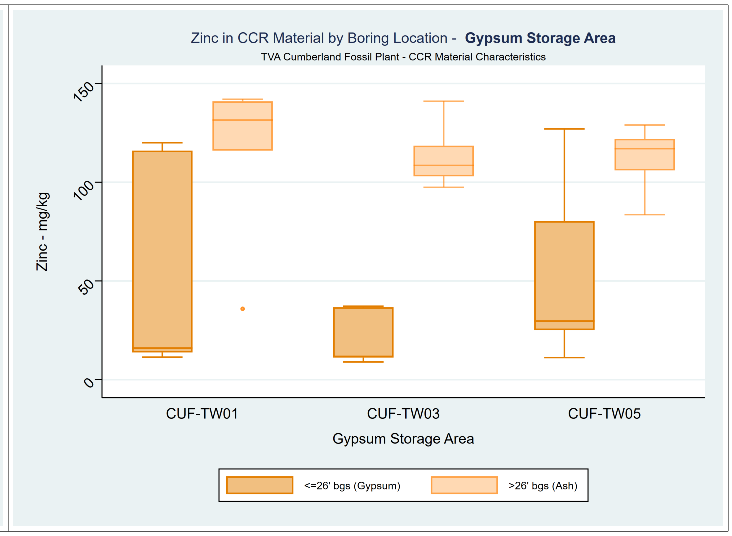

Silver in CCR Material by Boring Location - **Gypsum Storage Area**
TVA Cumberland Fossil Plant - CCR Material Characteristics
Silver - mg/kg
0
.5
1
1.5
2
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)


Vanadium in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Vanadium - mg/kg
0
100
200
300
400
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only


Vanadium in CCR Material by Boring Location - **Gypsum Storage Area**
TVA Cumberland Fossil Plant - CCR Material Characteristics
Vanadium - mg/kg
0
100
200
300
400
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)



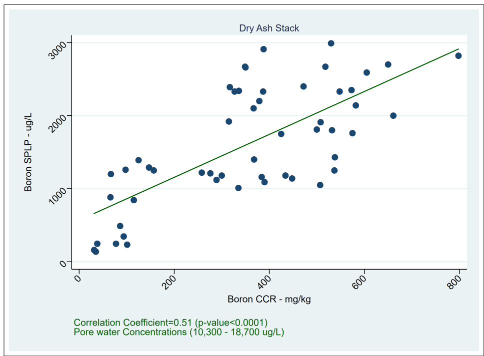
Zinc in CCR Material by Boring Location & CCR Unit
TVA Cumberland Fossil Plant - CCR Material Characteristics
Zinc - mg/kg
0
200
400
600
800
CUF-TW01
CUF-TW02
CUF-TW03
CUF-TW04
CUF-TW05
CUF-TW06
CUF-TW07
CUF-TW08
CUF-TW09
ALT-2
ALT-7B
B-1
B-2
B-2, B-2A
B-3,B-3A,B-3B,ALT-5
B-4
Gypsum Storage Area
Dry Ash Stack
Stilling Pond (including Retention Pond)
CCR samples from CUF-TW01, CUF-TW03, and CUF-TW05 were collected in both gypsum and ash
whereas, CCR samples from CUF-TW02, CUF-TW04, and CUF-TW06 were collected in gypsum layer only

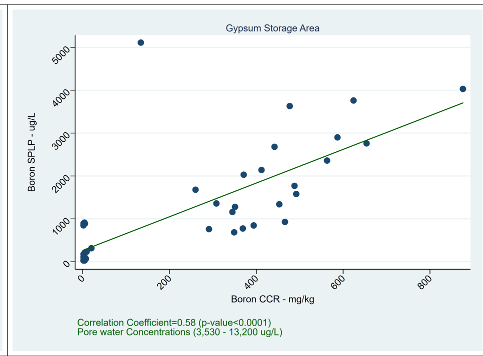


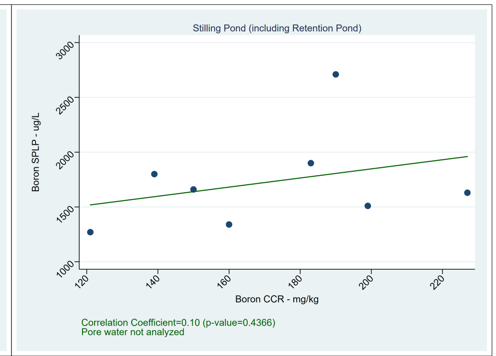
Zinc in CCR Material by Boring Location - **Gypsum Storage Area**
TVA Cumberland Fossil Plant - CCR Material Characteristics
Zinc - mg/kg
0
50
100
150
CUF-TW01
CUF-TW03
CUF-TW05
Gypsum Storage Area
<=26' bgs (Gypsum)
>26' bgs (Ash)

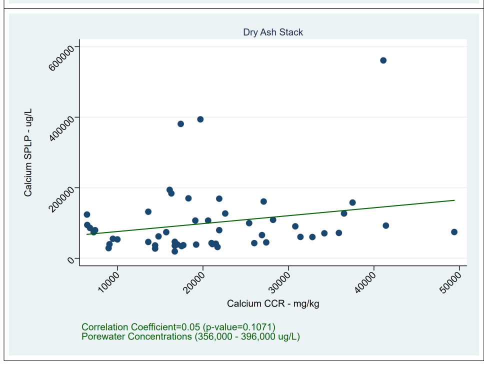
ATTACHMENT E.2-C
SCATTER PLOTS AND REGRESSION

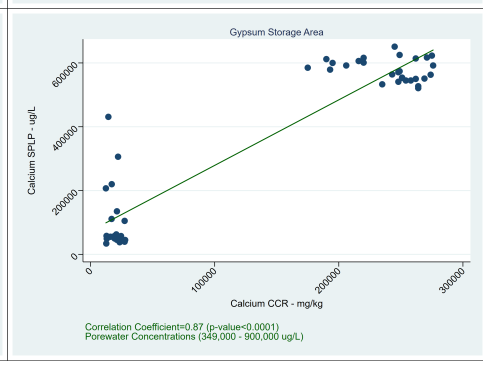
Scatter Plots (SPLP and CCR Material
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

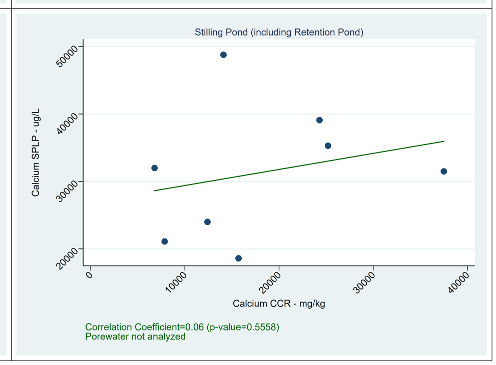




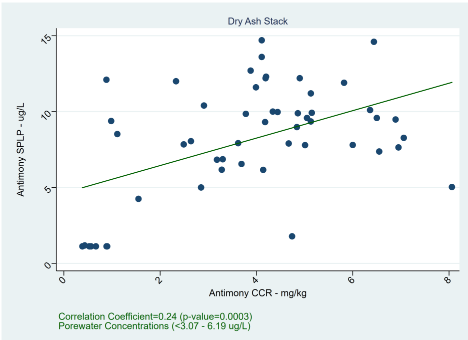








Scatter Plots (SPLP and CCR Material
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee



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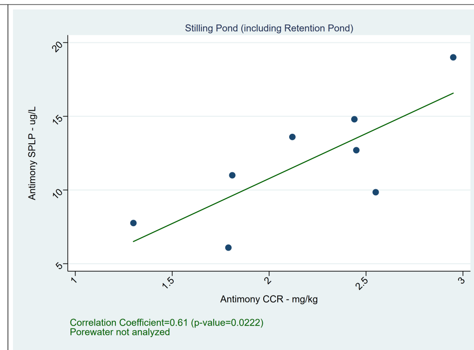

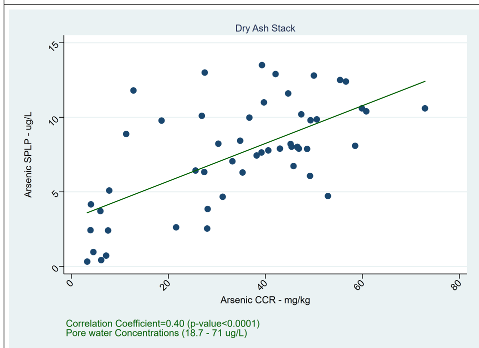

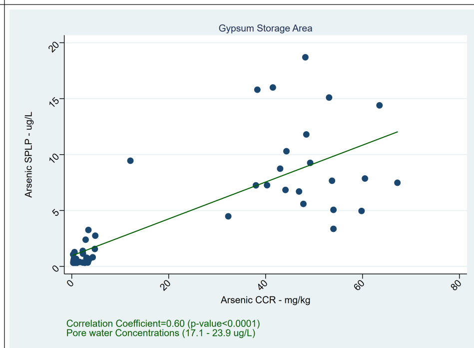

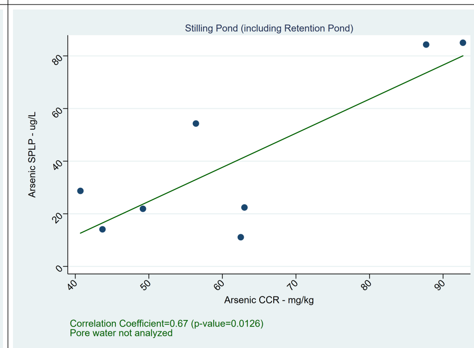

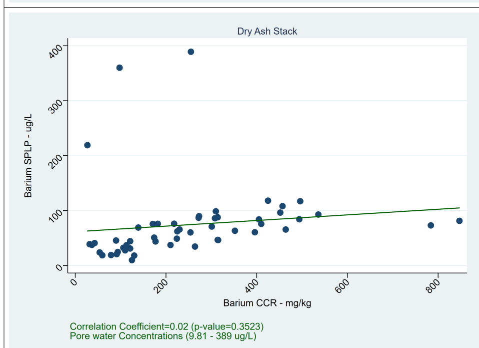

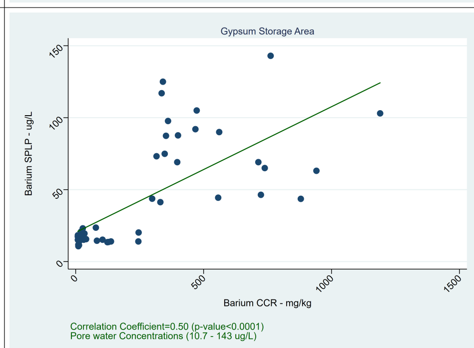

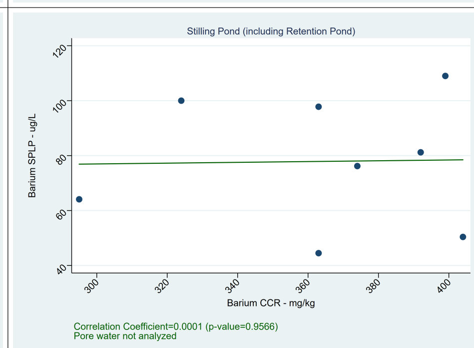

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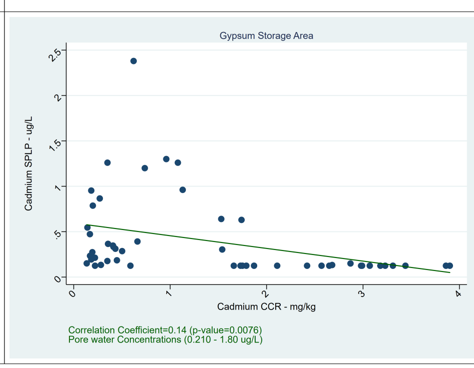
Beryllium/Gypsum Storage Area, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets

Beryllium/Stilling Pond (including Retention Pond), Insufficient Data, 50% non-Detects in SPLP or CCR Material Data Sets

Cadmium/Dry Ash Stack, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets



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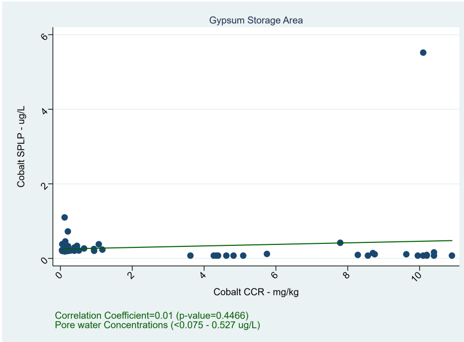
Cobalt/Dry Ash Stack, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets		Cobalt/Stilling Pond (including Retention Pond), Insufficient Data - > 50% non-Detects in SPLP or CCR Material Data Sets
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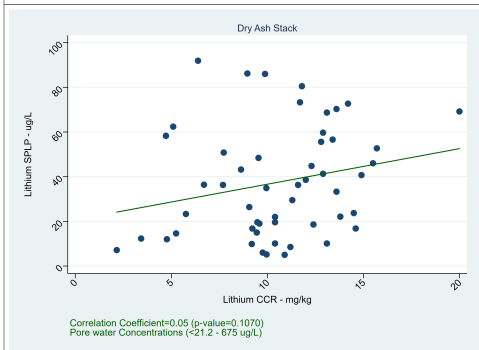
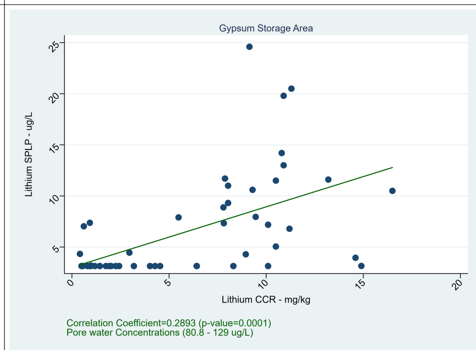
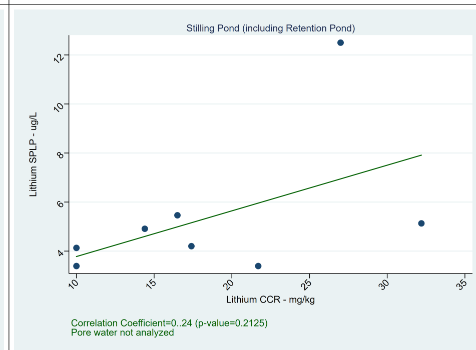
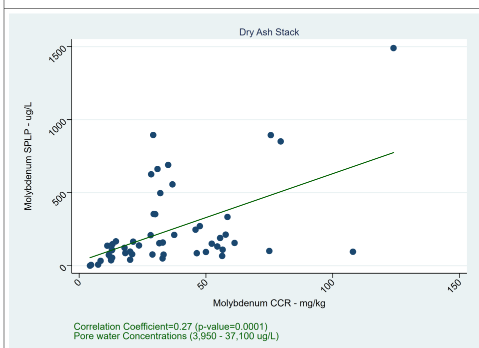
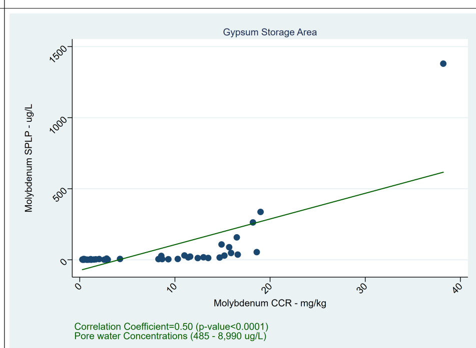
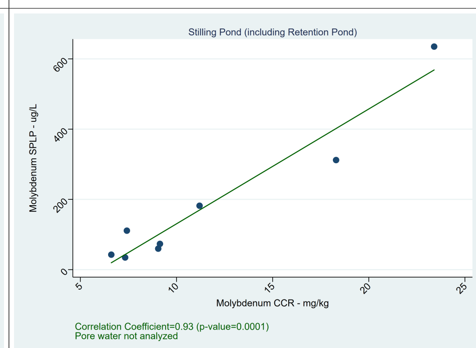
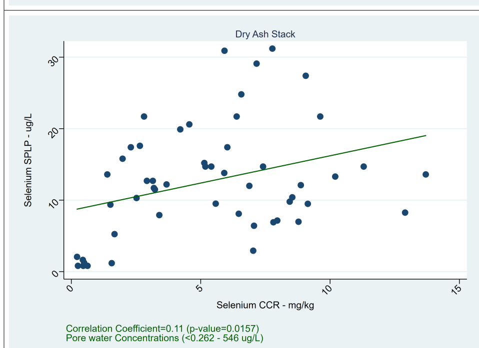
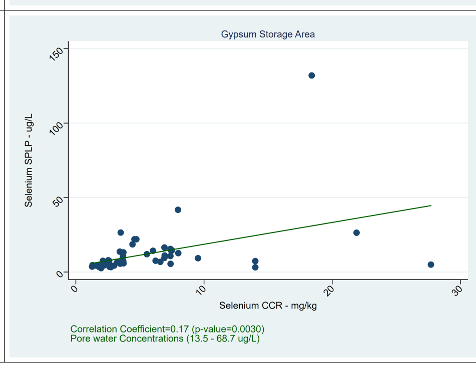
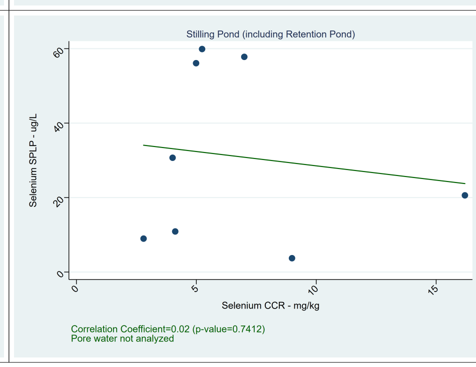
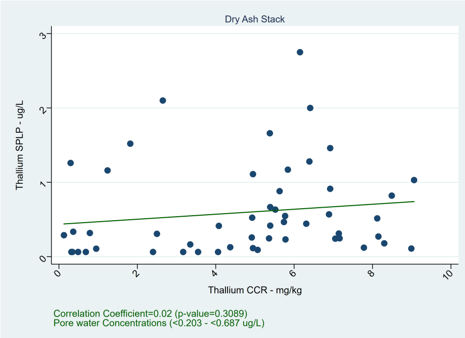
		
Mercury/Dry Ash Stack, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets	Mercury/Gypsum Storage Area, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets	Mercury/Stilling Pond (including Retention Pond), Insufficient Data, 50% non-Detects in SPLP or CCR Material Data Sets
		
		

	Thallium/Gypsum Storage Area, Insufficient Data, > 50% non-Detects in SPLP or CCR Material Data Sets	Thallium/Stilling Pond (including Retention Pond), Insufficient Data, 50% non-Detects in SPLP or CCR Material Data Sets

Scatter Plots (SPLP and CCR Material
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

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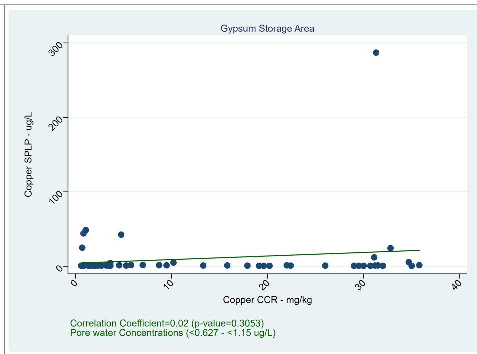
<td>
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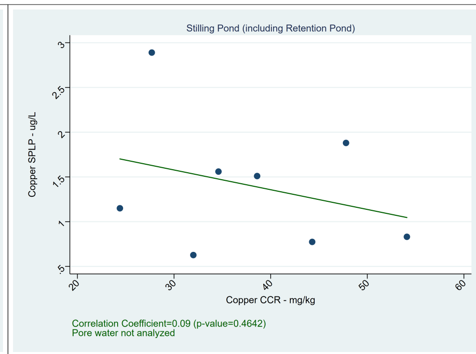
<td>
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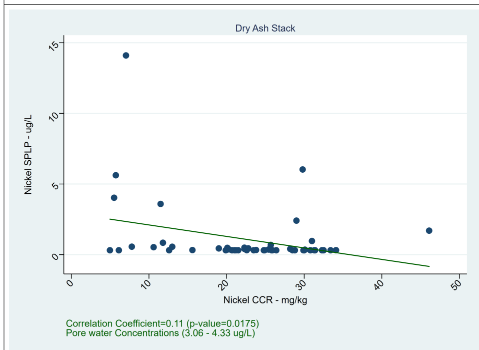
<td>
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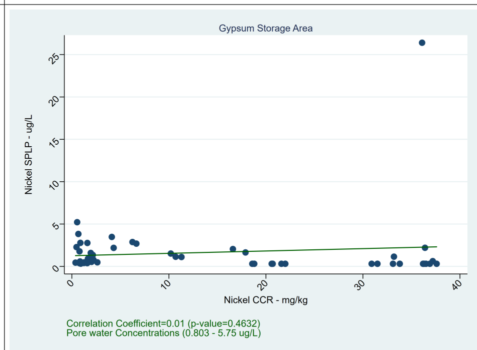
<td>
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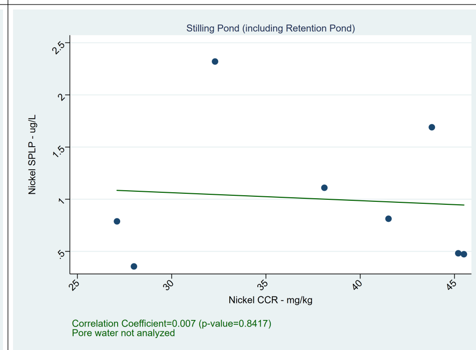
<td>
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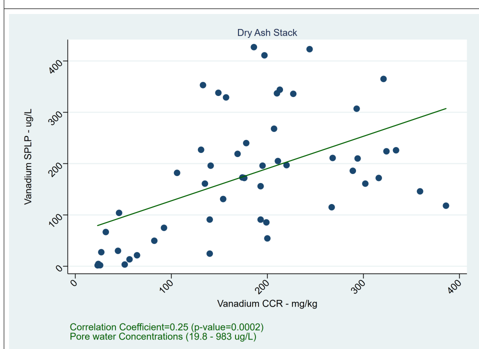
<td>
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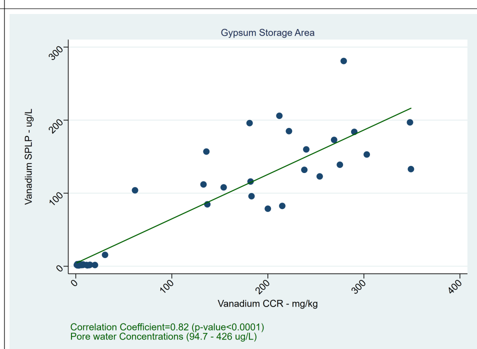
<td>
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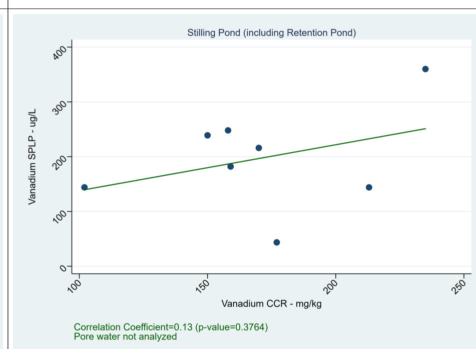
<td>
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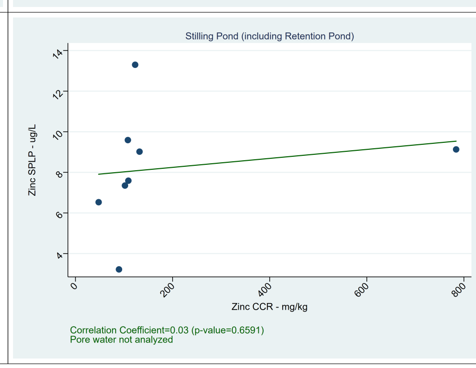
<td>
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APPENDIX E.3

STATISTICAL ANALYSIS OF GROUNDWATER ANALYTICAL RESULTS

Appendix E.3 - Statistical Analysis of Groundwater Analytical Results

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

REVISION LOG

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022, TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023, TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Appendix E.3 - Statistical Analysis of Groundwater Analytical Results was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________

Melissa Whitfield Aslund, PhD, Environmental Scientist

Reviewed by ______________________

Chris LaLonde, Risk Assessor

Approved by ______________________

Rebekah Brooks, PG, Senior Principal Hydrogeologist

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Abbreviations

CASRN	Chemical Abstracts Service Registry Number
CCR	Coal Combustion Residuals
CCR Parameters	Constituents listed in Appendices III and IV of 40 CFR 257 and five inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04
CCR Rule	Title 40, Code of Federal Regulations, Part 257
CFR	Code of Federal Regulations
CUF Plant	Cumberland Fossil Plant
EAR	Environmental Assessment Report
EI	Environmental Investigation
GSLs	Groundwater Screening Levels
NA	Not Available
%	Percent
RCRA	Resource Conservation and Recovery Act
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TVA	Tennessee Valley Authority
Unified Guidance	Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance
USEPA	United States Environmental Protection Agency

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to summarize the statistical analyses performed on groundwater quality data to support evaluations conducted for the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. These statistical analyses include an evaluation of groundwater quality data collected at the CUF Plant for the Tennessee Department of Environment and Conservation (TDEC) Order Environmental Investigation (EI), in compliance with the Title 40, Code of Federal Regulations (Title 40 CFR) Part 257 (Coal Combustion Residuals [CCR] Rule) monitoring program, and the TDEC permitted landfill groundwater monitoring program. The statistical analysis in this appendix focused on the parameters listed in Appendices III and IV of Title 40 CFR 257 and five additional inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04 (CCR Parameters) (see Table E.3-1). The wells included in this statistical analysis are listed in Table E.3-2.

The dataset compiled for statistical analysis includes available analytical data for groundwater samples collected from the wells listed in Table E.3-2 between November 2016 and August 2022, although the specific start date and frequency of sampling may vary between wells based on date of well installation and the applicable monitoring program. This time period was selected because it coincides with modifications that were made to the monitoring program at the CUF Plant in 2016. Although older data were available for some wells (i.e., CUF-93-1, CUF-93-2R, CUF-93-3, and CUF-93-4), a qualitative data review for these wells revealed several instances where distinct shifts in concentration trends/ level of data variability occurred concurrent to the modifications made to the monitoring program in 2016 (see **Attachment E.3-A**). As described in USEPA (2009), statistical analyses to compare groundwater quality data to a fixed limit (e.g., groundwater screening level [GSL]) should be completed using the most recent stable measurements. Therefore, further statistical analyses described herein were based on data collected starting in November 2016 for the wells listed in Table E.3-2.

The complete groundwater quality results for the dataset compiled for statistical analysis are reported in Appendix H.1.

Table E.3-1 – CCR Parameters Evaluated in Statistical Analysis

Parameter	CASRN
CCR Rule Appendix III Parameters	
Boron	7440-42-8
Calcium	7440-70-2
Chloride	16887-00-6
Fluoride[1] (also Appendix IV)	16984-48-8
pH	NA
Sulfate	14808-79-8
TDS	NA
CCR Rule Appendix IV Parameters	
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Cadmium	7440-43-9
Chromium	7440-47-3
Cobalt	7440-48-4
Lead	7439-92-1
Lithium	7439-93-2
Mercury	7439-97-6
Molybdenum	7439-98-7
Radium-226+228	13982-63-3/ 15262-20-1
Selenium	7782-49-2
Thallium	7440-28-0
Additional TDEC Appendix I Parameters	
Copper	7440-50-8
Nickel	7440-02-0
Silver	7440-22-4
Vanadium	7440-62-2
Zinc	7440-66-6

Notes: CASRN - Chemical Abstracts Service Registry Number; CCR – Coal Combustion Residuals; NA - Not available; TDS - Total dissolved solids
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV constituent. In this table and in the results figures and tables for this report, fluoride has been grouped with the Appendix III constituents only to avoid duplication.

Table E.3-2 - Groundwater Monitoring Wells and Parameters Included in Statistical Analysis

Well Location	Well	Program			Parameters Included in Statistical Analysis		
		EI Wells	TDEC Permitted Landfill Wells	CCR Rule Wells	CCR Rule Appendix III	CCR Rule Appendix IV	TDEC Appendix I
Background	CUF-1001	X			X	X	X
	CUF-201		X	X	X	X	X
	CUF-202		X	X	X	X	X
Upgradient	CUF-93-4		X		X	X	X
Dry Ash Stack	CUF-93-1		X		X	X	X
	CUF-93-1D		X		X	X	X
	CUF-1002	X			X	X	X
	CUF-209		X	X	X	X	X
	CUF-211		X	X	X	X	X
Gypsum Storage Area	CUF-93-2R		X	X	X	X	X
	CUF-93-3		X	X	X	X	X
	CUF-1003	X			X	X	X
	CUF-1006	X			X	X	X
	CUF-212		X	X	X	X	X
Stilling Pond	CUF-205			X	X	X	X
	CUF-206			X	X	X	X
	CUF-207			X	X	X	X
	CUF-208			X	X	X	X

2.0 METHODS

2.1 EXPLORATORY DATA ANALYSIS

The initial step of statistical analysis was the exploratory data analysis. The process of the exploratory data analysis utilizes simple summary statistics (e.g., mean, median, standard deviation and percentiles) and graphical representations to identify important characteristics of an analytical dataset, such as the center of the data (i.e., mean, median), variation, distribution, patterns, presence of outliers and randomness.

Summary statistics were calculated for each well-constituent pair. These summary statistics include information such as total number of available samples, frequency of detection, and maximum detected values and detected concentrations for each well-constituent pair. Exploratory data plots for each well-constituent pair (i.e., box plots and time series plots) were also constructed to support a visual review of the data and identify potential outliers.

Outliers are data points that are abnormally high or low as compared to other measurements and may represent anomalous data or data errors. Outliers may also represent natural variation of concentrations in environmental systems. Therefore, where potential outliers were visually identified in box plots or time-series plots, secondary statistical screening was completed using Tukey's procedure to identify extreme outliers (Tukey 1977) followed by statistical testing for outliers (Dixon or Rosner's test, α=0.05). Following confirmation of the outliers as statistically significant, a desktop evaluation was conducted to verify that the data points were not errors (e.g., laboratory or transcriptional error). Field forms, data validation reports, and other variables in the dataset that could influence analytical results were also evaluated. If a verifiable error was discovered, the outlier was removed and, if possible, replaced with a corrected value.

In the absence of a verifiable error, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability). If an outlier was identified as suitable for removal from further statistical analysis, a clear and defensible rationale based on multiple lines of evidence was provided. In addition, values that were identified as outliers and removed from further evaluation in the present statistical analysis were retained in the historical database and will be reevaluated for inclusion or exclusion in future statistical analyses of this dataset.

2.2 COMPARISON OF GROUNDWATER QUALITY DATA TO GROUNDWATER SCREENING LEVELS

The United States Environmental Protection Agency (USEPA) document "*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance"* (USEPA 2009; hereafter referred to as the Unified Guidance) describes statistical methods for comparing groundwater concentrations to fixed standards such as the TDEC-approved groundwater screening levels (GSLs) identified in Appendix A.2. In the Unified Guidance, a confidence interval approach is recommended for comparing groundwater monitoring data to a fixed numerical limit. If the underlying population is stable (i.e., no trend is present), then the Unified Guidance indicates that comparison to a fixed standard can be made based on a confidence interval around the mean. However, the Unified Guidance indicates that "*where the data exhibit a trend over time the interval will incorporate not only the natural variability in the underlying population, but also additional variation induced by the trend itself. The net result is a confidence interval that can be much wider than expected for a given confidence level and sample size (n).*" Therefore, in the presence of a statistically significant trend, the Unified Guidance recommends constructing a confidence band around a trend line, where the comparison is made to the fixed standard based on the confidence band as of the most recent evaluated sampling event, rather than a static confidence interval around the mean.

For the groundwater data reviewed herein, these approaches were applied to identify well-constituent pairs where the available data indicate a statistically significant concentration above or equal to the GSL for constituents other than pH, or statistically significant values outside the GSL range for pH. For this dataset, the null hypothesis was that the groundwater concentrations were less than the GSL for constituents other than pH and that levels were within the GSL range for pH. In accordance with the methods described in the Unified Guidance, constituent concentrations were determined to represent a statistically significant concentration above or equal to a GSL for constituents other than pH, only when there were sufficient data to support statistical confidence band or interval evaluation and the applicable lower confidence band or interval was greater than or equal to the GSL as of the most recent sampling event included in the statistical analysis. For pH, which has both an upper and lower GSL, a statistical difference was identified if there were sufficient data to support statistical analysis, and either the applicable lower confidence band or interval was greater than or equal to the upper GSL or the applicable upper confidence band or interval was less than or equal to the lower GSL as of the most recent sampling event included in the statistical analysis. Whether comparison should be made using a confidence band or confidence interval was determined for each well-constituent pair based on the results of a linear regression trend analysis for each well-constituent pair. If no significant linear trend was detected ($p \geq 0.05$ for the regression slope), comparison to the GSLs was completed based on a static confidence interval around the mean. If a statistically significant linear trend was present ($p < 0.05$ for the regression slope), comparison to the GSLs was completed based on a confidence band around the linear regression trend line at the most recent evaluated sampling event. In both cases, the confidence band or intervals were constructed with 98 percent (%) confidence, which correspond to a lower confidence limit with 99% confidence.

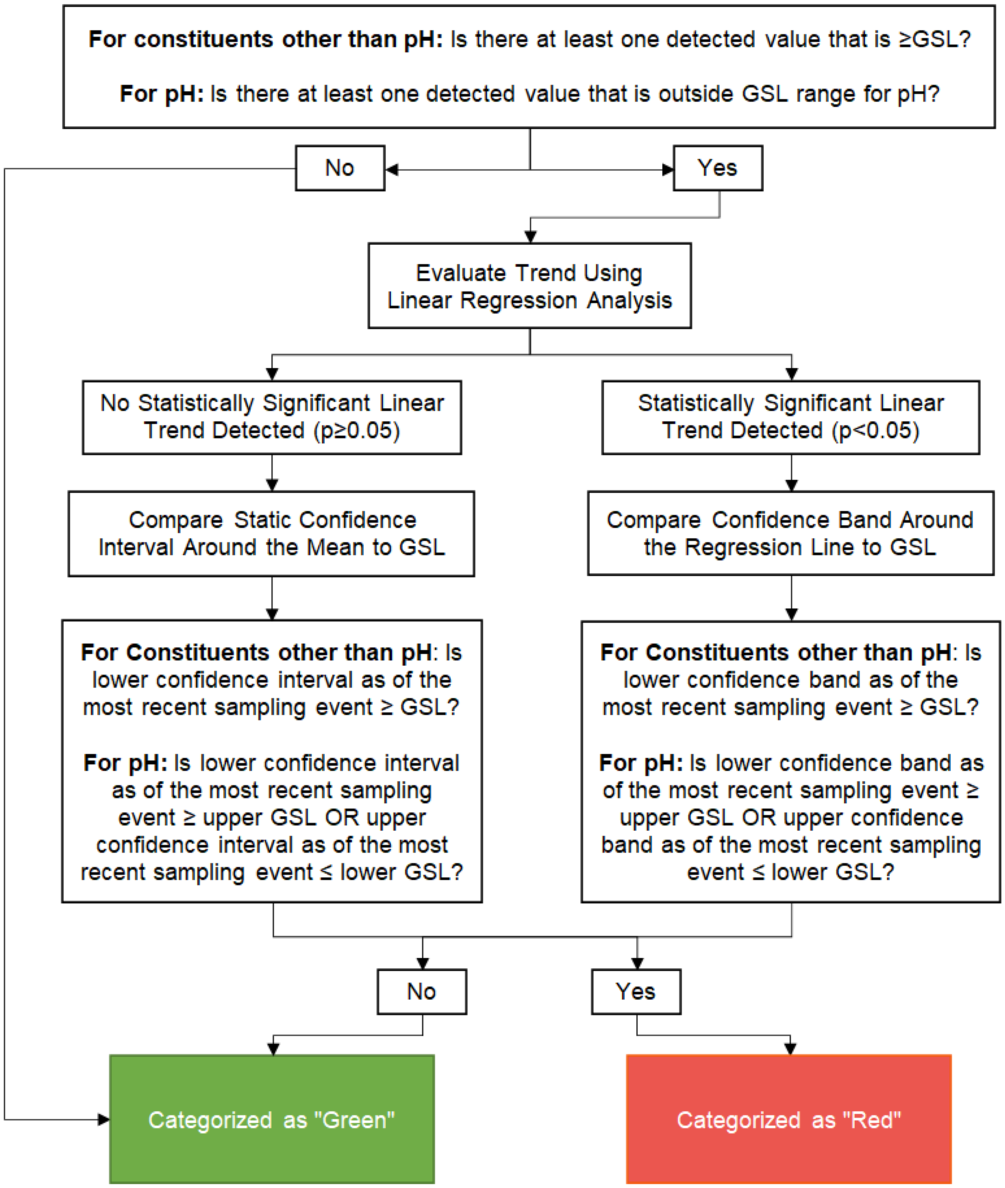
Additional details regarding the methods used to compare groundwater quality data to groundwater screening levels are provided below. As described below, the approach adopted for this comparison was dependent on the number of samples available and the proportion of detected concentrations for each well-constituent pair.

2.2.1 Linear Regression Trend Analysis and Confidence Band Evaluation

For well-constituent pairs with five or more samples and at least four detected values, groundwater quality data were compared to GSLs using a linear regression trend analysis and confidence interval/ confidence band evaluation summarized in **Figure E.3-1** (below) and described in more detail in this section.

First, data were screened to identify if there were reported individual values greater than or equal to the GSL for constituents other than pH or outside the GSL range for pH. In the absence of such a value, well-constituent pairs were classified as 'Green'. If such a value was observed, then linear regression analysis was completed to identify well-constituent pairs with a statistically significant linear trend ($p<0.05$) over the analyzed time period. As noted above, if no statistically significant linear trend was detected ($p \geq 0.05$), a static confidence interval around the mean was used for comparison to the GSLs. If a statistically significant linear trend was present ($p<0.05$), a confidence band around the linear regression trend line at the most recent evaluated sampling event was used for comparison to the GSLs. In both cases, 98% confidence intervals were constructed, which correspond to a lower confidence limit with 99% confidence. Non-detect values were conservatively represented at the reported detection limit.

The resulting confidence intervals and confidence bands were then compared to the GSL for the analyzed well-constituent pairs as of the most recent sampling event included in the statistical analysis. For constituents other than pH, well-constituent pairs were classified as 'Red', indicating a statistically significant concentration above or equal to the GSL at a 99% confidence level only if the applicable lower confidence band or interval was greater than or equal to the GSL as of the most recent sampling event included in the statistical analysis (see examples in Figure E.3-2 below). For pH, well-constituent pairs were classified as 'Red', indicating a statistically significant difference from the GSL range at a 99% confidence level, if the applicable lower confidence band or interval was greater than or equal to the upper GSL or if the applicable upper confidence interval was less than or equal to the lower GSL as of the most recent sampling event included in the statistical analysis (see examples in Figure E.3-3 below). The remaining well-constituent pairs with five or more samples and at least four detected values that were not classified as 'Red' using the linear regression trend analysis and confidence interval/ confidence band evaluation described above were classified as 'Green'. The 'Green' category indicates that as of the most recent sampling event included in the analysis, constituent levels were not statistically significantly greater than or equal to the GSL (for constituents other than pH) and not statistically greater than or equal to the upper GSL or less than or equal to the lower GSL for pH at a 99% confidence level.



Note: GSL = TDEC-approved Groundwater Screening Level (see Appendix A.2)

Figure E.3-1 – Flow chart summarizing linear regression trend analysis and confidence interval/ confidence band evaluation

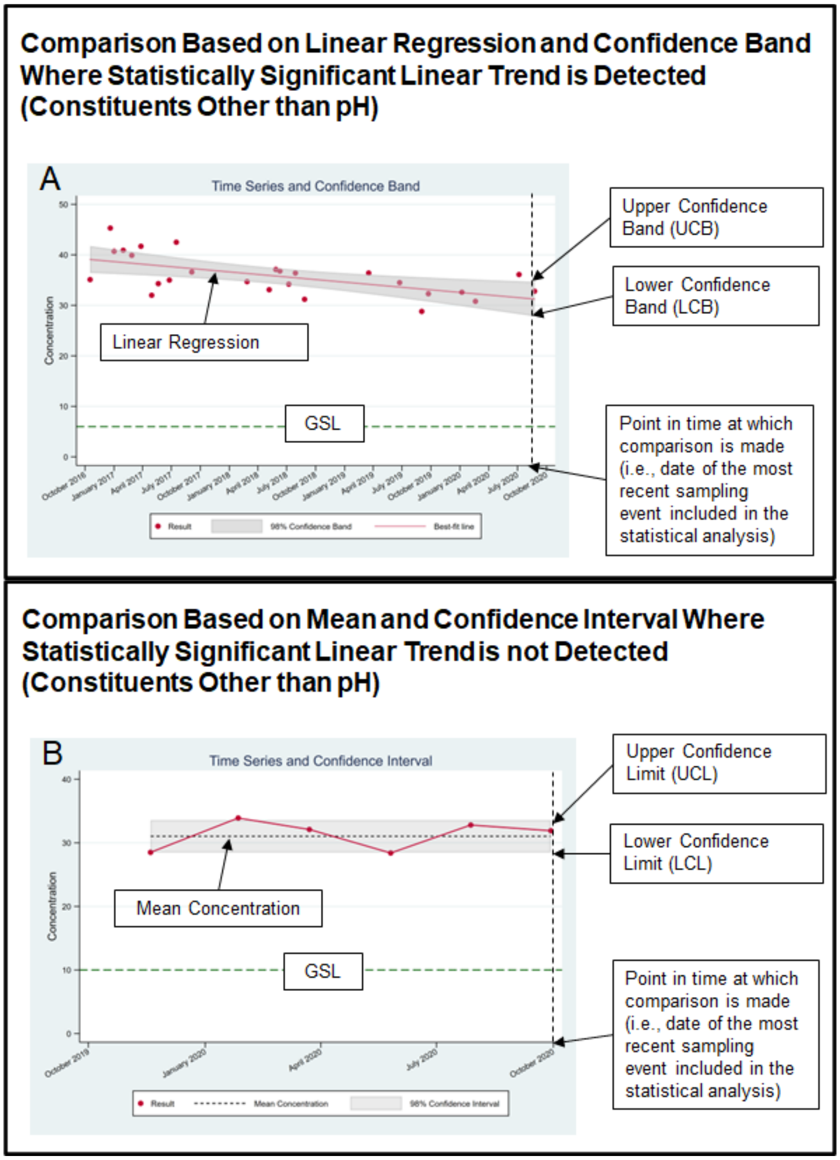


Figure E.3-2 – Examples of well-constituent pairs classified as ‘Red’ for constituents other than pH (A) in the presence of a statistically significant linear trend (p<0.05) and (B) in the absence of a statistically significant linear trend (p≥0.05)

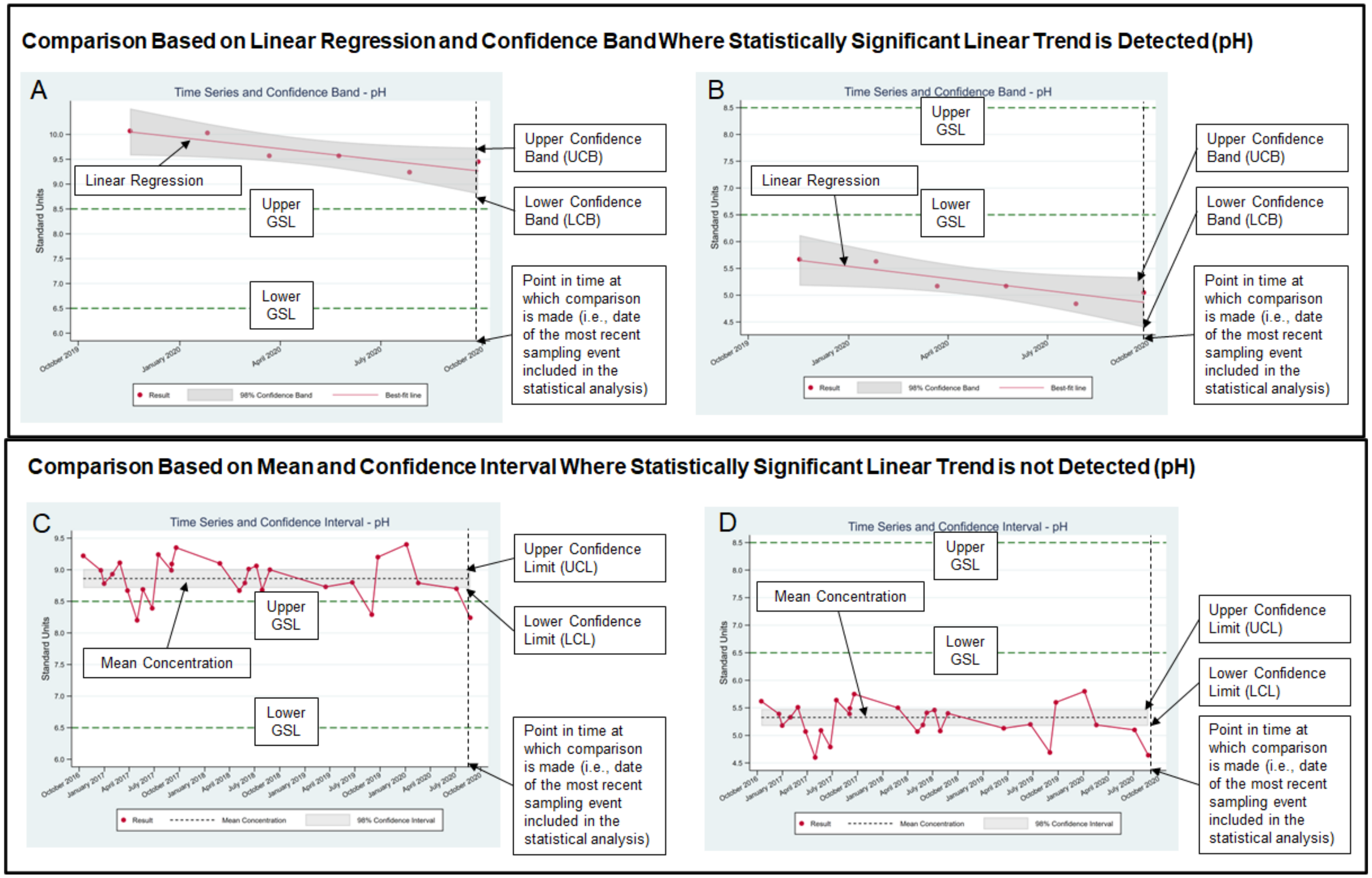


Figure E.3-3 - Examples of well-constituent pairs classified as 'Red' for pH (A, B) in the presence of a statistically significant linear trend ($p<0.05$) and (C, D) in the absence of a statistically significant linear trend ($p \geq 0.05$)

2.2.2 Evaluation for Well-Constituent Pairs Using Point-by-Point Method

Well-constituent pairs with less than five samples in the dataset or less than four detected results were not well suited to a linear regression trend analysis and confidence band or interval evaluation. Therefore, an alternate evaluation was completed for these well-constituent pairs based on a point-by-point comparison of the reported concentration for each sample to the applicable GSL. In this approach, well-constituent pairs were classified as ‘Green*,’ if there were no detected values that were greater than or equal to the GSL for constituents other than pH, or there were no detected values outside the GSL range for pH. However, if there was a limited dataset (i.e., less than five samples in the dataset or less than four detected results), and at least one value was greater than or equal to the GSL for constituents other than pH or there were detected values outside the GSL range for pH, this triggered further data review and an alternate evaluation of that well-constituent pair. For these well-constituent pairs, the available data were reviewed and alternate statistical approaches were considered (e.g., completing a statistical evaluation resulting in a ‘Red’ or ‘Green’ classification as described in Section 0 using the limited dataset). If such an alternate evaluation was required, then this was clearly identified and additional rationale provided in the applicable sub-sections of Section 0.

3.0 RESULTS AND DISCUSSION

3.1 EXPLORATORY DATA ANALYSIS

Summary statistics for each evaluated well-constituent pair are provided in Attachment E.3-B**,** with results grouped by well and sorted by constituent type. Exploratory data analysis plots for each well-constituent pair (i.e., box plots and time-series plots) are provided in Attachments E.3-C and E.3-D. These plots were reviewed to identify potential outliers and provide a qualitative evaluation of data distribution. The plots also provide a preliminary comparison of the results from individual sampling events to the applicable GSLs. There were no outliers removed from further statistical analysis based on this evaluation.

3.2 COMPARISON OF GROUNDWATER QUALITY DATA TO APPROVED GROUNDWATER SCREENING LEVELS

A summary of the results comparing groundwater quality data to GSLs is provided in Table E.3-3. The confidence bands or confidence intervals generated to support this comparison are provided in Attachment E.3-E, and the statistical results of these regression analyses are reported in Attachment E.3-F. Further discussion is provided below.

There were 34 well-constituent pairs for which no significant trend was detected. Comparison to the GSLs for these well-constituent pairs was completed based on a static confidence interval around the mean as shown in Attachment E.3-E. However, there were 31 well-constituent pairs where a statistically significant decreasing trend was detected and 23 well-constituent pairs where a statistically significant increasing trend was detected, as indicated in Attachment E.3-F. Comparison to the GSLs for these well-constituent pairs was completed based on a confidence band around the trend line as shown in Attachment E.3-E.

APPENDIX E.3 - STATISTICAL ANALYSIS OF GROUNDWATER ANALYTICAL RESULTS

August 14, 2023

Table E.3-3 – Summary of Statistically Significant Concentrations/Values Compared to Groundwater Screening Levels

Parameter	Background			Upgradient	Dry Ash Stack					Gypsum Storage Area					Stilling Pond			
	CUF-1001	CUF-201	CUF-202	CUF-93-4	CUF-93-1	CUF-93-1D	CUF-1002	CUF-209	CUF-211	CUF-93-2R	CUF-93-3	CUF-1003	CUF-1006	CUF-212	CUF-205	CUF-206	CUF-207	CUF-208
CCR Rule Appendix III Parameters																		
Boron	Green	Green	Green	Red	Green	Red	Green	Red	Red	Red	Red	Green	Red	Red	Green	Red	Red	Green
Chloride	Green	Green	Green	Red	Red	Green	Green	Green	Red	Red	Green	Green	Red	Red	Green	Red	Red	Red
Fluoride[1] (also Appendix IV)	Green	Green	Green	Green*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
pH (field)	Green	Green	Green	Green	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Sulfate	Red	Green	Green	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
Total Dissolved Solids	Red	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Red
CCR Rule Appendix IV Parameters																		
Antimony	Green*	Green*	Green*	Green*	Green	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Arsenic	Green	Green	Green	Green*	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Green
Barium	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Beryllium	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Cadmium	Green*	Green*	Green	Green*	Green*	Green*	Green*	Green*	Green	Green	Green*	Green	Green*	Green*	Green	Green*	Green*	Green*
Chromium	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Cobalt	Green	Green	Green	Green	Red	Green	Green	Green	Red	Green	Green	Green	Red	Red	Green	Green	Green	Green
Lead	Green*	Green*	Green*	Green*	Green	Green*	Green*	Green	Green	Green	Green	Green*	Green*	Green	Green*	Green*	Green*	Green*
Lithium	Green	Green*	Green	Green	Green	Green	Green*	Green	Green	Green	Red	Green*	Green*	Green	Green*	Green*	Green*	Green*
Mercury	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Molybdenum	Green	Green	Green	Green*	Green	Green	Green	Red	Green	Green	Green	Green	Red	Green	Green	Green	Green	Green
Radium-226+228	Green*	Green*	Green	Green	Green	Green*	Green*	Green	Green	Green	Green	Green*	Green*	Green	Green	Green	Green	Green*
Selenium	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Thallium	Green*	Green*	Green	Green*	Green	Green*	Green*	Green	Green	Green	Green*	Green*	Green*	Green	Green*	Green	Green*	Green*
Additional TDEC Appendix I Parameters																		
Copper	Green*	Green*	Green*	Green*	Green	Green*	Green*	Green*	Green*	Green	Green*	Green	Green*	Green*	Green	Green*	Green*	Green*
Nickel	Green	Green	Green	Green	Green	Green	Green*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Silver	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Vanadium	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green*	Green	Green*	Green*	Green*	Green*	Green*	Green*	Green*
Zinc	Green*	Green*	Green*	Green*	Green	Green*	Green*	Green*	Green	Green	Green*	Green*	Green*	Green	Green	Green*	Green*	Green*

Notes:
The dataset compiled for statistical analysis includes available analytical data for groundwater samples collected between November 2016 and August 2022.
Green - No statistically significant concentration greater than or equal to the GSL for constituents other than pH and no statistically significant difference outside the GSL range for pH.
Green* - Limited dataset (sample size <5 or <4 detected values), but none of the available results are greater than or equal to the GSL or outside the GSL range for pH.
Red - Statistically significant concentration greater than or equal to the GSL for constituents other than pH or a statistically significant difference outside the GSL range for pH.
Bold colors are used to represent CCR Rule Appendix IV Parameter and TDEC Appendix I Parameter results; subdued colors represent CCR Rule Appendix III Parameter results.
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV constituent. In this table, fluoride has been grouped only with the Appendix III constituents to avoid duplication of results.

In total, 57 well-constituent pairs were identified with CCR Parameters at statistically significant concentrations greater than or equal to the GSL for constituents other than pH. There was also one well where a statistically significant difference less than or equal to the lower GSL for pH was observed. The well-constituent pairs with statistically significant concentrations greater than or equal to the GSL or outside the GSL range for pH (i.e., categorized as 'Red' in Table E.3-3) are summarized in Table E.3-4.

Table E.3-4 – Summary of Statistically Significant Concentrations Greater than or Equal to the GSL or outside the GSL range

Well Location	Well	Appendix III					Appendix IV			
		Boron	Chloride	pH (field)	Sulfate	Total Dissolved Solids	Arsenic	Cobalt	Lithium	Molybdenum
Background	CUF-1001	-	-	-	X	X	-	-	-	-
Upgradient	CUF-93-4	X	X	-	X	X	-	-	-	-
Dry Ash Stack	CUF-93-1	-	X	X	X	X	X	X	-	-
	CUF-93-1D	X	-	-	X	X	-	-	-	-
	CUF-1002	-	-	-	X	X	-	-	-	-
	CUF-209	X	-	-	X	X	-	-	-	X
	CUF-211	X	X	-	X	X	-	X	-	-
Gypsum Storage Area	CUF-93-2R	X	X	-	X	X	-	-	-	-
	CUF-93-3	X	-	-	-	X	-	-	X	-
	CUF-1003	-	-	-	X	X	-	-	-	-
	CUF-1006	X	X	-	X	X	-	X	-	X
	CUF-212	X	X	-	X	X	-	X	-	-
Stilling Pond	CUF-206	X	X	-	X	X	X	-	-	-
	CUF-207	X	X	-	X	X	-	-	-	-
	CUF-208	-	X	-	X	X	-	-	-	-

Notes
Well-constituent pairs with CCR Parameters at statistically significant concentrations greater than or equal to the GSL for constituents other than pH or outside the GSL range for pH are identified with an 'X' and highlighted gray.
Dash (-) indicates the absence of a statistically significant concentration greater than or equal to the GSL or outside the GSL range for pH for that well-constituent pair.

4.0 REFERENCES

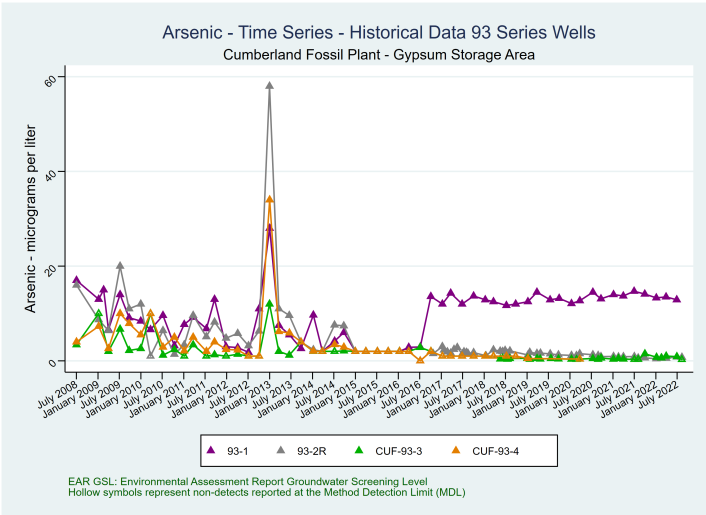
Tukey, J.W. (1977). *Exploratory Data Analysis*. Reading, Massachusetts: Addison-Wesley. 1977.

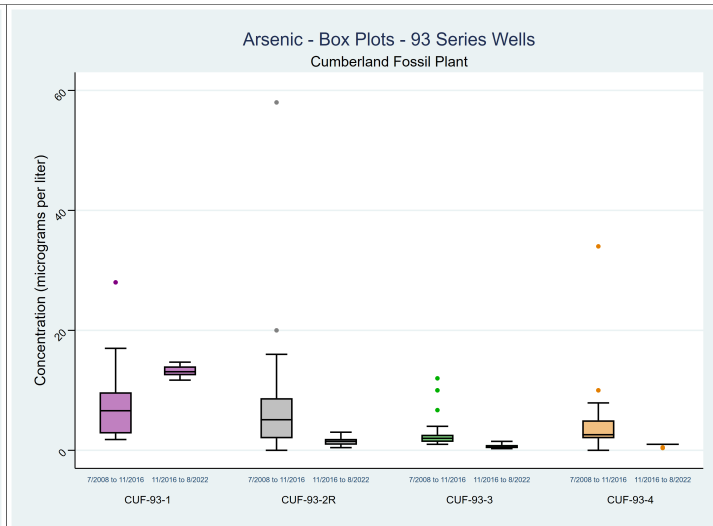
United States Environmental Protection Agency. (2009). *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA 530/R-09-007, 884 pp.

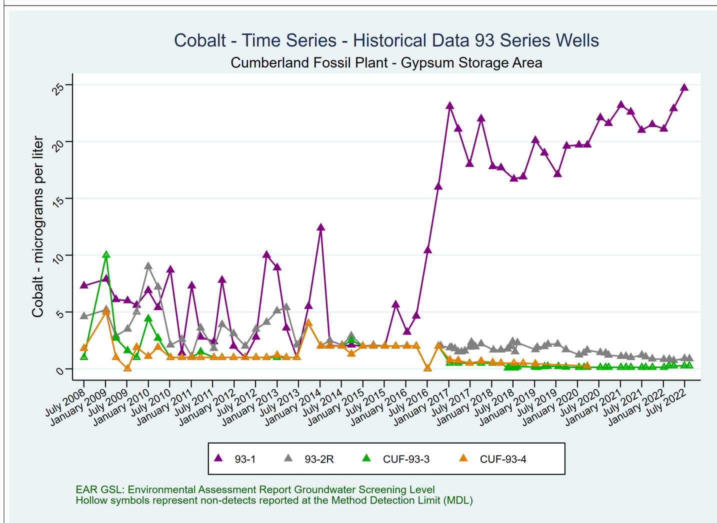
ATTACHMENT E.3-A

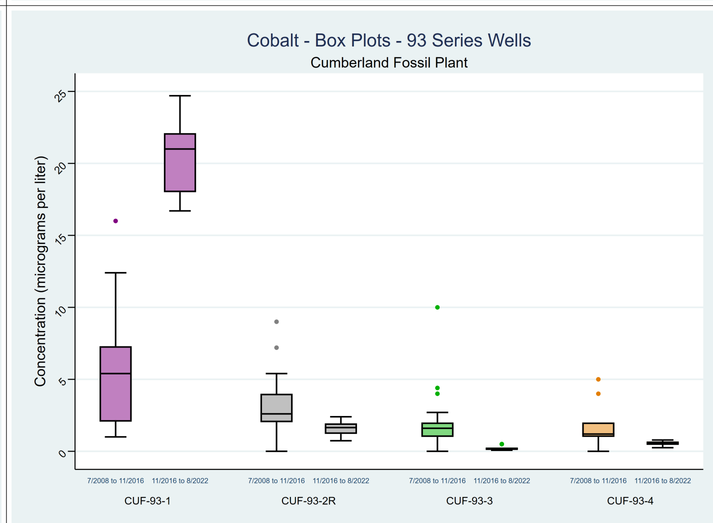
REVIEW OF HISTORICAL DATA COLLECTED PRIOR TO NOVEMBER 2016

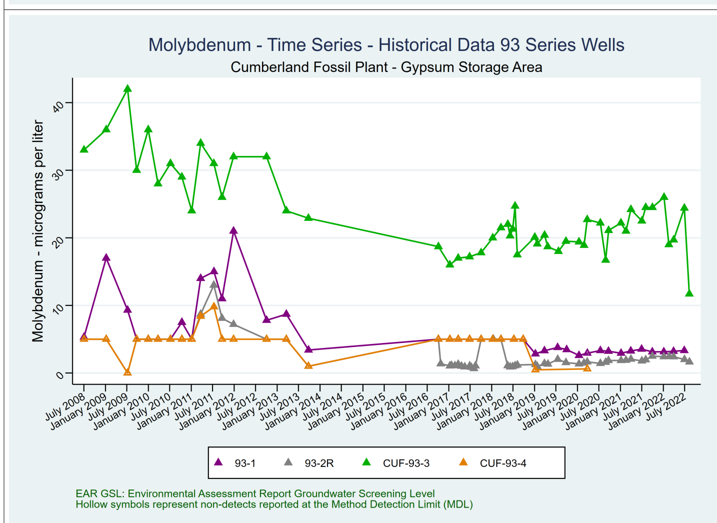
Comparison of Historical Results (7/2006 to 11/2016) to Current Results (11/2016 through 8/2022
93 Series Wells
Cumberland Fossil Plant - Cumberland City, Tennessee

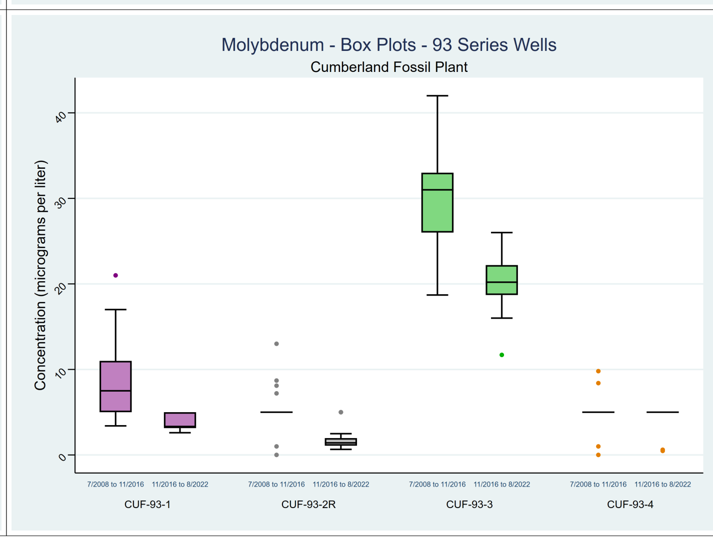












ATTACHMENT E.3-B
SUMMARY STATISTICS

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-1001									
CCR Rule Appendix III Parameters									
Boron	10/10	--	0.0%	2,450	4,080	3,169	542.7	3,070	4,026
Calcium	10/10	--	0.0%	228,000	276,000	255,600	16,754	261,500	273,300
Chloride	10/10	--	0.0%	35,800	67,200	53,100	9,484	53,850	66,030
Fluoride1 (also Appendix IV)	9/10	(165 - 165)	10.0%	105	177	149.4	22.04	156	176.6
pH	10/10	--	0.0%	6.03	8.33	7.115	0.562	7.17	7.858
Sulfate	10/10	--	0.0%	388,000	543,000	477,100	45,508	472,500	535,350
TDS	10/10	--	0.0%	703,000	1,160,000	1,014,600	124,921	1,055,000	1,128,500
CCR Rule Appendix IV Parameters									
Antimony	0/10	(0.378 - 0.506)	100.0%	N/A	N/A	N/A	N/A	0.378	0.506
Arsenic	9/10	(0.52 - 0.52)	10.0%	0.531	2.83	1.496	0.905	1.013	2.781
Barium	10/10	--	0.0%	33.6	82.3	53.1	14.89	53.05	73.3
Beryllium	1/10	(0.155 - 0.274)	90.0%	0.182	0.182	0.159	0.00945	0.182	0.274
Cadmium	0/10	(0.125 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.217	0.217
Chromium	0/10	(1.53 - 2.78)	100.0%	N/A	N/A	N/A	N/A	1.53	2.231
Cobalt	10/10	--	0.0%	0.529	3.96	1.301	1.016	0.979	2.912
Lead	1/10	(0.128 - 0.167)	90.0%	0.147	0.147	0.13	0.00628	0.128	0.167
Lithium	4/10	(3.39 - 8.05)	60.0%	1.08	11.4	2.527	3.109	3.39	9.893
Mercury	0/10	(0.101 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	10/10	--	0.0%	63.9	225	133.3	52.79	134.5	206.6
Radium-226+228	3/10	(0.328 - 0.87)	70.0%	0.307	1.37	0.473	0.348	0.518	1.161
Selenium	2/10	(1.51 - 2.62)	80.0%	0.893	1.61	0.983	0.237	1.51	2.62
Thallium	0/10	(0.128 - 0.472)	100.0%	N/A	N/A	N/A	N/A	0.148	0.472
TDEC Appendix I Parameters									
Copper	1/10	(0.627 - 1.14)	90.0%	1.01	1.01	0.682	0.134	0.758	1.14
Nickel	5/10	(0.574 - 2.61)	50.0%	0.481	3.96	1.397	1.14	1.775	3.402
Silver	0/10	(0.121 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	1/10	(0.776 - 1.57)	90.0%	1.66	1.66	0.864	0.265	0.991	1.62
Zinc	0/10	(2.88 - 4.07)	100.0%	N/A	N/A	N/A	N/A	3.22	3.688
Well: CUF-201									
CCR Rule Appendix III Parameters									
Boron	6/44	(7.81 - 80)	86.4%	8.59	36.8	10.26	5.878	37.7	77.02
Calcium	42/42	--	0.0%	22,500	28,800	24,810	1,139	24,800	25,995
Chloride	43/44	(1130 - 1130)	2.3%	984	2,100	1,552	218.2	1,565	1,790
Fluoride1 (also Appendix IV)	35/44	(26.3 - 159)	20.5%	88.9	222	123.8	35.74	130	176.9
pH	44/44	--	0.0%	6.65	10.03	7.11	0.494	7.085	7.369
Sulfate	40/44	(1280 - 1960)	9.1%	739	2,220	1,428	322.1	1,380	1,969
TDS	44/44	--	0.0%	67,000	129,000	97,205	13,377	98,000	118,400
CCR Rule Appendix IV Parameters									
Antimony	3/43	(0.352 - 2)	93.0%	0.45	1.28	0.383	0.146	0.443	1.928
Arsenic	41/43	(0.343 - 1)	4.7%	0.321	7.01	3.054	2.362	2.31	6.46
Barium	43/43	--	0.0%	15.1	33.1	22.8	5.015	23.7	29.73
Beryllium	1/43	(0.057 - 1)	97.7%	0.258	0.258	0.0626	0.033	0.182	0.927
Cadmium	0/43	(0.0781 - 1)	100.0%	N/A	N/A	N/A	N/A	0.125	0.922
Chromium	0/43	(0.339 - 2.05)	100.0%	N/A	N/A	N/A	N/A	1.53	2
Cobalt	29/43	(0.075 - 0.5)	32.6%	0.109	1.15	0.4	0.282	0.422	0.807
Lead	3/43	(0.0675 - 1)	93.0%	0.121	0.266	0.0841	0.0417	0.128	0.932
Lithium	2/43	(0.831 - 5)	95.3%	2.23	4.55	1.031	0.679	3.39	4.976
Mercury	0/43	(0.0521 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.101	0.193
Molybdenum	39/43	(1.64 - 5)	9.3%	0.943	3.29	1.918	0.568	2.05	4.829
Radium-226+228	1/27	(0 - 1.047)	96.3%	0.288	0.288	0.018	0.0697	0.254	0.819
Selenium	0/43	(0.348 - 5)	100.0%	N/A	N/A	N/A	N/A	1.27	4.762
Thallium	2/43	(0.036 - 1)	95.3%	0.073	0.184	0.0422	0.0257	0.148	0.947
TDEC Appendix I Parameters									
Copper	3/27	(0.627 - 2)	88.9%	0.755	7.67	0.94	1.337	0.627	2
Nickel	12/27	(0.312 - 1.56)	55.6%	0.371	2.25	0.483	0.378	0.456	1.41
Silver	0/25	(0.121 - 1)	100.0%	N/A	N/A	N/A	N/A	0.177	1
Vanadium	1/25	(0.776 - 1.23)	96.0%	1.02	1.02	0.787	0.0498	0.991	1.044
Zinc	1/25	(2.42 - 5)	96.0%	3.4	3.4	2.474	0.224	3.22	5

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-202									
CCR Rule Appendix III Parameters									
Boron	11/44	(17.9 - 80)	75.0%	17.4	78	25.12	13.83	38.6	79.7
Calcium	42/42	--	0.0%	58,300	75,500	62,626	2,930	62,500	66,800
Chloride	43/44	(1220 - 1220)	2.3%	819	1,870	1,411	183	1,425	1,670
Fluoride1 (also Appendix IV)	38/44	(156 - 223)	13.6%	118	311	182.8	35.43	188	222.9
pH	45/45	--	0.0%	7.12	9.69	7.436	0.367	7.4	7.6
Sulfate	44/44	--	0.0%	11,900	21,700	17,007	1,865	17,000	19,925
TDS	44/44	--	0.0%	185,000	232,000	211,182	11,136	212,000	229,850
CCR Rule Appendix IV Parameters									
Antimony	3/43	(0.378 - 2)	93.0%	0.406	0.42	0.384	0.0131	0.443	1.97
Arsenic	10/43	(0.22 - 1)	76.7%	0.242	0.469	0.265	0.0765	0.319	0.95
Barium	43/43	--	0.0%	5.23	37.8	18.24	8.349	15.9	33.06
Beryllium	3/43	(0.057 - 1)	93.0%	0.186	0.216	0.069	0.0399	0.182	0.927
Cadmium	12/43	(0.0781 - 1)	72.1%	0.125	0.645	0.14	0.103	0.217	0.964
Chromium	0/43	(0.339 - 2)	100.0%	N/A	N/A	N/A	N/A	1.53	1.996
Cobalt	22/43	(0.075 - 0.5)	48.8%	0.078	3.59	0.232	0.528	0.134	0.5
Lead	2/43	(0.0675 - 1)	95.3%	0.134	0.145	0.073	0.0192	0.128	0.932
Lithium	15/43	(2.36 - 7.08)	65.1%	1.63	3.58	2.446	0.576	3.39	5
Mercury	0/43	(0.0521 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.101	0.193
Molybdenum	40/43	(5 - 5.06)	7.0%	2.56	9.66	5.291	2.233	5.1	8.702
Radium-226+228	4/27	(0 - 1.361)	85.2%	0.104	1.009	0.0843	0.213	0.198	0.873
Selenium	0/43	(0.348 - 5)	100.0%	N/A	N/A	N/A	N/A	1.27	4.762
Thallium	25/43	(0.0531 - 1.1)	41.9%	0.13	1.25	0.471	0.406	0.606	1.127
TDEC Appendix I Parameters									
Copper	3/27	(0.627 - 2)	88.9%	1.5	19.9	1.417	3.634	0.627	2
Nickel	12/27	(0.312 - 1.86)	55.6%	0.345	1.23	0.594	0.351	0.517	1.23
Silver	0/25	(0.121 - 1)	100.0%	N/A	N/A	N/A	N/A	0.177	1
Vanadium	2/25	(0.776 - 1.45)	92.0%	0.945	1.19	0.826	0.102	0.991	1.23
Zinc	3/25	(2.42 - 5)	88.0%	4.09	4.7	2.698	0.677	3.22	5
Well: CUF-93-4									
CCR Rule Appendix III Parameters									
Boron	10/10	--	0.0%	10,700	13,400	11,910	699.9	11,950	12,905
Calcium	4/4	--	0.0%	495,000	583,000	526,000	39,958	513,000	574,150
Chloride	10/10	--	0.0%	277,000	388,000	350,500	34,310	363,000	386,200
Fluoride1 (also Appendix IV)	1/10	(141 - 500)	90.0%	293	293	157.9	47.77	250	406.9
pH	6/6	--	0.0%	6.5	6.8	6.55	0.122	6.5	6.725
Sulfate	10/10	--	0.0%	1,020,000	1,320,000	1,197,000	104,142	1,225,000	1,306,500
TDS	10/10	--	0.0%	2,320,000	2,980,000	2,695,000	197,892	2,740,000	2,926,000
CCR Rule Appendix IV Parameters									
Antimony	1/10	(1.12 - 2)	90.0%	0.656	0.656	0.656	0	2	2
Arsenic	1/10	(0.383 - 1)	90.0%	0.491	0.491	0.437	0.054	1	1
Barium	9/9	--	0.0%	38.4	51	43.81	4.341	45.6	49.44
Beryllium	0/9	(0.057 - 1)	100.0%	N/A	N/A	N/A	N/A	1	1
Cadmium	0/10	(0.125 - 1)	100.0%	N/A	N/A	N/A	N/A	1	1
Chromium	0/10	(1.53 - 2)	100.0%	N/A	N/A	N/A	N/A	2	2
Cobalt	5/10	(0.251 - 0.5)	50.0%	0.441	0.785	0.484	0.192	0.5	0.765
Lead	0/10	(0.094 - 1)	100.0%	N/A	N/A	N/A	N/A	1	1
Lithium	10/10	--	0.0%	5.91	13.5	9.567	2.948	9.445	13.28
Mercury	0/10	(0.101 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.2	0.2
Molybdenum	0/10	(0.474 - 5)	100.0%	N/A	N/A	N/A	N/A	5	5
Radium-226+228	7/10	(0.212 - 0.661)	30.0%	0.32	1.368	0.505	0.308	0.461	1.05
Selenium	0/10	(0.813 - 5)	100.0%	N/A	N/A	N/A	N/A	5	5
Thallium	1/10	(0.15 - 1)	90.0%	0.154	0.154	0.152	0.002	1	1
TDEC Appendix I Parameters									
Copper	2/10	(2 - 2)	80.0%	0.737	1.43	1.084	0.347	2	2
Nickel	10/10	--	0.0%	1.51	10.2	5.608	2.296	5.275	8.949
Silver	0/10	(0.121 - 1)	100.0%	N/A	N/A	N/A	N/A	1	1
Vanadium	3/9	(0.991 - 10)	66.7%	1.01	1.51	1.124	0.196	1.25	6.78
Zinc	1/10	(3.22 - 5)	90.0%	5.02	5.02	3.4	0.54	5	5.011

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-93-1									
CCR Rule Appendix III Parameters									
Boron	23/23	--	0.0%	767	1,170	922.2	106.4	908	1,157
Calcium	17/17	--	0.0%	446,000	591,000	522,588	40,318	535,000	575,000
Chloride	23/23	--	0.0%	642,000	790,000	713,696	32,856	712,000	759,600
Fluoride1 (also Appendix IV)	10/23	(114 - 500)	56.5%	68.9	351	114.6	61.97	157	340.9
pH	18/18	--	0.0%	6.1	6.8	6.444	0.161	6.44	6.715
Sulfate	23/23	--	0.0%	390,000	661,000	512,522	89,531	481,000	650,600
TDS	23/23	--	0.0%	1,950,000	2,840,000	2,273,478	225,320	2,220,000	2,721,000
CCR Rule Appendix IV Parameters									
Antimony	7/23	(0.378 - 2)	69.6%	0.42	0.862	0.485	0.146	0.658	2
Arsenic	23/23	--	0.0%	11.7	14.7	13.17	0.908	13.1	14.5
Barium	22/22	--	0.0%	101	177	134.1	20.81	134	163
Beryllium	0/22	(0.057 - 1)	100.0%	N/A	N/A	N/A	N/A	0.182	1
Cadmium	2/23	(0.125 - 1)	91.3%	0.129	0.179	0.14	0.0229	0.217	1
Chromium	0/23	(1.53 - 2.53)	100.0%	N/A	N/A	N/A	N/A	1.53	2
Cobalt	23/23	--	0.0%	16.7	24.7	20.4	2.281	21	23.19
Lead	7/23	(0.128 - 1)	69.6%	0.137	3.18	0.314	0.617	0.31	1
Lithium	6/23	(3.14 - 11.4)	73.9%	1.58	12.5	3.153	2.8	3.39	11.4
Mercury	0/23	(0.101 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.13	0.2
Molybdenum	14/23	(2.94 - 5)	39.1%	2.6	3.78	3.188	0.297	3.33	5
Radium-226+228	15/23	(0 - 1.445)	34.8%	0.657	2.364	0.873	0.605	0.872	2.01
Selenium	0/23	(0.739 - 5)	100.0%	N/A	N/A	N/A	N/A	1.51	5
Thallium	10/23	(0.148 - 1)	56.5%	0.163	0.612	0.243	0.124	0.393	1
TDEC Appendix I Parameters									
Copper	5/23	(0.627 - 2)	78.3%	0.725	1.02	0.722	0.127	1.02	2
Nickel	22/23	(4.62 - 4.62)	4.3%	4.15	5.94	5.2	0.522	5.3	5.928
Silver	0/23	(0.121 - 1)	100.0%	N/A	N/A	N/A	N/A	0.177	1
Vanadium	1/22	(0.776 - 2.13)	95.5%	1.2	1.2	0.797	0.0924	0.991	1.723
Zinc	21/23	(13.5 - 21.5)	8.7%	7.8	17.3	12.19	2.673	12.9	17.16
Well: CUF-93-1D									
CCR Rule Appendix III Parameters									
Boron	13/13	--	0.0%	4,010	6,580	5,045	629.1	4,980	6,148
Calcium	13/13	--	0.0%	245,000	310,000	280,077	18,337	285,000	307,000
Chloride	13/13	--	0.0%	148,000	180,000	163,615	9,996	162,000	177,000
Fluoride1 (also Appendix IV)	11/13	(130 - 170)	15.4%	161	432	230.1	78	217	353.4
pH	12/12	--	0.0%	6.5	7.2	6.795	0.194	6.775	7.145
Sulfate	13/13	--	0.0%	423,000	827,000	564,462	109,388	541,000	760,400
TDS	13/13	--	0.0%	1,190,000	1,550,000	1,326,154	96,224	1,330,000	1,472,000
CCR Rule Appendix IV Parameters									
Antimony	0/13	(0.378 - 0.506)	100.0%	N/A	N/A	N/A	N/A	0.378	0.506
Arsenic	13/13	--	0.0%	2.91	5.68	4.44	0.788	4.43	5.458
Barium	13/13	--	0.0%	54.7	89.3	65.84	10.26	64.2	83.72
Beryllium	1/13	(0.182 - 0.274)	92.3%	0.36	0.36	0.196	0.0474	0.182	0.308
Cadmium	0/13	(0.125 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.217	0.217
Chromium	0/13	(1.53 - 1.53)	100.0%	N/A	N/A	N/A	N/A	1.53	1.53
Cobalt	13/13	--	0.0%	0.386	13.1	5.514	3.929	5.73	11.42
Lead	1/13	(0.128 - 0.167)	92.3%	0.177	0.177	0.132	0.0131	0.128	0.171
Lithium	12/13	(17.1 - 17.1)	7.7%	4.39	15.2	9.155	3.368	10	15.96
Mercury	0/13	(0.101 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.13	0.13
Molybdenum	13/13	--	0.0%	2.24	11	4.568	2.295	3.92	8.888
Radium-226+228	2/13	(0.092 - 1.082)	84.6%	0.903	1.989	0.313	0.537	0.639	1.445
Selenium	0/13	(0.739 - 1.51)	100.0%	N/A	N/A	N/A	N/A	1.51	1.51
Thallium	2/13	(0.148 - 0.472)	84.6%	0.165	0.282	0.162	0.0383	0.148	0.472
TDEC Appendix I Parameters									
Copper	0/13	(0.627 - 1.14)	100.0%	N/A	N/A	N/A	N/A	0.627	1.14
Nickel	4/13	(0.336 - 0.517)	69.2%	0.38	1.36	0.439	0.269	0.336	0.854
Silver	0/13	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	0/13	(0.776 - 0.991)	100.0%	N/A	N/A	N/A	N/A	0.991	0.991
Zinc	2/13	(2.88 - 9.2)	84.6%	4.59	5.26	3.252	0.802	3.22	7.544

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-1002									
CCR Rule Appendix III Parameters									
Boron	8/11	(258 - 351)	27.3%	226	414	312.7	57.96	341	389
Calcium	11/11	--	0.0%	196,000	240,000	215,000	13,784	214,000	236,500
Chloride	11/11	--	0.0%	22,800	57,300	31,955	10,537	29,400	50,250
Fluoride1 (also Appendix IV)	11/11	--	0.0%	276	739	381.5	126.9	329	576.5
pH	11/11	--	0.0%	6	7.05	6.838	0.293	6.92	7.03
Sulfate	11/11	--	0.0%	251,000	476,000	329,818	66,403	337,000	430,500
TDS	11/11	--	0.0%	759,000	957,000	868,273	65,635	853,000	952,000
CCR Rule Appendix IV Parameters									
Antimony	0/11	(0.378 - 0.506)	100.0%	N/A	N/A	N/A	N/A	0.378	0.506
Arsenic	11/11	--	0.0%	0.378	6.92	2.675	2.597	1.1	6.61
Barium	11/11	--	0.0%	49.6	106	72.54	18.89	75.2	97.6
Beryllium	0/11	(0.155 - 0.274)	100.0%	N/A	N/A	N/A	N/A	0.182	0.274
Cadmium	0/11	(0.125 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.217	0.217
Chromium	0/11	(1.53 - 2.71)	100.0%	N/A	N/A	N/A	N/A	1.53	2.12
Cobalt	6/11	(0.134 - 0.261)	45.5%	0.135	1.32	0.373	0.37	0.261	1.05
Lead	1/11	(0.128 - 0.167)	90.9%	0.154	0.154	0.131	0.00817	0.128	0.167
Lithium	2/11	(0.831 - 6.08)	81.8%	0.855	9.07	1.591	2.365	3.39	7.575
Mercury	0/11	(0.101 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	9/11	(2.47 - 2.73)	18.2%	0.888	2.61	1.609	0.544	1.83	2.67
Radium-226+228	3/11	(0 - 0.988)	72.7%	0.125	1.053	0.226	0.383	0.704	1.021
Selenium	0/11	(0.739 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.51	2.62
Thallium	1/11	(0.128 - 0.472)	90.9%	0.345	0.345	0.152	0.0682	0.148	0.472
TDEC Appendix I Parameters									
Copper	0/11	(0.627 - 1.14)	100.0%	N/A	N/A	N/A	N/A	0.627	1.14
Nickel	2/11	(0.336 - 1.86)	81.8%	1.02	2.35	0.597	0.595	0.517	2.105
Silver	0/11	(0.121 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	1/11	(0.776 - 1.66)	90.9%	1.73	1.73	0.863	0.274	0.991	1.695
Zinc	1/11	(2.88 - 4.62)	90.9%	9.13	9.13	3.448	1.797	3.22	6.875
Well: CUF-209									
CCR Rule Appendix III Parameters									
Boron	40/40	--	0.0%	1,890	32,300	14,684	10,364	8,055	29,355
Calcium	40/40	--	0.0%	146,000	652,000	402,450	153,776	363,500	606,600
Chloride	40/40	--	0.0%	95,900	314,000	187,198	59,092	183,000	273,200
Fluoride1 (also Appendix IV)	35/40	(91.9 - 359)	12.5%	111	438	200.3	74.75	191	381.3
pH	41/41	--	0.0%	6.65	7.88	6.964	0.213	7	7.13
Sulfate	40/40	--	0.0%	105,000	1,620,000	772,825	598,319	586,500	1,570,500
TDS	40/40	--	0.0%	613,000	2,920,000	1,688,050	849,052	1,590,000	2,880,500
CCR Rule Appendix IV Parameters									
Antimony	1/39	(0.163 - 2.79)	97.4%	2.99	2.99	0.235	0.447	0.443	1.287
Arsenic	38/39	(2.25 - 2.25)	2.6%	1.68	12.7	6.317	4.062	5.85	12.13
Barium	39/39	--	0.0%	33.2	180	66.28	29.79	58.8	112
Beryllium	2/39	(0.057 - 0.274)	94.9%	0.149	0.194	0.0662	0.0306	0.155	0.274
Cadmium	2/39	(0.0781 - 0.217)	94.9%	0.143	0.832	0.1	0.119	0.125	0.217
Chromium	0/39	(0.339 - 2.31)	100.0%	N/A	N/A	N/A	N/A	1.53	1.75
Cobalt	37/39	(0.97 - 1.33)	5.1%	0.91	3.4	1.959	0.789	1.69	3.236
Lead	6/39	(0.0675 - 0.318)	84.6%	0.13	0.245	0.0905	0.0457	0.13	0.318
Lithium	9/39	(1.49 - 4.77)	76.9%	0.931	3.94	1.672	0.872	2.86	3.978
Mercury	0/39	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	39/39	--	0.0%	7.94	1,430	339.4	408	49.2	1214
Radium-226+228	9/23	(0.0662 - 0.964)	60.9%	0.327	1.938	0.489	0.5	0.63	1.274
Selenium	0/39	(0.348 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.62
Thallium	4/39	(0.036 - 0.472)	89.7%	0.174	0.539	0.0731	0.116	0.128	0.474
TDEC Appendix I Parameters									
Copper	3/23	(0.627 - 1.3)	87.0%	0.919	4.11	0.868	0.772	0.627	2.2
Nickel	20/23	(1.25 - 3.3)	13.0%	0.378	2.15	1.332	0.471	1.28	2.501
Silver	1/21	(0.121 - 0.223)	95.2%	0.933	0.933	0.16	0.173	0.177	0.223
Vanadium	0/21	(0.776 - 1.34)	100.0%	N/A	N/A	N/A	N/A	0.991	0.991
Zinc	2/21	(2.42 - 13.7)	90.5%	2.93	3.88	2.597	0.369	3.22	6.56

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-211									
CCR Rule Appendix III Parameters									
Boron	40/40	--	0.0%	2,940	8,190	5,421	717.4	5,445	6,195
Calcium	40/40	--	0.0%	202,000	373,000	250,400	51,291	228,000	348,600
Chloride	40/40	--	0.0%	154,000	458,000	247,825	86,533	211,500	411,950
Fluoride1 (also Appendix IV)	30/40	(70.1 - 1180)	25.0%	70.7	233	112.4	37.12	110	214
pH	40/40	--	0.0%	6.29	8.03	6.625	0.287	6.62	6.819
Sulfate	40/40	--	0.0%	175,000	555,000	272,425	93,330	233,500	475,100
TDS	40/40	--	0.0%	908,000	1,690,000	1,142,075	232,080	1,055,000	1,621,500
CCR Rule Appendix IV Parameters									
Antimony	1/39	(0.129 - 1.12)	97.4%	0.392	0.392	0.143	0.0587	0.443	1.12
Arsenic	39/39	--	0.0%	7.24	12.1	9.855	1.009	9.86	11.5
Barium	39/39	--	0.0%	102	218	173.7	26.88	178	202.1
Beryllium	1/39	(0.057 - 0.274)	97.4%	0.148	0.148	0.0624	0.0214	0.155	0.274
Cadmium	38/39	(0.304 - 0.304)	2.6%	0.243	8.15	1.647	1.851	1.1	7.153
Chromium	0/39	(0.339 - 2.45)	100.0%	N/A	N/A	N/A	N/A	1.53	1.785
Cobalt	39/39	--	0.0%	5.62	19.2	8.526	3.886	6.83	17.43
Lead	4/39	(0.0675 - 0.318)	89.7%	0.175	0.488	0.0919	0.076	0.128	0.318
Lithium	25/39	(3.14 - 8.89)	35.9%	1.55	5.72	3.567	1.24	4.31	6.275
Mercury	0/39	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	38/39	(6.06 - 6.06)	2.6%	3.29	13.4	7.636	2.243	8.08	9.974
Radium-226+228	17/23	(0.685 - 1.247)	26.1%	0.742	1.766	1.134	0.353	1.223	1.743
Selenium	0/39	(0.348 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.62
Thallium	9/39	(0.0531 - 0.472)	76.9%	0.04	0.482	0.0814	0.104	0.128	0.472
TDEC Appendix I Parameters									
Copper	3/23	(0.627 - 1.3)	87.0%	0.64	1.12	0.681	0.152	0.627	1.14
Nickel	21/23	(3.74 - 4.54)	8.7%	3.3	5.01	3.897	0.491	3.74	4.72
Silver	0/21	(0.121 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	0/21	(0.776 - 1.16)	100.0%	N/A	N/A	N/A	N/A	0.991	0.991
Zinc	13/21	(3.22 - 10.3)	38.1%	3.75	12.7	5.537	2.786	4.98	11.3
Well: CUF-93-2R									
CCR Rule Appendix III Parameters									
Boron	43/43	--	0.0%	9,480	29,600	19,427	4,492	18,700	25,580
Calcium	42/42	--	0.0%	803,000	1,230,000	915,286	73,453	899,500	998,700
Chloride	43/43	--	0.0%	427,000	1,160,000	882,442	223,336	924,000	1,149,000
Fluoride1 (also Appendix IV)	16/43	(65 - 500)	62.8%	68.2	348	89.74	47.29	102	261.7
pH	43/43	--	0.0%	6.3	8.19	6.549	0.274	6.5	6.709
Sulfate	43/43	--	0.0%	1,120,000	1,800,000	1,399,535	154,673	1,390,000	1,660,000
TDS	43/43	--	0.0%	3,010,000	5,080,000	3,779,767	561,217	3,800,000	4,606,000
CCR Rule Appendix IV Parameters									
Antimony	2/42	(0.257 - 2)	95.2%	0.903	1.17	0.3	0.18	0.443	1.959
Arsenic	42/42	--	0.0%	0.45	3.02	1.464	0.63	1.485	2.425
Barium	42/42	--	0.0%	32.2	44.8	38.78	2.753	38.65	42.99
Beryllium	2/41	(0.057 - 1)	95.1%	0.345	0.622	0.0789	0.0992	0.182	0.622
Cadmium	39/42	(0.565 - 1)	7.1%	0.13	3.16	0.697	0.487	0.555	1.361
Chromium	2/42	(0.339 - 2.81)	95.2%	0.4	0.507	0.361	0.05	1.53	2
Cobalt	42/42	--	0.0%	0.734	2.4	1.579	0.468	1.65	2.295
Lead	5/42	(0.094 - 1)	88.1%	0.138	1.03	0.135	0.154	0.133	1
Lithium	17/42	(2.65 - 8.07)	59.5%	1.51	5.69	2.804	1.082	3.495	5.663
Mercury	0/42	(0.0521 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.101	0.197
Molybdenum	38/42	(0.833 - 5)	9.5%	0.653	2.49	1.468	0.496	1.415	4.874
Radium-226+228	19/26	(0.145 - 0.608)	26.9%	0.271	1.9	0.84	0.582	0.712	1.723
Selenium	0/42	(0.362 - 12.7)	100.0%	N/A	N/A	N/A	N/A	1.51	5
Thallium	28/42	(0.0531 - 1)	33.3%	0.11	1.05	0.185	0.159	0.162	1
TDEC Appendix I Parameters									
Copper	7/27	(0.627 - 2)	74.1%	0.79	1.65	0.783	0.265	0.869	2
Nickel	27/27	--	0.0%	2.94	6.73	5.107	0.843	5.14	6.202
Silver	1/25	(0.121 - 1)	96.0%	0.188	0.188	0.125	0.0158	0.177	1
Vanadium	0/25	(0.776 - 1)	100.0%	N/A	N/A	N/A	N/A	0.991	1
Zinc	10/25	(2.42 - 7.54)	60.0%	3.29	12.5	3.857	2.524	3.39	9.988

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-93-3									
CCR Rule Appendix III Parameters									
Boron	35/35	--	0.0%	5,050	11,000	6,486	942.2	6,440	7,342
Calcium	30/30	--	0.0%	192,000	265,000	229,800	17,099	228,500	260,750
Chloride	35/35	--	0.0%	82,900	163,000	120,469	19,749	117,000	151,700
Fluoride1 (also Appendix IV)	34/35	(390 - 390)	2.9%	221	490	371.9	61.31	385	460.4
pH	33/33	--	0.0%	6.39	7.3	6.756	0.14	6.74	6.952
Sulfate	35/35	--	0.0%	82,000	144,000	121,546	13,300	122,000	140,500
TDS	35/35	--	0.0%	795,000	1,010,000	940,771	48,593	942,000	1,010,000
CCR Rule Appendix IV Parameters									
Antimony	2/34	(0.378 - 2)	94.1%	0.538	0.663	0.398	0.0667	0.442	2
Arsenic	22/34	(0.282 - 1)	35.3%	0.329	1.49	0.493	0.246	0.499	1.004
Barium	33/33	--	0.0%	148	224	181.8	16.87	182	205.4
Beryllium	1/33	(0.057 - 1)	97.0%	0.185	0.185	0.0623	0.0256	0.182	1
Cadmium	0/34	(0.125 - 1)	100.0%	N/A	N/A	N/A	N/A	0.217	1
Chromium	0/34	(0.631 - 2.13)	100.0%	N/A	N/A	N/A	N/A	1.53	2
Cobalt	10/34	(0.075 - 0.5)	70.6%	0.13	0.223	0.129	0.046	0.146	0.5
Lead	4/34	(0.094 - 1)	88.2%	0.097	0.227	0.102	0.0257	0.128	1
Lithium	34/34	--	0.0%	51.8	90.7	69.71	9.51	70.15	82.68
Mercury	0/34	(0.0653 - 0.2)	100.0%	N/A	N/A	N/A	N/A	0.13	0.2
Molybdenum	34/34	--	0.0%	11.7	26	20.35	3.006	20.2	24.57
Radium-226+228	19/29	(0.395 - 1.178)	34.5%	0.507	1.968	0.866	0.441	0.856	1.747
Selenium	0/34	(0.739 - 5)	100.0%	N/A	N/A	N/A	N/A	1.51	5
Thallium	1/34	(0.063 - 1)	97.1%	0.247	0.247	0.071	0.0375	0.148	1
TDEC Appendix I Parameters									
Copper	0/30	(0.627 - 2)	100.0%	N/A	N/A	N/A	N/A	0.627	2
Nickel	17/30	(0.336 - 1)	43.3%	0.331	0.83	0.466	0.129	0.517	1
Silver	0/26	(0.121 - 1)	100.0%	N/A	N/A	N/A	N/A	0.177	1
Vanadium	18/25	(0.991 - 2.43)	28.0%	1.04	2.5	1.424	0.405	1.35	2.428
Zinc	2/26	(2.88 - 5)	92.3%	3.21	32.3	4.091	5.644	3.22	5
Well: CUF-1003									
CCR Rule Appendix III Parameters									
Boron	10/10	--	0.0%	6,050	24,900	13,288	7,359	10,240	24,135
Calcium	10/10	--	0.0%	344,000	674,000	498,900	122,604	515,000	655,550
Chloride	10/10	--	0.0%	101,000	305,000	184,000	76,529	161,500	296,000
Fluoride1 (also Appendix IV)	9/10	(180 - 180)	10.0%	109	305	174.7	57.88	160.5	279.8
pH	10/10	--	0.0%	6.44	7.24	6.906	0.272	6.955	7.209
Sulfate	10/10	--	0.0%	932,000	1,740,000	1,361,300	269,656	1,365,000	1,731,000
TDS	10/10	--	0.0%	1,780,000	3,210,000	2,398,000	478,767	2,390,000	3,106,500
CCR Rule Appendix IV Parameters									
Antimony	3/10	(0.378 - 0.506)	70.0%	0.476	0.682	0.442	0.103	0.427	0.638
Arsenic	4/10	(0.282 - 0.608)	60.0%	0.329	1.25	0.443	0.298	0.332	1.011
Barium	10/10	--	0.0%	16.4	42.3	30.14	9.483	28.05	42.21
Beryllium	0/10	(0.155 - 0.481)	100.0%	N/A	N/A	N/A	N/A	0.187	0.418
Cadmium	5/10	(0.217 - 0.217)	50.0%	0.174	0.308	0.217	0.0552	0.217	0.304
Chromium	0/10	(1.53 - 3.19)	100.0%	N/A	N/A	N/A	N/A	1.53	3.046
Cobalt	7/10	(0.134 - 0.261)	30.0%	0.18	4.29	1.06	1.226	0.711	3.255
Lead	1/10	(0.128 - 0.167)	90.0%	0.128	0.128	0.128	0	0.128	0.167
Lithium	3/10	(3.39 - 8.1)	70.0%	1.31	5.65	2.144	1.45	3.39	7.83
Mercury	0/10	(0.101 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	10/10	--	0.0%	74.3	597	296.7	213.9	223	588.9
Radium-226+228	2/10	(0 - 0.977)	80.0%	0.417	0.548	0.138	0.221	0.392	0.94
Selenium	0/10	(0.739 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.51	2.62
Thallium	3/10	(0.148 - 0.557)	70.0%	0.216	0.416	0.227	0.0982	0.35	0.522
TDEC Appendix I Parameters									
Copper	4/10	(0.627 - 1.52)	60.0%	0.64	3.04	1.042	0.74	1.14	2.41
Nickel	4/10	(0.336 - 2.04)	60.0%	0.52	6.03	1.196	1.665	1.205	4.235
Silver	0/10	(0.121 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	2/10	(0.776 - 2.7)	80.0%	0.932	3.34	1.103	0.749	0.991	3.052
Zinc	3/10	(2.88 - 4.35)	70.0%	3.63	7.99	3.563	1.509	3.41	6.352

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-1006									
CCR Rule Appendix III Parameters									
Boron	7/7	--	0.0%	5,760	11,900	9,187	2,422	8,950	11,720
Calcium	7/7	--	0.0%	480,000	621,000	548,143	57,866	552,000	618,300
Chloride	7/7	--	0.0%	456,000	648,000	544,857	65,723	541,000	634,200
Fluoride1 (also Appendix IV)	5/7	(316 - 316)	28.6%	139	342	213	60.2	220	334.2
pH	6/6	--	0.0%	6.61	6.98	6.818	0.133	6.845	6.96
Sulfate	7/7	--	0.0%	509,000	954,000	779,286	164,175	813,000	942,000
TDS	7/7	--	0.0%	1,910,000	2,400,000	2,208,571	160,357	2,200,000	2,388,000
CCR Rule Appendix IV Parameters									
Antimony	3/7	(0.378 - 0.506)	57.1%	0.818	3.56	1.347	1.401	0.506	3.554
Arsenic	7/7	--	0.0%	0.449	6.94	3.444	2.438	3.49	6.613
Barium	7/7	--	0.0%	45	158	87.73	49.28	65.8	155.9
Beryllium	0/7	(0.182 - 0.274)	100.0%	N/A	N/A	N/A	N/A	0.182	0.274
Cadmium	2/7	(0.217 - 0.217)	71.4%	0.513	0.605	0.315	0.156	0.217	0.577
Chromium	0/7	(1.53 - 1.53)	100.0%	N/A	N/A	N/A	N/A	1.53	1.53
Cobalt	7/7	--	0.0%	3.6	11.2	7.281	3.113	7.22	11.02
Lead	1/7	(0.128 - 0.167)	85.7%	0.157	0.157	0.135	0.0126	0.157	0.167
Lithium	0/7	(0.831 - 3.39)	100.0%	N/A	N/A	N/A	N/A	3.39	3.39
Mercury	0/7	(0.13 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.13	0.13
Molybdenum	7/7	--	0.0%	104	267	193.1	62.22	204	263.7
Radium-226+228	1/7	(0.0605 - 0.737)	85.7%	1.133	1.133	0.214	0.375	0.565	1.014
Selenium	0/7	(0.739 - 1.51)	100.0%	N/A	N/A	N/A	N/A	1.51	1.51
Thallium	0/7	(0.148 - 0.472)	100.0%	N/A	N/A	N/A	N/A	0.148	0.472
TDEC Appendix I Parameters									
Copper	2/7	(0.627 - 1.14)	71.4%	1.02	1.14	0.813	0.217	1.14	1.14
Nickel	6/7	(4.95 - 4.95)	14.3%	2.09	4.32	3.02	0.677	2.98	4.761
Silver	0/7	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	0/7	(0.776 - 0.991)	100.0%	N/A	N/A	N/A	N/A	0.991	0.991
Zinc	3/7	(2.88 - 3.22)	57.1%	4.99	7.21	4.236	1.675	3.22	6.826
Well: CUF-212									
CCR Rule Appendix III Parameters									
Boron	40/40	--	0.0%	28,800	54,200	38,280	4,608	37,450	47,365
Calcium	40/40	--	0.0%	566,000	1,020,000	735,450	72,172	725,500	845,500
Chloride	40/40	--	0.0%	313,000	755,000	509,725	126,102	482,000	716,750
Fluoride1 (also Appendix IV)	21/40	(65 - 263)	47.5%	71.8	220	101.2	35.68	115.5	220.2
pH	40/40	--	0.0%	6.24	7.33	6.69	0.307	6.57	7.171
Sulfate	40/40	--	0.0%	1,200,000	2,020,000	1,459,000	133,816	1,465,000	1,593,500
TDS	40/40	--	0.0%	1,730,000	4,110,000	3,226,750	459,891	3,255,000	3,902,500
CCR Rule Appendix IV Parameters									
Antimony	2/39	(0.33 - 1.12)	94.9%	1.06	2.51	0.408	0.363	0.443	1.12
Arsenic	39/39	--	0.0%	2.57	8.37	4.941	1.547	4.7	7.374
Barium	39/39	--	0.0%	26.8	58.1	35.49	7.674	32.8	48.95
Beryllium	1/39	(0.057 - 0.274)	97.4%	0.759	0.759	0.075	0.111	0.182	0.274
Cadmium	0/39	(0.0781 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.125	0.217
Chromium	0/39	(0.339 - 1.88)	100.0%	N/A	N/A	N/A	N/A	1.53	1.776
Cobalt	39/39	--	0.0%	3	27.2	19.9	5.465	21.9	27.02
Lead	4/39	(0.094 - 0.318)	89.7%	0.154	0.247	0.109	0.0394	0.128	0.318
Lithium	6/39	(0.831 - 5.17)	84.6%	1.24	3.04	1.551	0.56	3.04	3.39
Mercury	0/39	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.101	0.13
Molybdenum	39/39	--	0.0%	13.5	94.9	23.33	13.38	21	36.25
Radium-226+228	9/23	(0.327 - 1.289)	60.9%	0.309	1.041	0.516	0.271	0.738	1.104
Selenium	0/39	(0.586 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.62
Thallium	22/39	(0.036 - 0.472)	43.6%	0.063	0.714	0.138	0.12	0.152	0.472
TDEC Appendix I Parameters									
Copper	3/23	(0.627 - 1.3)	87.0%	0.921	1.59	0.717	0.244	0.627	1.336
Nickel	23/23	--	0.0%	10	15	12.68	1.34	12.9	14.76
Silver	0/21	(0.121 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	3/21	(0.776 - 1.6)	85.7%	0.978	1.05	0.84	0.103	0.991	1.4
Zinc	4/21	(2.42 - 7.55)	81.0%	3.31	22.5	4.079	4.907	3.22	15

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-205									
CCR Rule Appendix III Parameters									
Boron	21/31	(145 - 178)	32.3%	120	213	144	21.73	150	195.5
Calcium	31/31	--	0.0%	106,000	158,000	135,000	10,780	134,000	154,500
Chloride	31/31	--	0.0%	3,590	6,980	5,227	996.3	5,130	6,440
Fluoride1 (also Appendix IV)	25/31	(84.8 - 128)	19.4%	59.1	184	102.2	25.82	107	133.5
pH	33/33	--	0.0%	6.72	7.19	6.939	0.104	6.93	7.124
Sulfate	31/31	--	0.0%	128,000	308,000	164,290	34,716	155,000	225,000
TDS	31/31	--	0.0%	374,000	578,000	483,161	43,367	477,000	568,000
CCR Rule Appendix IV Parameters									
Antimony	2/30	(0.378 - 1.29)	93.3%	0.45	0.452	0.385	0.0219	0.443	1.12
Arsenic	22/30	(0.313 - 0.738)	26.7%	0.248	0.806	0.426	0.137	0.409	0.707
Barium	30/30	--	0.0%	57.5	98.1	81.76	10.04	80.75	96.58
Beryllium	0/30	(0.057 - 0.378)	100.0%	N/A	N/A	N/A	N/A	0.131	0.266
Cadmium	22/30	(0.0781 - 0.217)	26.7%	0.168	0.354	0.204	0.0643	0.217	0.31
Chromium	1/30	(0.339 - 2.2)	96.7%	1.55	1.55	0.384	0.229	1.525	1.74
Cobalt	27/30	(0.246 - 0.524)	10.0%	0.247	1.78	0.642	0.354	0.565	1.448
Lead	1/30	(0.0675 - 0.318)	96.7%	0.379	0.379	0.0779	0.0559	0.128	0.318
Lithium	2/30	(2 - 3.82)	93.3%	1.22	3.69	1.305	0.451	3.075	3.6
Mercury	0/30	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.0653	0.13
Molybdenum	26/30	(0.61 - 0.844)	13.3%	0.691	1.35	0.909	0.18	0.891	1.226
Radium-226+228	6/14	(0.258 - 0.876)	57.1%	0.195	1.285	0.49	0.371	0.649	1.164
Selenium	0/30	(0.348 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.121
Thallium	3/30	(0.036 - 0.472)	90.0%	0.156	0.273	0.0534	0.0532	0.063	0.283
TDEC Appendix I Parameters									
Copper	5/14	(0.627 - 1.14)	64.3%	0.682	0.97	0.683	0.0975	0.627	1.03
Nickel	14/14	--	0.0%	2.99	12	6.295	2.407	6.345	9.595
Silver	0/12	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.198
Vanadium	1/12	(0.776 - 1.85)	91.7%	1.37	1.37	0.83	0.171	0.991	1.586
Zinc	5/12	(3.22 - 7.54)	58.3%	3.46	6.87	4.064	1.087	4.42	7.172
Well: CUF-206									
CCR Rule Appendix III Parameters									
Boron	33/33	--	0.0%	5,230	24,700	17,920	5,220	19,600	22,940
Calcium	33/33	--	0.0%	227,000	699,000	520,667	113,515	566,000	607,000
Chloride	33/33	--	0.0%	201,000	821,000	571,091	145,533	631,000	699,400
Fluoride1 (also Appendix IV)	9/33	(65 - 147)	72.7%	66.2	378	83.03	54.53	74.4	141.6
pH	35/35	--	0.0%	6.45	7.02	6.625	0.112	6.61	6.81
Sulfate	33/33	--	0.0%	311,000	1,400,000	884,242	248,075	958,000	1,084,000
TDS	33/33	--	0.0%	986,000	3,240,000	2,518,364	639,684	2,810,000	3,198,000
CCR Rule Appendix IV Parameters									
Antimony	0/32	(0.249 - 2.97)	100.0%	N/A	N/A	N/A	N/A	0.443	1.12
Arsenic	32/32	--	0.0%	9.27	23.9	12	3.047	10.45	17.44
Barium	32/32	--	0.0%	46.5	178	94.41	24.61	93.25	133.4
Beryllium	2/32	(0.057 - 0.352)	93.8%	0.189	0.524	0.0763	0.0841	0.155	0.309
Cadmium	0/32	(0.0781 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.125	0.217
Chromium	1/32	(0.339 - 2.1)	96.9%	0.58	0.58	0.361	0.0693	1.53	1.746
Cobalt	29/32	(0.457 - 1.31)	9.4%	0.15	6	0.811	1.05	0.56	2.316
Lead	0/32	(0.0675 - 0.318)	100.0%	N/A	N/A	N/A	N/A	0.128	0.318
Lithium	2/32	(0.831 - 3.66)	93.8%	2.57	7.19	1.123	1.158	2.56	3.512
Mercury	0/32	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.0832	0.13
Molybdenum	29/32	(0.633 - 0.951)	9.4%	0.628	1.43	0.876	0.169	0.857	1.235
Radium-226+228	12/16	(0.138 - 1.438)	25.0%	1.071	3.2	1.368	0.705	1.328	2.784
Selenium	0/32	(0.739 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.01
Thallium	4/32	(0.036 - 0.472)	87.5%	0.149	0.536	0.0743	0.115	0.128	0.472
TDEC Appendix I Parameters									
Copper	3/16	(0.627 - 1.14)	81.3%	0.666	1.91	0.743	0.322	0.627	1.333
Nickel	9/16	(0.336 - 4.34)	43.8%	0.464	25.2	3.505	6.637	0.653	16.05
Silver	0/14	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	0/14	(0.776 - 0.991)	100.0%	N/A	N/A	N/A	N/A	0.991	0.991
Zinc	3/14	(2.88 - 3.98)	78.6%	3.72	6.33	3.27	0.913	3.22	4.803

Summary Statistics - Groundwater Investigation									
Cumberland Fossil Plant - Cumberland City, Tennessee									
Parameter	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using Detects & Non-Detects			
				Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Well: CUF-207									
CCR Rule Appendix III Parameters									
Boron	33/33	--	0.0%	7,830	32,600	25,196	6,305	26,600	31,200
Calcium	33/33	--	0.0%	180,000	588,000	464,970	107,347	488,000	570,200
Chloride	33/33	--	0.0%	172,000	702,000	565,848	147,446	616,000	696,400
Fluoride1 (also Appendix IV)	25/33	(65.8 - 178)	24.2%	74.6	503	156.4	92.04	149	304
pH	34/34	--	0.0%	5.19	7.16	6.709	0.301	6.76	6.88
Sulfate	33/33	--	0.0%	301,000	1,170,000	974,424	244,401	1,060,000	1,148,000
TDS	33/33	--	0.0%	922,000	3,070,000	2,591,879	619,384	2,830,000	3,042,000
CCR Rule Appendix IV Parameters									
Antimony	1/32	(0.185 - 2.39)	96.9%	0.41	0.41	0.201	0.0579	0.443	1.12
Arsenic	28/32	(1.01 - 1.19)	12.5%	0.576	2.96	1.255	0.722	0.992	2.813
Barium	32/32	--	0.0%	35.2	67.7	53.98	8.391	55.25	66.06
Beryllium	1/32	(0.057 - 0.274)	96.9%	0.698	0.698	0.077	0.112	0.155	0.274
Cadmium	0/32	(0.0781 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.125	0.217
Chromium	1/32	(0.339 - 2.39)	96.9%	2.98	2.98	0.422	0.46	1.53	2.225
Cobalt	25/32	(0.242 - 1.31)	21.9%	0.18	1.82	0.376	0.283	0.325	0.945
Lead	2/32	(0.0675 - 0.318)	93.8%	0.159	0.403	0.0829	0.0611	0.128	0.318
Lithium	2/32	(0.831 - 7.36)	93.8%	2.45	3.65	1.055	0.652	2.56	3.997
Mercury	0/32	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.0832	0.13
Molybdenum	32/32	--	0.0%	5.28	22.4	17.7	5.173	19.75	21.69
Radium-226+228	11/16	(0.496 - 0.94)	31.3%	0.975	2.746	1.275	0.694	1.136	2.299
Selenium	1/32	(0.531 - 2.62)	96.9%	1.98	1.98	0.579	0.26	1.27	2.268
Thallium	1/32	(0.036 - 0.472)	96.9%	0.176	0.176	0.041	0.026	0.0955	0.472
TDEC Appendix I Parameters									
Copper	2/16	(0.627 - 1.57)	87.5%	0.727	0.902	0.658	0.0785	0.627	1.248
Nickel	4/16	(0.336 - 2.59)	75.0%	0.336	0.702	0.383	0.1	0.336	1.174
Silver	0/14	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	0/14	(0.776 - 1.07)	100.0%	N/A	N/A	N/A	N/A	0.991	1.019
Zinc	1/14	(2.88 - 3.53)	92.9%	4.5	4.5	2.996	0.417	3.22	3.87
Well: CUF-208									
CCR Rule Appendix III Parameters									
Boron	33/33	--	0.0%	4,860	19,000	10,945	4,378	10,400	17,660
Calcium	33/33	--	0.0%	483,000	903,000	667,091	100,286	648,000	804,600
Chloride	33/33	--	0.0%	479,000	1,080,000	627,848	108,541	596,000	728,600
Fluoride1 (also Appendix IV)	15/33	(26.3 - 162)	54.5%	41.6	525	91.44	102.4	79.6	270.2
pH	34/34	--	0.0%	5.73	7.07	6.701	0.205	6.725	6.831
Sulfate	33/33	--	0.0%	585,000	1,310,000	992,273	211,826	906,000	1,284,000
TDS	33/33	--	0.0%	2,040,000	3,840,000	2,895,152	478,370	2,990,000	3,464,000
CCR Rule Appendix IV Parameters									
Antimony	2/32	(0.138 - 3.04)	93.8%	0.483	0.56	0.173	0.111	0.443	1.12
Arsenic	31/32	(3.49 - 3.49)	3.1%	2.16	6.98	3.367	0.962	3.125	4.849
Barium	32/32	--	0.0%	29.9	45.6	34.99	3.656	34.45	40.73
Beryllium	2/32	(0.057 - 0.274)	93.8%	0.266	0.45	0.0765	0.0772	0.155	0.274
Cadmium	0/32	(0.0781 - 0.217)	100.0%	N/A	N/A	N/A	N/A	0.125	0.217
Chromium	0/32	(0.339 - 1.95)	100.0%	N/A	N/A	N/A	N/A	1.53	1.564
Cobalt	32/32	--	0.0%	3.9	10.1	5.967	1.214	5.715	7.852
Lead	2/32	(0.0675 - 0.318)	93.8%	0.133	0.245	0.079	0.0391	0.128	0.318
Lithium	3/32	(0.831 - 4.75)	90.6%	1.04	3.64	1.093	0.626	2.69	3.748
Mercury	0/32	(0.0521 - 0.13)	100.0%	N/A	N/A	N/A	N/A	0.0832	0.13
Molybdenum	32/32	--	0.0%	1.86	102	10.38	19.42	4.625	43.01
Radium-226+228	3/16	(0.0367 - 1.18)	81.3%	0.316	1.481	0.244	0.431	0.362	1.255
Selenium	0/32	(0.348 - 2.62)	100.0%	N/A	N/A	N/A	N/A	1.27	2.01
Thallium	2/32	(0.036 - 0.472)	93.8%	0.179	0.407	0.0537	0.0717	0.0955	0.472
TDEC Appendix I Parameters									
Copper	3/16	(0.627 - 1.14)	81.3%	0.657	1.08	0.672	0.121	0.627	1.14
Nickel	13/16	(3.23 - 5.17)	18.8%	2.56	5.08	3.16	0.633	3.035	5.103
Silver	0/14	(0.177 - 0.223)	100.0%	N/A	N/A	N/A	N/A	0.177	0.223
Vanadium	1/14	(0.776 - 0.991)	92.9%	1.06	1.06	0.796	0.0731	0.991	1.015
Zinc	3/14	(2.88 - 7.04)	78.6%	3.45	6.44	3.319	0.979	3.51	6.962

Notes

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

Except for Radium-226 + 228, and pH, all units micrograms per litre (µg/L).

Units for Radium 226+228 are picocuries per liter (pCi/L).

Units for pH are standard units (SU).

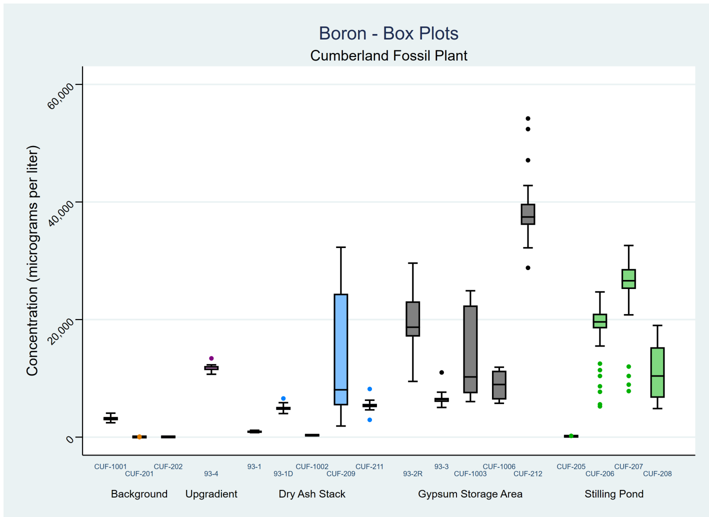
Mean and Standard Deviation are Kaplan Meier (KM) Mean and Standard Deviation for data with reported non-detect values.

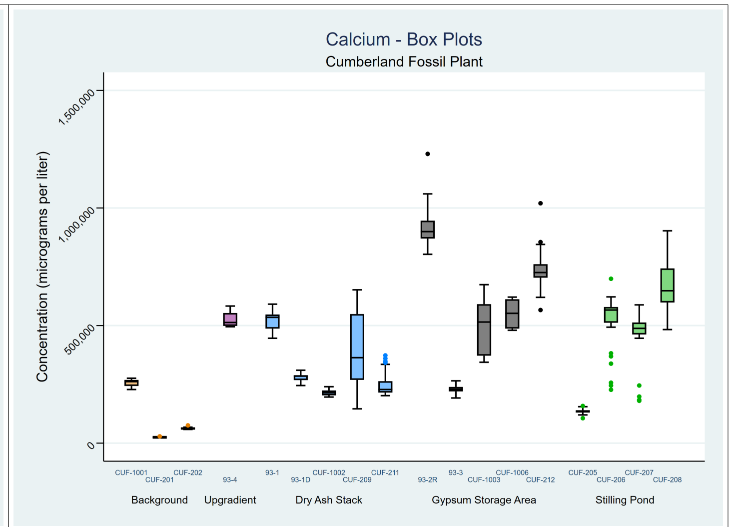
All non-detects reported at the laboratory reporting limit

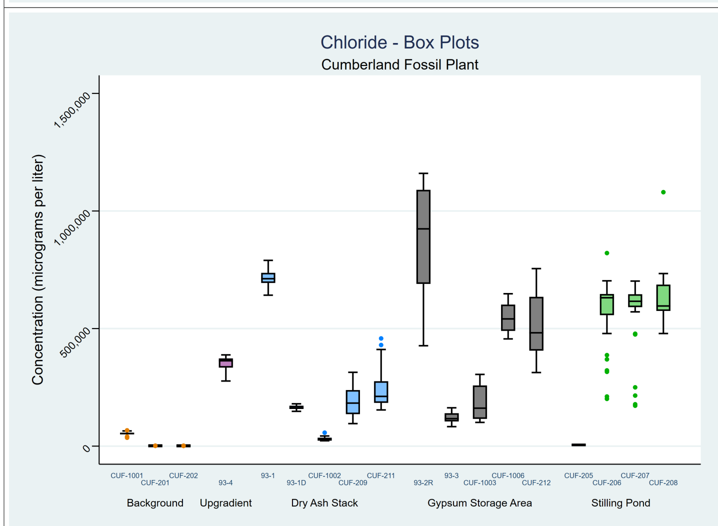
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV constituent. In this table, fluoride has been grouped with the Appendix III constituents only to avoid duplication of results.

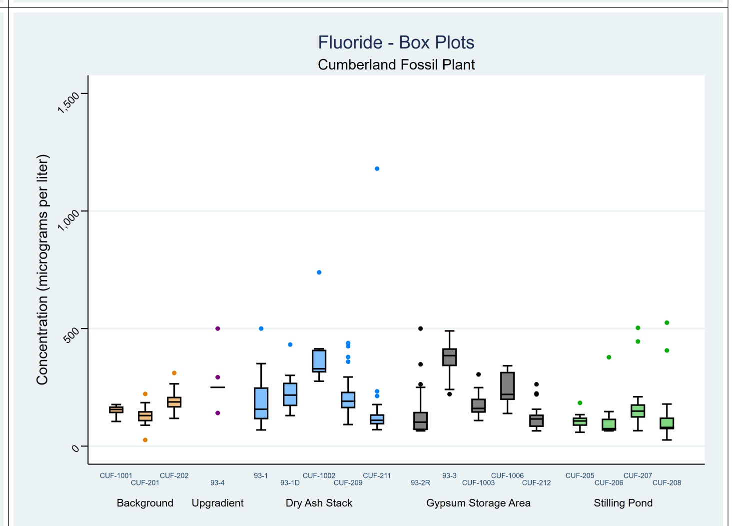
ATTACHMENT E.3-C
BOX PLOTS

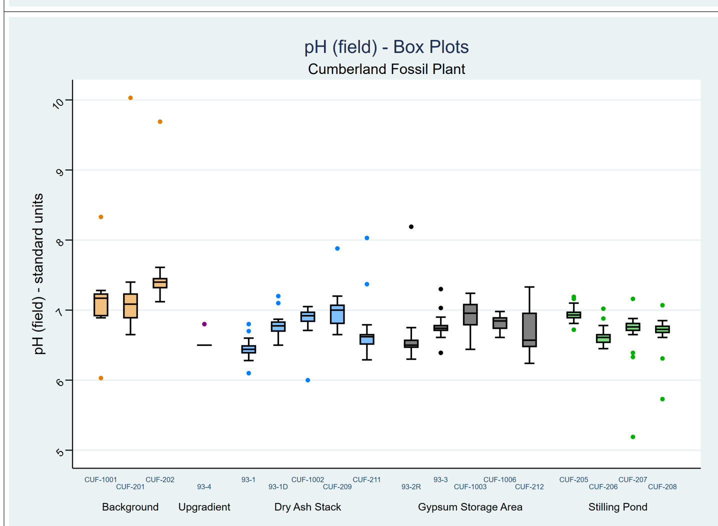
Box Plots
CCR Rule Appendix III Parameters
Cumberland Fossil Plant - Cumberland City, Tennessee

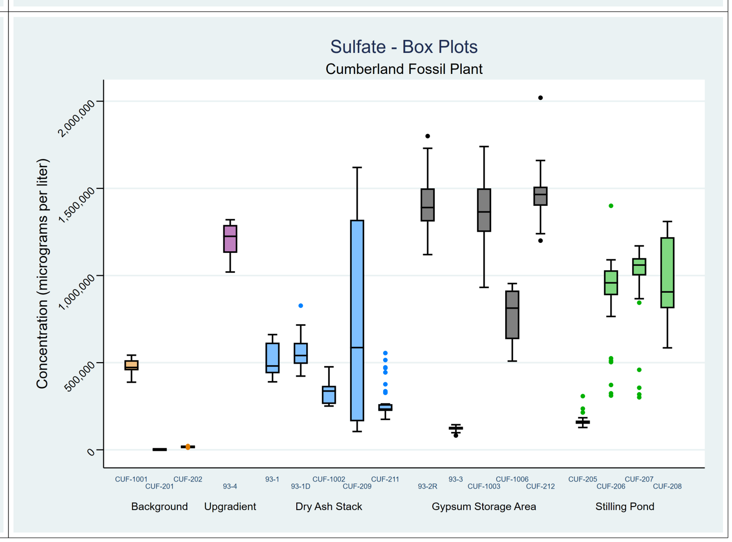


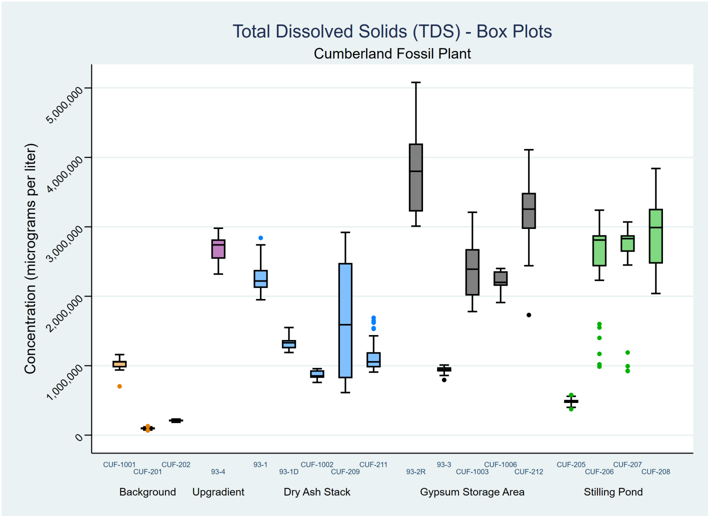












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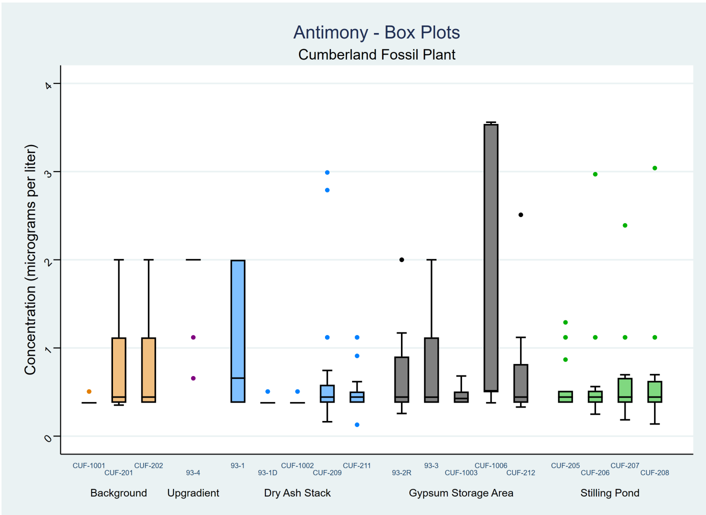
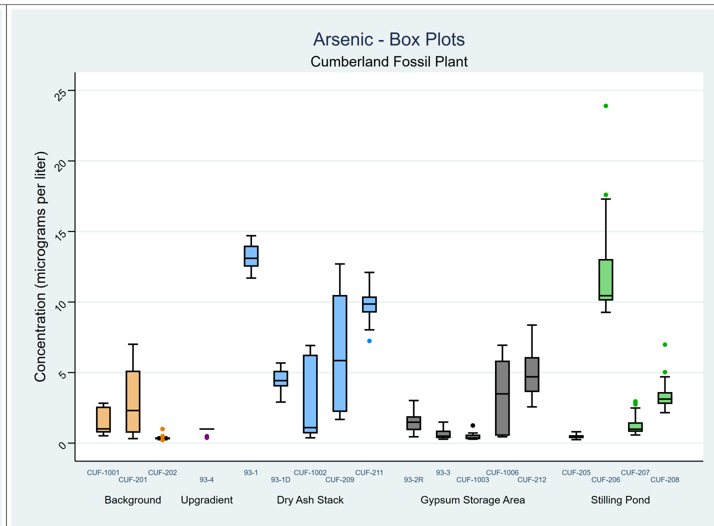
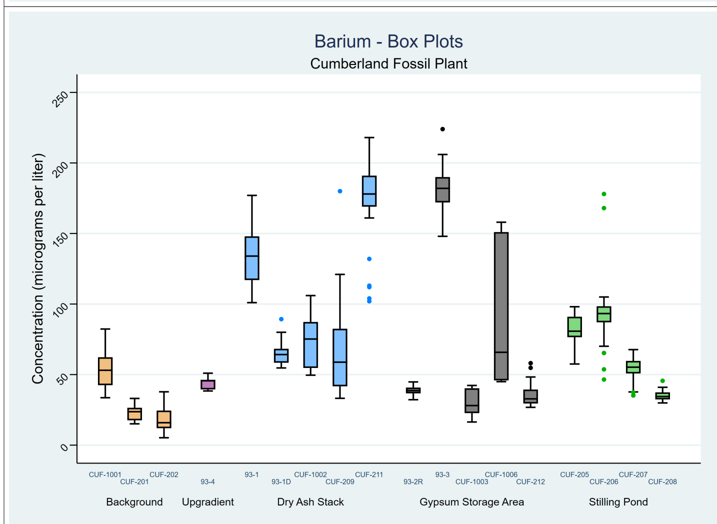
Box Plots

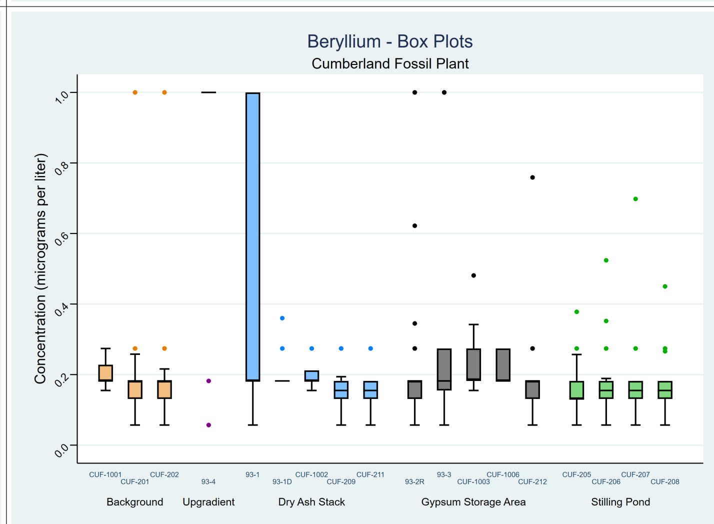
CCR Rule Appendix IV Parameters

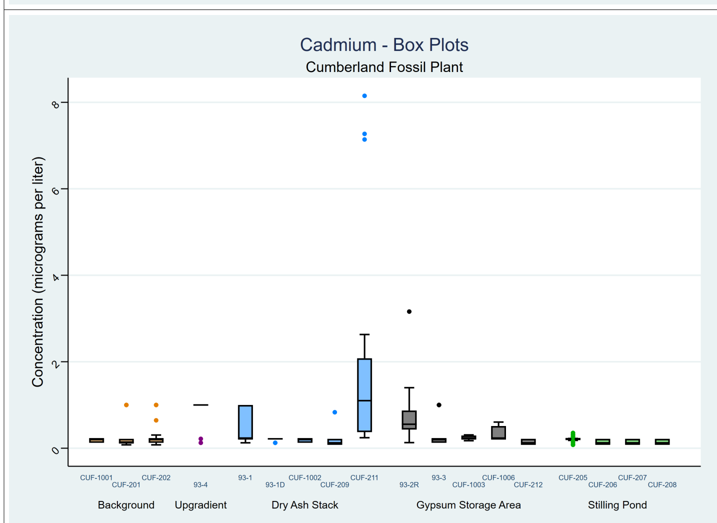
Cumberland Fossil Plant - Cumberland City, Tennessee

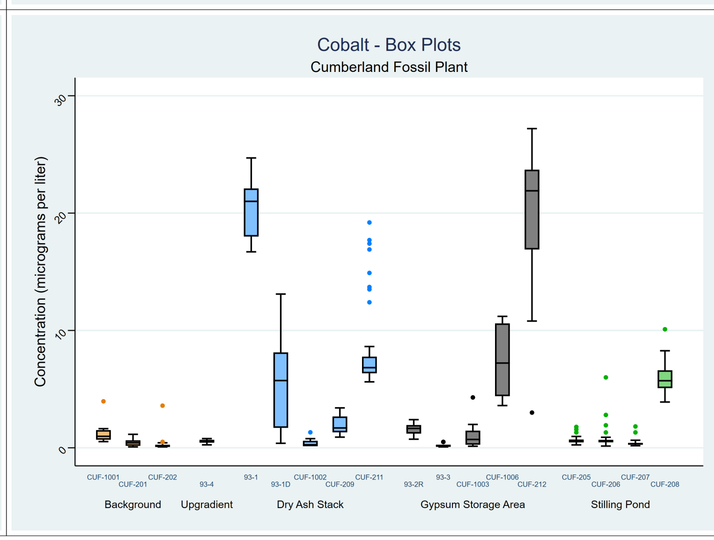




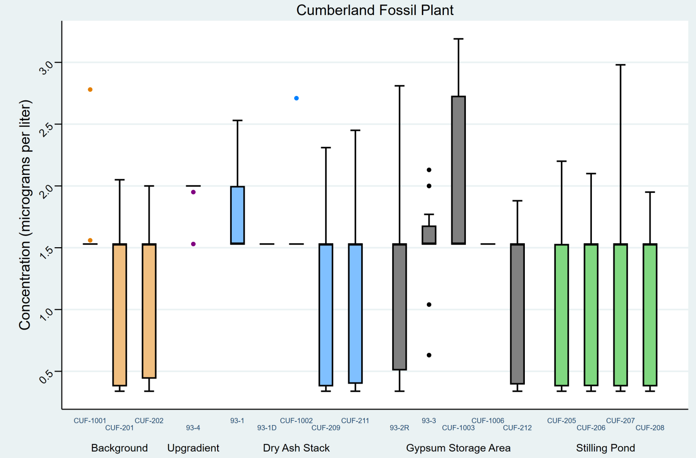




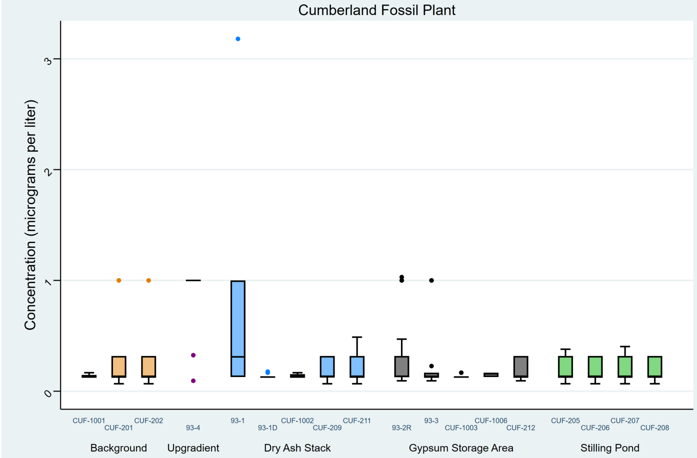




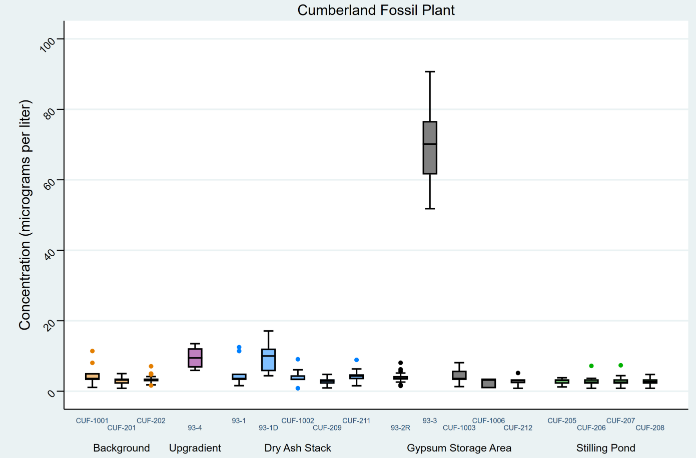
Chromium - Box Plots
Cumberland Fossil Plant



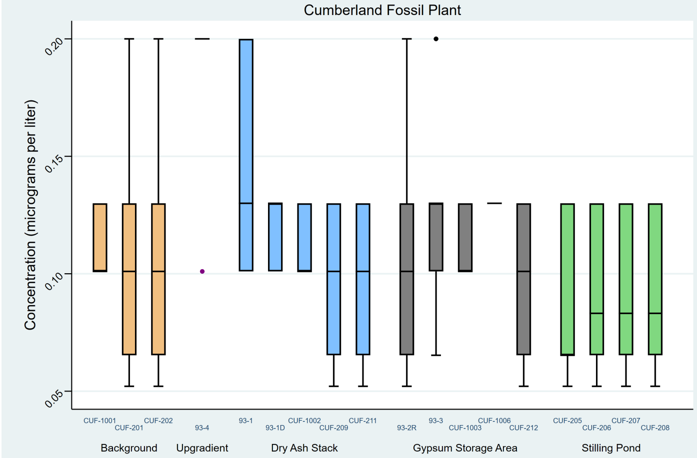
Lead - Box Plots
Cumberland Fossil Plant



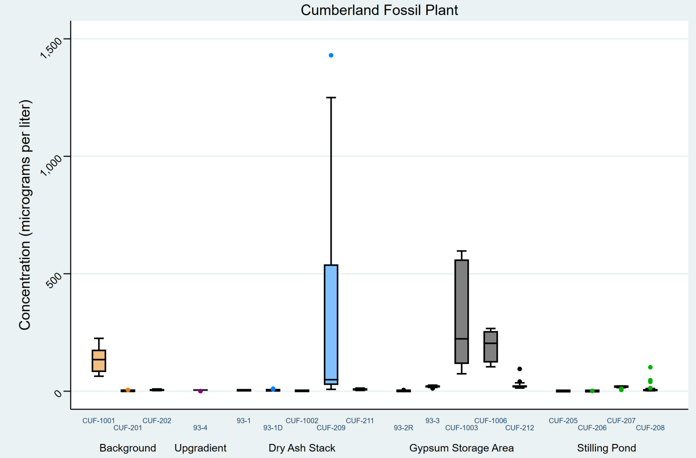
Lithium - Box Plots
Cumberland Fossil Plant



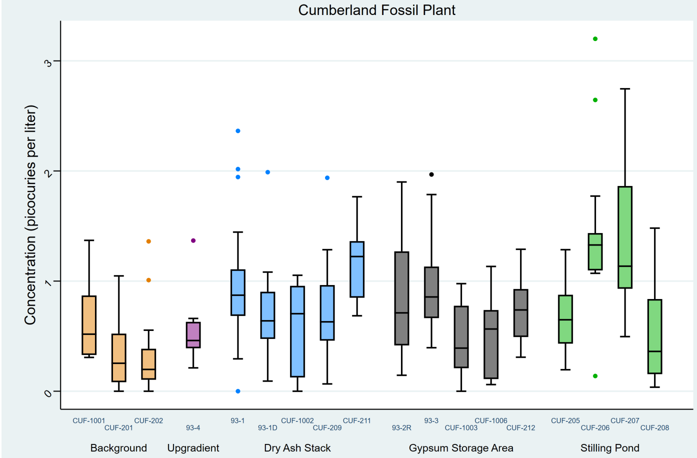
Mercury - Box Plots
Cumberland Fossil Plant

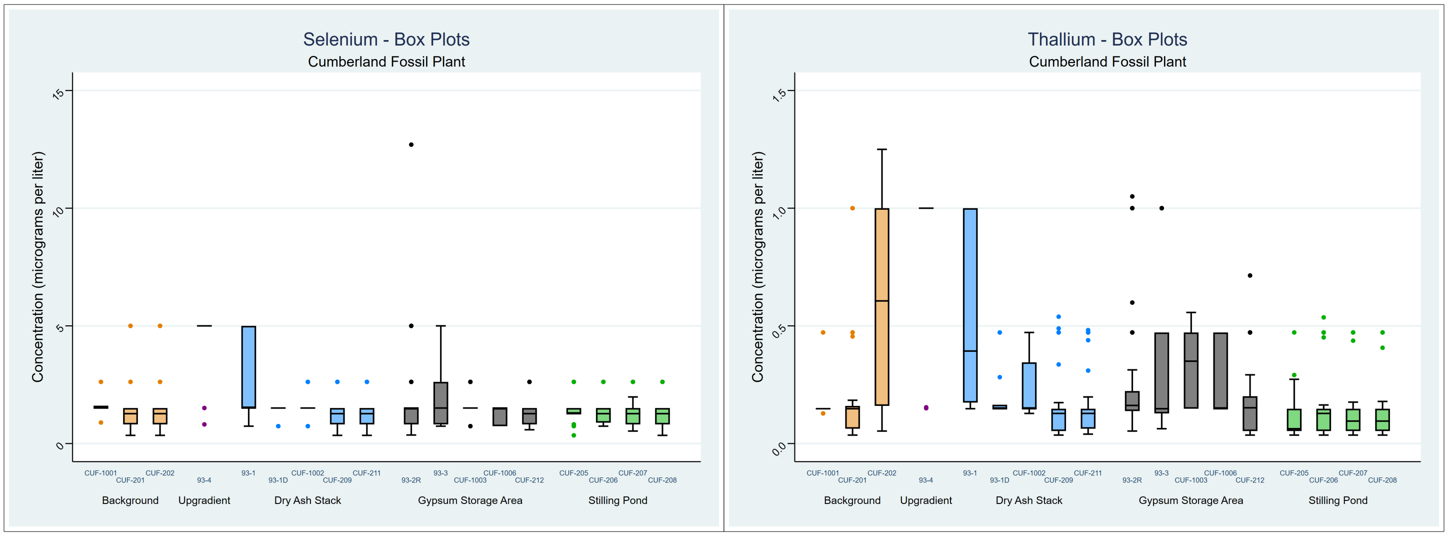


Molybdenum - Box Plots
Cumberland Fossil Plant

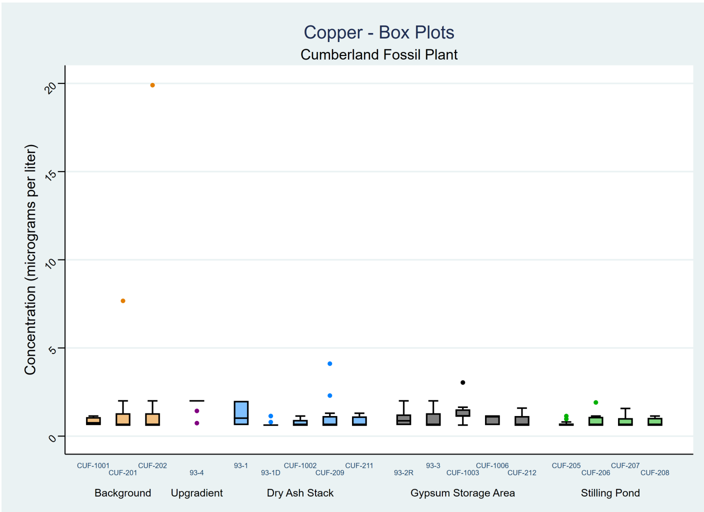


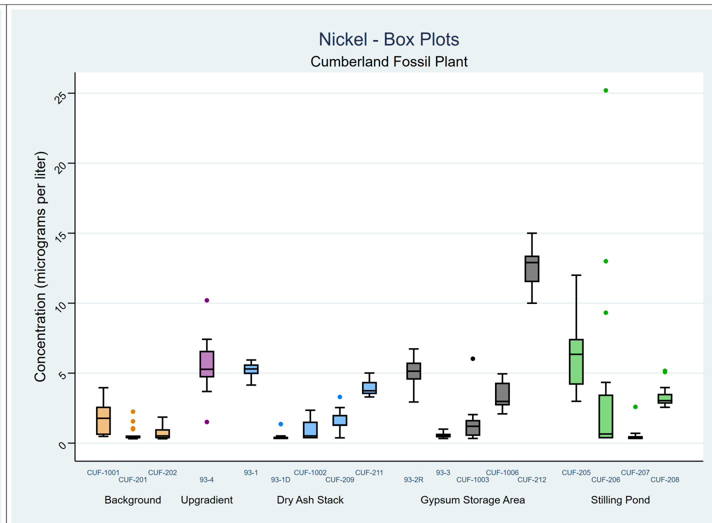
Radium 226+228 - Box Plots
Cumberland Fossil Plant

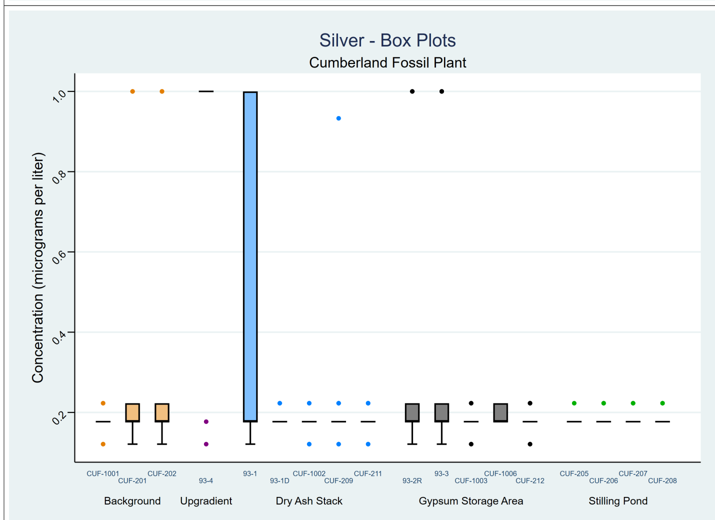


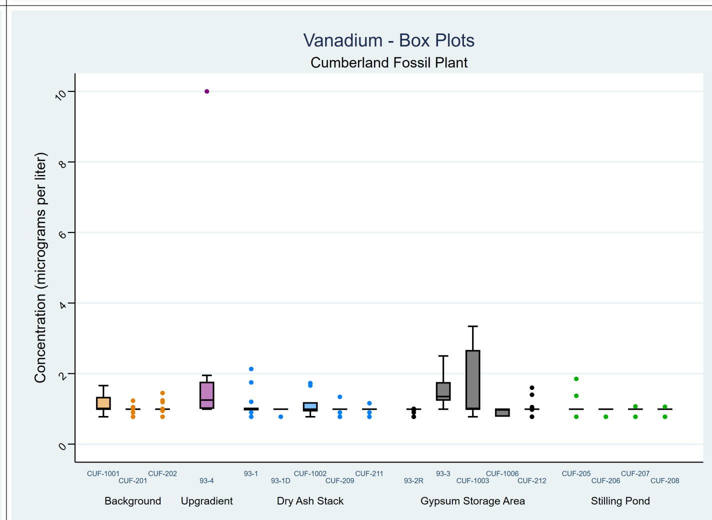

Selenium - Box Plots
Cumberland Fossil Plant
Concentration (micrograms per liter)
0
5
10
15
CUF-1001
CUF-201
CUF-202
93-4
93-1
93-1D
CUF-1002
CUF-209
CUF-211
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
CUF-205
CUF-206
CUF-207
CUF-208
Background
Upgradient
Dry Ash Stack
Gypsum Storage Area
Stilling Pond
Thallium - Box Plots
Cumberland Fossil Plant
Concentration (micrograms per liter)
0.0
0.5
1.0
1.5
CUF-1001
CUF-201
CUF-202
93-4
93-1
93-1D
CUF-1002
CUF-209
CUF-211
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
CUF-205
CUF-206
CUF-207
CUF-208
Background
Upgradient
Dry Ash Stack
Gypsum Storage Area
Stilling Pond

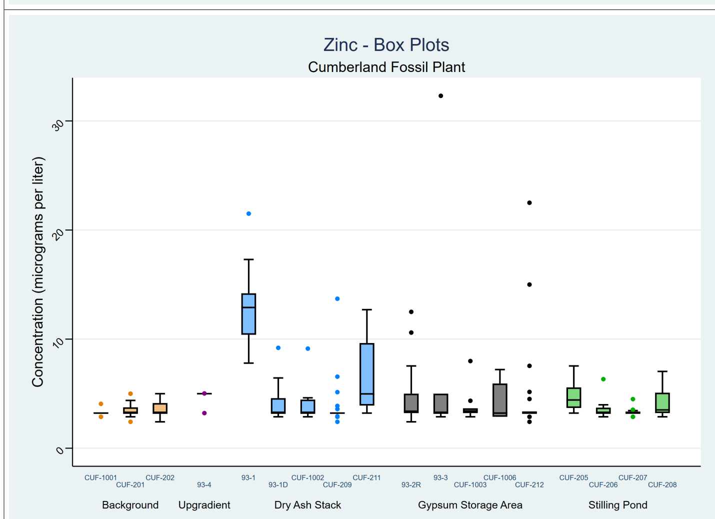
Box Plots
TDEC Appendix I Parameters
Cumberland Fossil Plant - Cumberland City, Tennessee











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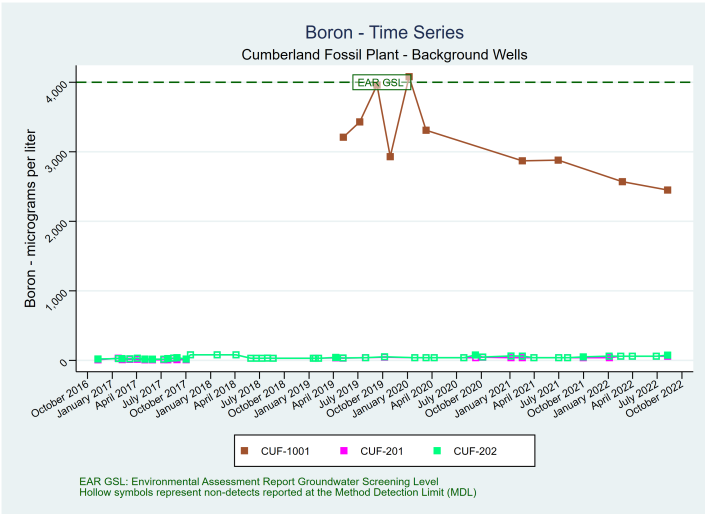
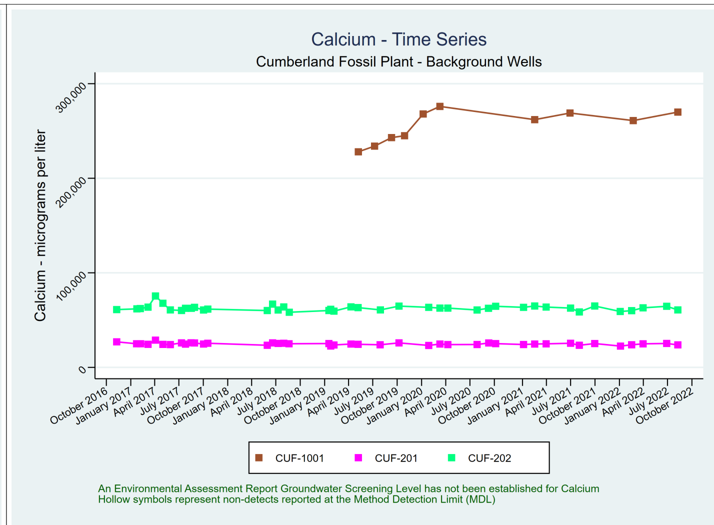
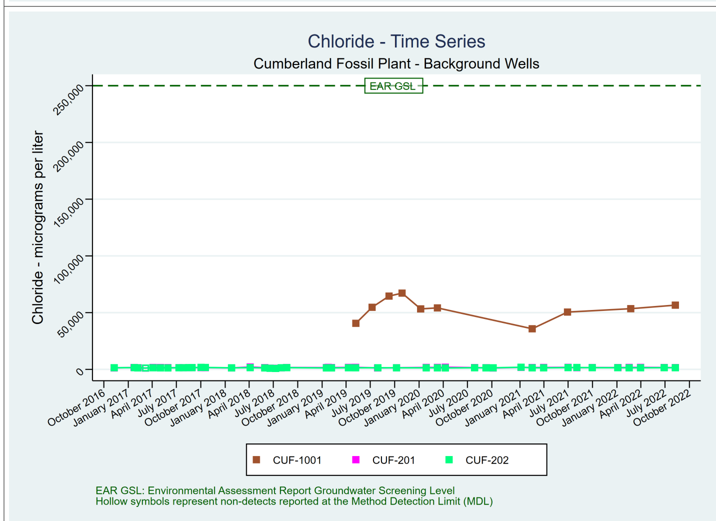
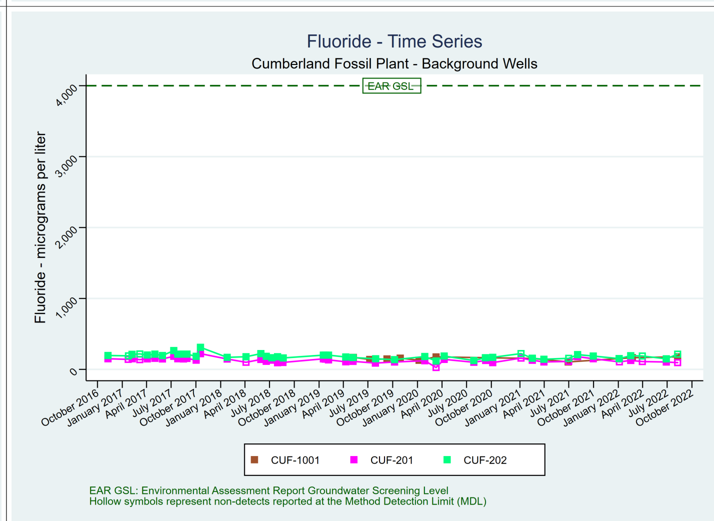
ATTACHMENT E.3-D
TIME SERIES PLOTS

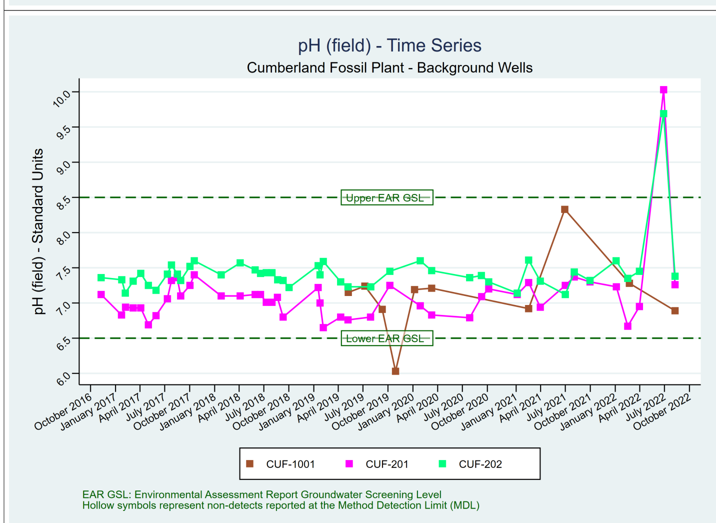
Time Series Plots
Background Wells
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

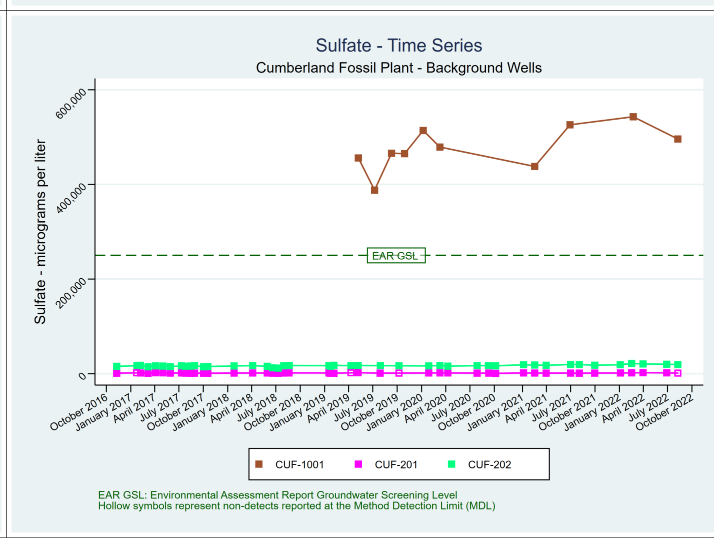


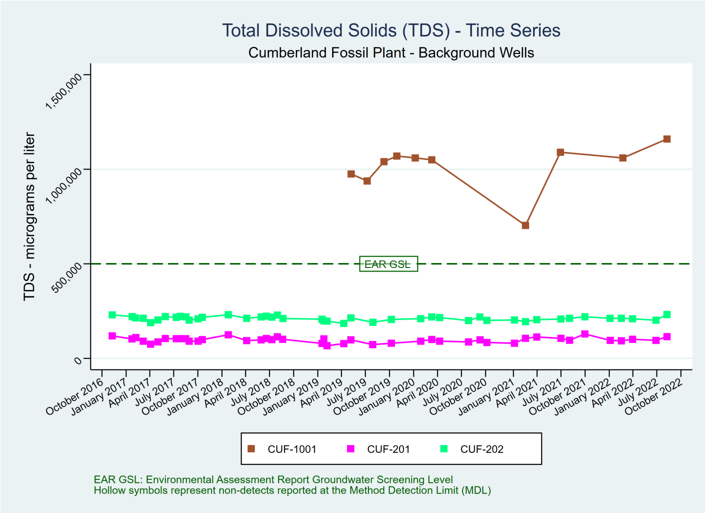












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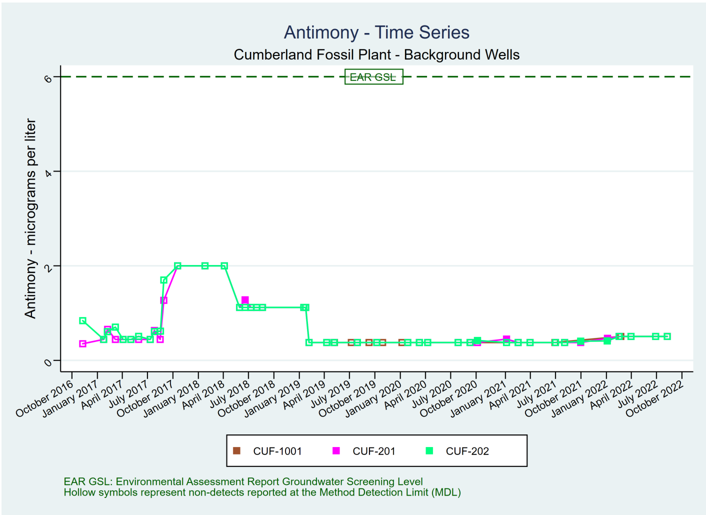
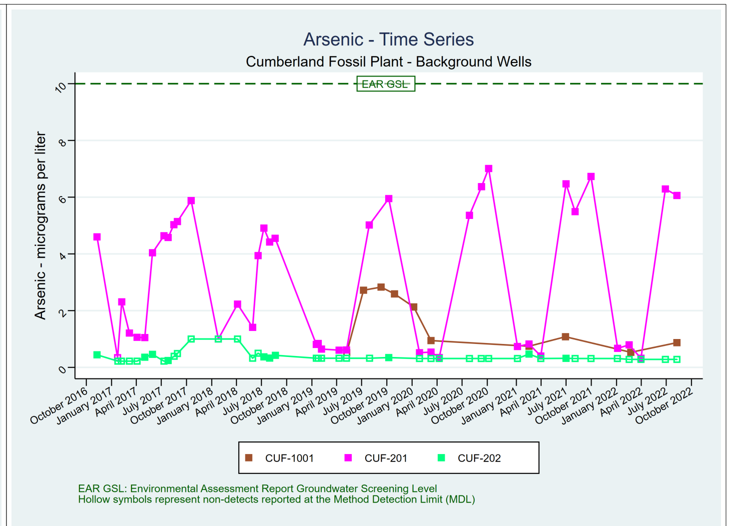
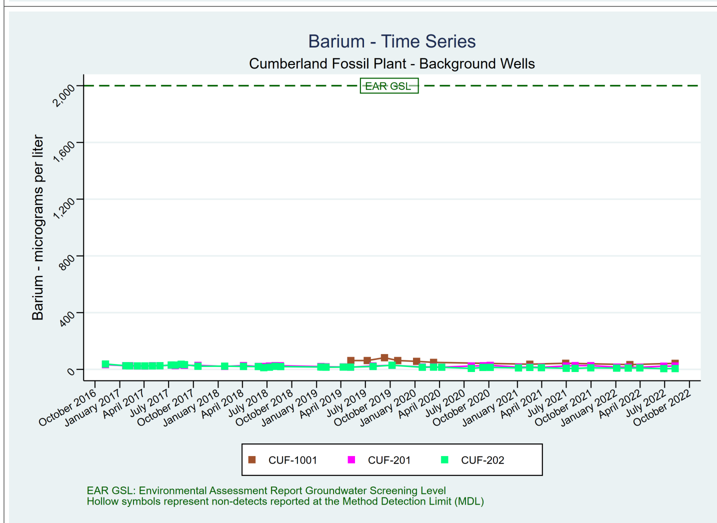
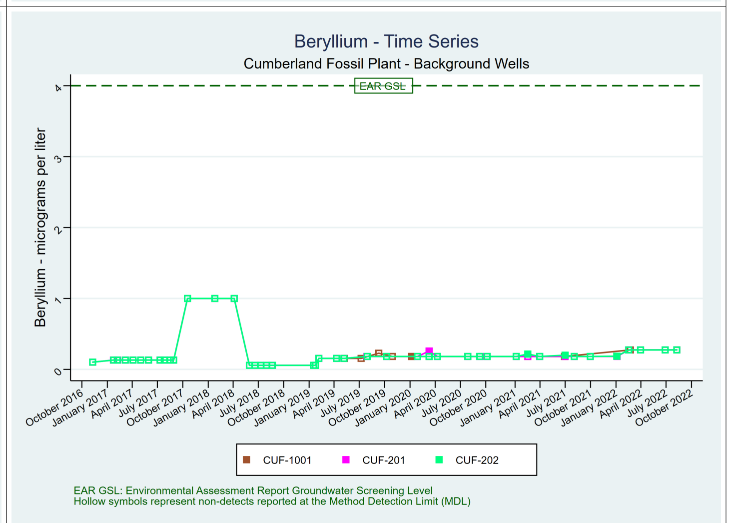
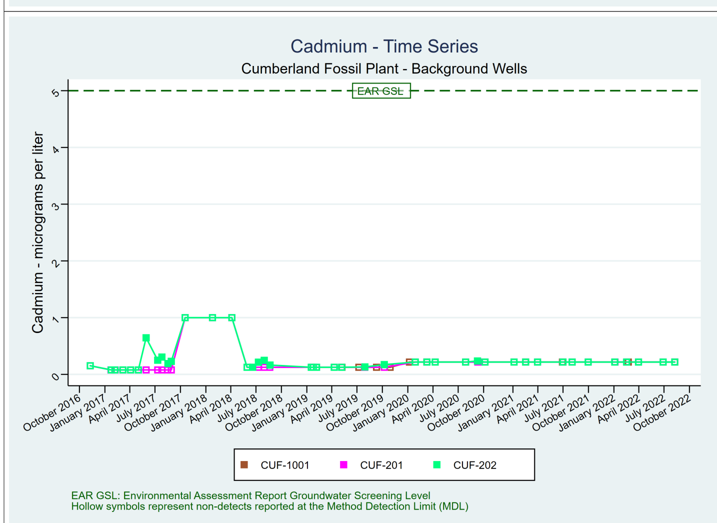
Time Series Plots
Background Wells
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

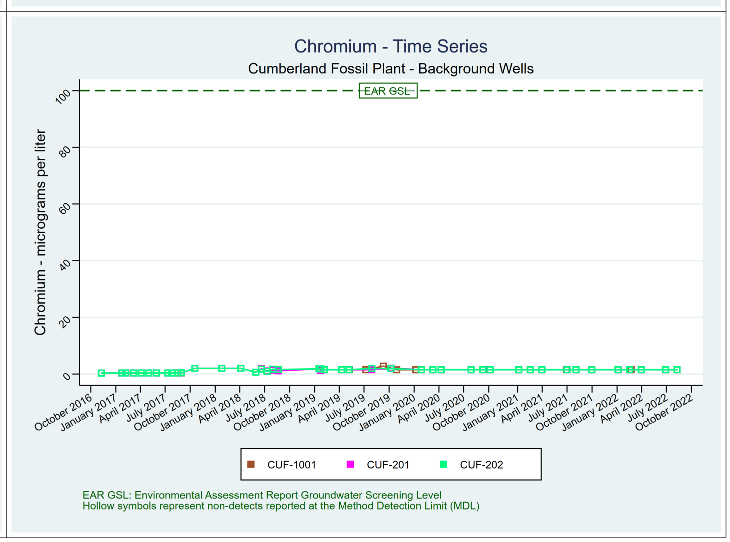


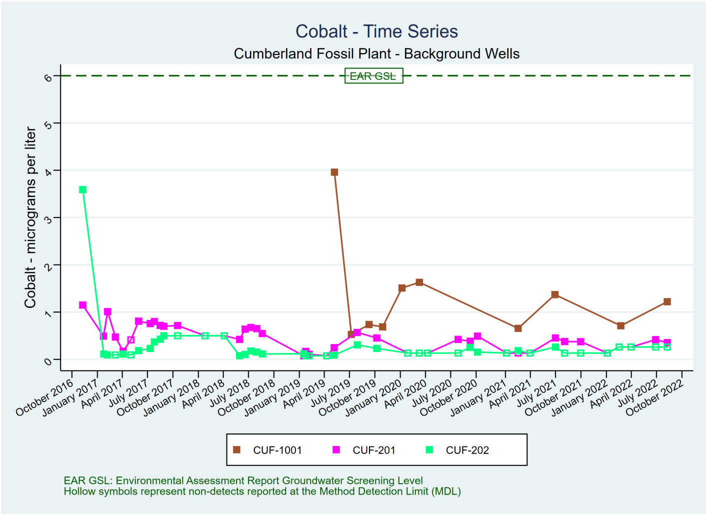


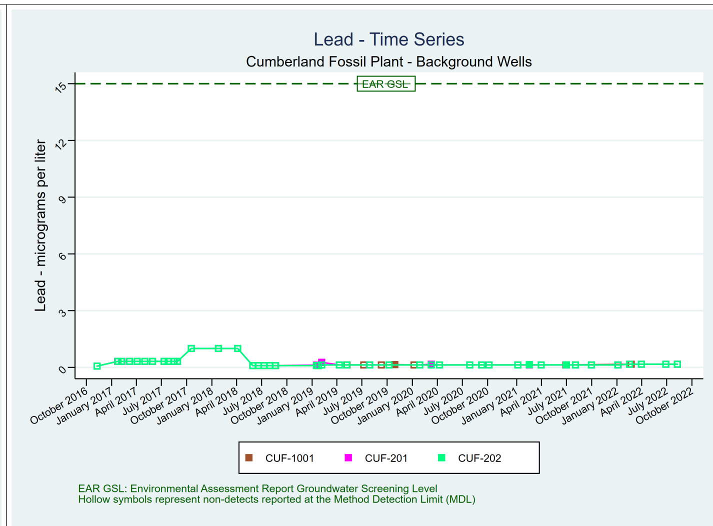


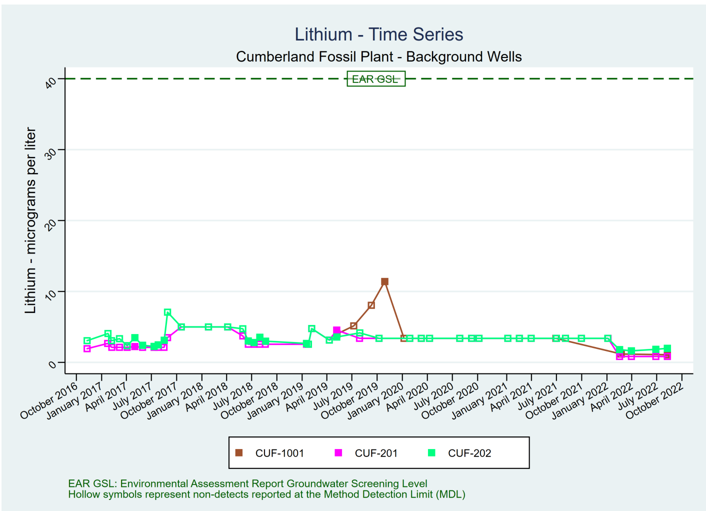


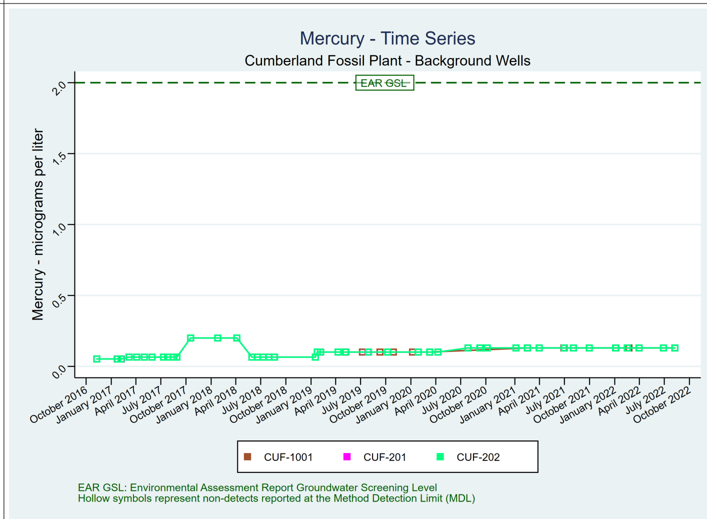


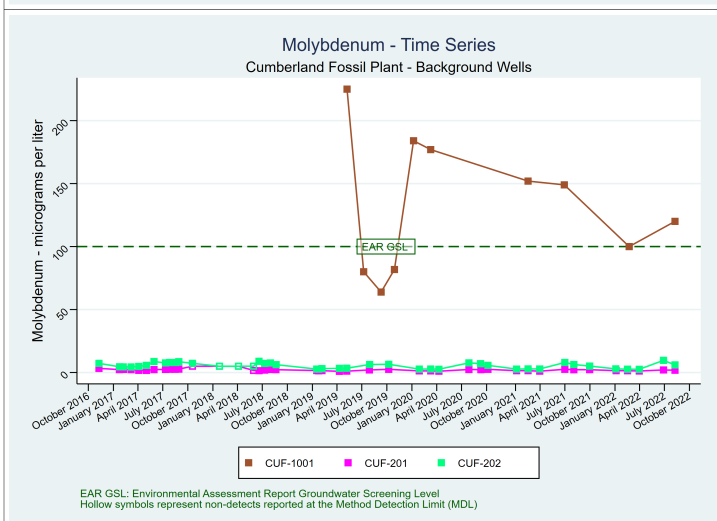


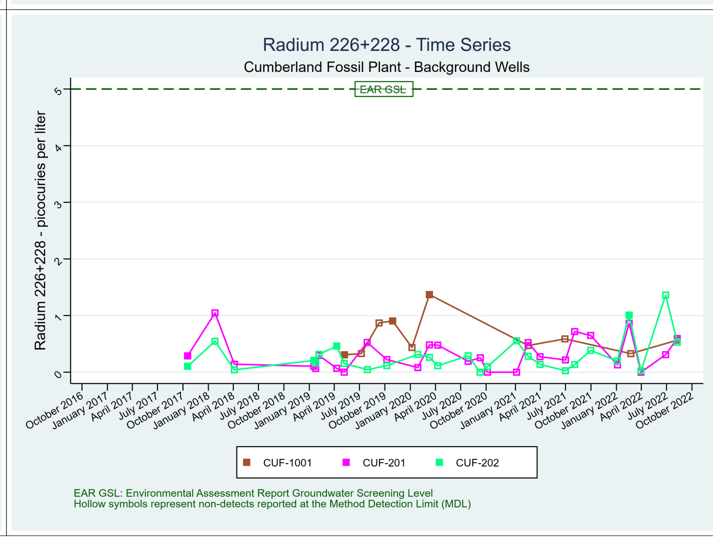

Cobalt - Time Series
Cumberland Fossil Plant - Background Wells
Cobalt - micrograms per liter
EAR GSL
0 1 2 3 4 5 6
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

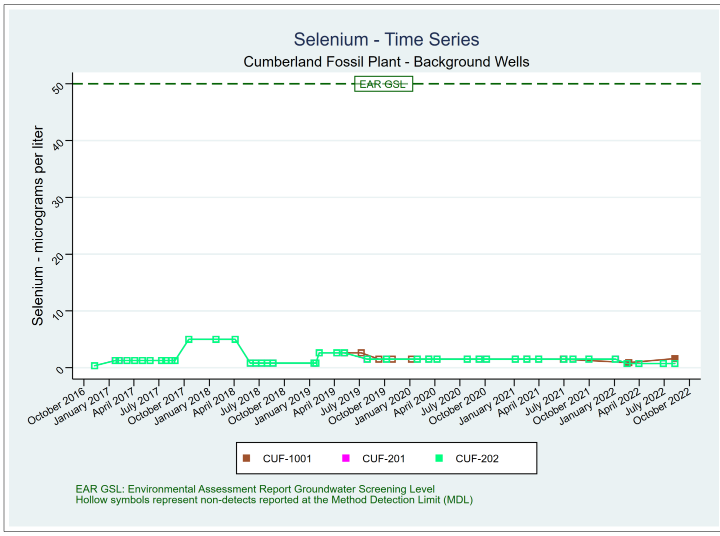

Lead - Time Series
Cumberland Fossil Plant - Background Wells
Lead - micrograms per liter
EAR GSL
0 3 6 9 12 15
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

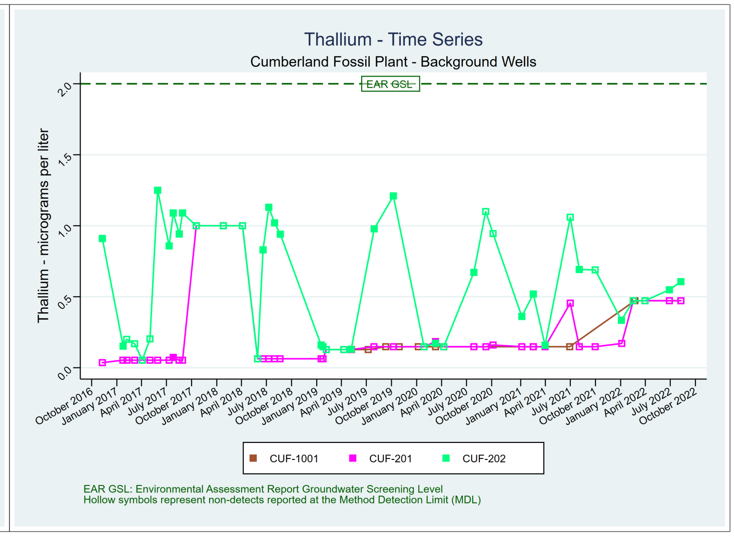

Lithium - Time Series
Cumberland Fossil Plant - Background Wells
Lithium - micrograms per liter
EAR GSL
0 10 20 30 40
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Mercury - Time Series
Cumberland Fossil Plant - Background Wells
Mercury - micrograms per liter
EAR GSL
0.0 0.5 1.0 1.5 2.0
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

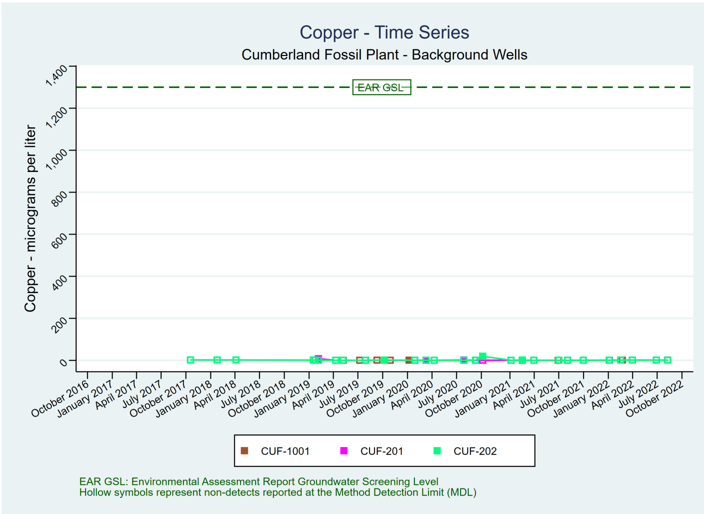

Molybdenum - Time Series
Cumberland Fossil Plant - Background Wells
Molybdenum - micrograms per liter
EAR GSL
0 50 100 150 200
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

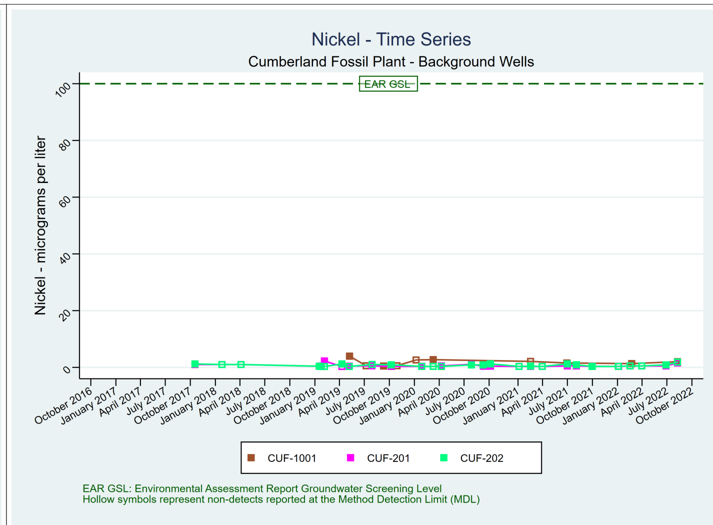

Radium 226+228 - Time Series
Cumberland Fossil Plant - Background Wells
Radium 226+228 - picocuries per liter
EAR GSL
0 1 2 3 4 5
October 2016 January 2017 April 2017 July 2017 October 2017 January 2018 April 2018 July 2018 October 2018 January 2019 April 2019 July 2019 October 2019 January 2020 April 2020 July 2020 October 2020 January 2021 April 2021 July 2021 October 2021 January 2022 April 2022 July 2022 October 2022
CUF-1001 CUF-201 CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

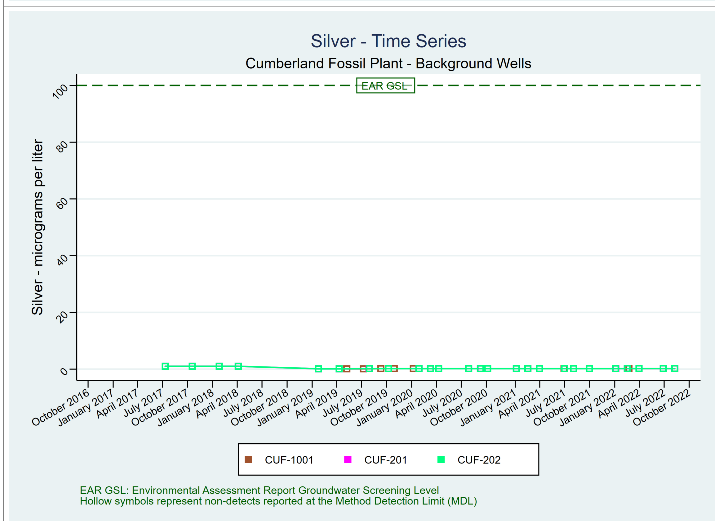

Selenium - Time Series
Cumberland Fossil Plant - Background Wells
EAR GSL
Selenium - micrograms per liter
0
10
20
30
40
50
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
CUF-1001
CUF-201
CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

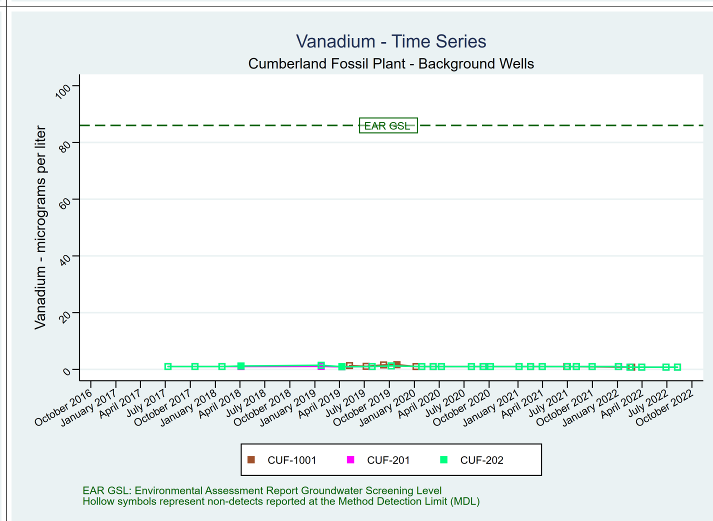

Thallium - Time Series
Cumberland Fossil Plant - Background Wells
EAR GSL
Thallium - micrograms per liter
0.0
0.5
1.0
1.5
2.0
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
CUF-1001
CUF-201
CUF-202
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

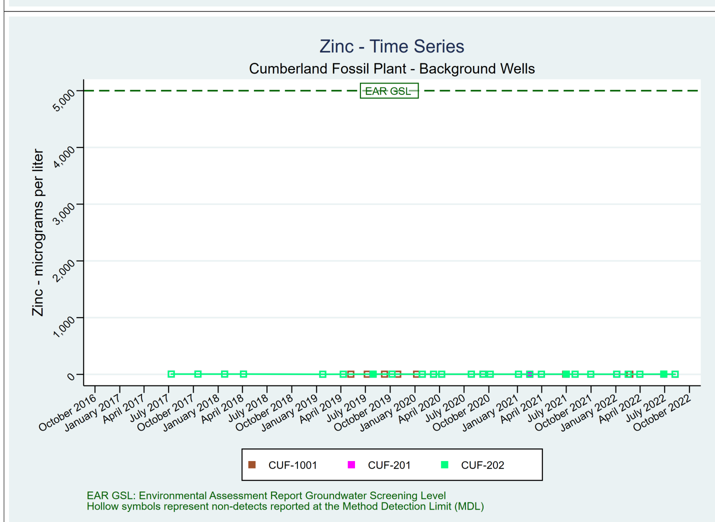
Time Series Plots
Background Wells
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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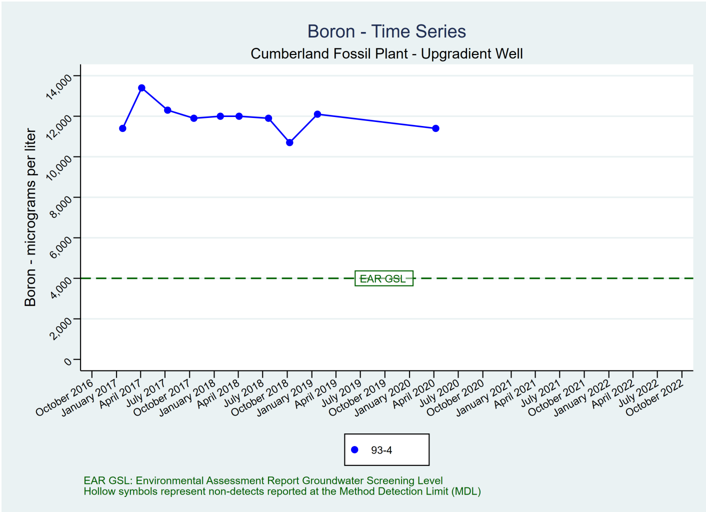
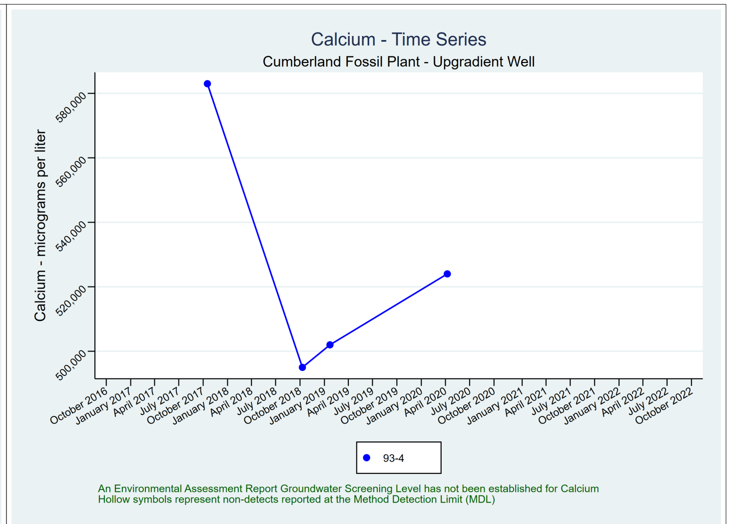
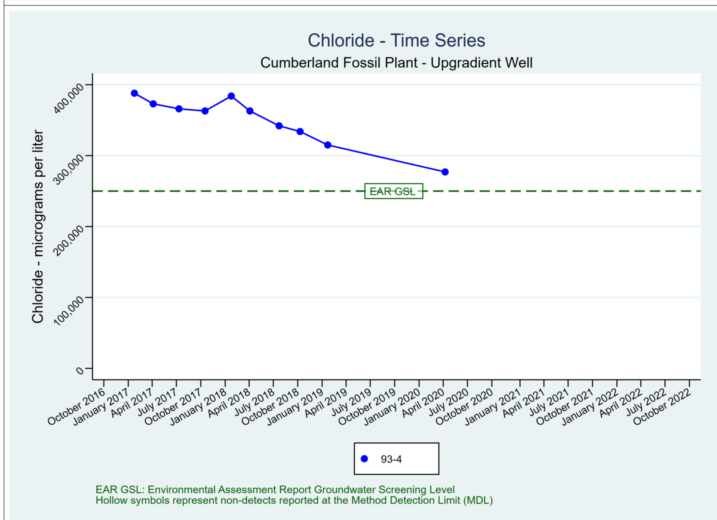
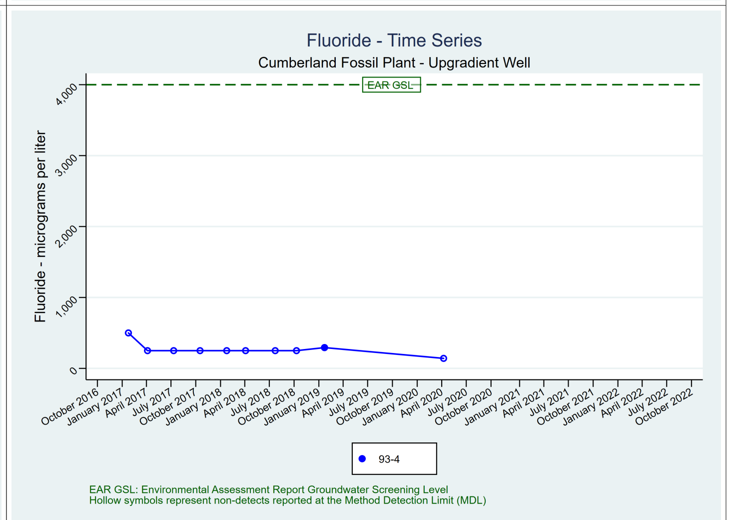
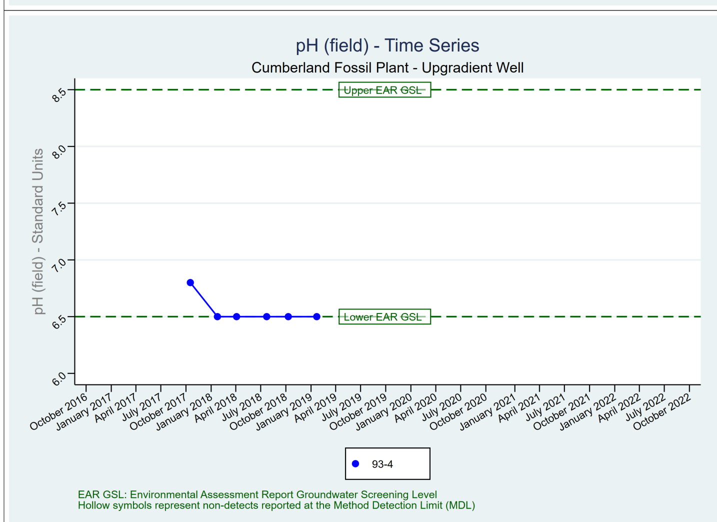
Time Series Plots
Upgradient Well
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

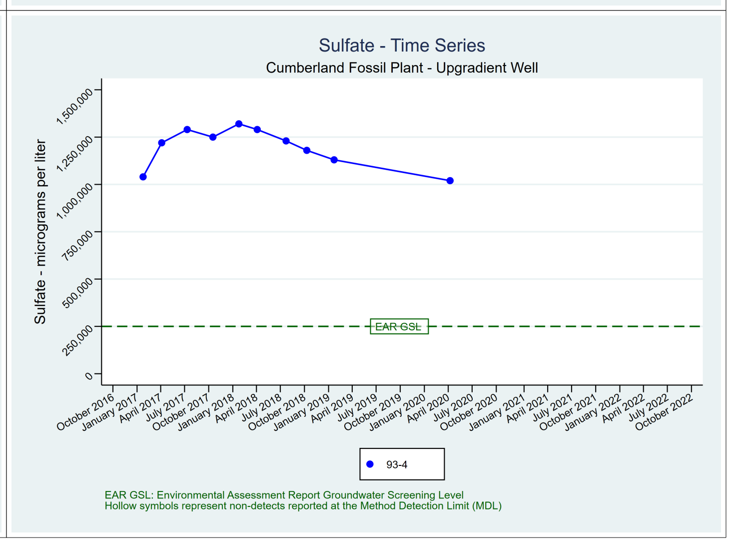


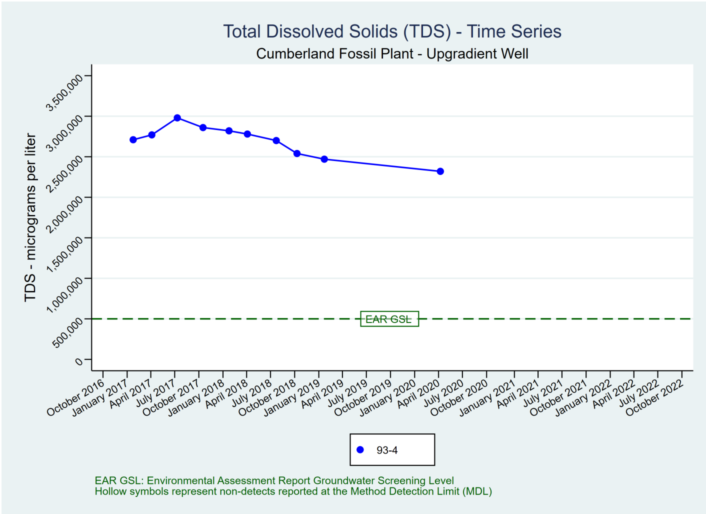












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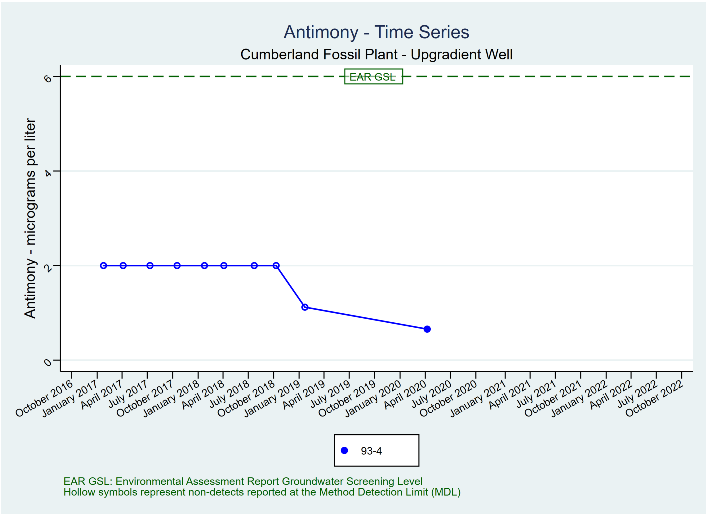
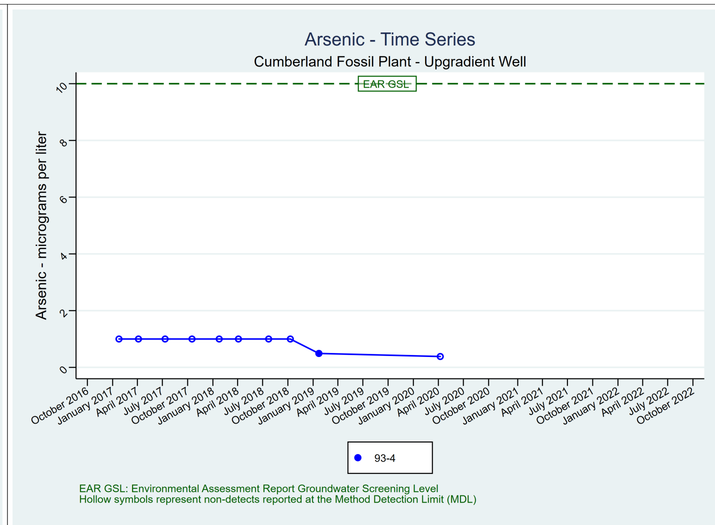
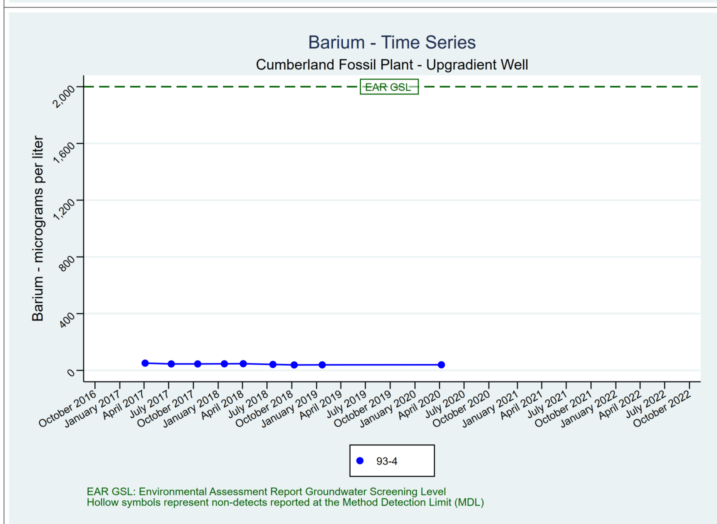
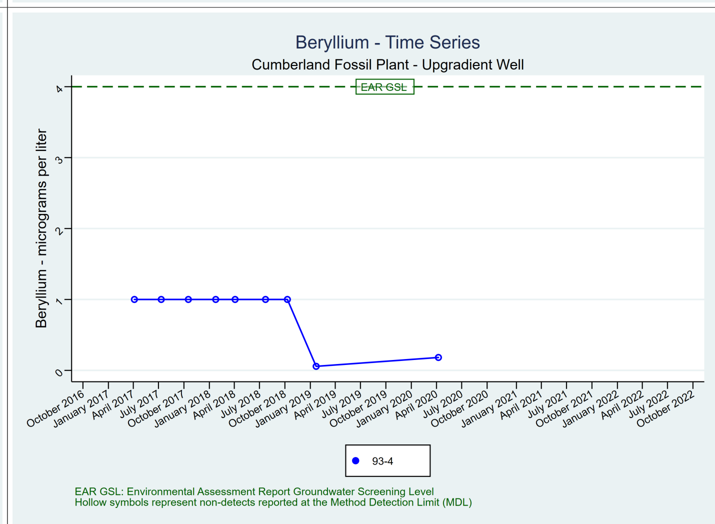
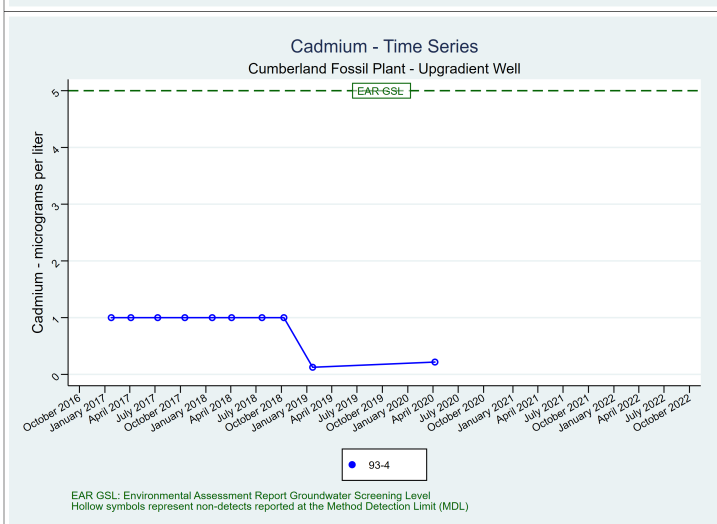
Time Series Plots
Upgradient Well
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

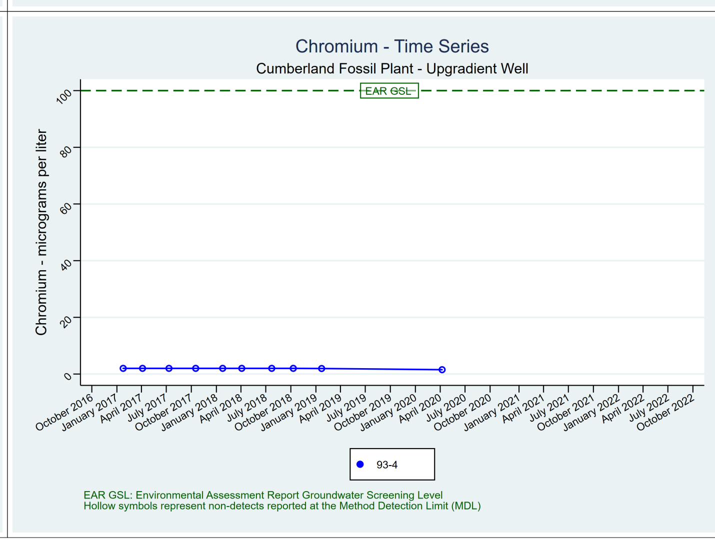


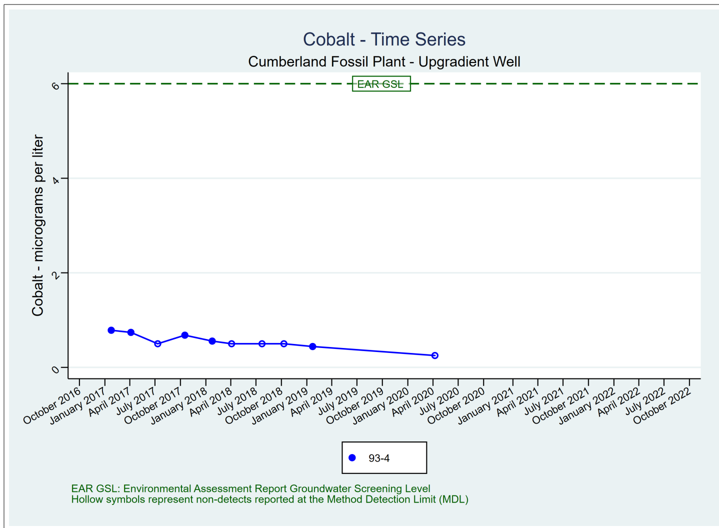


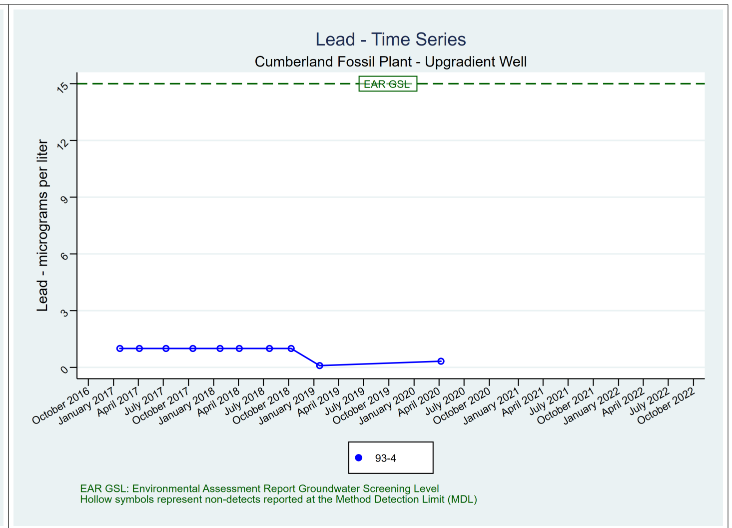


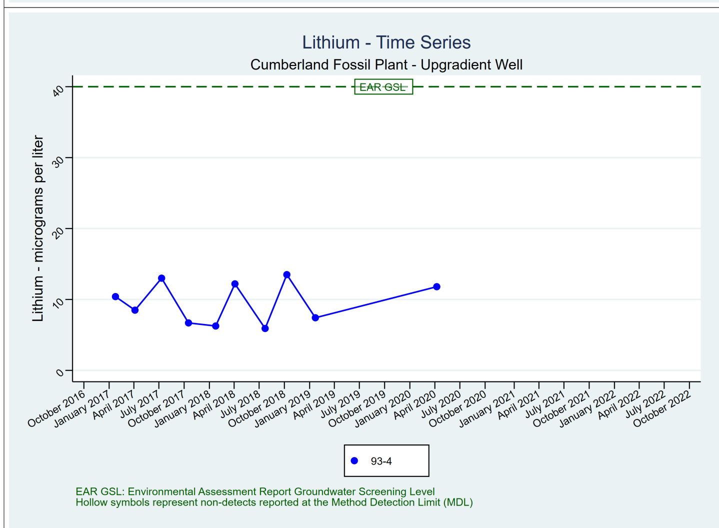


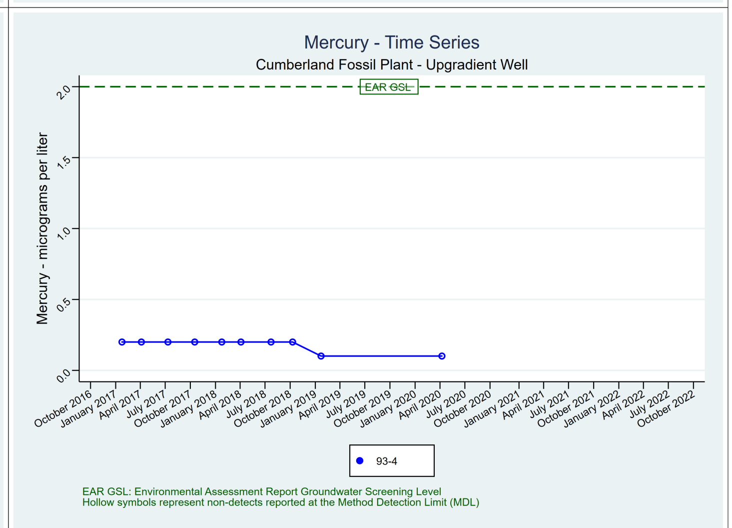


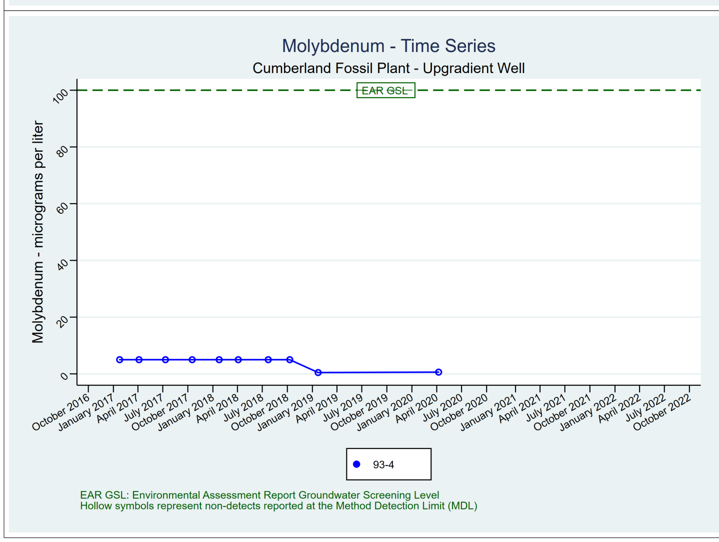


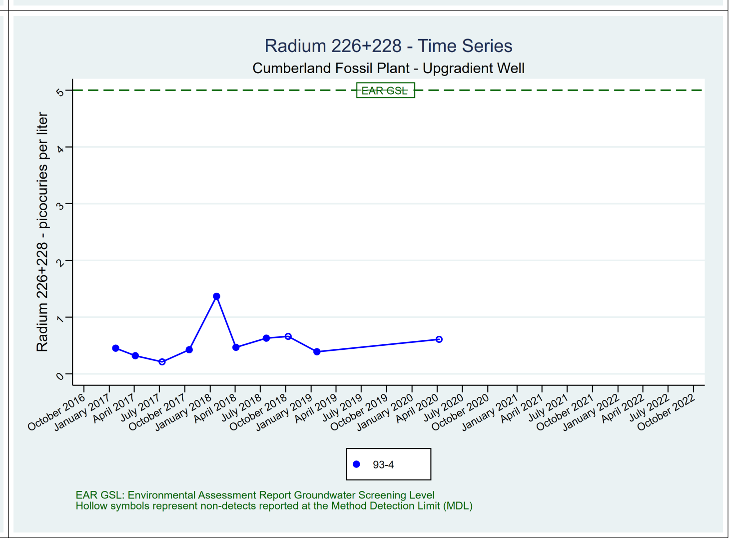

Cobalt - Time Series
Cumberland Fossil Plant - Upgradient Well
Cobalt - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

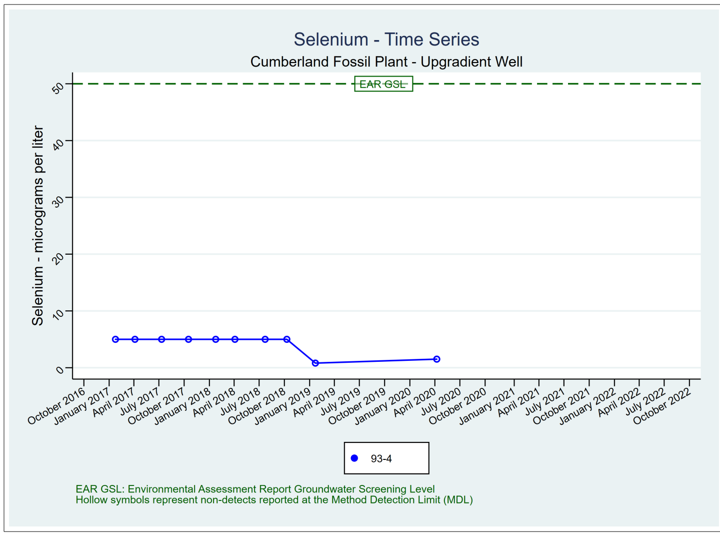

Lead - Time Series
Cumberland Fossil Plant - Upgradient Well
Lead - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

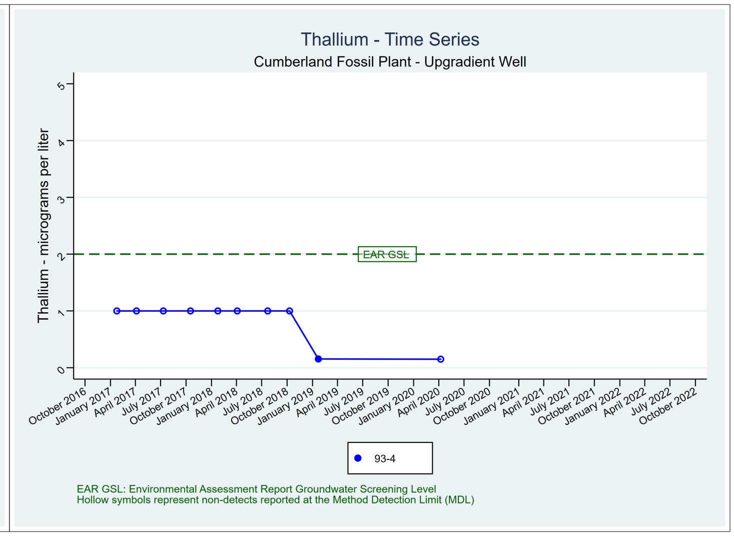

Lithium - Time Series
Cumberland Fossil Plant - Upgradient Well
Lithium - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Mercury - Time Series
Cumberland Fossil Plant - Upgradient Well
Mercury - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

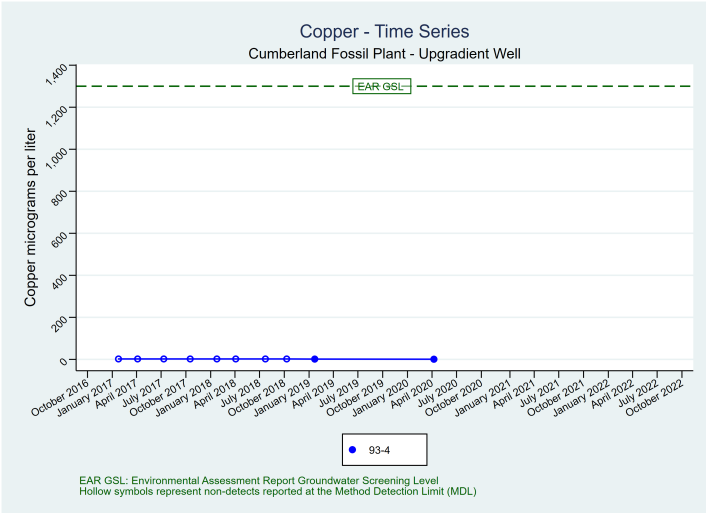

Molybdenum - Time Series
Cumberland Fossil Plant - Upgradient Well
Molybdenum - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

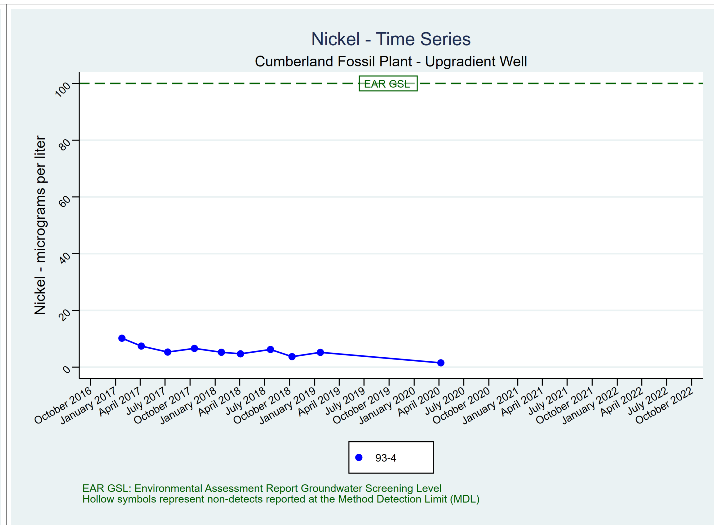

Radium 226+228 - Time Series
Cumberland Fossil Plant - Upgradient Well
Radium 226+228 - picocuries per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

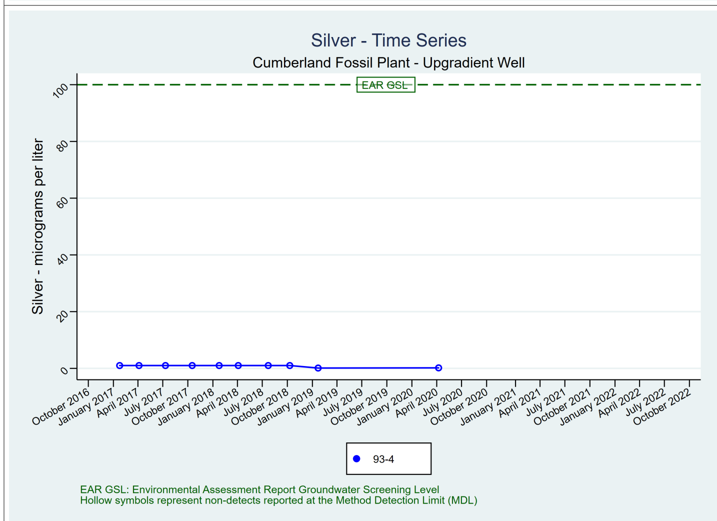

Selenium - Time Series
Cumberland Fossil Plant - Upgradient Well
Selenium - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

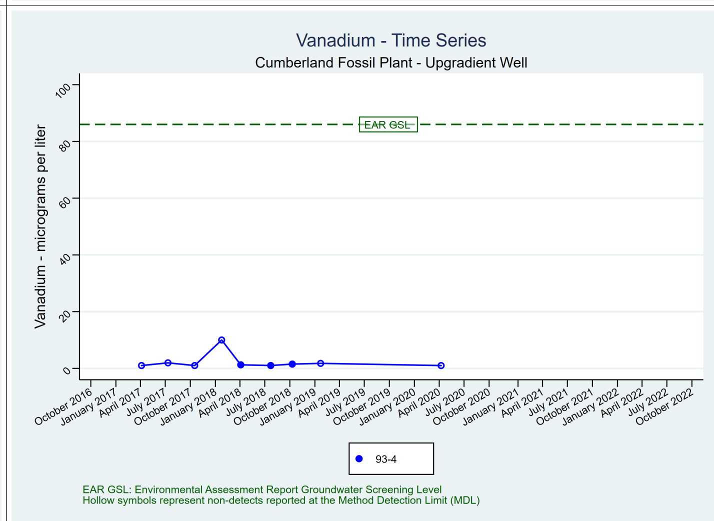

Thallium - Time Series
Cumberland Fossil Plant - Upgradient Well
Thallium - micrograms per liter
EAR GSL
93-4
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

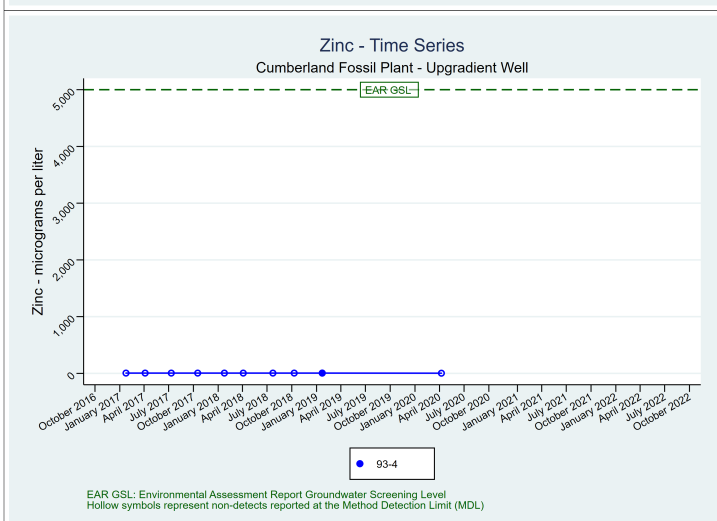
Time Series Plots
Upgradient Well
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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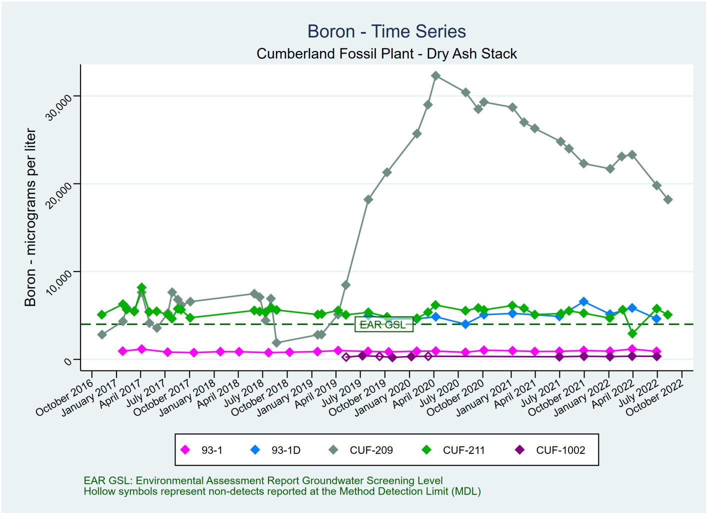
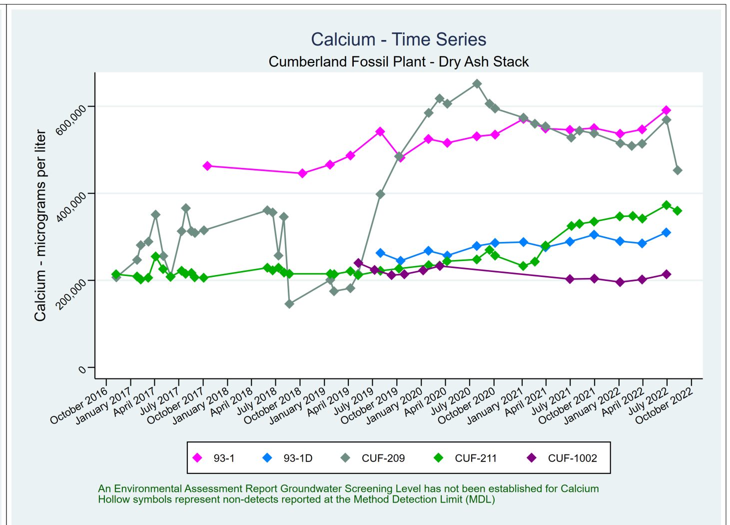
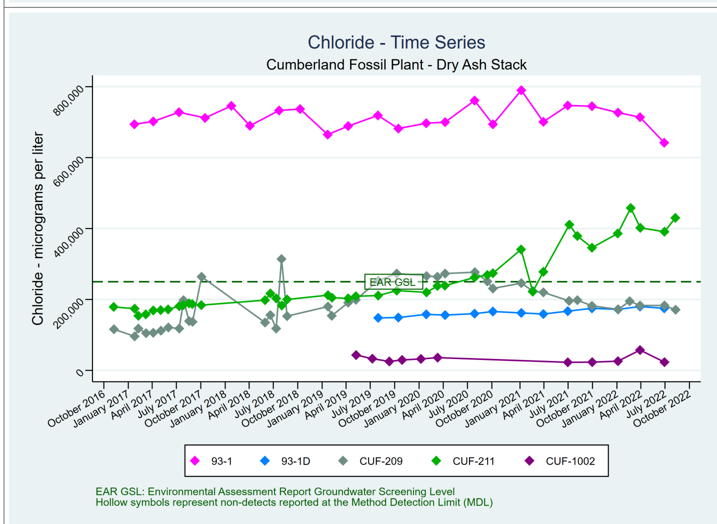
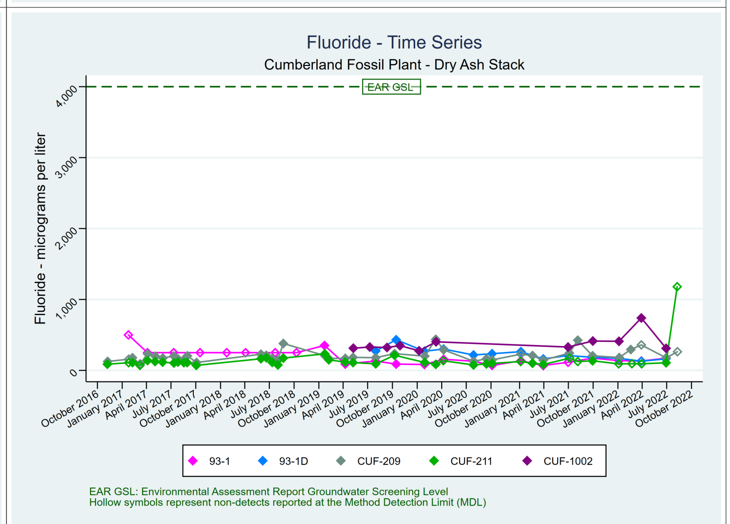
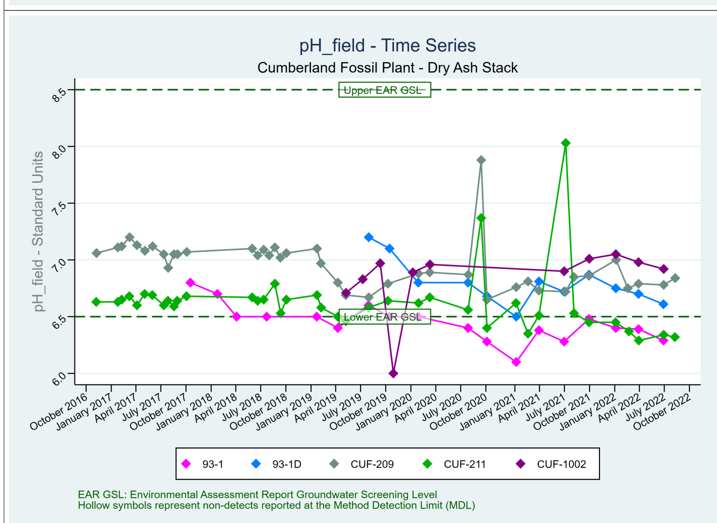
Time Series Plots
Dry Ash Stack
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

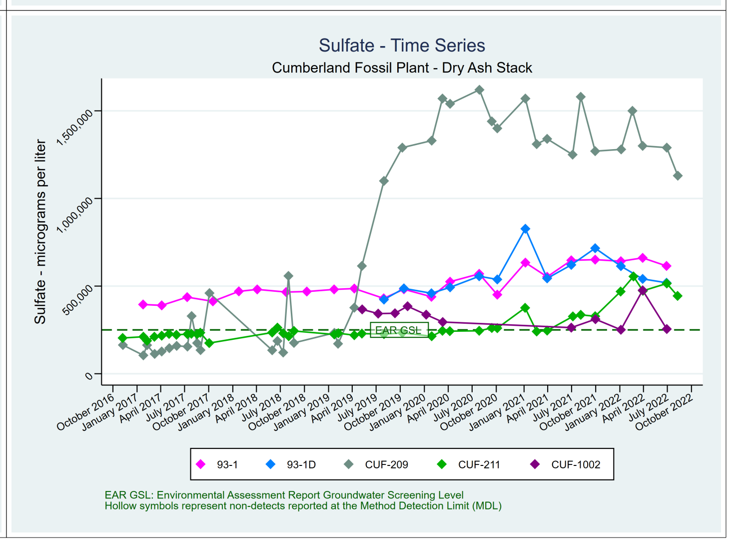


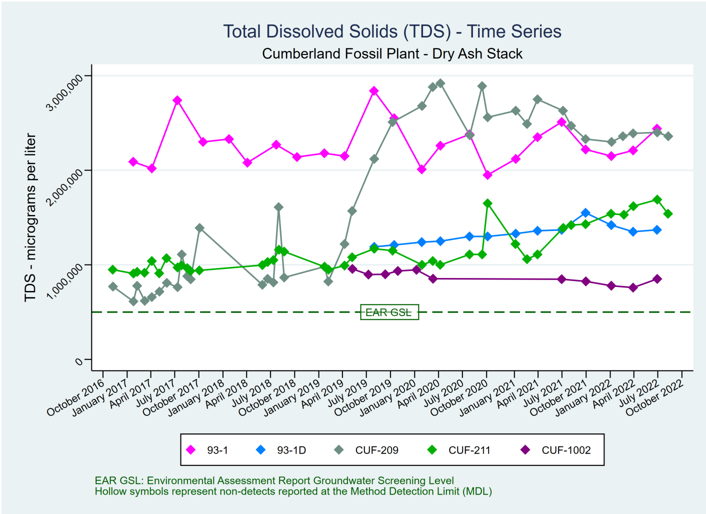












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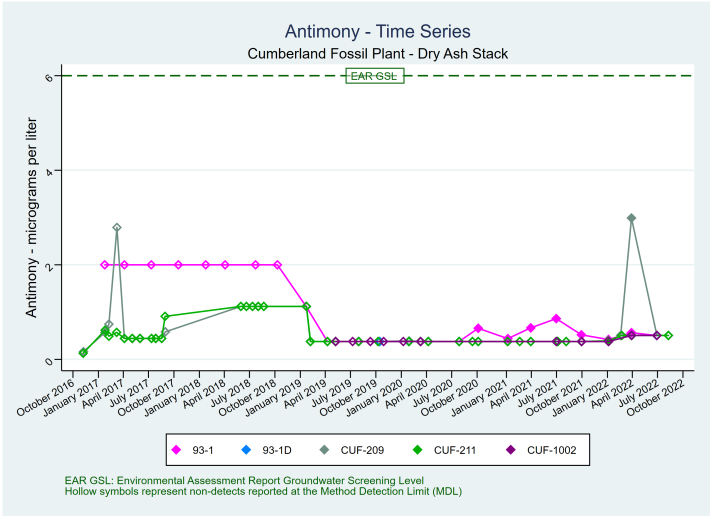
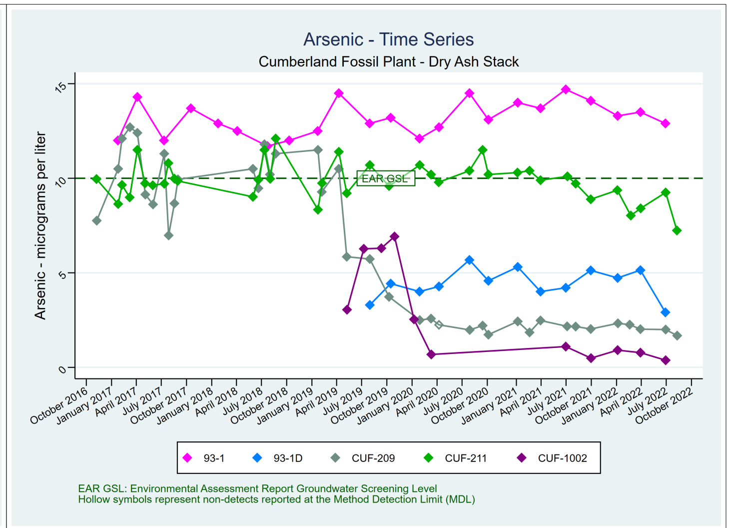
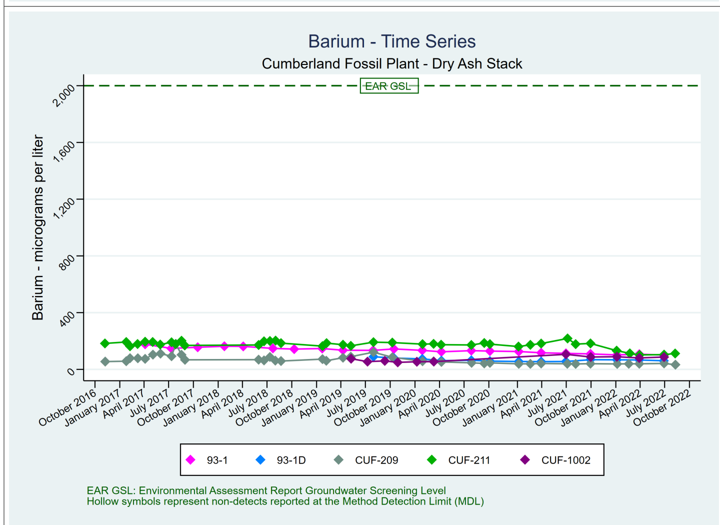
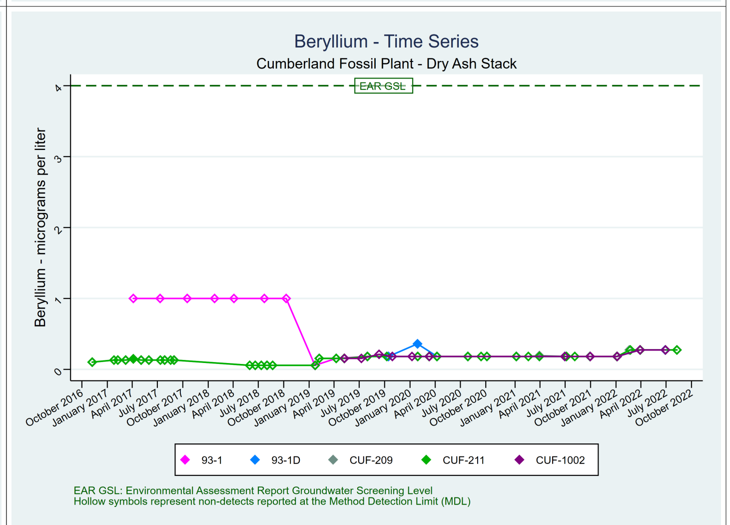
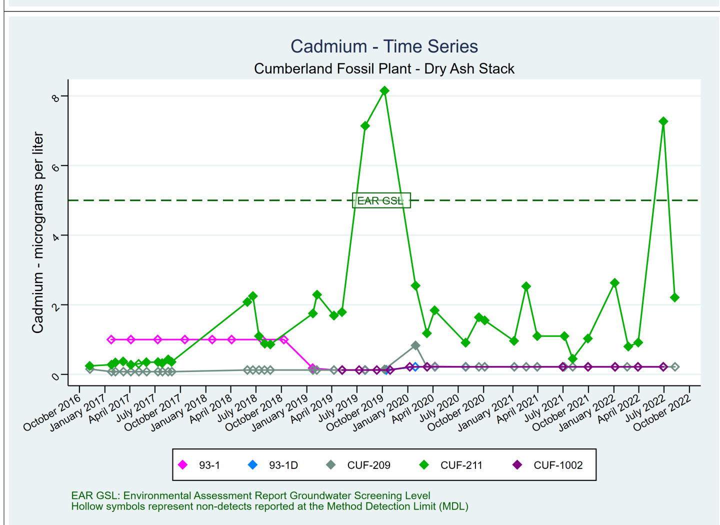
Time Series Plots
Dry Ash Stack
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

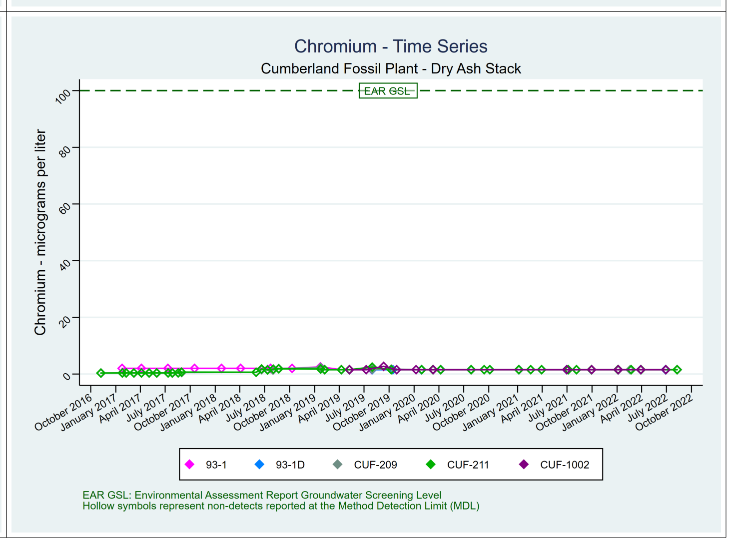


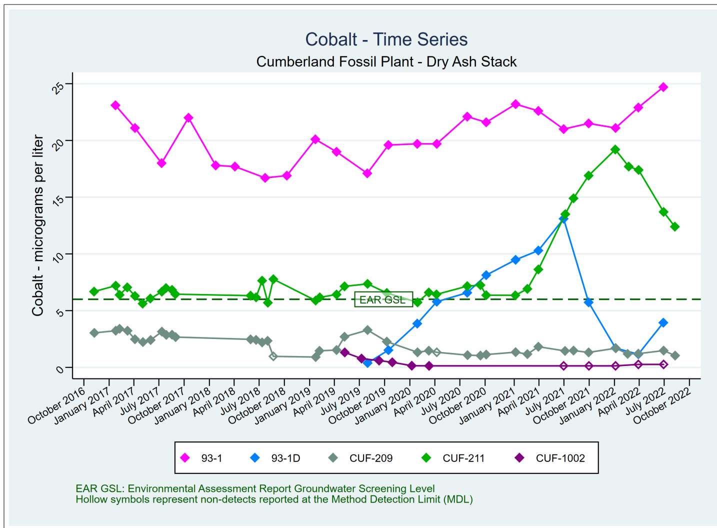


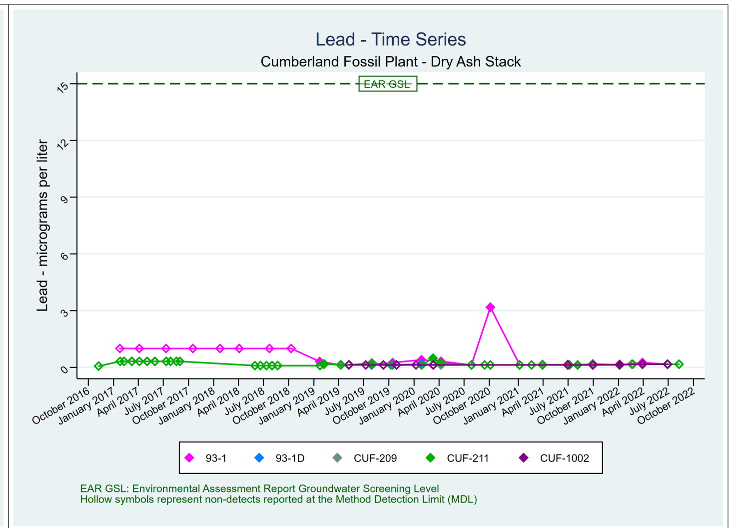


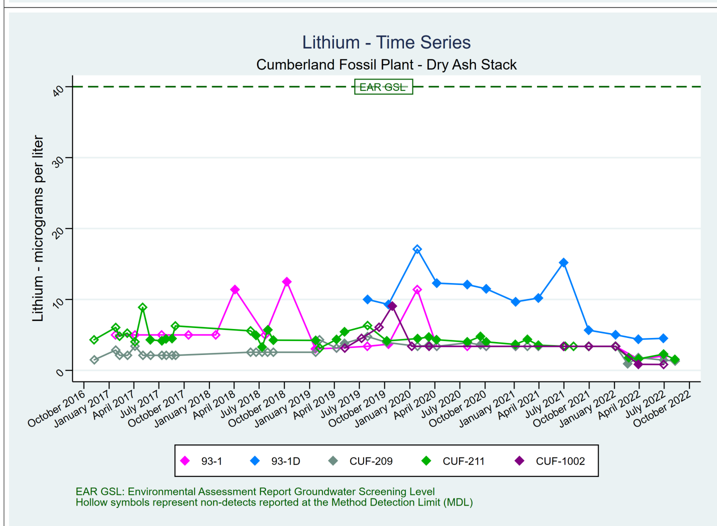


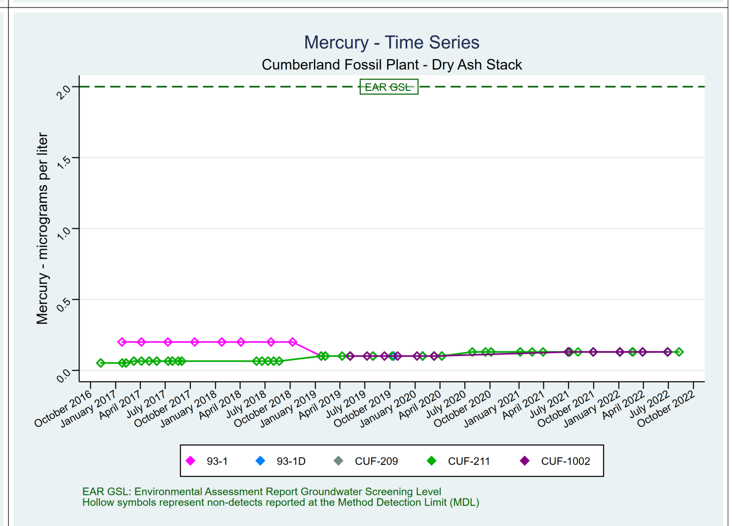


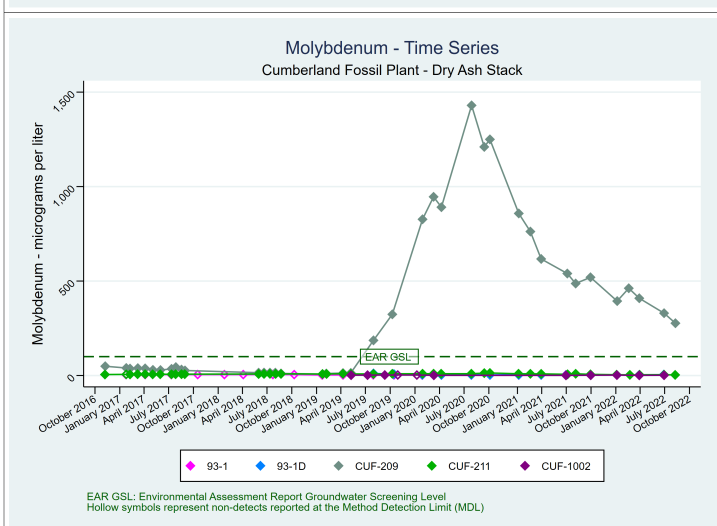


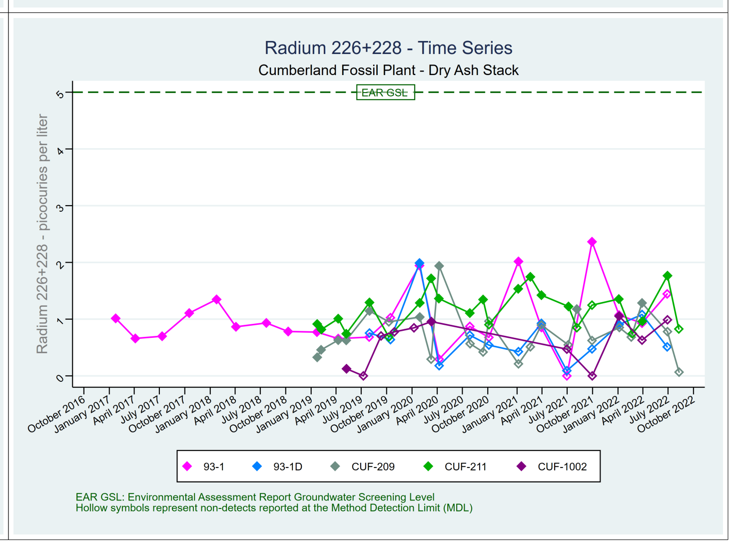

Cobalt - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Cobalt - micrograms per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

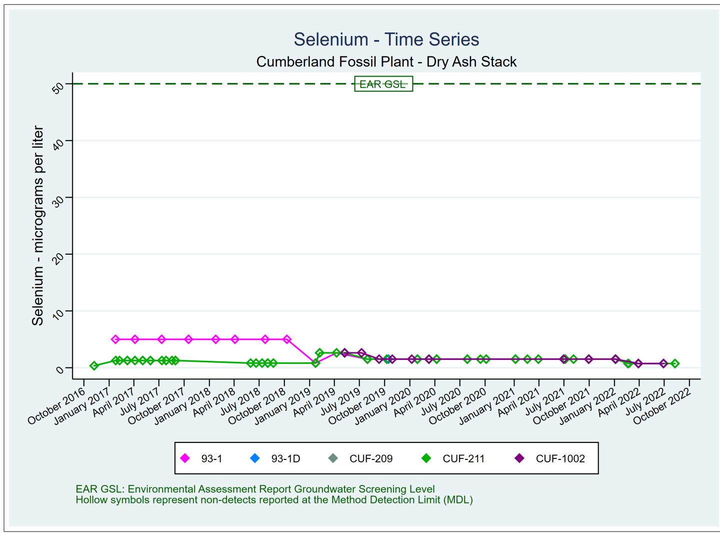

Lead - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Lead - micrograms per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Lithium - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Lithium - micrograms per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

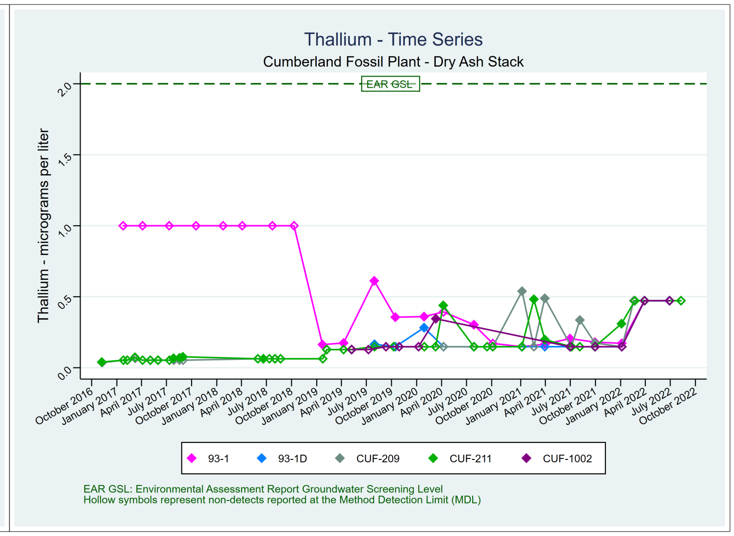

Mercury - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Mercury - micrograms per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Molybdenum - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Molybdenum - micrograms per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Radium 226+228 - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Radium 226+228 - picocuries per liter
EAR GSL
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

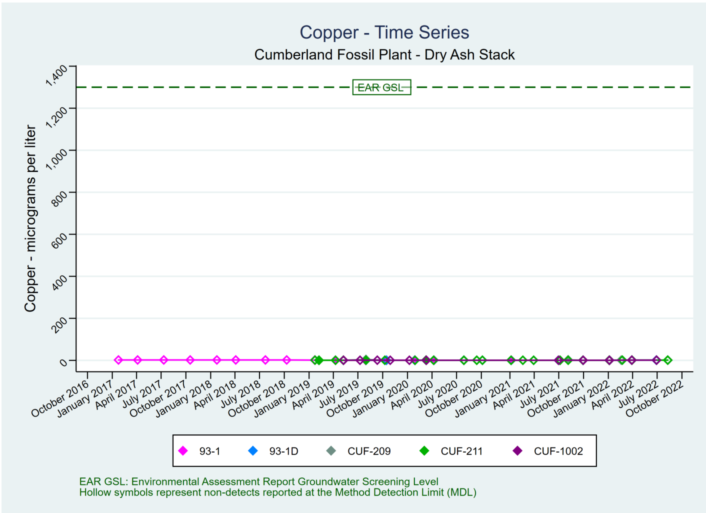


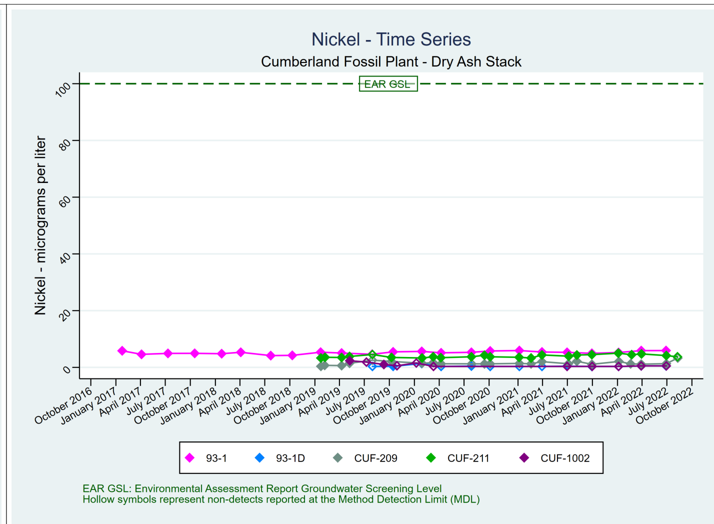
Selenium - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Selenium - micrograms per liter
EAR GSL
0
10
20
30
40
50
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

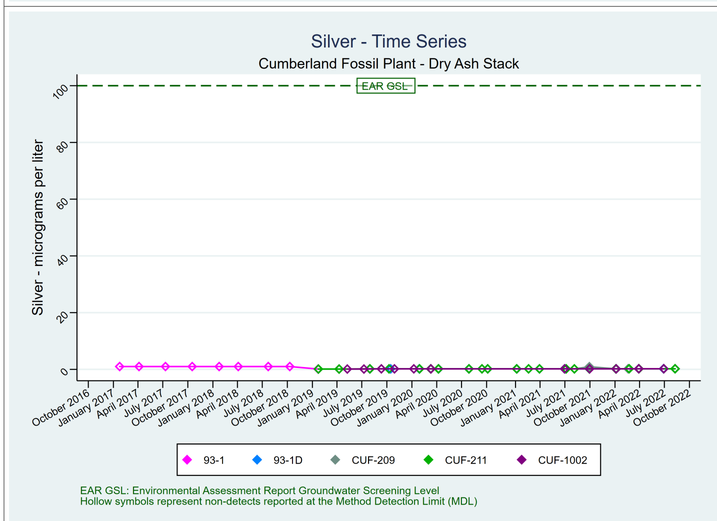


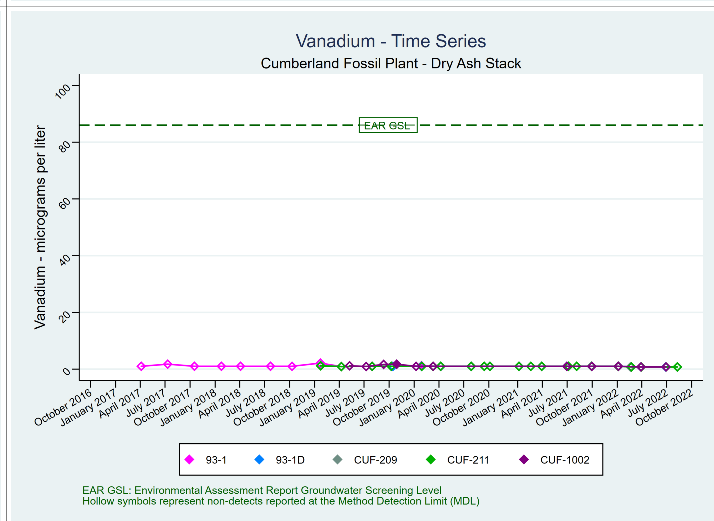
Thallium - Time Series
Cumberland Fossil Plant - Dry Ash Stack
Thallium - micrograms per liter
EAR GSL
0.0
0.5
1.0
1.5
2.0
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
93-1
93-1D
CUF-209
CUF-211
CUF-1002
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

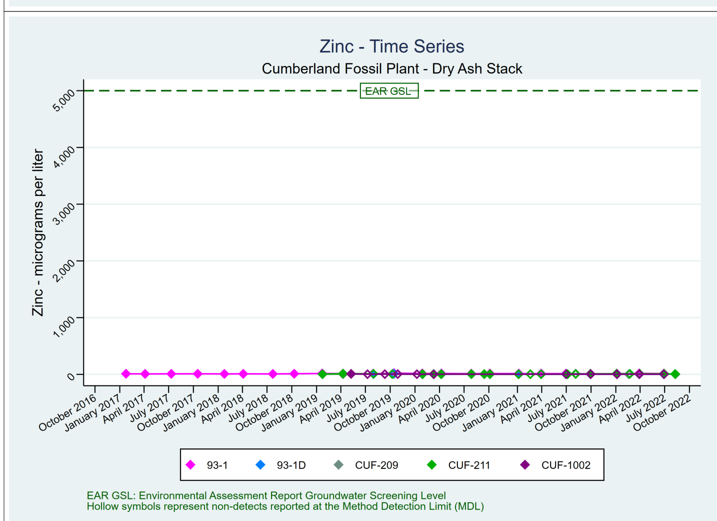
Time Series Plots
Dry Ash Stack
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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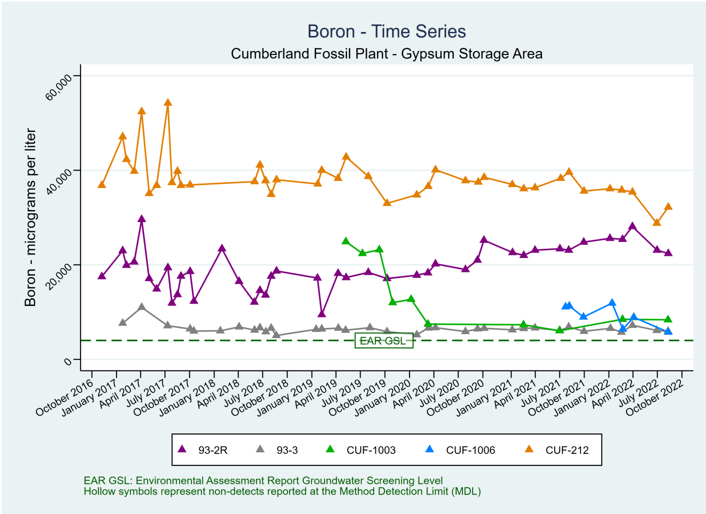
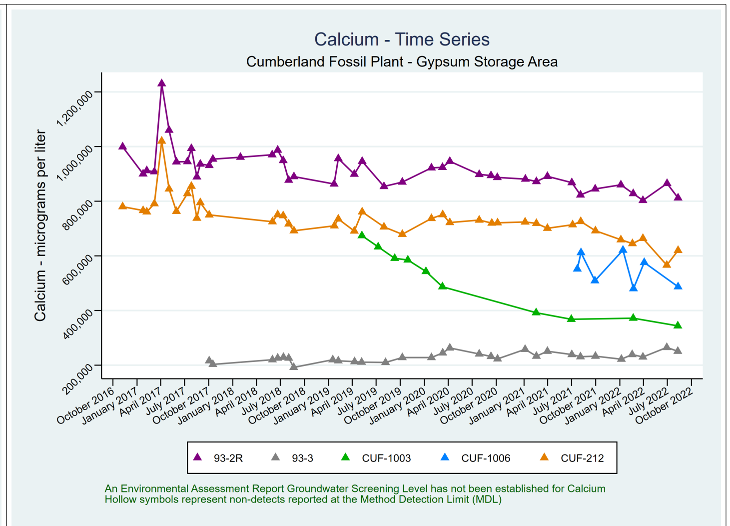
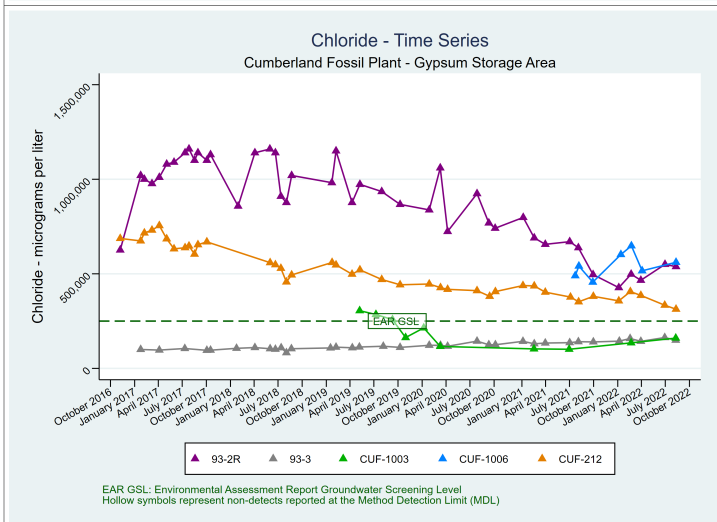
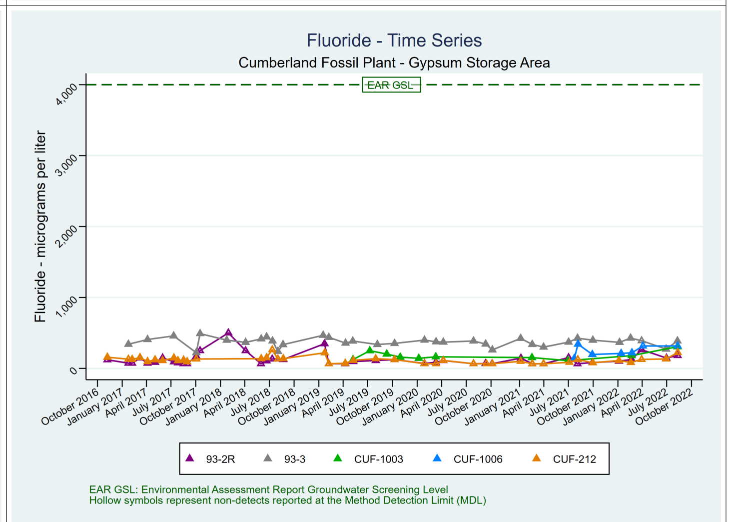
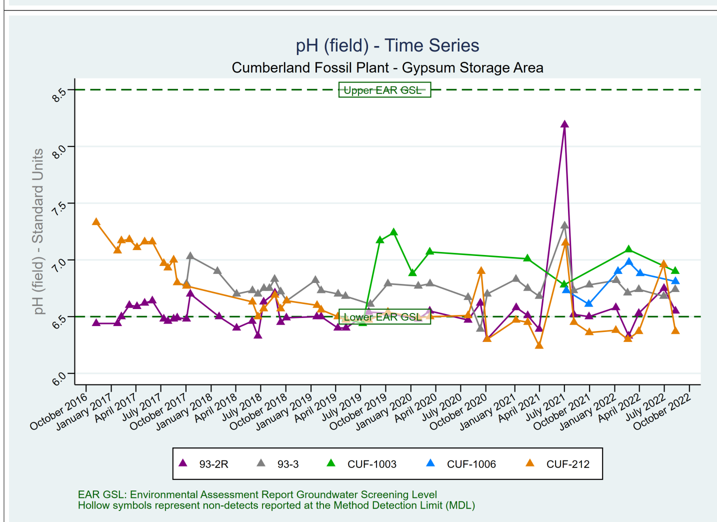
Time Series Plots
Gypsum Storage Area
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

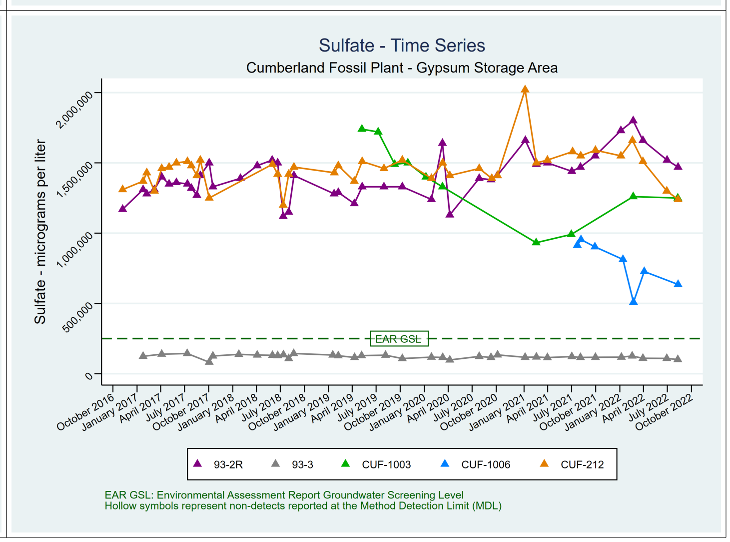


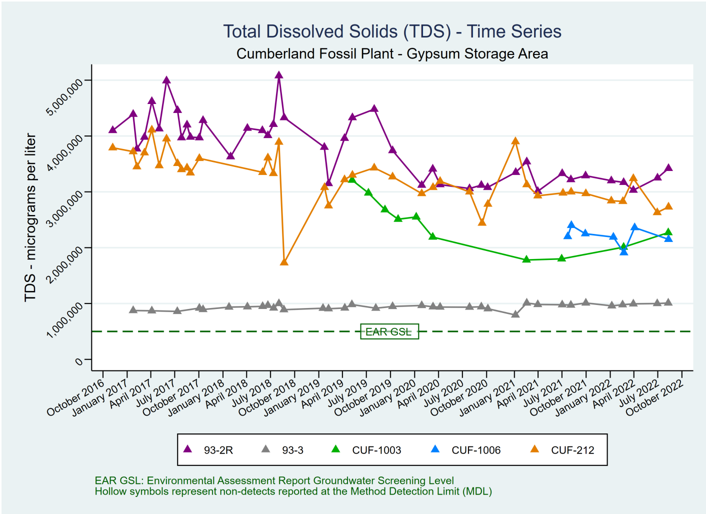












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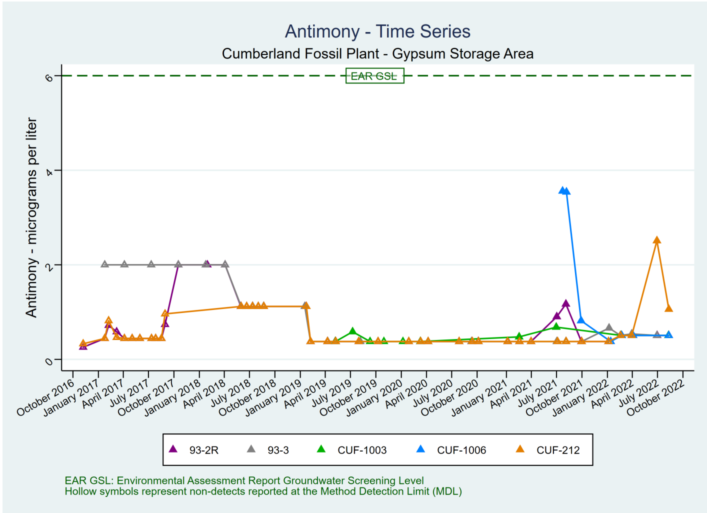
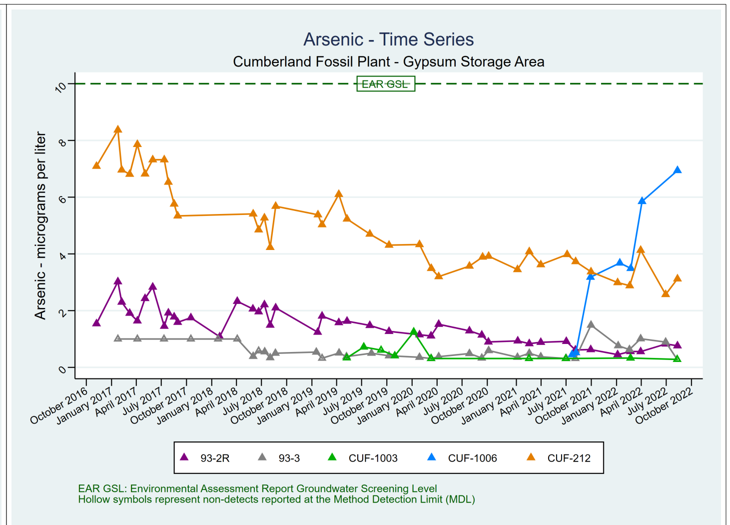
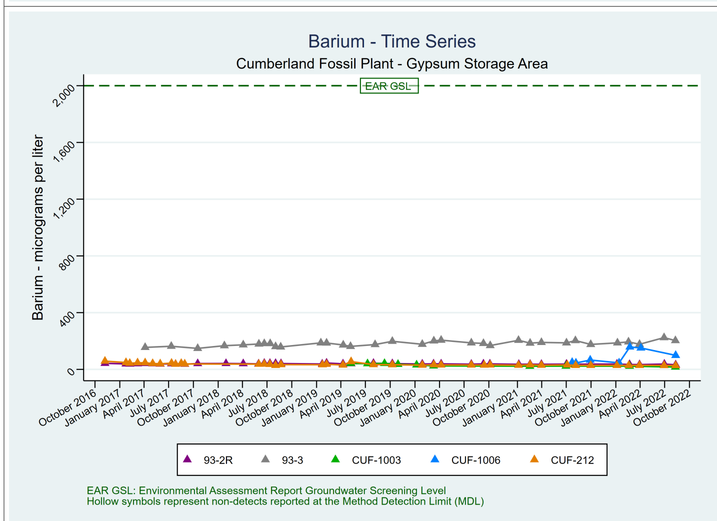
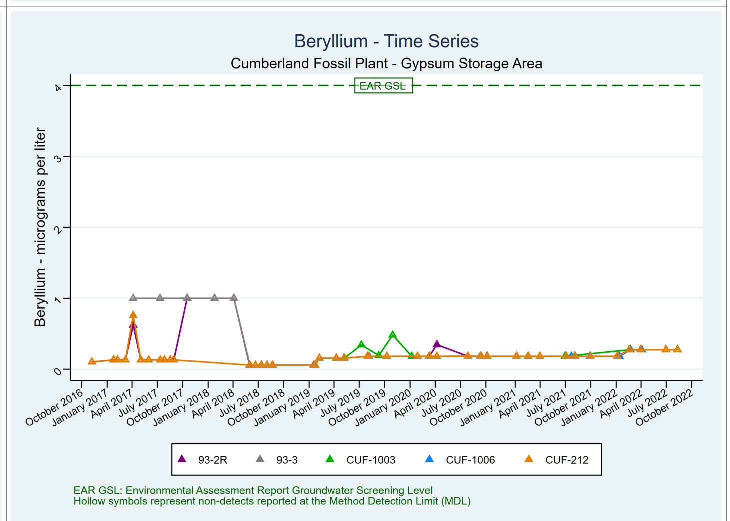
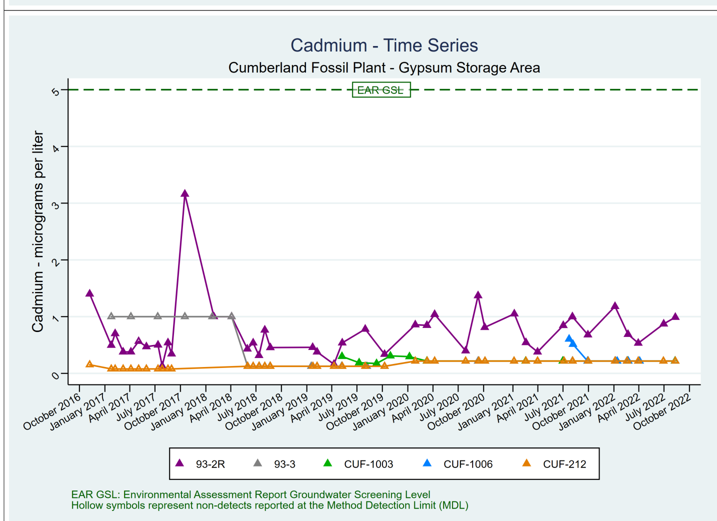
Time Series Plots
Gypsum Storage Area
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

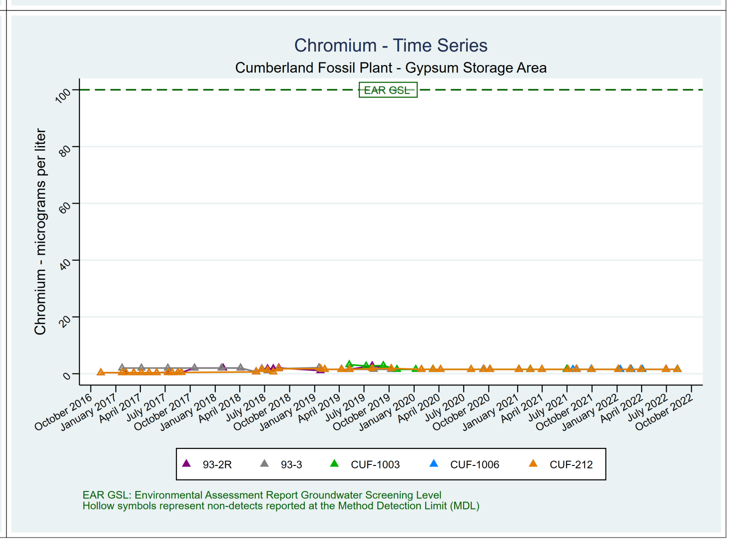


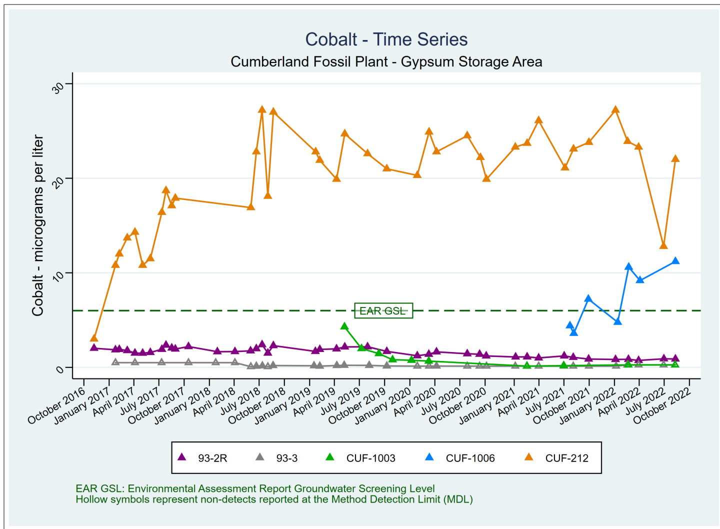


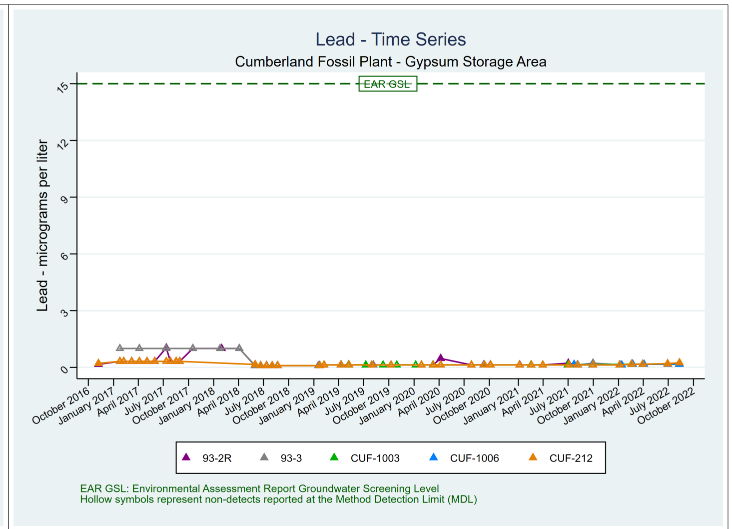


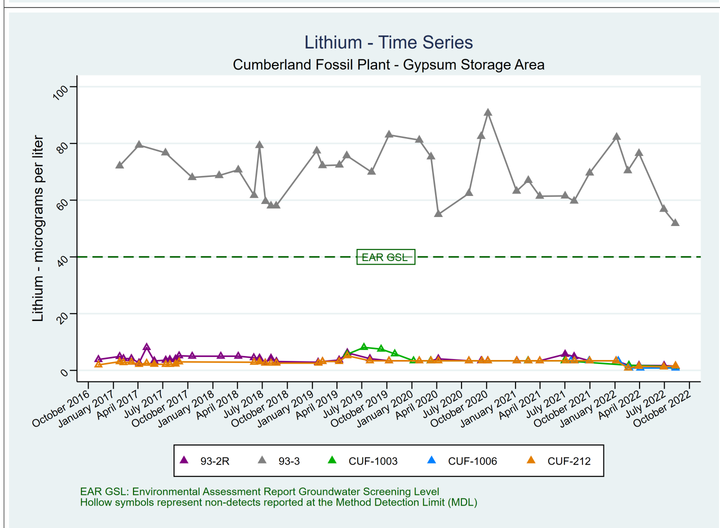


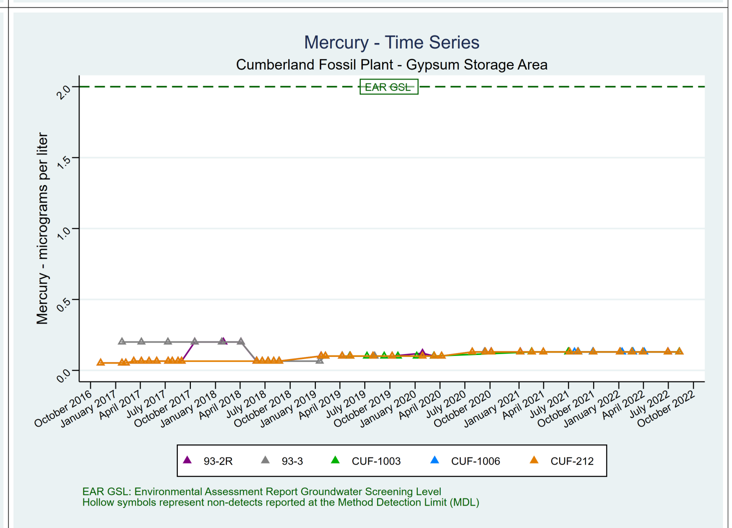


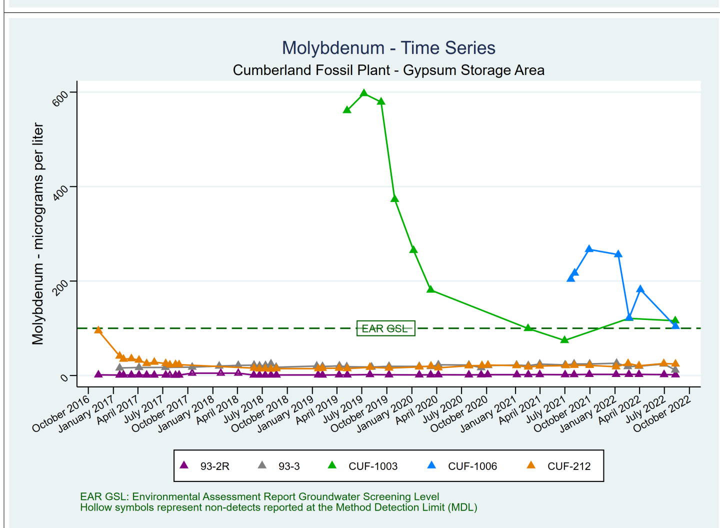


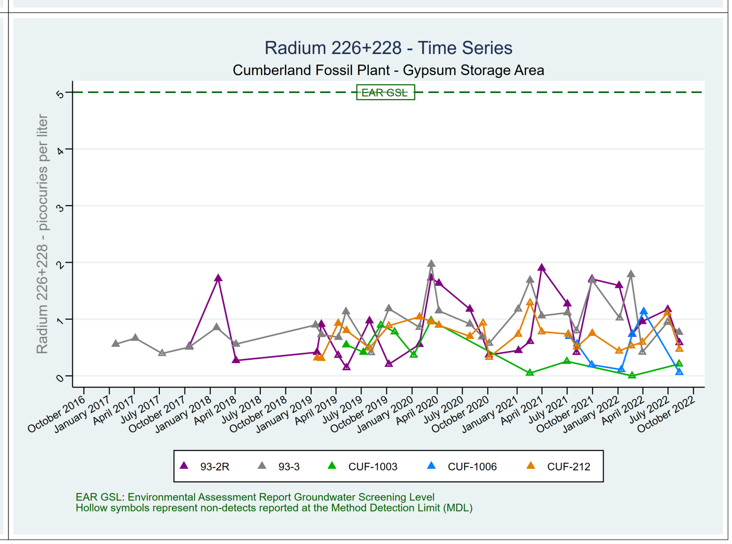

Cobalt - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Cobalt - micrograms per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

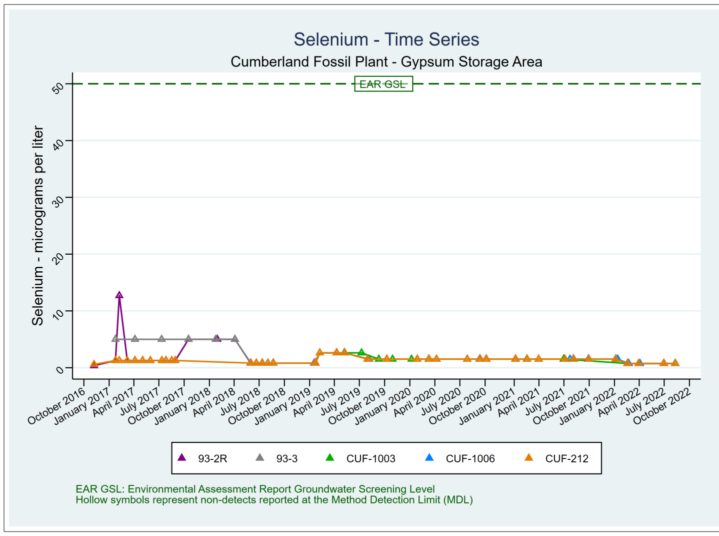

Lead - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Lead - micrograms per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

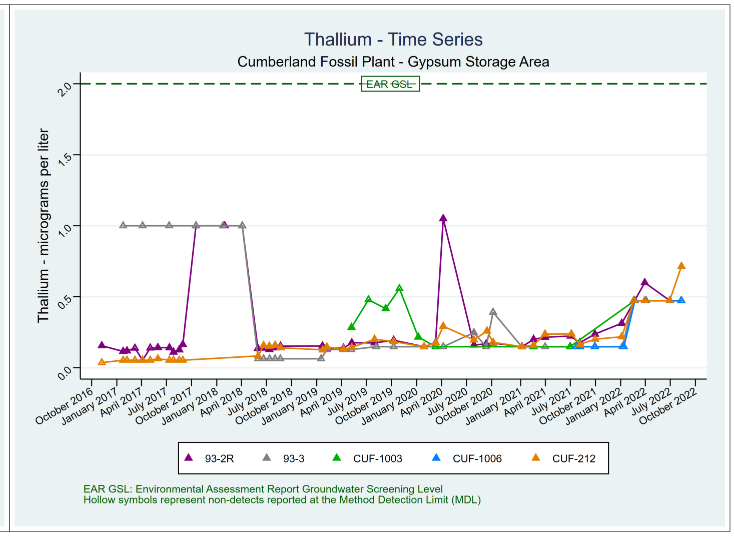

Lithium - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Lithium - micrograms per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Mercury - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Mercury - micrograms per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

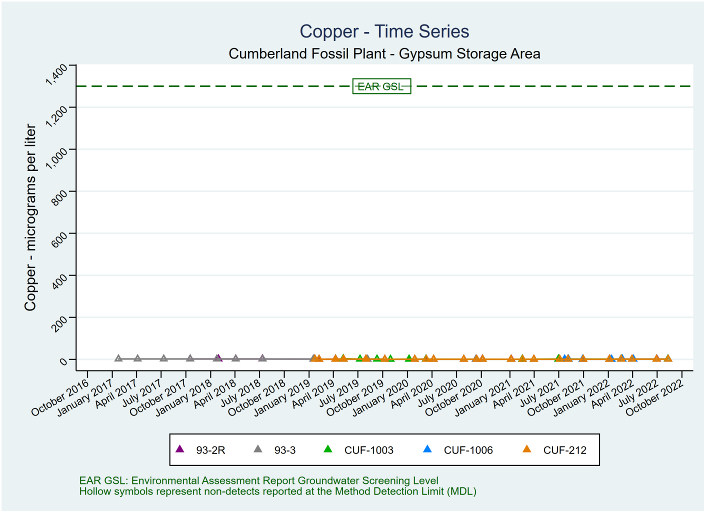

Molybdenum - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Molybdenum - micrograms per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

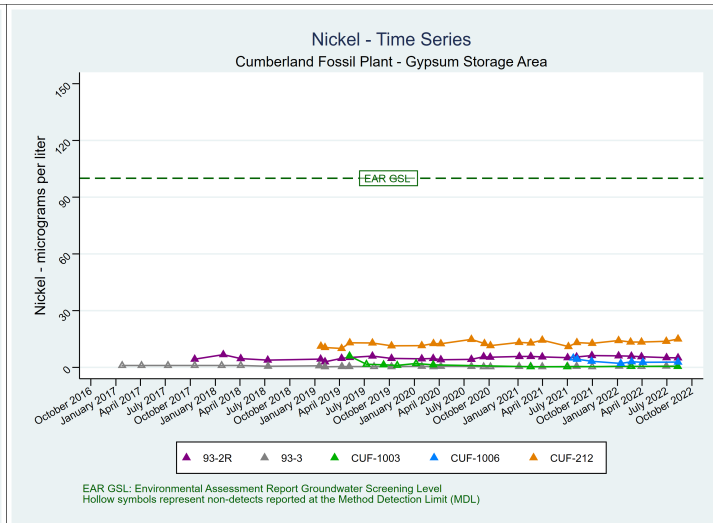

Radium 226+228 - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
Radium 226+228 - picocuries per liter
EAR GSL
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

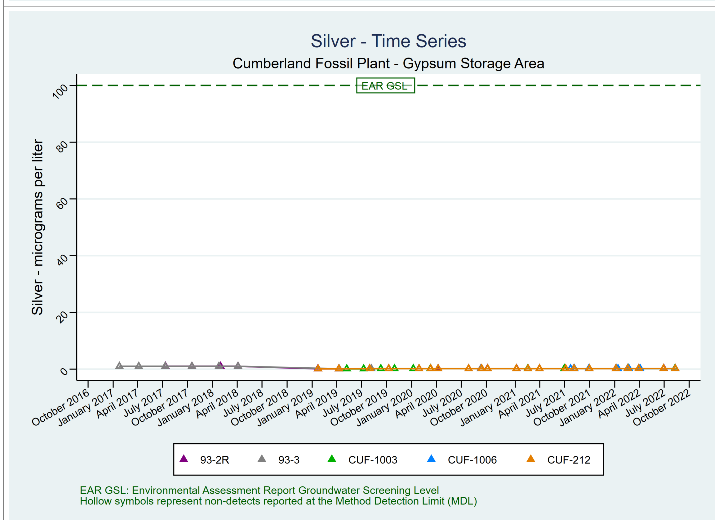

Selenium - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
EAR GSL
Selenium - micrograms per liter
0
10
20
30
40
50
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

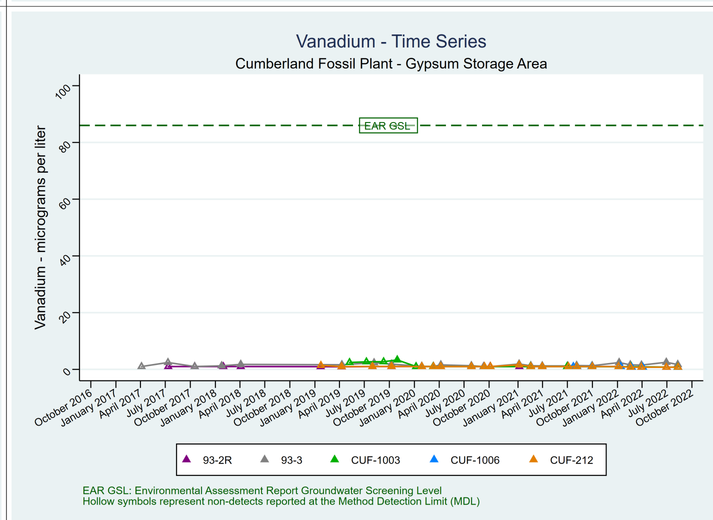

Thallium - Time Series
Cumberland Fossil Plant - Gypsum Storage Area
EAR GSL
Thallium - micrograms per liter
0.0
0.5
1.0
1.5
2.0
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
93-2R
93-3
CUF-1003
CUF-1006
CUF-212
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

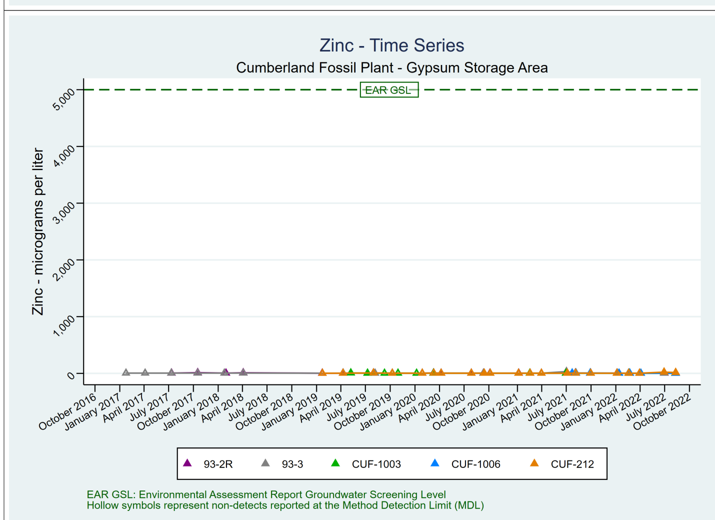
Time Series Plots
Gypsum Storage Area
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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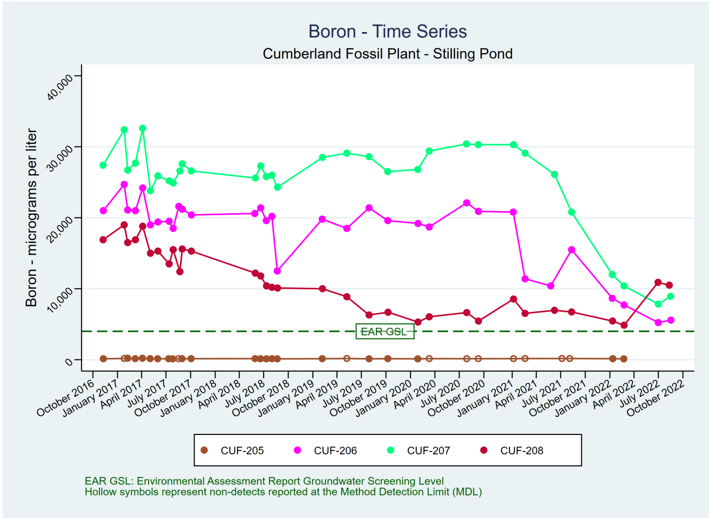
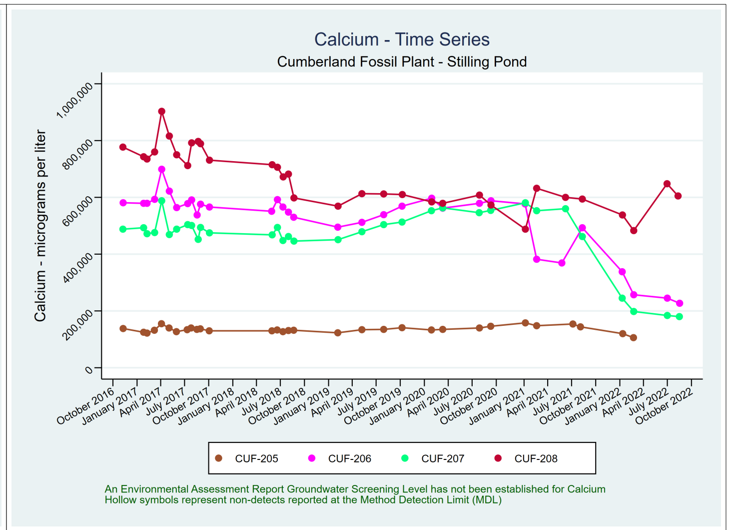
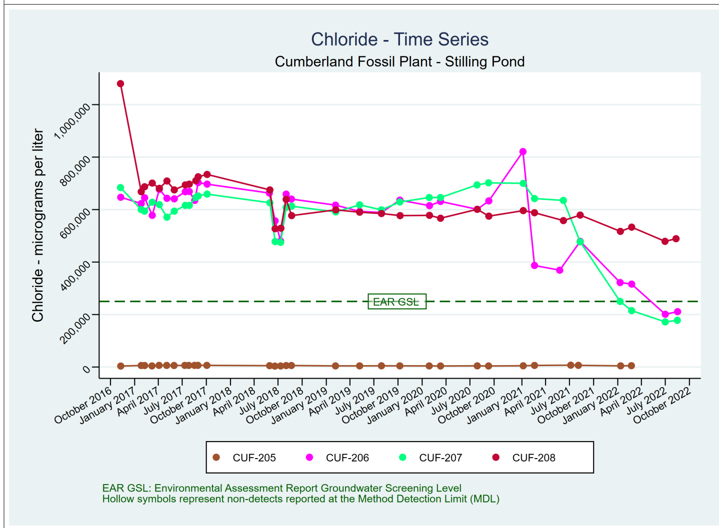
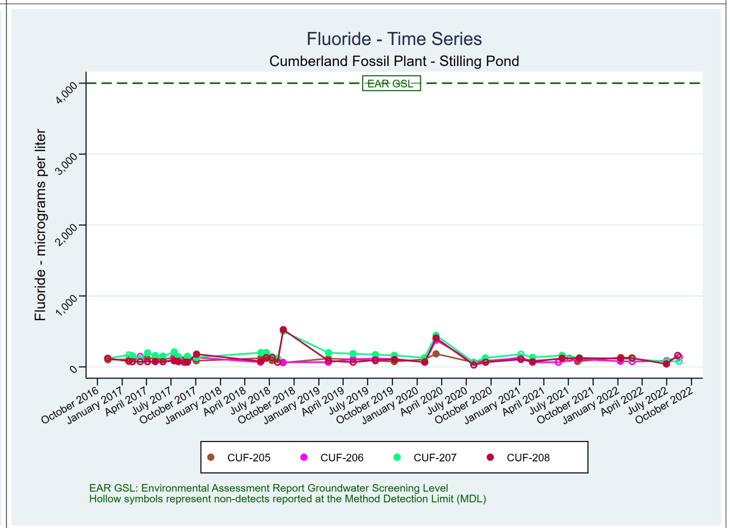
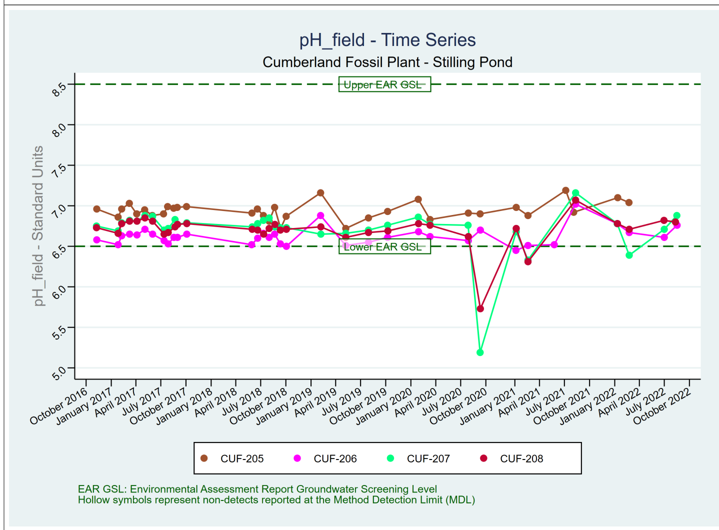
Time Series Plots
Stilling Pond
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

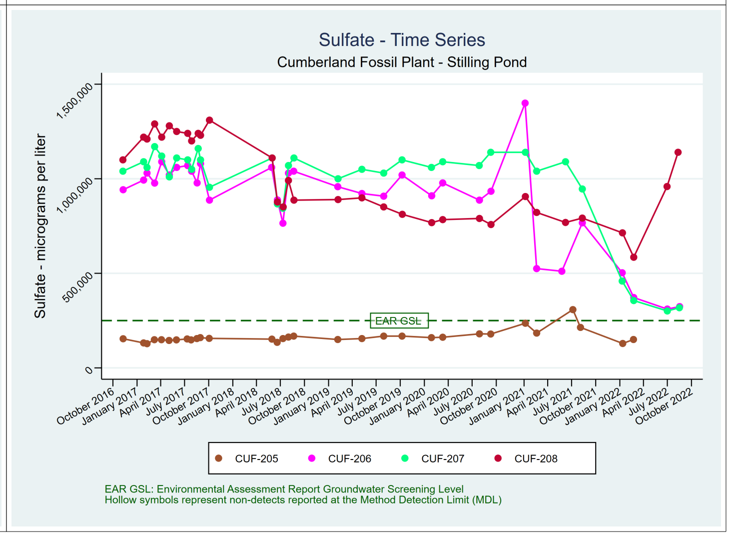


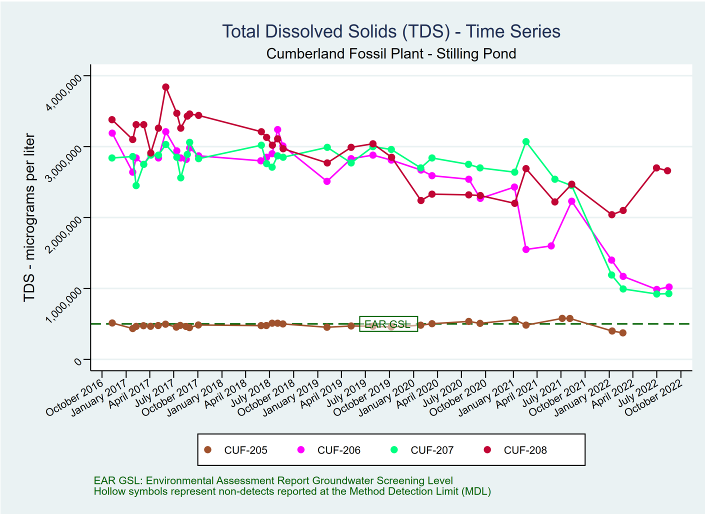












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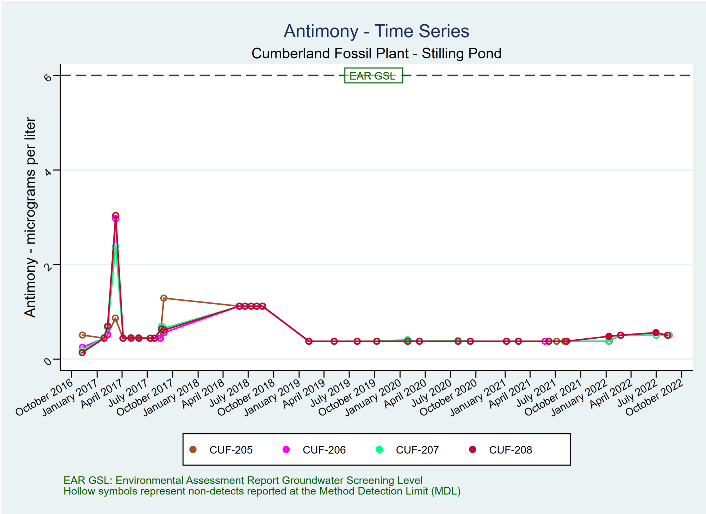
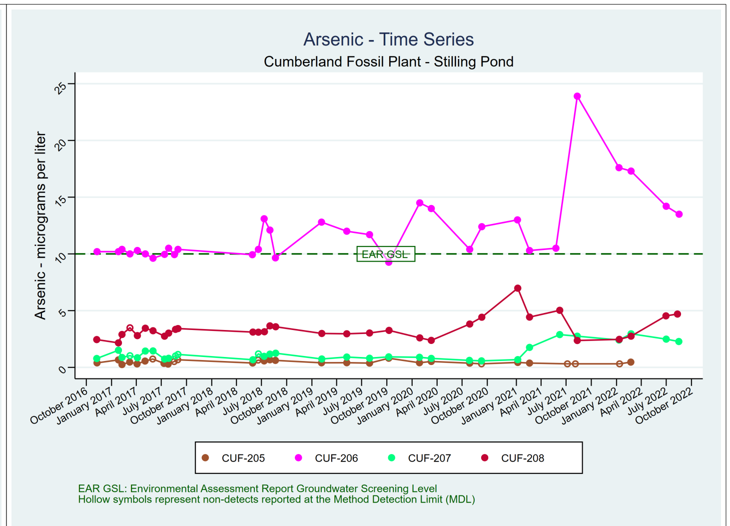
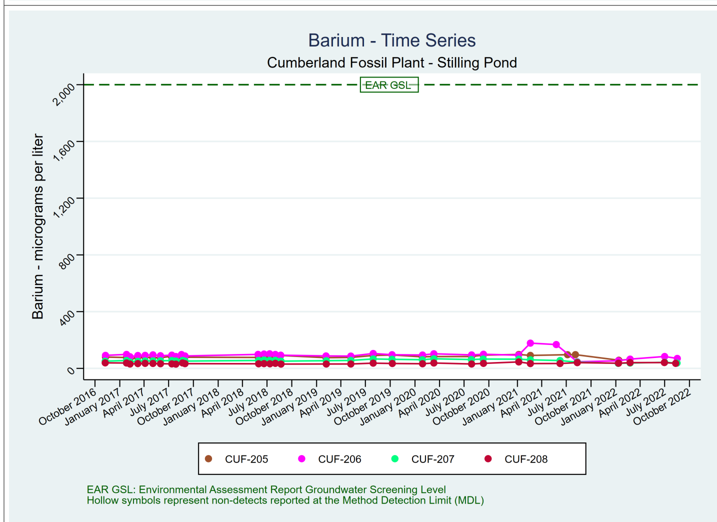
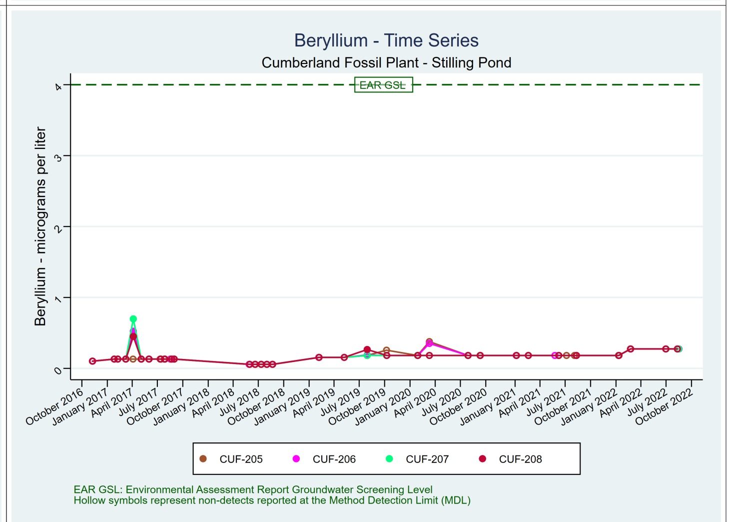
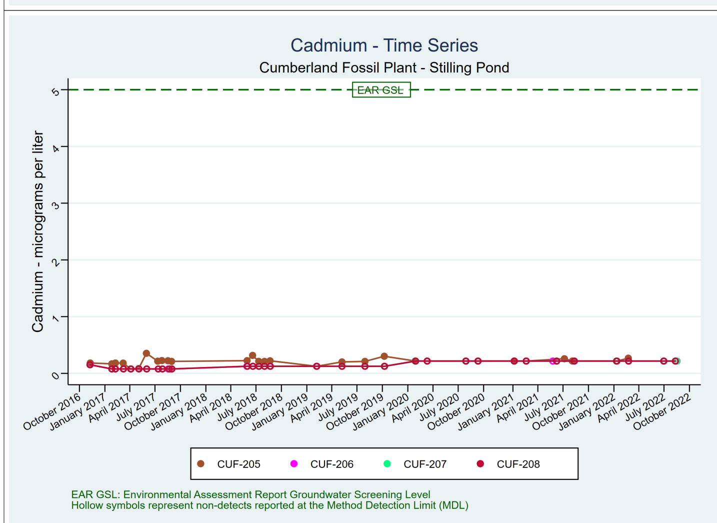
Time Series Plots
Stilling Pond
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

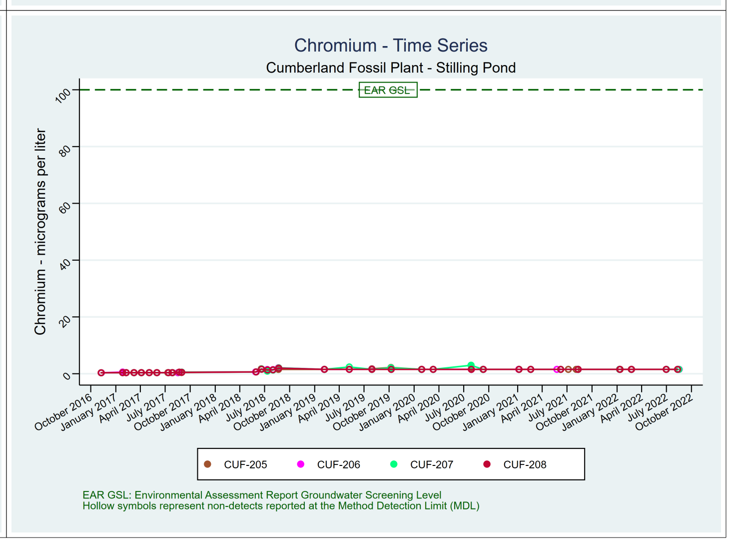


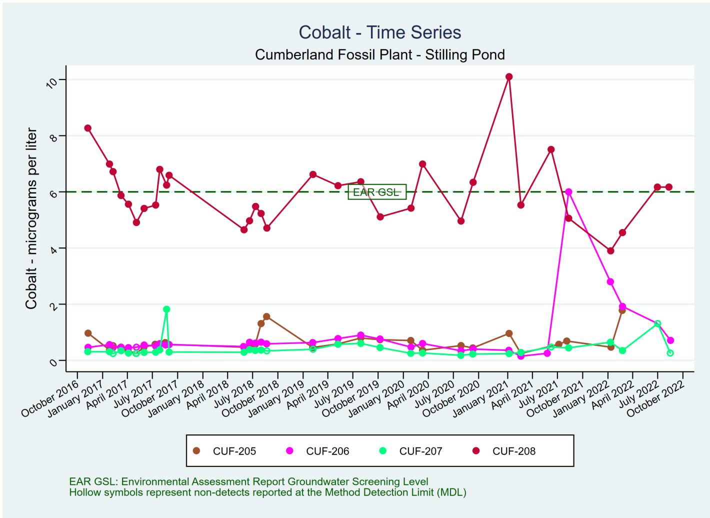


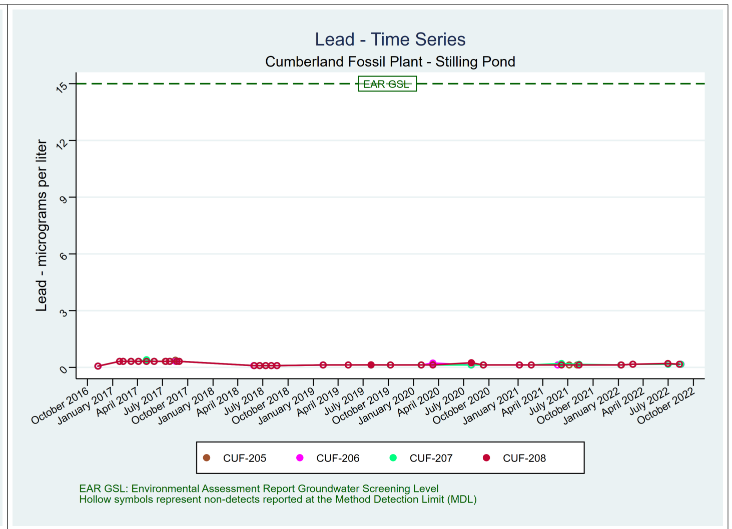


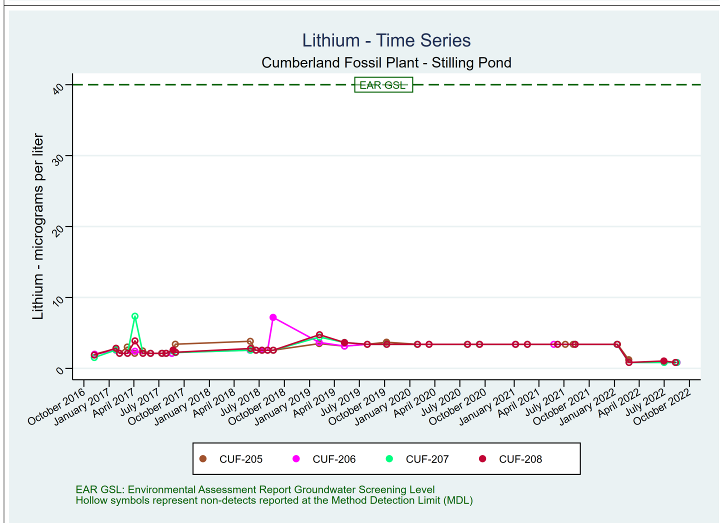


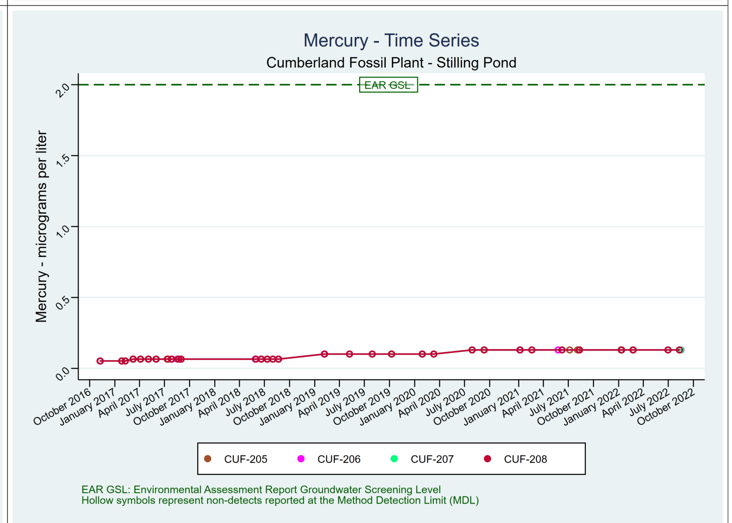


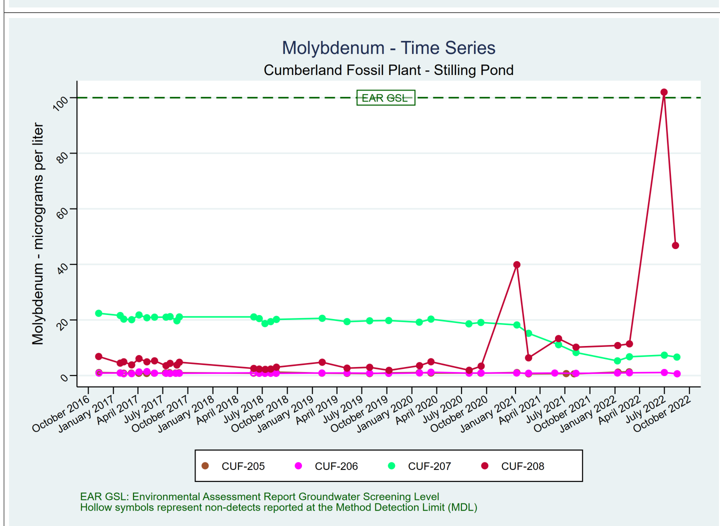


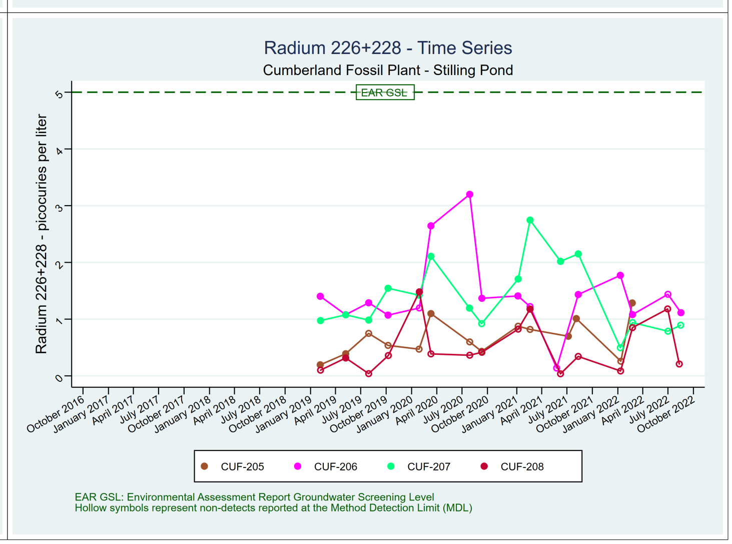

Cobalt - Time Series
Cumberland Fossil Plant - Stilling Pond
Cobalt - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

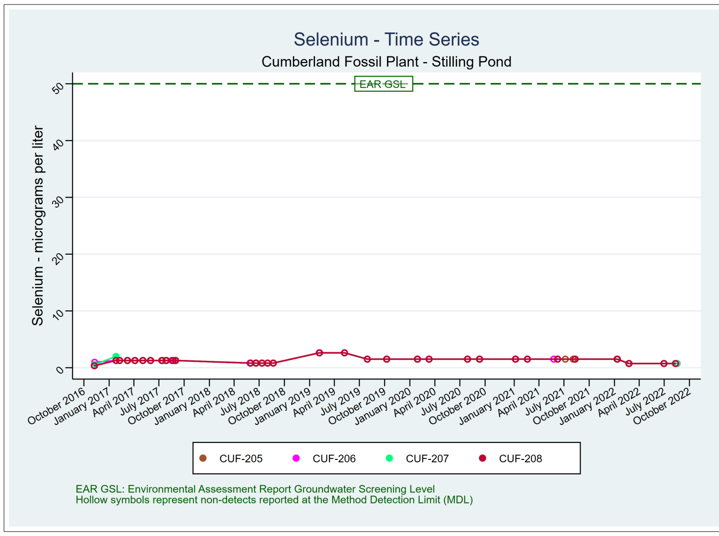

Lead - Time Series
Cumberland Fossil Plant - Stilling Pond
Lead - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Lithium - Time Series
Cumberland Fossil Plant - Stilling Pond
Lithium - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

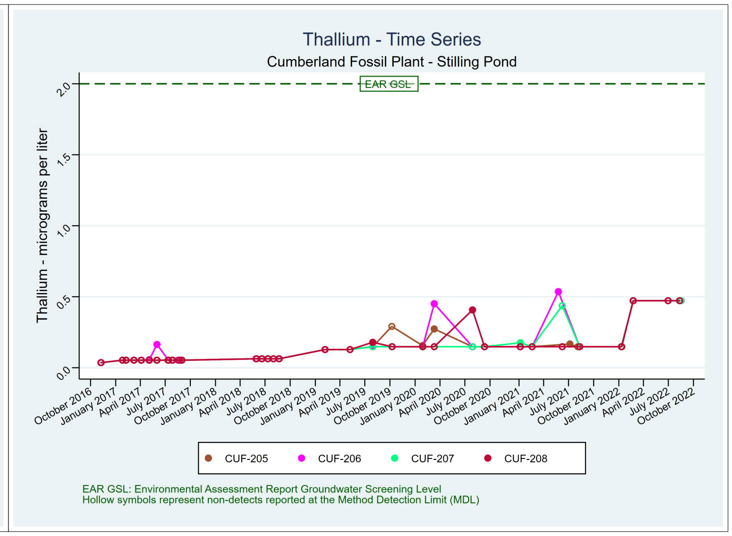

Mercury - Time Series
Cumberland Fossil Plant - Stilling Pond
Mercury - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Molybdenum - Time Series
Cumberland Fossil Plant - Stilling Pond
Molybdenum - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)


Radium 226+228 - Time Series
Cumberland Fossil Plant - Stilling Pond
Radium 226+228 - picocuries per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

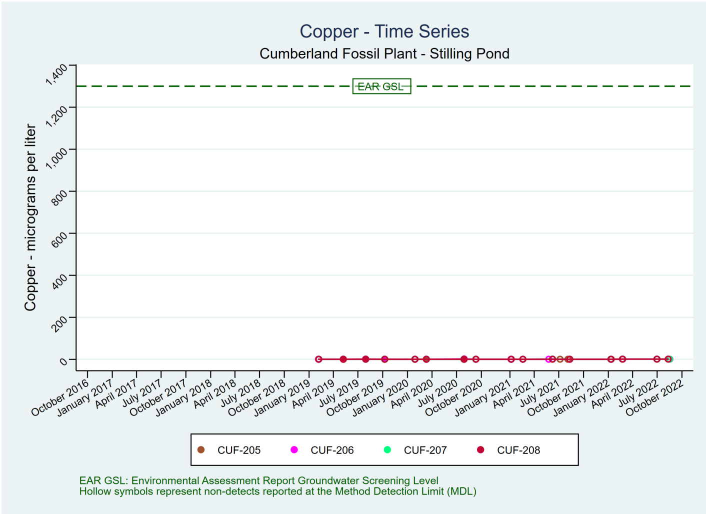


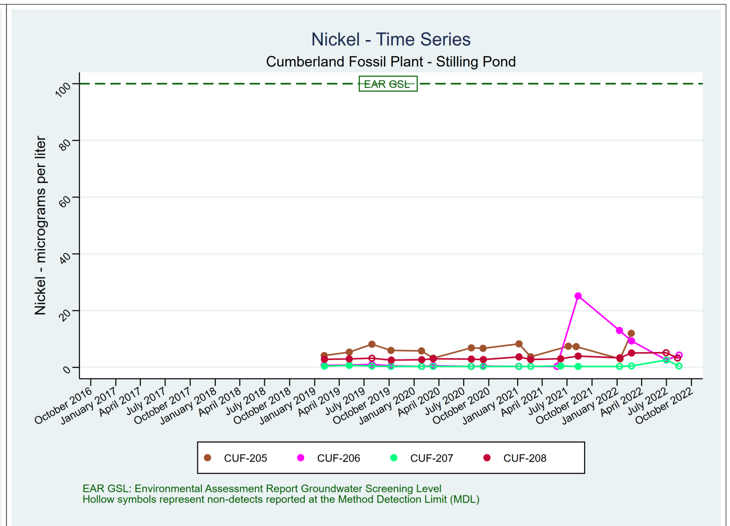
Selenium - Time Series
Cumberland Fossil Plant - Stilling Pond
Selenium - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

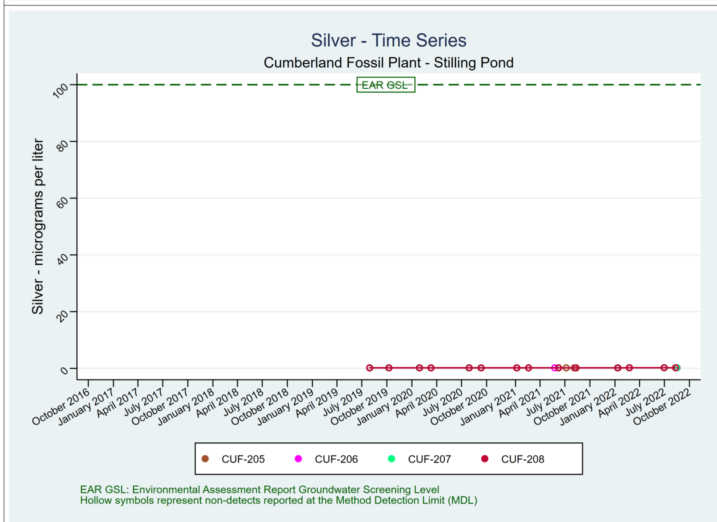


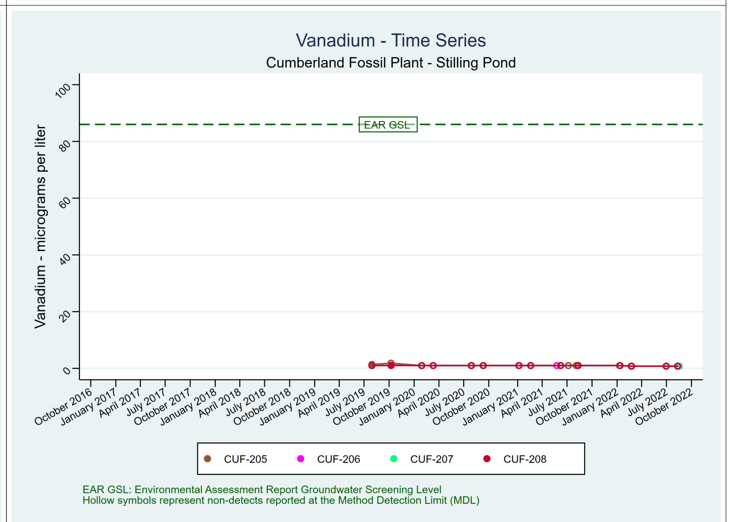
Thallium - Time Series
Cumberland Fossil Plant - Stilling Pond
Thallium - micrograms per liter
EAR GSL
CUF-205
CUF-206
CUF-207
CUF-208
EAR GSL: Environmental Assessment Report Groundwater Screening Level
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)

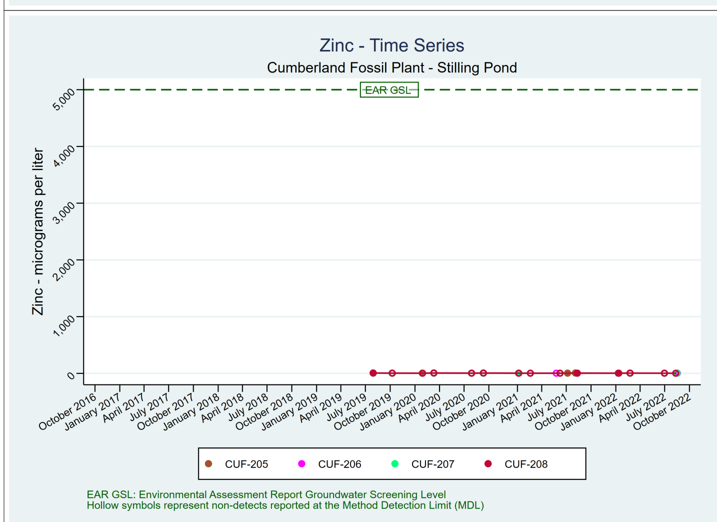
Time Series Plots
Stilling Pond
TDEC Appendix I Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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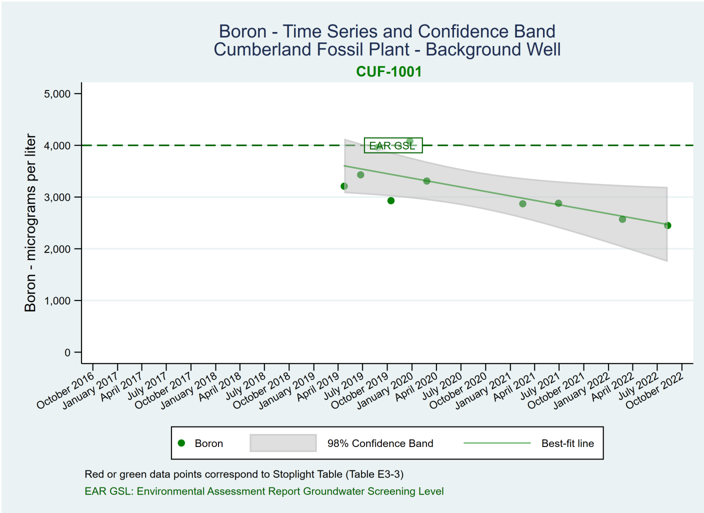
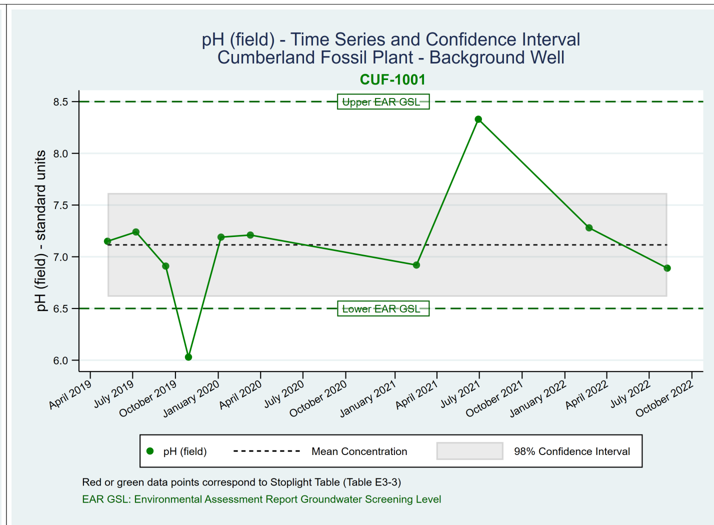
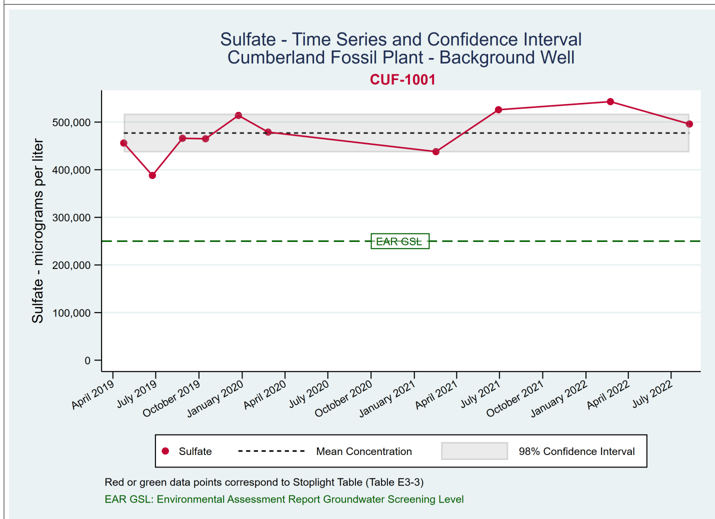
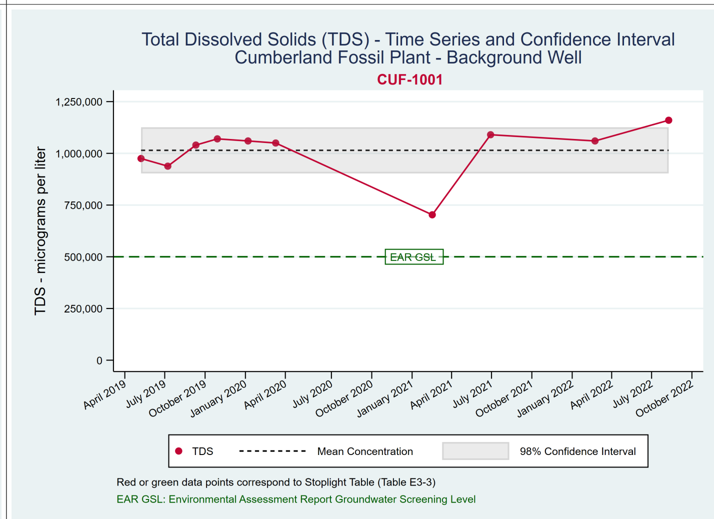
ATTACHMENT E.3-E
LINEAR REGRESSION PLOTS

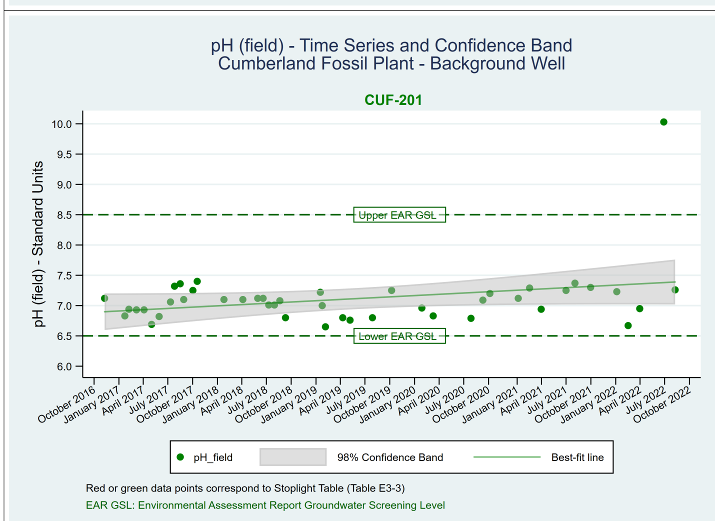
Regression Plots
Background Wells
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

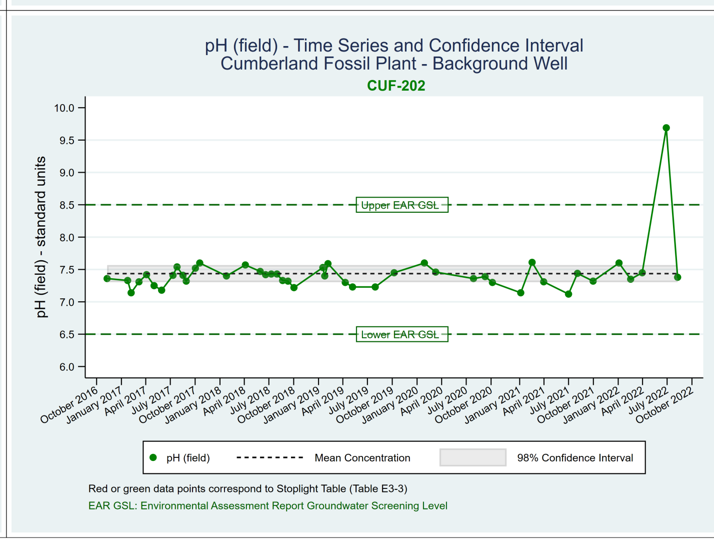




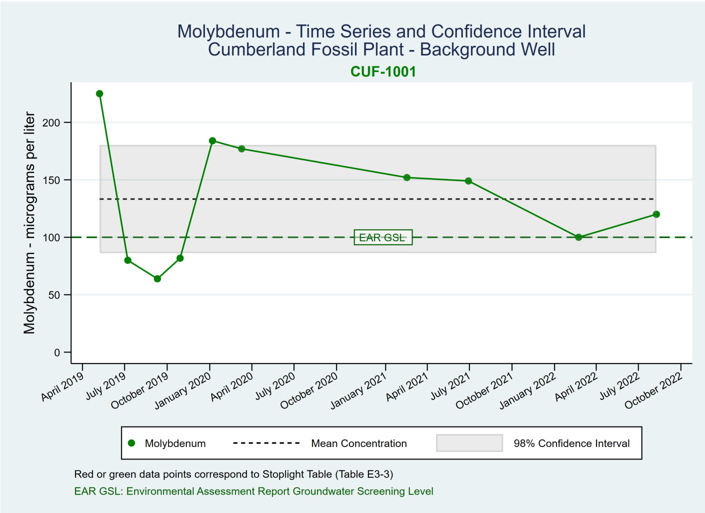








Regression Plots
Background Wells
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee



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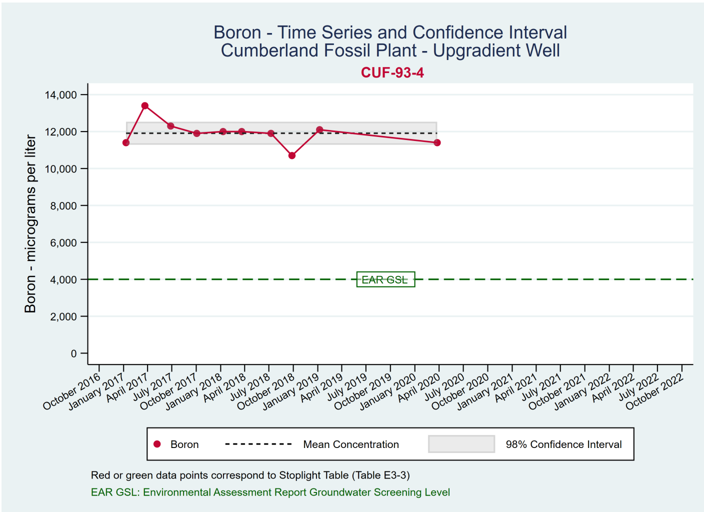
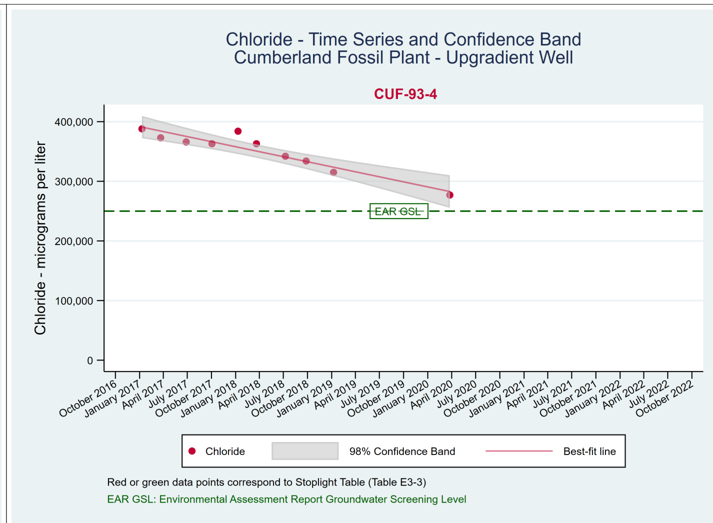
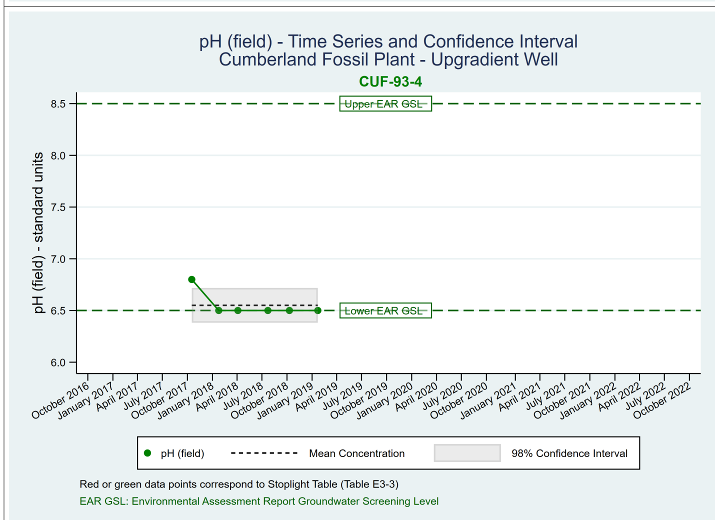
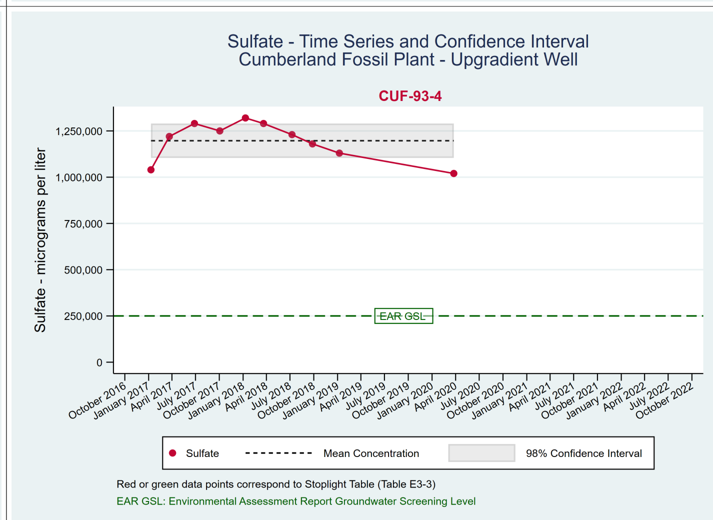
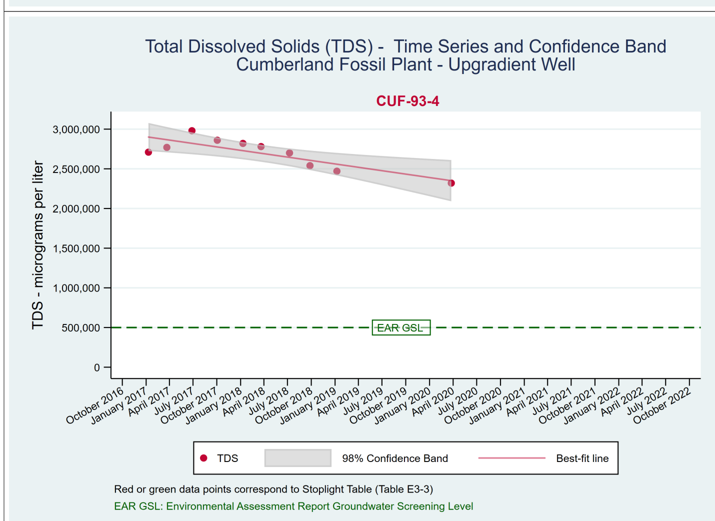
Regression Plots
Upgradient Well
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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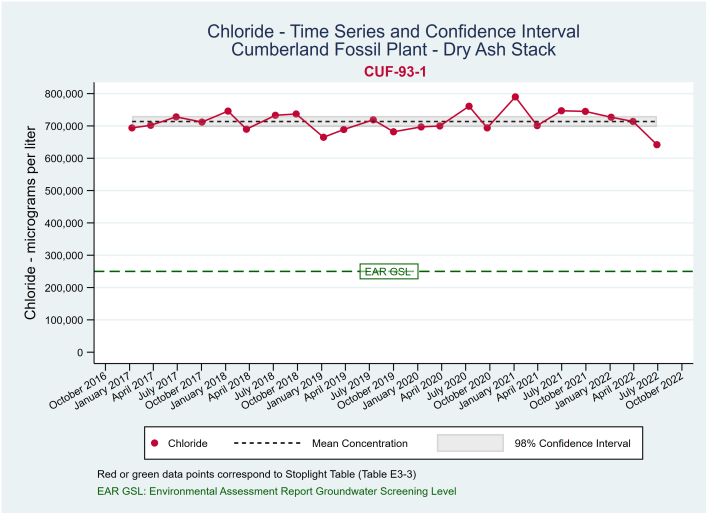
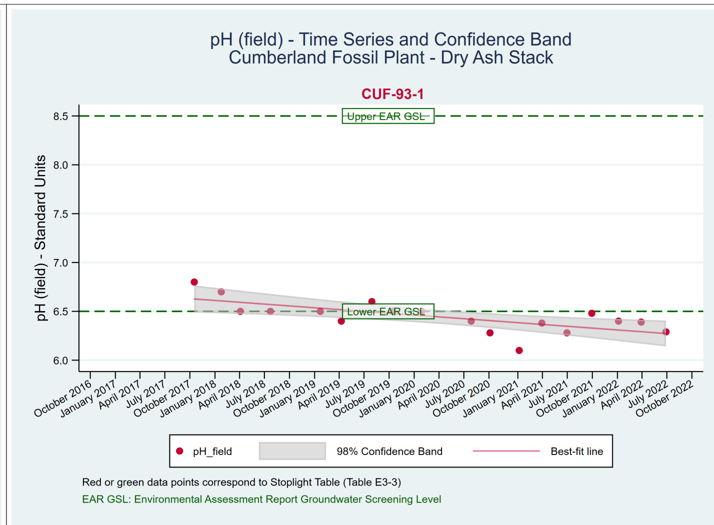
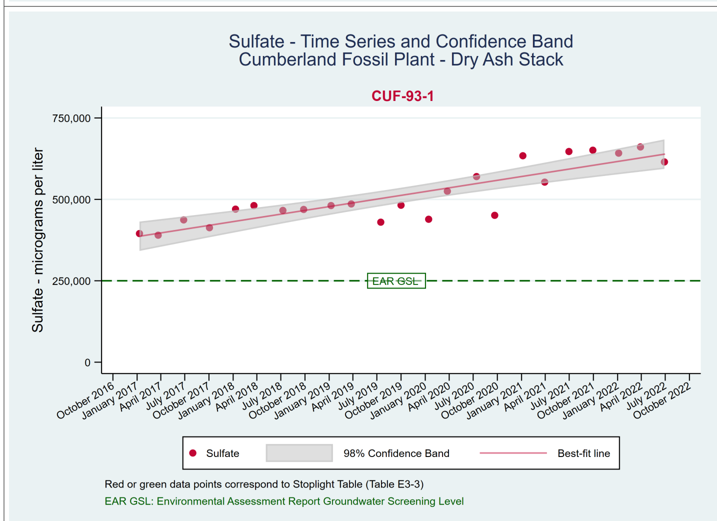
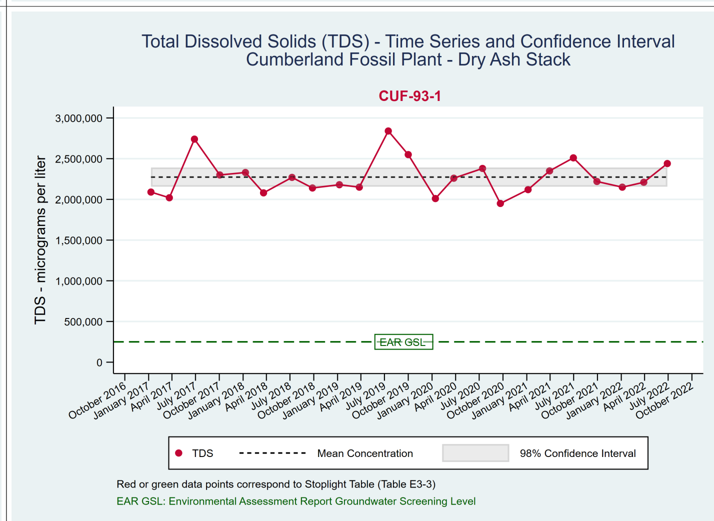
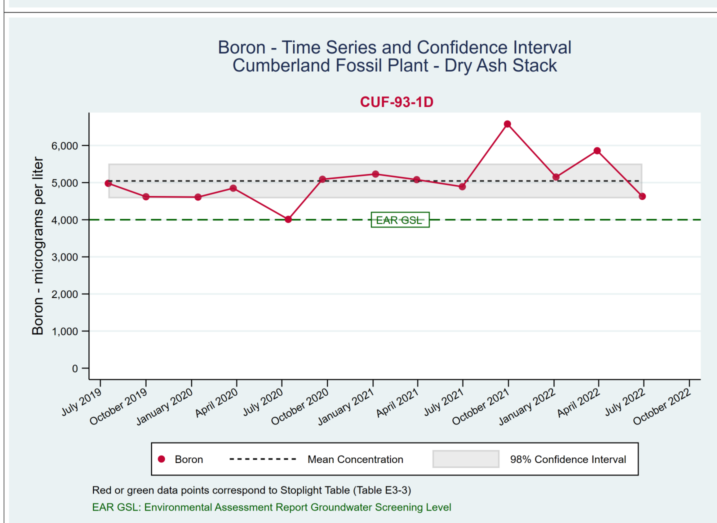
Regression Plots
Dry Ash Stack
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

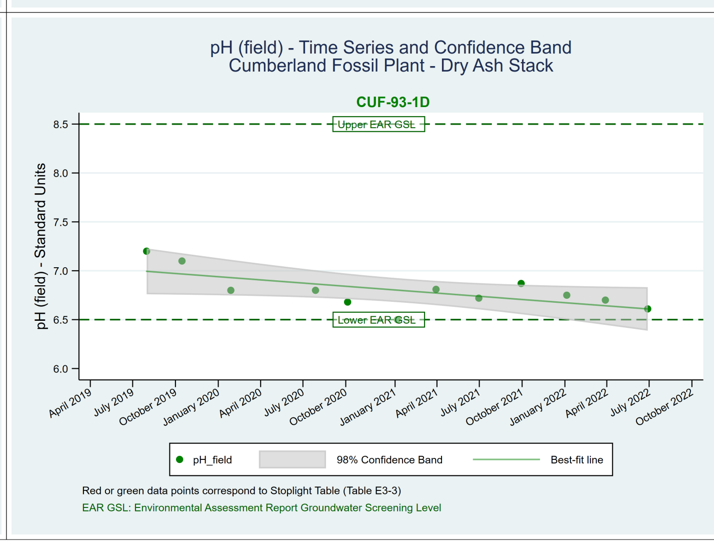


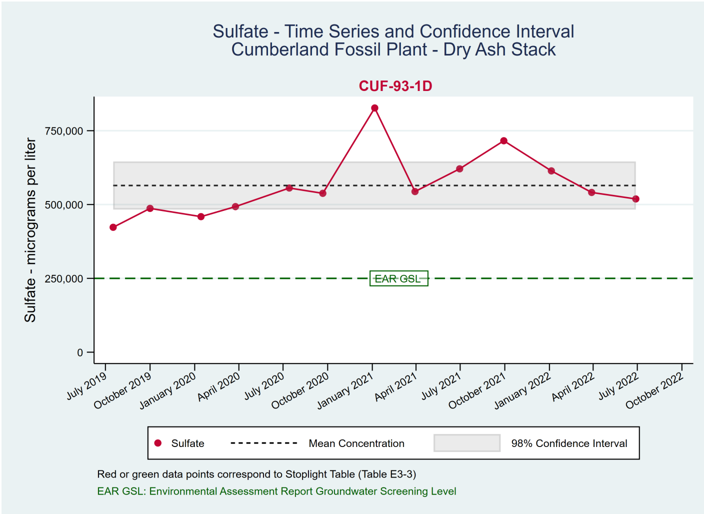


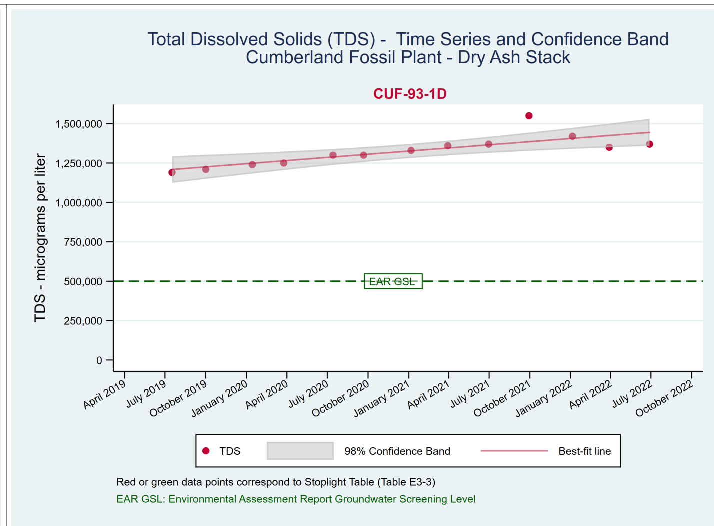


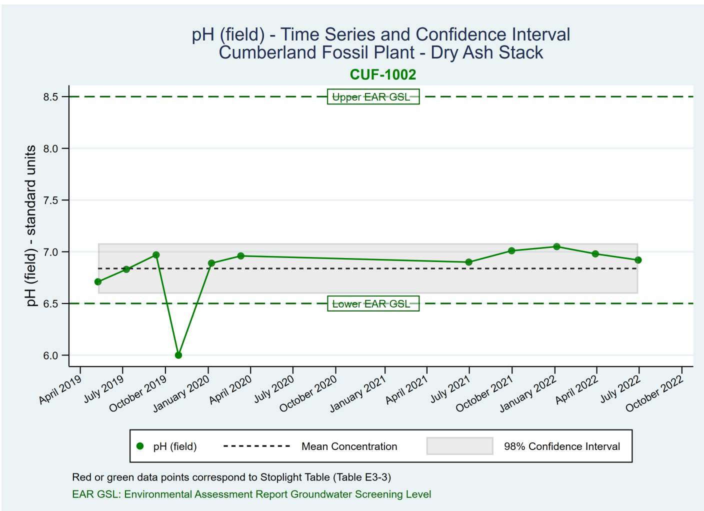


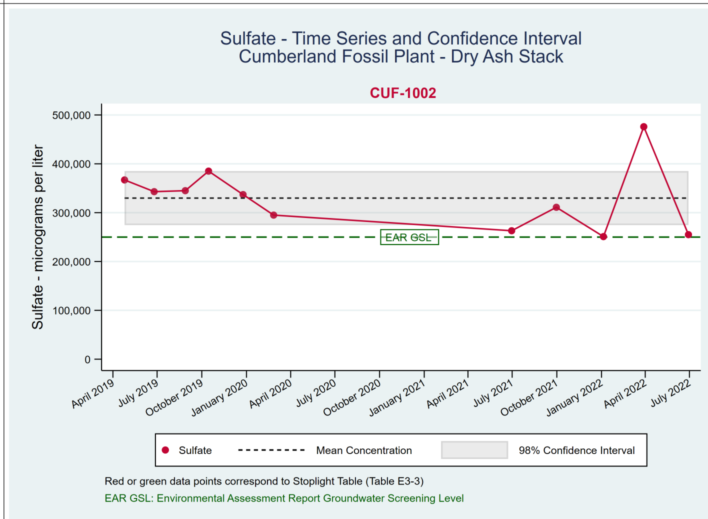


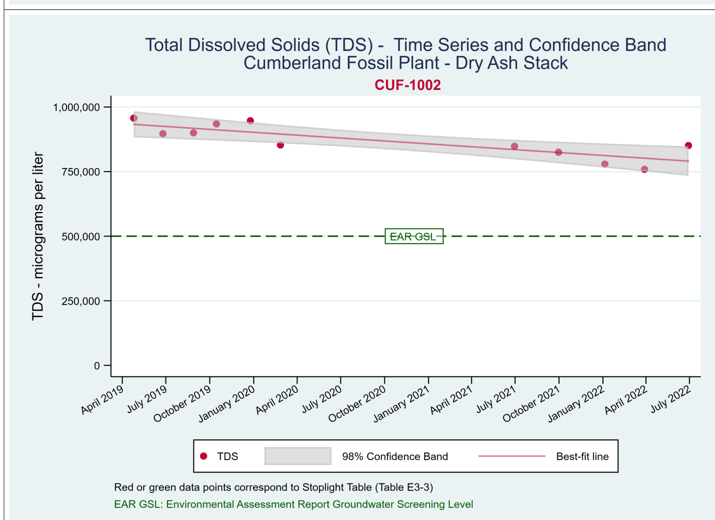


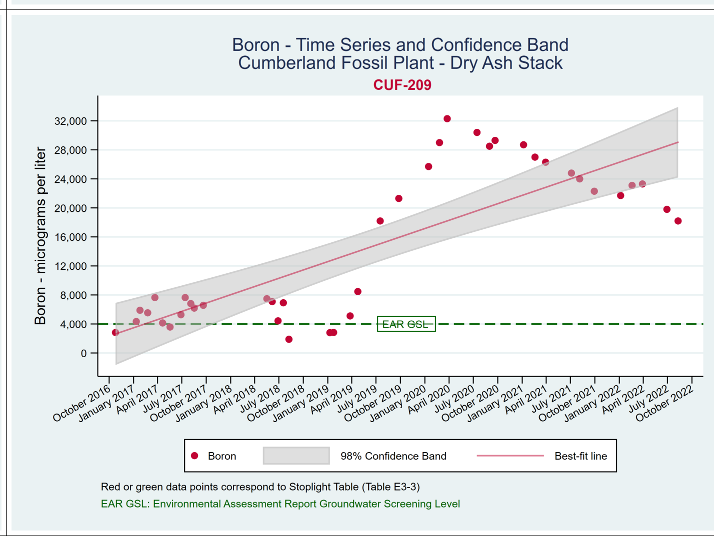

Sulfate - Time Series and Confidence Interval
Cumberland Fossil Plant - Dry Ash Stack
CUF-93-1D
Sulfate - micrograms per liter
EAR GSL
Sulfate
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

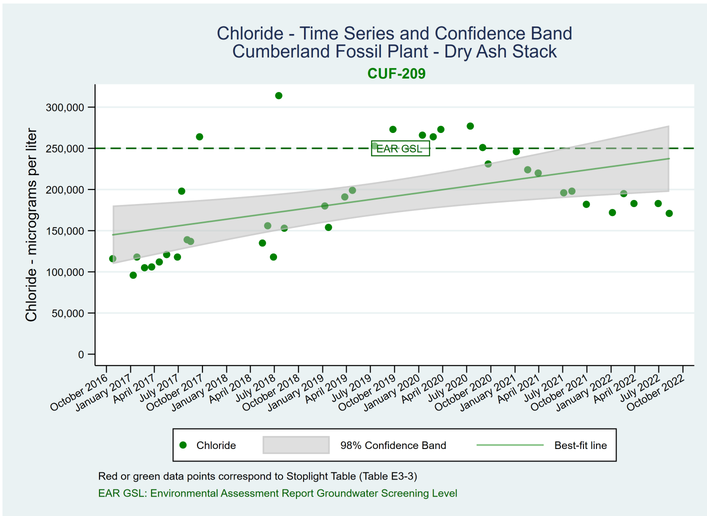

Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-93-1D
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

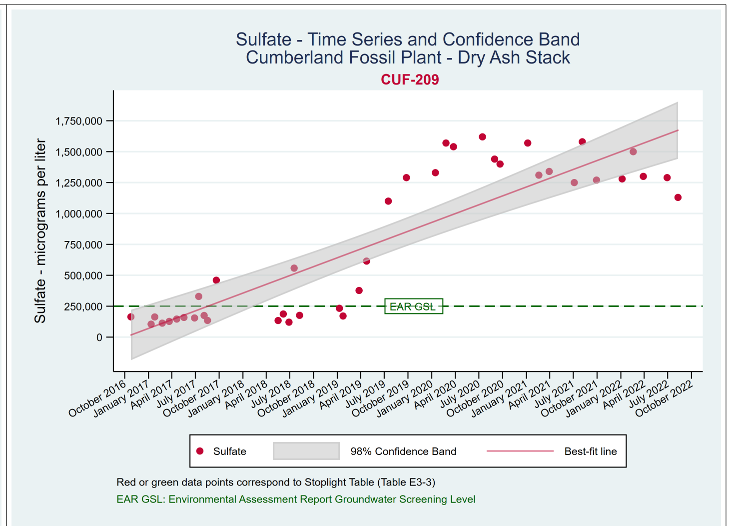

pH (field) - Time Series and Confidence Interval
Cumberland Fossil Plant - Dry Ash Stack
CUF-1002
pH (field) - standard units
Upper EAR GSL
Lower EAR GSL
pH (field)
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

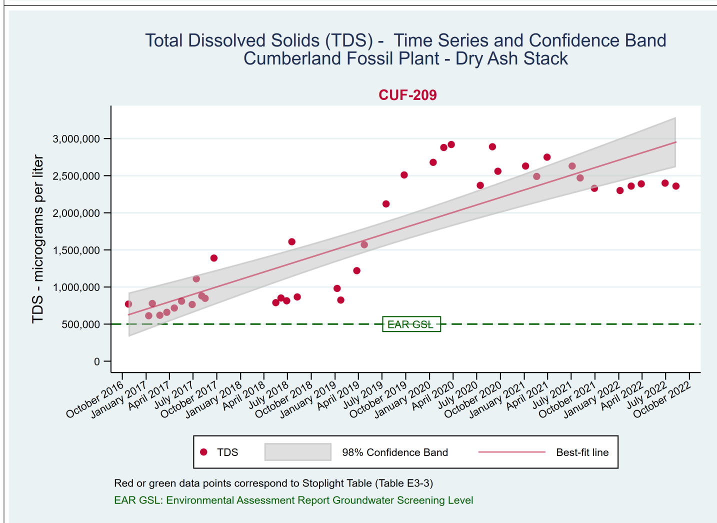

Sulfate - Time Series and Confidence Interval
Cumberland Fossil Plant - Dry Ash Stack
CUF-1002
Sulfate - micrograms per liter
EAR GSL
Sulfate
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

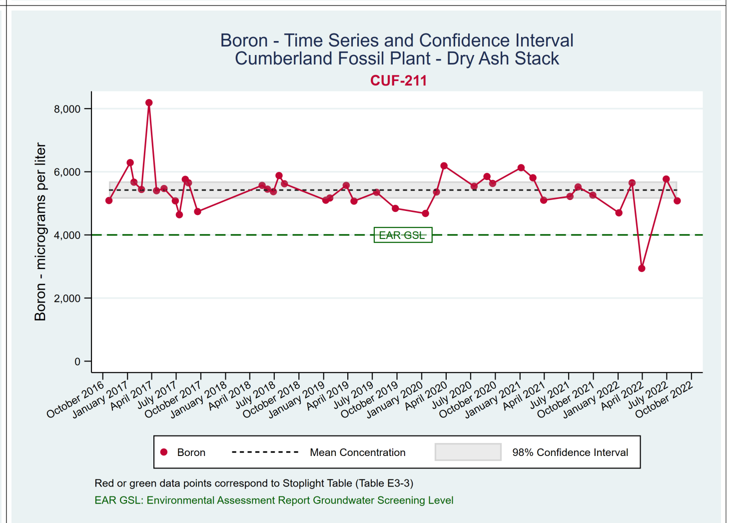

Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-1002
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

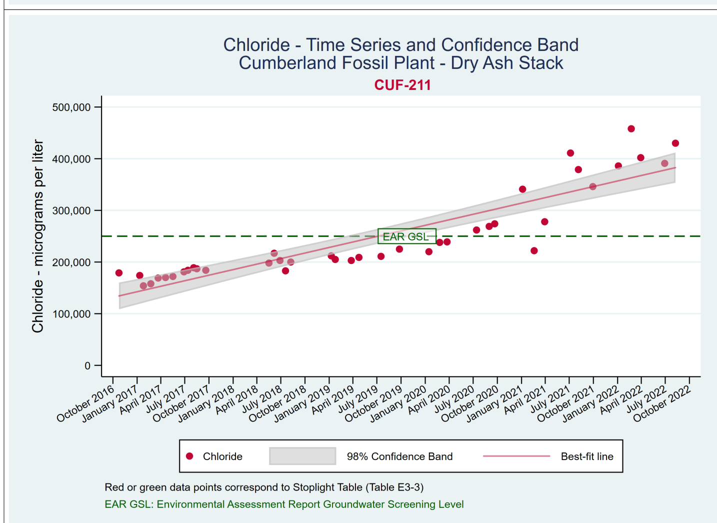

Boron - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-209
Boron - micrograms per liter
EAR GSL
Boron
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

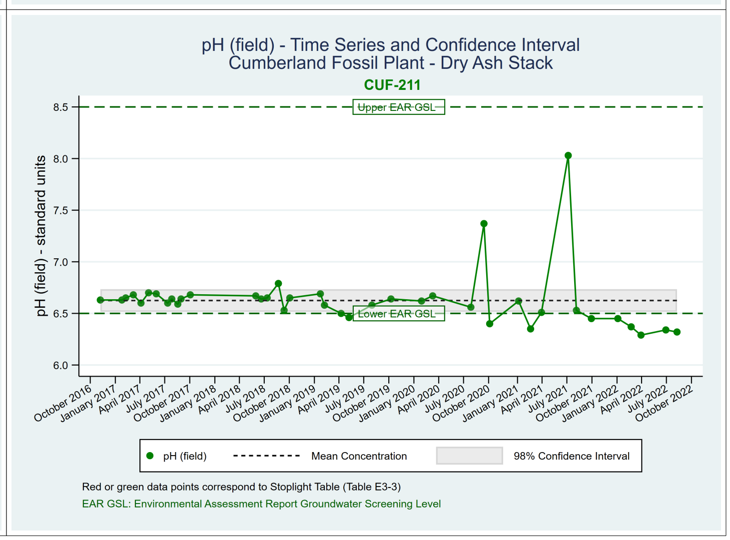

Chloride - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-209
Chloride - micrograms per liter
EAR GSL
Chloride
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

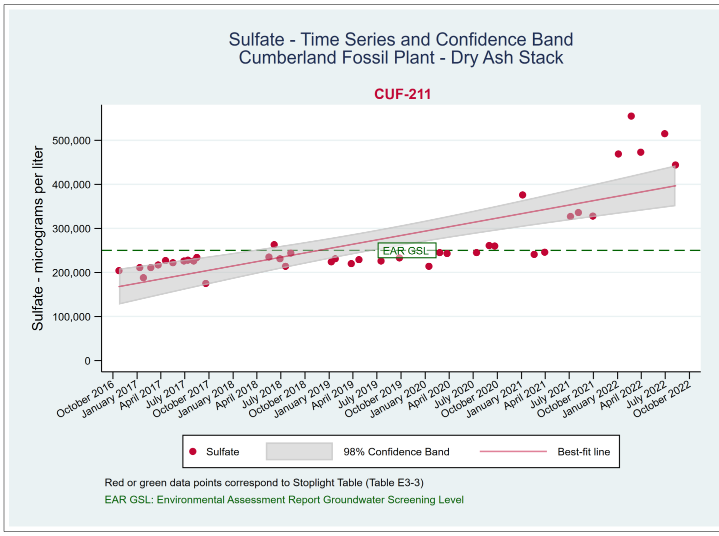

Sulfate - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-209
Sulfate - micrograms per liter
EAR GSL
Sulfate
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level


Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-209
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

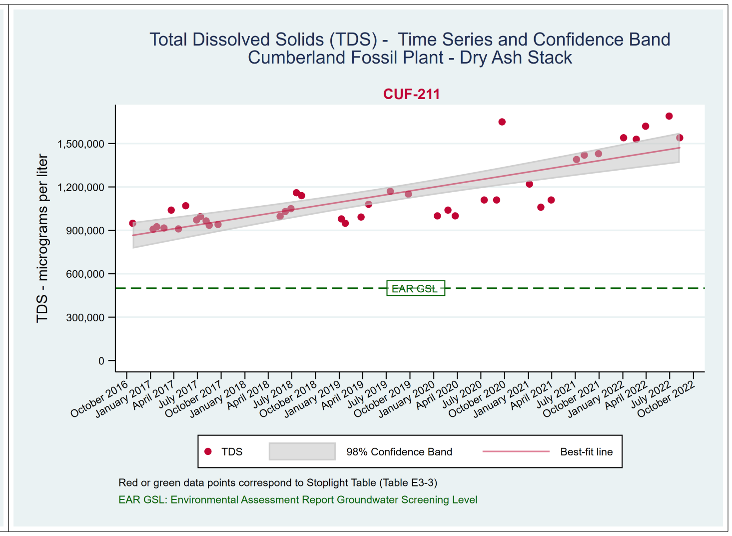

Boron - Time Series and Confidence Interval
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
Boron - micrograms per liter
EAR GSL
Boron
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level


Chloride - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
Chloride - micrograms per liter
EAR GSL
Chloride
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level


pH (field) - Time Series and Confidence Interval
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
pH (field) - standard units
Upper EAR GSL
Lower EAR GSL
pH (field)
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

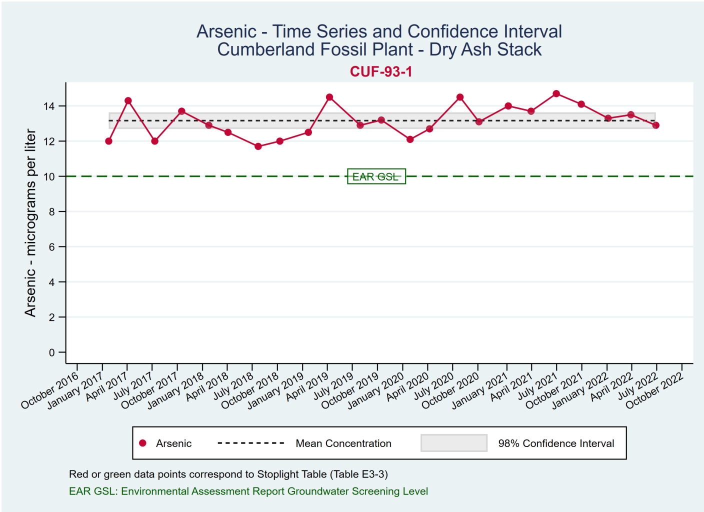


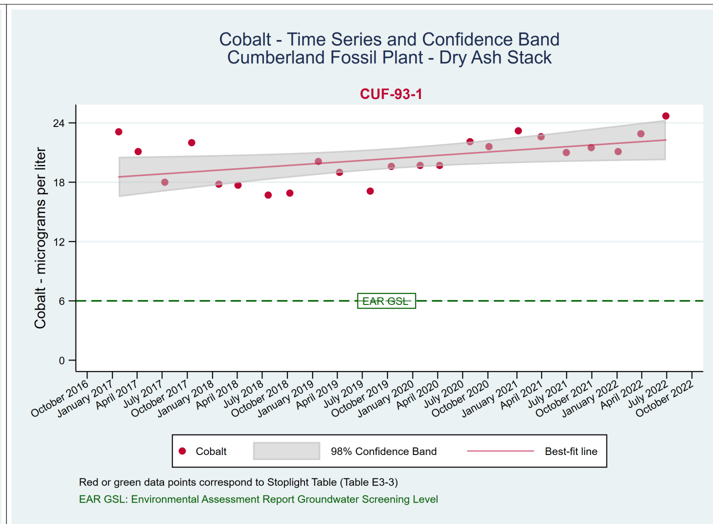
Sulfate - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
Sulfate - micrograms per liter
500,000
400,000
300,000
200,000
100,000
0
EAR GSL
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
Sulfate
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

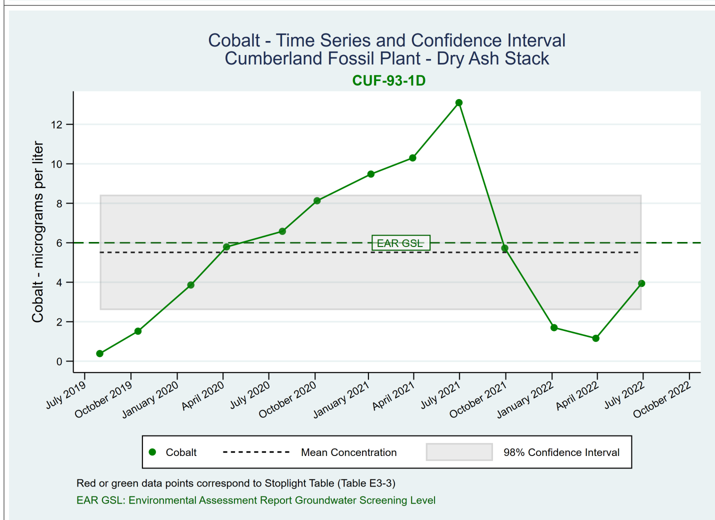


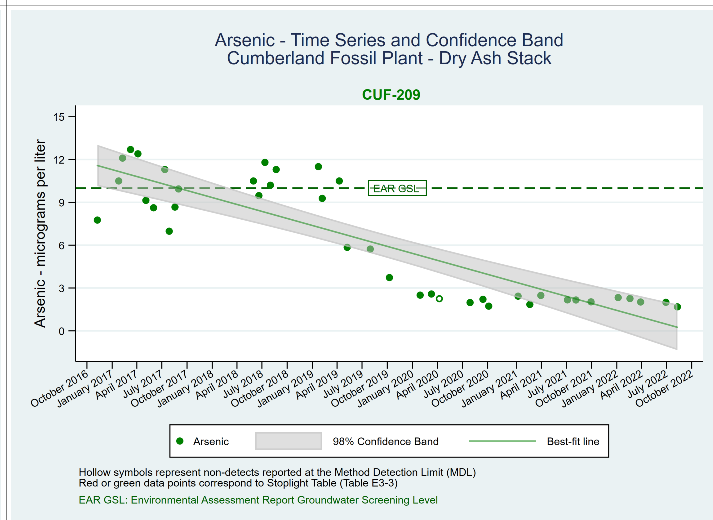
Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
TDS - micrograms per liter
1,500,000
1,200,000
900,000
600,000
300,000
0
EAR GSL
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

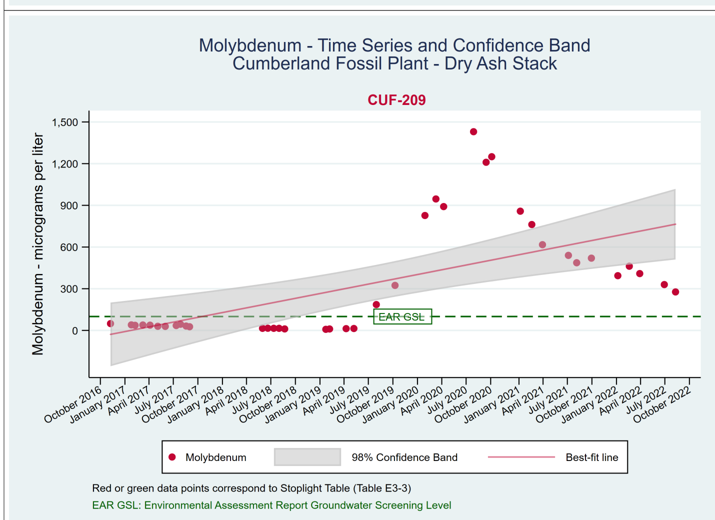
Regression Plots
Dry Ash Stack
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

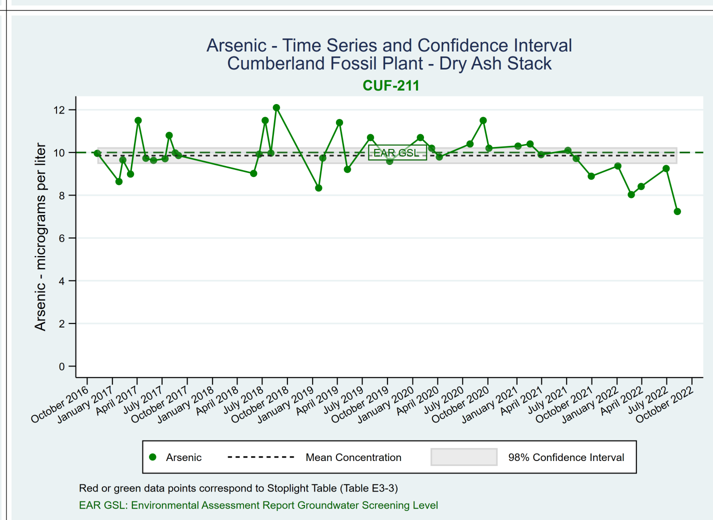


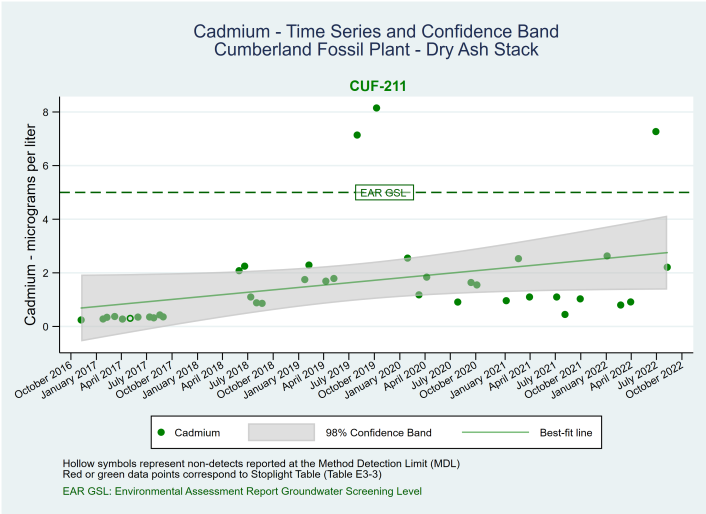




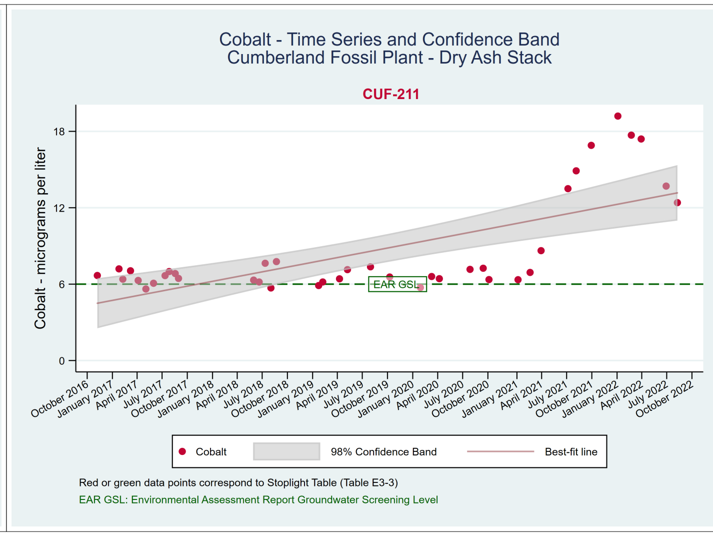






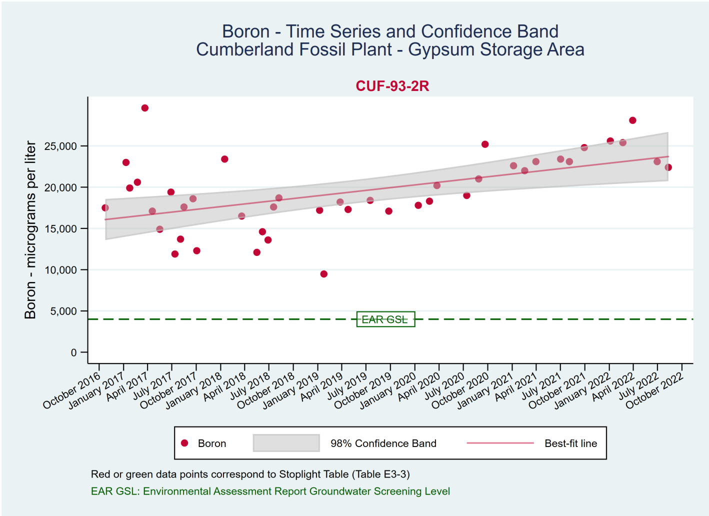


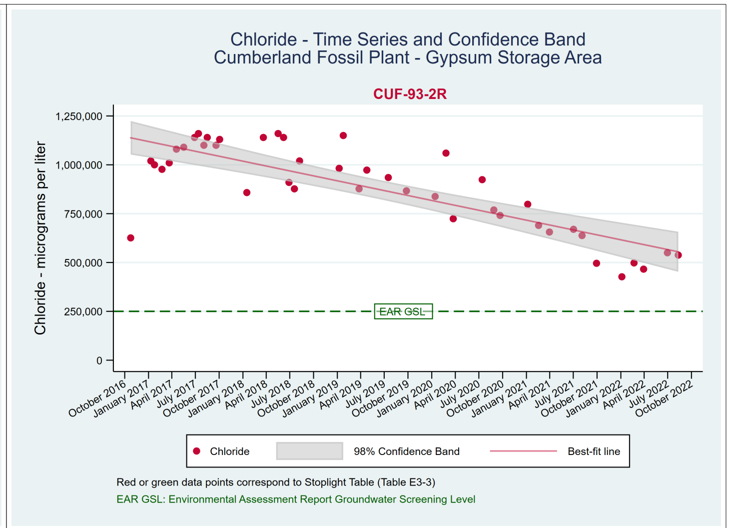
Cadmium - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
Cadmium - micrograms per liter
EAR GSL
Cadmium
98% Confidence Band
Best-fit line
Hollow symbols represent non-detects reported at the Method Detection Limit (MDL)
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

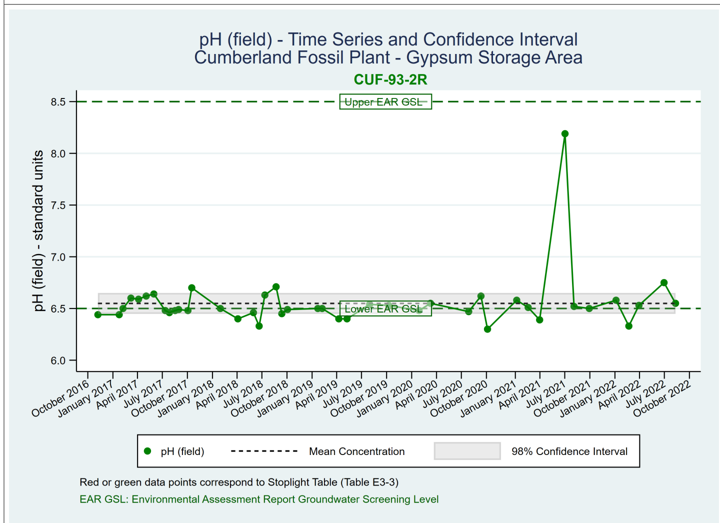


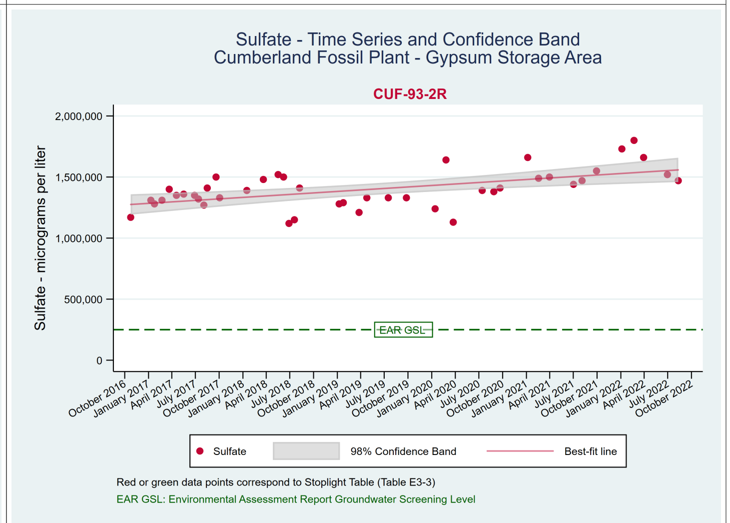
Cobalt - Time Series and Confidence Band
Cumberland Fossil Plant - Dry Ash Stack
CUF-211
Cobalt - micrograms per liter
EAR GSL
Cobalt
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

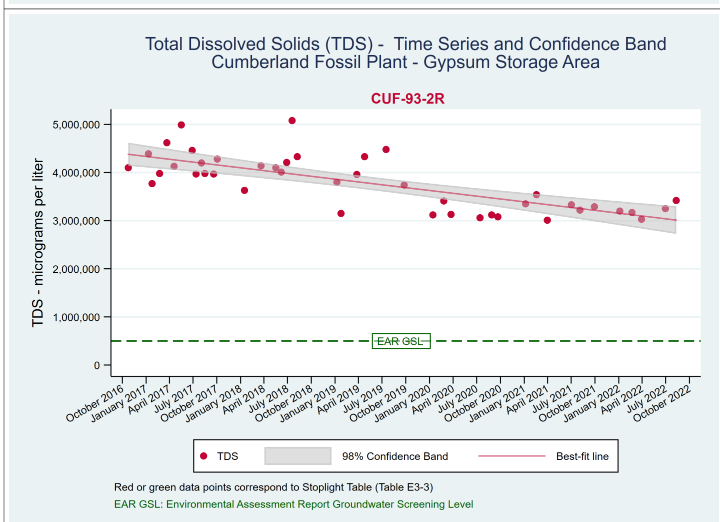
Regression Plots
Gypsum Storage Area
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

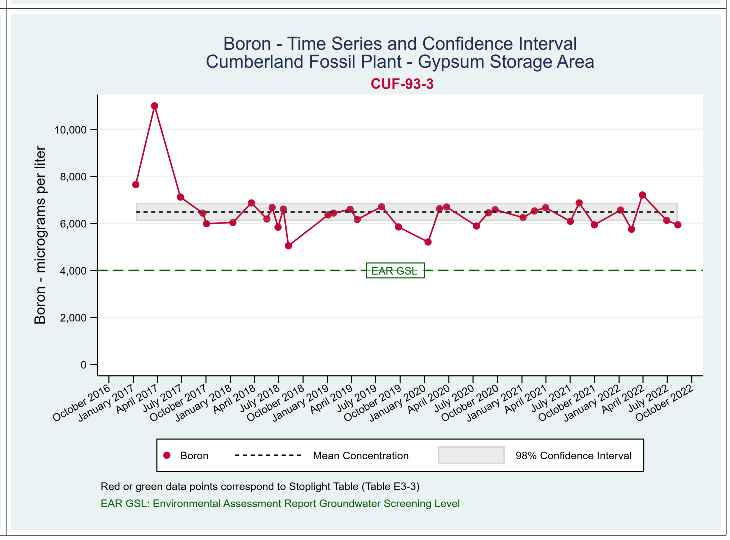


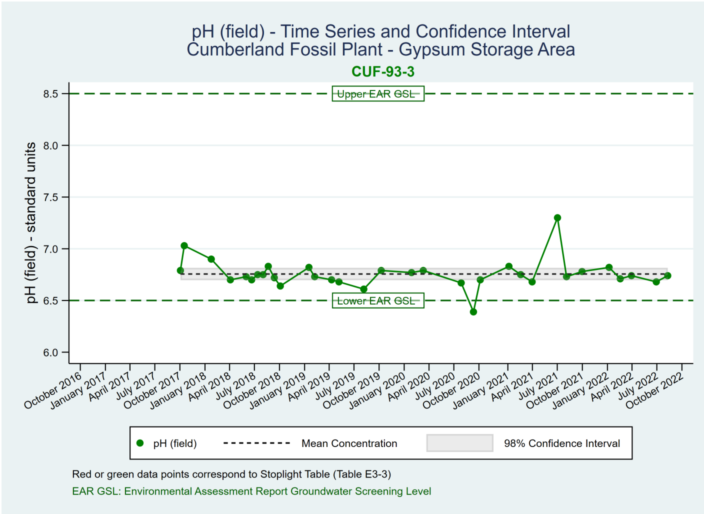


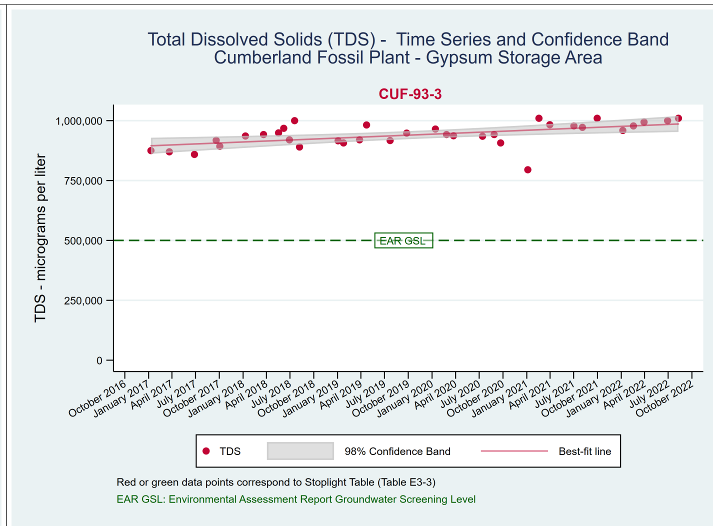


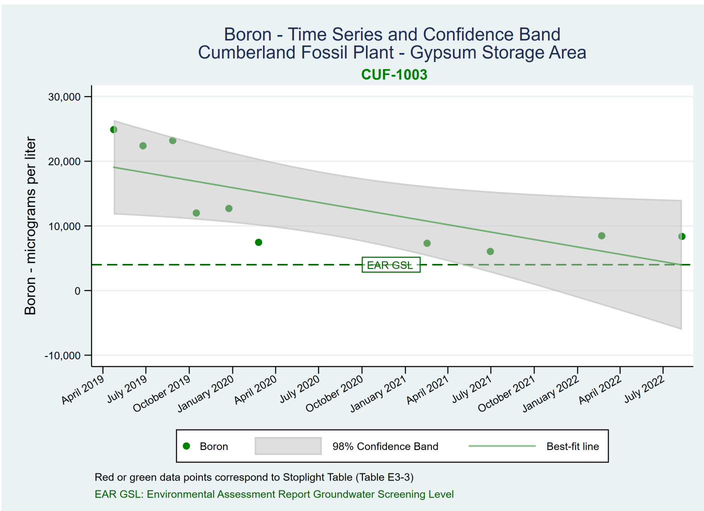


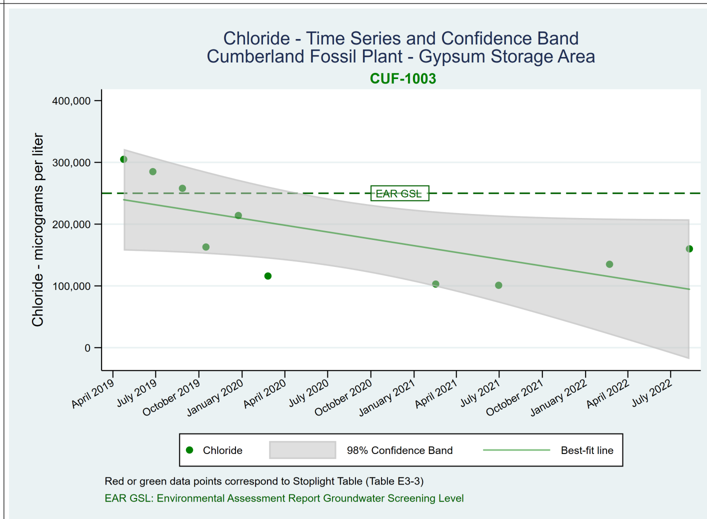


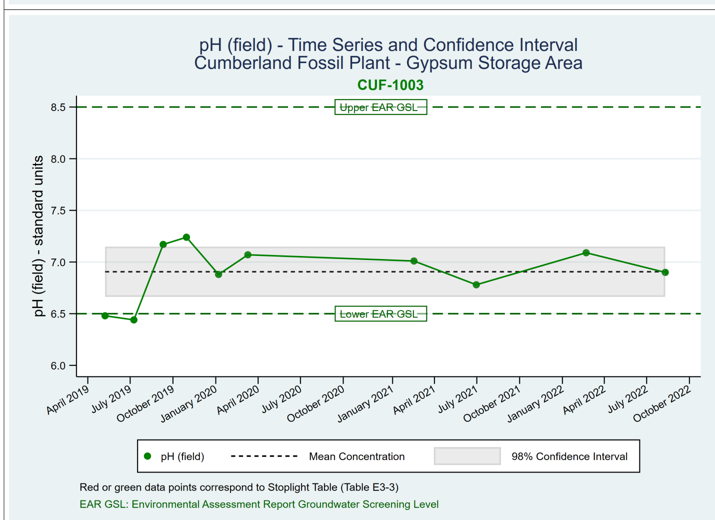


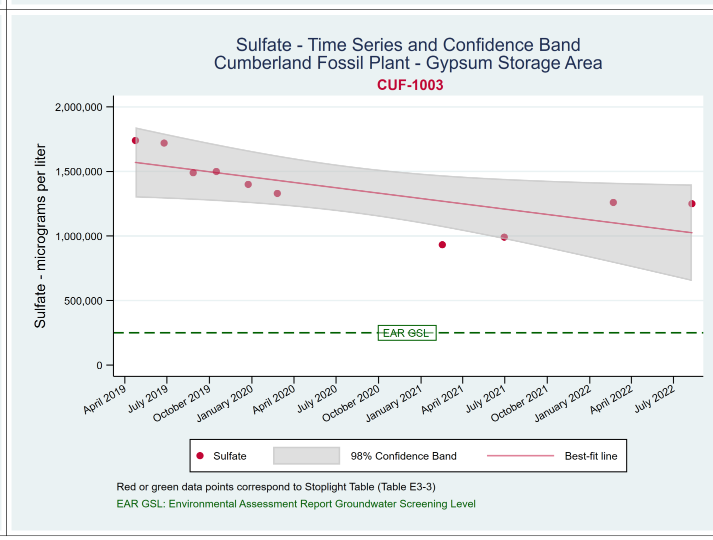

pH (field) - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-93-3
Upper EAR GSL
Lower EAR GSL
pH (field) - standard units
8.5
8.0
7.5
7.0
6.5
6.0
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
pH (field)
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

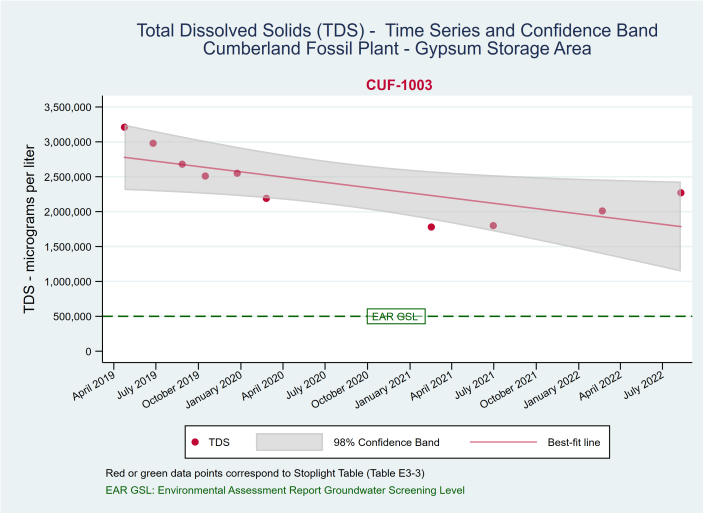

Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-93-3
EAR GSL
TDS - micrograms per liter
1,000,000
750,000
500,000
250,000
0
October 2016
January 2017
April 2017
July 2017
October 2017
January 2018
April 2018
July 2018
October 2018
January 2019
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

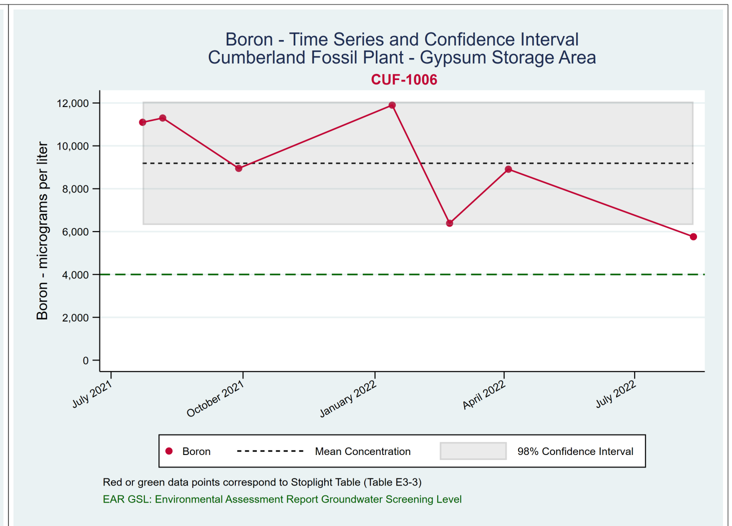

Boron - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1003
EAR GSL
Boron - micrograms per liter
30,000
20,000
10,000
0
-10,000
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
Boron
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

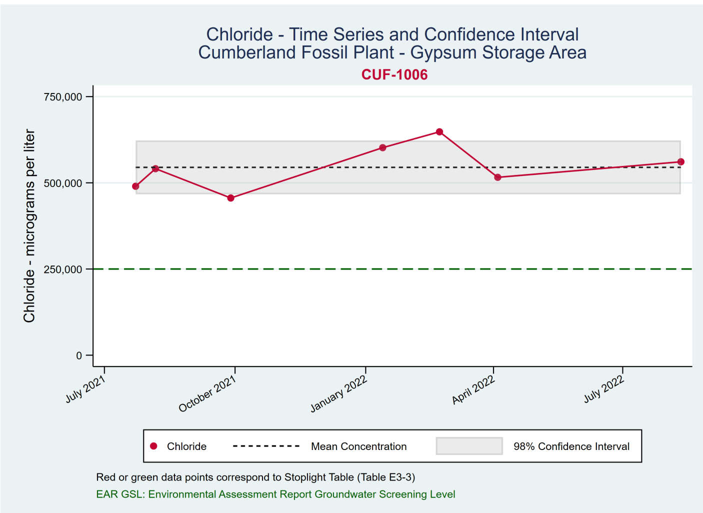

Chloride - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1003
EAR GSL
Chloride - micrograms per liter
400,000
300,000
200,000
100,000
0
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
Chloride
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

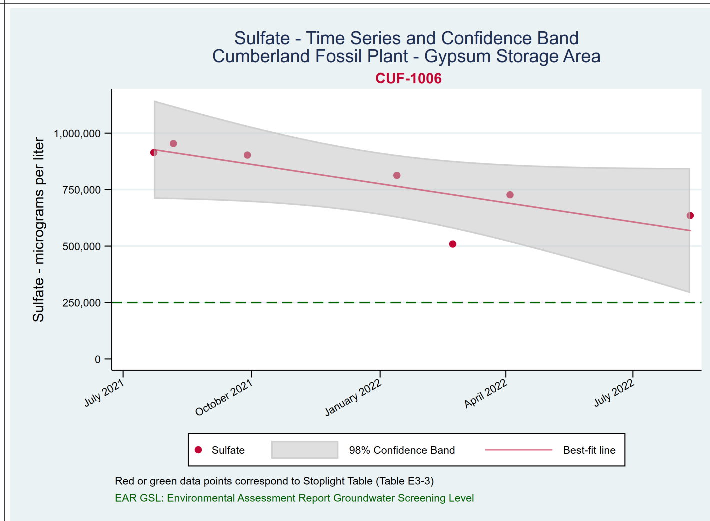

pH (field) - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1003
Upper EAR GSL
Lower EAR GSL
pH (field) - standard units
8.5
8.0
7.5
7.0
6.5
6.0
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
October 2022
pH (field)
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

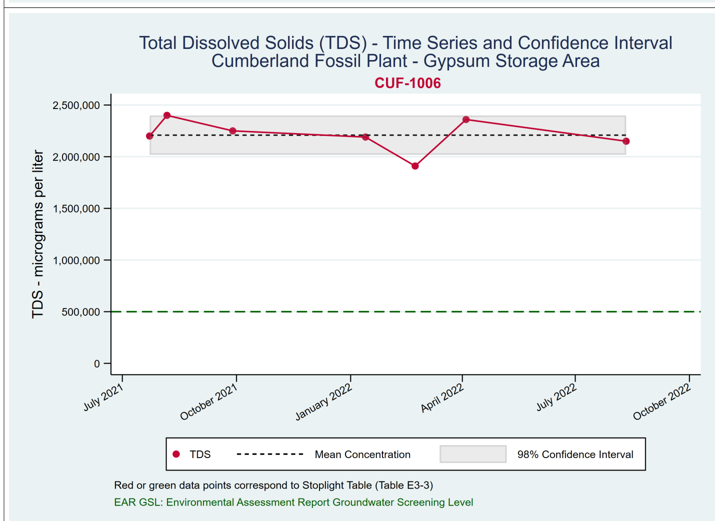

Sulfate - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1003
EAR GSL
Sulfate - micrograms per liter
2,000,000
1,500,000
1,000,000
500,000
0
April 2019
July 2019
October 2019
January 2020
April 2020
July 2020
October 2020
January 2021
April 2021
July 2021
October 2021
January 2022
April 2022
July 2022
Sulfate
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

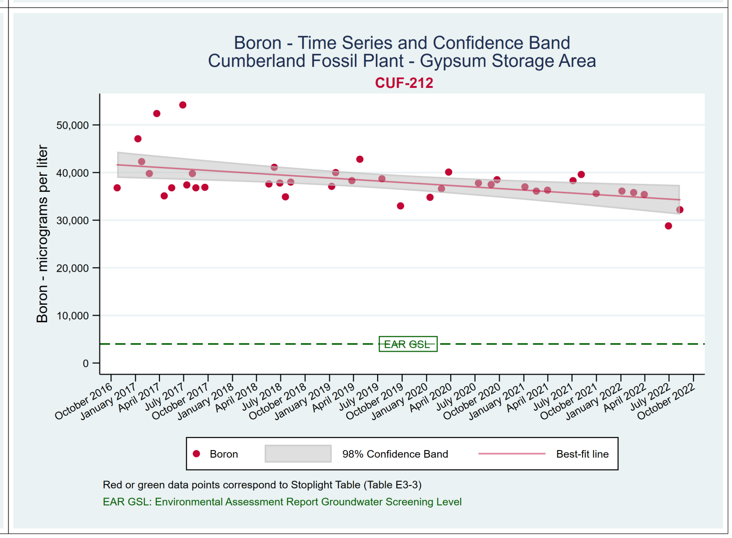

Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1003
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

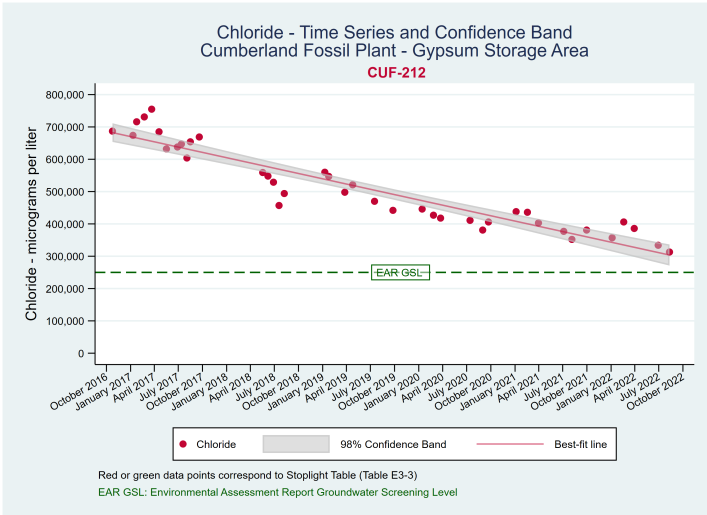

Boron - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1006
Boron - micrograms per liter
Boron
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level


Chloride - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1006
Chloride - micrograms per liter
Chloride
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

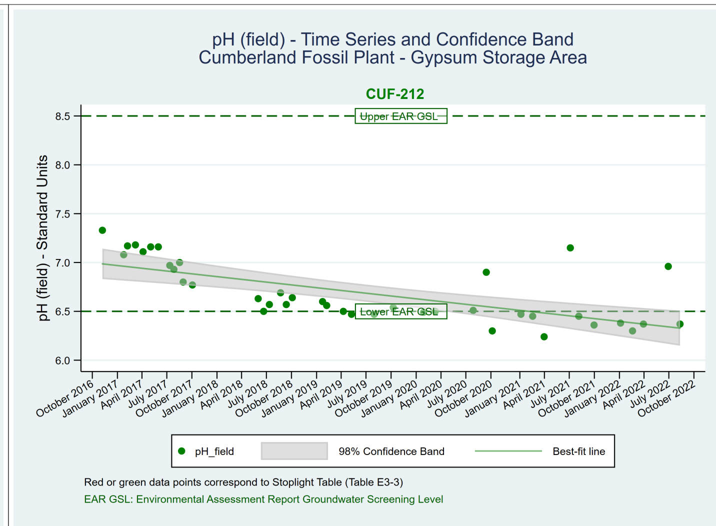

Sulfate - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1006
Sulfate - micrograms per liter
Sulfate
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level


Total Dissolved Solids (TDS) - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-1006
TDS - micrograms per liter
TDS
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

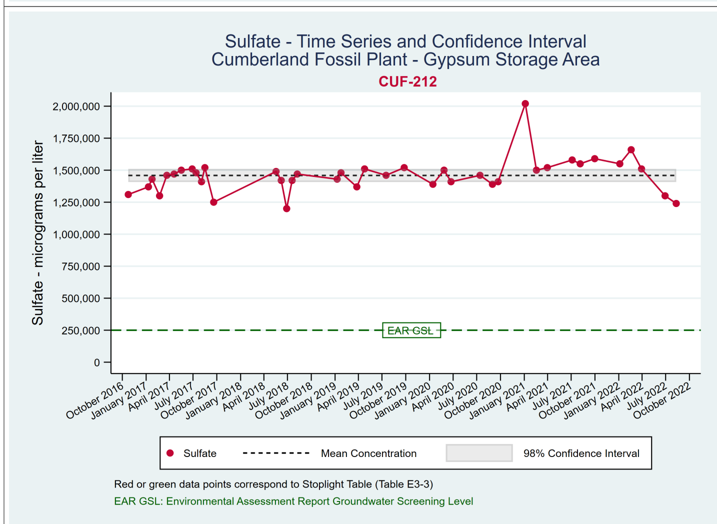

Boron - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-212
Boron - micrograms per liter
EAR GSL
Boron
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level



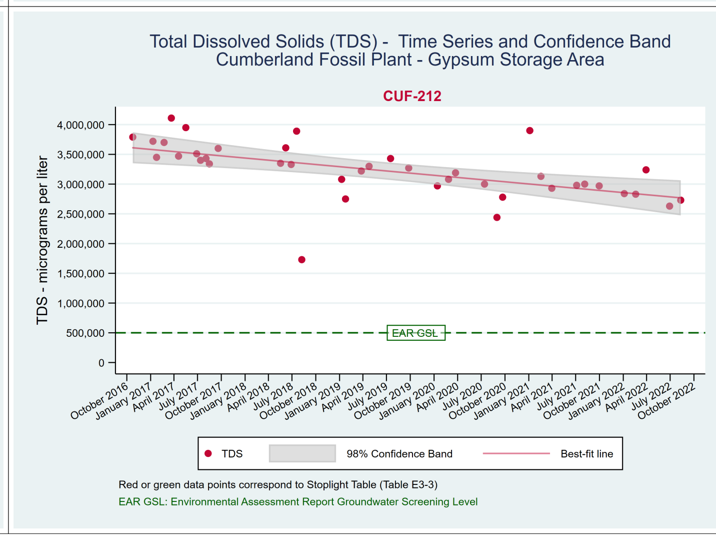
Chloride - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-212
Chloride - micrograms per liter
EAR GSL
Chloride
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level



pH (field) - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-212
pH (field) - Standard Units
Upper EAR GSL
Lower EAR GSL
pH_field
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

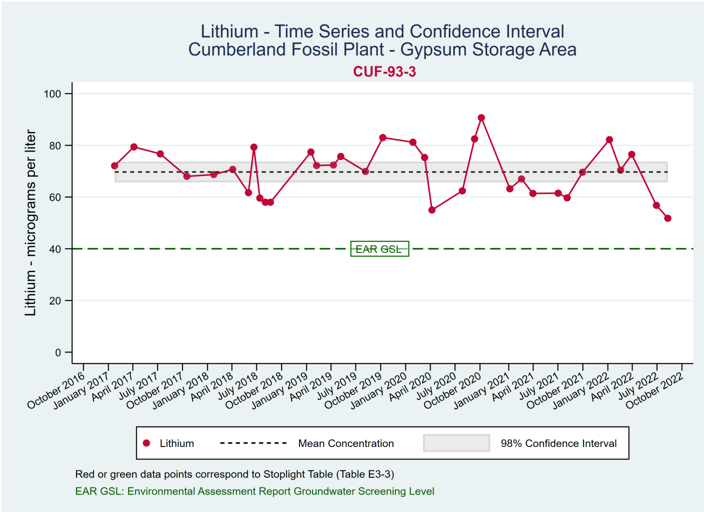


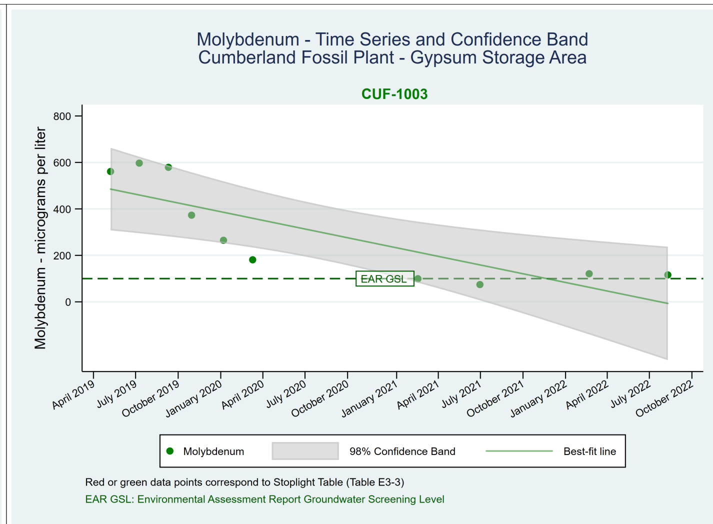
Sulfate - Time Series and Confidence Interval
Cumberland Fossil Plant - Gypsum Storage Area
CUF-212
Sulfate - micrograms per liter
EAR GSL
Sulfate
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

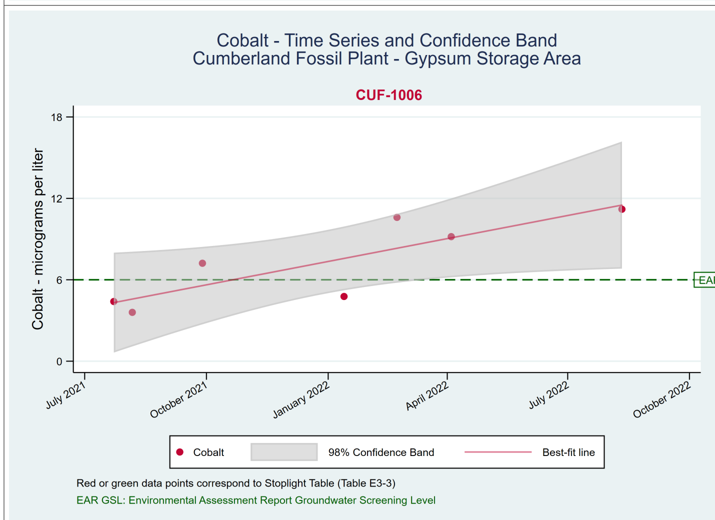


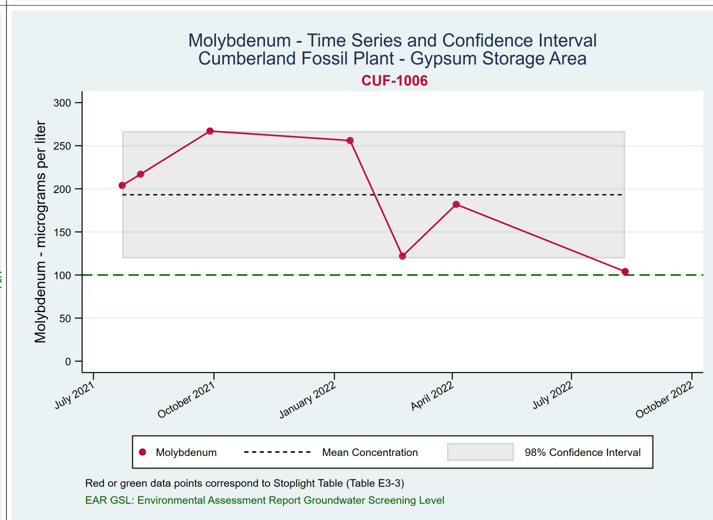
Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Gypsum Storage Area
CUF-212
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

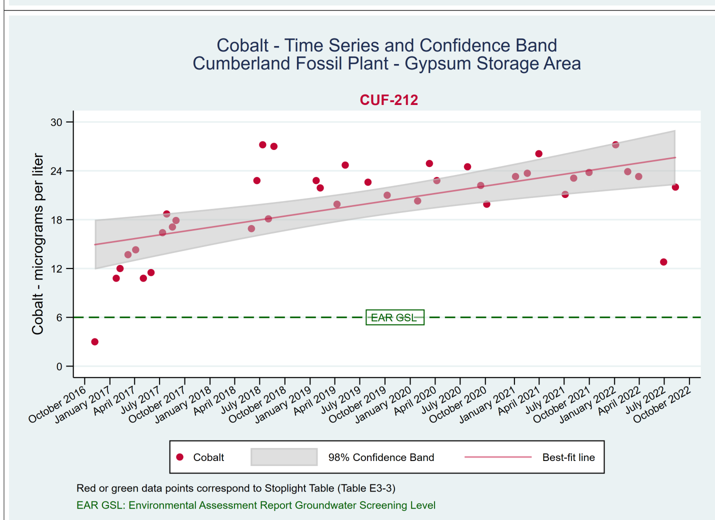
Regression Plots
Gypsum Storage Area
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee











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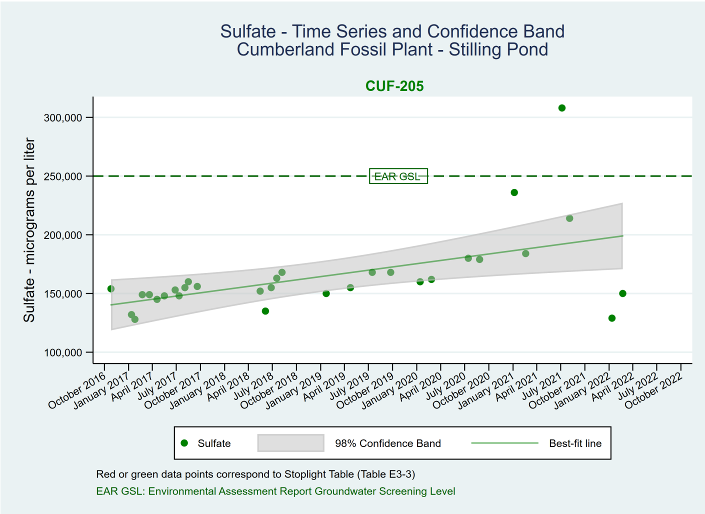
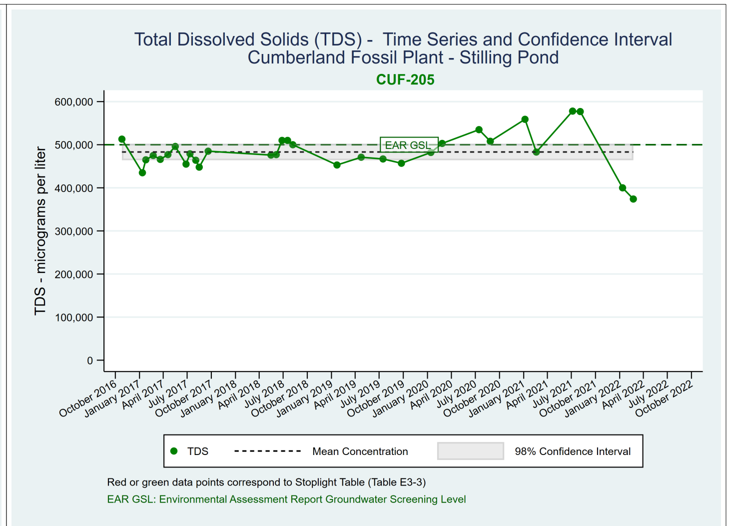
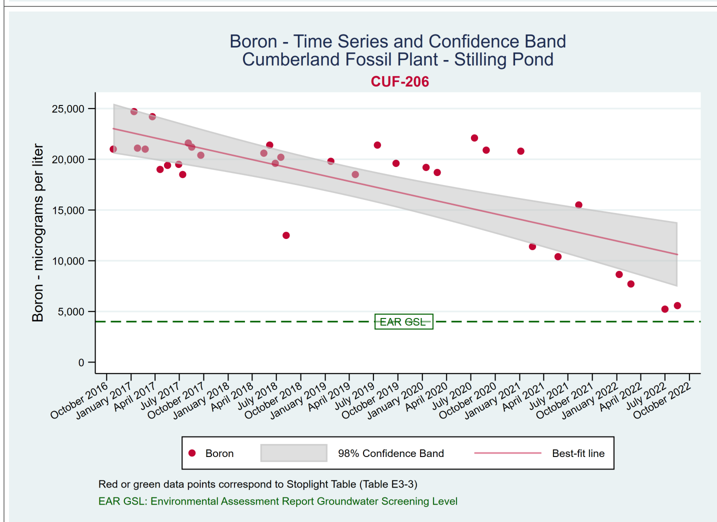
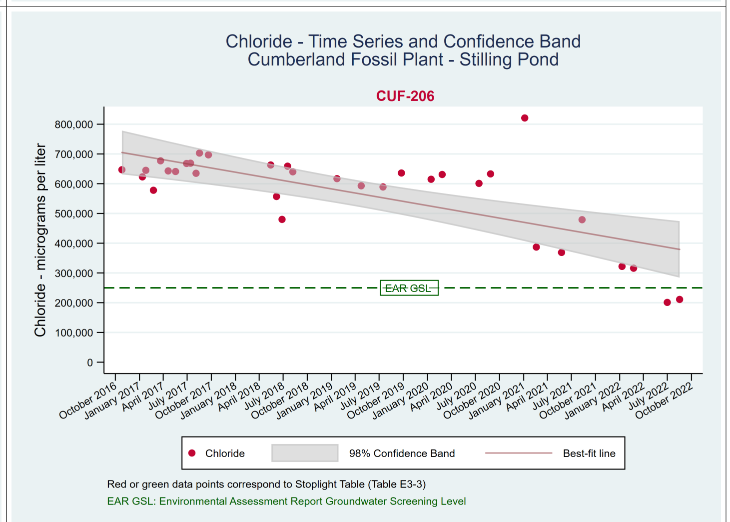
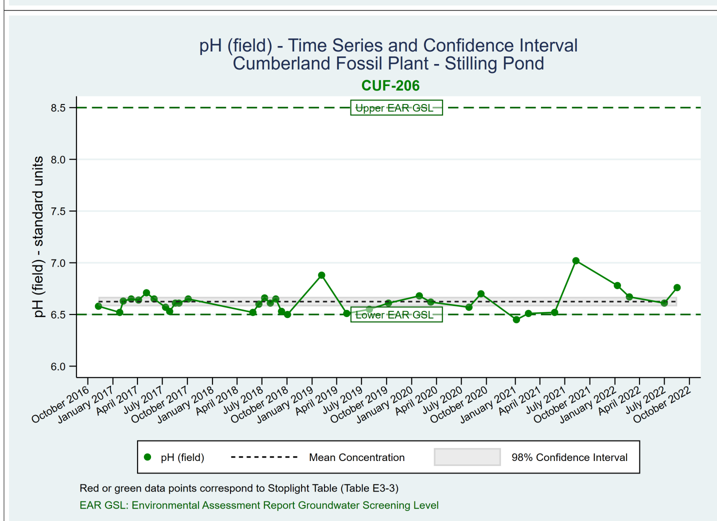
Regression Plots
Stilling Pond
CCR Rule Appendix III Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee

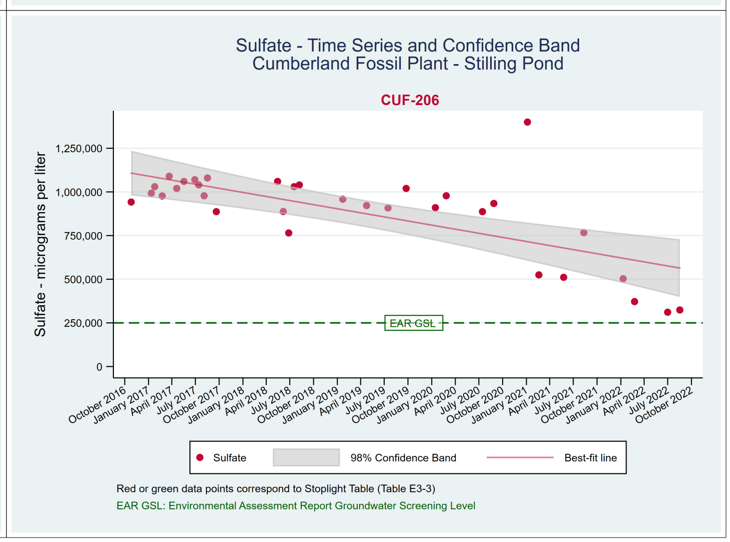


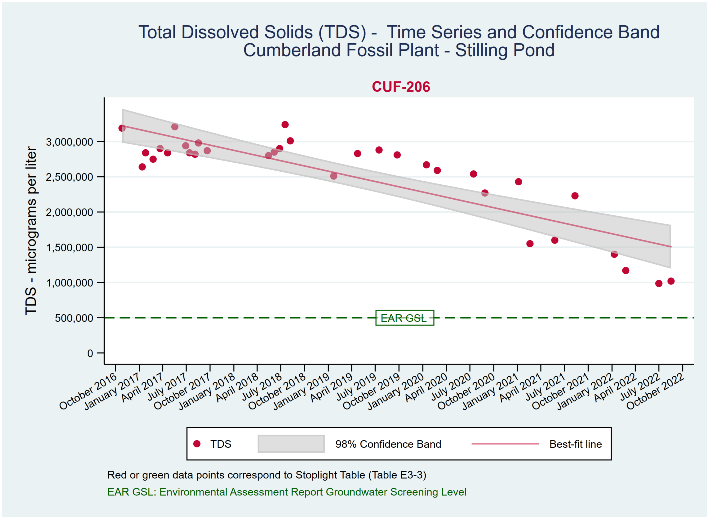




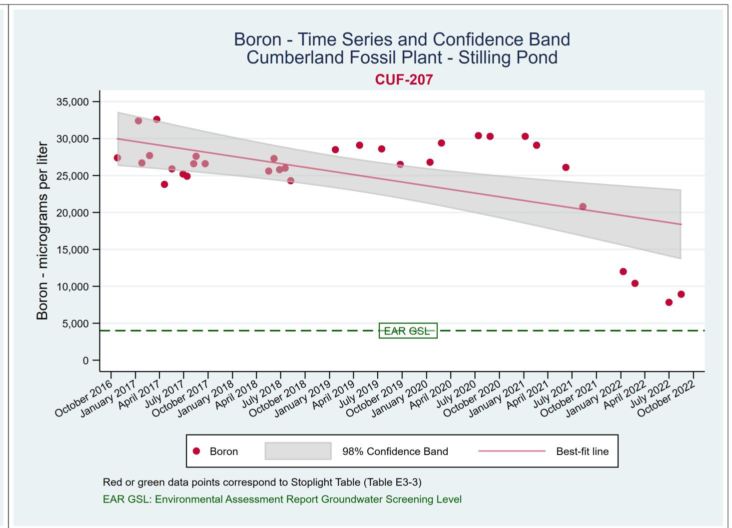




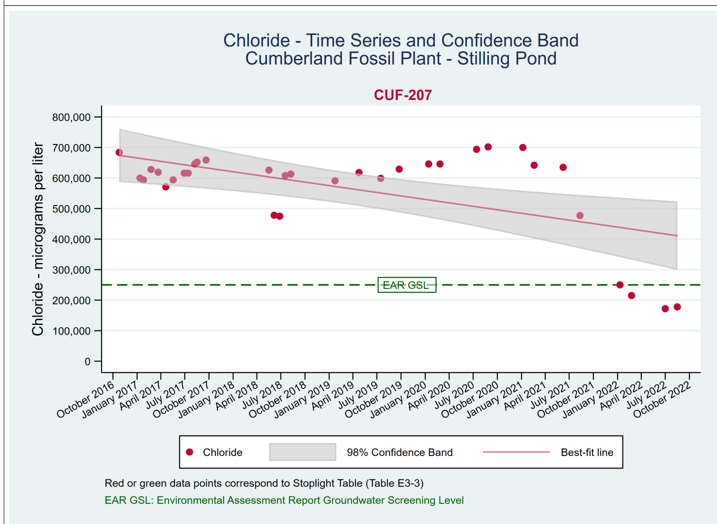




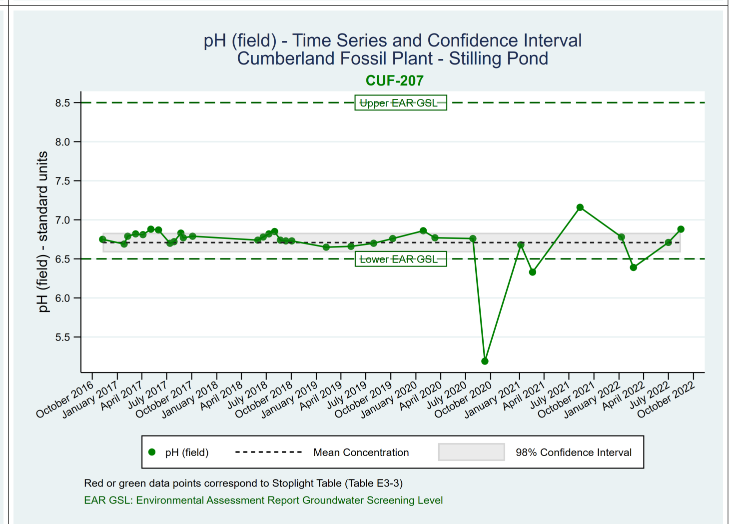
Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Stilling Pond
CUF-206
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level



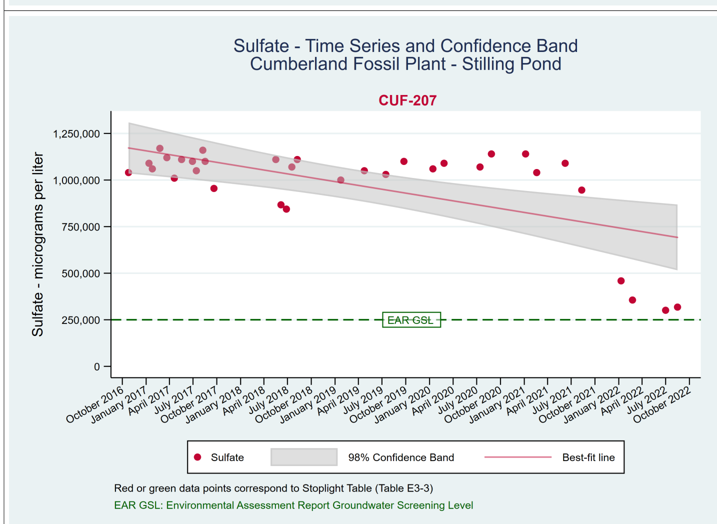
Boron - Time Series and Confidence Band
Cumberland Fossil Plant - Stilling Pond
CUF-207
Boron - micrograms per liter
EAR GSL
Boron
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level



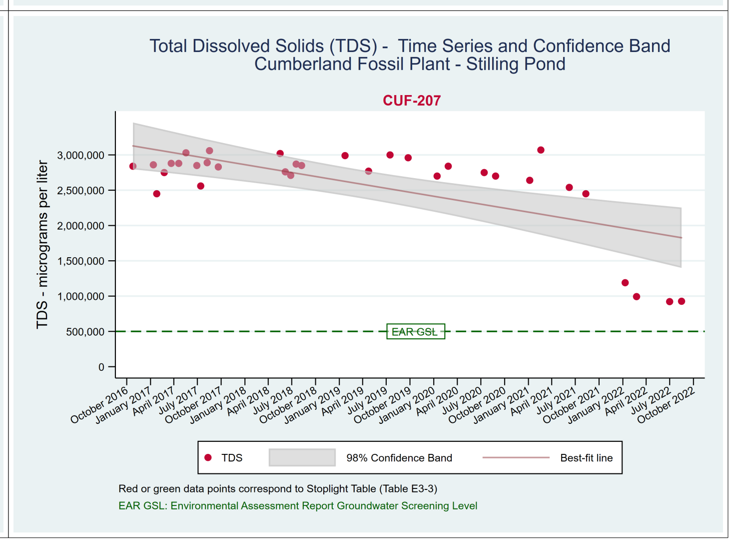
Chloride - Time Series and Confidence Band
Cumberland Fossil Plant - Stilling Pond
CUF-207
Chloride - micrograms per liter
EAR GSL
Chloride
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level



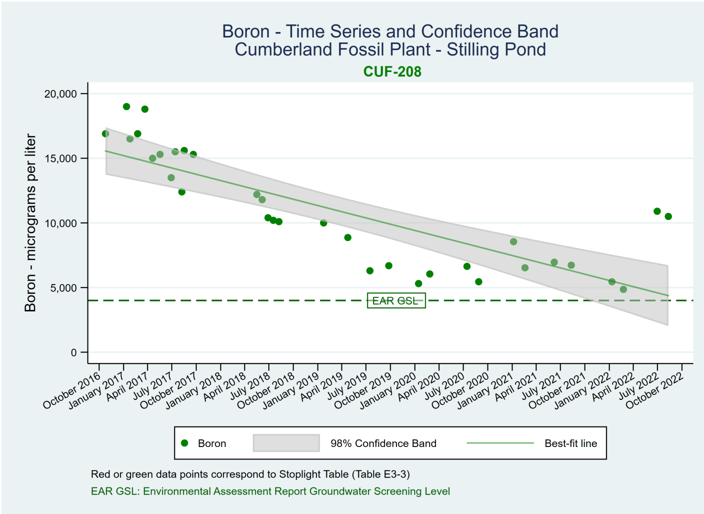
pH (field) - Time Series and Confidence Interval
Cumberland Fossil Plant - Stilling Pond
CUF-207
pH (field) - standard units
Upper EAR GSL
Lower EAR GSL
pH (field)
Mean Concentration
98% Confidence Interval
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

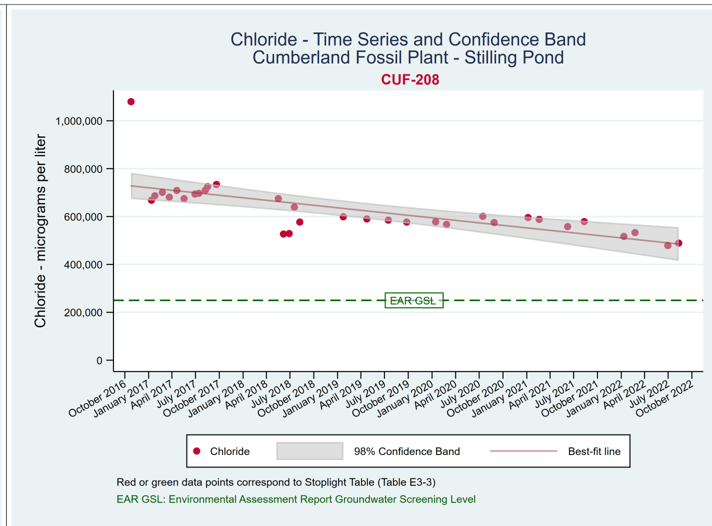


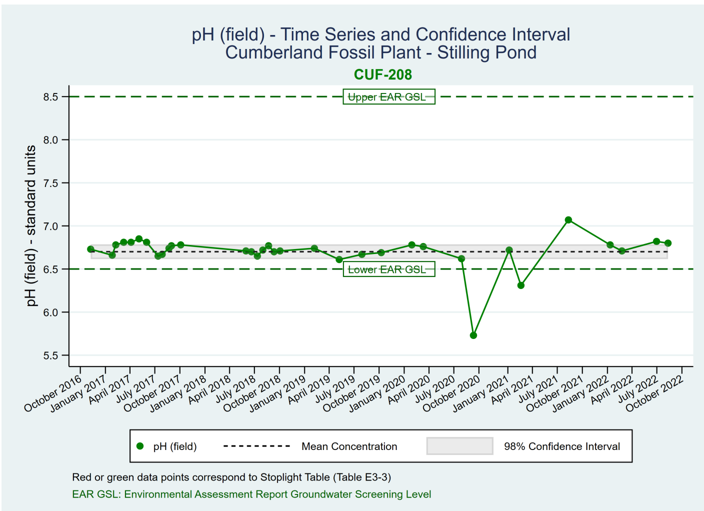
Sulfate - Time Series and Confidence Band
Cumberland Fossil Plant - Stilling Pond
CUF-207
Sulfate - micrograms per liter
EAR GSL
Sulfate
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level

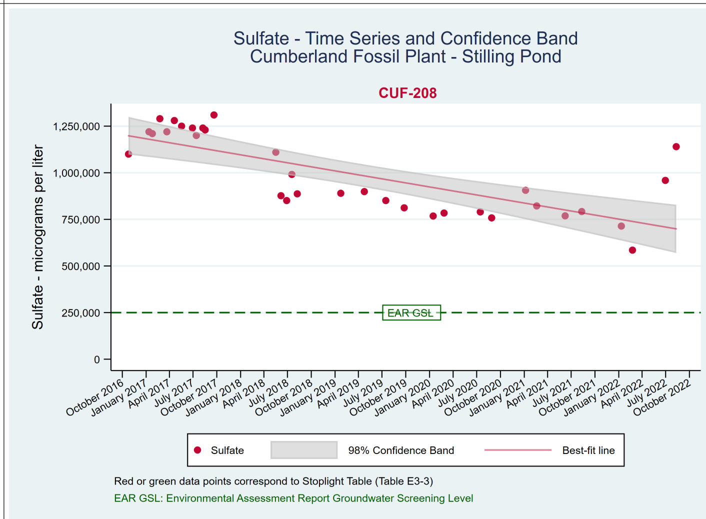


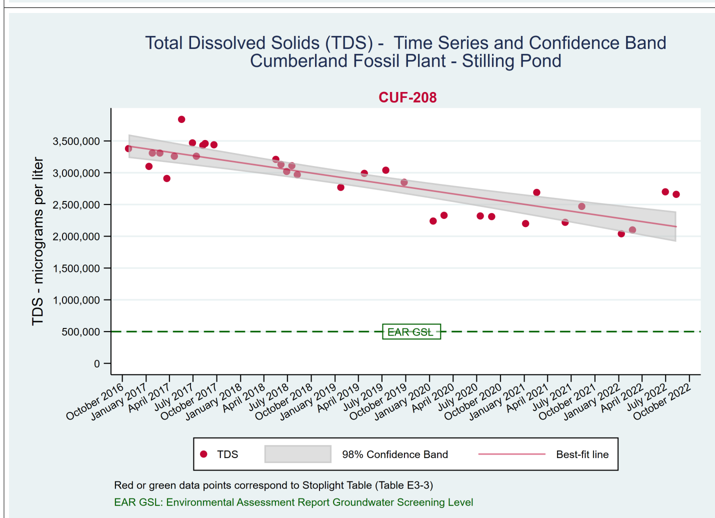
Total Dissolved Solids (TDS) - Time Series and Confidence Band
Cumberland Fossil Plant - Stilling Pond
CUF-207
TDS - micrograms per liter
EAR GSL
TDS
98% Confidence Band
Best-fit line
Red or green data points correspond to Stoplight Table (Table E3-3)
EAR GSL: Environmental Assessment Report Groundwater Screening Level











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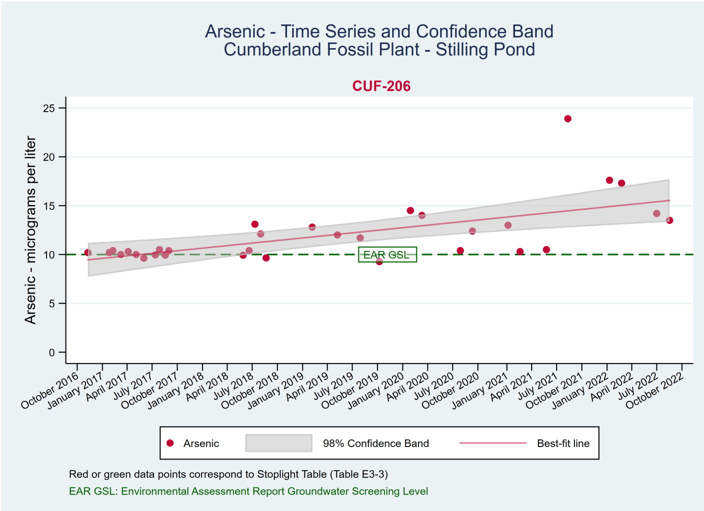
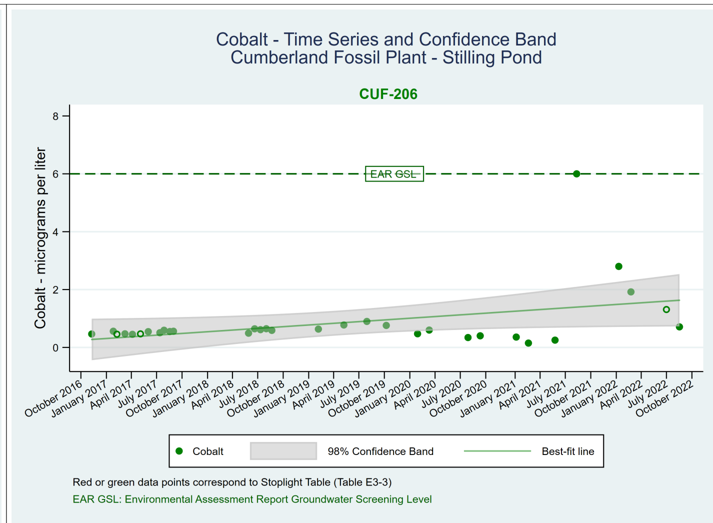
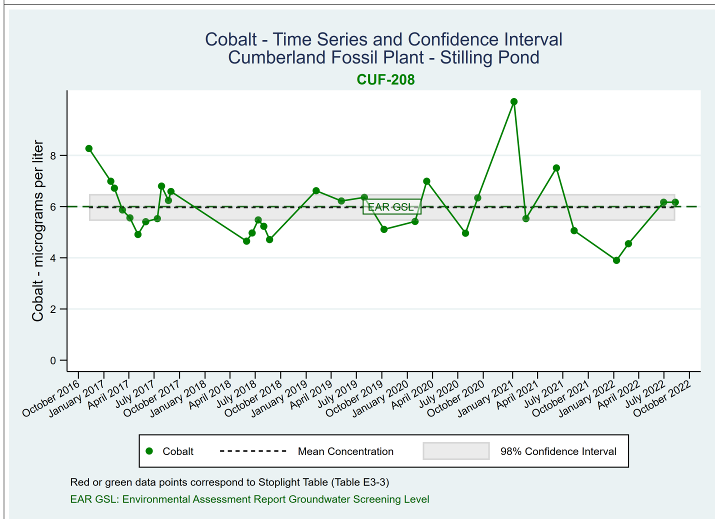
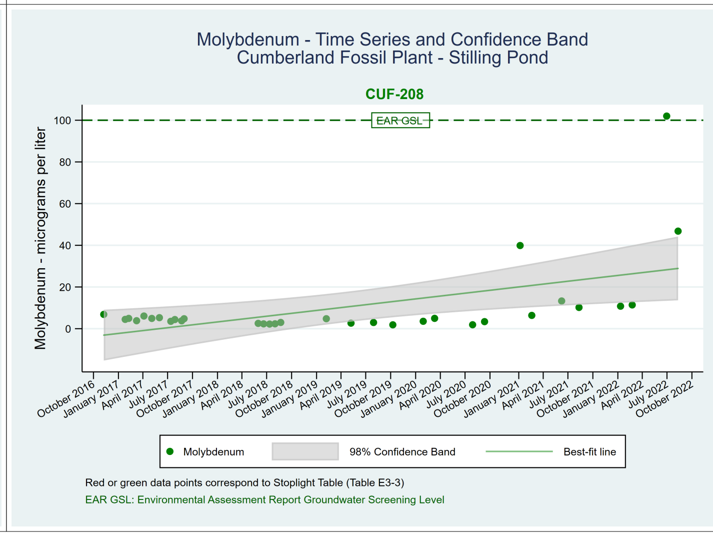
Regression Plots
Stilling Pond
CCR Rule Appendix IV Parameters
Cumberland Fossil Plant, Cumberland City, Tennessee









ATTACHMENT E.3-F
LINEAR REGRESSION RESULTS

Well	Constituent Type	Constituent	p-value	Trend summary[1]
CUF-1001	CCR Rule Appendix III Parameters	Boron	0.0129	Decreasing
		pH (field)	0.4579	No trend detected
		Sulfate	0.0711	No trend detected
		Total dissolved solids	0.547	No trend detected
	CCR Rule Appendix IV Parameters	Molybdenum	0.7833	No trend detected
CUF-201	CCR Rule Appendix III Parameters	pH (field)	0.0449	Increasing
CUF-202	CCR Rule Appendix III Parameters	pH (field)	0.0712	No trend detected
CUF-93-4	CCR Rule Appendix III Parameters	Boron	0.1985	No trend detected
		Chloride	0.0001	Decreasing
		pH (field)	0.1603	No trend detected
		Sulfate	0.2493	No trend detected
		Total dissolved solids	0.003	Decreasing
CUF-93-1	CCR Rule Appendix III Parameters	Chloride	0.7843	No trend detected
		pH (field)	0.0013	Decreasing
		Sulfate	<0.0001	Increasing
		Total dissolved solids	0.8656	No trend detected
	CCR Rule Appendix IV Parameters	Arsenic	0.0606	No trend detected
		Cobalt	0.0135	Increasing
CUF-93-1D	CCR Rule Appendix III Parameters	Boron	0.1271	No trend detected
		pH (field)	0.0204	Decreasing
		Sulfate	0.1263	No trend detected
		Total dissolved solids	0.001	Increasing
	CCR Rule Appendix IV Parameters	Cobalt	0.6575	No trend detected
CUF-1002	CCR Rule Appendix III Parameters	pH (field)	0.1766	No trend detected
		Sulfate	0.4562	No trend detected
		Total dissolved solids	0.0012	Decreasing
CUF-209	CCR Rule Appendix III Parameters	Boron	<0.0001	Increasing
		Chloride	0.0013	Increasing
		Sulfate	<0.0001	Increasing
		Total dissolved solids	<0.0001	Increasing
	CCR Rule Appendix IV Parameters	Arsenic	<0.0001	Decreasing
		Molybdenum	<0.0001	Increasing
CUF-211	CCR Rule Appendix III Parameters	Boron	0.1132	No trend detected
		Chloride	<0.0001	Increasing
		pH (field)	0.4819	No trend detected
		Sulfate	<0.0001	Increasing
		Total dissolved solids	<0.0001	Increasing
	CCR Rule Appendix IV Parameters	Arsenic	0.0987	No trend detected
		Cadmium	0.0306	Increasing
		Cobalt	<0.0001	Increasing
CUF-93-2R	CCR Rule Appendix III Parameters	Boron	0.0003	Increasing
		Chloride	<0.0001	Decreasing
		pH (field)	0.2535	No trend detected
		Sulfate	0.0001	Increasing
		Total dissolved solids	<0.0001	Decreasing
CUF-93-3	CCR Rule Appendix III Parameters	Boron	0.0775	No trend detected
		pH (field)	0.8146	No trend detected
		Total dissolved solids	0.0005	Increasing
	CCR Rule Appendix IV Parameters	Lithium	0.3313	No trend detected

CUF-1003	CCR Rule Appendix III Parameters	Boron	0.0154	Decreasing
		Chloride	0.0312	Decreasing
		pH (field)	0.4966	No trend detected
		Sulfate	0.018	Decreasing
		Total dissolved solids	0.014	Decreasing
	CCR Rule Appendix IV Parameters	Molybdenum	0.0034	Decreasing
CUF-1006	CCR Rule Appendix III Parameters	Boron	0.0591	No trend detected
		Chloride	0.3115	No trend detected
		Sulfate	0.032	Decreasing
		total dissolved solids	0.4587	No trend detected
	CCR Rule Appendix IV Parameters	Cobalt	0.0172	Increasing
		Molybdenum	0.0865	No trend detected
CUF-212	CCR Rule Appendix III Parameters	Boron	0.001	Decreasing
		Chloride	<0.0001	Decreasing
		pH (field)	<0.0001	Decreasing
		Sulfate	0.0654	No trend detected
		Total dissolved solids	0.0001	Decreasing
	CCR Rule Appendix IV Parameters	Cobalt	<0.0001	Increasing
CUF-205	CCR Rule Appendix III Parameters	Sulfate	0.002	Increasing
		Total dissolved solids	0.3975	No trend detected
CUF-206	CCR Rule Appendix III Parameters	Boron	<0.0001	Decreasing
		Chloride	<0.0001	Decreasing
		pH (field)	0.1607	No trend detected
		Sulfate	<0.0001	Decreasing
		Total dissolved solids	<0.0001	Decreasing
	CCR Rule Appendix IV Parameters	Arsenic	0.0001	Increasing
		Cobalt	0.0213	Increasing
CUF-207	CCR Rule Appendix III Parameters	Boron	0.0004	Decreasing
		Chloride	0.0006	Decreasing
		pH (field)	0.2246	No trend detected
		Sulfate	0.0001	Decreasing
		Total dissolved solids	<0.0001	Decreasing
CUF-208	CCR Rule Appendix III Parameters	Boron	<0.0001	Decreasing
		Chloride	<0.0001	Decreasing
		pH (field)	0.4703	No trend detected
		Sulfate	<0.0001	Decreasing
		Total dissolved solids	<0.0001	Decreasing
	CCR Rule Appendix IV Parameters	Cobalt	0.6779	No trend detected
		Molybdenum	0.002	Increasing

Notes

CCR Rule - Title 40, Code of Federal Regulations, Part 257

1. Trend evaluated using linear regression. Regression considered significant when $p<0.05$.

APPENDIX E.4

STATISTICAL ANALYSIS OF SEEP INVESTIGATION

Appendix D – Statistical Analysis of Water Quality Parameters

Cumberland Fossil Plant
Seep Investigation

April 9, 2021

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

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Lexington, Kentucky

Revision Record

Revision	Description	Date
0	Submittal to TDEC	April 9, 2021

Sign-off Sheet

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Prepared by ______________________________
Chris LaLonde, Associate Senior Statistician/Risk Assessor

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Approved by ______________________________
Rebekah Brooks, Principal Hydrogeologist

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Abbreviations

α	alpha
AOC	Area of Concern
AOI	Area of Interest
CUF Plant	Cumberland Fossil Plant
CCR	Coal Combustion Residuals
DO	Dissolved Oxygen
H_a	Alternative hypothesis
H_o	Null hypothesis
Q-Q plots	Quartile-Quartile plots
SAP	Sampling and Analysis Plan
SAR	Sampling and Analysis Report
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

A statistical analysis of water quality parameter data collected adjacent to the Cumberland Fossil Plant (CUF Plant) in Wells Creek and Ponds 3A and 3b (Unnamed Tributary) was conducted as part of the seep investigation. The statistical analysis was used to evaluate whether there are statistically significant differences between monitoring results collected “adjacent to” and “upstream of” historical seep /Area of Concern (AOC)/ Area of Interest (AOI) locations for four water quality parameters (i.e., dissolved oxygen [DO], pH, specific conductance, and temperature). This appendix to the CUF Plant Seep Sampling and Analysis Report (SAR) presents the statistical approach and methods used for this analysis and the analysis results.

2.0 OBJECTIVE

The objective of the statistical analysis is to identify statistically significant differences between four specific water quality parameters (i.e., DO, pH, specific conductance, and temperature) measured "adjacent" to inaccessible historical seep/AOC/AOI locations and results measured "upstream" of those locations. As described in Section 3.2.1 of this SAR, one historical seep location and one AOC were identified adjacent to Wells Creek, two historical seep locations (combined or "clustered" for analysis because of close proximity) and one AOI were identified adjacent to the Unnamed Tributary. These locations were targeted for water quality parameter monitoring at the CUF Plant for the seep investigation. The historical seep/AOC/AOI locations included in this statistical analysis are listed in Table D.1 and shown in Exhibits A.1, A.2, and A.3 (Appendix A).

Water quality parameter measurements were not taken at historical seep locations A, 1, 3, 7, 8, 9, 10, 11, 12, and 13 because these locations are above the perimeter dike, and any seepage is captured by the perimeter drainage ditch and routed to the Bottom Ash Pond, which discharges via the NPDES outfall. Water quality parameter measurements were not taken at historical seep locations below the perimeter dike (historical seeps 6 and 15) because the banks in these areas were exposed between the riprap and waterline, and no active seeps were observed by boat. Historical seep locations 16 and 17 are not located adjacent to surface water. Upstream control and intermediate area water quality parameter measurements were not conducted for the CUF seep investigation because no suitable upsteam areas were identified, and no intermediate areas were observed within the riprap areas, respectively.

Additional AOI will be identified only when statistically significant evidence indicates that: 1) water quality parameter results collected "adjacent" to historical seep/AOC/AOI locations are different than water quality parameter results collected "upstream" of historical seep/AOC/AOI locations for all four parameters.

3.0 DATASETS

In accordance with the Seep Sampling and Analysis Plan (SAP), datasets were generated consisting of water quality parameter measurements for each of the four field parameters (i.e., DO, pH, specific conductance, and temperature) for each historical seep/AOC/AOI location identified by Tennessee Valley Authority for evaluation. The data used in the statistical analysis were obtained in spreadsheet format from the "*Seep Investigation/ Surface Stream Field Parameter Measurement Forms*", which were prepared in real time as the field investigation was being conducted. Statistical datasets were established based on proximity to individual or combined historical seep/AOC/AOI locations. A summary of the measurement location identifications and the number of measurements collected is provided in Table D.1.

4.0 STATISTICAL ANALYSIS METHODS

In accordance with the Seep SAP, the following statistical analysis method was used to evaluate the water quality parameter measurement results:

- Formal hypothesis testing was used to identify statistically significant differences between adjacent and upstream monitoring data for historical seep/AOC/AOI locations by comparison of mean/median parameter concentrations between the datasets.

The statistical analysis was conducted in three phases: 1) exploratory data analysis/outlier screening, 2) testing of statistical assumptions, and 3) formal hypothesis testing. These phases are discussed below. Analyses were conducted using United States Environmental Protection Agency (USEPA) ProUCL (version 5.1.002) and STATA Statistics and Data Analysis (version 15.1).

4.1 EXPLORATORY DATA ANALYSIS/OUTLIER SCREENING

Initially, the monitoring data associated with historical seep areas/AOC/AOI locations were plotted on time-series graphs and in box plots. Time-series graphs allow for the identification of trends, potential outliers, and to visually identify differences between water quality parameter measurements that were collected in a downstream to upstream direction. Box plots allow for the identification of potential outliers and provide a basic sense of the potential underlying statistical distributions. The time-series and box plots are presented in Attachment D.1. In addition to graphical analysis, descriptive statistics were calculated for each water quality parameter for each historical seep/AOC/AOI location. A summary of the descriptive statistics is presented in Attachment D.2.Following the calculation of descriptive statistics, the data were screened for possible outliers. Outliers are data points that are abnormally high or low as compared to the rest of the measurements and may represent anomalous data and/or data errors. Outliers may also represent natural variation of constituent concentrations in environmental systems. During the seep investigation, water quality parameters were measured downstream, adjacent and upstream of historical seep/AOC/AOI locations. Utilizing the complete set of data to screen for the presence of outliers allowed for evaluation of potential spatial variation in the natural ecosystem. Screening for outliers is a critical step as outliers can bias the statistical testing results.

Potential outliers were identified graphically using side by side box plots and time-series graphs (Attachment D.1). Suspect visual outliers were further analyzed to determine if they are extreme outliers. The Tukey's procedure (Tukey 1977) as outlined in the USEPA document*: "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance"* (USEPA 2009) – (Unified Guidance) was used to identify extreme outliers. The Tukey's procedure is briefly outlined below:

Lower extreme outlier: The value is less than: 25th percentile – (3 x interquartile range)

or

Upper extreme outlier: The value is greater than: 75th percentile + (3 x interquartile range)

where:

Interquartile Range = 75th percentile value – 25th percentile value

If an outlier was identified visually and considered extreme (Tukey's procedure), then formal statistical testing (Dixon's and/or Rosner tests) was conducted to confirm that the data point is a statistically significant outlier. Utilizing the procedures outlined above, no outliers were identified.

4.2 TEST OF STATISTICAL ASSUMPTIONS

In environmental applications, formal hypothesis testing is commonly used to compare mean or median values between two "populations". In the case of the investigation of historical seep/AOC/AOI locations at the CUF Plant, the populations can be defined as monitoring results collected ***adjacent*** to the historical seep/AOC/AOI locations and monitoring results collected immediately ***upstream*** of the historical seep/AOC/AOI location.

Two sample t-tests were used to identify statistically significant differences between monitoring data collected adjacent to historical seep/AOC/AOI locations and data collected immediately upstream. As with most statistical tests, t-tests must meet statistical assumptions in order to produce reliable statistical conclusions. T-tests have two statistical assumptions: 1) the data "fit" or can be transformed to fit the normal distribution, and 2) the variance of each population being compared are equal (homoscedasticity).

The assumption of normality was tested visually using Normal Quantile-Quantile (Q-Q) plots and statistically using the Shapiro-Wilks Test (alpha [α] =0.01). The Q-Q plots are presented in Attachment D.3. When data sets collected "adjacent" and "upstream" of an historical seep/AOC/AOI location were both normally distributed, parametric t-tests were conducted to identify statistically significant differences in parameter measurements. If either the "adjacent" or "upstream" data set was not normally distributed or could not be transformed to a normally distributed data set, then non-parametric bootstrap methods were utilized to identify statistically significant differences in parameter measurements.

Data sets that are not normally distributed can often be transformed to a data set that is normally distributed using simple mathematical transformations on the data. Ladder of power transformation techniques were used to normalize data sets that were originally identified as not-normally distributed. If the data could be normalized, then parametric methods (t-tests) were utilized to identify statistically significant differences in parameter measurements.

The assumption of homoscedasticity was tested using the f-Test for the Equality of Two-Variances (α =0.05). In instances where variances were not equal, the Satterthwaite's degrees of freedom adjustment were used to account for unequal variances. The results of the evaluation of normality and equality of variances between the upstream and adjacent measurement locations are presented in Table D.2.

4.3 FORMAL HYPOTHESIS TESTING

The objective of formal hypothesis testing is to determine whether mean water quality parameter monitoring results for the "adjacent" datasets are statistically different than the results for the "upstream" datasets. Hypothesis tests are standard statistical methods used to decide between two competing alternatives based on available data. Uncertainties arise when sample statistics are used as estimates of "true" but unknown population parameters (mean, standard deviation). Hypothesis testing provides the framework for managing these uncertainties and controlling potential decision errors (Ofungwu 2014).

Hypothesis tests are set up based on two competing alternatives. The null hypothesis (H_o) represents baseline conditions or conditions of no effects/differences. The null hypothesis can be represented mathematically as:

H_o: Mean Adjacent – Mean Upstream = 0; or Mean Adjacent = Mean Upstream

The alternative hypothesis (H_a) is simply the opposite of the null hypothesis and can be written as:

H_a: Mean Adjacent – Mean Upstream ≠ 0

If there is an *a priori* idea that a parameter's mean may be greater than or less than the upstream mean the alternative hypothesis can be written as:

H_a: Mean Adjacent – Mean Upstream < 0 or Mean Adjacent – Mean Upstream > 0

The former alternative hypothesis is considered a two-sided test (e.g., it is unknown if the difference will be higher or lower and therefore, need to account for both possibilities). The later alternative hypotheses are considered a one-sided test (e.g., there is *a priori* knowledge of the direction of change – the parameter measurement is expected to be higher or lower when comparing adjacent to upstream monitoring data).

Appropriate hypothesis tests were established prior to examining the data. Two-sided tests were used to evaluate pH and temperature as there is no *a priori* knowledge that these parameters are expected to be higher or lower when comparing adjacent to upstream monitoring data. However, one-sided tests were used to evaluate specific conductance and DO based on the following assumptions: 1) the specific conductance would be expected to be higher adjacent to an active seep as opposed to upstream due to expected higher concentrations of metals in water emanating from a Coal Combustion Residuals (CCR) unit, and 2) the DO would be expected to be lower adjacent to an active seep in a similar area as opposed to DO in a surface stream.

The null and alternative hypotheses for the seep investigation are presented below:

- DO (milligrams/Liter)
  - H_o: Mean $DO_{Adjacent}$ – Mean $DO_{Upstream}$ = 0
  - H_a: Mean $DO_{Adjacent}$ – Mean $DO_{Upstream}$ < 0
- pH (Standard Units)
  - H_o: Mean $pH_{Adjacent}$ – Mean $pH_{Upstream}$ = 0
  - H_a: Mean $pH_{Adjacent}$ – Mean $pH_{Upstream}$ ≠ 0
- Specific Conductance (SC - microSiemens/centimeter)
  - H_o: Mean $SC_{Adjacent}$ - Mean $SC_{Upstream}$ = 0
  - H_a: Mean $SC_{Adjacent}$ – Mean $SC_{Upstream}$ > 0
- Temperature (Temp – degrees Celsius)
  - H_o: Mean $Temp_{Adjacent}$ – Mean $Temp_{Upstream}$ = 0
  - H_a: Mean $Temp_{Adjacent}$ – Mean $Temp_{Upstream}$ ≠ 0

Statistical hypothesis tests produce a p-value (probability value). The p-value represents the probability that the mean of the adjacent measurements is equal to the mean of the upstream measurements. If the p-value of a statistical test is ***small*** *(i.e., below the significance level)*, the normal procedure is to reject the H_o, accept the H_a, and conclude there is a ***statistically significant difference between adjacent and upstream monitoring results that is unlikely to have occurred by chance.***

The statistician establishes the "significance level" (α), which is typically set between 0.01 and 0.10. This can be thought of as an acceptable false positive rate (e.g., rejecting the null when the null is true, which is equivalent to finding a statistically significant difference between adjacent and upstream monitoring data, when in fact one does not exist).

The significance level for a single test needs to be adjusted in situations where multiple hypothesis tests are going to be conducted at a site. Conducting multiple statistical tests on a site increases the chances of getting a significant result simply by chance (e.g. false positive statistical test result). For example, 8 statistical tests were conducted in Wells Creek at the CUF Plant to identify differences in adjacent and upstream water quality parameter monitoring data for the seep investigation; if α is set at 0.1 and multiple testing is ignored, then the cumulative error rate can be calculated:

Cumulative error rate = $1-(1-0.1)^8$ = 57% chance of making false positive error

The Bonferroni correction was utilized to adjust the significance level to control the site-wide false positive rate described above. This method simply divides the desired overall significance level ($\alpha = 0.10$) by the number of hypothesis tests conducted in Wells Creek and the Unnamed Tributary, respectively. For the CUF plant, the adjustment yields an individual test significance level of 0.1/8 tests = 0.0125 for historical seep/AOC/AOI locations in the Unnamed Tributary and an individual test significance level of 0.1/8 tests = 0.0125 for historical seep/AOC/AOI locations in Wells Creek. Therefore, to reject the null hypothesis and determine that there is a statistically significant difference between adjacent and upstream monitoring results that is unlikely to have occurred by chance, the p-value of the test needs to be less than the adjusted significance level.

5.0 STATISTICAL ANALYSIS RESULTS

The following sections describe the results of the hypothesis testing comparing the water quality parameter results between the adjacent and upstream measurements at each of the historical seep/AOC/AOI locations.

5.1 HYPOTHESIS TESTING RESULTS: ADJACENT AND UPSTREAM MEASUREMENT COMPARISONS AT HISTORIC SEEP/AOC/AOI LOCATIONS

A historic seep/AOC is considered as an AOI when the mean values of all four water quality parameters (DO, pH, specific conductance and temperature) are found to be statistically different when comparing adjacent to upstream monitoring data. For pH and temperature, the difference between upstream and adjacent measurements may be either positive or negative. Specific conductance would be expected to increase in proximity to an active seep due to higher concentrations of metals in water emanating from a CCR unit, and DO would be expected to decrease as seep water from a similar area would show decreased DO relative to a surface stream. Therefore, only significant increases in specific conductance and significant decreases in DO in the adjacent areas, relative to the upstream areas, were evaluated. Table D.3 provides a summary of the hypothesis testing, including the p-values obtained using procedures described in preceding sections to identify significant differences between adjacent and upstream water quality parameter monitoring data by the one identified historical seep and one AOC location in Wells Creek and by the one identified historical seep cluster and one AOI location in the Unnamed Tributary. None of the evaluated historical seep/AOC/AOI locations were observed to have statistically significant values across all four prescribed parameters (Table D.3). Therefore, no AOIs were identified for further investigation or data collection based on the statistical analysis.

6.0 REFERENCES

Ofungwu, J., 2014. *Statistical Applications for Environmental Analysis and Risk Assessment*. Hoboken, New Jersey: John Wiley and Sons, Inc.

Tukey, J.W., 1977. *Exploratory Data Analysis*. Reading, Massachusetts: Addison-Wesely, 1977

U.S. Environmental Protection Agency, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*.

TABLES

TABLE D.1 – Summary of Water Quality Parameter Measurement Locations
Cumberland Fossil Plant
October 2019

Measurement Locations	Measurement Location IDs	Number of Measurements Downstream	Number of Measurements Adjacent	Number of Measurements Upstream
Unnamed Tributary				
Historic Seep Location 4 & 5 (HS45)	CUF-HS45-D-1 to CUF-HS45-U-45	16	19	10
AOI Location 1 (AOI1)	CUF-AOI1-A-46 to CUF-AOI1-A-60	--	15	16*
Wells Creek				
Historic Seep Location 14 (HS14)	CUF-HS14-D-61 to CUF-HS14-U-95	16	9	10
AOC Location 1 (AOC1)	CUF-AOC1-D-96 to CUF-AOC1-U-124	10	9	10

Notes:

1. Historic Seep (HS), Area of Interest (AOI), and Area of Concern (AOC) locations and measurement location identications (IDs) are shown on Exhibits A.1 through A.3.

*Downstream measurements for historic seep cluster 4 & 5 (HS45) and upstream measurements for AOI 1 overlap. As such, measurements collected downstream of HS45 were used as the upstream comparison group for AOI 1.

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TABLE D.2 – Tests of Normality and Equality of Variances between Adjacent and Upstream Monitoring Results
Cumberland Fossil Plant
October 2019

	Historical Seep/AOC/AOI Location			
	Unnamed Tributary		Wells Creek	
Monitoring Parameters	**HS45**	**AOI1**	**HS14**	**AOC1**
Number of Samples (Adjacent / Upstream)	19/10	15/16	9/10	9/10
Dissolved Oxygen	Not Normal	Normal / ≠	Normal / =	Normal / =
pH	Not Normal	Not Normal	Normal / =	Normal / =
Specific Conductance	Not Normal	Not Normal	Normal / =	Not Normal
Temperature	Not Normal	Normal / ≠	Normal / =	Normal / =

Notes:

=	Variances are equal when comparing adjacent and upstream data sets
≠	Variances are not equal when comparing adjacent and upstream data sets
AOC	Historical Area of Concern
AOI	Area of Interest
HS	Historical Seep
Normal	Data Sets (adjacent and upstream) are normally distributed (alpha=0.01)

TABLE D.3 – Summary of Statistical Hypothesis Testing
Cumberland Fossil Plant
October 2019

Historical Seep/ AOC/AOI Location	Number of Samples	p-value DO	p-value pH	p-value Specific Conductance	p-value Temperature
Unnamed Tributary					
	Adjacent / Upstream	mg/L	SU	uS/cm	DEG C
HS45	19/10	0.9960	0.5940	0.4980	0.1270
AOI1	15/16	**<0.0001**	**<0.0001**	0.2830	**<0.0001**
Wells Creek					
HS14	9/10	0.6444	**0.0027**	0.8639	0.0436
AOC1	9/10	0.1436	0.1420	0.0150	0.4015

Notes:

AOC	Historical Area of Concern
AOI	Area of Interest
DEG C	degrees Celsius
DO	Dissolved Oxygen
HS	Historical Seep
mg/L	milligrams per Liter
SU	Standard Units
SWFPR	site-wide false positive rate
uS/cm	microSiemens per centimeter

1. The p-value represents the probability that the mean of the adjacent measurements is equal to the mean of the upstream measurements. If a p-value is small (i.e., below the significance level), it is indicative that there is a statistically significant difference between adjacent and upstream monitoring results that is unlikely to have occurred by chance.

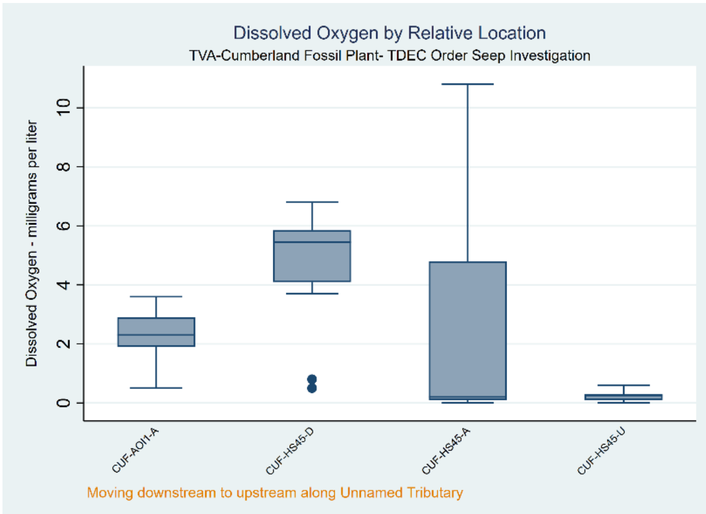
2. Bonferroni method used to adjust significance level (SWFPR/No. of statistical tests). Unnamed Tributary - adjusted to 0.10/8=0.0125 (4 parameters x 2 HS/AOI); Wells Creek - adjusted to 0.10/8= 0.0125 (4 parameters x 2 HS/AOC)

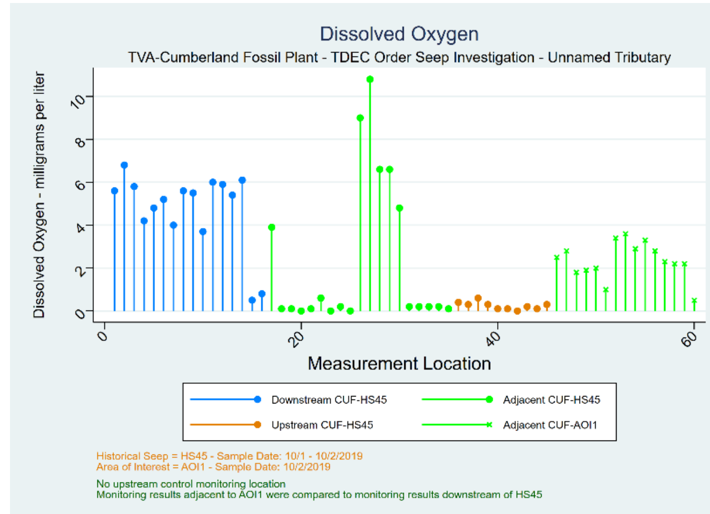
3. Shaded values indicate a statistically significant difference between measurements at relative locations to historical seeps/AOC/AOI (p-value is below adjusted significance level, reject null hypothesis).

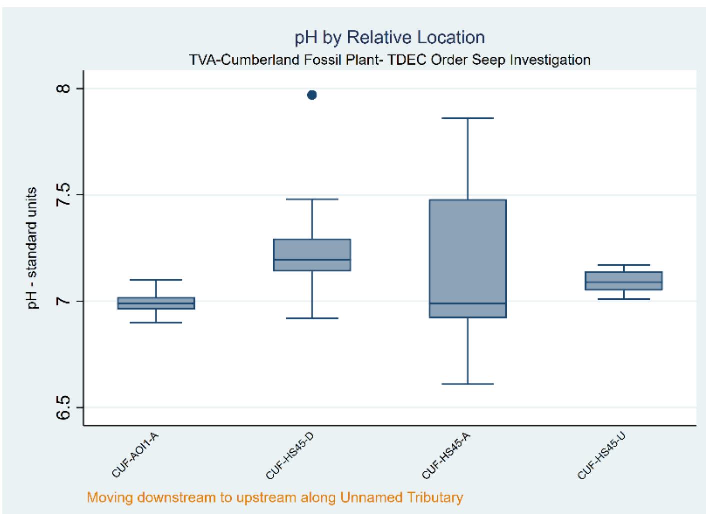
ATTACHMENT D.1

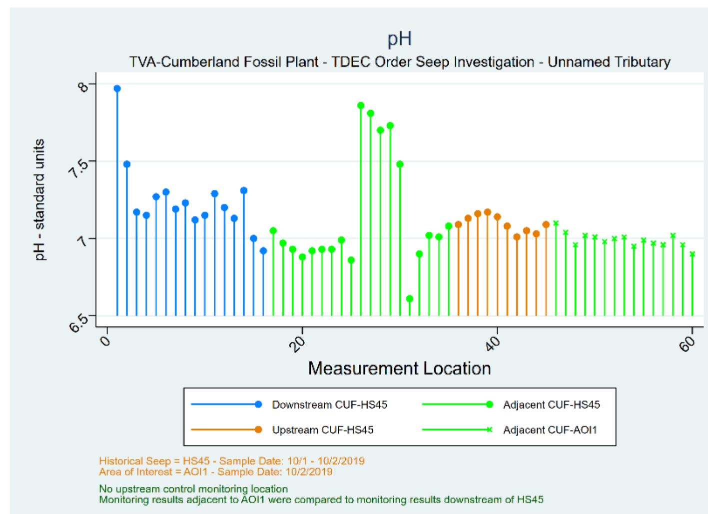
Measurement Results and Box Plots

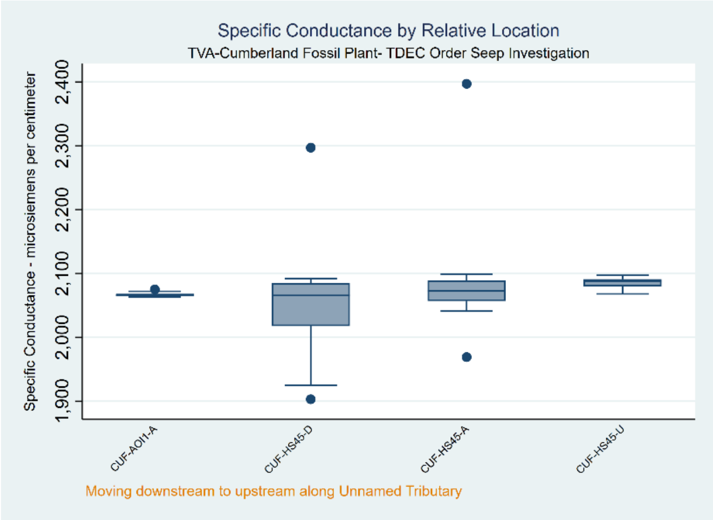
Measurement Results and Box Plots

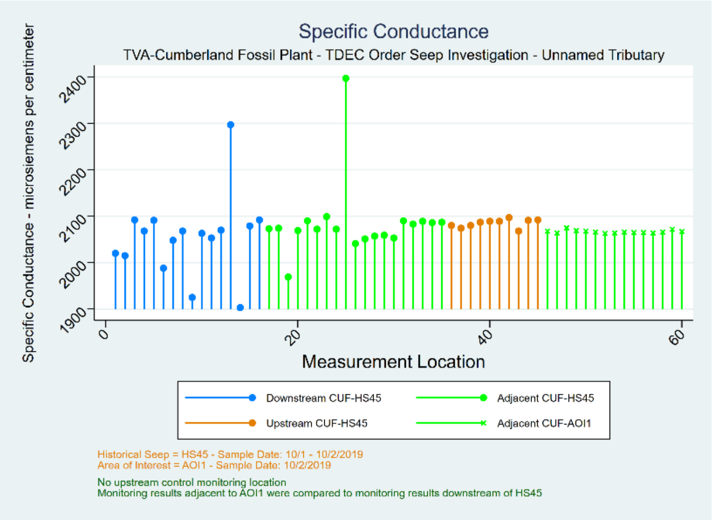


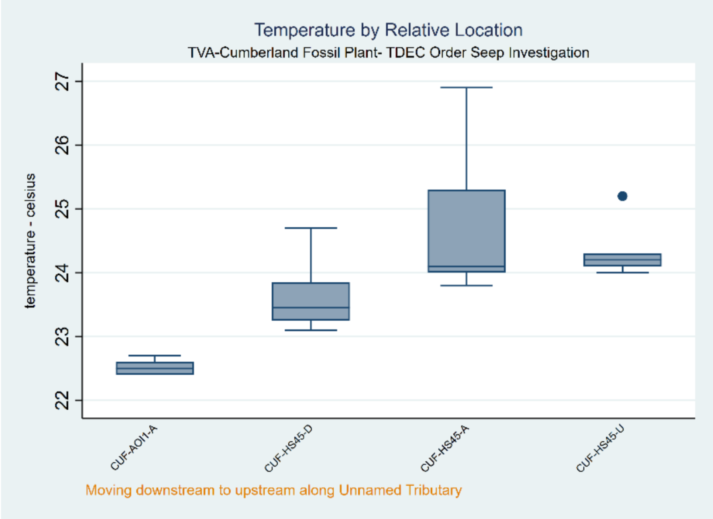


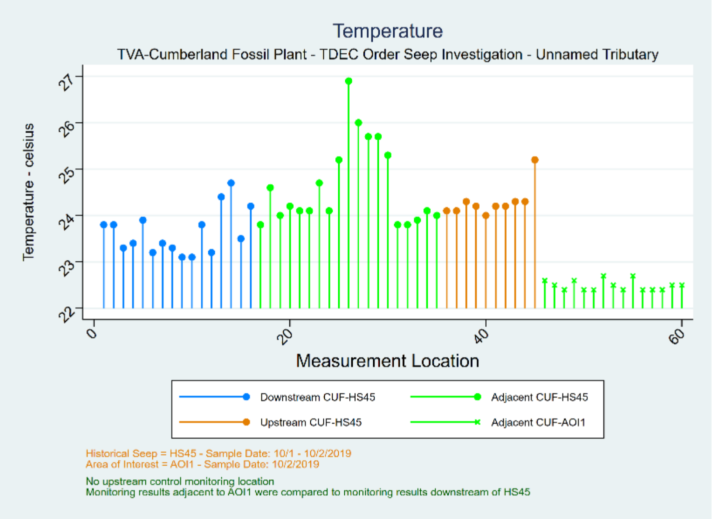


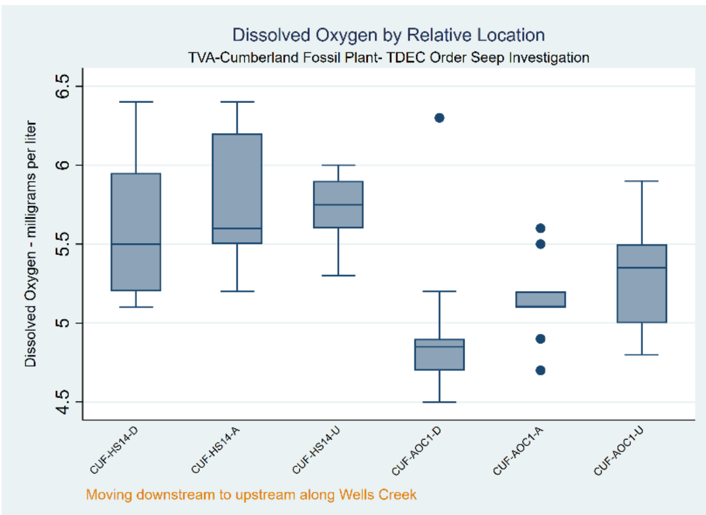


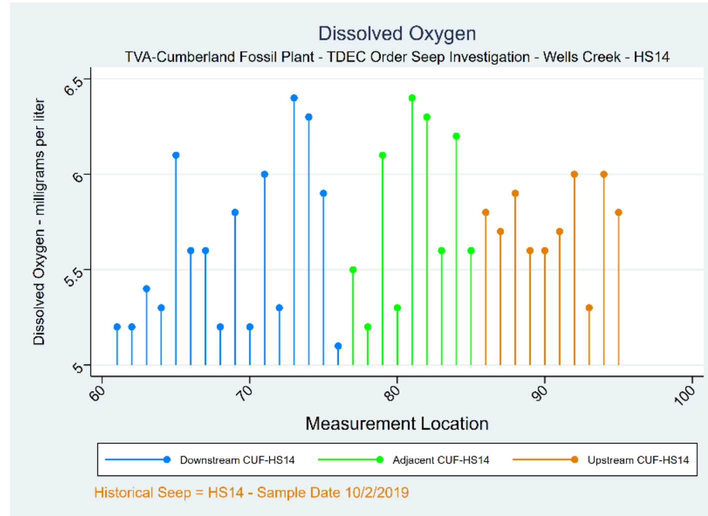

Specific Conductance by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
Specific Conductance - microsiemens per centimeter
1,900
2,000
2,100
2,200
2,300
2,400
CUF-AOI1-A
CUF-HS45-D
CUF-HS45-A
CUF-HS45-U
Moving downstream to upstream along Unnamed Tributary

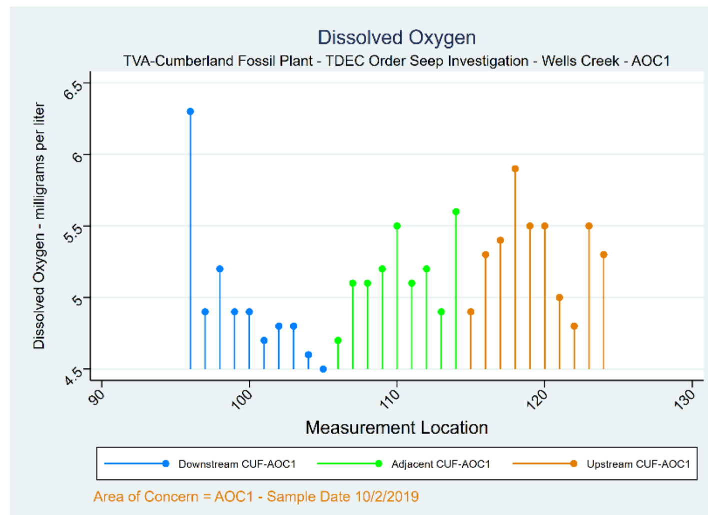

Specific Conductance
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Unnamed Tributary
Specific Conductance - microsiemens per centimeter
1900
2000
2100
2200
2300
2400
0
20
40
60
Measurement Location
Downstream CUF-HS45
Adjacent CUF-HS45
Upstream CUF-HS45
Adjacent CUF-AOI1
Historical Seep = HS45 - Sample Date: 10/1 - 10/2/2019
Area of Interest = AOI1 - Sample Date: 10/2/2019
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

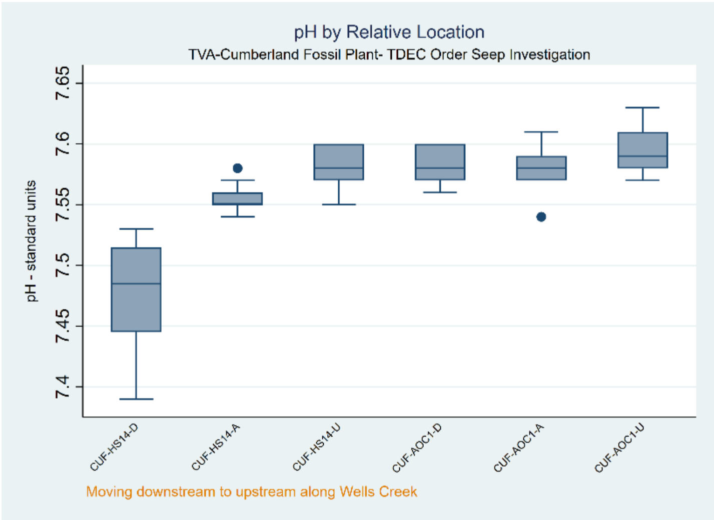

Temperature by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
temperature - celsius
22
23
24
25
26
27
CUF-AOI1-A
CUF-HS45-D
CUF-HS45-A
CUF-HS45-U
Moving downstream to upstream along Unnamed Tributary


Temperature
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Unnamed Tributary
Temperature - celsius
22
23
24
25
26
27
0
20
40
60
Measurement Location
Downstream CUF-HS45
Adjacent CUF-HS45
Upstream CUF-HS45
Adjacent CUF-AOI1
Historical Seep = HS45 - Sample Date: 10/1 - 10/2/2019
Area of Interest = AOI1 - Sample Date: 10/2/2019
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

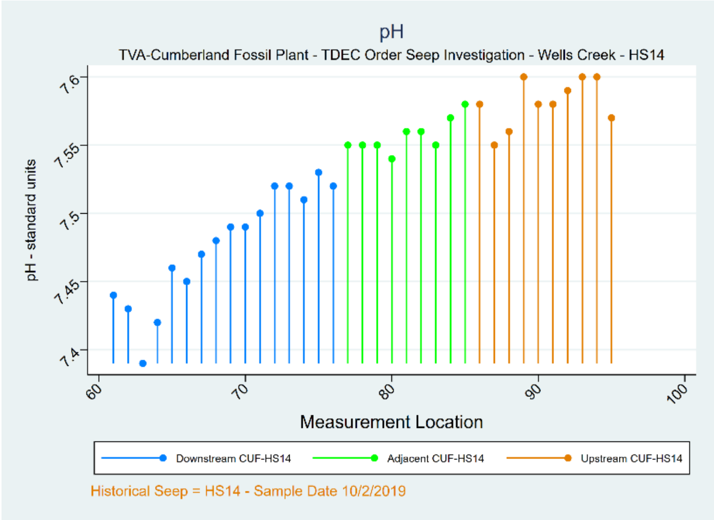

Dissolved Oxygen by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
Dissolved Oxygen - milligrams per liter
CUF-HS14-D
CUF-HS14-A
CUF-HS14-U
CUF-AOC1-D
CUF-AOC1-A
CUF-AOC1-U
Moving downstream to upstream along Wells Creek


Dissolved Oxygen
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - HS14
Dissolved Oxygen - milligrams per liter
Measurement Location
Downstream CUF-HS14
Adjacent CUF-HS14
Upstream CUF-HS14
Historical Seep = HS14 - Sample Date 10/2/2019

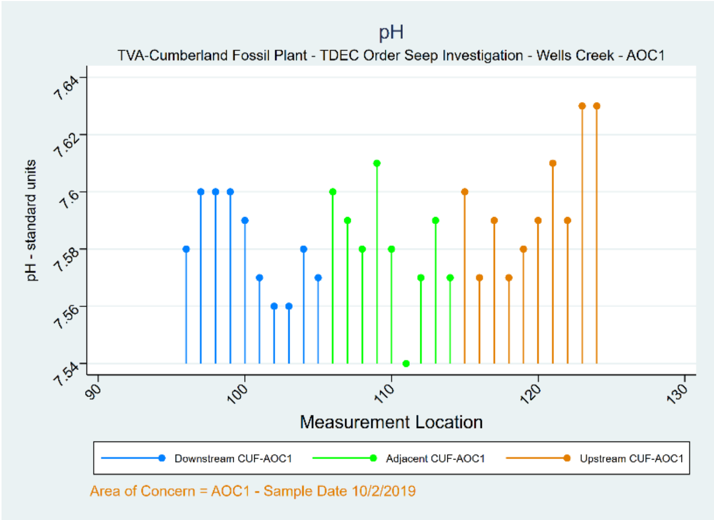

Dissolved Oxygen
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - AOC1
Dissolved Oxygen - milligrams per liter
Measurement Location
Downstream CUF-AOC1
Adjacent CUF-AOC1
Upstream CUF-AOC1
Area of Concern = AOC1 - Sample Date 10/2/2019



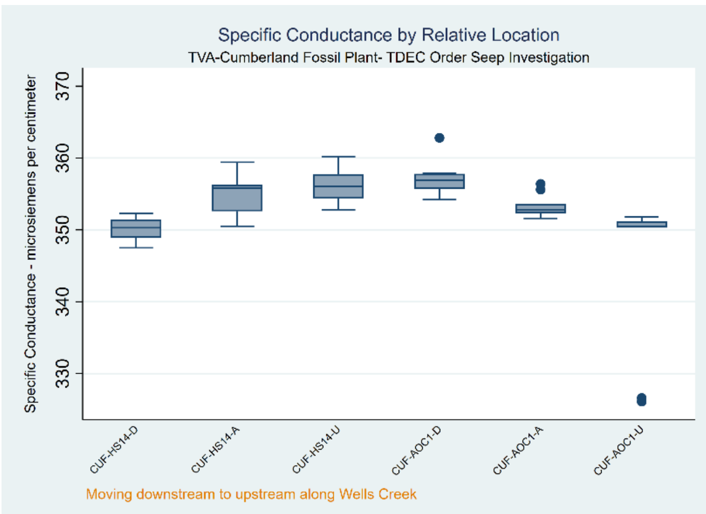
pH by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
pH - standard units
7.4
7.45
7.5
7.55
7.6
7.65
CUF-HS14-D
CUF-HS14-A
CUF-HS14-U
CUF-AOC1-D
CUF-AOC1-A
CUF-AOC1-U
Moving downstream to upstream along Wells Creek

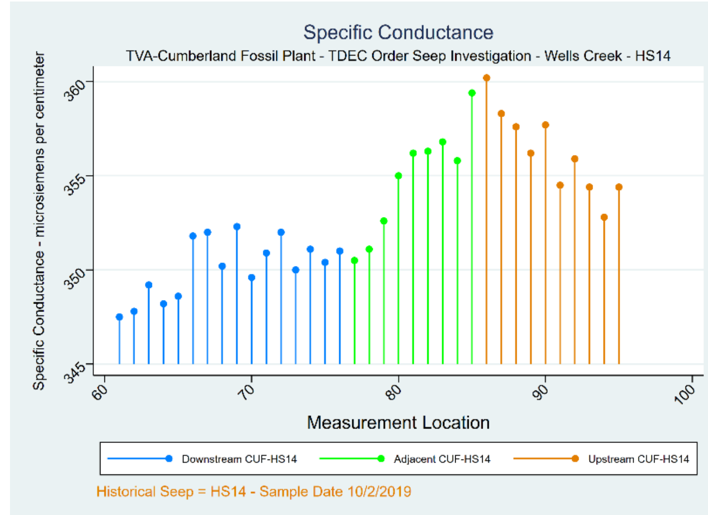


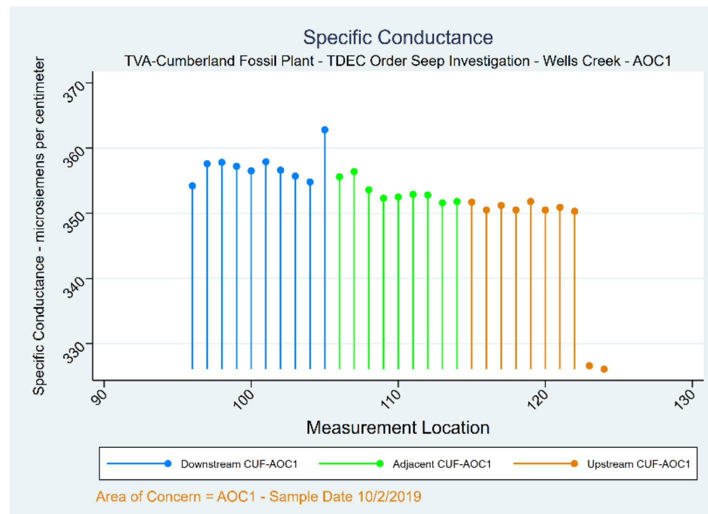
pH
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - HS14
pH - standard units
7.4
7.45
7.5
7.55
7.6
60
70
80
90
100
Measurement Location
Downstream CUF-HS14
Adjacent CUF-HS14
Upstream CUF-HS14
Historical Seep = HS14 - Sample Date 10/2/2019

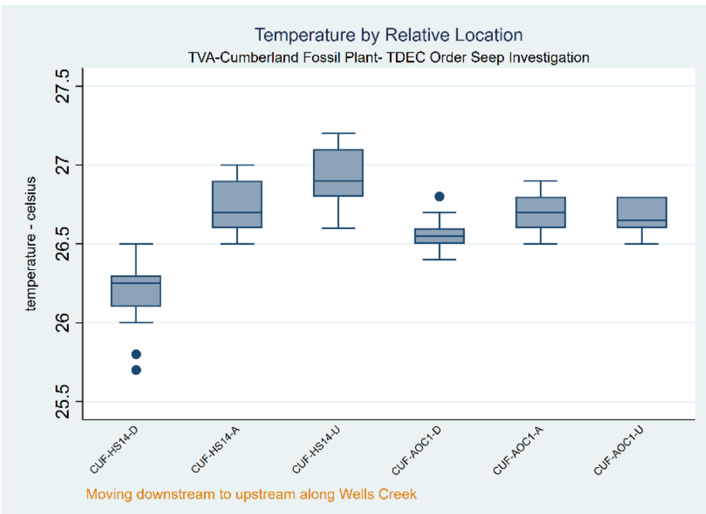


pH
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - AOC1
pH - standard units
7.54
7.56
7.58
7.6
7.62
7.64
90
100
110
120
130
Measurement Location
Downstream CUF-AOC1
Adjacent CUF-AOC1
Upstream CUF-AOC1
Area of Concern = AOC1 - Sample Date 10/2/2019

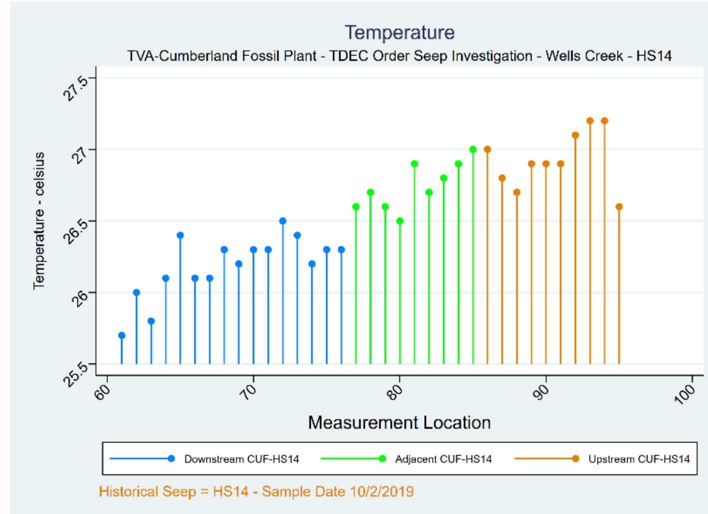

Specific Conductance by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
Specific Conductance - microsiemens per centimeter
330
340
350
360
370
CUF-HS14-D
CUF-HS14-A
CUF-HS14-U
CUF-AOC1-D
CUF-AOC1-A
CUF-AOC1-U
Moving downstream to upstream along Wells Creek


Specific Conductance
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - HS14
Specific Conductance - microsiemens per centimeter
345
350
355
360
60
70
80
90
100
Measurement Location
Downstream CUF-HS14
Adjacent CUF-HS14
Upstream CUF-HS14
Historical Seep = HS14 - Sample Date 10/2/2019

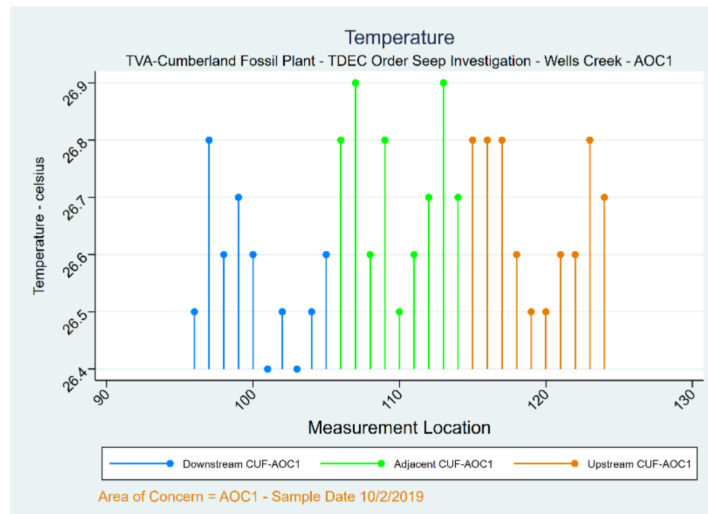

Specific Conductance
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - AOC1
Specific Conductance - microsiemens per centimeter
330
340
350
360
370
90
100
110
120
130
Measurement Location
Downstream CUF-AOC1
Adjacent CUF-AOC1
Upstream CUF-AOC1
Area of Concern = AOC1 - Sample Date 10/2/2019



Temperature by Relative Location
TVA-Cumberland Fossil Plant- TDEC Order Seep Investigation
temperature - celsius
25.5
26
26.5
27
27.5
CUF-HS14-D
CUF-HS14-A
CUF-HS14-U
CUF-AOC1-D
CUF-AOC1-A
CUF-AOC1-U
Moving downstream to upstream along Wells Creek



Temperature
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - HS14
Temperature - celsius
25.5
26
26.5
27
27.5
60
70
80
90
100
Measurement Location
Downstream CUF-HS14
Adjacent CUF-HS14
Upstream CUF-HS14
Historical Seep = HS14 - Sample Date 10/2/2019



Temperature
TVA-Cumberland Fossil Plant - TDEC Order Seep Investigation - Wells Creek - AOC1
Temperature - celsius
26.4
26.5
26.6
26.7
26.8
26.9
90
100
110
120
130
Measurement Location
Downstream CUF-AOC1
Adjacent CUF-AOC1
Upstream CUF-AOC1
Area of Concern = AOC1 - Sample Date 10/2/2019

ATTACHMENT D.2

Summary of Descriptive Statistics

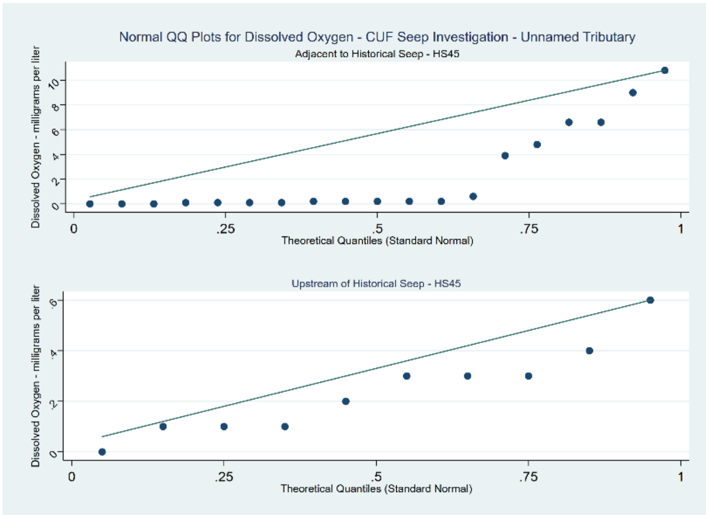
Summary of Descriptive Statistics Cumberland Fossil Plant - Seep Investigation								
Historical Seep/Area of Concern/Area of Interest	**Relative Location to Historical Seep/ Area of Concern**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**	**Median**	**95th Percentile**
Unnamed Tributary								
Dissolved Oxygen (milligrams per Liter)								
HS45	Downstream	16	0.5	6.8	4.74	1.79	5.45	6.8
	Adjacent	19	0	10.8	2.30	3.52	0.2	10.8
	Upstream	10	0	0.6	0.24	0.18	0.25	0.6
AOI1	Adjacent	15	0.5	3.6	2.35	0.85	2.3	3.6
	Upstream*	16	0.5	6.8	4.74	1.79	5.45	6.8
pH (Standard Units)								
HS45	Downstream	16	6.92	7.97	7.24	0.23	7.195	7.97
	Adjacent	19	6.61	7.86	7.14	0.37	6.99	7.86
	Upstream	10	7.01	7.17	7.10	0.05	7.09	7.17
AOI1	Adjacent	15	6.9	7.1	6.99	0.05	6.99	7.1
	Upstream*	16	6.92	7.97	7.24	0.23	7.195	7.97
Specific Conductivity (microsiemens per centimeter)								
HS45	Downstream	16	1903	2297	2054.50	86.09	2065.5	2297
	Adjacent	19	1969	2397	2084.79	80.80	2073	2397
	Upstream	10	2068	2097	2084.70	8.97	2088	2097
AOI1	Adjacent	15	2063	2075	2066.80	3.26	2066	2075
	Upstream*	16	1903	2297	2054.50	86.09	2065.5	2297
Temperature (Celsius)								
HS45	Downstream	16	23.1	24.7	23.63	0.48	23.45	24.7
	Adjacent	19	23.8	26.9	24.63	0.91	24.1	26.9
	Upstream	10	24	25.2	24.29	0.33	24.2	25.2
AOI1	Adjacent	15	22.4	22.7	22.49	0.11	22.5	22.7
	Upstream*	16	23.1	24.7	23.63	0.48	23.45	24.7
Wells Creek								
Dissolved Oxygen (milligrams per Liter)								
HS14	Downstream	16	5.1	6.4	5.60	0.43	5.5	6.4
	Adjacent	9	5.2	6.4	5.80	0.45	5.6	6.4
	Upstream	10	5.3	6	5.74	0.21	5.75	6
AOC1	Downstream	10	4.5	6.3	4.96	0.51	4.85	6.3
	Adjacent	9	4.7	5.6	5.16	0.27	5.1	5.6
	Upstream	10	4.8	5.9	5.31	0.33	5.35	5.9
pH (Standard Units)								
HS14	Downstream	16	7.39	7.53	7.48	0.04	7.485	7.53
	Adjacent	9	7.54	7.58	7.56	0.01	7.55	7.58
	Upstream	10	7.55	7.6	7.58	0.02	7.58	7.6
AOC1	Downstream	10	7.56	7.6	7.58	0.02	7.58	7.6
	Adjacent	9	7.54	7.61	7.58	0.02	7.58	7.61
	Upstream	10	7.57	7.63	7.60	0.02	7.59	7.63
Specific Conductivity (microsiemens per centimeter)								
HS14	Downstream	16	347.5	352.3	350.16	1.56	350.3	352.3
	Adjacent	9	350.5	359.4	354.86	2.90	355.8	359.4
	Upstream	10	352.8	360.2	356.20	2.25	356.05	360.2
AOC1	Downstream	10	354.2	362.8	357.11	2.36	356.9	362.8
	Adjacent	9	351.6	356.4	353.28	1.66	352.8	356.4
	Upstream	10	326.1	351.8	346.01	10.38	350.5	351.8
Temperature (Celsius)								
HS14	Downstream	16	25.7	26.5	26.19	0.22	26.25	26.5
	Adjacent	9	26.5	27	26.74	0.17	26.7	27
	Upstream	10	26.6	27.2	26.93	0.20	26.9	27.2
AOC1	Downstream	10	26.4	26.8	26.56	0.13	26.55	26.8
	Adjacent	9	26.5	26.9	26.72	0.14	26.7	26.9
	Upstream	10	26.5	26.8	26.67	0.13	26.65	26.8

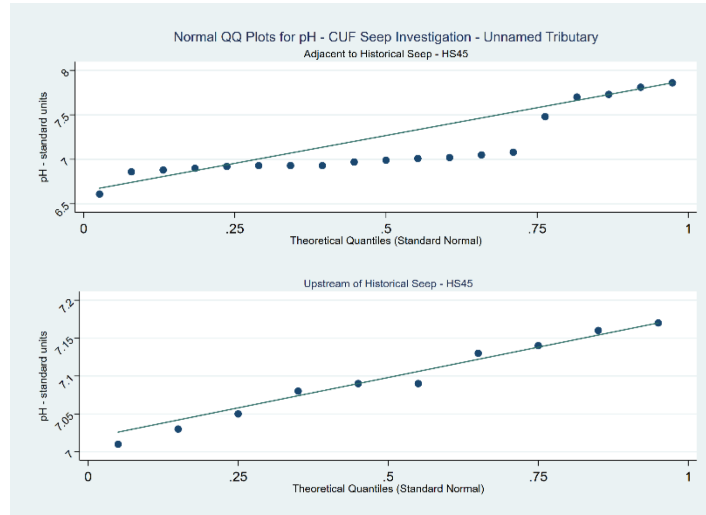
*Downstream measurements for historic seep cluster 4 & 5 (HS45) and upstream measurements for AOI 1 overlap. As such, measurements collected downstream of HS45 were used as the upstream comparison group for AOI 1.

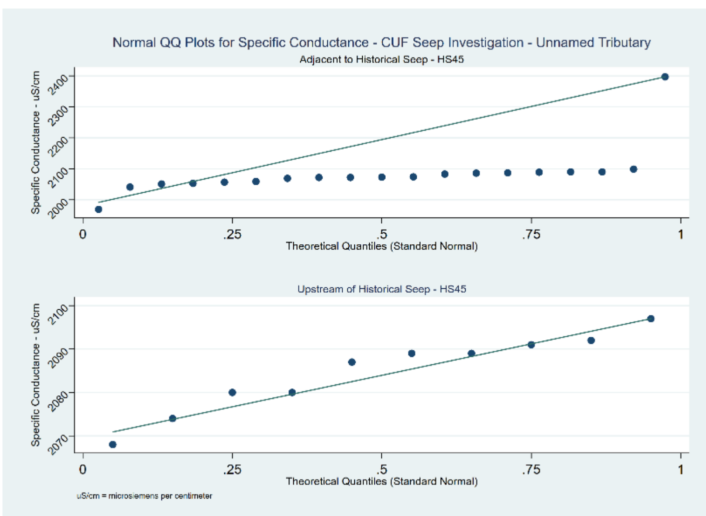
ATTACHMENT D.3

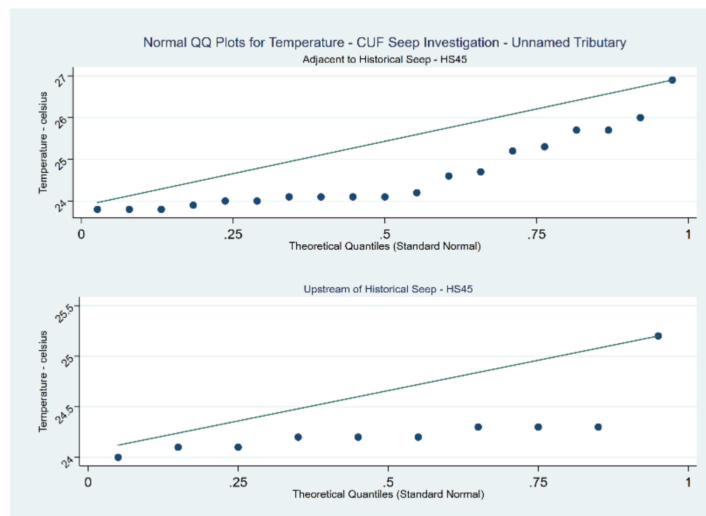
Normal Q-Q Plots

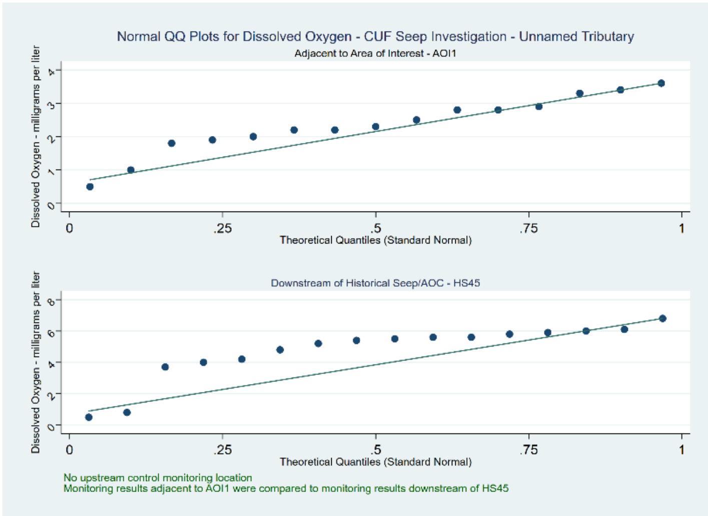
Normal Q-Q Plots

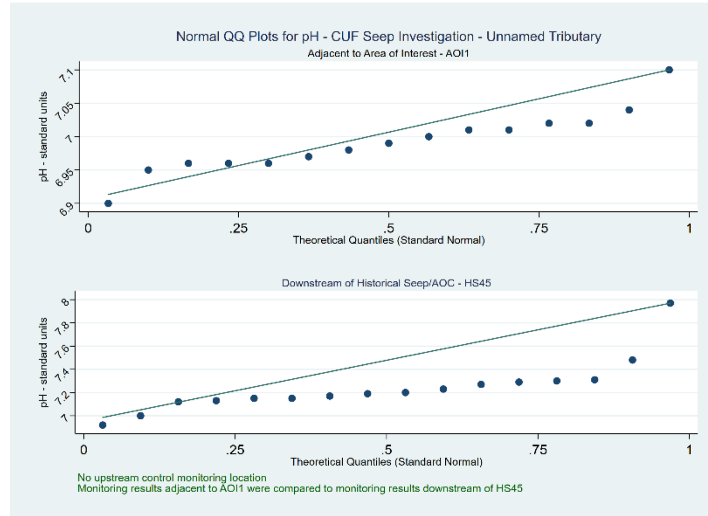




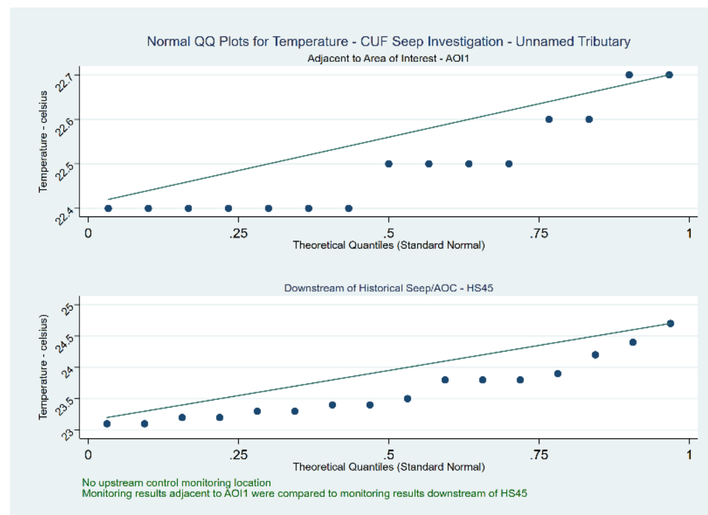


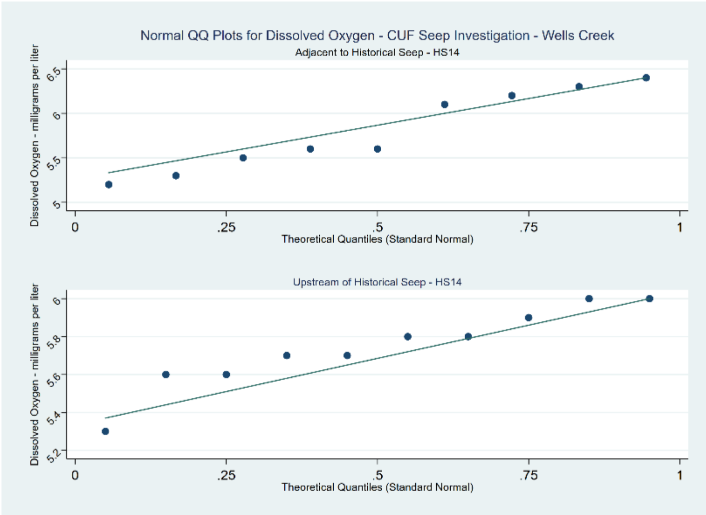


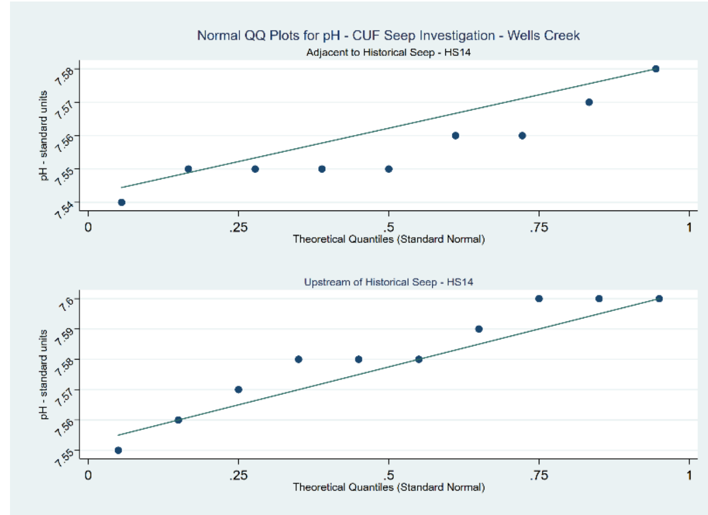

Normal QQ Plots for Dissolved Oxygen - CUF Seep Investigation - Unnamed Tributary
Adjacent to Area of Interest - AOI1
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)
Downstream of Historical Seep/AOC - HS45
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

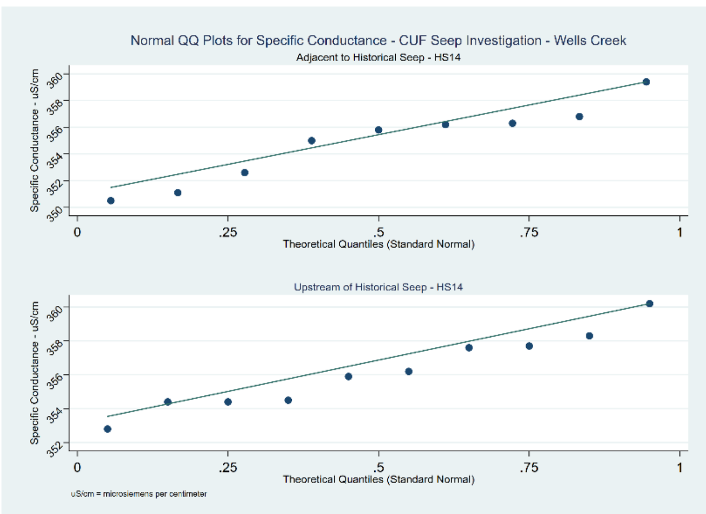

Normal QQ Plots for pH - CUF Seep Investigation - Unnamed Tributary
Adjacent to Area of Interest - AOI1
pH - standard units
Theoretical Quantiles (Standard Normal)
Downstream of Historical Seep/AOC - HS45
pH - standard units
Theoretical Quantiles (Standard Normal)
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

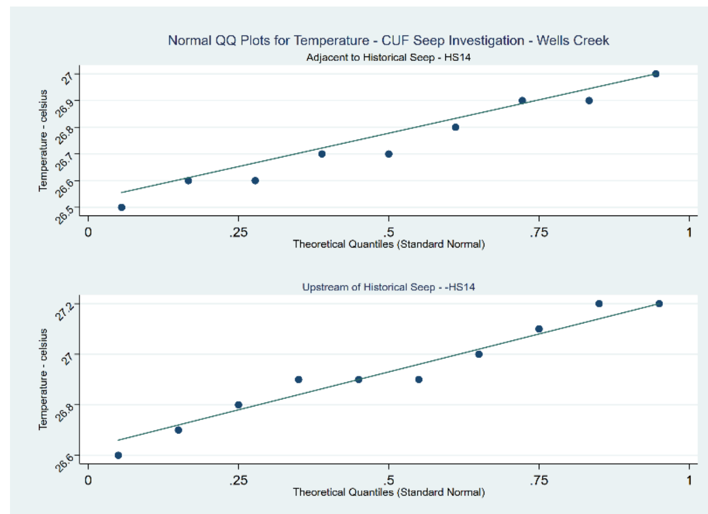

Normal QQ Plots for Specific Conductance - CUF Seep Investigation - Unnamed Tributary
Adjacent to Area of Interest - AOI1
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
Downstream of Historical Seep/AOC - HS45
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

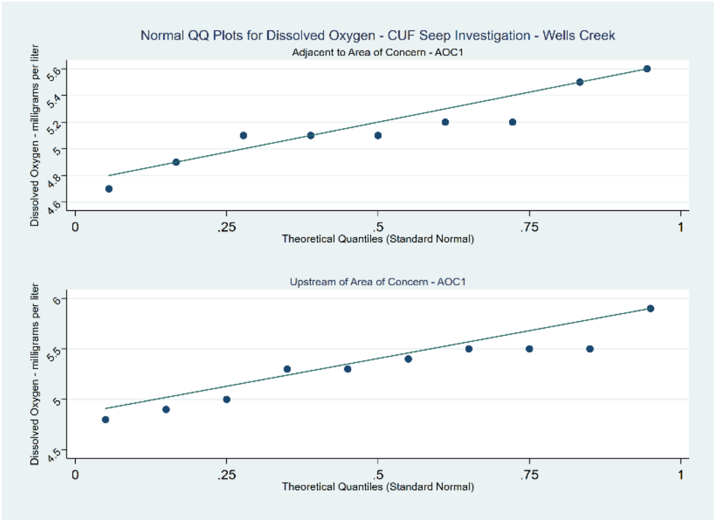

Normal QQ Plots for Temperature - CUF Seep Investigation - Unnamed Tributary
Adjacent to Area of Interest - AOI1
Temperature - celsius
Theoretical Quantiles (Standard Normal)
Downstream of Historical Seep/AOC - HS45
Temperature - celsius)
Theoretical Quantiles (Standard Normal)
No upstream control monitoring location
Monitoring results adjacent to AOI1 were compared to monitoring results downstream of HS45

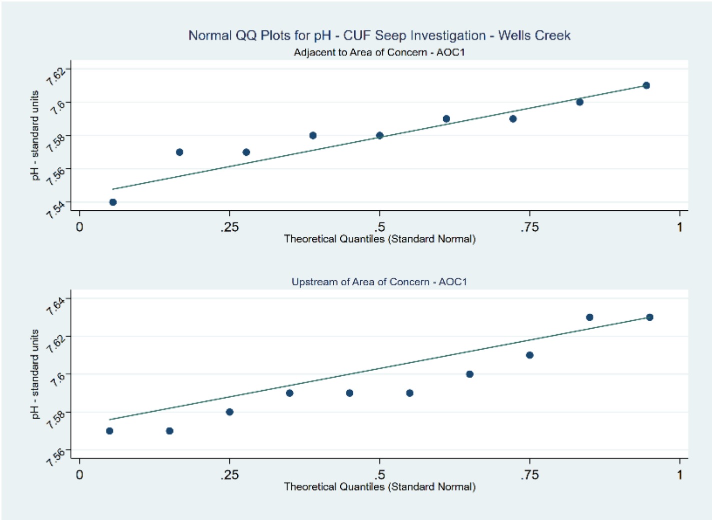

Normal QQ Plots for Dissolved Oxygen - CUF Seep Investigation - Wells Creek
Adjacent to Historical Seep - HS14
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)
Upstream of Historical Seep - HS14
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)

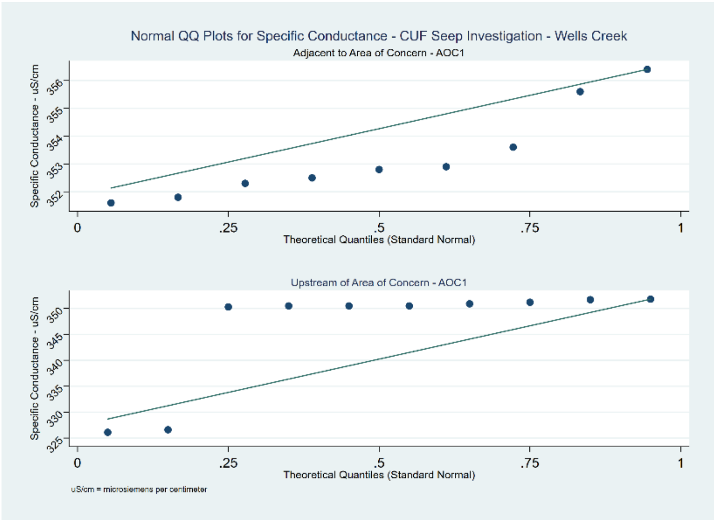

Normal QQ Plots for pH - CUF Seep Investigation - Wells Creek
Adjacent to Historical Seep - HS14
pH - standard units
Theoretical Quantiles (Standard Normal)
Upstream of Historical Seep - HS14
pH - standard units
Theoretical Quantiles (Standard Normal)

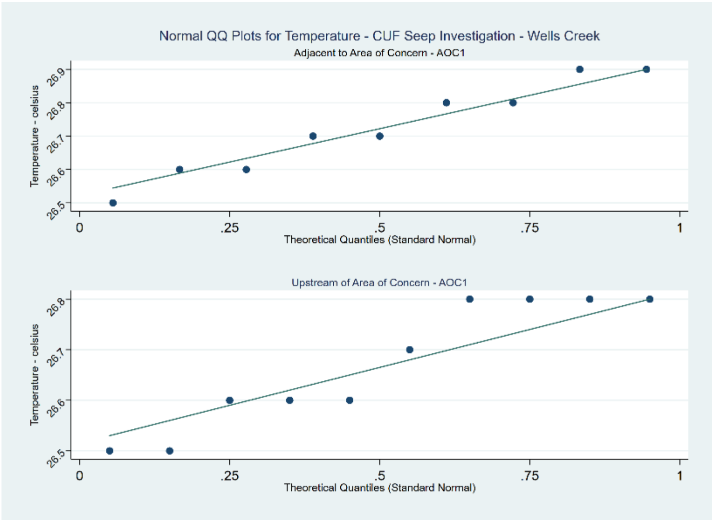

Normal QQ Plots for Specific Conductance - CUF Seep Investigation - Wells Creek
Adjacent to Historical Seep - HS14
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
Upstream of Historical Seep - HS14
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
uS/cm = microsiemens per centimeter


Normal QQ Plots for Temperature - CUF Seep Investigation - Wells Creek
Adjacent to Historical Seep - HS14
Temperature - celsius
Theoretical Quantiles (Standard Normal)
Upstream of Historical Seep - -HS14
Temperature - celsius
Theoretical Quantiles (Standard Normal)


Normal QQ Plots for Dissolved Oxygen - CUF Seep Investigation - Wells Creek
Adjacent to Area of Concern - AOC1
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)
Upstream of Area of Concern - AOC1
Dissolved Oxygen - milligrams per liter
Theoretical Quantiles (Standard Normal)


Normal QQ Plots for pH - CUF Seep Investigation - Wells Creek
Adjacent to Area of Concern - AOC1
pH - standard units
Theoretical Quantiles (Standard Normal)
Upstream of Area of Concern - AOC1
pH - standard units
Theoretical Quantiles (Standard Normal)


Normal QQ Plots for Specific Conductance - CUF Seep Investigation - Wells Creek
Adjacent to Area of Concern - AOC1
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
Upstream of Area of Concern - AOC1
Specific Conductance - uS/cm
Theoretical Quantiles (Standard Normal)
uS/cm = microsiemens per centimeter


Normal QQ Plots for Temperature - CUF Seep Investigation - Wells Creek
Adjacent to Area of Concern - AOC1
Temperature - celsius
Theoretical Quantiles (Standard Normal)
Upstream of Area of Concern - AOC1
Temperature - celsius
Theoretical Quantiles (Standard Normal)

APPENDIX E.5

STATISTICAL ANALYSIS OF SURFACE STREAM DATA

Appendix E.5 - Statistical Analysis of Surface Stream Data

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

REVISION LOG

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022 TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023 TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Appendix E.5 - Statistical Analysis of Surface Stream Data was prepared by Stantec Consulting Services Inc. (“Stantec”) for the account of Tennessee Valley Authority (the “Client”). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ____________________

Chris La Londe, Senior Risk Assessor

Reviewed by ____________________

Melissa Whitfield Aslund, PhD, Environmental Scientist

Approved by ____________________

Rebekah Brooks, PG, Principal Hydrogeologist

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

Abbreviations

CASRN	Chemical Abstracts Service Registry Number
CCR	Coal Combustion Residuals
CCR Parameters	Constituents listed in Appendices III and IV of 40 CFR 257 and five inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04
CCR Rule	Title 40, Code of Federal Regulations, Part 257
CUF Plant	Cumberland Fossil Plant
EAR	Environmental Assessment Report
EI	Environmental Investigation
ESV	Ecological Screening Value
IQR	Interquartile Range
MDL	Method Detection Limit
NA	Not Available
PCA	Principal Component Analysis
SSL_{HH}	Site-specific Human Health Screening Levels
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
µg/L	micrograms per Liter

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to summarize the statistical analyses performed on surface stream data to support evaluations conducted for the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. The surface stream samples were collected between November 2018 and May 2020 in four water bodies in proximity to the CUF Plant. Further details regarding the surface stream sampling and a summary of the analytical data results are presented in Appendix J.1 and the *CUF Plant Surface Stream Sampling and Analysis Report* (Appendix J.2). Phase 2 supplemental surface stream and sediment sampling was performed in the Unnamed Tributary and immediately downstream of its confluence with Wells Creek in June/July 2021. Results from the Phase 2 supplemental sampling are included in this EAR

For the Environmental Investigation (EI), surface stream samples were collected from locations along sample transects or individual locations from four water bodies proximate to the CUF Plant coal combustion residual (CCR) management units: Cumberland River, Wells Creek, Unnamed Tributary, and Discharge Channel. Sample transects/location names, locations relative to CUF Plant CCR management units, and the numbers of samples collected from each water body are presented in Table E.5-1. Fourteen samples were collected from the Discharge Channel; however, these samples were not included in the statistical analysis because conditions in the Discharge Channel are not representative of natural surface stream conditions and the Discharge Channel is regulated under a National Pollutant Discharge Elimination System permit (#TN0005789). The constituents listed in Appendices III and IV of 40 CFR 257 and five additional inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04 (CCR Parameters) included in the statistical analysis are presented in Table E.5-2.

Table E.5-1 – Surface Stream Sample Transect/Locations, CUF Plant

Water Body	Transect/Location Name	Location Relative to CCR Management Units	Number of Samples
Cumberland River	CuR01, CuR02, CuR03	Upstream	55
	CuR04, CuR05	Adjacent	32
	CuR06, CuR07	Downstream	43
Wells Creek	WC01, WC02, WC03	Upstream	19
	WC03.5, WC04, WC05, WC06, WC07, WC08, WC09, WC10	Adjacent	53
	WC11	Downstream	4
Unnamed Tributary	UT01, UT01.5, UT02, UT03, UT03.25, UT03.5, UT03.75, UT04, UT05	Adjacent	44

Notes: Fourteen samples collected from the Discharge Channel were not included in the statistical analysis; conditions in the Discharge Channel do not represent natural stream conditions and the Discharge Channel is regulated under a NPDES permit.

Table E.5-2 – CCR Parameters Evaluated in Statistical Analysis

CCR Parameter	CASRN
CCR Rule Appendix III Parameters	
Boron	7440-42-8
Calcium	7440-70-2
Chloride	16887-00-6
Fluoride[1] (also Appendix IV)	16984-48-8
pH	Not Available (NA)
Sulfate	14808-79-8
Total Dissolved Solids	NA
CCR Rule Appendix IV Parameters	
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Cadmium	7440-43-9
Chromium	7440-47-3
Cobalt	7440-48-4
Lead	7439-92-1
Lithium	7439-93-2
Mercury	7439-97-6
Molybdenum	7439-98-7
Radium-226+228	13982-63-3/ 15262-20-1
Selenium	7782-49-2
Thallium	7440-28-0
TDEC Appendix I Parameters	
Copper	7440-50-8
Nickel	7440-02-0
Silver	7440-22-4
Vanadium	7440-62-2
Zinc	7440-66-6
Other	
Hardness	NA
Iron	7439-89-6
Magnesium	7439-95-4
Manganese	7439-96-5
Total Suspended Solids	NA

Notes: CASRN: Chemical Abstracts Service Registry Number; CCR Rule - Title 40, Code of Federal Regulations, Part 257; NA – Not available; TDEC - Tennessee Department of Environment and Conservation.
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV CCR Parameter. In this table, and in the results figures and tables for this report, fluoride has been grouped with the Appendix III CCR Parameters only to avoid duplication.

The following sections present the methods and results from the general exploratory data analysis using summary statistics, data plots, and outlier screening, and a comparison of surface stream results to Site-specific Ecological Screening Values (ESVs) and Human Health Screening Levels (SSL_{HH}) that were developed for the EAR. The site specific ESVs and SSL_{HH} for surface stream data are provided in Appendix A.2.

Additional statistical analyses (principal component analysis [PCA] and hypothesis testing) were performed if the following conditions were satisfied: 1) CCR parameter concentrations were above ESVs or SSL_{HH} and 2) data were collected from transects/locations adjacent and from transects/locations either upstream or downstream to the CUF Plant CCR management units. Since CCR parameter concentrations were not above ESVs or SSL_{HH} in the surface stream datasets, no additional statistical analyses were conducted.

2.0 METHODS

The statistical evaluation for the surface stream data collected at the CUF Plant for the EI was conducted in three parts: 1) exploratory data analysis, 2) comparison of results to site-specific ESVs and to generic $SSL_{HH,}$ and 3) additional statistical analysis, when warranted.

2.1 EXPLORATORY DATA ANALYSIS

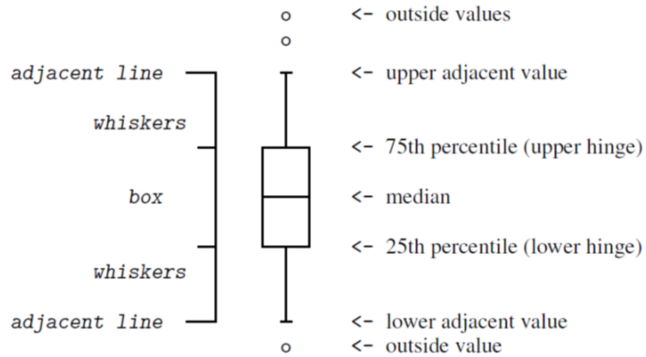
Exploratory data analysis is the initial step of statistical analysis. It utilizes simple summary statistics (e.g. mean, median, standard deviation and percentiles) and graphical representations to identify characteristics of an analytical dataset, such as the center of the data (mean, median), variation, distribution, spatial or temporal patterns, presence of outliers, and randomness.

2.1.1 Summary Statistics

Summary statistics were calculated for each CCR Parameter grouped by water body and aggregated by the transect's position relative to the CUF Plant CCR management units (upstream, adjacent and downstream). Summary statistics also were calculated for the following additional water quality parameters: hardness, iron, magnesium, manganese, and total suspended solids. Summary statistics include information such as the total numbers of available samples, the frequencies of detection, ranges of reporting limits, minimum and maximum detected concentrations, mean concentrations, standard deviations, median concentrations and the 95th percentile concentrations. Where applicable, summary statistics were calculated for the results for both total and dissolved metal results. Summary statistics tables are presented in Attachment E.5-A.

2.1.2 Exploratory Data Plots

Exploratory data plots (box plots and transect plots) were constructed using the surface stream results for total metals to support a visual review of the data. Box plots were used to identify the center of the data, distribution, and variability, and to visually identify potential outliers. The diagram below graphically depicts the basics of the construction of the box plots (StataCorp LLC 2017).



The box portion of the plot is the interquartile range (IQR), which represents the middle 50 percent of data, with the bottom of the box being the 25th percentile and the top of the box being the 75th percentile. The line inside the box is the median concentration. The top of the upper "whisker" represents the first observed concentration above the 75th percentile, whereas the bottom of the lower "whisker" represents the first observed concentration below the 25th percentile (upper adjacent value and lower adjacent value, respectively). Values that lie outside of the adjacent values represent outside (or outlier) concentrations (i.e. concentrations at the upper and lower ends of the distribution of the data). The method detection limit (MDL) was used as the reported value in order to construct the box plot when analytical results were reported as non-detects.

Side-by-side box plots were constructed for the surface stream CCR Parameter data and aggregated by transect and water body. These box plots were useful in identifying differences in CCR Parameter concentrations between transects and water bodies and were especially useful for visually identifying potential outliers.

Box plots were also prepared that compared results by transect in an individual water body. Transects ordered by relative location to the CUF Plant CCR management units (upstream, adjacent, downstream) were useful in assessing upstream to downstream patterns within a given water body, as well as data distribution and variability. This type of box plot was not constructed for the Unnamed Tributary because all transects were adjacent to the CUF Plant CCR management units. Box plots for CCR Rule Appendix III, CCR Rule Appendix IV, and TDEC Appendix I CCR Parameters are presented in Attachment E.5-B.

Transect plots were constructed for each water body that showed individual sample results aggregated by transect, position relative to the CUF Plant CCR management units (upstream, adjacent, or downstream), and relative position within the water body (right bank, center channel, or left bank).

- Cumberland River: Left Bank = Fossil Plant Bank; Right Bank = Opposite Bank
- Wells Creek and Unnamed Tributary: Left Bank = Opposite Bank; Right Bank = Fossil Plant Bank

The symbols used in the transect plots indicate whether the reported result is a detected concentration (solid symbol) or a non-detect reported at the MDL (hollow symbol).

Multiple transect plots were constructed for each CCR Parameter. Individual plots were constructed with a reference line for the SSL_{HH} using analytical results collected in the Cumberland River, because the Cumberland River is a potable water source, as described in Appendix J.1. Neither Wells Creek nor the Unnamed Tributary are sources of potable water. Transect plots with a reference line for the site-specific ESVs were constructed using analytical results collected in the Cumberland River, Wells Creek, and the Unnamed Tributary. In many cases, the sample results were much lower than either SSL_{HH} or ESVs, so including the reference lines induced a scaling effect which obscured patterns in the data. A third plot was produced for each CCR Parameter without a reference line in order to better identify patterns.

Transect plots provide more detailed information than side-by-side box plots and allow a more rigorous evaluation of the data. These plots are particularly useful in identifying potential patterns in the dataset (trends), frequency of detection, outliers, spatial differences relative to the CUF Plant CCR management units (upstream, adjacent, and downstream), and differences relative to the position in the water body (right bank, center channel, or left bank). The transect plots are presented in Attachment E.5-C.

2.1.3 Outlier Screening

Outliers are data points that are abnormally high or low as compared to other measurements and may represent anomalous data or data errors. Outliers may also represent natural variations of CCR Parameter concentrations in environmental systems. Screening for outliers is an important step because outliers can bias statistical estimates, statistical testing results, and inferences.

Outlier values were initially screened visually using the side-by-side box plots. If suspected visual outliers were identified, then Tukey's procedure was used to identify extreme outliers (Tukey 1977). This method relies on the IQR, which is defined as the 75th percentile value minus the 25th percentile value. Values were identified as potential outliers as follows:

- **Lower extreme outliers** are less than the 25th percentile minus 3 x IQR
- **Upper extreme outliers** are greater than the 75th percentile plus 3 x IQR.

Finally, when the potential outliers were identified visually and by Tukey's procedure, then statistical testing for outliers (Dixon or Rosner's Test) was conducted to determine if those data points were statistically significant outliers.

Following confirmation of the outliers as statistically significant, a desktop evaluation was conducted to verify that the data points were not errors (e.g., laboratory or transcriptional errors). Field forms, data validation reports and other variables in the dataset that could influence analytical results also were evaluated at this point. If a verifiable error was discovered, the outlier was removed and, if possible, replaced with a corrected value.

In the absence of a verifiable error, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability). If an outlier was identified as suitable for removal from further statistical analysis, a clear and defensible rationale based on multiple lines of evidence was provided. In addition, values that were identified as outliers and removed from further evaluation in the present statistical analysis were retained in the historical database and will be reevaluated for inclusion or exclusion in future statistical analyses of this dataset. The results of the outlier screening for the CUF Plant surface stream data set are provided in Section 3.1.

2.2 COMPARISON OF SURFACE STREAM RESULTS TO ESVs AND SSL_{HH}

The analytical results for total metals in the surface stream dataset were compared to both water body specific ESVs and generic SSL_{HH}, as provided in Appendix A.2. Screening against SSL_{HH} values was only done for surface stream data from the Cumberland River because it is the only waterbody used as a potable water source. Results were summarized graphically using transect plots and in tabular format in Tables in Appendix J.1. Results are reported for each water body separately since ESVs for some parameters are hardness dependent (cadmium, chromium, lead, copper, nickel, silver, and zinc) and therefore, vary by water body.

When an analytical sample result for a CCR Parameter was above the ESV and data were collected from transects/locations adjacent and from transect/locations upstream and/or downstream to the CUF Plant CCR management units, additional statistical evaluation of that CCR parameter was applied in the EAR. This additional evaluation included:

- Formal hypothesis testing to identify differences between upstream, adjacent, and downstream results, and
- PCA to identify the variables and individual samples that explain the greatest proportion of variability (provide the greatest amount of information) in the data sets.

No additional statistical analyses were conducted (PCA and hypothesis testing) for the surface stream datasets as described in Section 3.2.

3.0 RESULTS AND DISCUSSION

3.1 SUMMARY STATISTICS, EXPLORATORY DATA PLOTS, AND OUTLIER SCREENING

Summary statistics tables are presented in Attachment E.5-A, box plots are presented in Attachment E.5-B, and transect plots are presented in Attachment E.5-C. Box plots and transect plots that were used to identify the potential statistical outliers are presented in Attachment E.5-D. The summary statistics and exploratory data plots were aggregated by water body and transect location relative to the CUF Plant CCR management units (upstream, adjacent, downstream) and sample position in the water body (right bank, center channel, and left bank).

The outlier screening method described in Section 2.1.3 identified six outliers that were determined to be suitable for removal from further statistical analysis (Table E.5-3). These outliers were initially identified using exploratory data plots (see Attachment E.5-D) and confirmed as statistical outliers using Rosner's Outlier Test (p-value<0.01) and the Tukey's Extreme Outlier Test. Subsequently, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability).

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For each of the outliers identified for exclusion from further statistical analysis in Table E.5-3, this exclusion was supported by a spatial review that compared the magnitude of the outlier result to the distribution of concentrations for that parameter in surface water at the sampled locations in Cumberland River, Wells Creek, and the Unnamed Tributary. This spatial comparison was supported by a visual review of the box-plots and transect plots for these parameters in surface stream samples as presented in Appendix E.5-D. The results of this spatial review indicated that the outliers in Table E.5-3 represent values that are considerably separated from all other surface stream concentrations for that parameter for samples collected in the vicinity of the CUF plant from Cumberland River, Wells Creek, and the Unnamed Tributary. As such, these results were outliers not only for the individual sampling locations where they were collected but were also outliers in the context of a much larger dataset. Inclusion of outliers that are well-separated from the dominant data in statistical analysis can distort calculated decision statistics, which may in turn lead to incorrect remediation decisions (USEPA 2022). It is preferable to compute environmental statistics based on datasets that represent the main population (USEPA 2022). Therefore, it was determined that inclusion of the outliers in Table E.5-3 in further statistical analysis would obscure statistical interpretation of the available surface stream data and these values were removed from further statistical analysis in the EAR (i.e., excluded from the summary statistics, box-plots, and transect plots presented in Attachments E.5-A, E.5-B, and E.5-C, respectively). However, these outliers remain in the historical dataset and will require reevaluation for inclusion/ exclusion if these data are analyzed in future reports.

Table E.5-3 - Statistically Significant Outliers – CUF Plant, Surface Stream

CCR Parameter	Water body	Sample Location	Sample ID	Lowest Applicable Ecological Screening Value (ESV) or Human Health Screening Level (SSL_{HH})	Does Outlier Exceed Lowest Applicable ESV or SSL_{HH}?	Outlier Value
Arsenic	Cumberland River	CuR01 (Upstream of CUF Plant)	CUF-STR-CuR01-LB-MID-20181105	10 µg/L (SSL_{HH})	No	28.3 µg/L
Copper	Wells Creek	WC07 (Adjacent to CUF Plant)	CUF-STR-WC07-LB-SUR-20190813	11.9 µg/L (Dissolved Chronic ESV)	Yes	12.5 µg/L
Nickel	Cumberland River	CuR05 (Adjacent to CUF Plant)	CUF-STR-CUR05-RB-BOT-20200527	52.0 µg/L (Dissolved Chronic ESV)	No	7.72 µg/L
Radium 226+228	Cumberland River	CuR05 (Adjacent to CUF Plant)	CUF-STR-CUR05-RB-SUR-20190904	3 pCi/L (Total Chronic ESV)	Yes	3.34 pCi/L

CCR Parameter	Water body	Sample Location	Sample ID	Lowest Applicable Ecological Screening Value (ESV) or Human Health Screening Level (SSL_{HH})	Does Outlier Exceed Lowest Applicable ESV or SSL_{HH}?	Outlier Value
Zinc	Cumberland River	CuR01 (Upstream of CUF Plant)	CUF-STR-CuR01-LB-SUR-20190904	118 µg/L (Dissolved Chronic ESV)	No	78.7 µg/L
	Wells Creek	WC03 (Upstream of CUF Plant)	CUF-STR-WC03-RB-SUR-20181129	157 µg/L (Dissolved Chronic ESV)	No	88.1 µg/L

Notes: µg/L – micrograms per Liter; pCi/L – picocuries per Liter; ID – Identification

3.2 COMPARISON OF SURFACE STREAM RESULTS TO ESVS AND SSL_{HH}

There were no sample results above chronic ESVs, acute ESVs, or SSL_{HH} from surface stream sampling in the Cumberland River or Wells Creek[1].

Boron and calcium concentrations were above chronic ESVs in the Unnamed Tributary. Each of the sampled transects in the Unnamed Tributary were adjacent to the CUF Plant CCR management units, so additional statistical analyses, such as PCA and formal hypothesis testing to assess differences between the transect locations relative to the CUF Plant CCR management units were not used. Boron and calcium will be further evaluated in the context of the CARA Plan.

4.0 REFERENCES

StataCorp. (2017) Stata Graphics Reference Manual Stata: Release 15. Statistical Software. College Station, TX: StataCorp LLC.

Tukey, J.W. (1977). *Exploratory Data Analysis*. Reading, Massachusetts: Addison-Wesley. 1977.

United States Environmental Protection Agency (USEPA). (2022). ProUCL Version 5.2.0 Technical Guide: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Washington DC. USEPA Office of Research and Development.

[1] Concentrations of copper in Wells Creek surface stream and Radium 226+228 in Cumberland River surface stream were above applicable ESVs; however, these results were determined to represent statistically significant outliers and were not included in the statistical analyses. The CCR Parameter concentrations for the additional outliers noted in Table E.5-3 were not above their respective ESVs.

ATTACHMENT E.5-A - SUMMARY STATISTICS BY WATER BODY

Summary Statistics - Cumberland River
Surface Stream Investigation
Cumberland Fossil Plant - Cumberland City, Tennessee

Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
CCR Rule Appendix III Parameters											
Boron	Upstream	D	3/55	(30.3 - 38.6)	94.6%	48.7	58.5	31.5	5.19	38.6	41.6
		T	6/55	(30.3 - 38.6)	89.1%	39.1	65.3	32.3	6.5	38.6	45.9
	Adjacent	D	13/32	(38.6 - 171)	59.4%	41.7	227	74.3	47.7	77.4	167
		T	27/32	(38.6 - 38.6)	15.6%	38.7	237	96.8	52.2	95.2	177
	Downstream	D	19/43	(30.3 - 38.6)	55.8%	32.8	77.3	43.1	17.1	38.6	75.9
		T	19/43	(30.3 - 38.6)	55.8%	38	105	47.7	23.9	38.6	99.8
Calcium	Upstream	D	55/55	--	0.0%	23,600	38,900	31,100	5,520	28,200	37,400
		T	55/55	--	0.0%	24,300	37,900	30,800	5,230	28,500	37,400
	Adjacent	D	32/32	--	0.0%	24,500	31,800	27,800	2,100	27,900	31,400
		T	32/32	--	0.0%	24,200	31,900	28,100	1,980	28,300	31,200
	Downstream	D	43/43	--	0.0%	24,700	37,700	30,600	3,410	29,600	35,100
		T	43/43	--	0.0%	26,200	36,500	31,100	3,340	29,800	35,800
Chloride	Upstream	N	55/55	--	0.0%	2,920	7,250	4,330	1,030	4,150	5,620
	Adjacent	N	32/32	--	0.0%	2,880	8,040	4,730	1,450	4,380	7,580
	Downstream	N	43/43	--	0.0%	2,940	5,550	3,990	655	3,760	5,440
Sulfate	Upstream	N	55/55	--	0.0%	16,700	24,100	21,400	1,570	21,100	23,300
	Adjacent	N	32/32	--	0.0%	18,600	33,100	24,500	4,170	23,900	32,200
	Downstream	N	43/43	--	0.0%	16,400	27,200	21,600	3,080	19,900	26,900
TDS	Upstream	N	55/55	--	0.0%	97,000	146,000	124,000	10,200	126,000	138,000
	Adjacent	N	32/32	--	0.0%	80,000	172,000	126,000	17,900	124,000	148,000
	Downstream	N	43/43	--	0.0%	101,000	202,000	126,000	17,200	126,000	146,000
CCR Rule Appendix IV Parameters											
Antimony	Upstream	D	22/55	(0.378 - 1.12)	60.0%	0.429	3.64	0.687	0.524	1.12	1.15
		T	14/55	(0.378 - 1.12)	74.6%	0.424	1.81	0.55	0.327	1.12	1.3
	Adjacent	D	0/32	(0.378 - 0.656)	100.0%	--	--	--	--	0.378	0.453
		T	6/32	(0.378 - 0.378)	81.3%	0.387	0.816	0.4	0.0801	0.378	0.497
	Downstream	D	8/43	(0.378 - 1.12)	81.4%	0.569	2.36	0.512	0.339	0.617	1.12
		T	4/43	(0.378 - 1.12)	90.7%	0.432	3.02	0.531	0.561	0.378	1.94
Arsenic	Upstream	D	48/55	(0.313 - 0.323)	12.7%	0.331	1.16	0.633	0.223	0.565	0.95
		T	51/54	(0.313 - 0.323)	5.6%	0.357	1.36	0.772	0.254	0.722	1.14
	Adjacent	D	2/32	(0.313 - 1.25)	93.8%	0.371	0.477	0.326	0.0401	0.424	1.11
		T	32/32	--	0.0%	0.347	1.28	0.715	0.314	0.584	1.23
	Downstream	D	39/43	(0.313 - 0.323)	9.3%	0.315	0.911	0.557	0.203	0.492	0.854
		T	43/43	--	0.0%	0.323	1.4	0.734	0.26	0.678	1.12
Barium	Upstream	D	55/55	--	0.0%	18.3	66.6	22.3	6.3	21.6	24.2
		T	55/55	--	0.0%	20.7	31.1	25.9	2.18	26	29.4
	Adjacent	D	32/32	--	0.0%	18.6	25.1	21.6	1.71	21.6	24.1
		T	32/32	--	0.0%	22.7	31.5	25.9	2.28	25.7	30.7
	Downstream	D	43/43	--	0.0%	18.3	24.8	21.2	1.54	21.3	23.5
		T	43/43	--	0.0%	21.7	28.4	25.1	1.56	25.2	27.5
Beryllium	Upstream	D	0/55	(0.057 - 0.608)	100.0%	--	--	--	--	0.182	0.183
		T	1/55	(0.057 - 0.501)	98.2%	0.076	0.076	0.0577	0.00359	0.182	0.308
	Adjacent	D	3/32	(0.182 - 0.182)	90.6%	0.196	0.407	0.192	0.0418	0.182	0.232
		T	0/32	(0.182 - 0.314)	100.0%	--	--	--	--	0.182	0.261
	Downstream	D	0/43	(0.057 - 0.221)	100.0%	--	--	--	--	0.182	0.182
		T	1/43	(0.057 - 0.619)	97.7%	0.057	0.057	0.057	0	0.182	0.275
Cadmium	Upstream	D	2/55	(0.125 - 0.217)	96.4%	0.156	0.196	0.127	0.0108	0.125	0.217
		T	3/55	(0.125 - 0.217)	94.6%	0.135	0.23	0.129	0.0184	0.125	0.217
	Adjacent	D	1/32	(0.125 - 0.217)	96.9%	0.17	0.17	0.128	0.0112	0.217	0.217
		T	1/32	(0.125 - 0.217)	96.9%	0.135	0.135	0.126	0.00249	0.217	0.217
	Downstream	D	0/43	(0.125 - 0.217)	100.0%	--	--	--	--	0.125	0.217
		T	1/43	(0.125 - 0.217)	97.7%	0.153	0.153	0.126	0.00466	0.125	0.217
Chromium	Upstream	D	23/55	(0.631 - 1.53)	58.2%	2.1	3.68	1.51	1.06	1.53	3.07
		T	25/55	(0.631 - 1.94)	54.6%	1.66	4.62	1.77	1.29	1.8	3.65
	Adjacent	D	1/32	(1.53 - 3.03)	96.9%	2.05	2.05	1.55	0.0982	1.53	2.95
		T	10/32	(1.53 - 1.53)	68.8%	1.6	3.91	1.85	0.656	1.53	3.27
	Downstream	D	8/43	(0.631 - 2.29)	81.4%	1.79	2.85	0.973	0.724	1.53	2.67
		T	22/43	(0.631 - 1.53)	48.8%	0.631	5.29	1.31	1.16	1.53	3.3

Summary Statistics - Cumberland River Surface Stream Investigation Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Cobalt	Upstream	D	16/55	(0.075 - 0.187)	70.9%	0.078	0.26	0.0886	0.0334	0.075	0.166
		T	38/55	(0.213 - 0.468)	30.9%	0.221	0.662	0.316	0.101	0.298	0.547
	Adjacent	D	0/32	(0.075 - 0.24)	100.0%	--	--	--	--	0.134	0.168
		T	21/32	(0.36 - 0.45)	34.4%	0.239	0.613	0.335	0.0937	0.356	0.54
	Downstream	D	7/43	(0.075 - 0.152)	83.7%	0.075	0.097	0.078	0.00666	0.091	0.134
		T	13/43	(0.246 - 0.45)	69.8%	0.209	0.499	0.285	0.0774	0.364	0.47
Fluoride	Upstream	N	55/55	--	0.0%	66.5	90.9	78.1	7.83	78.6	90.1
	Adjacent	N	32/32	--	0.0%	47.5	130	86	21.2	85.5	125
	Downstream	N	43/43	--	0.0%	63.1	107	81.3	12.7	77.2	105
Lead	Upstream	D	4/55	(0.094 - 0.128)	92.7%	0.181	0.451	0.106	0.0531	0.128	0.19
		T	34/55	(0.298 - 0.817)	38.2%	0.319	1.52	0.442	0.189	0.435	0.854
	Adjacent	D	2/32	(0.128 - 0.128)	93.8%	0.139	0.173	0.13	0.008	0.128	0.133
		T	32/32	--	0.0%	0.372	1.34	0.613	0.216	0.582	1.1
	Downstream	D	1/43	(0.094 - 0.128)	97.7%	1.95	1.95	0.137	0.28	0.128	0.128
		T	26/43	(0.318 - 0.787)	39.5%	0.329	0.633	0.442	0.0929	0.486	0.691
Lithium	Upstream	D	13/55	(2.56 - 3.39)	76.4%	2.76	5.23	2.91	0.685	3.39	4.5
		T	25/55	(2.56 - 3.39)	54.6%	3.42	5.36	3.45	1.04	3.39	5.25
	Adjacent	D	6/32	(3.39 - 3.39)	81.3%	3.39	4.54	3.46	0.221	3.39	3.76
		T	10/32	(3.39 - 3.39)	68.8%	3.41	5.37	3.71	0.577	3.39	4.85
	Downstream	D	10/43	(2.56 - 3.39)	76.7%	3.66	4.44	2.91	0.651	3.39	4.18
		T	10/43	(2.56 - 3.65)	76.7%	4.37	6.31	3.13	1.07	3.39	5.24
Mercury	Upstream	D	0/55	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
		T	0/55	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
	Adjacent	D	0/32	(0.101 - 0.13)	100.0%	--	--	--	--	0.13	0.13
		T	0/32	(0.101 - 0.13)	100.0%	--	--	--	--	0.13	0.13
	Downstream	D	0/43	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
		T	0/43	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
Molybdenum	Upstream	D	3/55	(0.474 - 2.3)	94.6%	0.494	0.636	0.48	0.0234	0.61	0.689
		T	1/55	(0.474 - 2.02)	98.2%	0.673	0.673	0.478	0.0271	0.61	0.629
	Adjacent	D	22/32	(0.61 - 0.61)	31.3%	0.631	1.36	0.796	0.217	0.701	1.2
		T	20/32	(0.61 - 0.61)	37.5%	0.616	1.42	0.783	0.215	0.682	1.19
	Downstream	D	11/43	(0.474 - 1.68)	74.4%	0.48	0.83	0.547	0.127	0.61	0.891
		T	14/43	(0.474 - 2.14)	67.4%	0.554	0.863	0.57	0.127	0.615	1.63
Radium-226+228	Upstream	T	5/55	(0.00 - 1.25)	90.9%	0.116	0.35	0.034	0.0805	0.179	0.483
	Adjacent	T	1/27	(0.0193 - 1.74)	96.3%	0.645	0.645	0.0541	0.143	0.506	1.14
	Downstream	T	2/43	(0.00 - 0.850)	95.4%	0.182	0.517	0.0198	0.0875	0.107	0.692
Selenium	Upstream	D	3/55	(0.813 - 1.51)	94.6%	1.57	1.98	0.864	0.217	1.51	1.53
		T	2/55	(0.813 - 1.51)	96.4%	1.7	2.13	0.853	0.21	1.51	1.51
	Adjacent	D	2/32	(1.51 - 1.51)	93.8%	1.83	1.99	1.54	0.0989	1.51	1.65
		T	3/32	(1.51 - 1.51)	90.6%	1.53	1.78	1.52	0.0538	1.51	1.59
	Downstream	D	2/43	(0.813 - 1.51)	95.4%	1.57	1.57	0.848	0.159	1.51	1.51
		T	1/43	(0.813 - 1.51)	97.7%	1.75	1.75	0.835	0.141	1.51	1.51
Thallium	Upstream	D	1/55	(0.063 - 0.317)	98.2%	0.066	0.066	0.0631	0.000567	0.148	0.155
		T	3/55	(0.063 - 0.408)	94.6%	0.081	0.102	0.066	0.00907	0.148	0.22
	Adjacent	D	6/32	(0.148 - 0.148)	81.3%	0.169	0.439	0.171	0.0643	0.148	0.314
		T	0/32	(0.148 - 0.436)	100.0%	--	--	--	--	0.148	0.203
	Downstream	D	1/43	(0.063 - 0.223)	97.7%	0.25	0.25	0.0673	0.0282	0.148	0.148
		T	0/43	(0.063 - 0.295)	100.0%	--	--	--	--	0.148	0.204
TDEC Appendix I Parameters											
Copper	Upstream	D	19/55	(0.627 - 1.37)	65.5%	0.654	1.58	0.772	0.215	1.3	1.32
		T	26/55	(0.627 - 1.3)	52.7%	0.74	2.53	1.08	0.377	1.3	1.9
	Adjacent	D	15/32	(0.627 - 1.35)	53.1%	0.905	2.08	1.08	0.502	1.13	1.92
		T	31/32	(0.627 - 0.627)	3.1%	0.682	2.99	1.93	0.689	1.9	2.92
	Downstream	D	16/43	(0.627 - 1.3)	62.8%	0.822	1.87	0.949	0.337	1.3	1.58
		T	29/43	(1.3 - 1.3)	32.6%	0.791	2.83	1.42	0.551	1.34	2.44
Nickel	Upstream	D	42/55	(0.336 - 0.336)	23.6%	0.338	1.51	0.542	0.268	0.457	1.17
		T	55/55	--	0.0%	0.439	2.23	1.06	0.316	1.03	1.57
	Adjacent	D	31/32	(0.336 - 0.336)	3.1%	0.403	0.92	0.634	0.156	0.61	0.874
		T	31/31	--	0.0%	0.85	1.53	1.19	0.179	1.19	1.43
	Downstream	D	23/43	(0.336 - 1.51)	46.5%	0.338	0.87	0.509	0.112	0.63	1.29
		T	25/43	(0.997 - 2.59)	41.9%	0.615	1.44	1.03	0.204	1.22	1.89

Summary Statistics - Cumberland River Surface Stream Investigation Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Silver	Upstream	D	0/55	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/55	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
	Adjacent	D	0/32	(0.177 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/32	(0.177 - 0.177)	100.0%	--	--	--	--	0.177	0.177
	Downstream	D	0/43	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/43	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
Vanadium	Upstream	D	23/55	(0.899 - 2.39)	58.2%	2.09	3.37	1.63	0.871	2.09	2.98
		T	24/55	(0.991 - 3.11)	56.4%	1.09	4.12	2.04	1.22	2.72	3.99
	Adjacent	D	0/32	(0.991 - 3.28)	100.0%	--	--	--	--	0.991	3.1
		T	29/32	(0.991 - 0.991)	9.4%	1.03	4.65	1.93	1.01	1.47	3.97
	Downstream	D	26/43	(0.899 - 0.991)	39.5%	0.901	2.9	1.36	0.654	0.991	2.75
		T	41/43	(0.991 - 0.991)	4.7%	0.991	5.44	2.15	0.977	1.88	3.7
Zinc	Upstream	D	24/55	(2.42 - 14)	56.4%	3.24	18.9	3.45	2.29	3.43	5.63
		T	2/54	(2.98 - 9.14)	96.3%	3.45	4.3	3.07	0.274	4.26	7.19
	Adjacent	D	7/32	(3.22 - 3.22)	78.1%	3.56	11.8	3.92	1.83	3.22	7.39
		T	10/32	(3.22 - 11.4)	68.8%	3.29	8.97	3.65	1.05	3.44	8.69
	Downstream	D	6/43	(2.42 - 9.12)	86.1%	3.49	3.82	2.67	0.489	3.49	5.41
		T	4/43	(3.22 - 17.9)	90.7%	4.16	29.7	4.23	3.98	5.58	9.39
Other Analyzed Constituents											
Hardness	Upstream	N	55/55	--	0.0%	81,800	120,000	101,000	14,100	97,300	118,000
	Adjacent	N	32/32	--	0.0%	81,600	111,000	95,400	7,710	95,000	110,000
	Downstream	N	43/43	--	0.0%	88,600	119,000	104,000	9,370	103,000	117,000
Iron	Upstream	D	8/55	(14.1 - 19.5)	85.5%	15	538	34	96	20	43
		T	55/55	--	0.0%	248	968	523	158	505	792
	Adjacent	D	7/32	(19.5 - 19.5)	78.1%	20	126	26	20	20	54
		T	32/32	--	0.0%	404	859	565	105	545	804
	Downstream	D	6/43	(14.1 - 19.5)	86.1%	20	150	20	22	20	49
		T	43/43	--	0.0%	281	717	468	116	462	684
Magnesium	Upstream	D	55/55	--	0.0%	4,910	6,110	5,690	296	5,780	6,000
		T	55/55	--	0.0%	5,060	6,340	5,850	353	5,990	6,250
	Adjacent	D	32/32	--	0.0%	5,090	7,800	6,060	772	5,870	7,630
		T	32/32	--	0.0%	5,130	8,090	6,150	768	5,990	7,830
	Downstream	D	43/43	--	0.0%	5,230	7,420	6,240	508	6,350	7,110
		T	43/43	--	0.0%	5,550	7,490	6,430	477	6,460	7,260
Manganese	Upstream	D	50/55	(1.35 - 1.35)	9.1%	1	13	5	3	4	12
		T	55/55	--	0.0%	40	108	63	14	58	89
	Adjacent	D	31/32	(1.35 - 1.35)	3.1%	2	24	7	5	6	15
		T	32/32	--	0.0%	48	121	76	15	75	99
	Downstream	D	37/43	(1.35 - 1.35)	14.0%	2	17	5	3	5	11
		T	43/43	--	0.0%	42	106	65	12	63	82
TSS	Upstream	N	55/55	--	0.0%	8,500	31,400	17,200	5,190	16,100	27,200
	Adjacent	N	32/32	--	0.0%	14,000	31,300	21,200	4,530	21,600	30,100
	Downstream	N	43/43	--	0.0%	9,800	24,600	16,500	3,780	16,500	22,400

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

Statistical data sets were aggregated by location of transect relative to the CCR management units (upstream, adjacent downstream) and sample fraction (total, dissolved, or normal)

Except for Radium 226 + 228, all units are in micrograms per liter (µg/L)

Units for Radium 226+228 are picocuries per liter (pCi/L)

Fractions reported include dissolved (D), total (T), and normal (N)

Non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

Summary Statistics - Wells Creek
Surface Stream Investigation
Cumberland Fossil Plant - Cumberland City, Tennessee

Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
CCR Rule Appendix III Parameters											
Boron	Upstream	D	3/19	(30.3 - 57.5)	84.2%	39.4	43.3	32.27	4.31	38.6	51.56
		T	4/19	(30.3 - 55.7)	79.0%	41.9	62.1	34.54	8.57	38.6	56.34
	Adjacent	D	48/53	(56.7 - 91.6)	9.4%	46.3	222	103.1	43.36	91.7	162.8
		T	46/53	(45.5 - 82.3)	13.2%	48.6	188	101.8	41.57	92.4	157.4
	Downstream	D	2/4	(193 - 196)	50.0%	40.4	93.7	67.05	26.65	143.4	195.6
		T	4/4	--	0.0%	41.7	206	122.4	71.19	120.9	197.6
Calcium	Upstream	D	19/19	--	0.0%	51,200	56,500	54,053	1,498	54,100	56,320
		T	19/19	--	0.0%	52,900	58,500	55,358	1,647	55,600	57,690
	Adjacent	D	53/53	--	0.0%	44,600	61,600	54,436	3,464	54,100	59,460
		T	53/53	--	0.0%	40,500	63,200	54,226	3,532	55,000	58,900
	Downstream	D	4/4	--	0.0%	25,600	41,600	33,425	8,393	33,250	41,315
		T	4/4	--	0.0%	24,700	45,700	33,875	10,263	32,550	44,725
Chloride	Upstream	N	19/19	--	0.0%	3,490	5,400	4,347	593	4,590	5,202
	Adjacent	N	53/53	--	0.0%	5,240	10,900	7,666	1,168	7,510	8,986
	Downstream	N	4/4	--	0.0%	3,320	8,160	5,873	2,341	6,005	8,066
Sulfate	Upstream	N	19/19	--	0.0%	4,860	10,600	6,795	1,556	6,340	9,349
	Adjacent	N	53/53	--	0.0%	7,350	33,800	13,274	3,684	13,100	16,880
	Downstream	N	4/4	--	0.0%	19,800	28,400	22,475	3,983	20,850	27,290
TDS	Upstream	N	19/19	--	0.0%	117,000	200,000	166,105	20,215	175,000	185,600
	Adjacent	N	53/53	--	0.0%	154,000	229,000	184,755	14,307	185,000	201,600
	Downstream	N	4/4	--	0.0%	119,000	162,000	140,250	18,025	140,000	159,450
CCR Rule Appendix IV Parameters											
Antimony	Upstream	D	0/19	(0.378 - 1.12)	100.0%	--	--	--	--	0.378	1.12
		T	0/19	(0.378 - 1.12)	100.0%	--	--	--	--	0.378	1.12
	Adjacent	D	1/53	(0.378 - 1.12)	98.1%	1.53	1.53	0.4	0.157	0.378	1.12
		T	0/53	(0.378 - 1.12)	100.0%	--	--	--	--	0.378	1.12
	Downstream	D	0/4	(0.378 - 1.13)	100.0%	--	--	--	--	0.458	1.041
		T	1/4	(0.378 - 0.378)	75.0%	0.625	0.625	0.44	0.107	0.378	0.588
Arsenic	Upstream	D	17/19	(0.416 - 0.447)	10.5%	0.326	0.643	0.469	0.0879	0.472	0.615
		T	6/19	(0.323 - 1.13)	68.4%	0.404	0.581	0.43	0.0852	0.573	0.839
	Adjacent	D	39/53	(0.323 - 0.431)	26.4%	0.344	1.33	0.664	0.32	0.663	1.108
		T	14/53	(0.323 - 2.01)	73.6%	0.325	0.81	0.399	0.107	0.637	1.562
	Downstream	D	1/4	(0.313 - 1.15)	75.0%	0.417	0.417	0.365	0.052	0.739	1.137
		T	3/4	(0.313 - 0.313)	25.0%	0.717	1.36	0.868	0.393	0.899	1.318
Barium	Upstream	D	19/19	--	0.0%	27.3	39.7	32.63	4.36	32.6	39.61
		T	12/19	(36.9 - 45.2)	36.8%	28	48.3	32.34	5.62	35.3	46.5
	Adjacent	D	53/53	--	0.0%	23.8	44.2	30.95	3.795	30.1	36.1
		T	50/53	(40.9 - 46.1)	5.7%	27.5	63.5	35.88	8.566	32.9	53.36
	Downstream	D	4/4	--	0.0%	19.1	28.8	24.28	4.946	24.6	28.71
		T	4/4	--	0.0%	22.9	41.8	31.13	9.336	29.9	40.95
Beryllium	Upstream	D	1/19	(0.057 - 0.182)	94.7%	0.269	0.269	0.0682	0.0473	0.182	0.191
		T	0/19	(0.057 - 0.471)	100.0%	--	--	--	--	0.182	0.34
	Adjacent	D	1/53	(0.057 - 0.375)	98.1%	0.305	0.305	0.0618	0.0341	0.182	0.266
		T	0/53	(0.057 - 0.863)	100.0%	--	--	--	--	0.182	0.258
	Downstream	D	2/4	(0.182 - 0.182)	50.0%	0.228	0.338	0.233	0.0637	0.205	0.322
		T	1/4	(0.182 - 0.182)	75.0%	0.425	0.425	0.243	0.105	0.182	0.389
Cadmium	Upstream	D	0/19	(0.125 - 0.125)	100.0%	--	--	--	--	0.125	0.125
		T	1/19	(0.125 - 0.125)	94.7%	0.191	0.191	0.128	0.0147	0.125	0.132
	Adjacent	D	2/53	(0.125 - 0.217)	96.2%	0.15	0.243	0.128	0.0164	0.125	0.217
		T	1/53	(0.125 - 0.217)	98.1%	0.538	0.538	0.133	0.0562	0.125	0.217
	Downstream	D	0/4	(0.125 - 0.217)	100.0%	--	--	--	--	0.171	0.217
		T	1/4	(0.125 - 0.217)	75.0%	0.127	0.127	0.126	0.001	0.172	0.217
Chromium	Upstream	D	1/19	(1.53 - 2.22)	94.7%	1.75	1.75	1.547	0.0586	1.53	2.085
		T	0/19	(1.53 - 2.54)	100.0%	--	--	--	--	1.78	2.486
	Adjacent	D	5/53	(0.8 - 2.44)	90.6%	1.55	2.08	0.911	0.327	1.53	2.084
		T	0/53	(0.835 - 3.16)	100.0%	--	--	--	--	1.53	2.292
	Downstream	D	0/4	(1.53 - 1.77)	100.0%	--	--	--	--	1.53	1.734
		T	0/4	(1.53 - 1.53)	100.0%	--	--	--	--	1.53	1.53

Summary Statistics - Wells Creek Surface Stream Investigation Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Cobalt	Upstream	D	19/19	--	0.0%	0.099	0.235	0.158	0.041	0.155	0.222
		T	9/19	(0.105 - 0.306)	52.6%	0.351	0.809	0.301	0.235	0.306	0.781
	Adjacent	D	51/53	(0.075 - 0.075)	3.8%	0.076	0.424	0.147	0.073	0.129	0.319
		T	28/53	(0.097 - 0.236)	47.2%	0.249	1.1	0.305	0.259	0.272	0.866
	Downstream	D	0/4	(0.134 - 0.184)	100.0%	--	--	--	--	0.146	0.18
		T	4/4	--	0.0%	0.252	0.639	0.475	0.163	0.504	0.622
Fluoride	Upstream	N	19/19	--	0.0%	43.5	433	99.88	103.4	71.6	352
	Adjacent	N	53/53	--	0.0%	39.3	105	71.91	17.15	75.3	99.3
	Downstream	N	4/4	--	0.0%	82.8	113	93.83	13.46	89.75	110
Lead	Upstream	D	0/19	(0.094 - 0.128)	100.0%	--	--	--	--	0.128	0.128
		T	10/19	(0.094 - 0.145)	47.4%	0.128	1.04	0.359	0.317	0.145	1.022
	Adjacent	D	5/53	(0.094 - 0.128)	90.6%	0.158	0.531	0.115	0.0739	0.128	0.271
		T	30/53	(0.094 - 0.449)	43.4%	0.118	1.45	0.343	0.332	0.286	1.057
	Downstream	D	0/4	(0.128 - 0.128)	100.0%	--	--	--	--	0.128	0.128
		T	4/4	--	0.0%	0.325	0.721	0.561	0.168	0.599	0.705
Lithium	Upstream	D	0/19	(2.56 - 3.71)	100.0%	--	--	--	--	3.39	3.422
		T	0/19	(2.56 - 3.54)	100.0%	--	--	--	--	3.39	3.405
	Adjacent	D	2/53	(2.56 - 3.39)	96.2%	3	3.76	2.607	0.189	3.39	3.39
		T	0/53	(2.56 - 3.39)	100.0%	--	--	--	--	3.39	3.39
	Downstream	D	1/4	(3.39 - 3.39)	75.0%	3.44	3.44	3.403	0.0217	3.39	3.433
		T	0/4	(3.39 - 3.39)	100.0%	--	--	--	--	3.39	3.39
Mercury	Upstream	D	0/19	(0.0653 - 0.101)	100.0%	--	--	--	--	0.101	0.101
		T	0/19	(0.0653 - 0.14)	100.0%	--	--	--	--	0.101	0.135
	Adjacent	D	5/53	(0.0653 - 0.13)	90.6%	0.108	0.196	0.0729	0.0255	0.101	0.134
		T	0/53	(0.0653 - 0.426)	100.0%	--	--	--	--	0.101	0.167
	Downstream	D	0/4	(0.101 - 0.13)	100.0%	--	--	--	--	0.116	0.13
		T	0/4	(0.101 - 0.13)	100.0%	--	--	--	--	0.116	0.13
Molybdenum	Upstream	D	0/19	(0.474 - 0.61)	100.0%	--	--	--	--	0.61	0.61
		T	1/19	(0.474 - 0.61)	94.7%	0.514	0.514	0.48	0.014	0.61	0.61
	Adjacent	D	14/53	(0.474 - 0.61)	73.6%	0.612	1.53	0.562	0.184	0.61	0.84
		T	13/53	(0.474 - 0.61)	75.5%	0.49	1.26	0.546	0.157	0.61	0.826
	Downstream	D	2/4	(0.61 - 0.61)	50.0%	0.853	0.917	0.748	0.139	0.732	0.907
		T	2/4	(0.61 - 0.61)	50.0%	0.756	0.821	0.699	0.0922	0.683	0.811
Radium-226+228	Upstream	T	2/19	(0.00225 - 0.446)	89.5%	0.339	0.665	0.0559	0.163	0.137	0.468
	Adjacent	T	2/53	(0 - 0.756)	96.2%	0.297	0.492	0.0175	0.0823	0.214	0.453
	Downstream	T	0/4	(0.0899 - 0.902)	100.0%	--	--	--	--	0.44	0.86
Selenium	Upstream	D	0/19	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
		T	0/19	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
	Adjacent	D	0/53	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
		T	0/53	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
	Downstream	D	0/4	(1.51 - 1.51)	100.0%	--	--	--	--	1.51	1.51
		T	0/4	(1.51 - 1.51)	100.0%	--	--	--	--	1.51	1.51
Thallium	Upstream	D	2/19	(0.063 - 0.148)	89.5%	0.154	0.193	0.0746	0.0345	0.148	0.158
		T	0/19	(0.063 - 0.277)	100.0%	--	--	--	--	0.148	0.234
	Adjacent	D	7/53	(0.063 - 0.454)	86.8%	0.159	1.07	0.108	0.157	0.148	0.418
		T	1/53	(0.063 - 1.17)	98.1%	1.42	1.42	0.0886	0.185	0.148	0.262
	Downstream	D	3/4	(0.148 - 0.148)	25.0%	0.179	0.275	0.204	0.0471	0.196	0.266
		T	0/4	(0.148 - 0.361)	100.0%	--	--	--	--	0.183	0.34

Summary Statistics - Wells Creek
Surface Stream Investigation
Cumberland Fossil Plant - Cumberland City, Tennessee

Parameter	Location Relative to CCR Management Units	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
TDEC Appendix I Parameters											
Copper	Upstream	D	0/19	(0.627 - 1.3)	100.0%	--	--	--	--	0.635	1.3
		T	0/19	(0.627 - 1.44)	100.0%	--	--	--	--	0.923	1.314
	Adjacent	D	3/53	(0.627 - 2.78)	94.3%	0.658	1.59	0.664	0.175	0.982	1.512
		T	5/53	(0.627 - 2.06)	90.6%	0.634	12.5	0.86	1.614	1.18	1.65
	Downstream	D	2/4	(0.627 - 0.627)	50.0%	0.917	1.2	0.843	0.238	0.772	1.158
		T	4/4	--	0.0%	0.744	1.76	1.281	0.436	1.31	1.717
Nickel	Upstream	D	1/19	(0.312 - 0.336)	94.7%	0.424	0.424	0.318	0.025	0.336	0.345
		T	1/19	(0.312 - 1.11)	94.7%	0.336	0.336	0.314	0.0072	0.336	0.964
	Adjacent	D	23/53	(0.312 - 0.336)	56.6%	0.32	2.44	0.433	0.331	0.336	1.01
		T	22/53	(0.312 - 1.46)	58.5%	0.365	1.89	0.539	0.347	0.403	1.46
	Downstream	D	4/4	--	0.0%	0.39	0.608	0.476	0.0931	0.453	0.586
		T	4/4	--	0.0%	0.867	1.09	1.003	0.104	1.028	1.089
Silver	Upstream	D	0/19	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/19	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
	Adjacent	D	0/53	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	1/53	(0.121 - 0.177)	98.1%	0.274	0.274	0.124	0.0208	0.177	0.177
	Downstream	D	0/4	(0.177 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/4	(0.177 - 0.177)	100.0%	--	--	--	--	0.177	0.177
Vanadium	Upstream	D	19/19	--	0.0%	0.991	1.85	1.374	0.221	1.36	1.805
		T	0/19	(0.991 - 3.08)	100.0%	--	--	--	--	1.78	2.72
	Adjacent	D	51/53	(0.899 - 0.899)	3.8%	0.91	2.42	1.328	0.404	1.14	2.128
		T	3/53	(0.899 - 3.84)	94.3%	1.12	1.71	0.954	0.158	1.39	2.936
	Downstream	D	0/4	(0.991 - 2.03)	100.0%	--	--	--	--	1.211	1.94
		T	3/4	(0.991 - 0.991)	25.0%	1.2	2.6	1.743	0.668	1.69	2.537
Zinc	Upstream	D	1/19	(2.42 - 4.12)	94.7%	2.73	2.73	2.464	0.108	3.22	3.949
		T	2/19	(2.42 - 8.48)	89.5%	4.13	88.1	7.132	19.09	4.35	16.44
	Adjacent	D	9/53	(2.42 - 8.35)	83.0%	3.14	4.59	2.682	0.548	3.22	4.464
		T	3/53	(2.42 - 21.7)	94.3%	2.76	3.5	2.509	0.244	3.5	8.406
	Downstream	D	0/4	(3.22 - 3.22)	100.0%	--	--	--	--	3.22	3.22
		T	1/4	(3.22 - 4.26)	75.0%	4.76	4.76	3.605	0.667	3.945	4.685
Other Analyzed Constituents											
Hardness	Upstream	N	19/19	--	0.0%	150,000	167,000	158,053	4,527	159,000	164,300
	Adjacent	N	53/53	--	0.0%	126,000	180,000	156,170	8,485	156,000	169,000
	Downstream	N	4/4	--	0.0%	82,400	141,000	109,050	28,945	106,400	138,750
Iron	Upstream	D	8/19	(19.5 - 20)	57.9%	25	58	27	11	20	49
		T	19/19	--	0.0%	119	1,100	374	310	192	1,082
	Adjacent	D	27/53	(19.5 - 36.3)	49.1%	17	485	44	77	20	175
		T	53/53	--	0.0%	106	1,590	360	311	236	851
	Downstream	D	0/4	(19.5 - 19.5)	100.0%	--	--	--	--	20	20
		T	4/4	--	0.0%	358	725	553	151	565	702
Magnesium	Upstream	D	19/19	--	0.0%	4,360	4,940	4,708	167	4,710	4,931
		T	19/19	--	0.0%	4,400	5,090	4,816	168	4,850	4,982
	Adjacent	D	53/53	--	0.0%	4,140	6,140	5,073	481	5,130	5,856
		T	53/53	--	0.0%	4,060	6,170	5,038	507	5,100	5,718
	Downstream	D	4/4	--	0.0%	5,050	6,980	6,048	929	6,080	6,935
		T	4/4	--	0.0%	5,010	6,770	5,915	866	5,940	6,734
Manganese	Upstream	D	19/19	--	0.0%	33	176	77	38	71	156
		T	19/19	--	0.0%	37	254	105	65	75	232
	Adjacent	D	51/53	(1.35 - 1.35)	3.8%	2	285	65	56	52	151
		T	53/53	--	0.0%	43	656	182	125	117	404
	Downstream	D	4/4	--	0.0%	10	29	16	9	13	27
		T	4/4	--	0.0%	57	252	140	96	126	242
TSS	Upstream	N	17/19	(500 - 500)	10.5%	1,000	43,500	11,400	12,332	4,600	37,110
	Adjacent	N	51/53	(500 - 1000)	3.8%	500	59,800	14,309	14,698	12,000	45,240
	Downstream	N	4/4	--	0.0%	10,700	30,600	21,350	8,169	22,050	29,370

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

Statistical data sets were aggregated by location of transect relative to the CCR management units (upstream, adjacent downstream) and sample fraction (total, dissolved, or normal)

Except for Radium 226 + 228, all units are in micrograms per liter (µg/L)

Units for Radium 226+228 are picocuries per liter (pCi/L)

Fractions reported include dissolved (D), total (T), and normal (N)

Non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

Summary Statistics - Unnamed Tributary Surface Stream Investigation Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	Gradient	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50^{th} Percentile	95^{th} Percentile
CCR Rule Appendix III Parameters											
Boron	Adjacent	D	44/44	--	0.0%	2,490	10,300	4,572	2,053	4,000	8,239
		T	44/44	--	0.0%	2,480	10,400	4,610	2,031	4,100	7,982
Calcium	Adjacent	D	44/44	--	0.0%	132,000	423,000	288,477	76,538	305,000	375,950
		T	44/44	--	0.0%	132,000	436,000	289,364	78,471	303,000	393,200
Chloride	Adjacent	N	44/44	--	0.0%	62,100	172,000	88,725	24,645	80,400	127,700
Sulfate	Adjacent	N	44/44	--	0.0%	203,000	860,000	599,864	196,815	639,000	847,800
TDS	Adjacent	N	44/44	--	0.0%	652,000	1,970,000	1,267,045	350,619	1,250,000	1,770,000
CCR Rule Appendix IV Parameters											
Antimony	Adjacent	D	1/44	(0.378 - 1.12)	97.7%	0.458	0.458	0.38	0.0128	0.378	1.12
		T	1/44	(0.378 - 1.12)	97.7%	0.388	0.388	0.378	0.0016	0.378	1.12
Arsenic	Adjacent	D	44/44	--	0.0%	0.465	1.79	0.943	0.409	0.782	1.529
		T	44/44	--	0.0%	0.508	2.02	1.051	0.435	0.827	1.749
Barium	Adjacent	D	44/44	--	0.0%	22.9	132	55.87	30.98	45.95	93.83
		T	44/44	--	0.0%	23.9	135	58.48	31.5	49.3	99
Beryllium	Adjacent	D	0/44	(0.057 - 0.182)	100.0%	--	--	--	--	0.182	0.182
		T	0/44	(0.057 - 0.182)	100.0%	--	--	--	--	0.182	0.182
Cadmium	Adjacent	D	0/44	(0.125 - 0.217)	100.0%	--	--	--	--	0.125	0.217
		T	2/44	(0.125 - 0.217)	95.5%	0.137	0.315	0.13	0.0283	0.125	0.217
Chromium	Adjacent	D	5/44	(1.08 - 2.02)	88.6%	1.54	2.48	1.185	0.314	1.53	2.08
		T	0/44	(1.32 - 2.15)	100.0%	--	--	--	--	1.53	1.942
Cobalt	Adjacent	D	38/44	(0.075 - 0.134)	13.6%	0.077	1.27	0.365	0.336	0.247	1.165
		T	38/44	(0.145 - 0.195)	13.6%	0.095	1.4	0.431	0.37	0.295	1.283
Fluoride	Adjacent	N	44/44	--	0.0%	115	222	148.9	29.37	146	207.6
Lead	Adjacent	D	1/44	(0.094 - 0.128)	97.7%	3.21	3.21	0.165	0.464	0.128	0.128
		T	5/44	(0.094 - 0.152)	88.6%	0.131	0.421	0.111	0.0642	0.128	0.155
Lithium	Adjacent	D	5/44	(2.56 - 3.39)	88.6%	3.89	5.48	2.79	0.671	3.39	4.532
		T	1/44	(2.56 - 5.14)	97.7%	4.9	4.9	2.617	0.361	3.39	4.934
Mercury	Adjacent	D	0/44	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
	Adjacent	T	0/44	(0.0653 - 0.13)	100.0%	--	--	--	--	0.101	0.13
Molybdenum	Adjacent	D	44/44	--	0.0%	13.6	427	65.01	79.92	45.5	119
		T	44/44	--	0.0%	13.6	443	66.75	82.25	47.95	124.6
Radium-226+228	Adjacent	T	4/44	(0 - 1.568)	90.9%	0.0994	1.003	0.0646	0.186	0.373	1.067
Selenium	Adjacent	D	0/44	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
		T	0/44	(0.813 - 1.51)	100.0%	--	--	--	--	1.51	1.51
Thallium	Adjacent	D	1/44	(0.063 - 0.148)	97.7%	0.204	0.204	0.0662	0.021	0.148	0.148
		T	0/44	(0.063 - 0.298)	100.0%	--	--	--	--	0.148	0.148
TDEC Appendix I Parameters											
Copper	Adjacent	D	4/44	(0.627 - 1.3)	90.9%	0.64	1.53	0.655	0.137	0.627	1.3
		T	13/44	(0.627 - 1.3)	70.5%	0.63	2.91	0.717	0.346	0.627	1.3
Nickel	Adjacent	D	44/44	--	0.0%	0.337	0.998	0.594	0.182	0.551	0.916
		T	44/44	--	0.0%	0.463	1.24	0.715	0.198	0.645	1.088
Silver	Adjacent	D	0/44	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
		T	0/44	(0.121 - 0.177)	100.0%	--	--	--	--	0.177	0.177
Vanadium	Adjacent	D	20/44	(0.991 - 1.6)	54.6%	1.02	5.09	1.377	0.789	1.085	2.986
		T	30/44	(0.991 - 1.51)	31.8%	1.01	6.71	1.571	1.115	1.245	3.721
Zinc	Adjacent	D	4/44	(2.42 - 4.2)	90.9%	3.42	4.7	2.551	0.43	3.22	3.777
		T	0/44	(2.42 - 9.3)	100.0%	--	--	--	--	3.23	7.216

Summary Statistics - Unnamed Tributary Surface Stream Investigation Cumberland Fossil Plant - Cumberland City, Tennessee											
Parameter	Gradient	Fraction	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
						Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Other Analyzed Constituents											
Hardness	Adjacent	N	44/44	--	0.0%	407,000	1,210,000	829,886	212,823	867,000	1,094,000
Iron	Adjacent	D	18/44	(14.1 - 155)	59.1%	14	617	64	128	29	341
		T	44/44	--	0.0%	34	1,320	378	384	169	1,114
Magnesium	Adjacent	D	44/44	--	0.0%	18,500	33,600	25,900	4,654	25,700	33,100
		T	44/44	--	0.0%	18,500	34,300	26,023	4,747	25,700	33,455
Manganese	Adjacent	D	44/44	--	0.0%	154	6,760	2,887	2,194	2,585	6,399
		T	44/44	--	0.0%	159	6,940	3,034	2,204	2,700	6,814
TSS	Adjacent	N	44/44	--	0.0%	700	66,500	17,669	14,833	16,300	49,925

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

Statistical data sets were aggregated by location of transect relative to the CCR management units (upstream, adjacent downstream) and sample fraction (total, dissolved, or normal)

Except for Radium 226 + 228, all units are in micrograms per liter (µg/L)

Units for Radium 226+228 are picocuries per liter (pCi/L)

Fractions reported include dissolved (D), total (T), and normal (N)

Non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

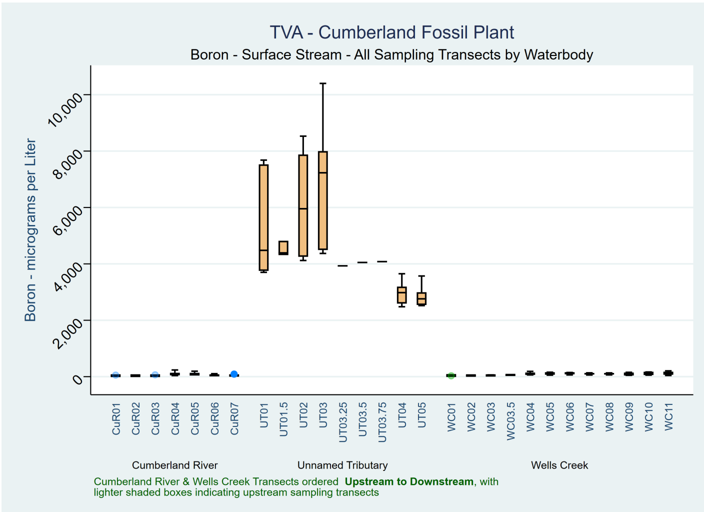
ATTACHMENT E.5-B - BOX PLOTS

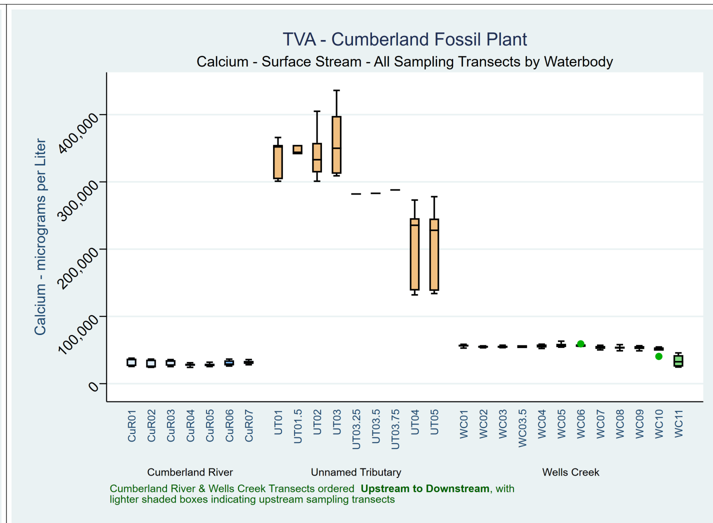
Box Plots

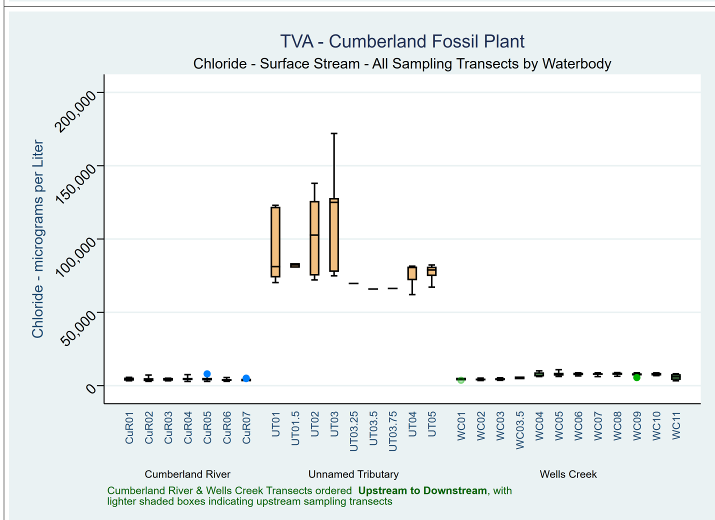
All Transects - CCR Rule Appendix III Parameters

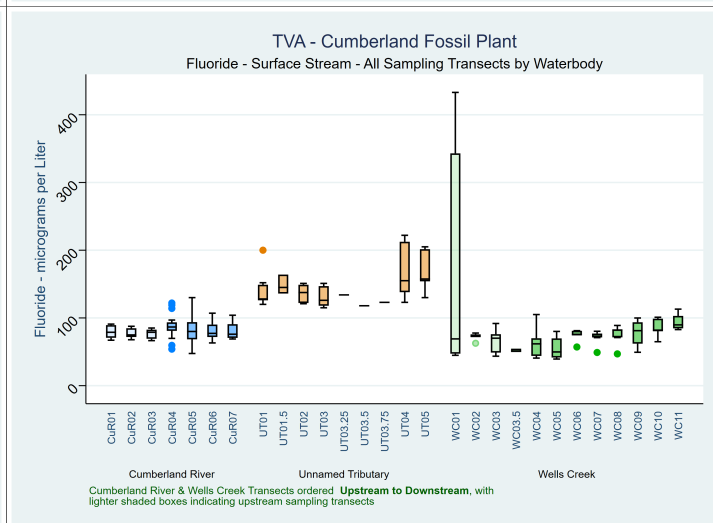
Surface Stream Investigation

Cumberland Fossil Plant, Cumberland City, Tennessee

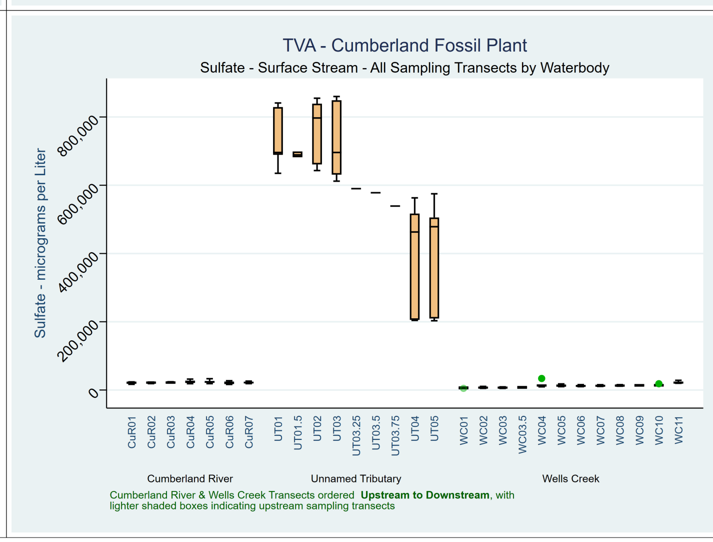


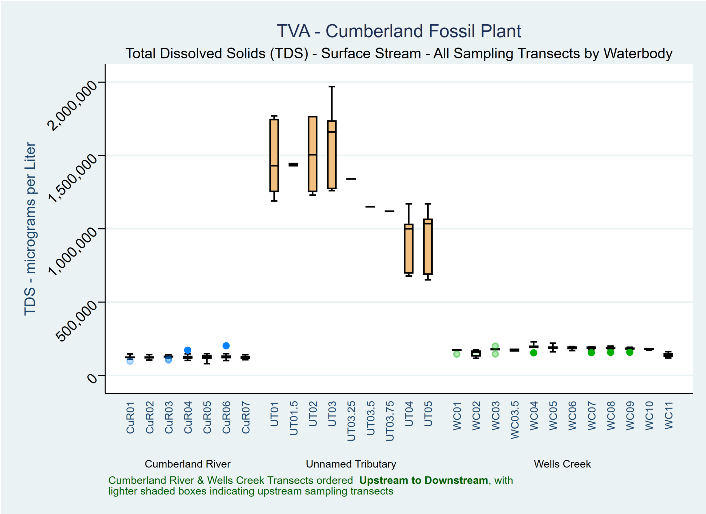






Place-holder for pH Field





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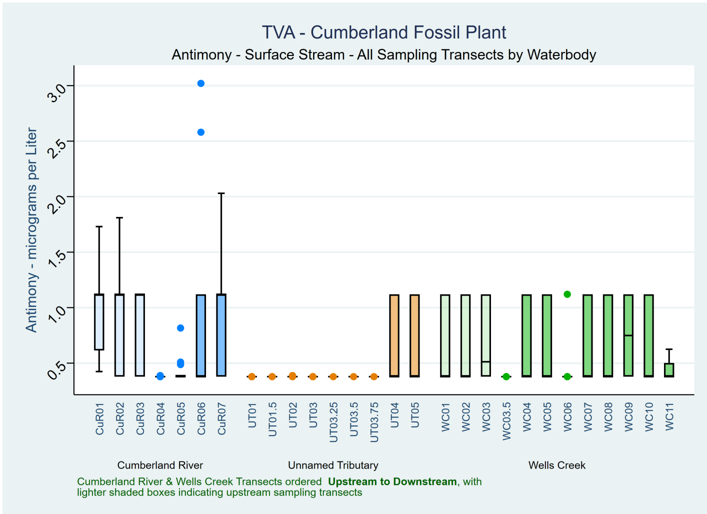
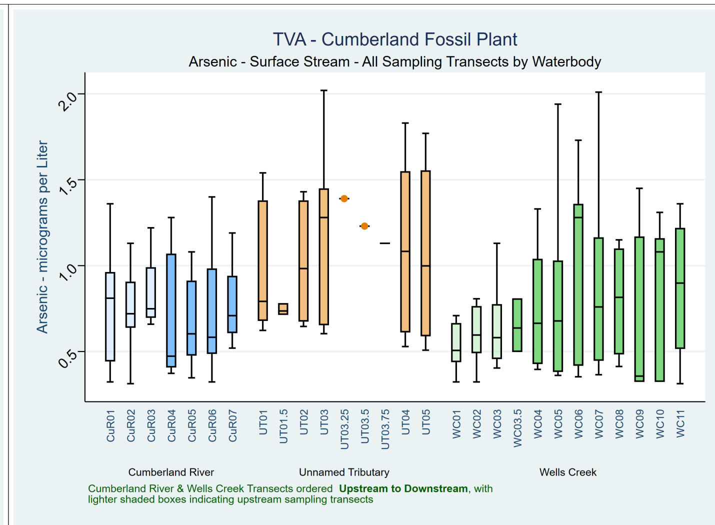
Box Plots

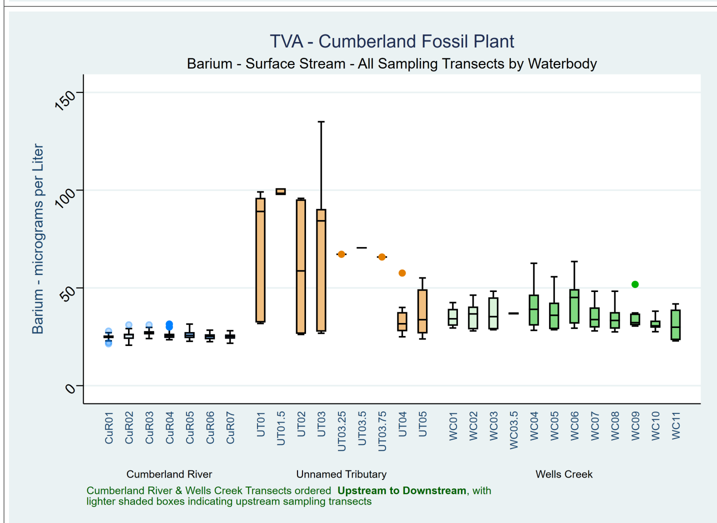
All Transects - CCR Rule Appendix IV Parameters

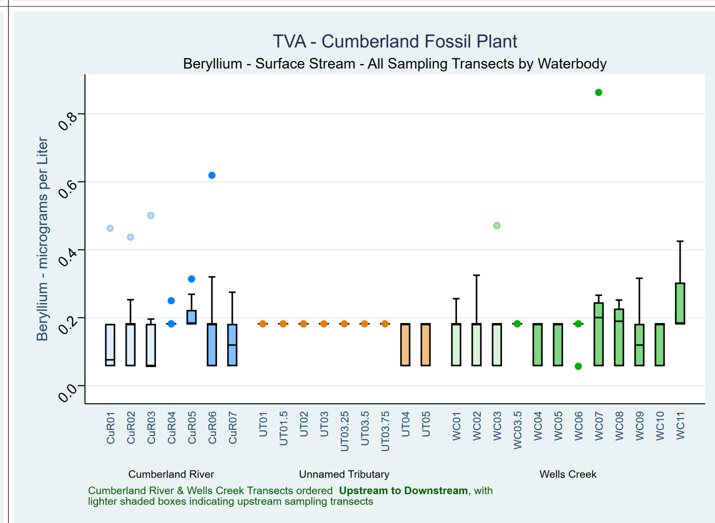
Surface Stream Investigation

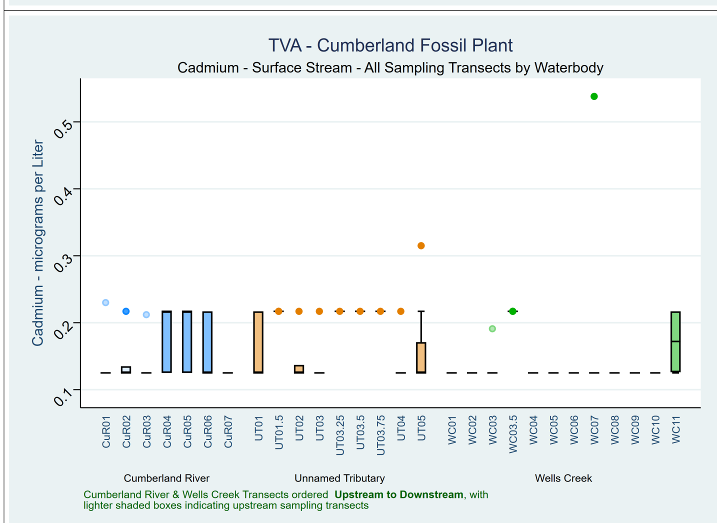
Cumberland Fossil Plant, Cumberland City, Tennessee

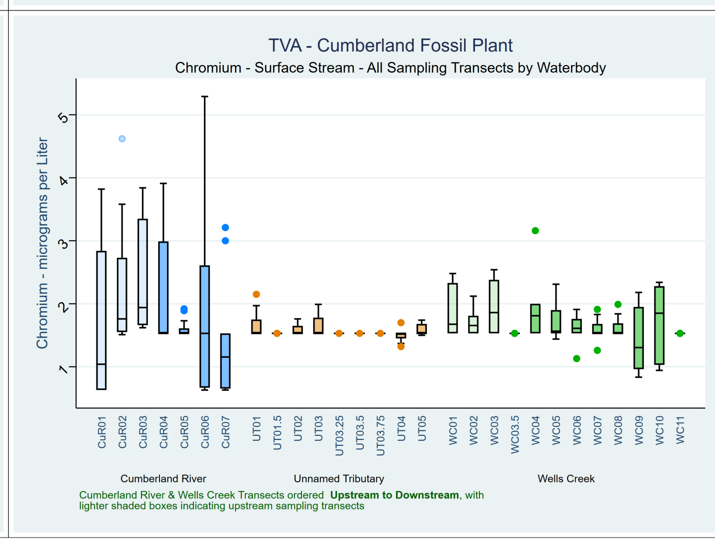


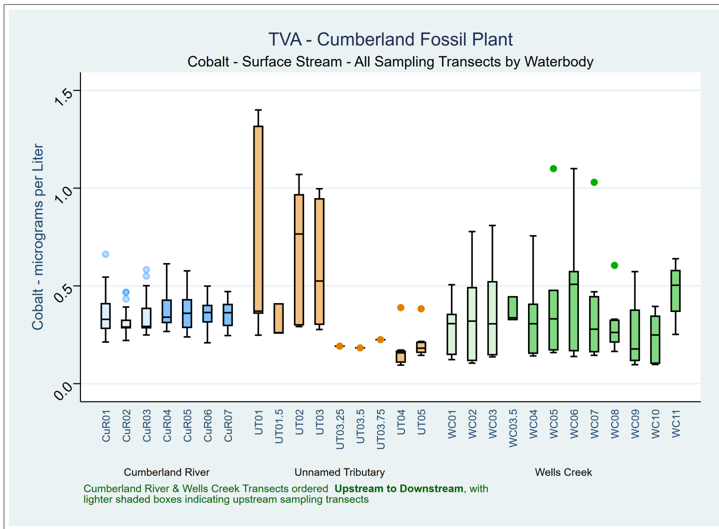


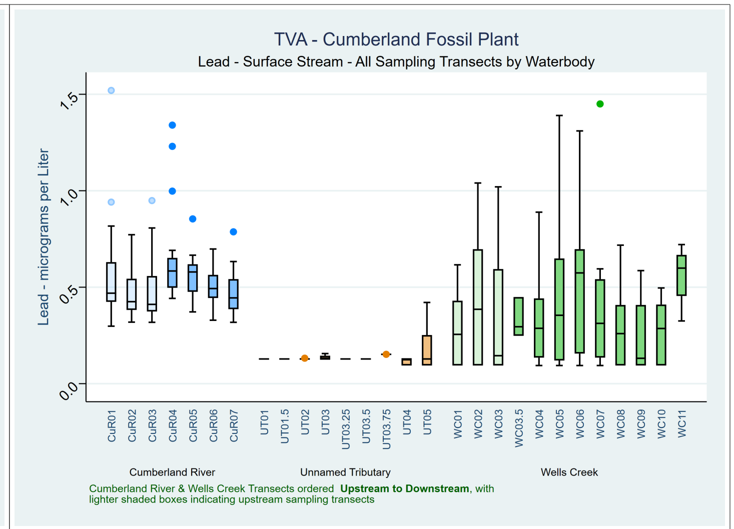


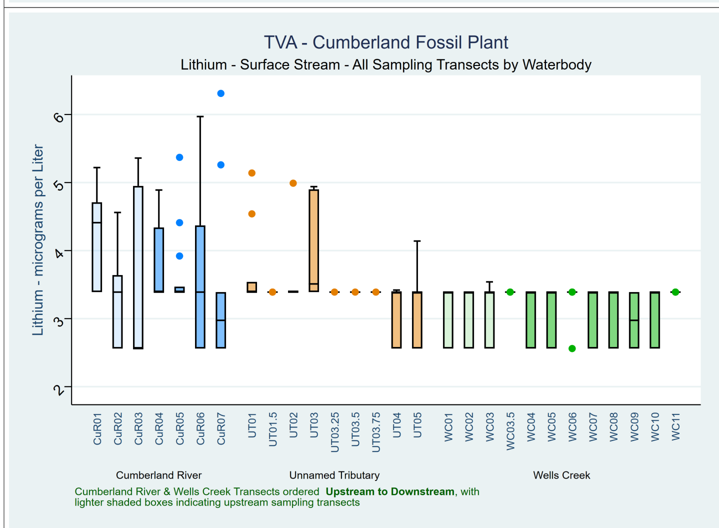


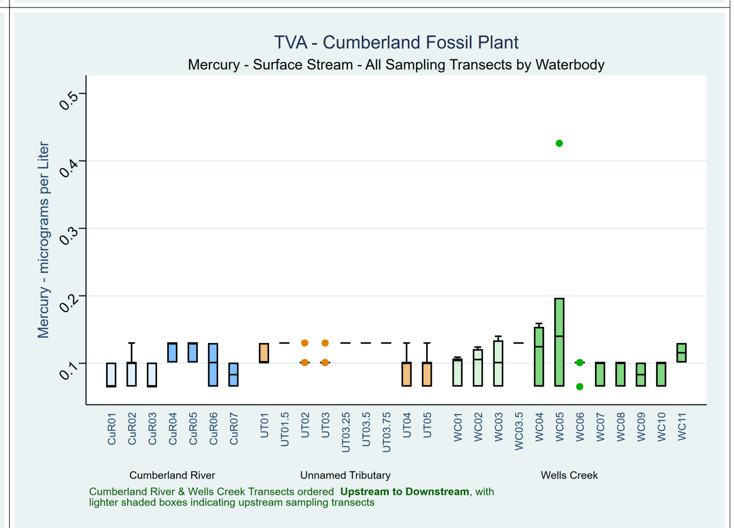


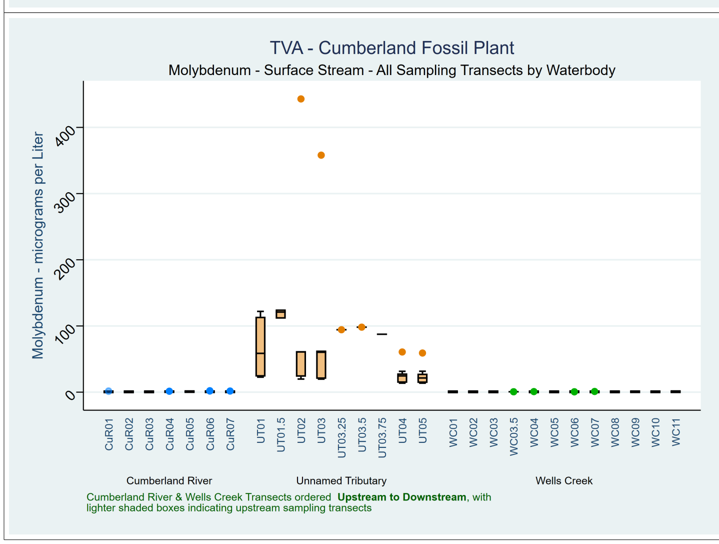


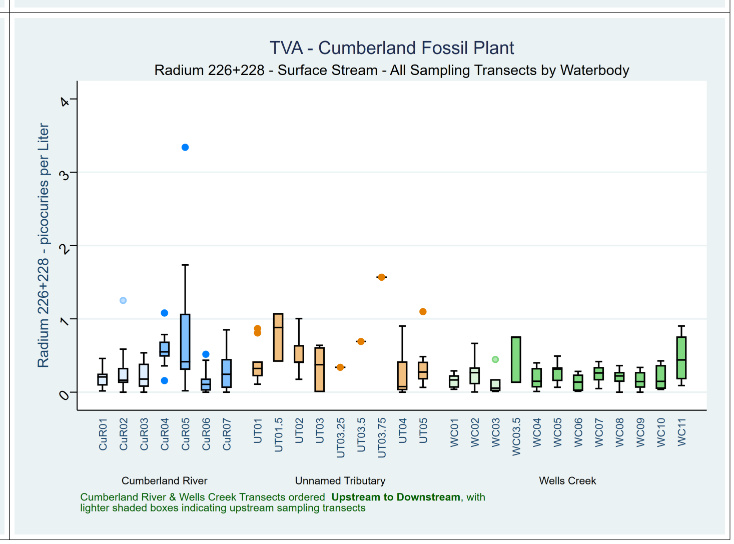

TVA - Cumberland Fossil Plant
Cobalt - Surface Stream - All Sampling Transects by Waterbody
Cobalt - micrograms per Liter
0.0
0.5
1.0
1.5
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects

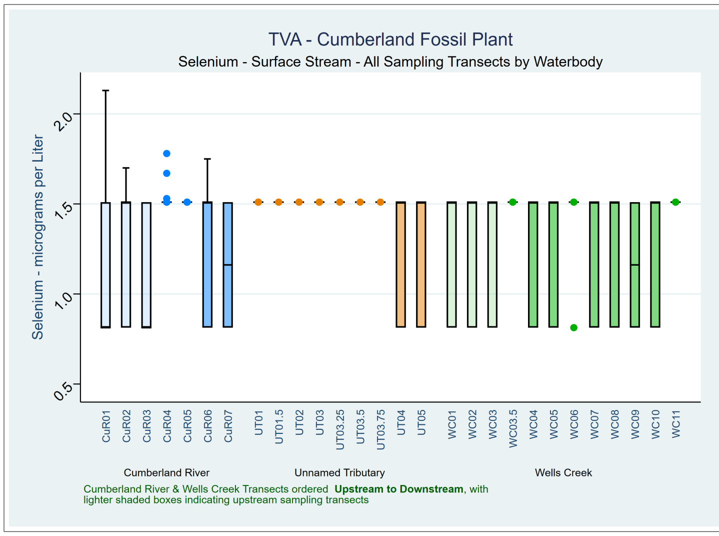

TVA - Cumberland Fossil Plant
Lead - Surface Stream - All Sampling Transects by Waterbody
Lead - micrograms per Liter
0.0
0.5
1.0
1.5
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Lithium - Surface Stream - All Sampling Transects by Waterbody
Lithium - micrograms per Liter
2
3
4
5
6
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects

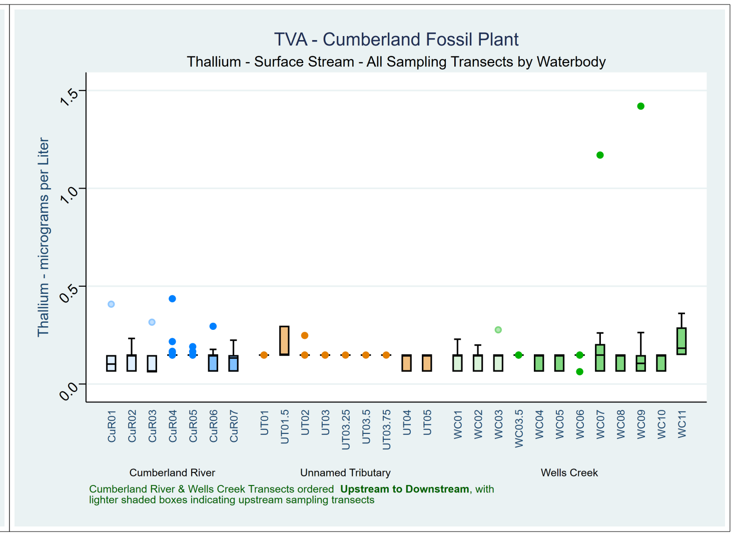

TVA - Cumberland Fossil Plant
Mercury - Surface Stream - All Sampling Transects by Waterbody
Mercury - micrograms per Liter
0.1
0.2
0.3
0.4
0.5
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Molybdenum - Surface Stream - All Sampling Transects by Waterbody
Molybdenum - micrograms per Liter
0
100
200
300
400
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Radium 226+228 - Surface Stream - All Sampling Transects by Waterbody
Radium 226+228 - picocuries per Liter
0
1
2
3
4
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered Upstream to Downstream, with lighter shaded boxes indicating upstream sampling transects

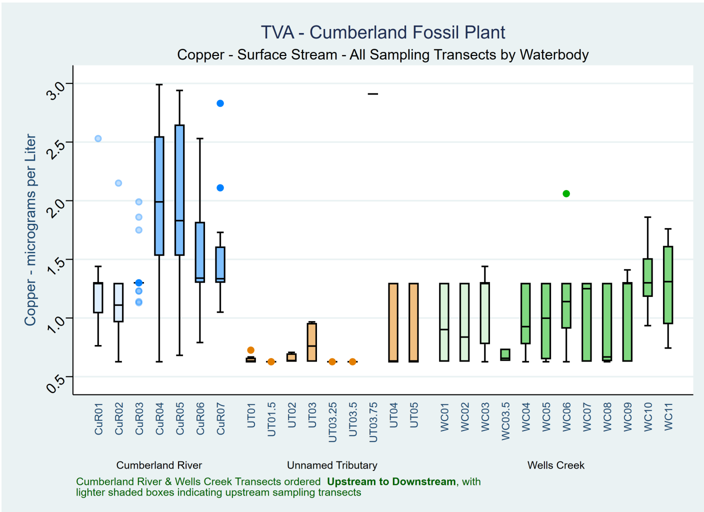


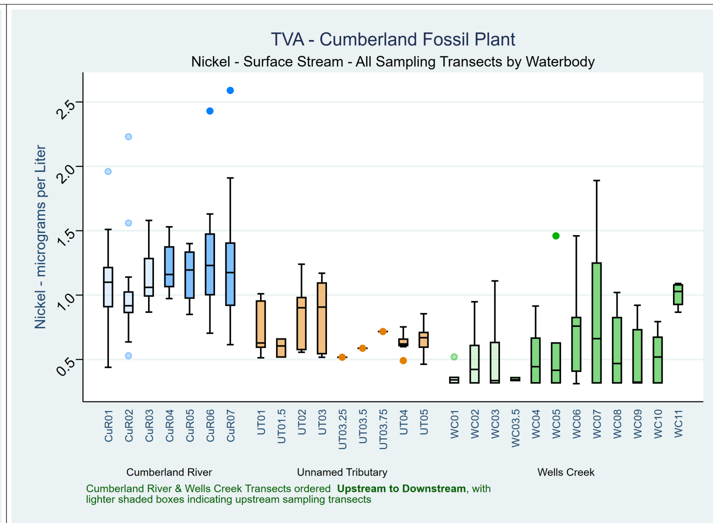
TVA - Cumberland Fossil Plant
Selenium - Surface Stream - All Sampling Transects by Waterbody
Selenium - micrograms per Liter
0.5
1.0
1.5
2.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered **Upstream to Downstream**, with lighter shaded boxes indicating upstream sampling transects

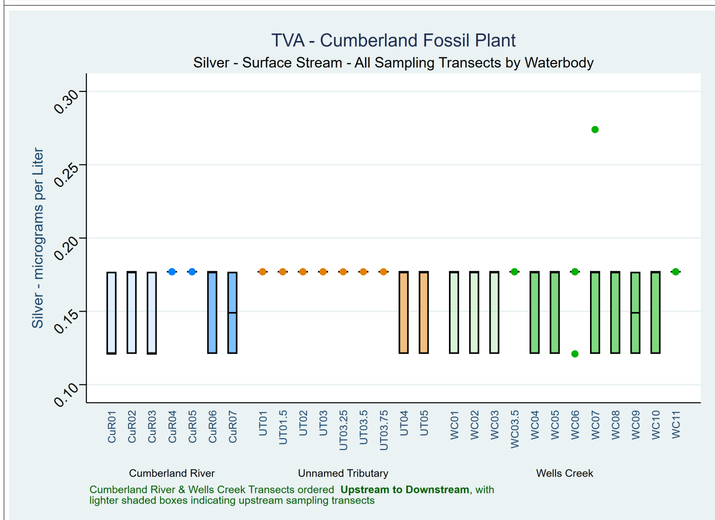


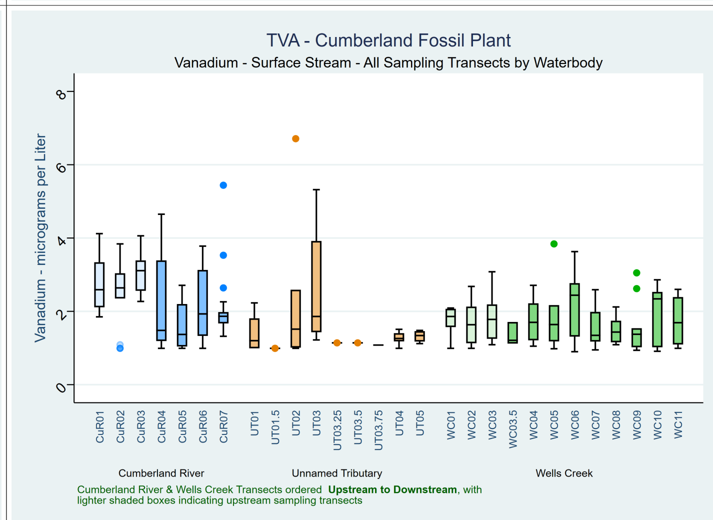
TVA - Cumberland Fossil Plant
Thallium - Surface Stream - All Sampling Transects by Waterbody
Thallium - micrograms per Liter
0.0
0.5
1.0
1.5
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Cumberland River
Unnamed Tributary
Wells Creek
Cumberland River & Wells Creek Transects ordered **Upstream to Downstream**, with lighter shaded boxes indicating upstream sampling transects

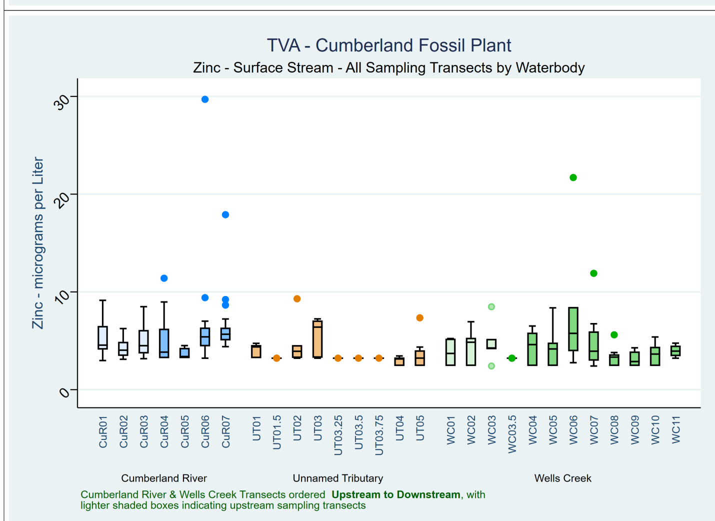
Box Plots
All Transects - TDEC Appendix I Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee











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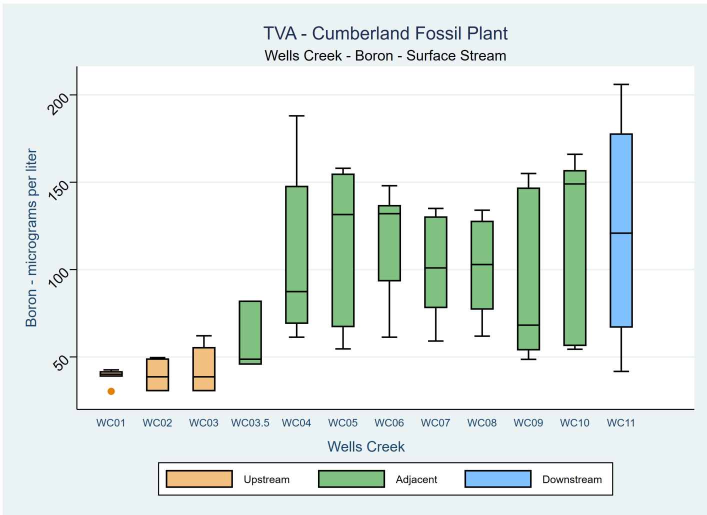
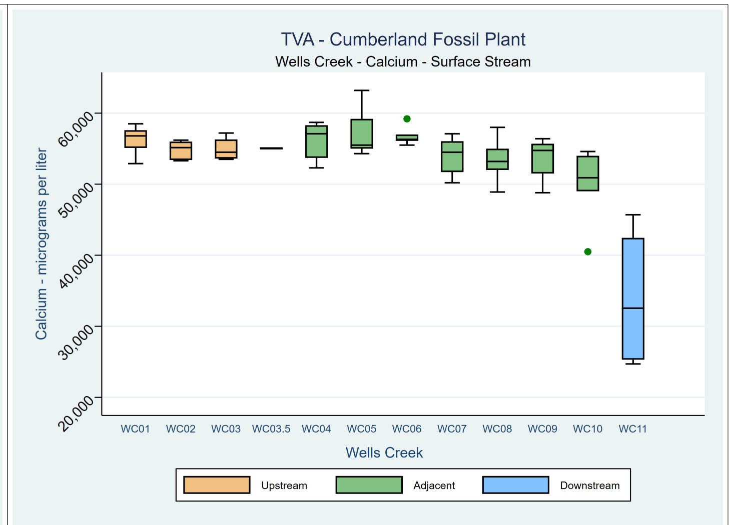
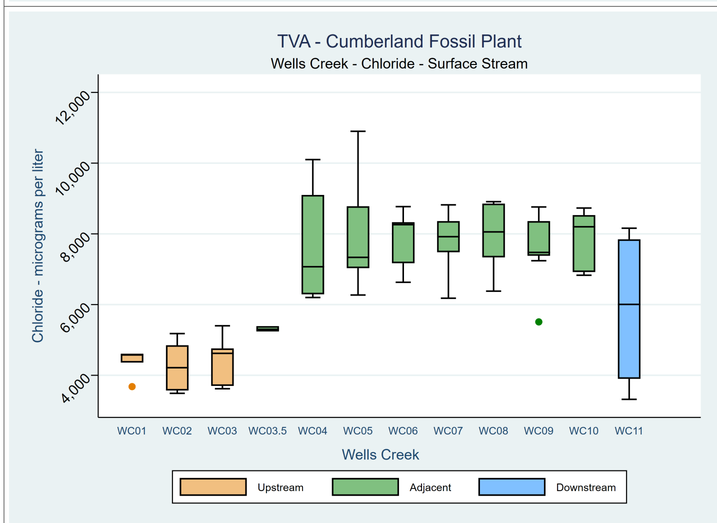
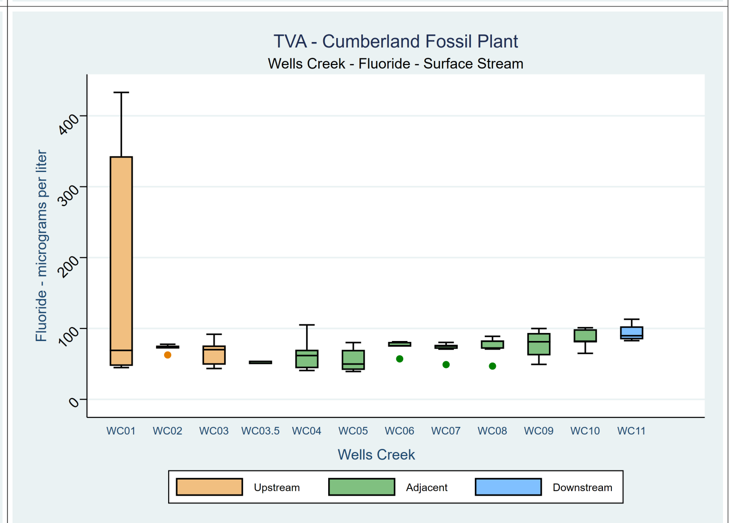
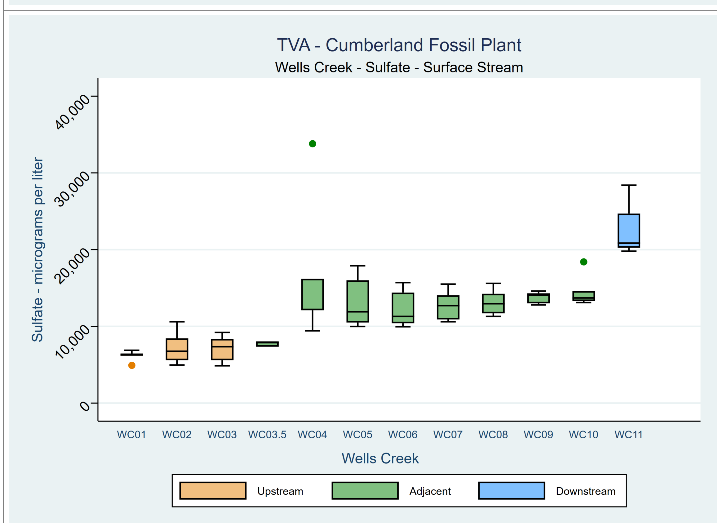
Box Plots
Wells Creek - CCR Rule Appendix III Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

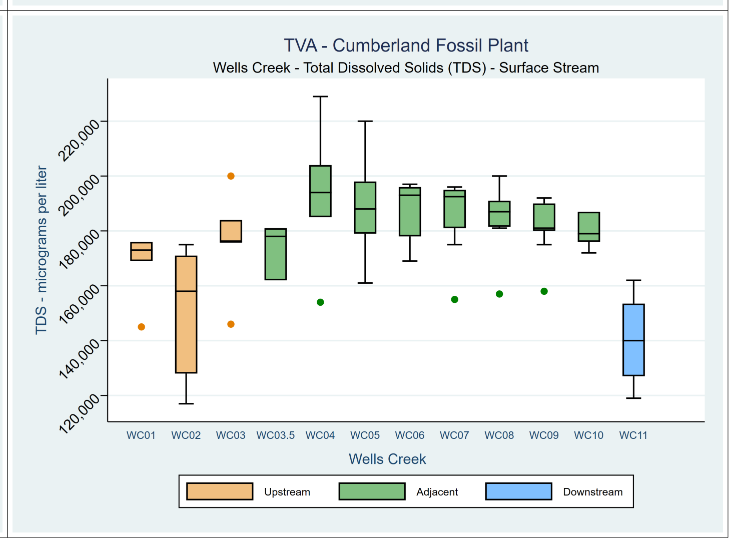




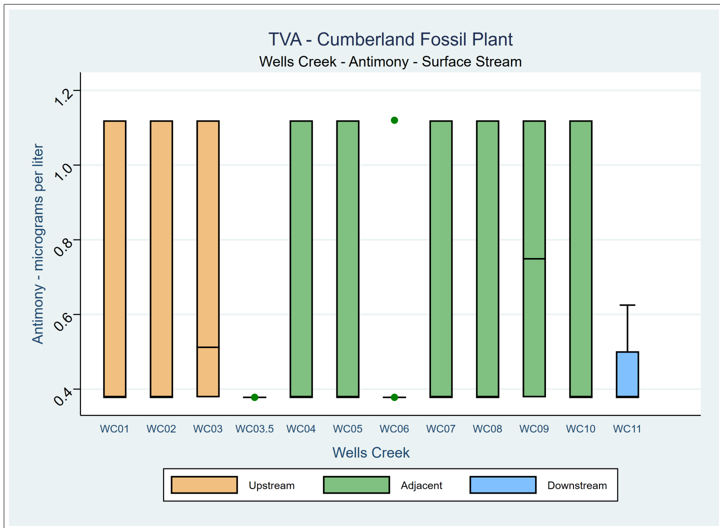


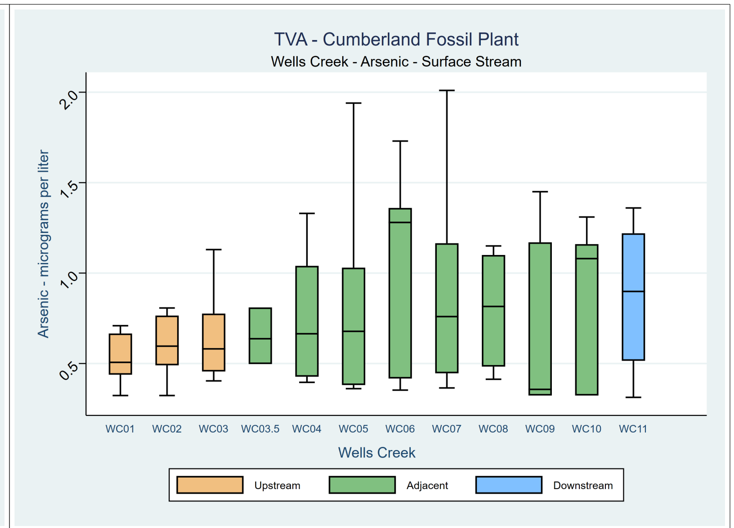


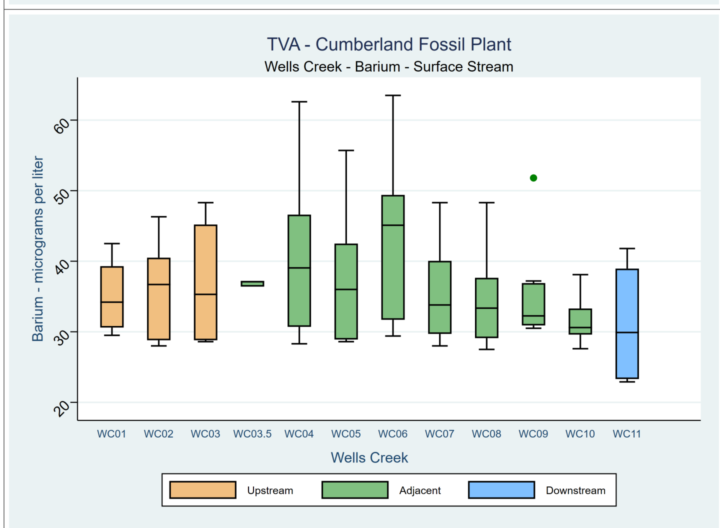


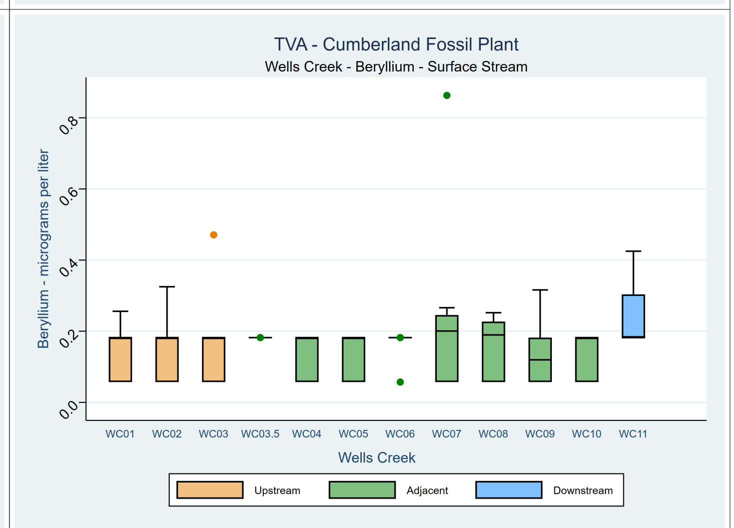


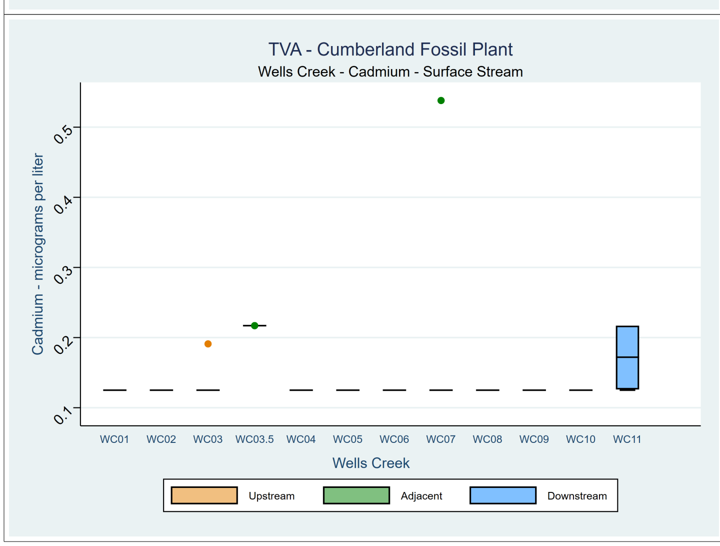
Box Plots
Wells Creek - CCR Rule Appendix IV Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

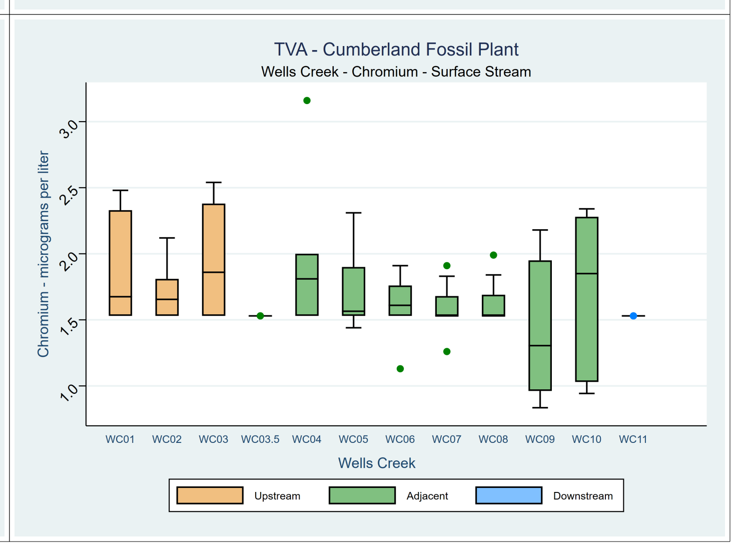


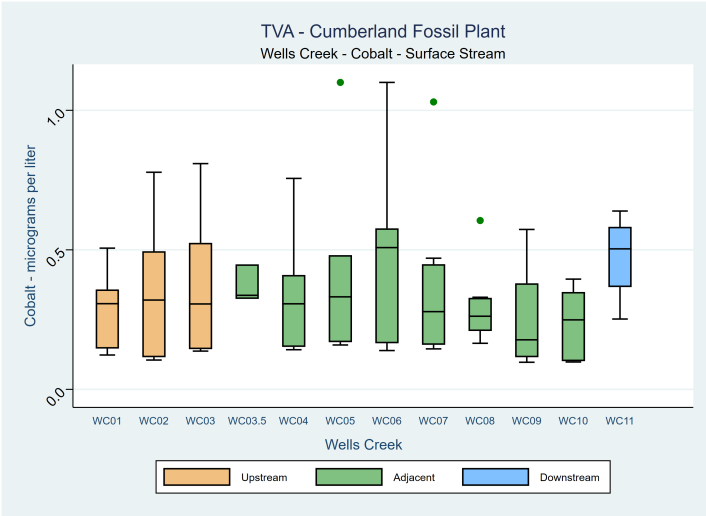


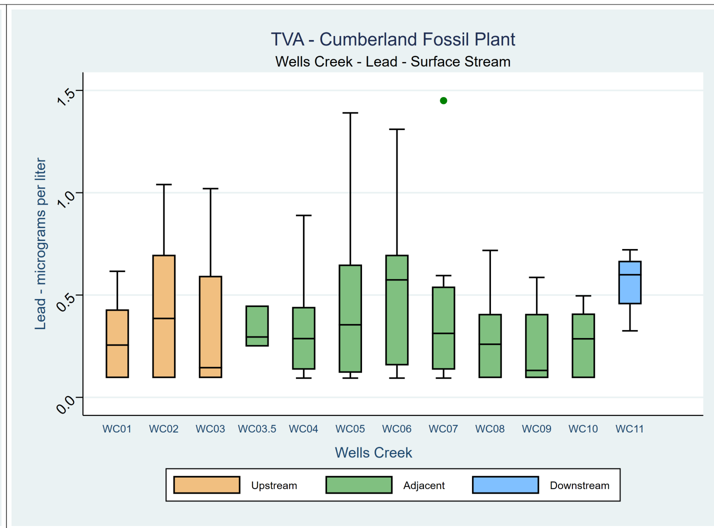


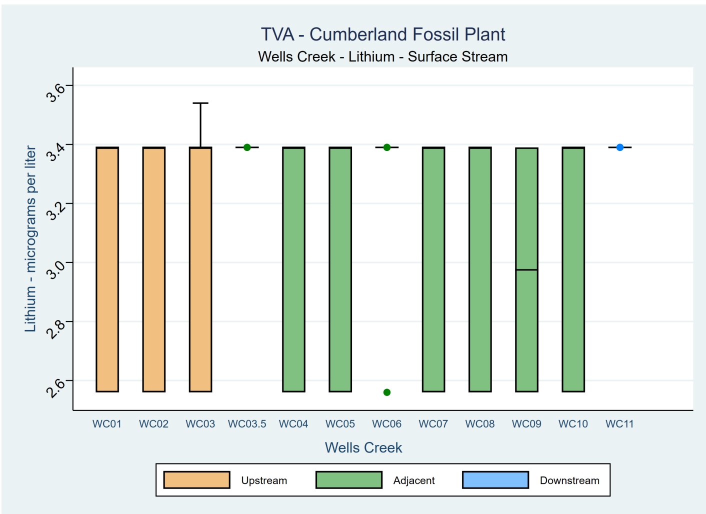


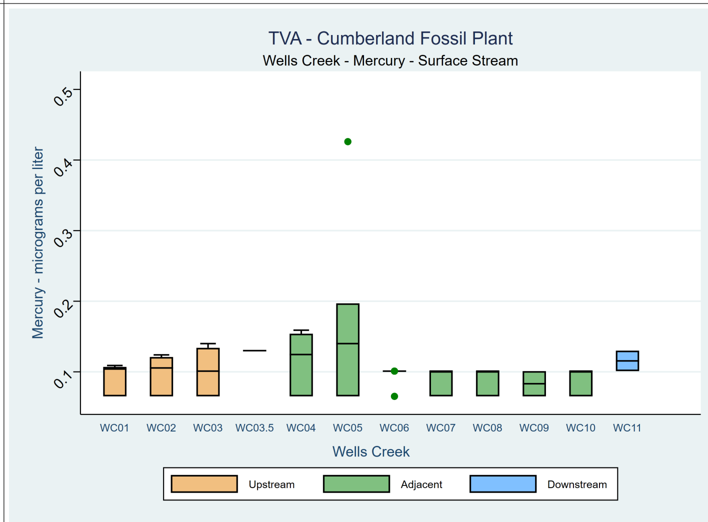


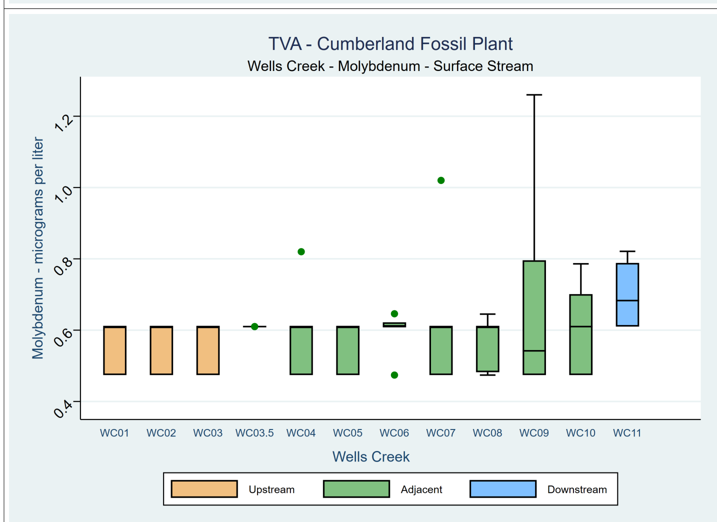


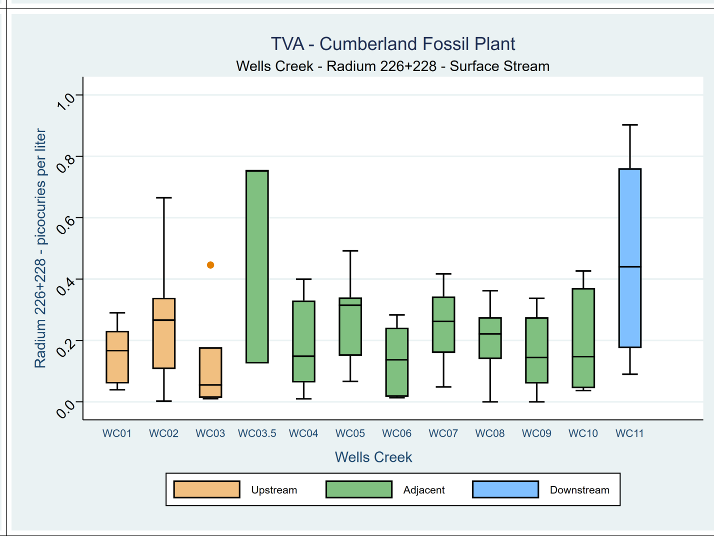

TVA - Cumberland Fossil Plant
Wells Creek - Cobalt - Surface Stream
Cobalt - micrograms per liter
0.0
0.5
1.0
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream

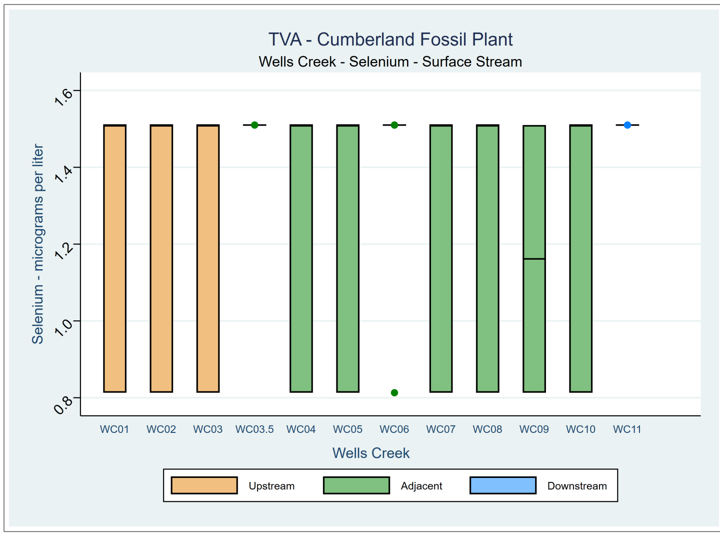

TVA - Cumberland Fossil Plant
Wells Creek - Lead - Surface Stream
Lead - micrograms per liter
0.0
0.5
1.0
1.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream

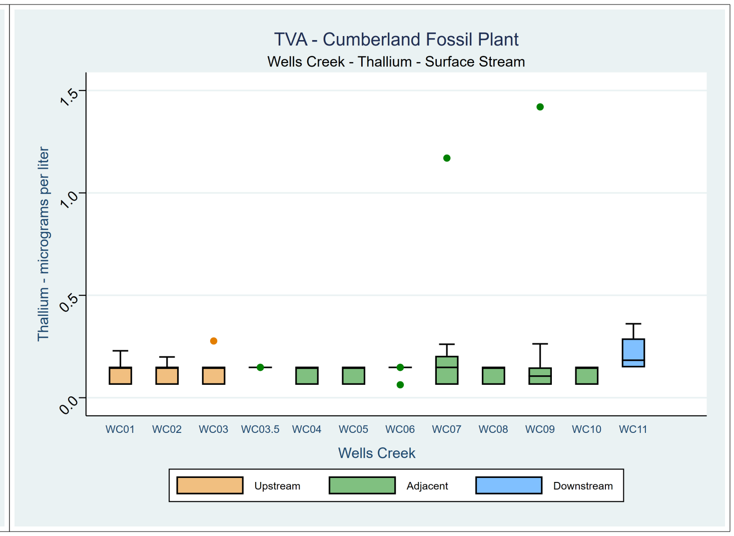

TVA - Cumberland Fossil Plant
Wells Creek - Lithium - Surface Stream
Lithium - micrograms per liter
2.6
2.8
3.0
3.2
3.4
3.6
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Wells Creek - Mercury - Surface Stream
Mercury - micrograms per liter
0.1
0.2
0.3
0.4
0.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Wells Creek - Molybdenum - Surface Stream
Molybdenum - micrograms per liter
0.4
0.6
0.8
1.0
1.2
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Wells Creek - Radium 226+228 - Surface Stream
Radium 226+228 - picocuries per liter
0.0
0.2
0.4
0.6
0.8
1.0
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Wells Creek
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Wells Creek - Selenium - Surface Stream
Selenium - micrograms per liter
0.8
1.0
1.2
1.4
1.6
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Wells Creek
Upstream
Adjacent
Downstream

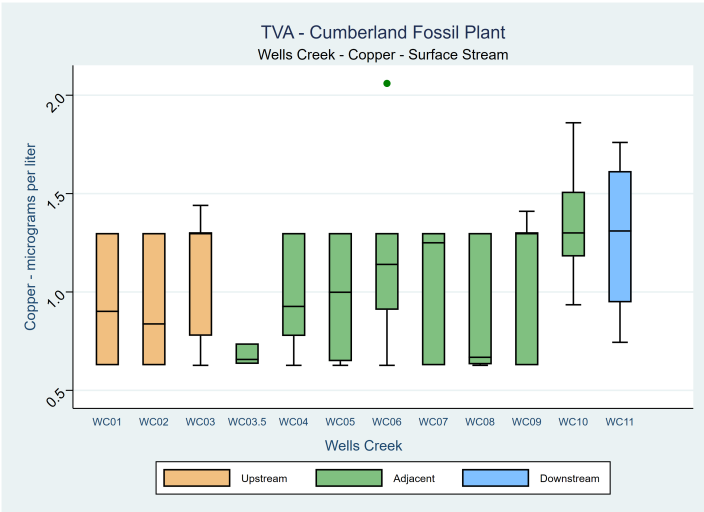

TVA - Cumberland Fossil Plant
Wells Creek - Thallium - Surface Stream
Thallium - micrograms per liter
0.0
0.5
1.0
1.5
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Wells Creek
Upstream
Adjacent
Downstream

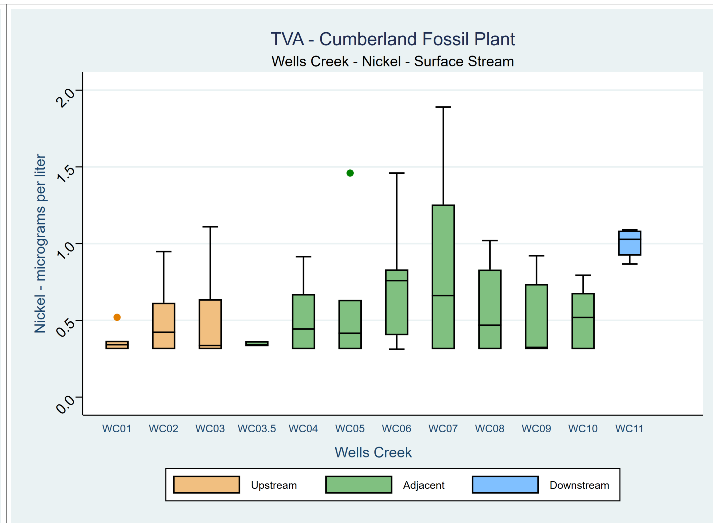
Box Plots

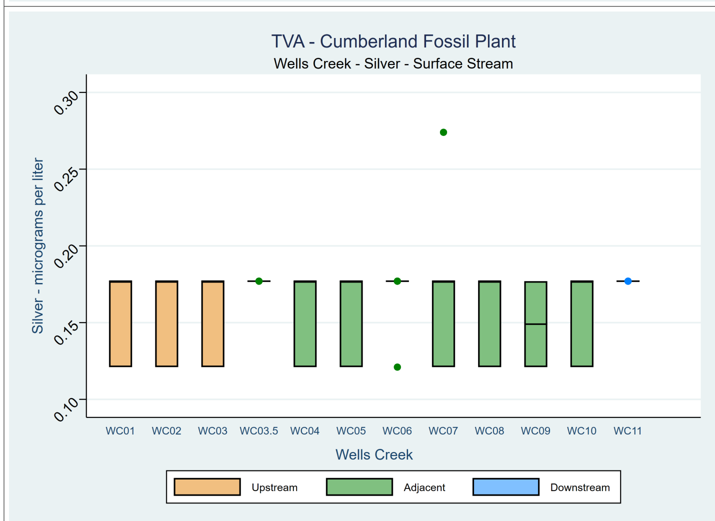
Wells Creek - TDEC Appendix I Parameters

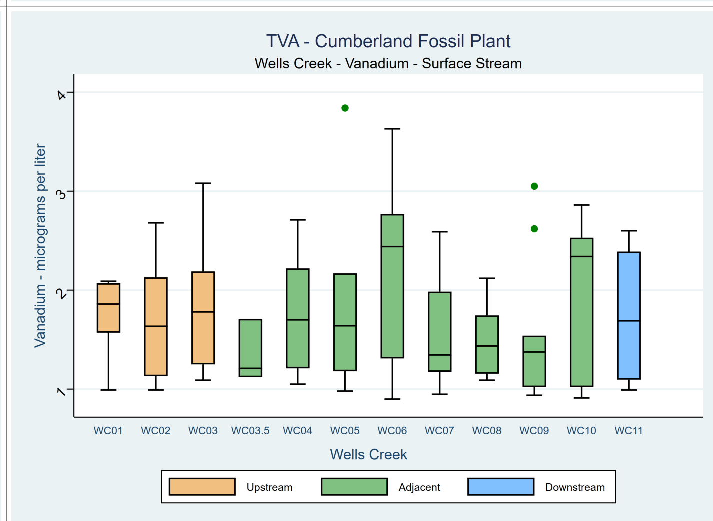
Surface Stream Investigation

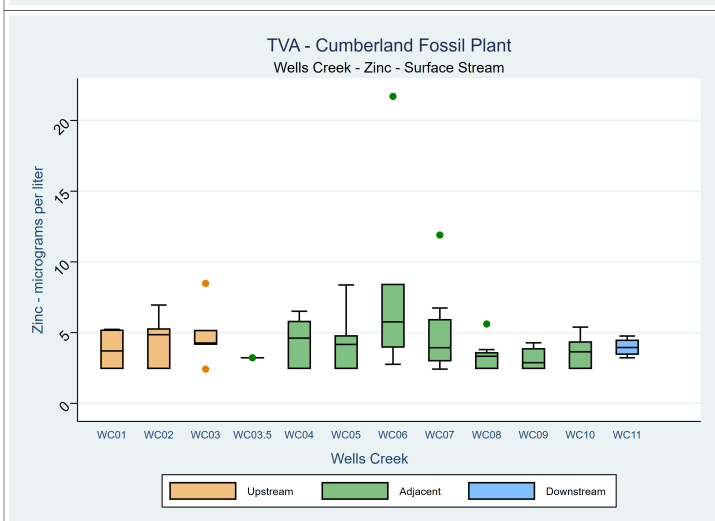
Cumberland Fossil Plant, Cumberland City, Tennessee











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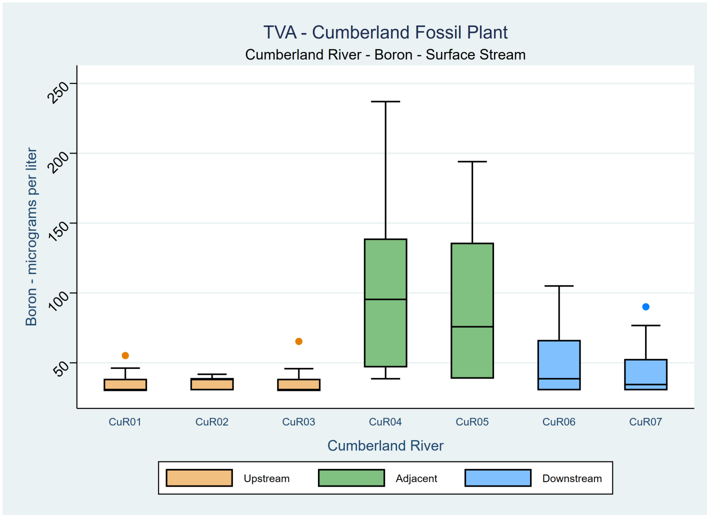
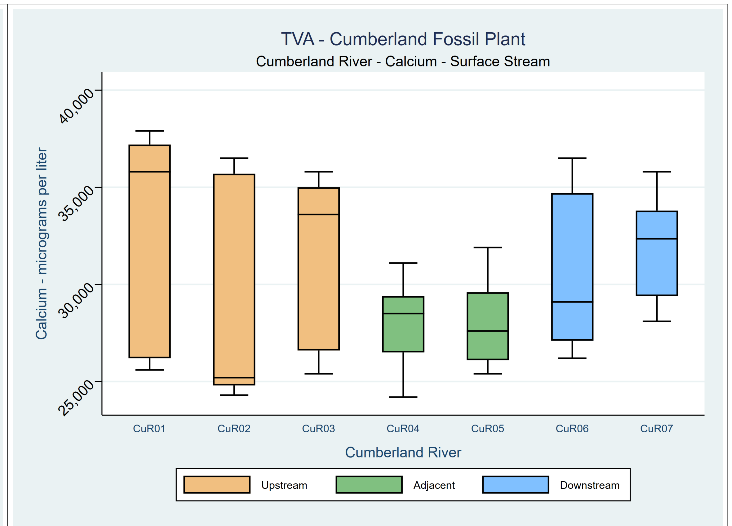
Box Plots

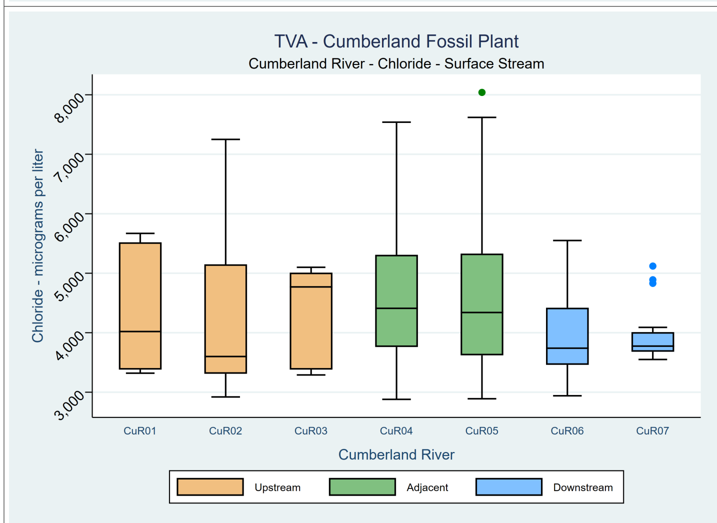
Cumberland River - CCR Rule Appendix III Parameters

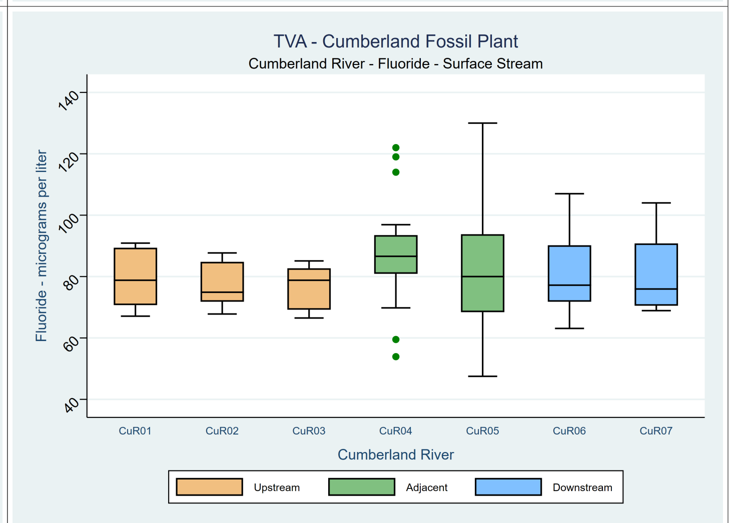
Surface Stream Investigation

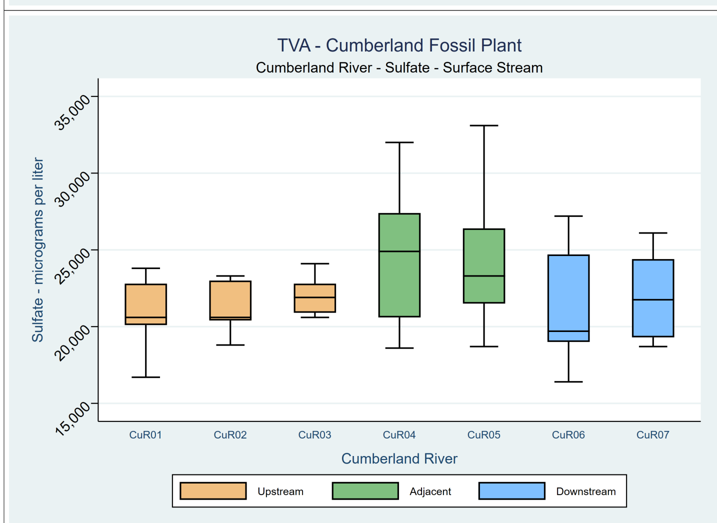
Cumberland Fossil Plant, Cumberland City, Tennessee

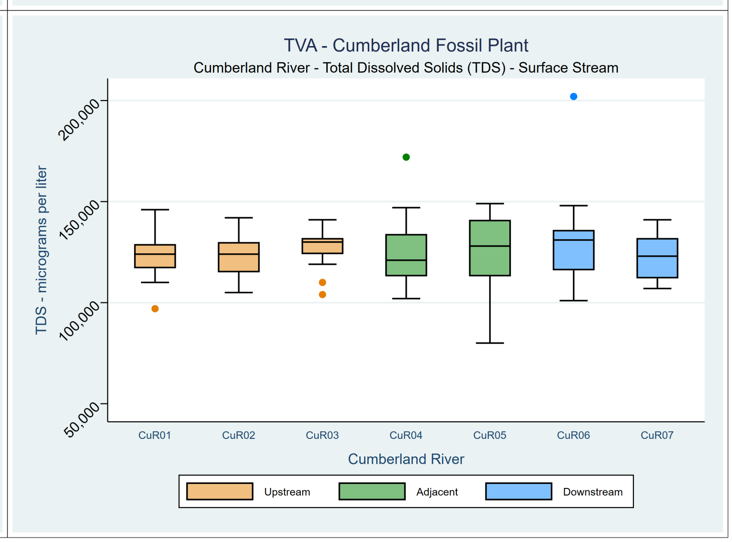




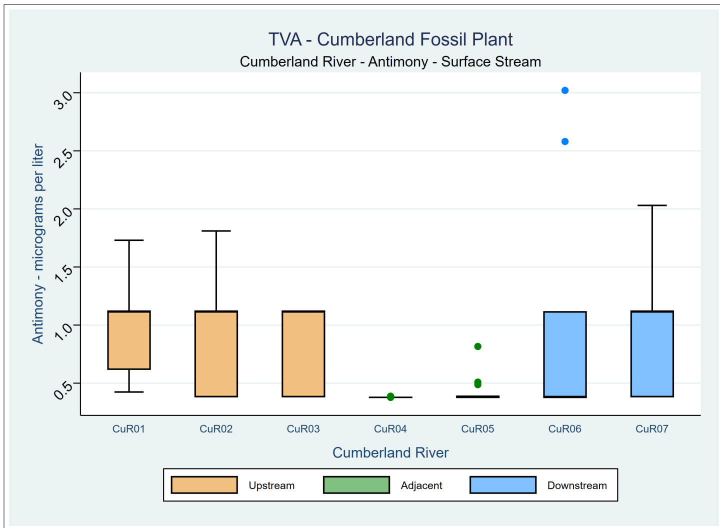


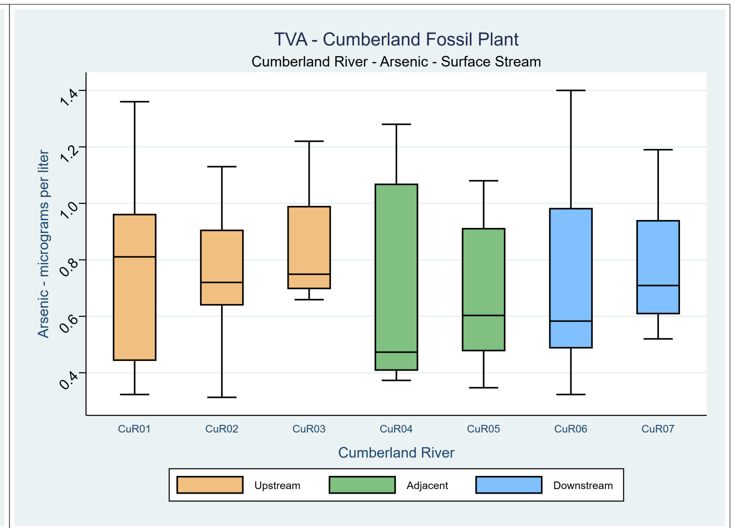


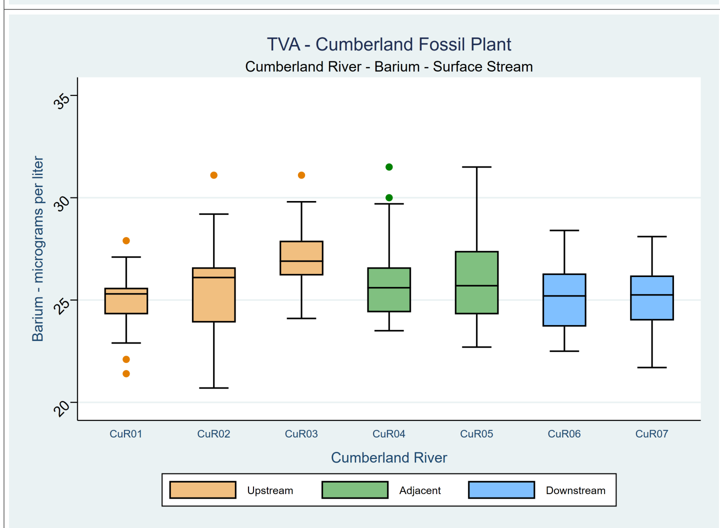


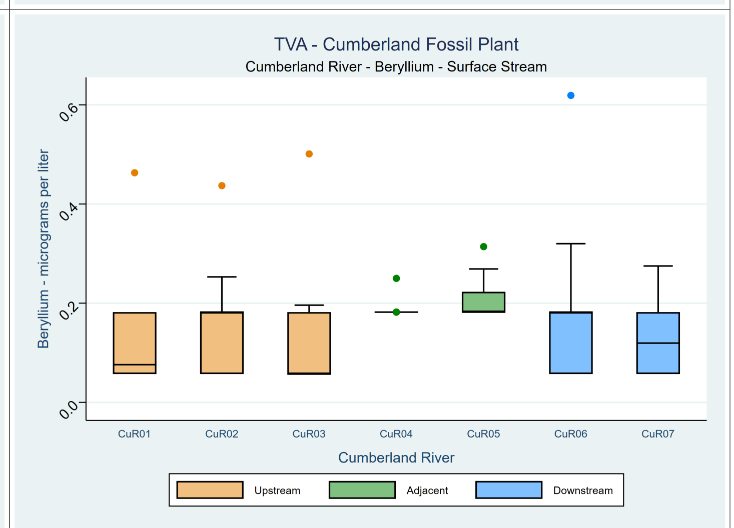


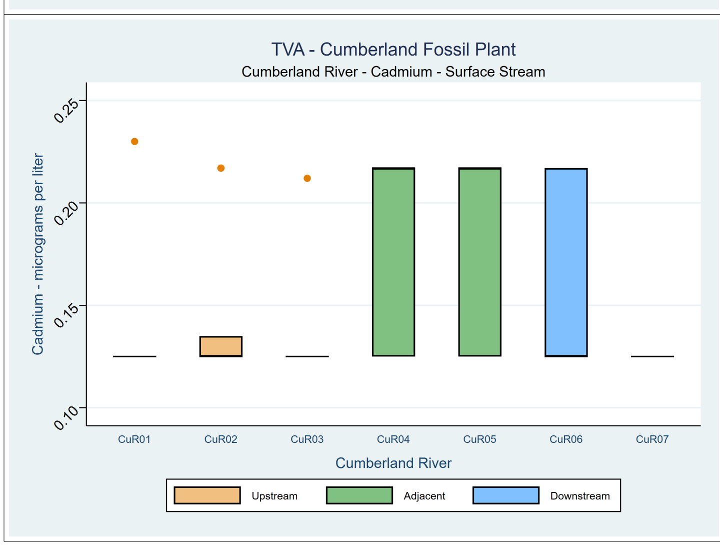
Box Plots
Cumberland River - CCR Rule Appendix IV Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

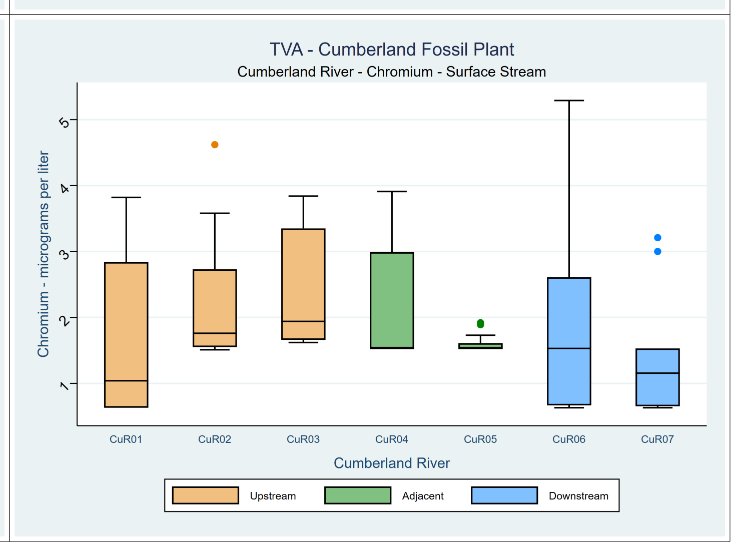


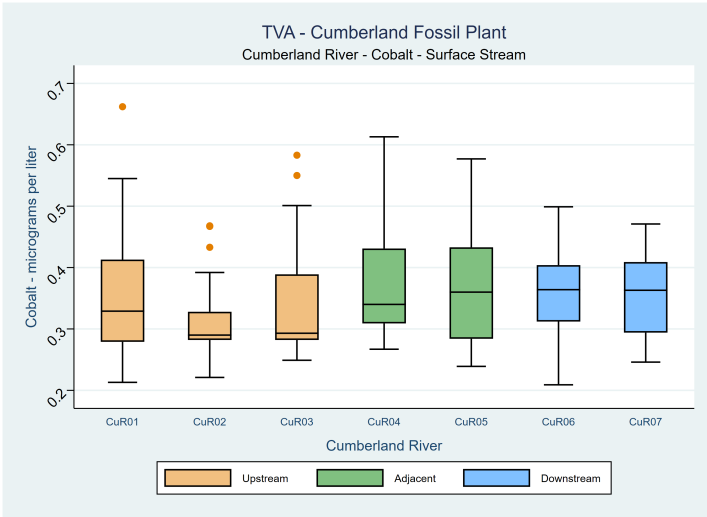


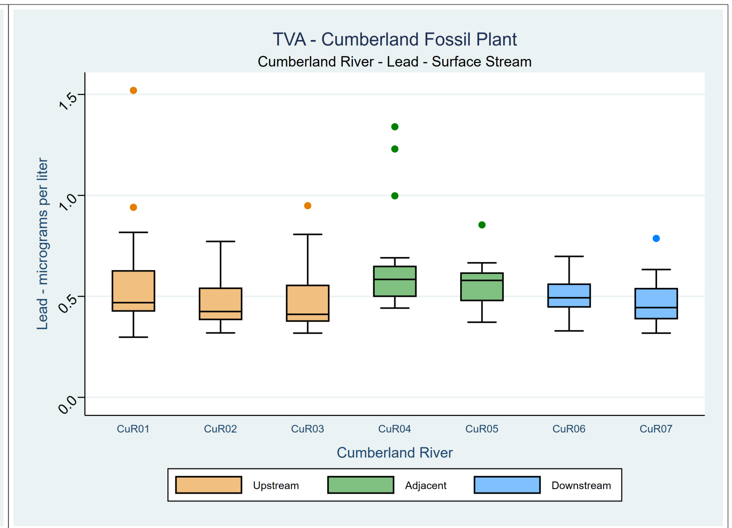


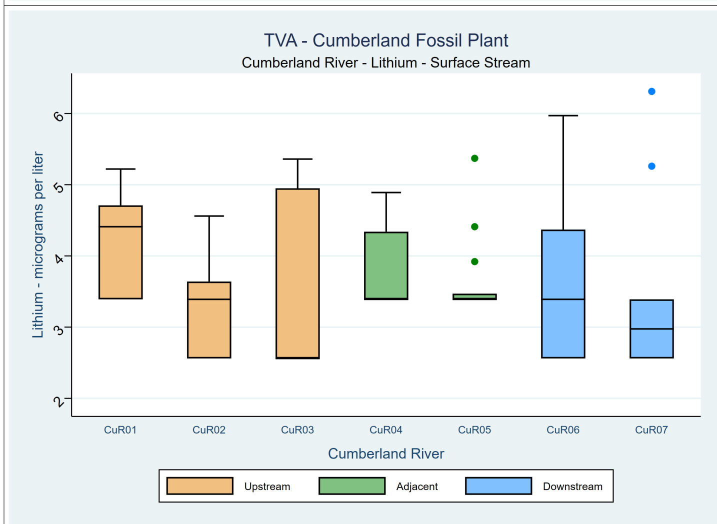


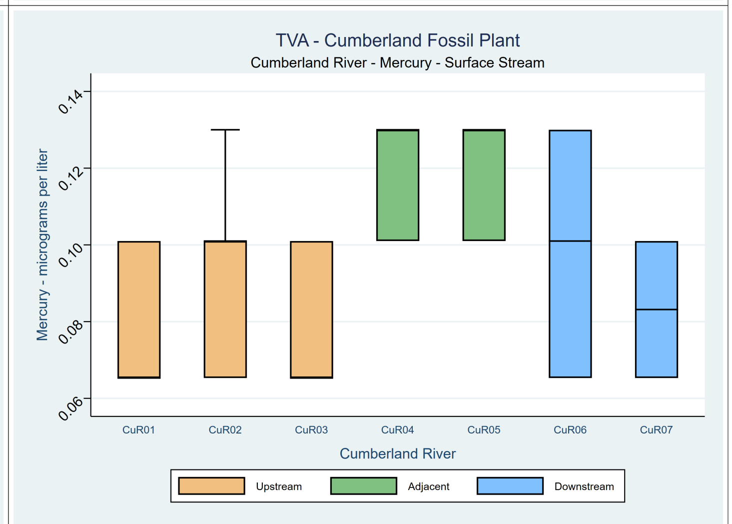


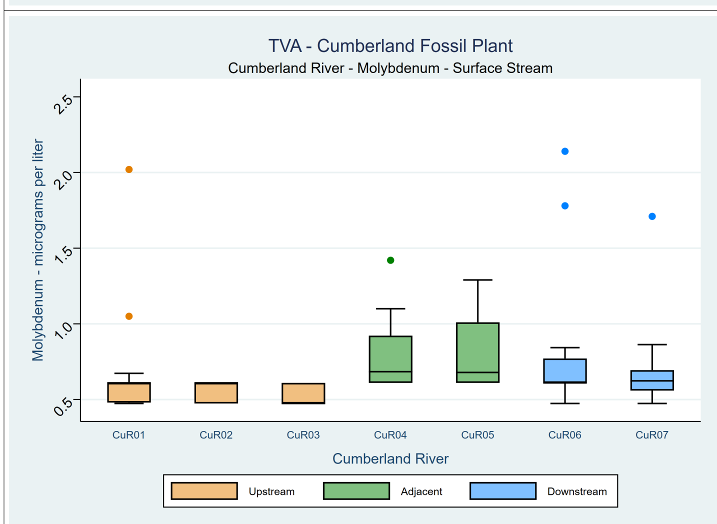


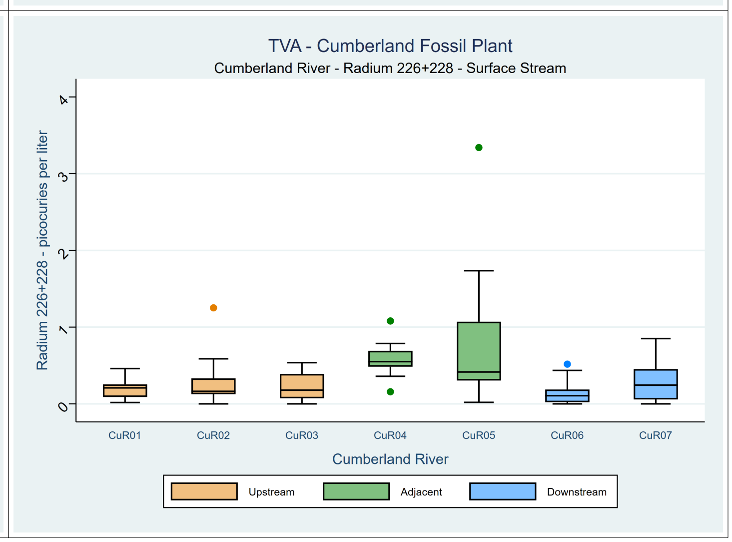

TVA - Cumberland Fossil Plant
Cumberland River - Cobalt - Surface Stream
Cobalt - micrograms per liter
0.2
0.3
0.4
0.5
0.6
0.7
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

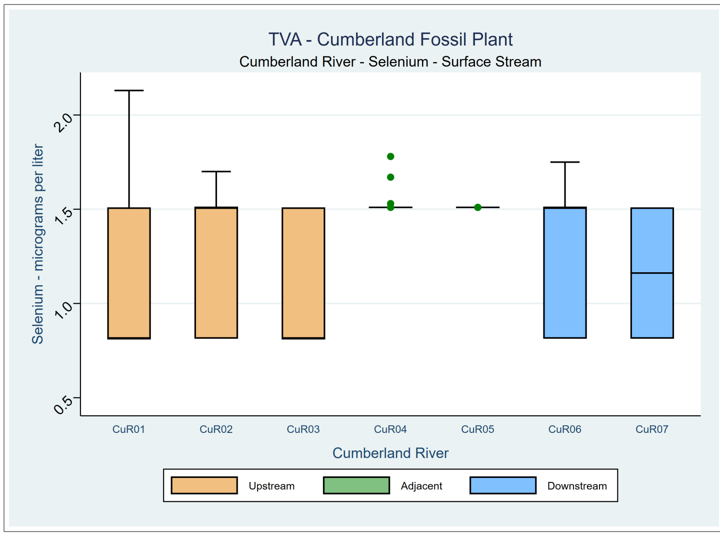

TVA - Cumberland Fossil Plant
Cumberland River - Lead - Surface Stream
Lead - micrograms per liter
0.0
0.5
1.0
1.5
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

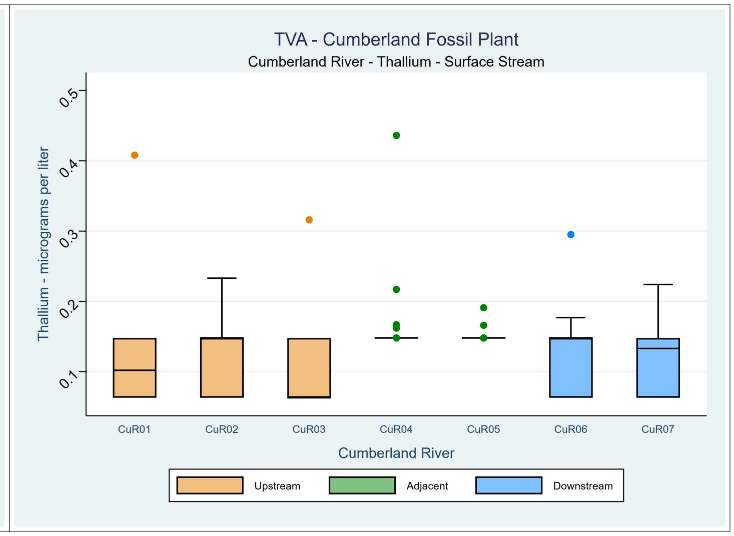

TVA - Cumberland Fossil Plant
Cumberland River - Lithium - Surface Stream
Lithium - micrograms per liter
2
3
4
5
6
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Cumberland River - Mercury - Surface Stream
Mercury - micrograms per liter
0.06
0.08
0.10
0.12
0.14
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

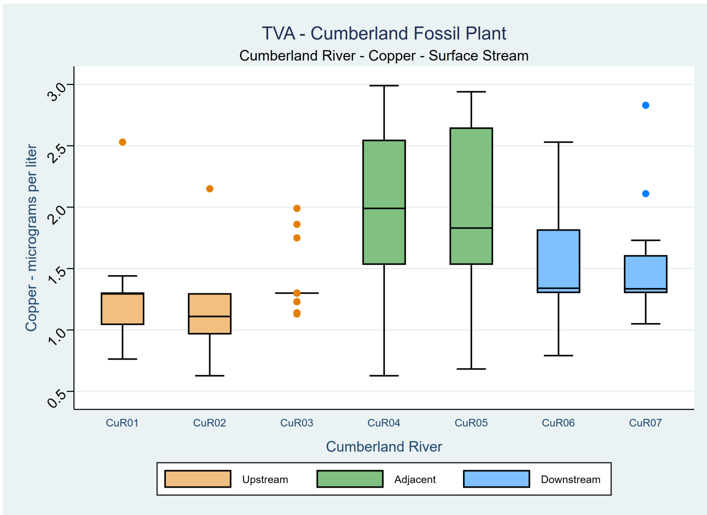

TVA - Cumberland Fossil Plant
Cumberland River - Molybdenum - Surface Stream
Molybdenum - micrograms per liter
0.5
1.0
1.5
2.0
2.5
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

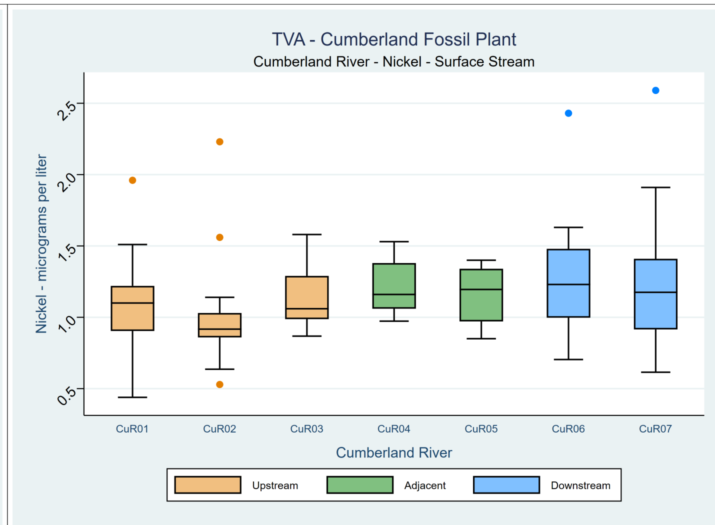

TVA - Cumberland Fossil Plant
Cumberland River - Radium 226+228 - Surface Stream
Radium 226+228 - picocuries per liter
0
1
2
3
4
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

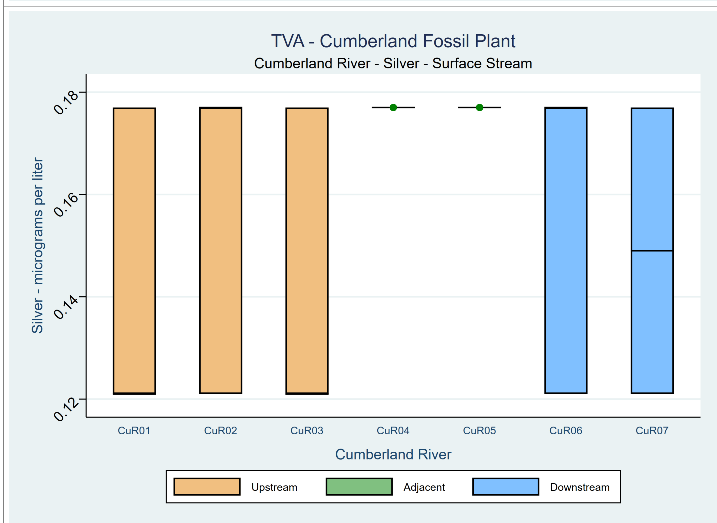

TVA - Cumberland Fossil Plant
Cumberland River - Selenium - Surface Stream
Selenium - micrograms per liter
0.5
1.0
1.5
2.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

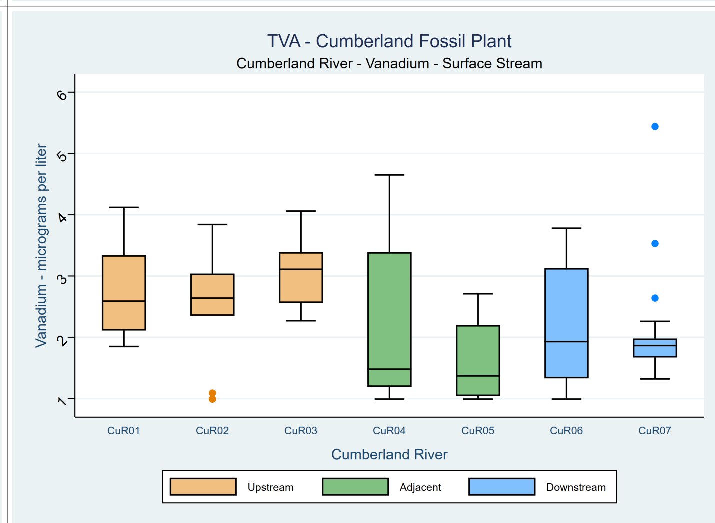

TVA - Cumberland Fossil Plant
Cumberland River - Thallium - Surface Stream
Thallium - micrograms per liter
0.1
0.2
0.3
0.4
0.5
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

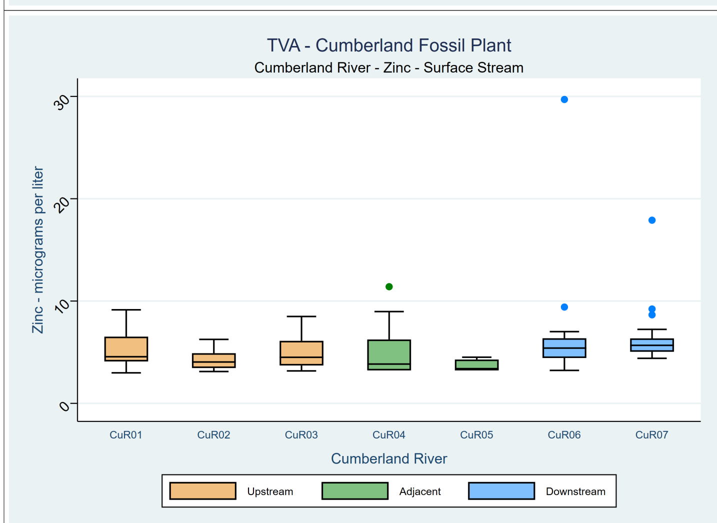
Box Plots
Cumberland River - TDEC Appendix I Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee











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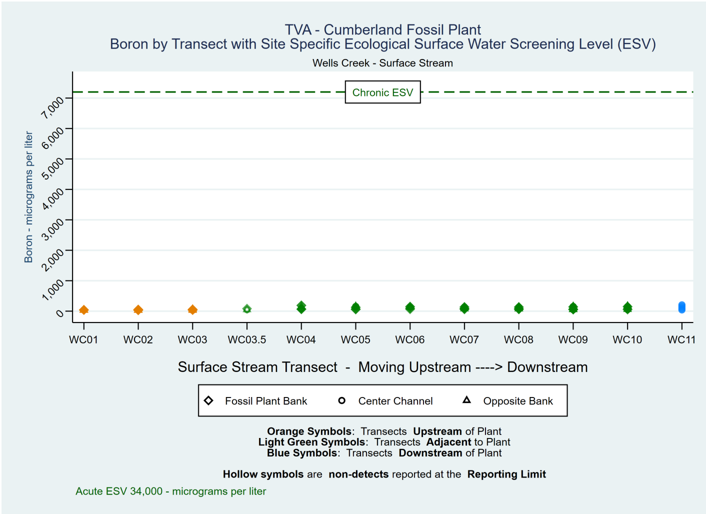
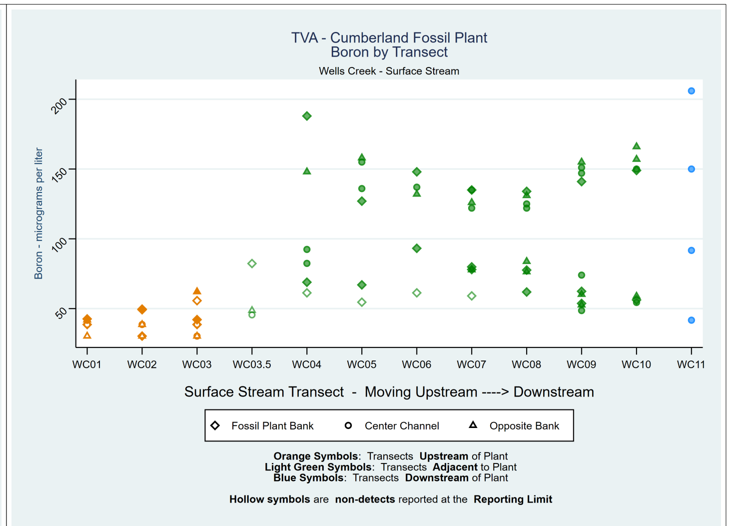
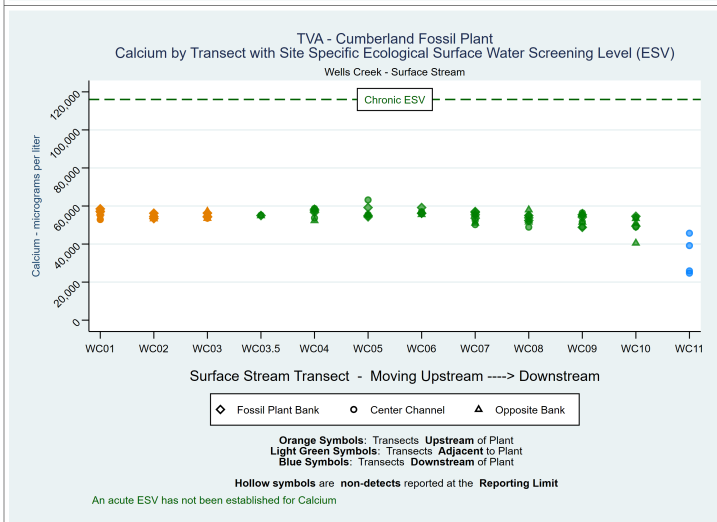
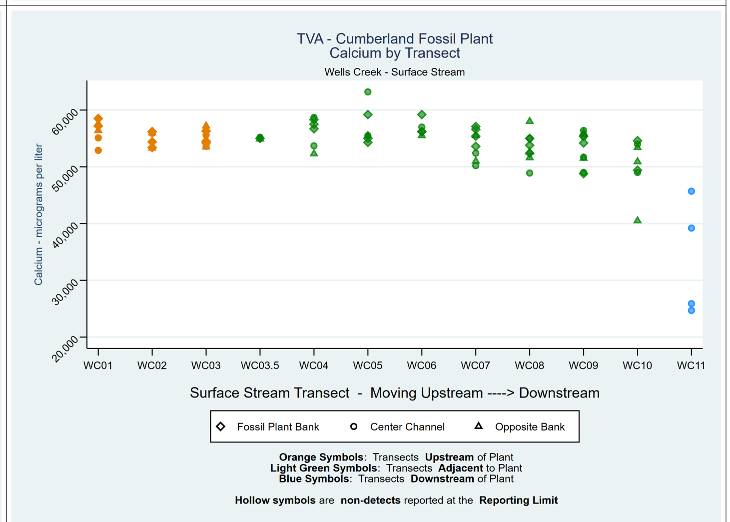
ATTACHMENT E.5-C - TRANSECT PLOTS

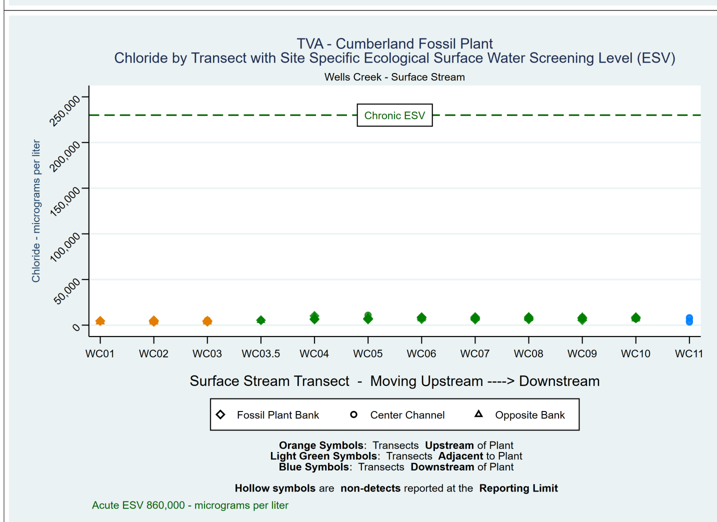
Transect Plots
Wells Creek - CCR Rule Appendix III Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

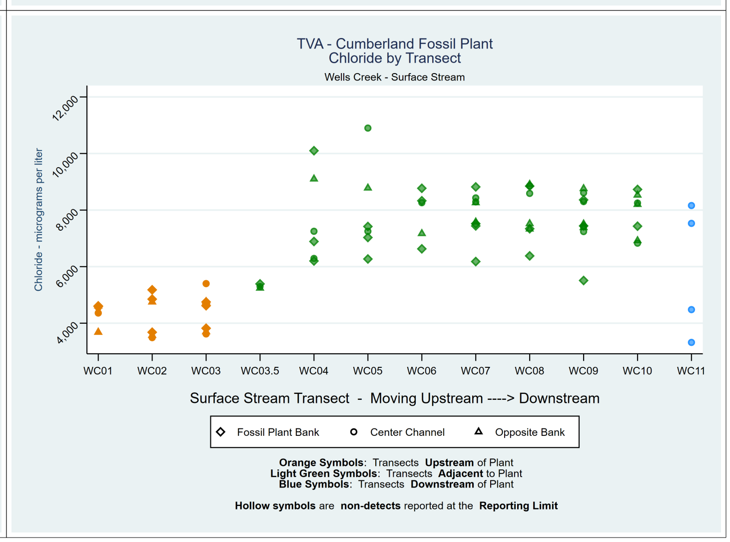


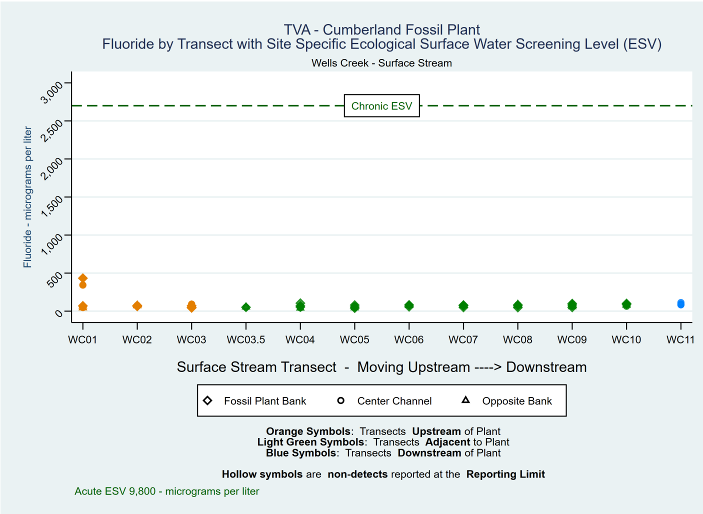


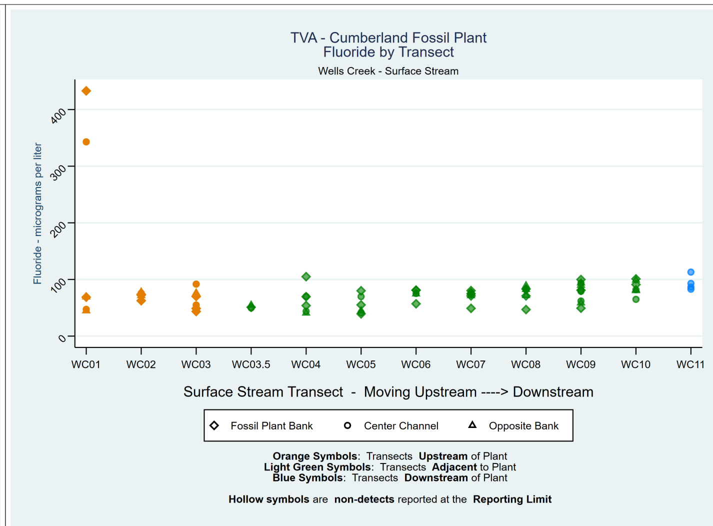








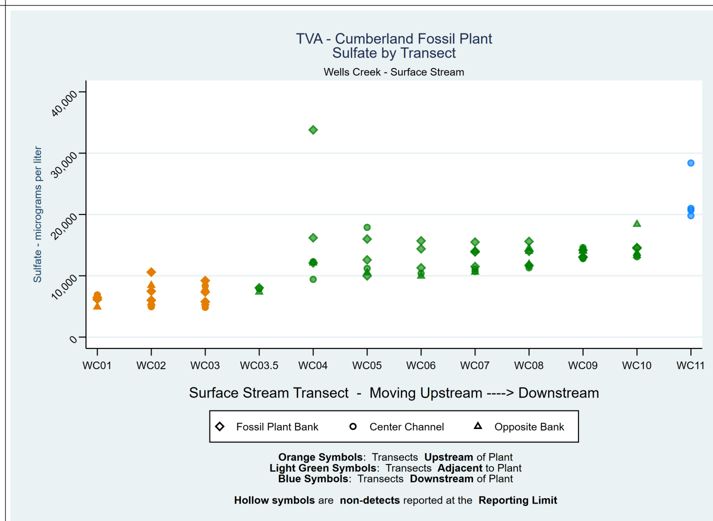




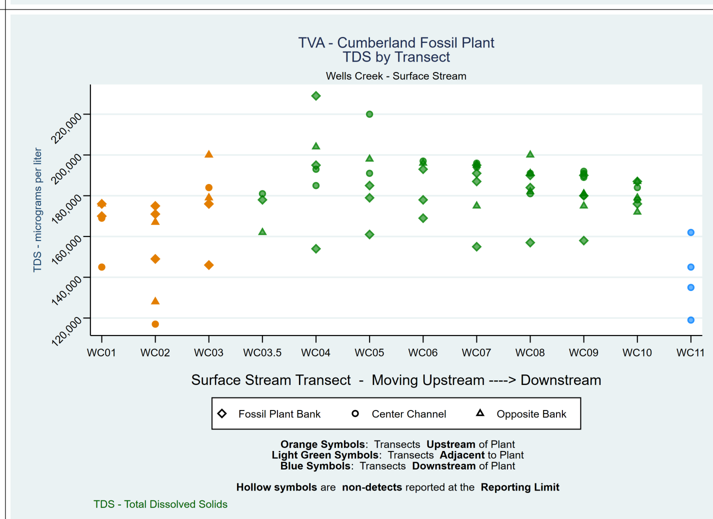
Place-holder for pH Field

Place-holder for pH Field

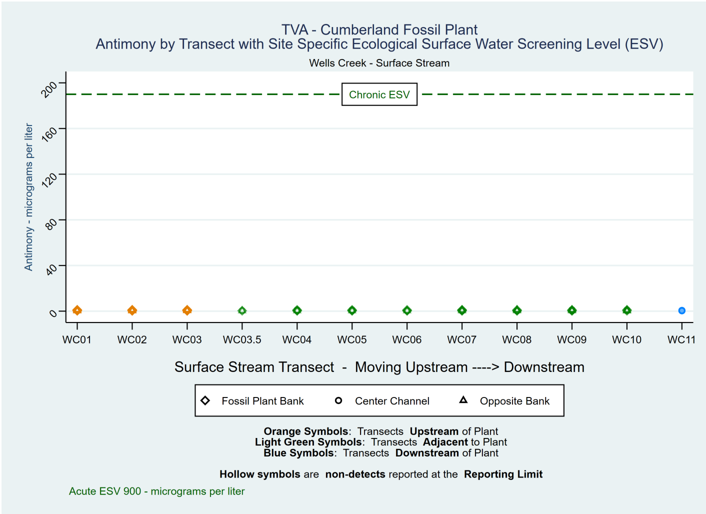
Acute or Chronic ESVs have not been established for sulfate

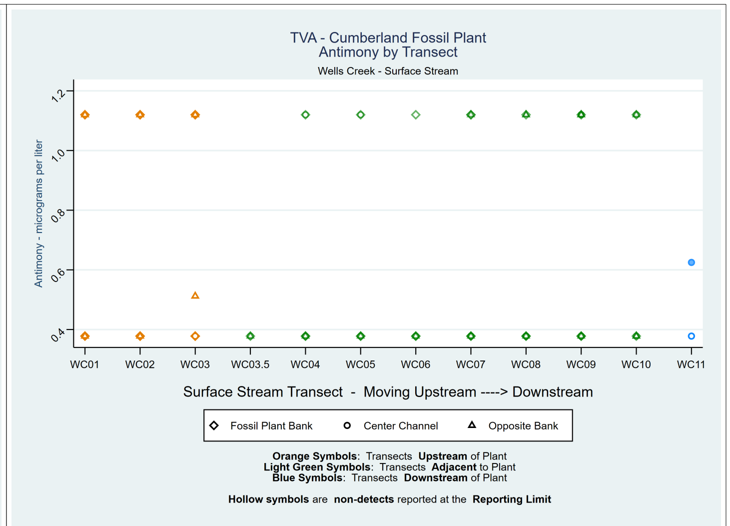


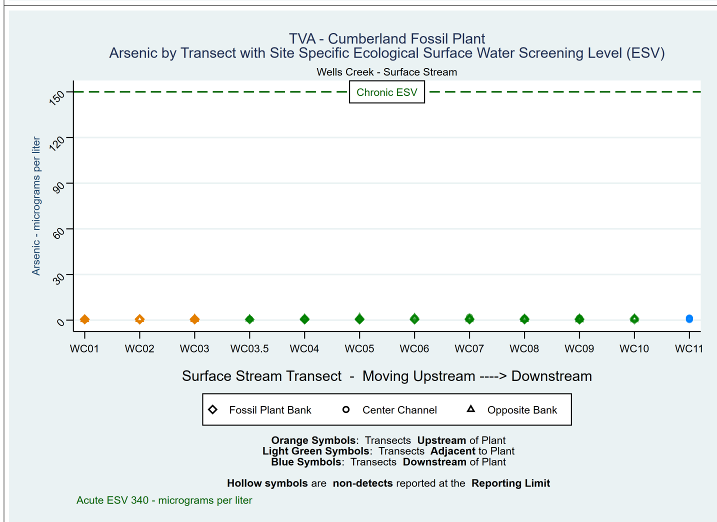
Acute or Chronic ESVs have not been established for total dissolved solids (TDS)

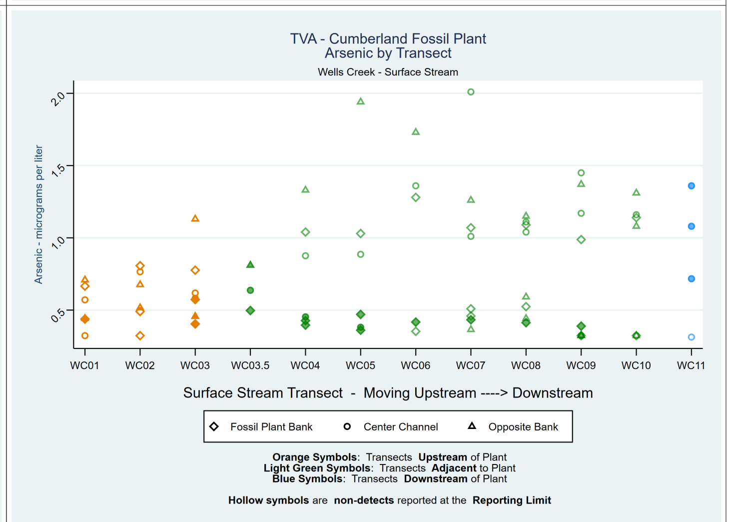


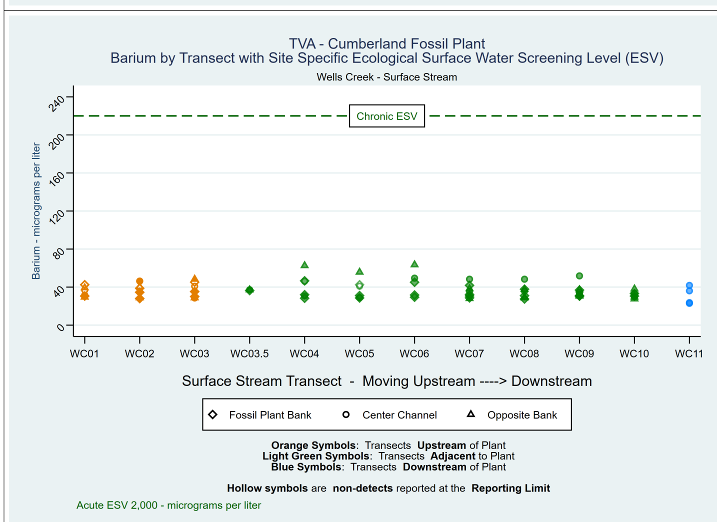
Transect Plots
Wells Creek - CCR Rule Appendix IV Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

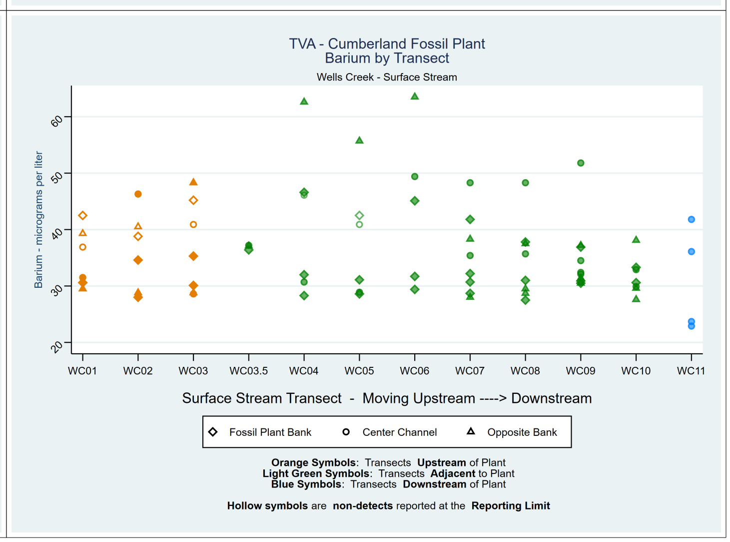


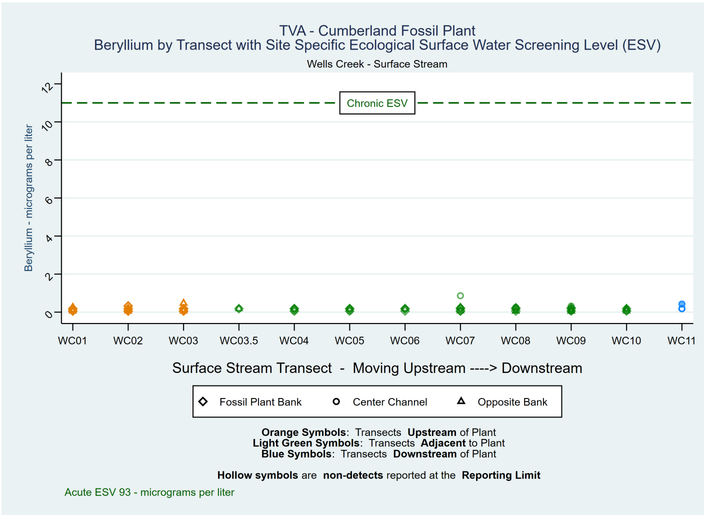


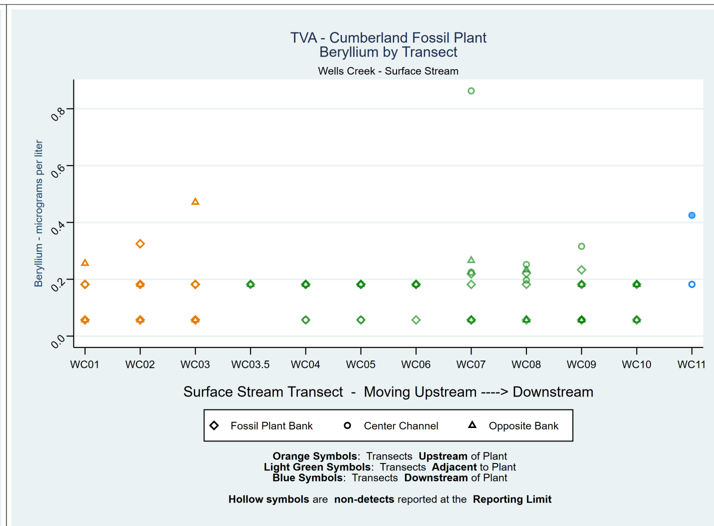


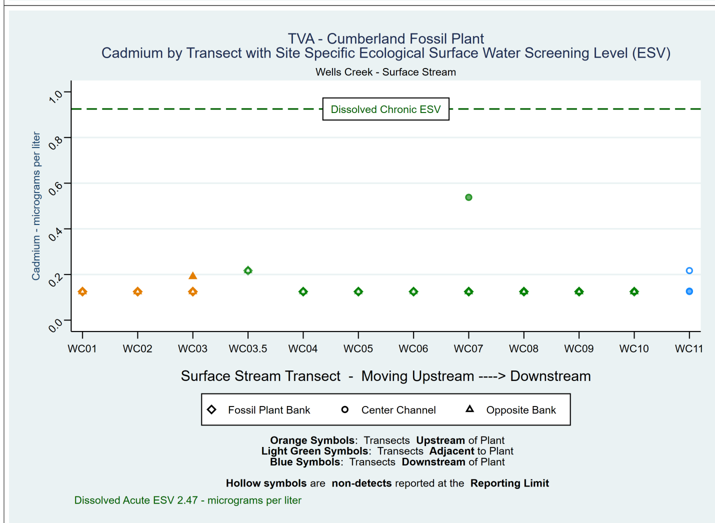


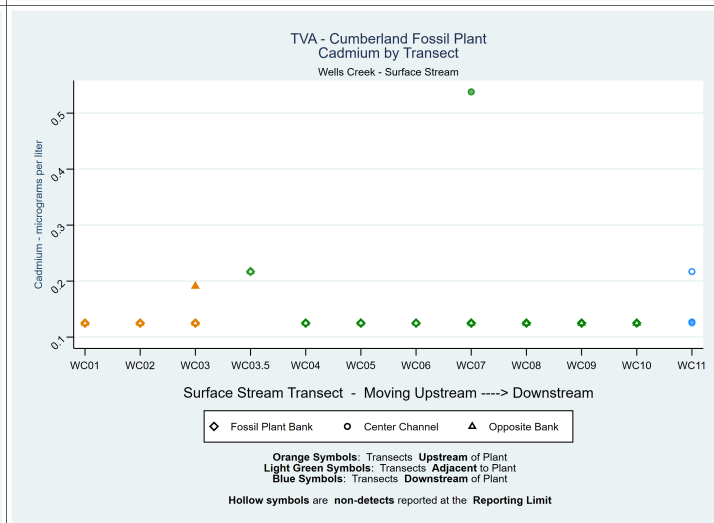


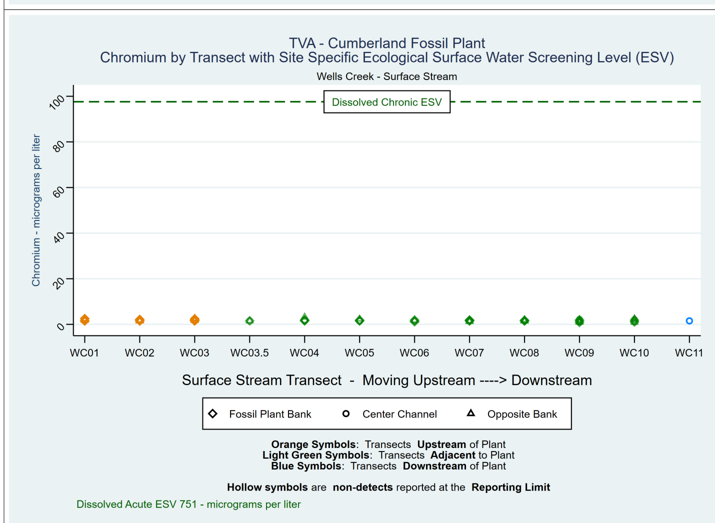


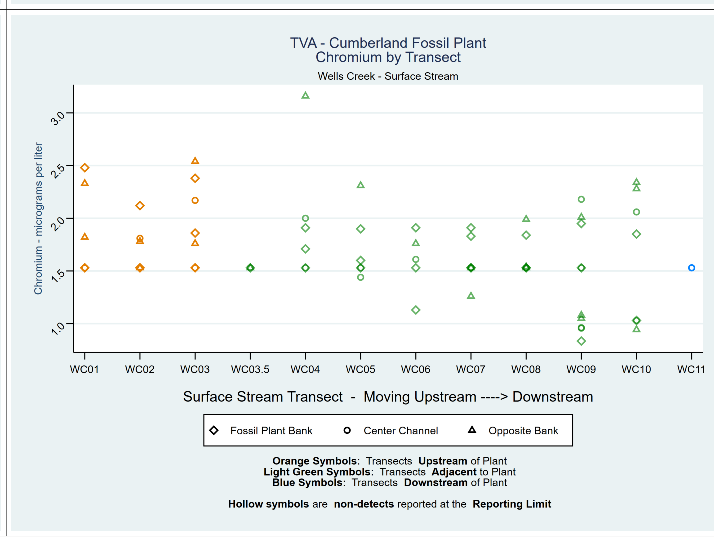

TVA - Cumberland Fossil Plant
Beryllium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Beryllium - micrograms per liter
0
2
4
6
8
10
12
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 93 - micrograms per liter

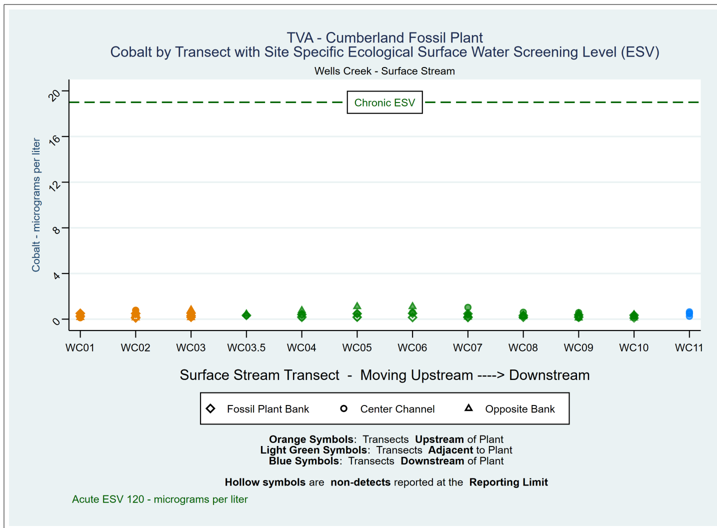

TVA - Cumberland Fossil Plant
Beryllium by Transect
Wells Creek - Surface Stream
Beryllium - micrograms per liter
0.0
0.2
0.4
0.6
0.8
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

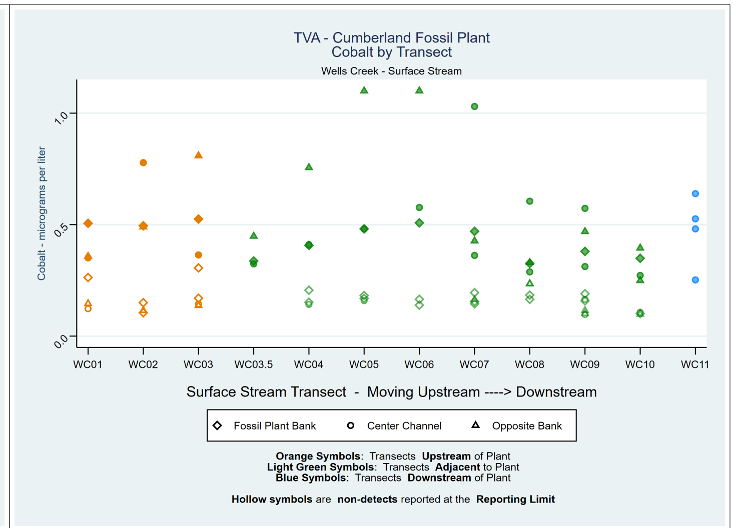

TVA - Cumberland Fossil Plant
Cadmium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Dissolved Chronic ESV
Cadmium - micrograms per liter
0.0
0.2
0.4
0.6
0.8
1.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 2.47 - micrograms per liter

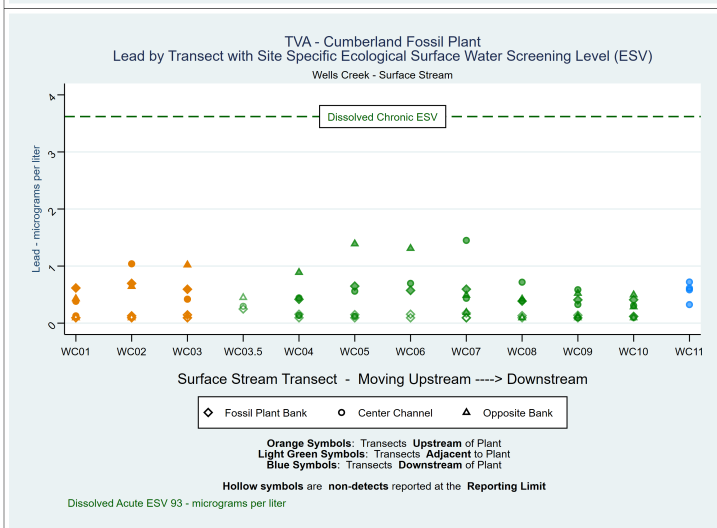

TVA - Cumberland Fossil Plant
Cadmium by Transect
Wells Creek - Surface Stream
Cadmium - micrograms per liter
0.1
0.2
0.3
0.4
0.5
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

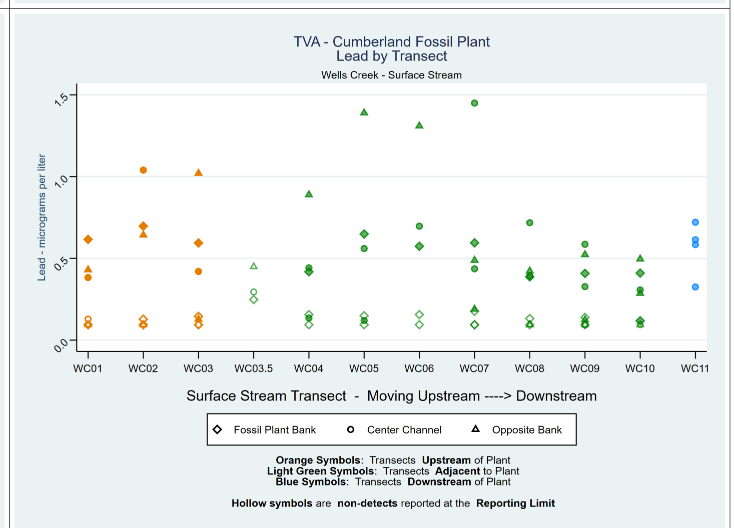

TVA - Cumberland Fossil Plant
Chromium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Dissolved Chronic ESV
Chromium - micrograms per liter
0
20
40
60
80
100
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 751 - micrograms per liter

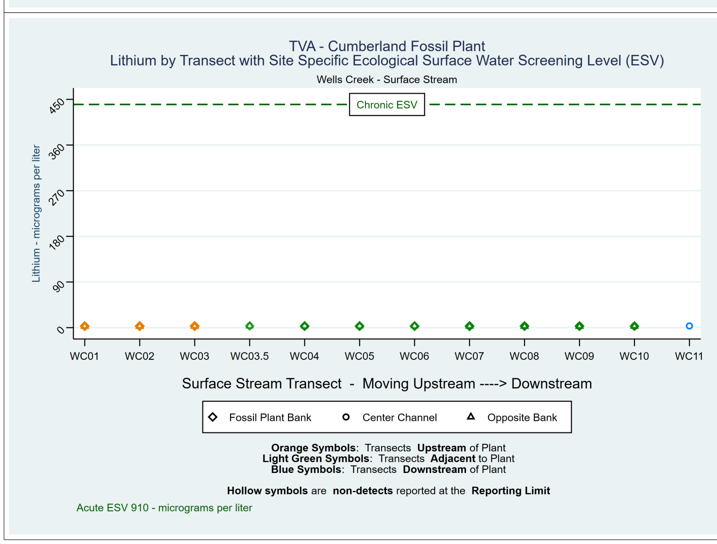

TVA - Cumberland Fossil Plant
Chromium by Transect
Wells Creek - Surface Stream
Chromium - micrograms per liter
1.0
1.5
2.0
2.5
3.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

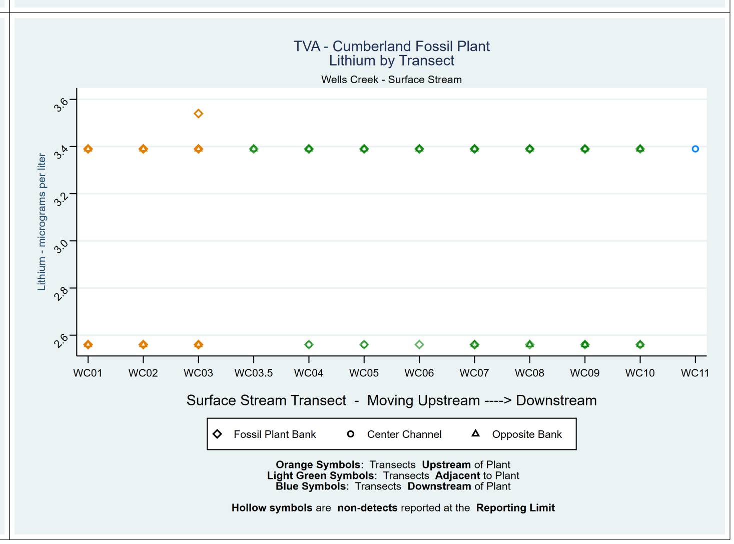

TVA - Cumberland Fossil Plant
Cobalt by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Cobalt - micrograms per liter
0
4
8
12
16
20
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 120 - micrograms per liter

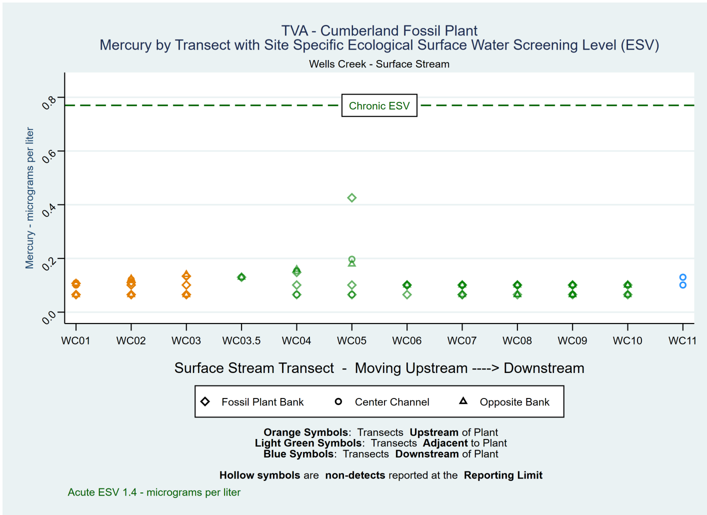

TVA - Cumberland Fossil Plant
Cobalt by Transect
Wells Creek - Surface Stream
Cobalt - micrograms per liter
0.0
0.5
1.0
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

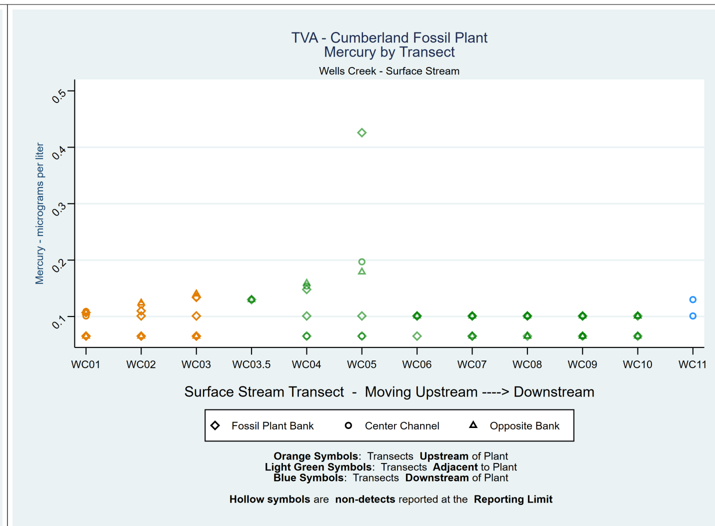

TVA - Cumberland Fossil Plant
Lead by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Dissolved Chronic ESV
Lead - micrograms per liter
0
1
2
3
4
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 93 - micrograms per liter

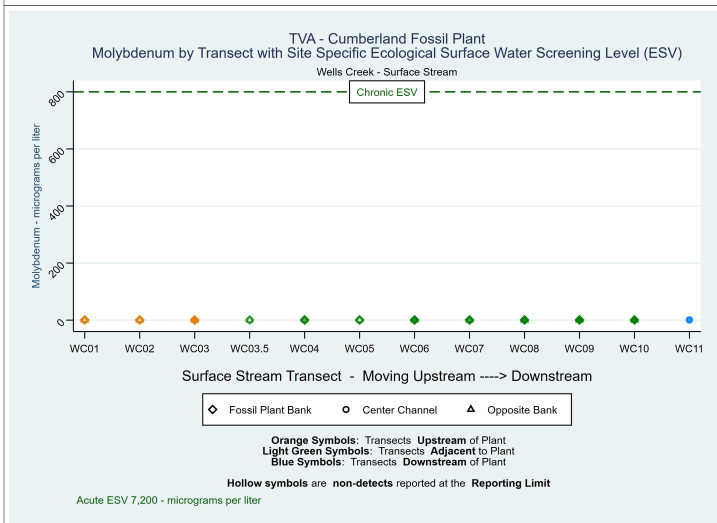

TVA - Cumberland Fossil Plant
Lead by Transect
Wells Creek - Surface Stream
Lead - micrograms per liter
0.0
0.5
1.0
1.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

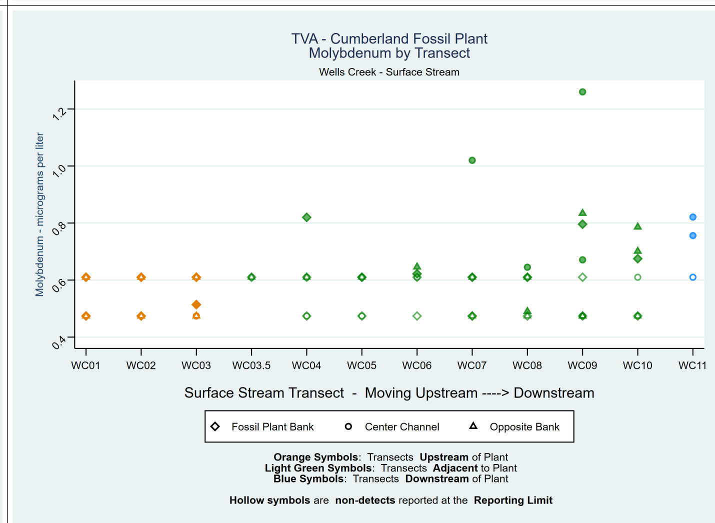

TVA - Cumberland Fossil Plant
Lithium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Lithium - micrograms per liter
0
90
180
270
360
450
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 910 - micrograms per liter

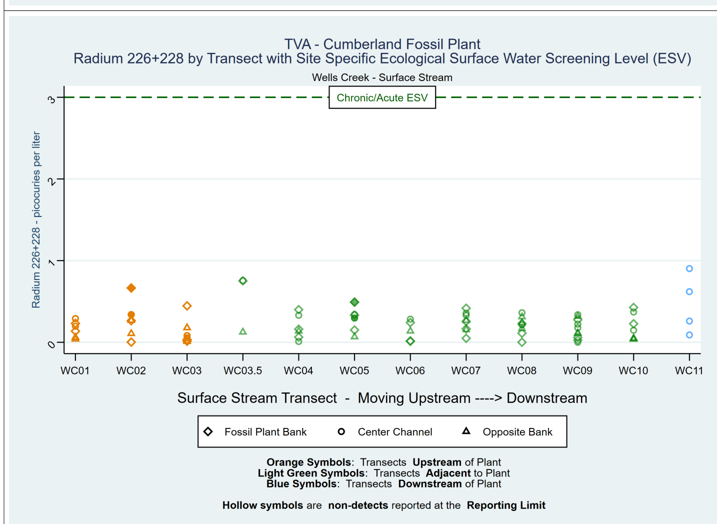

TVA - Cumberland Fossil Plant
Lithium by Transect
Wells Creek - Surface Stream
Lithium - micrograms per liter
2.6
2.8
3.0
3.2
3.4
3.6
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

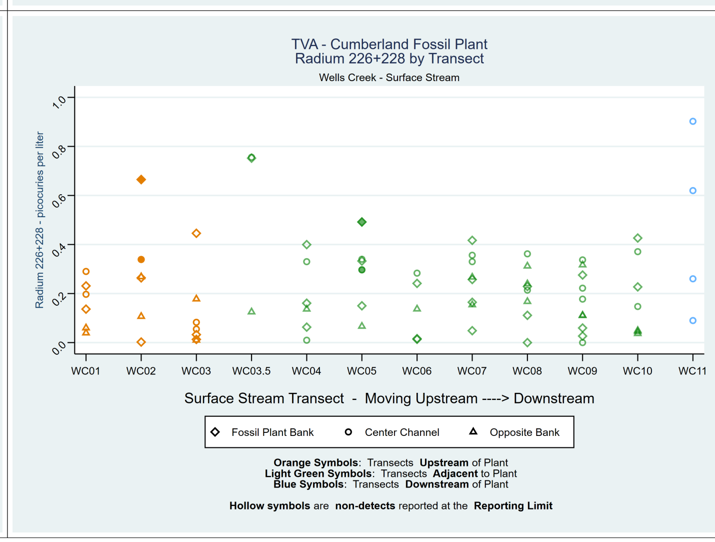

TVA - Cumberland Fossil Plant
Mercury by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Mercury - micrograms per liter
0.0
0.2
0.4
0.6
0.8
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 1.4 - micrograms per liter

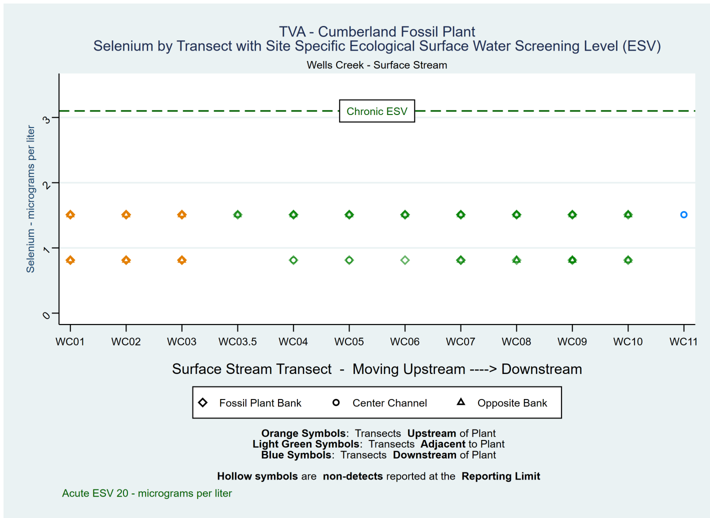

TVA - Cumberland Fossil Plant
Mercury by Transect
Wells Creek - Surface Stream
Mercury - micrograms per liter
0.1
0.2
0.3
0.4
0.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

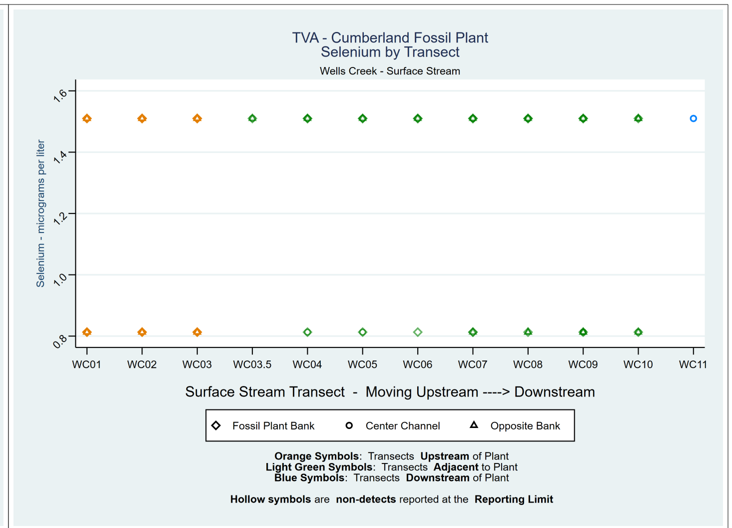

TVA - Cumberland Fossil Plant
Molybdenum by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Molybdenum - micrograms per liter
0
200
400
600
800
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 7,200 - micrograms per liter

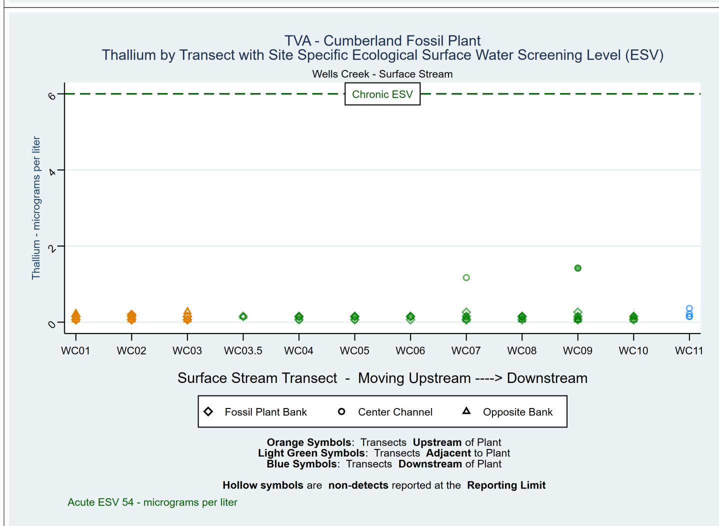

TVA - Cumberland Fossil Plant
Molybdenum by Transect
Wells Creek - Surface Stream
Molybdenum - micrograms per liter
0.4
0.6
0.8
1.0
1.2
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

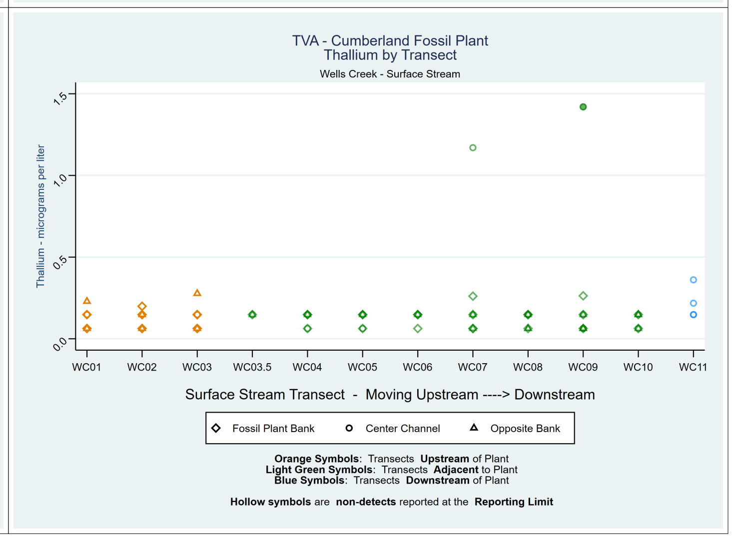

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic/Acute ESV
Radium 226+228 - picocuries per liter
0
1
2
3
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Radium 226+228 by Transect
Wells Creek - Surface Stream
Radium 226+228 - picocuries per liter
0.0
0.2
0.4
0.6
0.8
1.0
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Selenium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Selenium - micrograms per liter
0
1
2
3
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 20 - micrograms per liter


TVA - Cumberland Fossil Plant
Selenium by Transect
Wells Creek - Surface Stream
Selenium - micrograms per liter
0.8
1.0
1.2
1.4
1.6
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Thallium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Chronic ESV
Thallium - micrograms per liter
0
2
4
6
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 54 - micrograms per liter

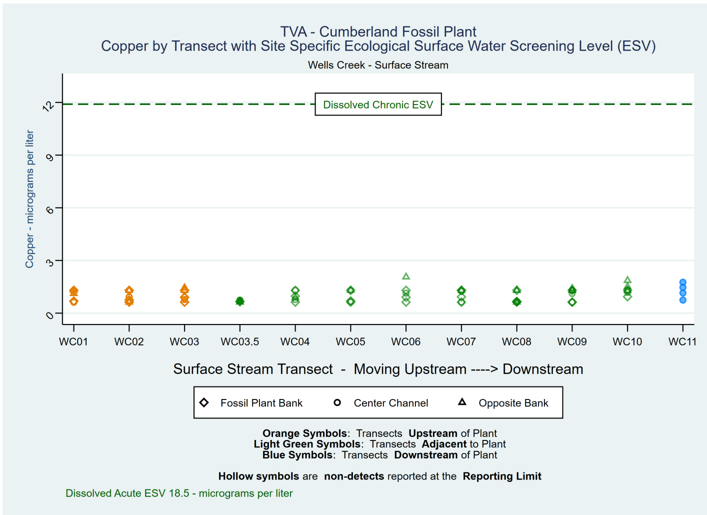

TVA - Cumberland Fossil Plant
Thallium by Transect
Wells Creek - Surface Stream
Thallium - micrograms per liter
0.0
0.5
1.0
1.5
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

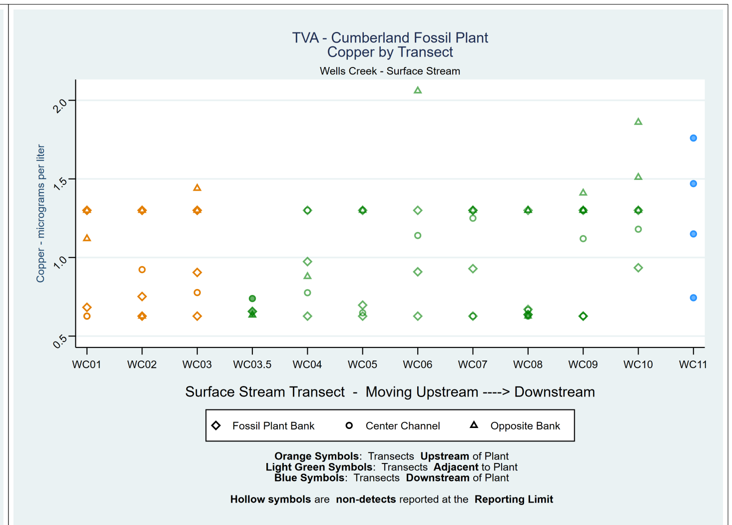
Transect Plots

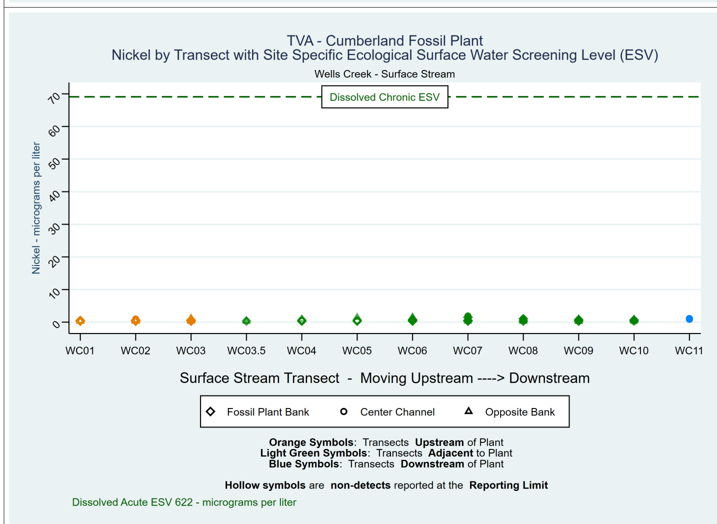
Wells Creek - TDEC Appendix I Parameters

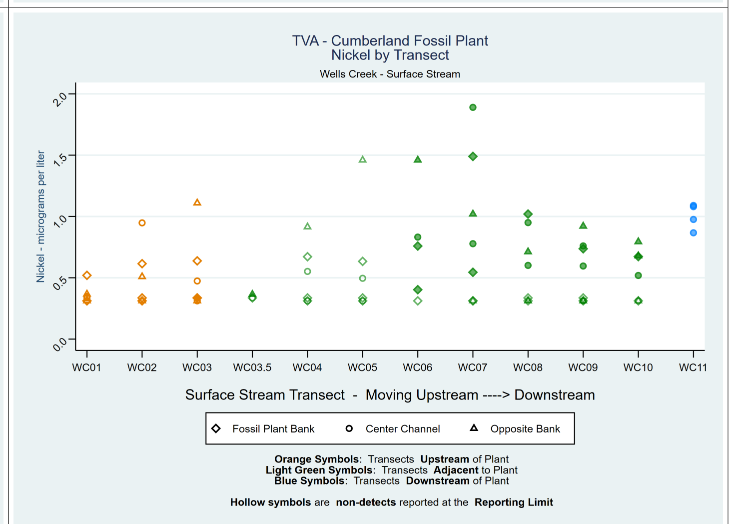
Surface Stream Investigation

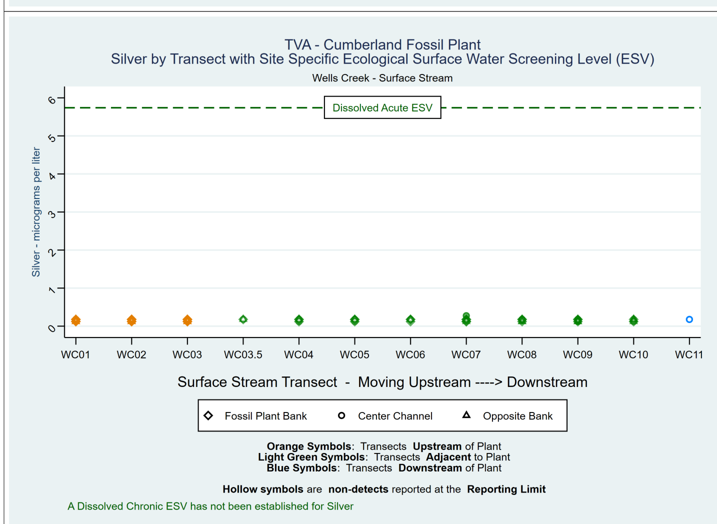
Cumberland Fossil Plant, Cumberland City, Tennessee

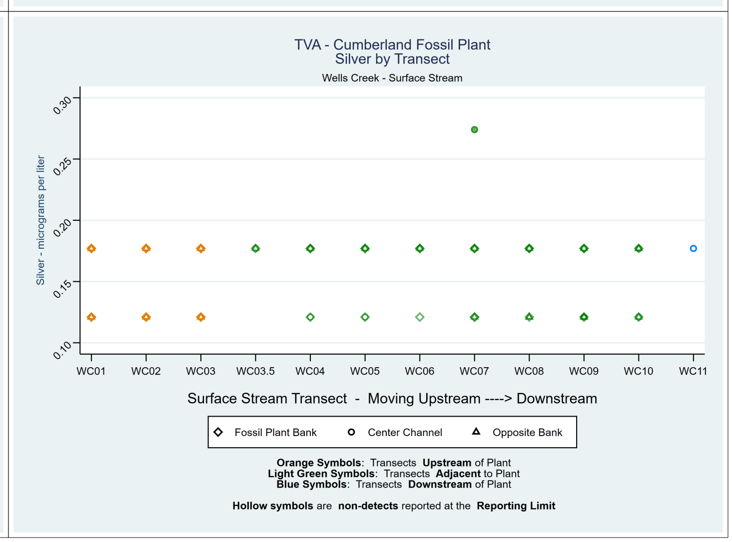


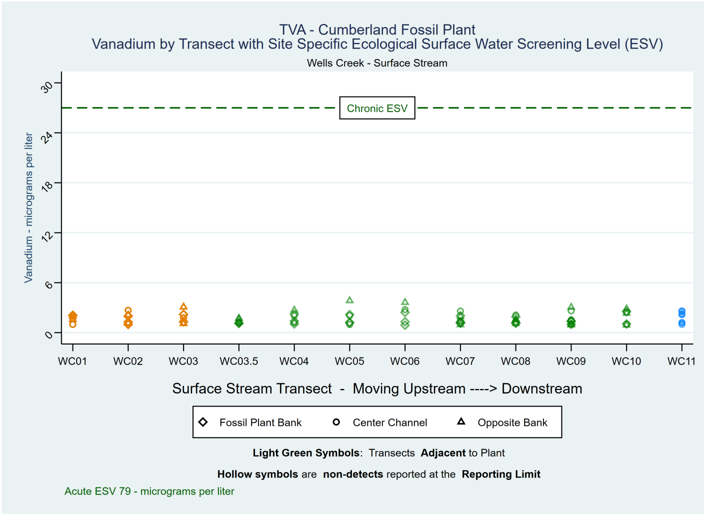


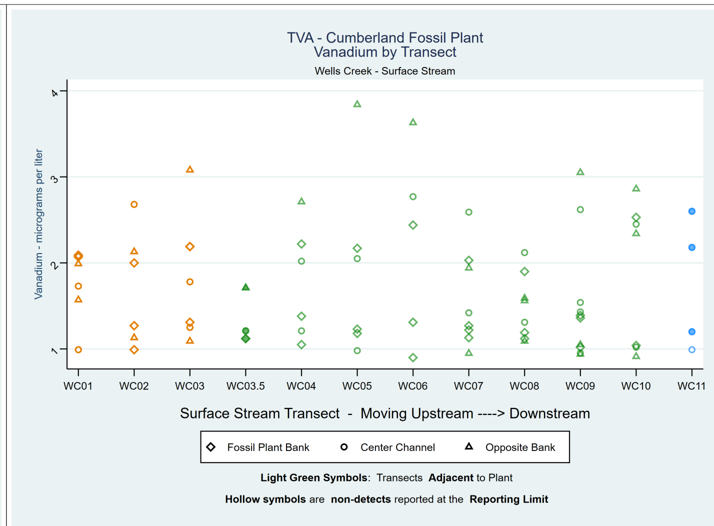


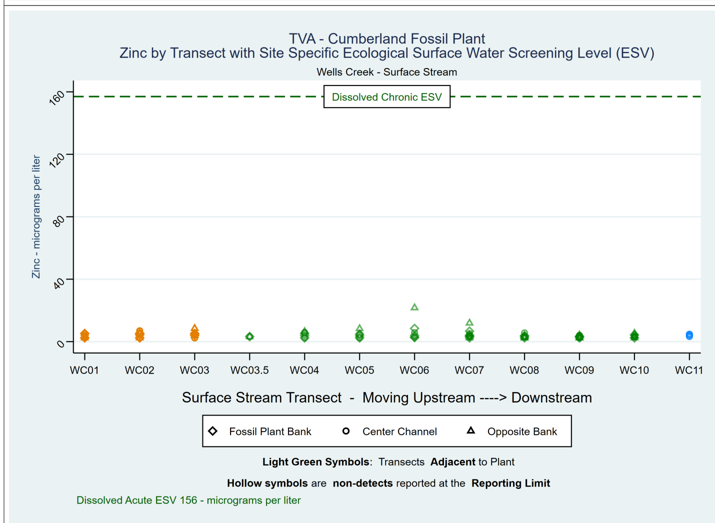


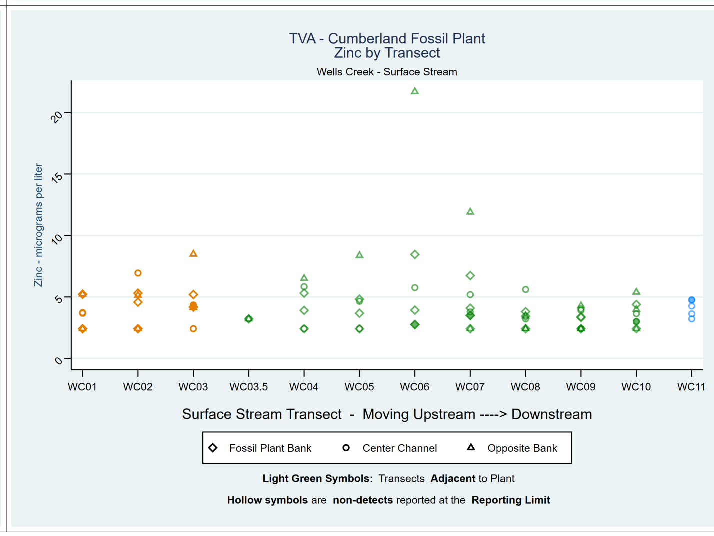





TVA - Cumberland Fossil Plant
Vanadium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Vanadium - micrograms per liter
0
6
12
18
24
30
Chronic ESV
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 79 - micrograms per liter


TVA - Cumberland Fossil Plant
Vanadium by Transect
Wells Creek - Surface Stream
Vanadium - micrograms per liter
1
2
3
4
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Zinc by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Wells Creek - Surface Stream
Zinc - micrograms per liter
0
40
80
120
160
Dissolved Chronic ESV
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 156 - micrograms per liter

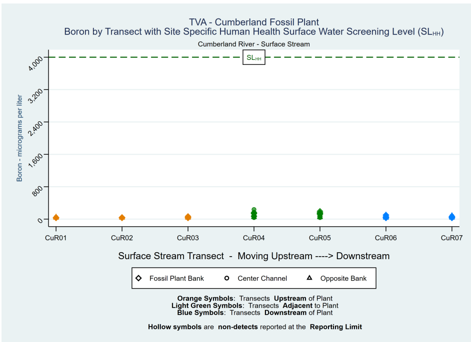

TVA - Cumberland Fossil Plant
Zinc by Transect
Wells Creek - Surface Stream
Zinc - micrograms per liter
0
5
10
15
20
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
WC11
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

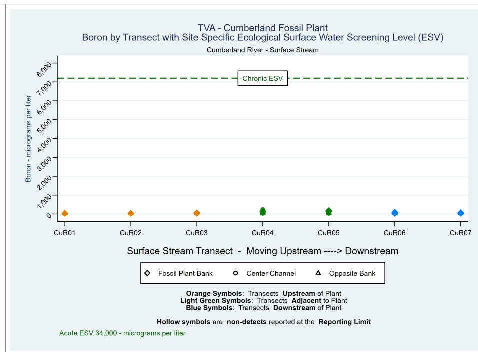
Transect Plots

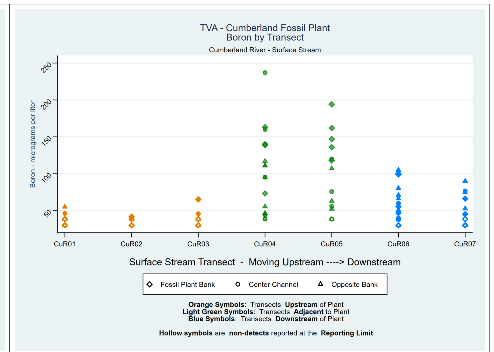
Cumberland River - CCR Rule Appendix III Parameters

Surface Stream Investigation

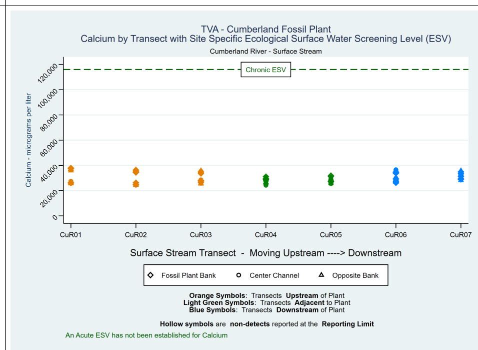
Cumberland Fossil Plant, Cumberland City, Tennessee

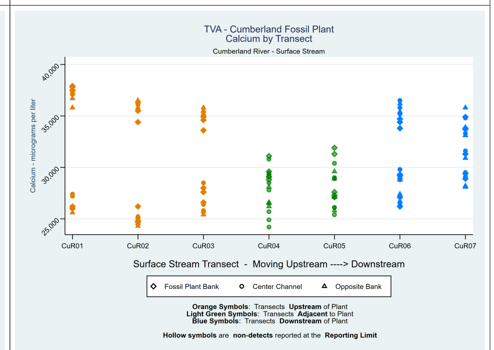


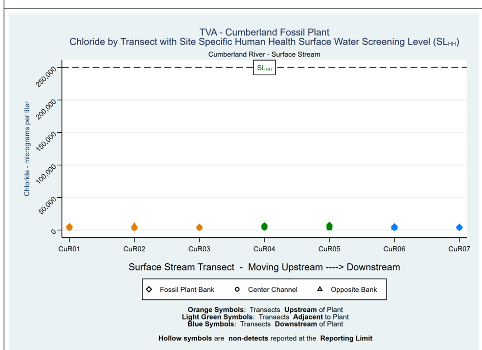


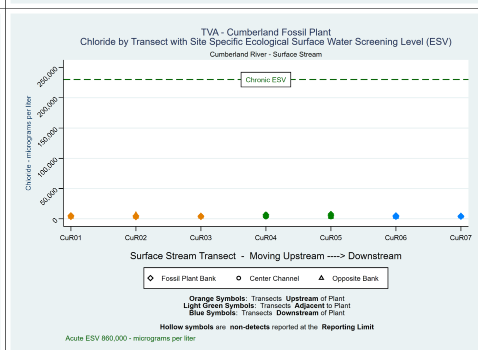


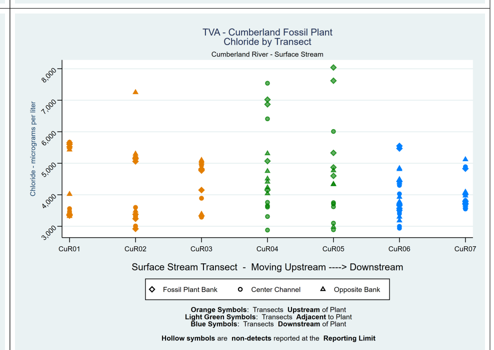
A human health screening level has not been established for calcium

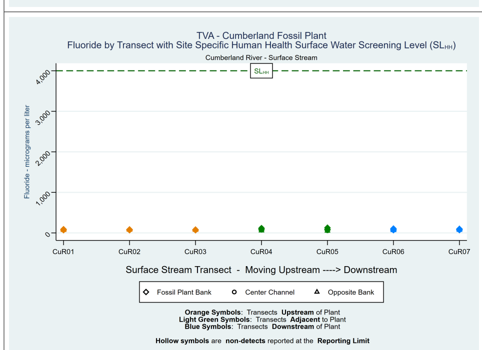


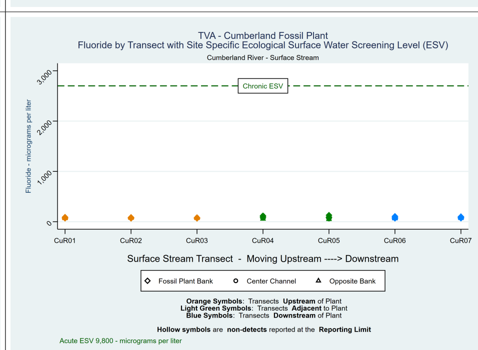


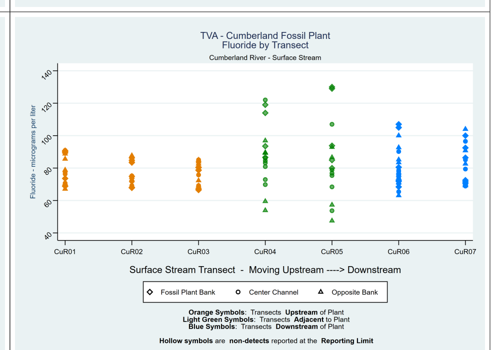












Place-holder for pH Field

Place-holder for pH Field

Place-holder for pH Field

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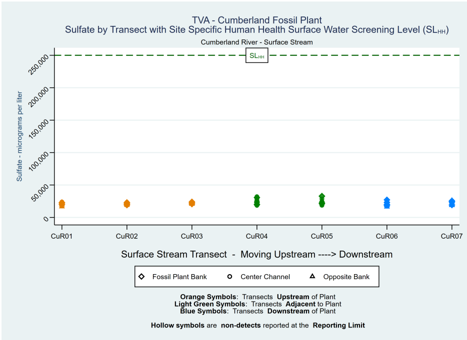
<td>
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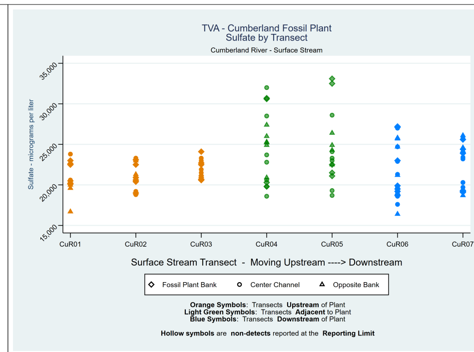
<td>Acute or Chronic ESVs have not been established for sulfate</td>
<td>
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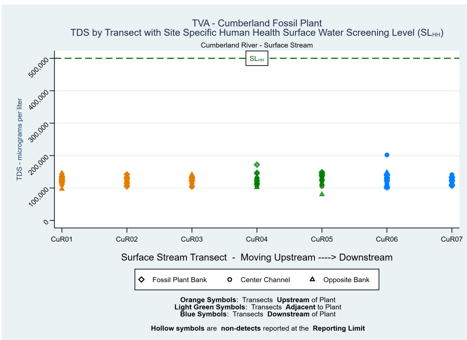
<td>
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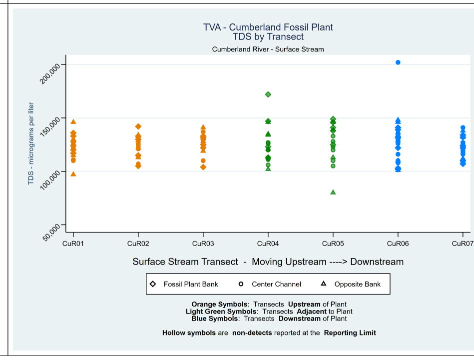
<td>Acute or Chronic ESVs have not been established for total dissolved solids (TDS)</td>
<td>
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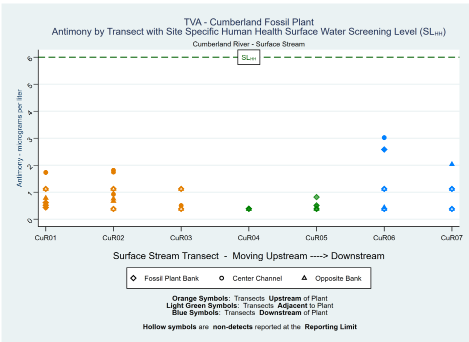
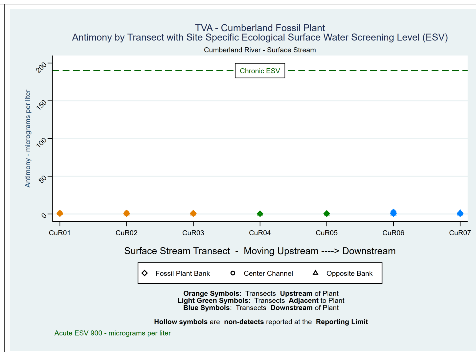
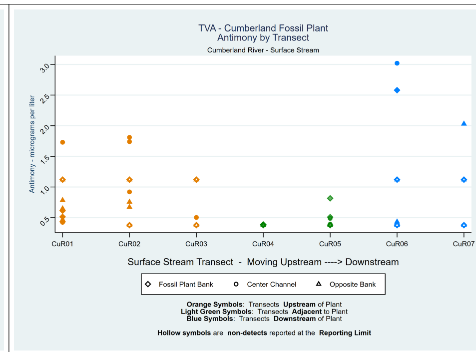
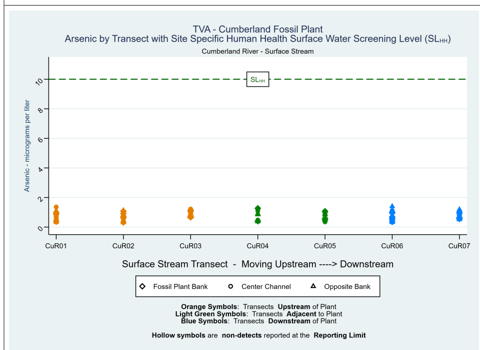
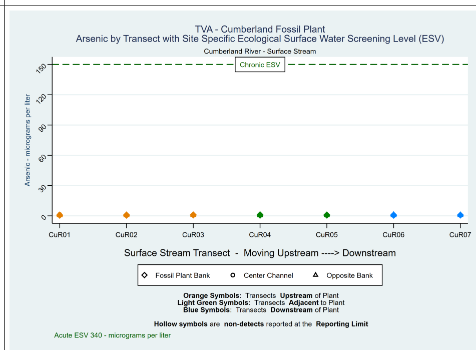
Transect Plots
Cumberland River - CCR Rule Appendix IV Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

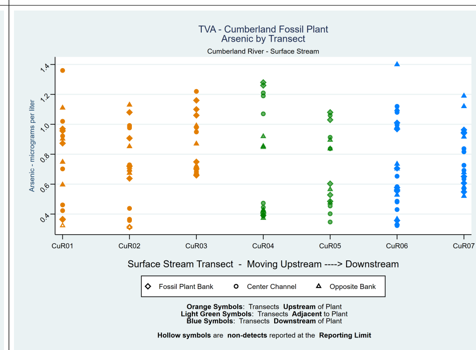


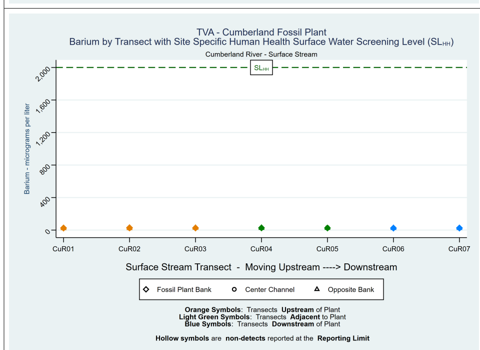


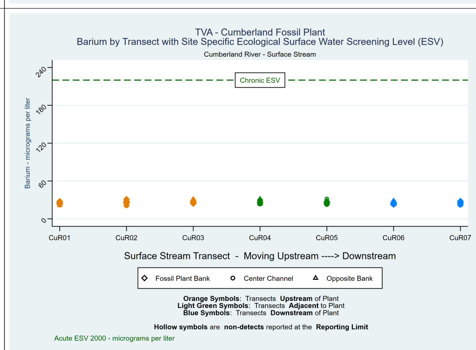


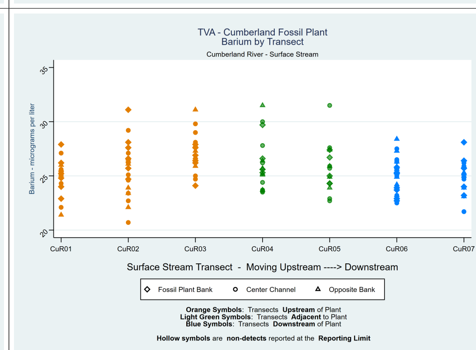


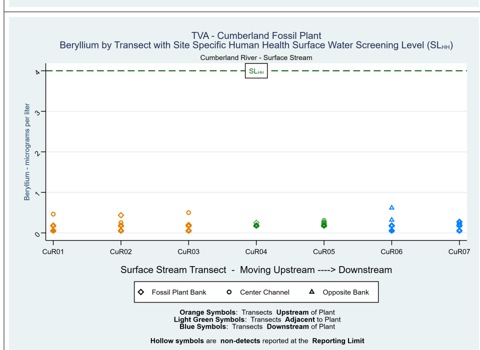


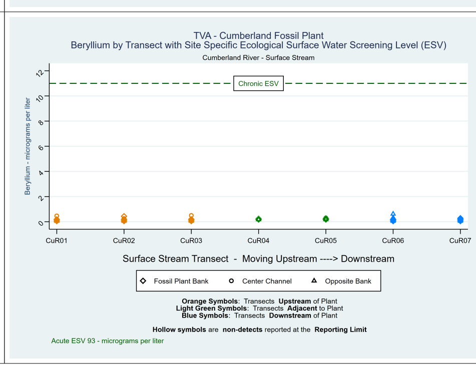


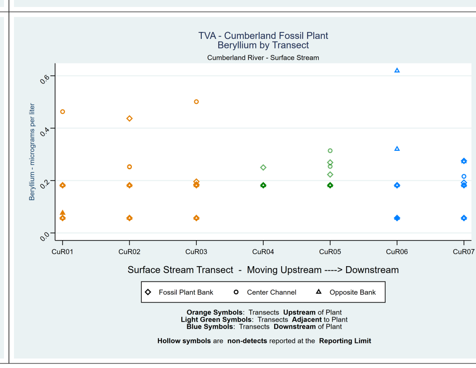




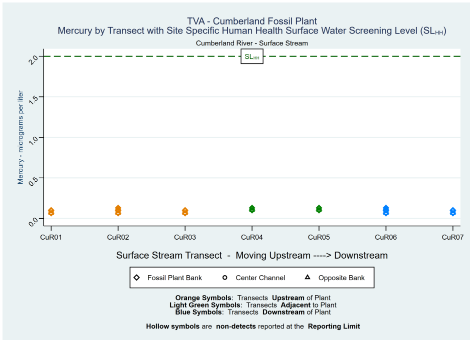


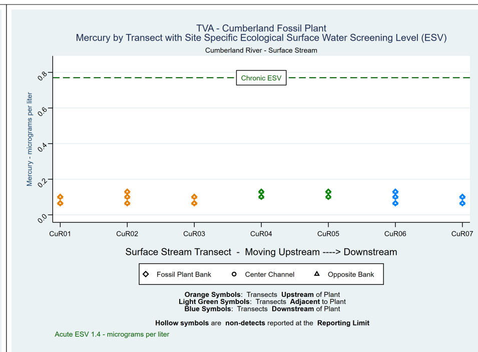


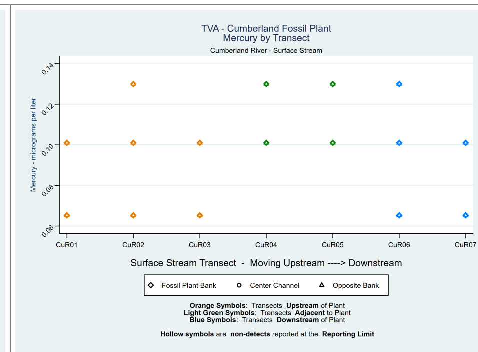


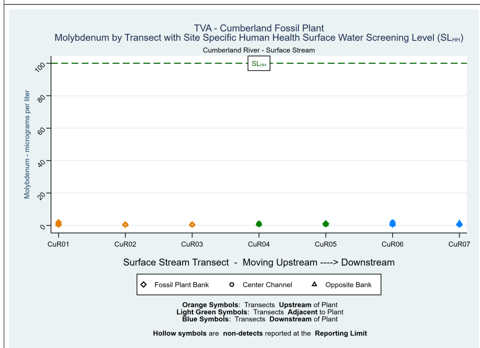


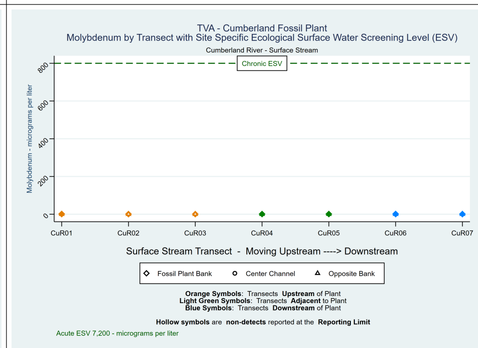
TVA - Cumberland Fossil Plant
Cadmium by Transect with Site Specific Human Health Surface Water Screening Level (SL$_{HH}$)
Cumberland River - Surface Stream
SL$_{HH}$
Cadmium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Cadmium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Dissolved Chronic ESV
Cadmium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 1.80 - micrograms per liter
TVA - Cumberland Fossil Plant
Cadmium by Transect
Cumberland River - Surface Stream
Cadmium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Chromium by Transect with Site Specific Human Health Surface Water Screening Level (SL$_{HH}$)
Cumberland River - Surface Stream
SL$_{HH}$
Chromium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Chromium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Dissolved Chronic ESV
Chromium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 570 - micrograms per liter
TVA - Cumberland Fossil Plant
Chromium by Transect
Cumberland River - Surface Stream
Chromium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Cobalt by Transect with Site Specific Human Health Surface Water Screening Level (SL$_{HH}$)
Cumberland River - Surface Stream
SL$_{HH}$
Cobalt - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Cobalt by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Cobalt - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 120 - micrograms per liter
TVA - Cumberland Fossil Plant
Cobalt by Transect
Cumberland River - Surface Stream
Cobalt - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Lead by Transect with Site Specific Human Health Surface Water Screening Level (SL$_{HH}$)
Cumberland River - Surface Stream
SL$_{HH}$
Lead - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Lead by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Dissolved Chronic ESV
Lead - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 64.6 - micrograms per liter
TVA - Cumberland Fossil Plant
Lead by Transect
Cumberland River - Surface Stream
Lead - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Lithium by Transect with Site Specific Human Health Surface Water Screening Level (SL$_{HH}$)
Cumberland River - Surface Stream
SL$_{HH}$
Lithium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
TVA - Cumberland Fossil Plant
Lithium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Lithium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 910 - micrograms per liter
TVA - Cumberland Fossil Plant
Lithium by Transect
Cumberland River - Surface Stream
Lithium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

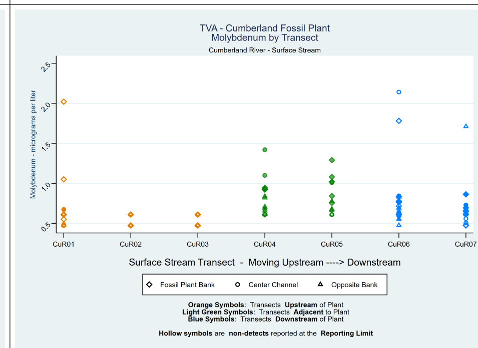

TVA - Cumberland Fossil Plant
Mercury by Transect with Site Specific Human Health Surface Water Screening Level (SL_HH)
Cumberland River - Surface Stream
SL_HH
Mercury - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

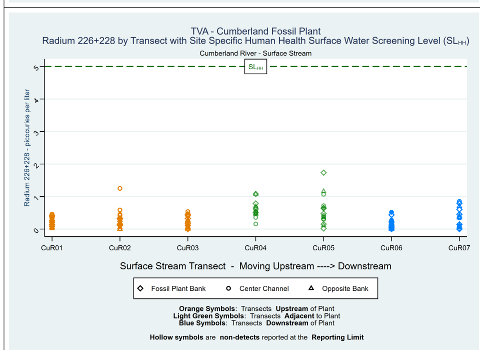

TVA - Cumberland Fossil Plant
Mercury by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Mercury - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 1.4 - micrograms per liter

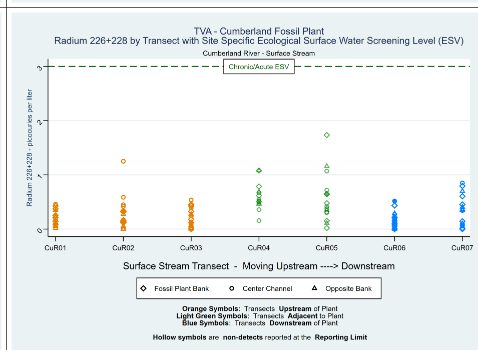

TVA - Cumberland Fossil Plant
Mercury by Transect
Cumberland River - Surface Stream
Mercury - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

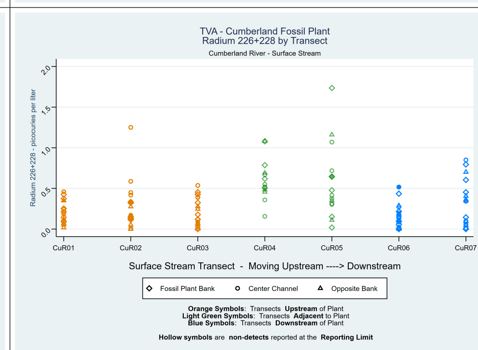

TVA - Cumberland Fossil Plant
Molybdenum by Transect with Site Specific Human Health Surface Water Screening Level (SL_HH)
Cumberland River - Surface Stream
SL_HH
Molybdenum - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

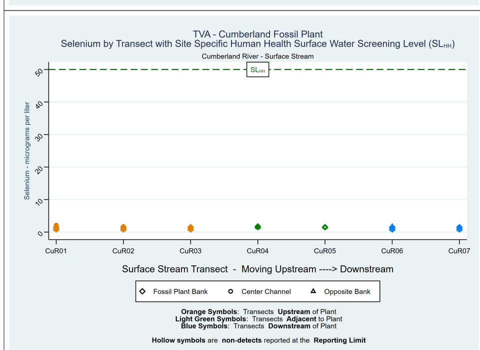

TVA - Cumberland Fossil Plant
Molybdenum by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Molybdenum - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 7,200 - micrograms per liter

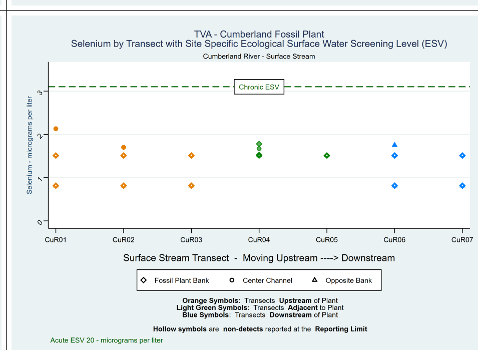

TVA - Cumberland Fossil Plant
Molybdenum by Transect
Cumberland River - Surface Stream
Molybdenum - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

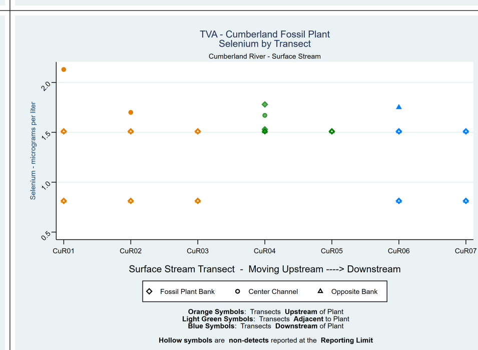

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect with Site Specific Human Health Surface Water Screening Level (SL_HH)
Cumberland River - Surface Stream
SL_HH
Radium 226+228 - picocuries per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

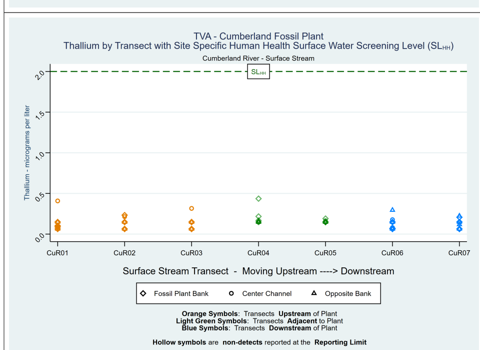

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic/Acute ESV
Radium 226+228 - picocuries per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

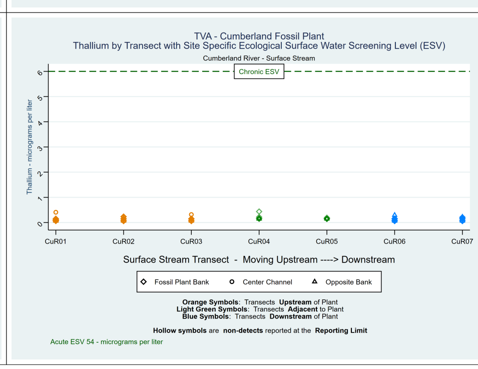

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect
Cumberland River - Surface Stream
Radium 226+228 - picocuries per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

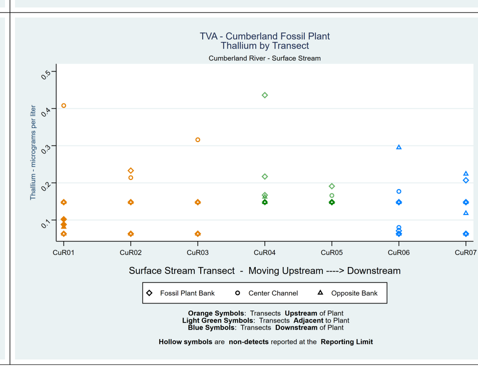

TVA - Cumberland Fossil Plant
Selenium by Transect with Site Specific Human Health Surface Water Screening Level (SL_HH)
Cumberland River - Surface Stream
SL_HH
Selenium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Selenium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Selenium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 20 - micrograms per liter


TVA - Cumberland Fossil Plant
Selenium by Transect
Cumberland River - Surface Stream
Selenium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Thallium by Transect with Site Specific Human Health Surface Water Screening Level (SL_HH)
Cumberland River - Surface Stream
SL_HH
Thallium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Thallium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Chronic ESV
Thallium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 54 - micrograms per liter

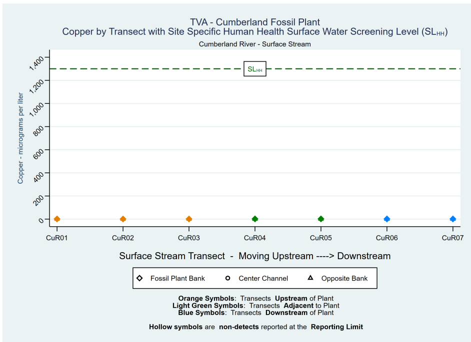

TVA - Cumberland Fossil Plant
Thallium by Transect
Cumberland River - Surface Stream
Thallium - micrograms per liter
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

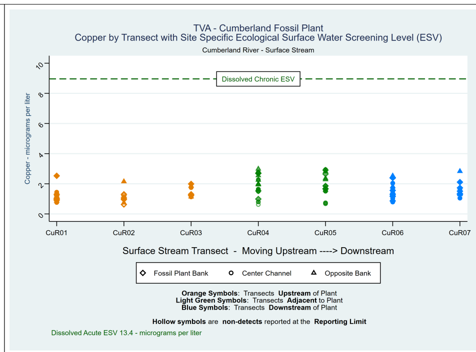
Transect Plots

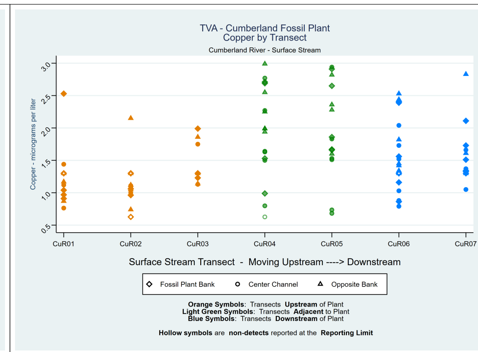
Cumberland River - TDEC Appendix I Parameters

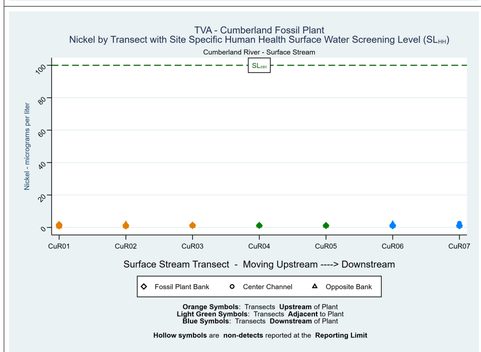
Surface Stream Investigation

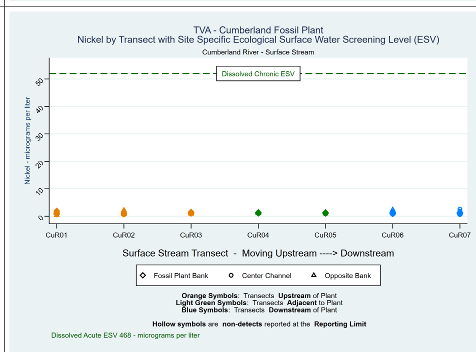
Cumberland Fossil Plant, Cumberland City, Tennessee

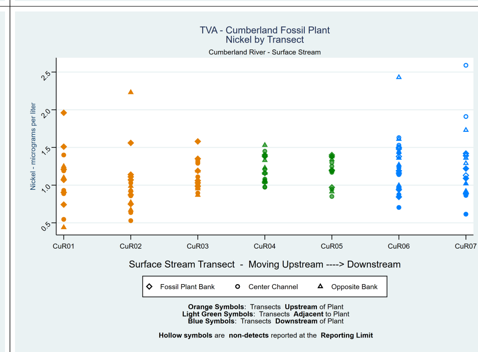


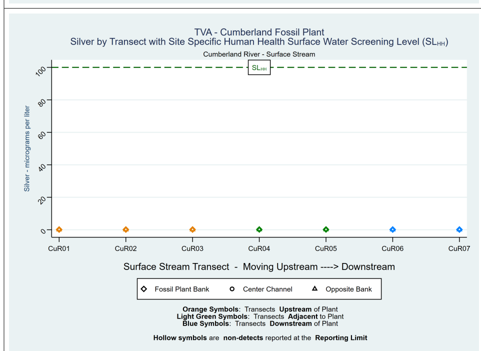


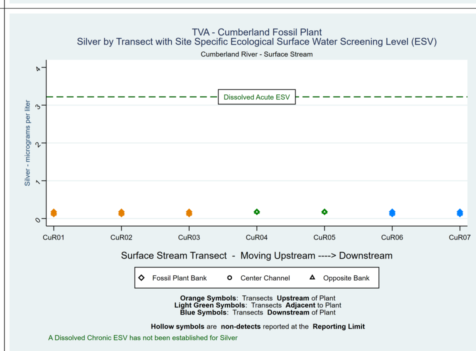


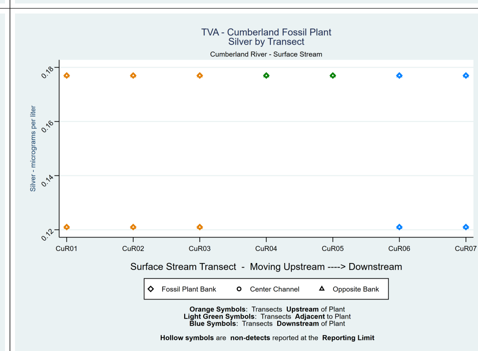


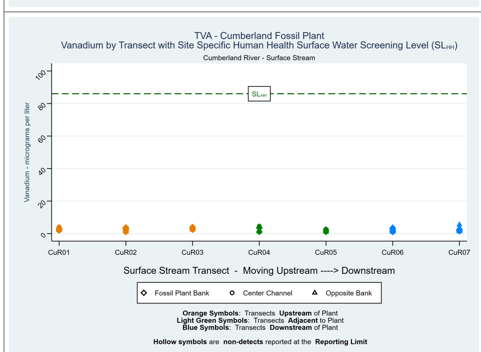


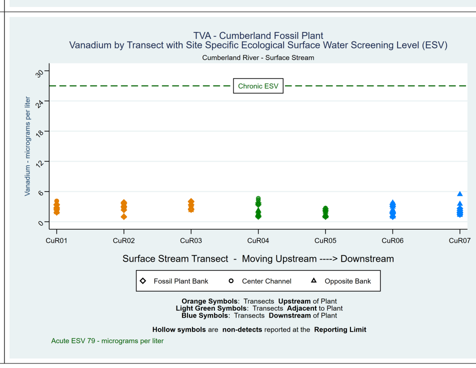


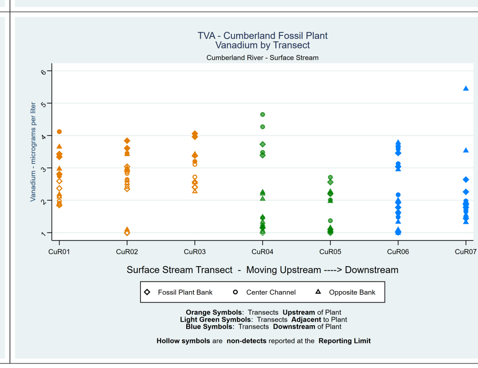


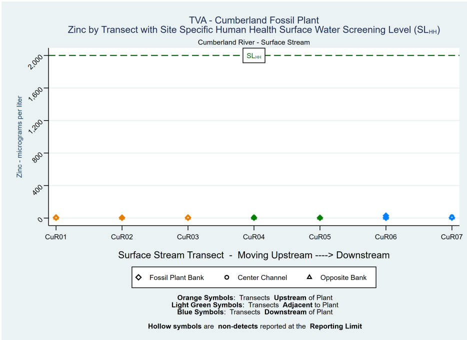


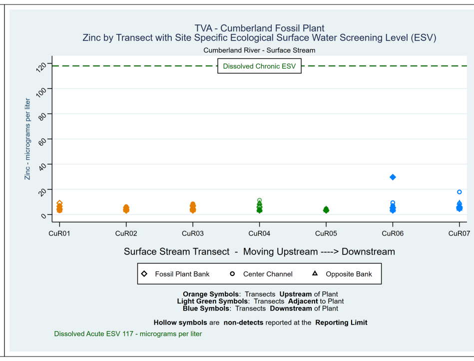


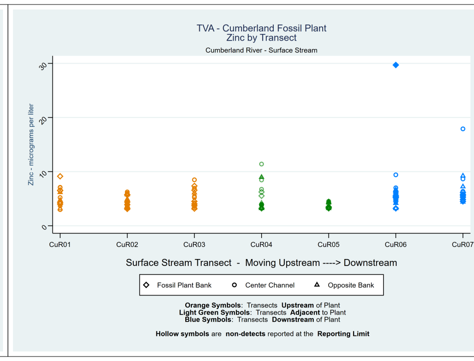




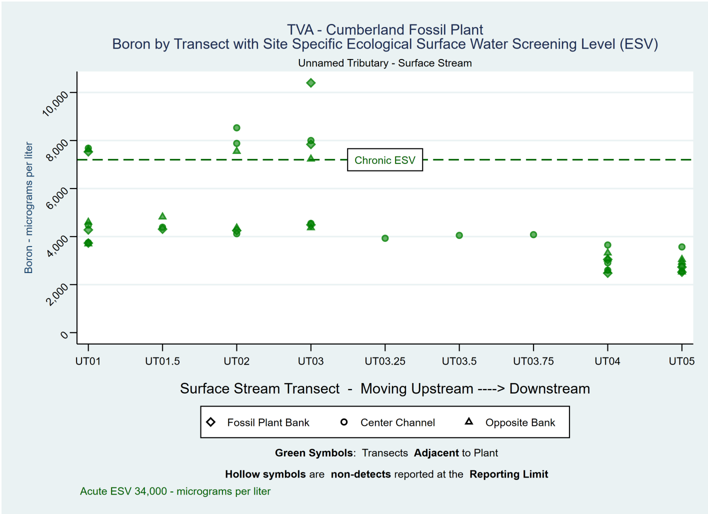


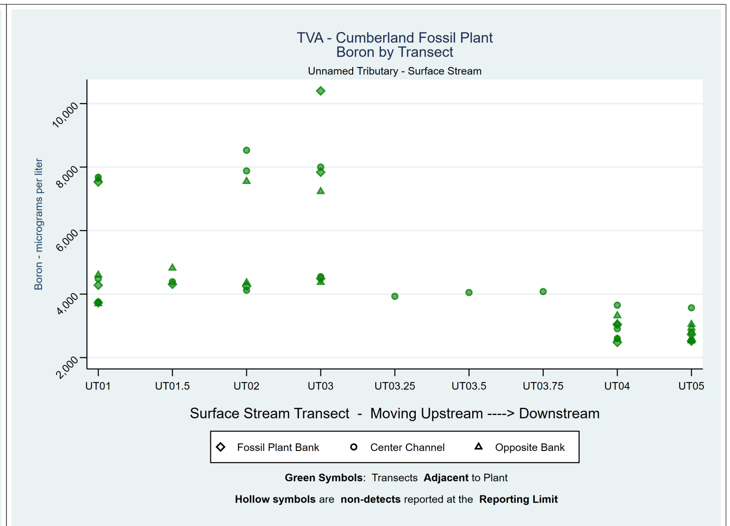

TVA - Cumberland Fossil Plant
Zinc by Transect with Site Specific Human Health Surface Water Screening Level (SL_{HH})
Cumberland River - Surface Stream
SL_{HH}
Zinc - micrograms per liter
0
400
800
1,200
1,600
2,000
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**

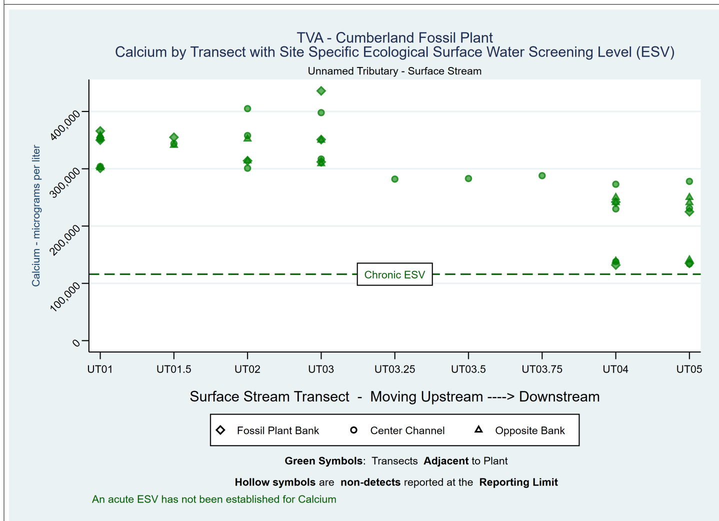

TVA - Cumberland Fossil Plant
Zinc by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Cumberland River - Surface Stream
Dissolved Chronic ESV
Zinc - micrograms per liter
0
20
40
60
80
100
120
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Dissolved Acute ESV 117 - micrograms per liter

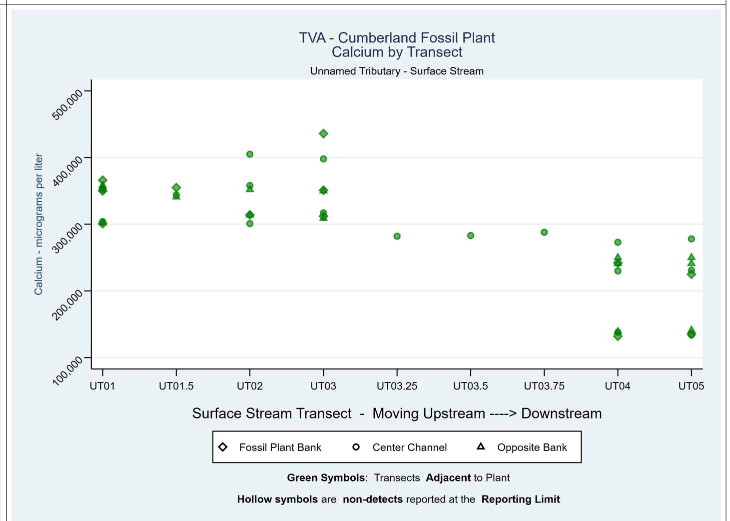

TVA - Cumberland Fossil Plant
Zinc by Transect
Cumberland River - Surface Stream
Zinc - micrograms per liter
0
10
20
30
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**

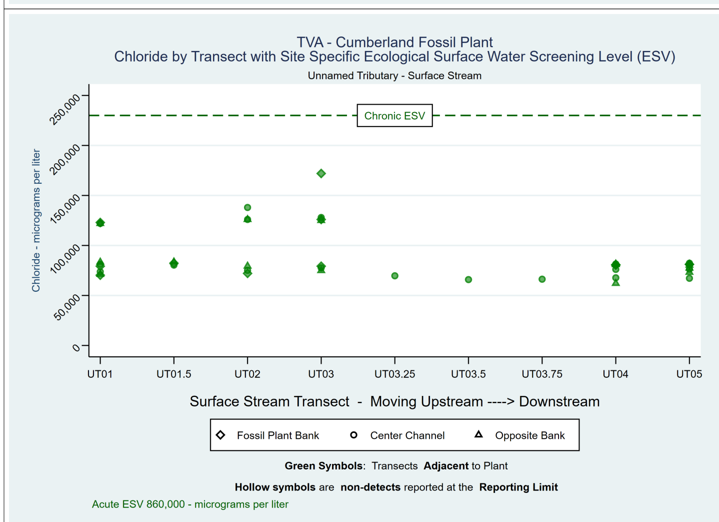
Transect Plots
Unnamed Tributary - CCR Rule Appendix III Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

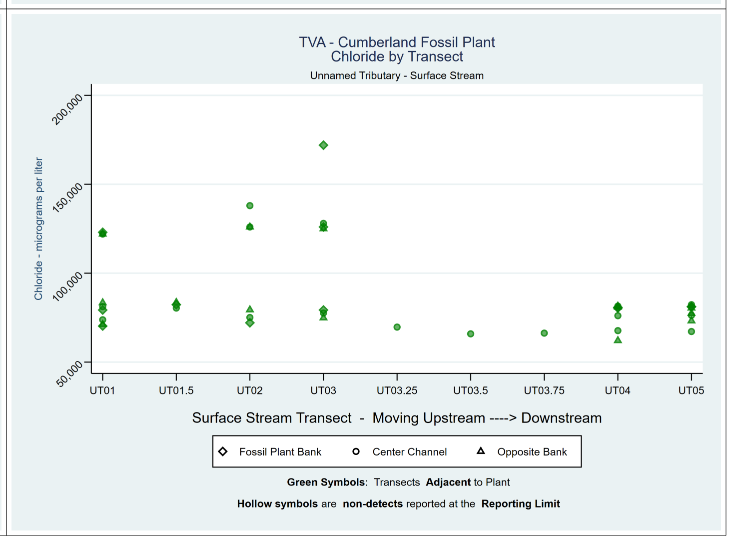


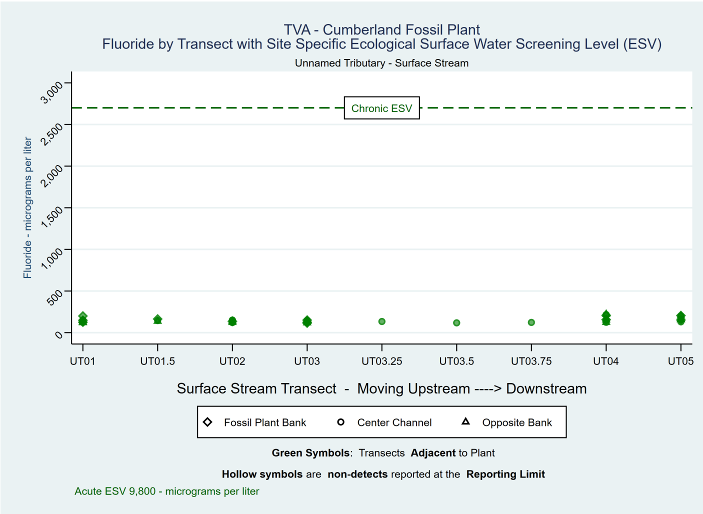


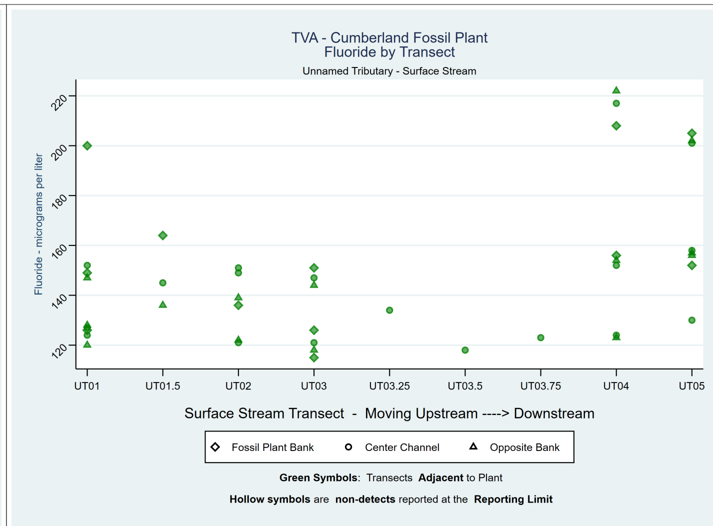








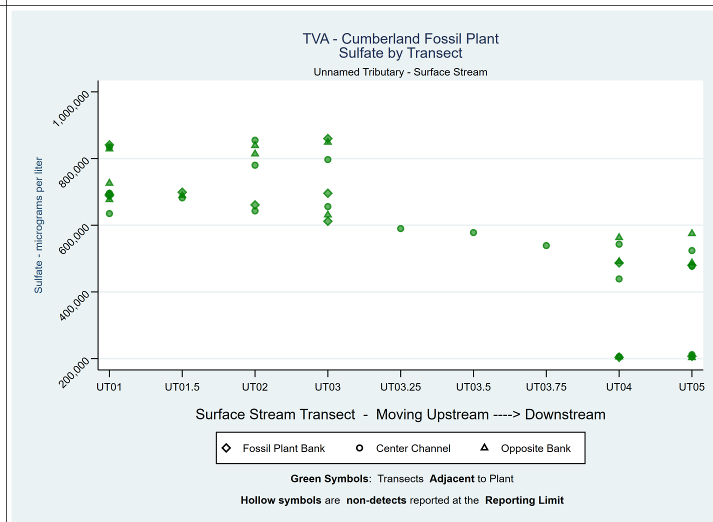




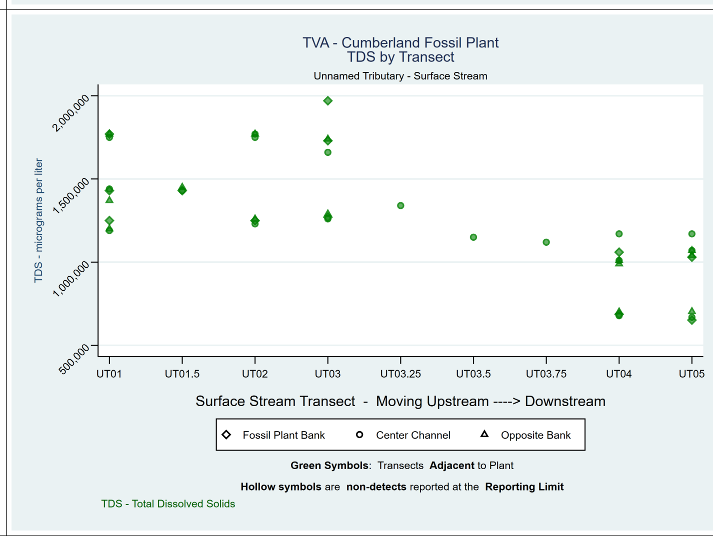
Place-holder for pH Field

Place-holder for pH Field

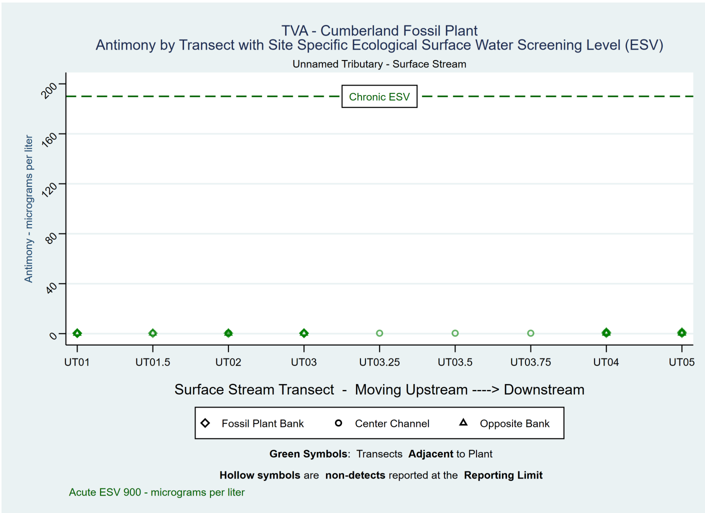
Acute or Chronic ESVs have not been established for sulfate

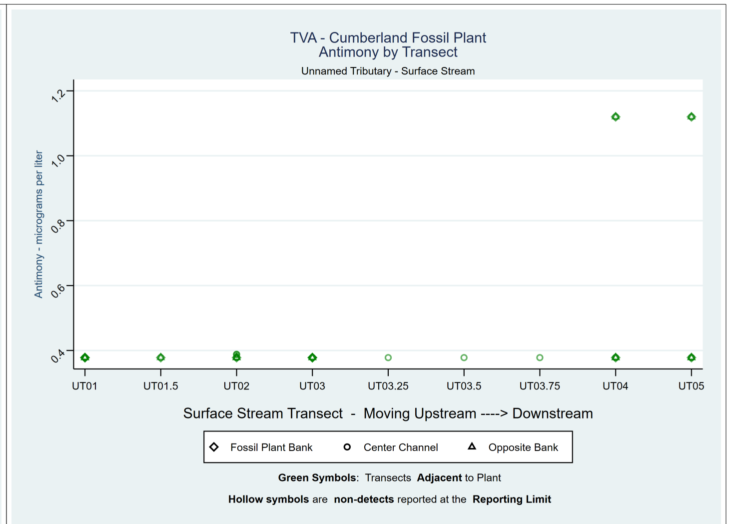


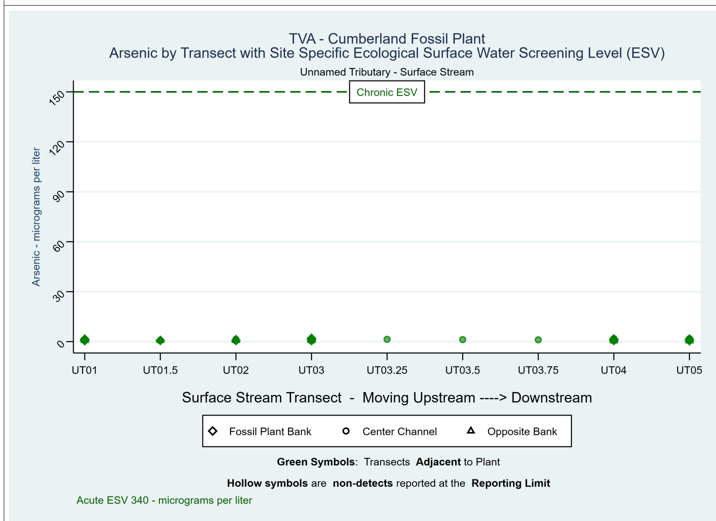
Acute or Chronic ESVs have not been established for total dissolved solids (TDS)

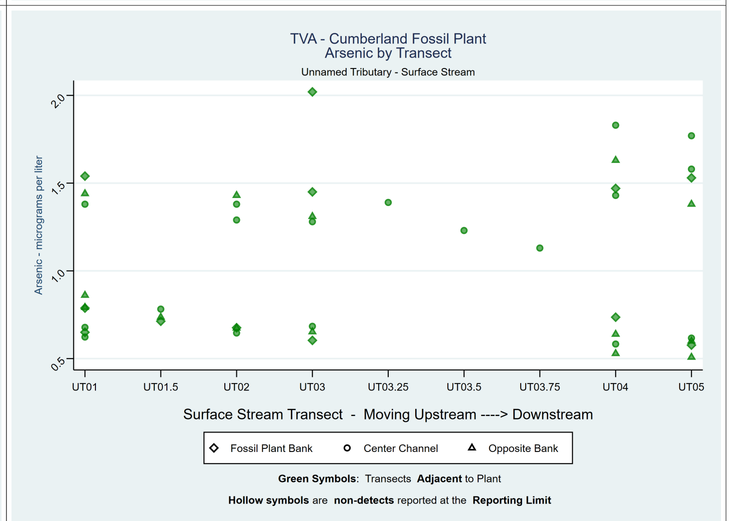


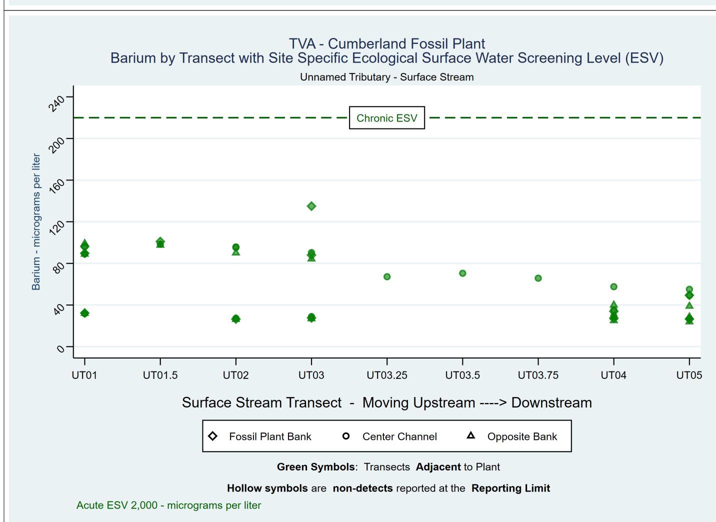
Transect Plots
Unnamed Tributary - CCR Rule Appendix IV Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

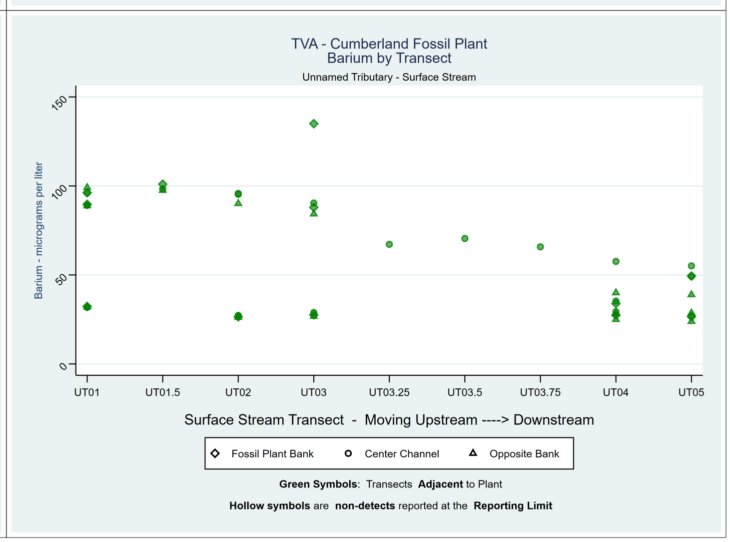


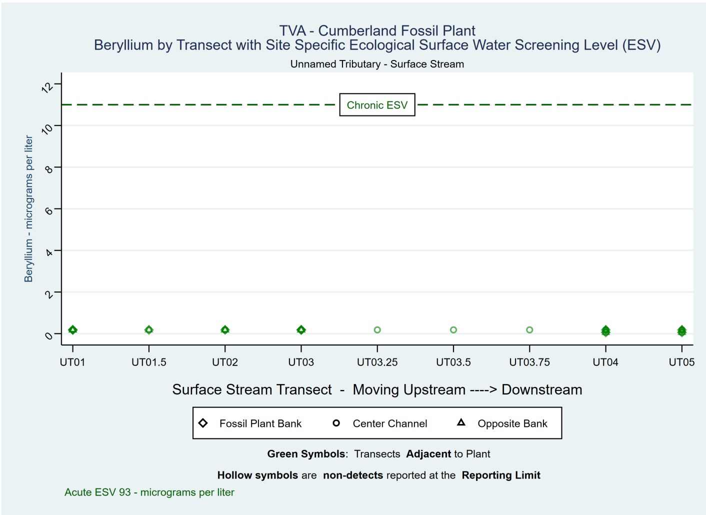


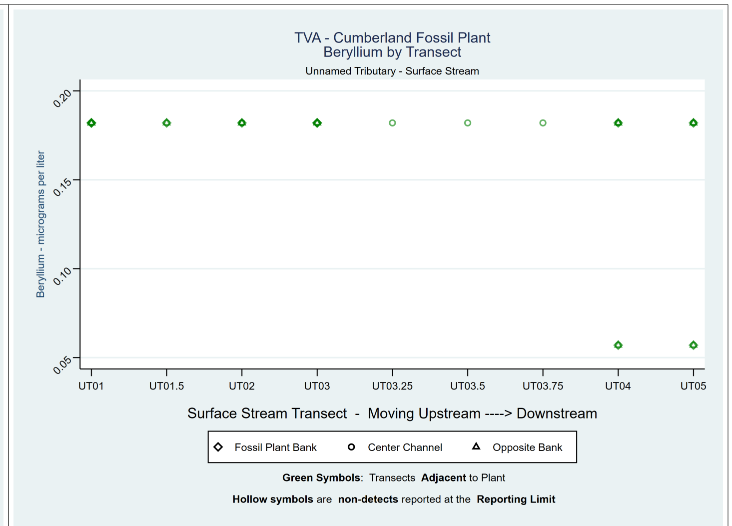


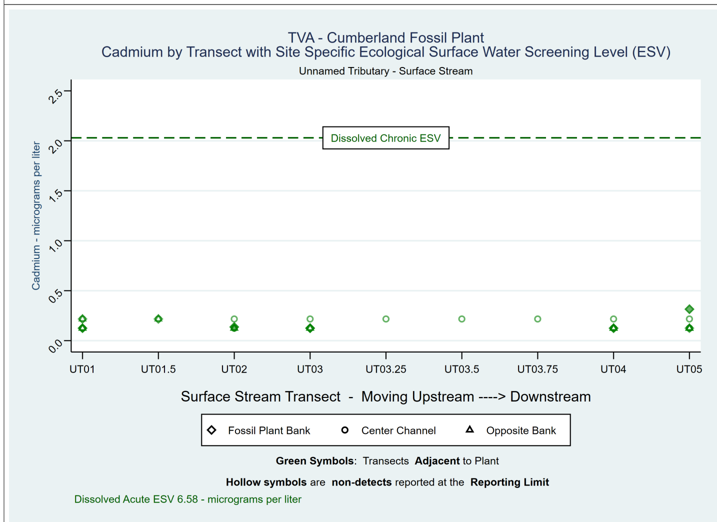


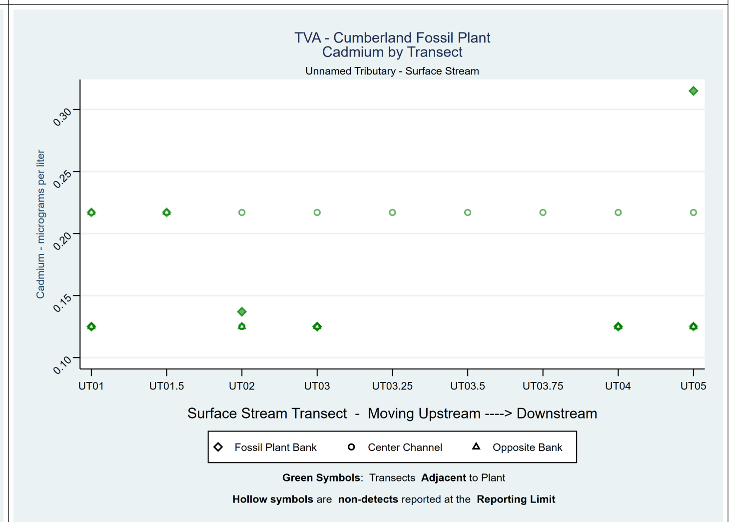


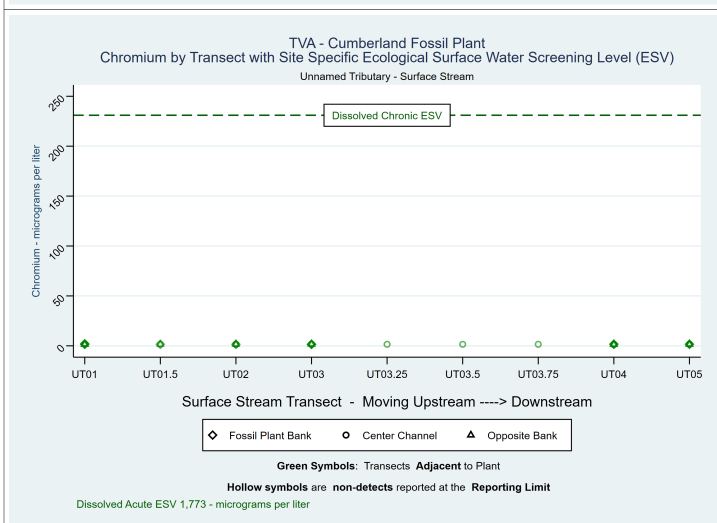


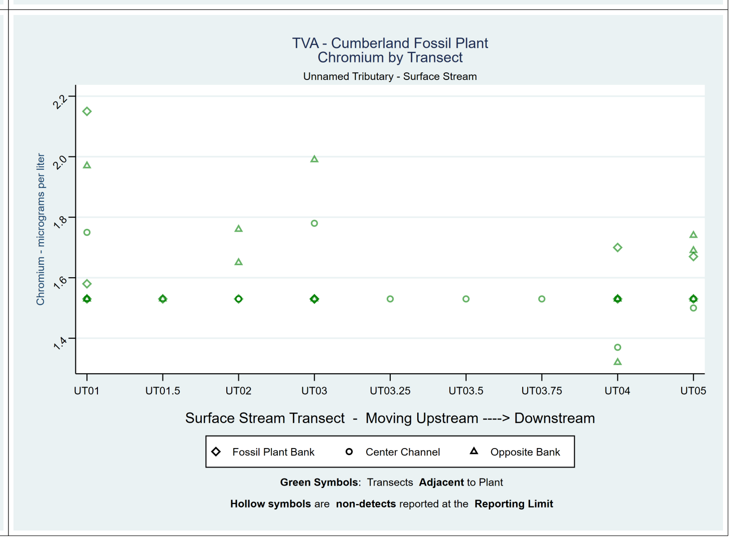

TVA - Cumberland Fossil Plant
Beryllium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Beryllium - micrograms per liter
0
2
4
6
8
10
12
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 93 - micrograms per liter

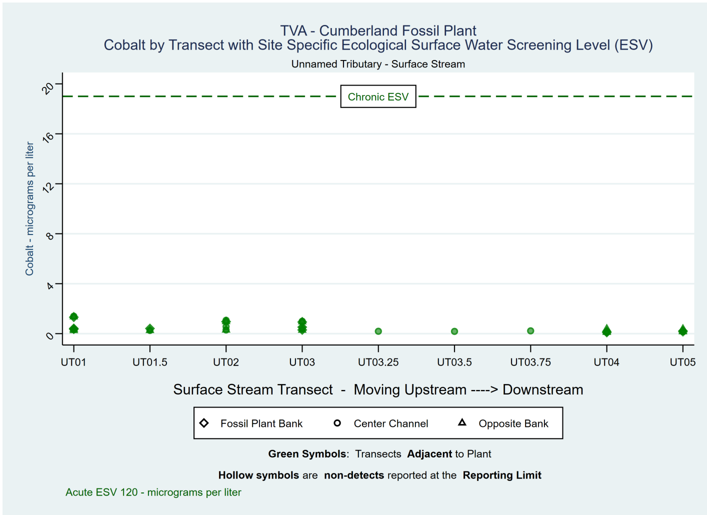

TVA - Cumberland Fossil Plant
Beryllium by Transect
Unnamed Tributary - Surface Stream
Beryllium - micrograms per liter
0.05
0.10
0.15
0.20
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

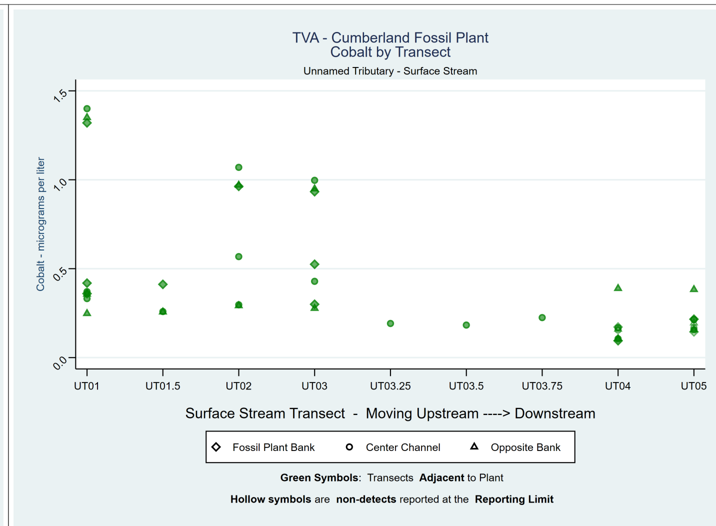

TVA - Cumberland Fossil Plant
Cadmium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Dissolved Chronic ESV
Cadmium - micrograms per liter
0.0
0.5
1.0
1.5
2.0
2.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 6.58 - micrograms per liter

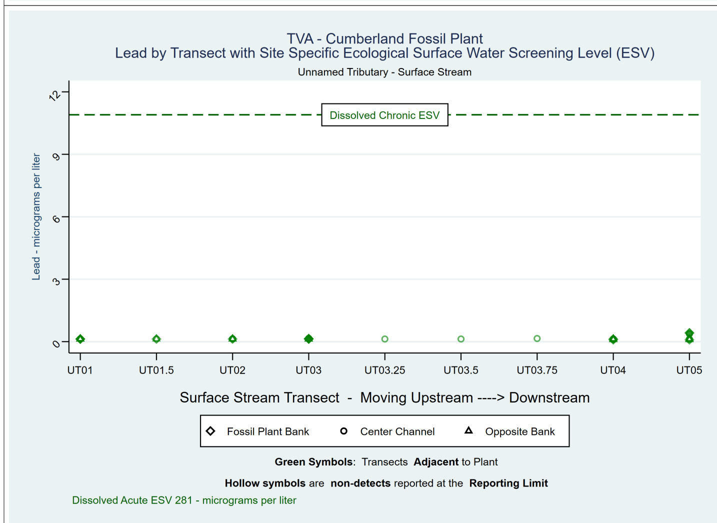

TVA - Cumberland Fossil Plant
Cadmium by Transect
Unnamed Tributary - Surface Stream
Cadmium - micrograms per liter
0.10
0.15
0.20
0.25
0.30
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

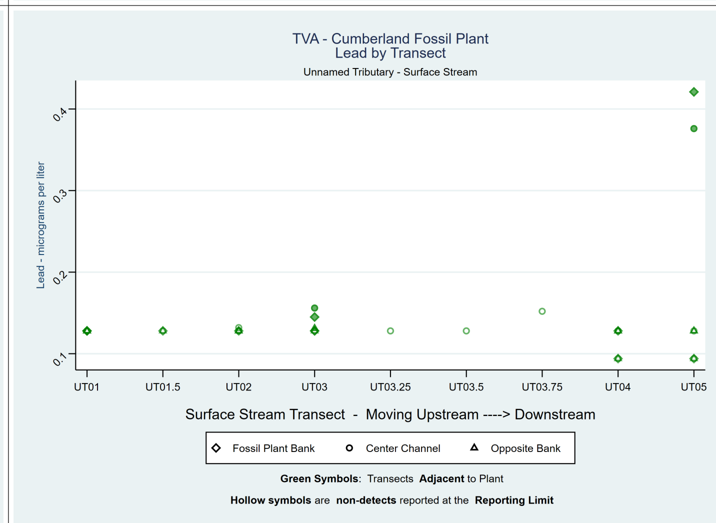

TVA - Cumberland Fossil Plant
Chromium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Dissolved Chronic ESV
Chromium - micrograms per liter
0
50
100
150
200
250
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 1,773 - micrograms per liter

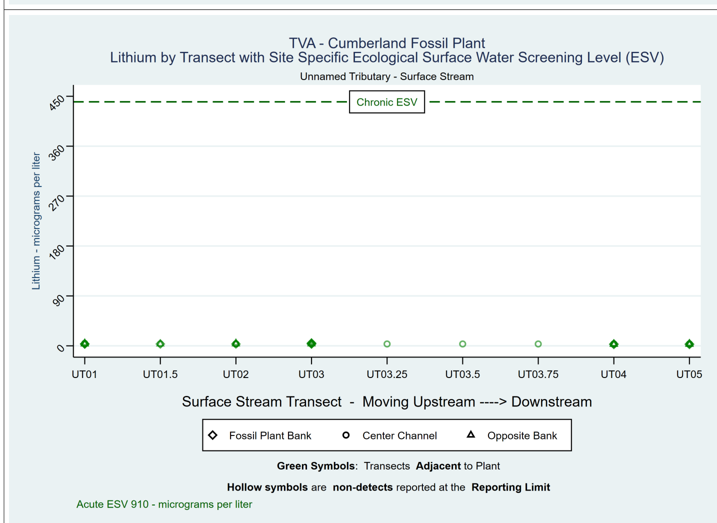

TVA - Cumberland Fossil Plant
Chromium by Transect
Unnamed Tributary - Surface Stream
Chromium - micrograms per liter
1.4
1.6
1.8
2.0
2.2
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

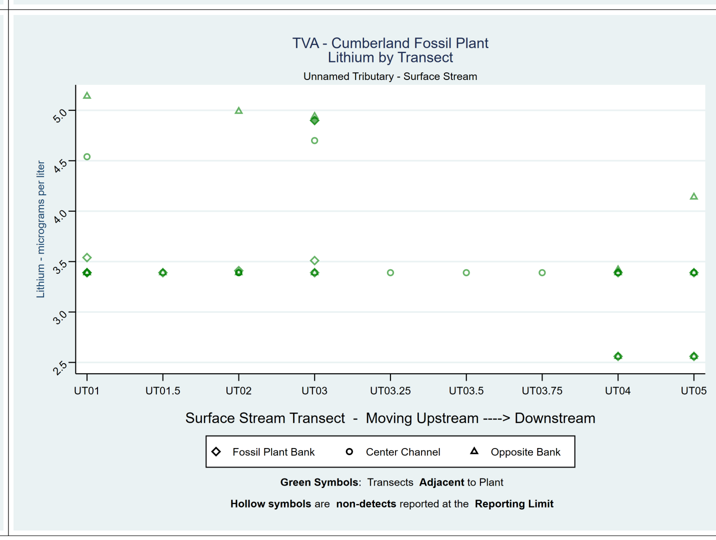

TVA - Cumberland Fossil Plant
Cobalt by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Cobalt - micrograms per liter
0
4
8
12
16
20
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 120 - micrograms per liter

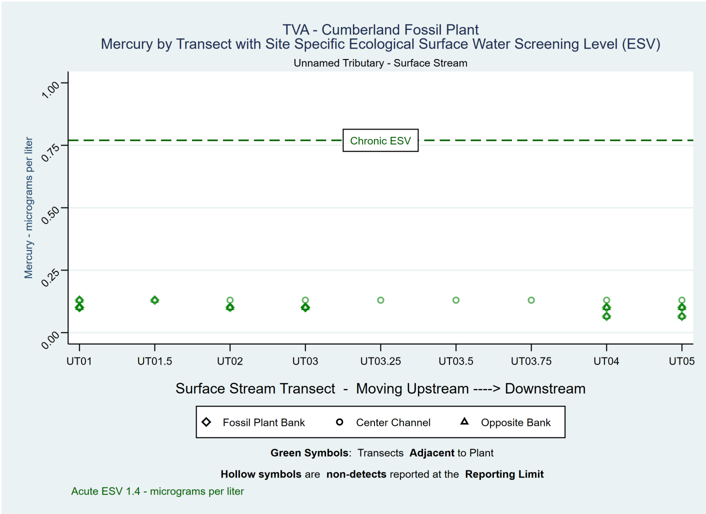

TVA - Cumberland Fossil Plant
Cobalt by Transect
Unnamed Tributary - Surface Stream
Cobalt - micrograms per liter
0.0
0.5
1.0
1.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

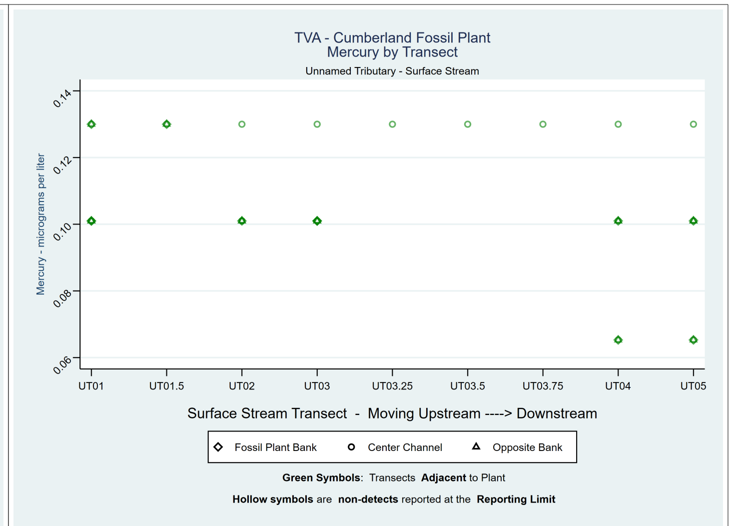

TVA - Cumberland Fossil Plant
Lead by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Dissolved Chronic ESV
Lead - micrograms per liter
0
3
6
9
12
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 281 - micrograms per liter

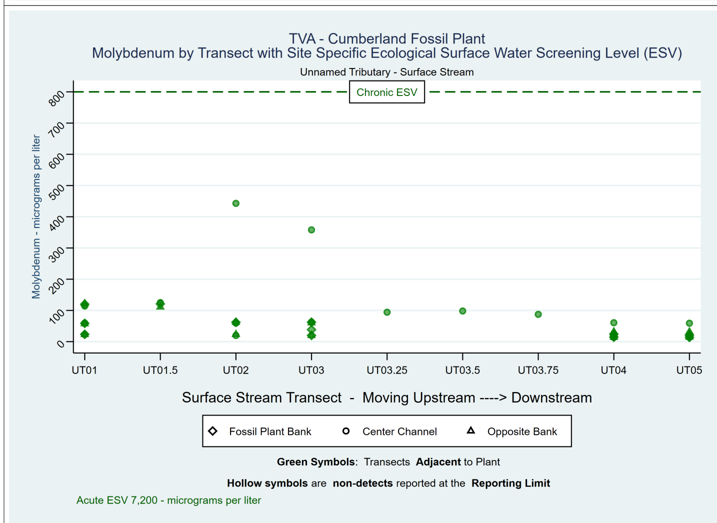

TVA - Cumberland Fossil Plant
Lead by Transect
Unnamed Tributary - Surface Stream
Lead - micrograms per liter
0.1
0.2
0.3
0.4
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

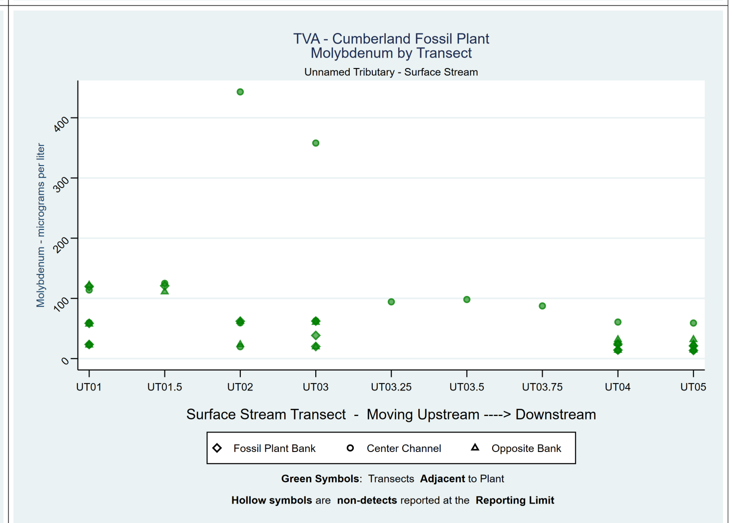

TVA - Cumberland Fossil Plant
Lithium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Lithium - micrograms per liter
0
90
180
270
360
450
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 910 - micrograms per liter

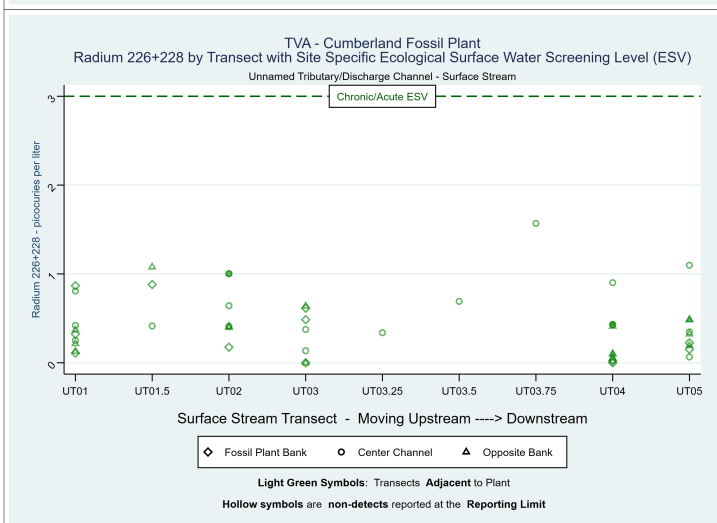

TVA - Cumberland Fossil Plant
Lithium by Transect
Unnamed Tributary - Surface Stream
Lithium - micrograms per liter
2.5
3.0
3.5
4.0
4.5
5.0
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

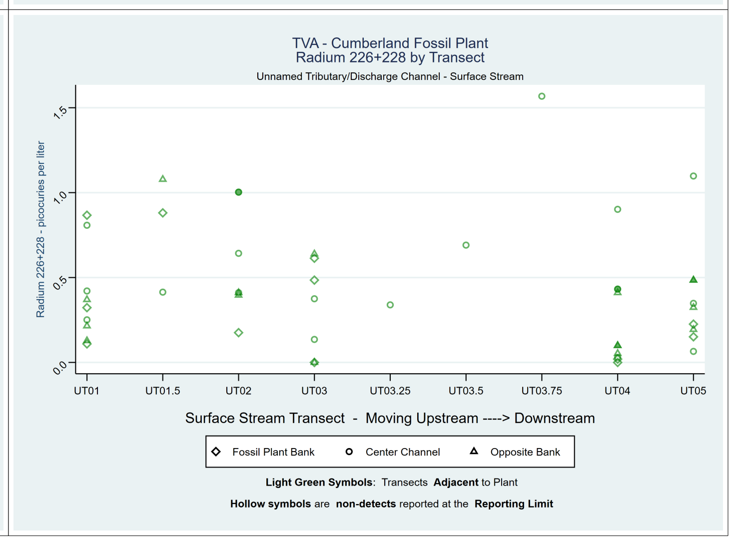

TVA - Cumberland Fossil Plant
Mercury by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Mercury - micrograms per liter
0.00
0.25
0.50
0.75
1.00
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 1.4 - micrograms per liter

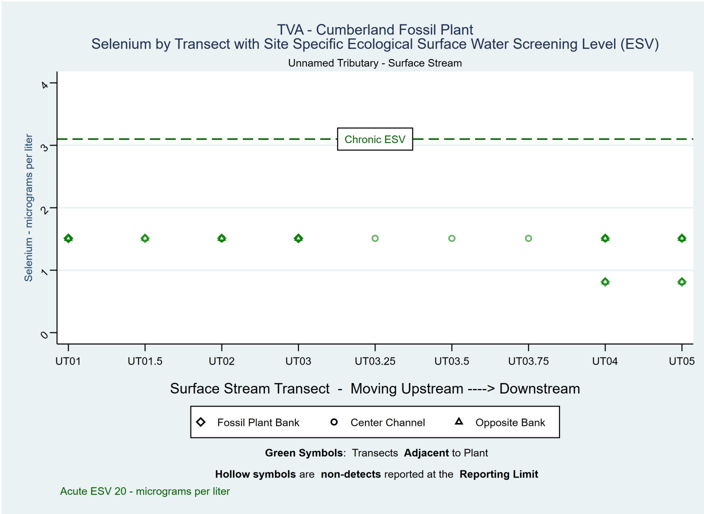

TVA - Cumberland Fossil Plant
Mercury by Transect
Unnamed Tributary - Surface Stream
Mercury - micrograms per liter
0.06
0.08
0.10
0.12
0.14
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Molybdenum by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Molybdenum - micrograms per liter
0
100
200
300
400
500
600
700
800
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 7,200 - micrograms per liter

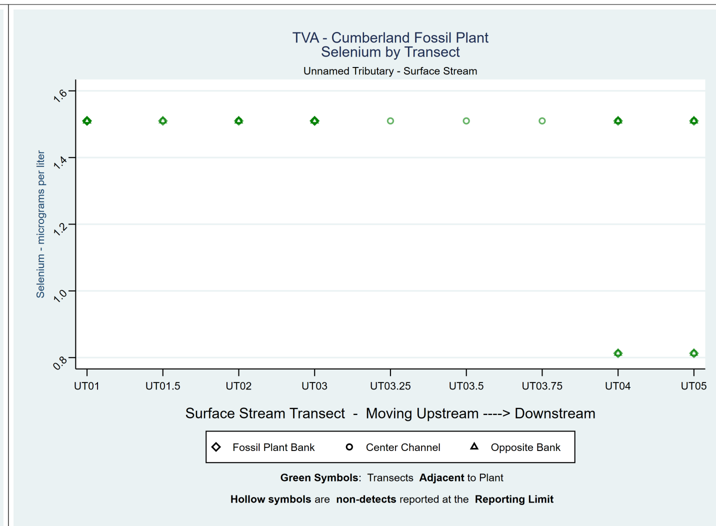

TVA - Cumberland Fossil Plant
Molybdenum by Transect
Unnamed Tributary - Surface Stream
Molybdenum - micrograms per liter
0
100
200
300
400
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit


TVA - Cumberland Fossil Plant
Radium 226+228 by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary/Discharge Channel - Surface Stream
Chronic/Acute ESV
Radium 226+228 - picocuries per liter
0
1
2
3
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

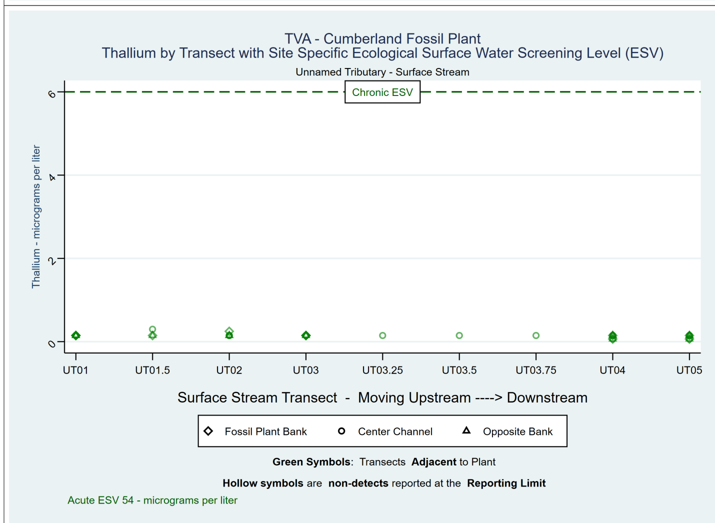

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect
Unnamed Tributary/Discharge Channel - Surface Stream
Radium 226+228 - picocuries per liter
0.0
0.5
1.0
1.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit



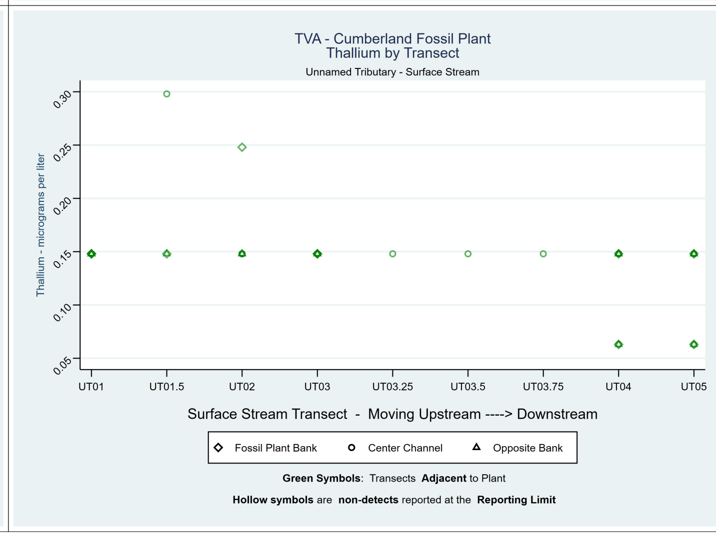
TVA - Cumberland Fossil Plant
Selenium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Selenium - micrograms per liter
Chronic ESV
0
1
2
3
4
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 20 - micrograms per liter



TVA - Cumberland Fossil Plant
Selenium by Transect
Unnamed Tributary - Surface Stream
Selenium - micrograms per liter
0.8
1.0
1.2
1.4
1.6
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

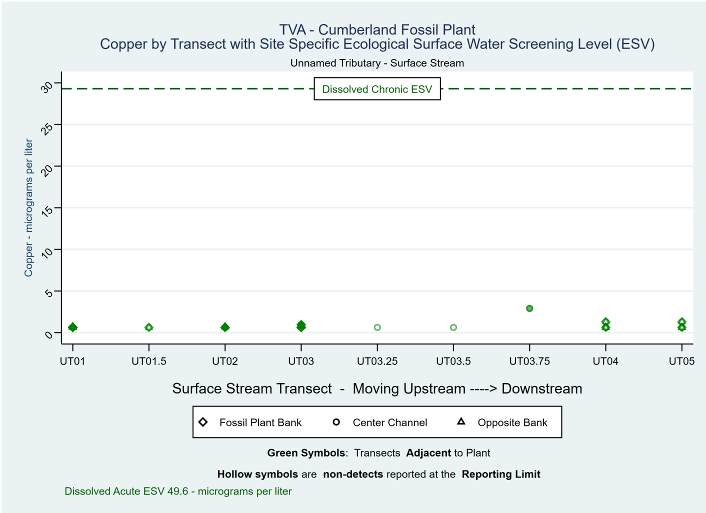


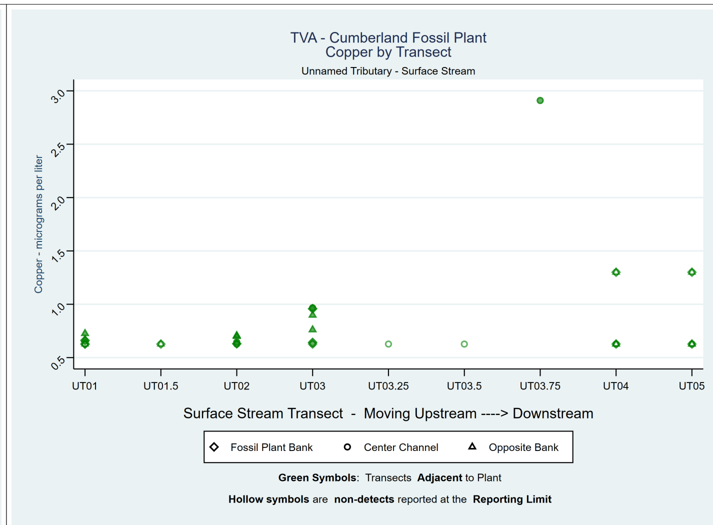
TVA - Cumberland Fossil Plant
Thallium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Thallium - micrograms per liter
Chronic ESV
0
2
4
6
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 54 - micrograms per liter

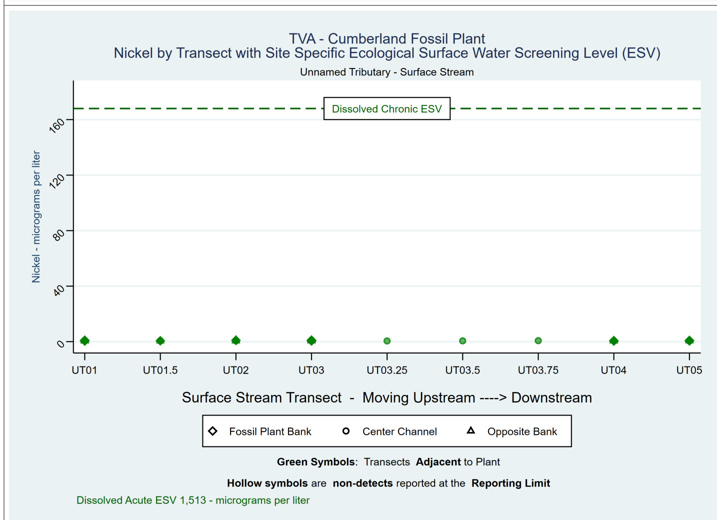


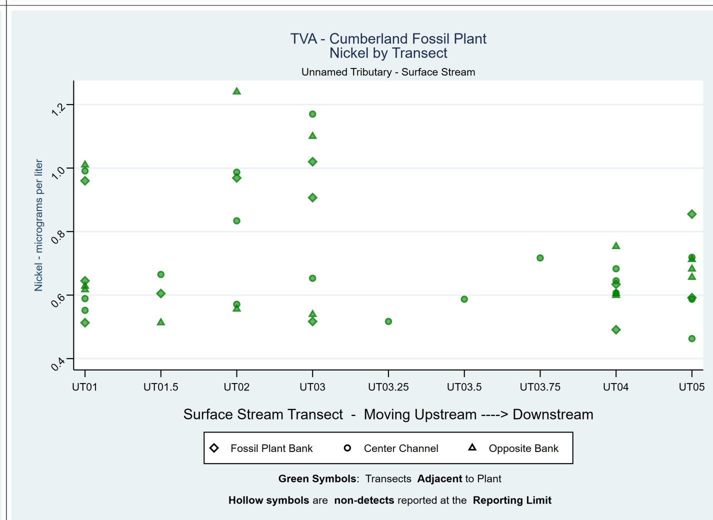
TVA - Cumberland Fossil Plant
Thallium by Transect
Unnamed Tributary - Surface Stream
Thallium - micrograms per liter
0.05
0.10
0.15
0.20
0.25
0.30
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

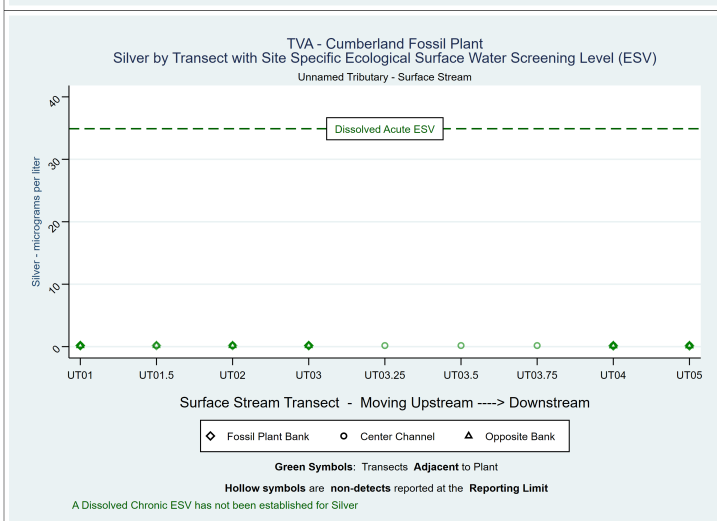
Transect Plots
Unnamed Tributary - TDEC Appendix I Parameters
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

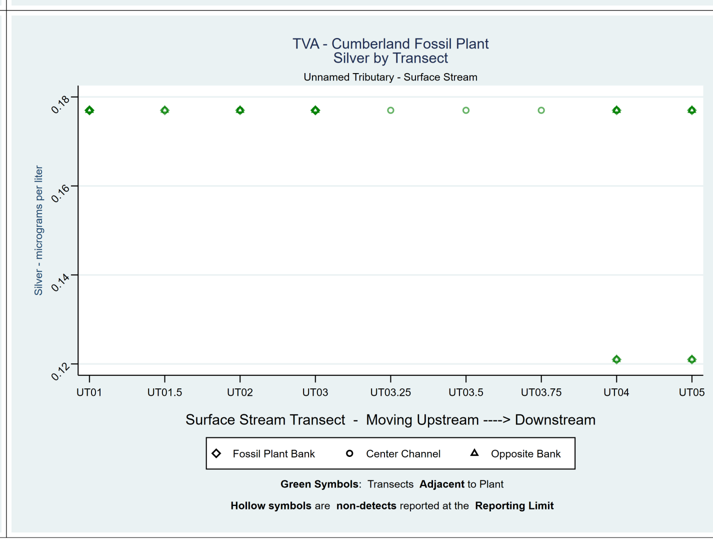


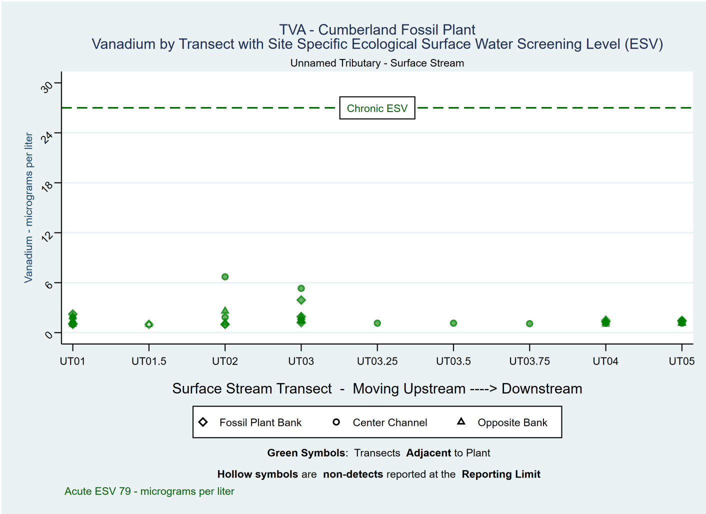


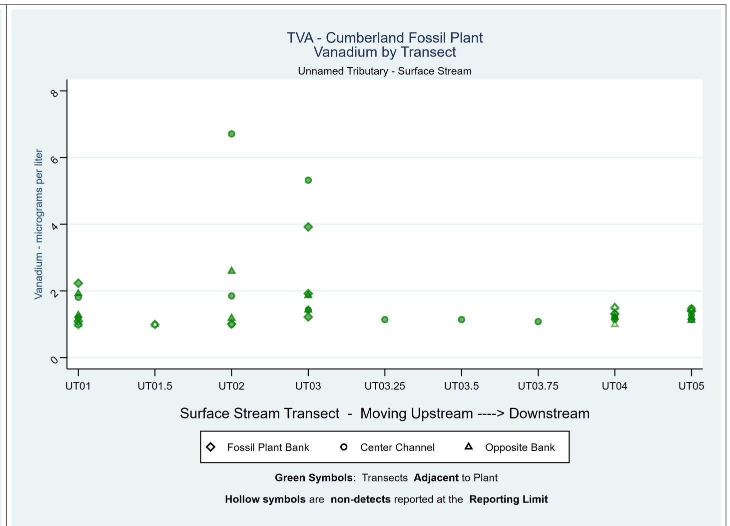


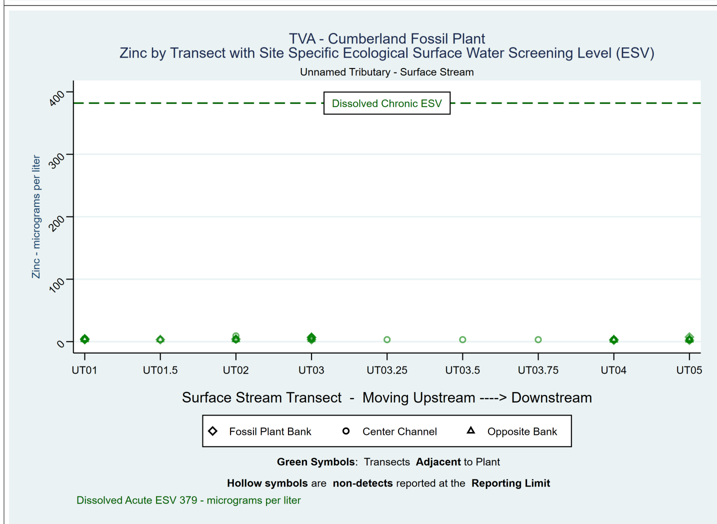


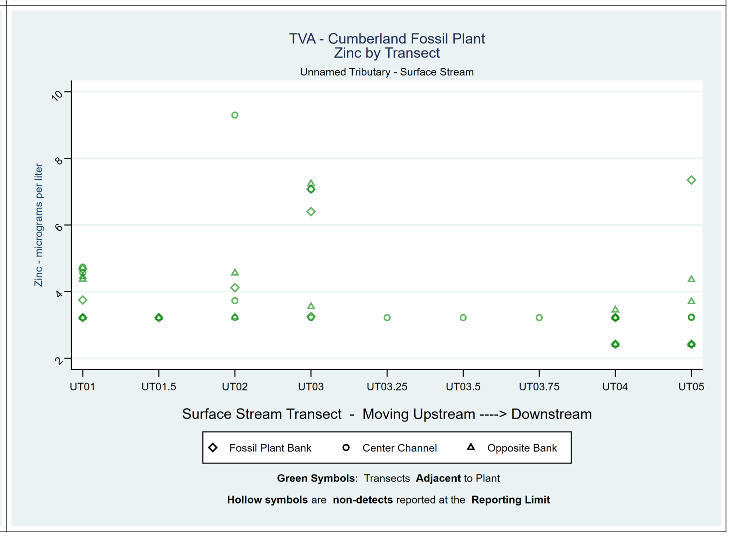





TVA - Cumberland Fossil Plant
Vanadium by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Chronic ESV
Vanadium - micrograms per liter
0
6
12
18
24
30
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV 79 - micrograms per liter

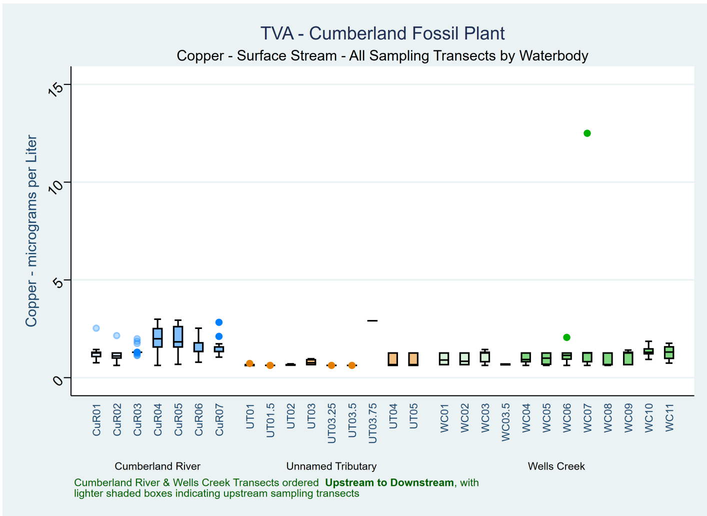

TVA - Cumberland Fossil Plant
Vanadium by Transect
Unnamed Tributary - Surface Stream
Vanadium - micrograms per liter
0
2
4
6
8
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

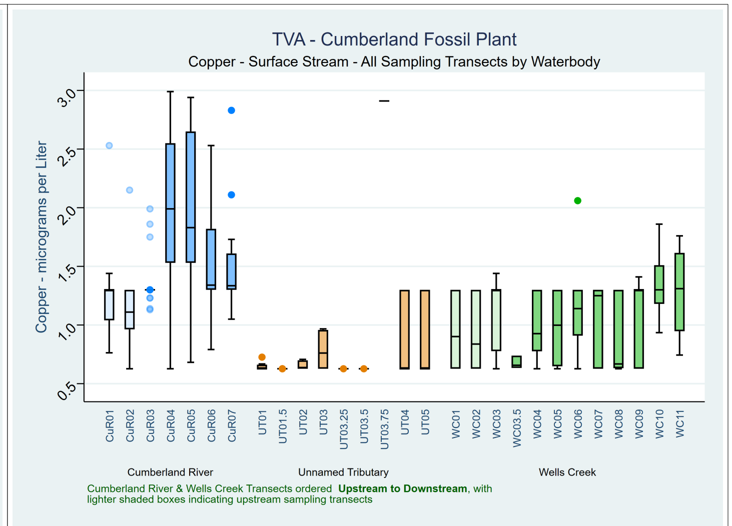

TVA - Cumberland Fossil Plant
Zinc by Transect with Site Specific Ecological Surface Water Screening Level (ESV)
Unnamed Tributary - Surface Stream
Dissolved Chronic ESV
Zinc - micrograms per liter
0
100
200
300
400
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Dissolved Acute ESV 379 - micrograms per liter

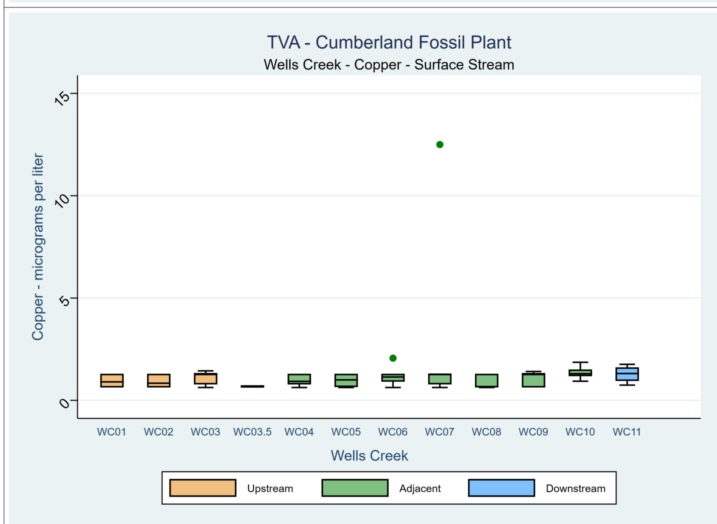

TVA - Cumberland Fossil Plant
Zinc by Transect
Unnamed Tributary - Surface Stream
Zinc - micrograms per liter
2
4
6
8
10
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Surface Stream Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit

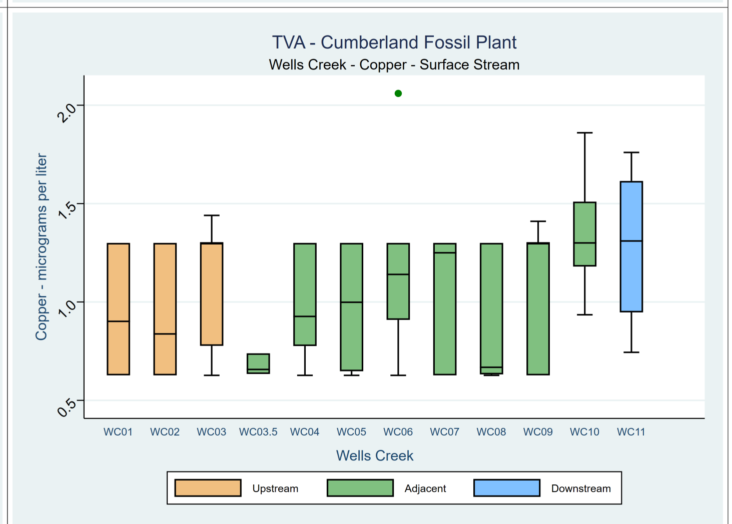
ATTACHMENT E.5-D - BOX AND TRANSECT PLOTS – STATISTICAL OUTLIERS

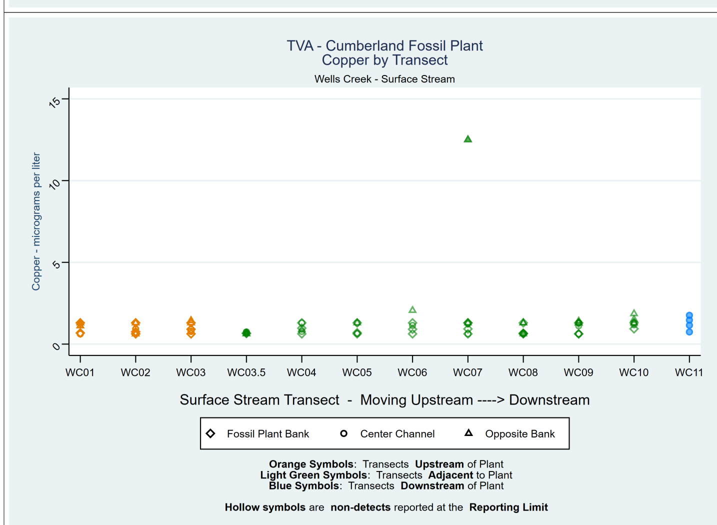
Box and Transect Plots - Statistical Outliers
Wells Creek
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

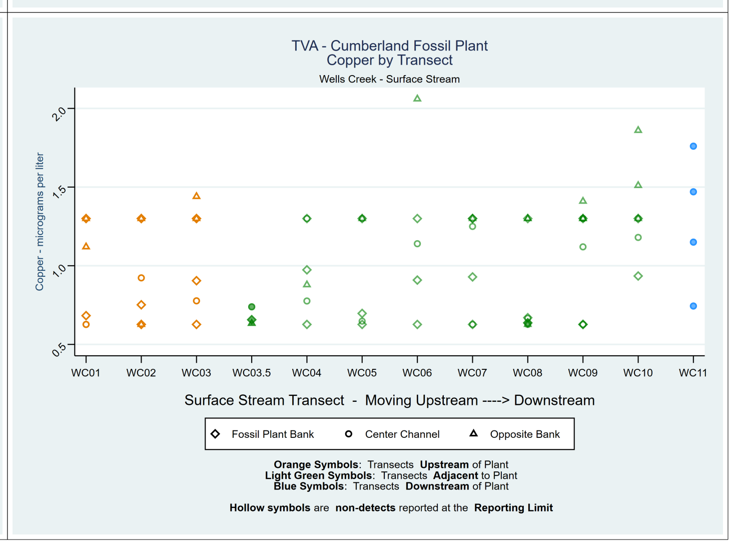




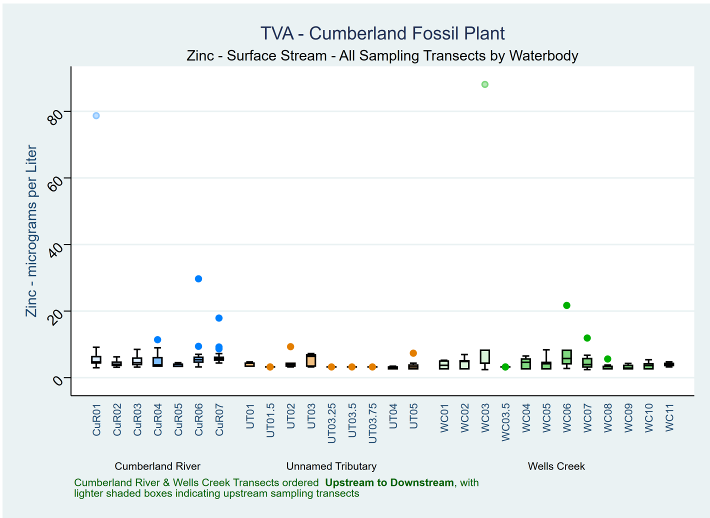


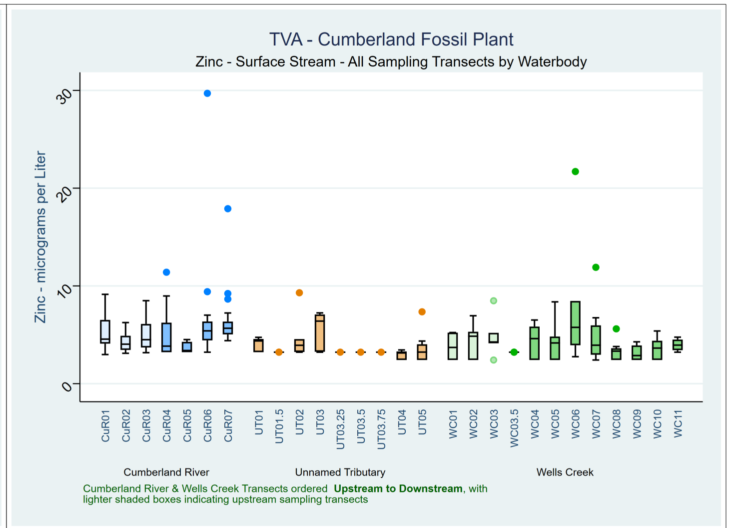


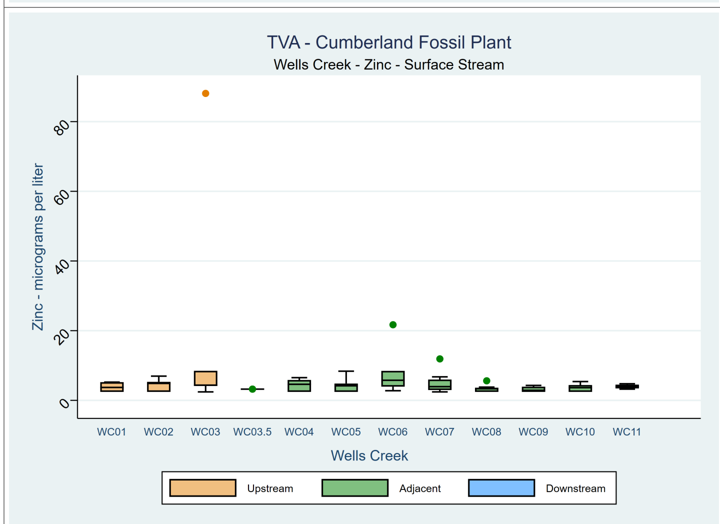


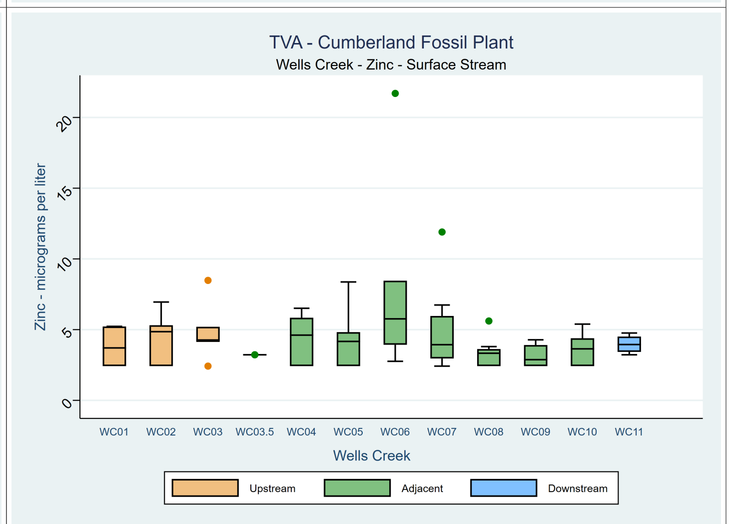


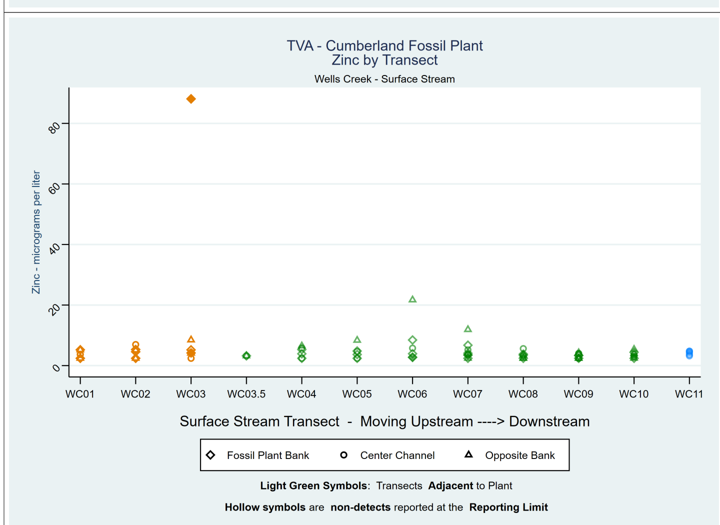
Box and Transect Plots - Statistical Outliers
Wells Creek
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

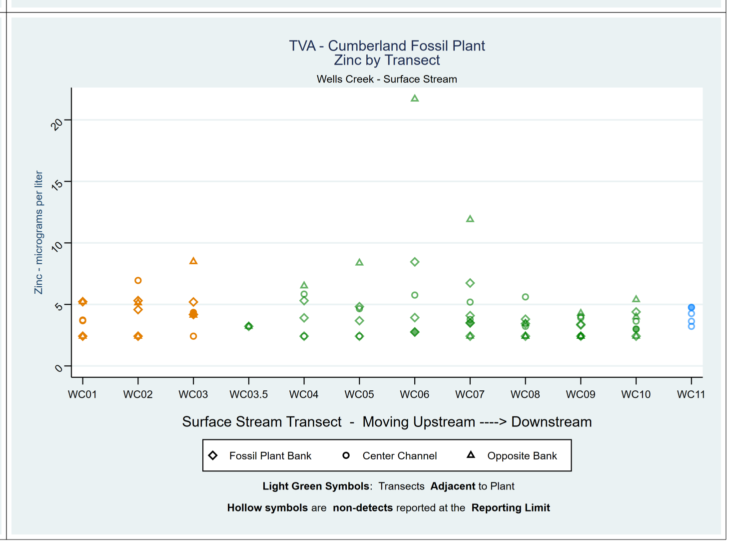




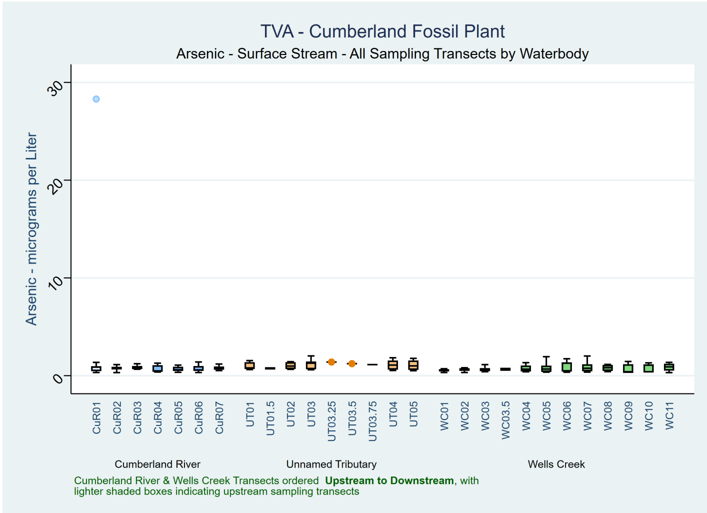


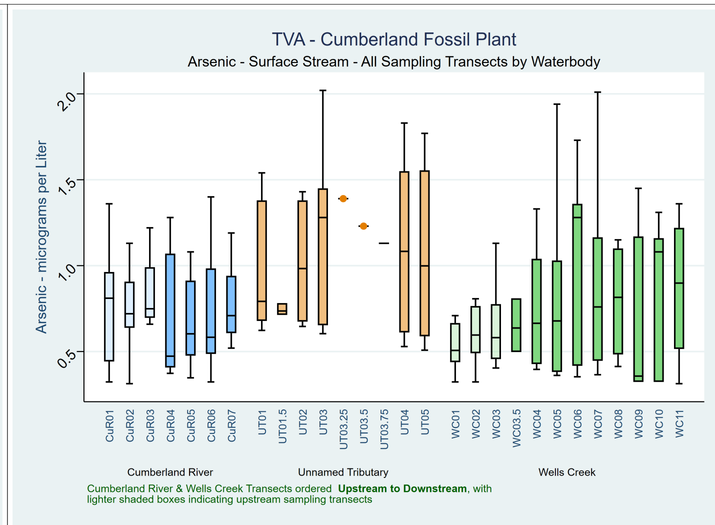


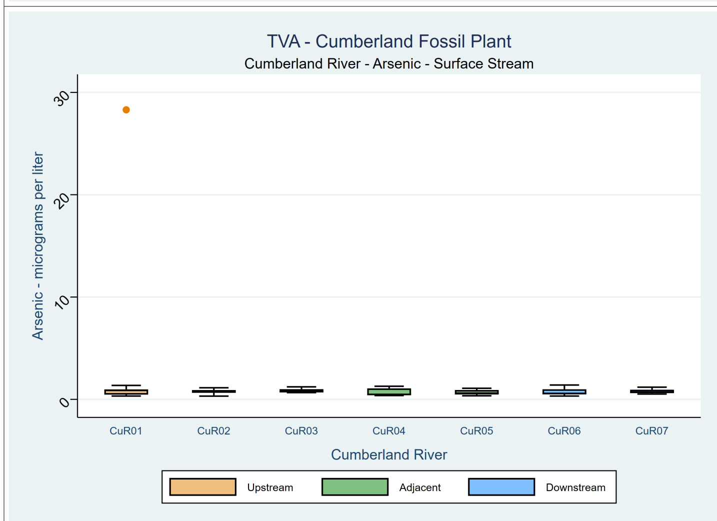


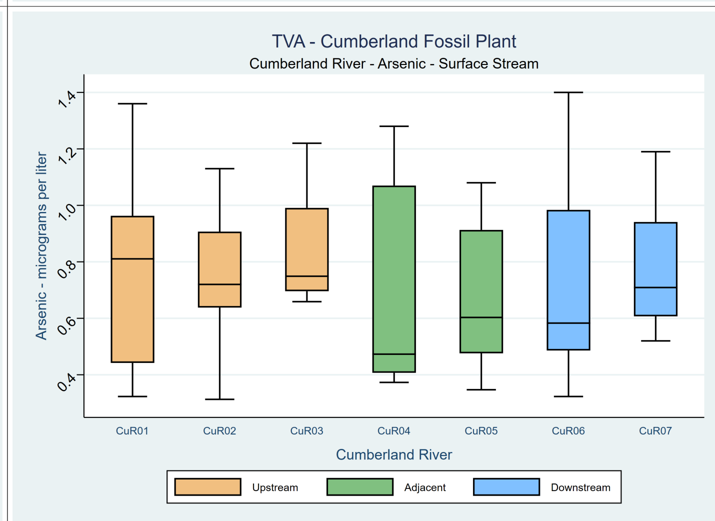


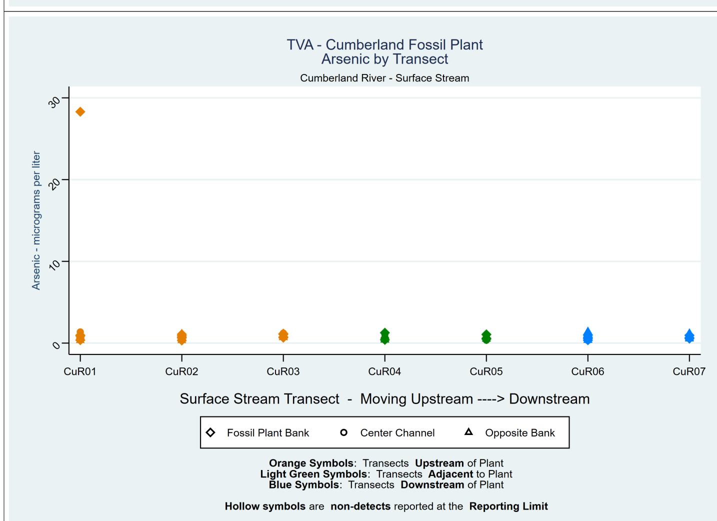
Box and Transect Plots - Statistical Outliers
Cumberland River
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

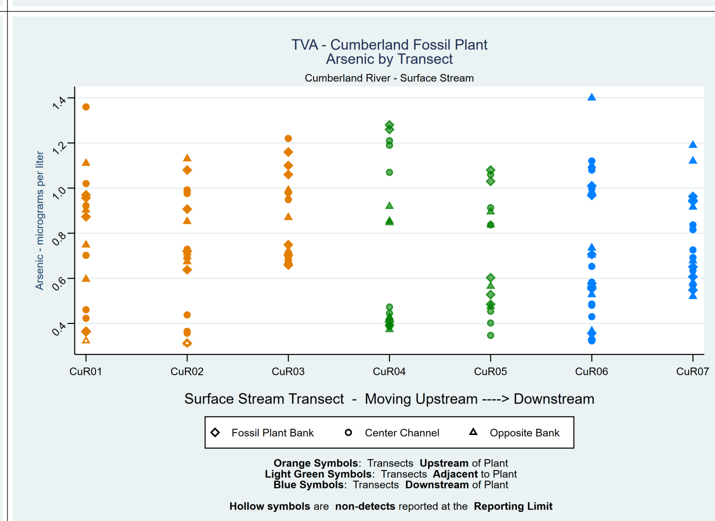




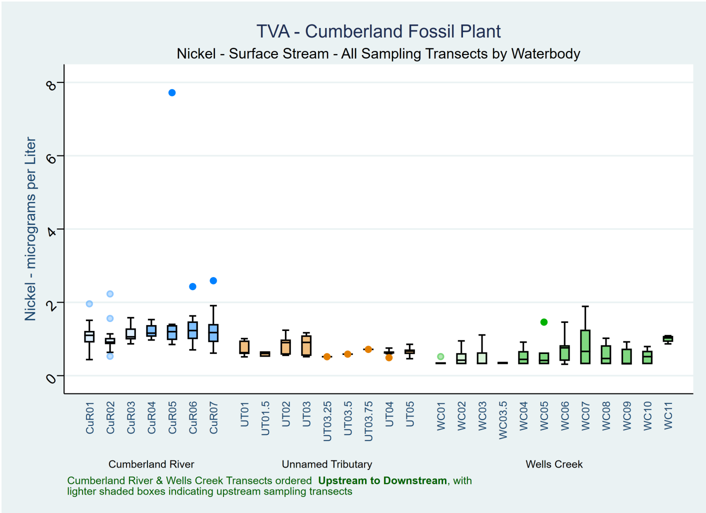


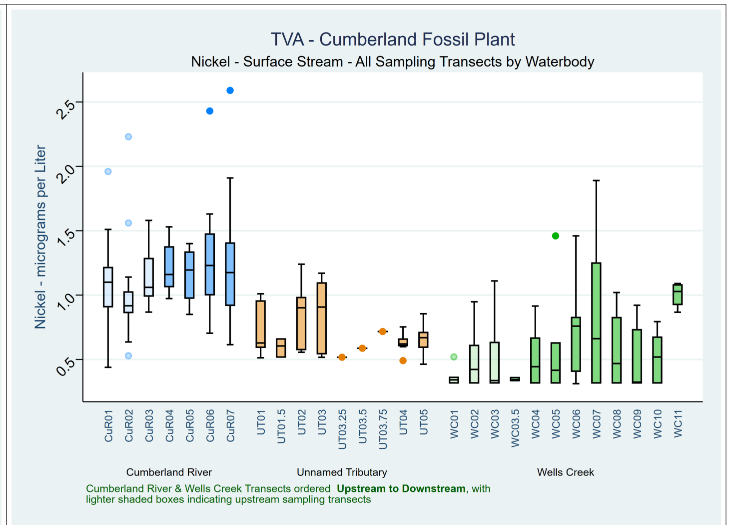


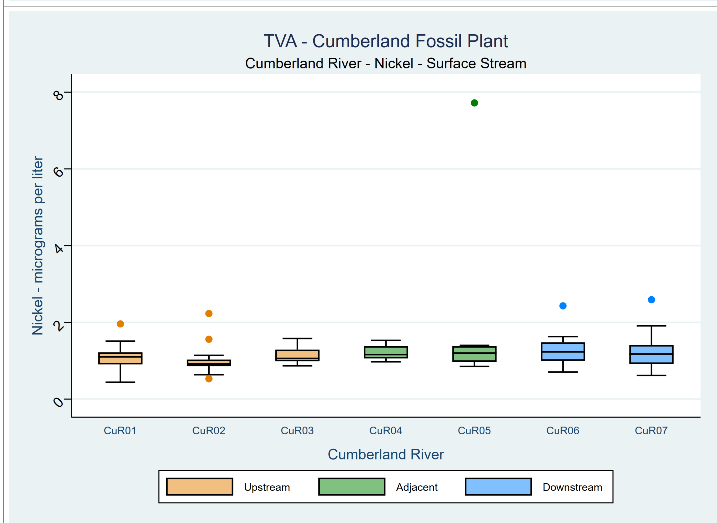


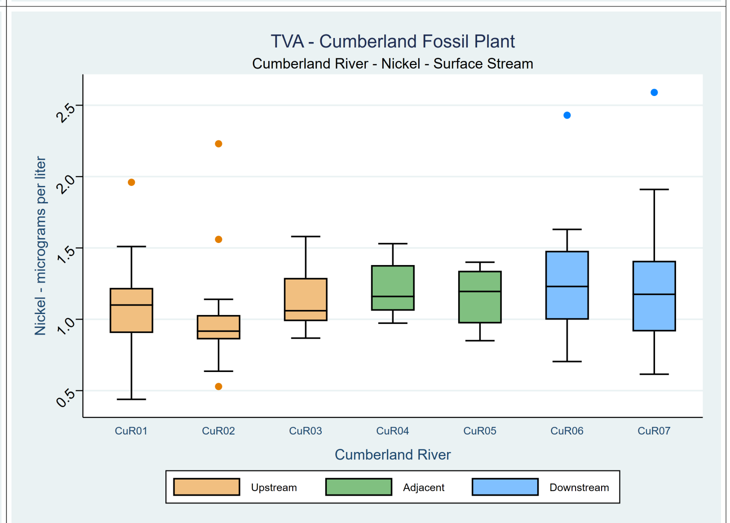


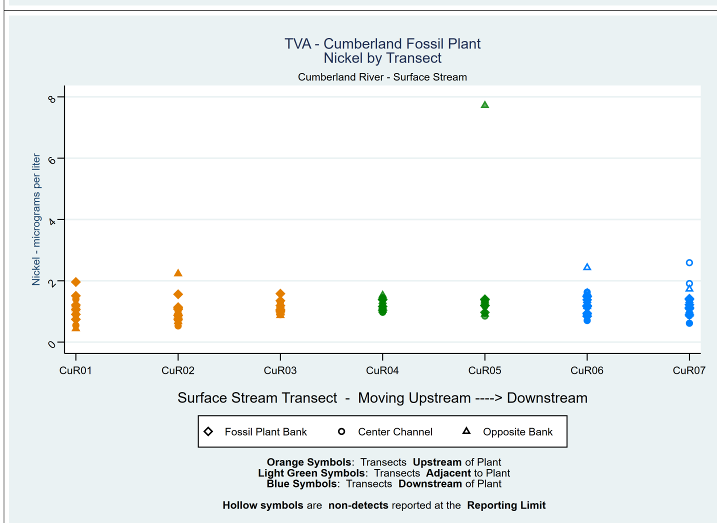
Box and Transect Plots - Statistical Outliers
Cumberland River
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

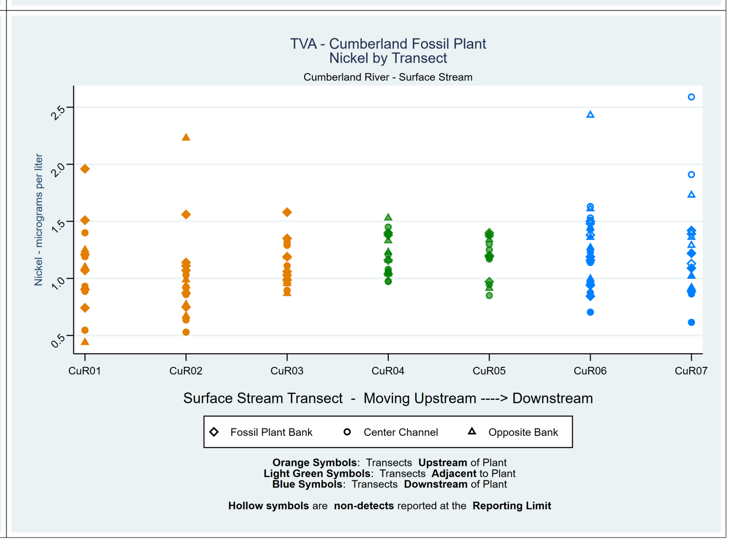




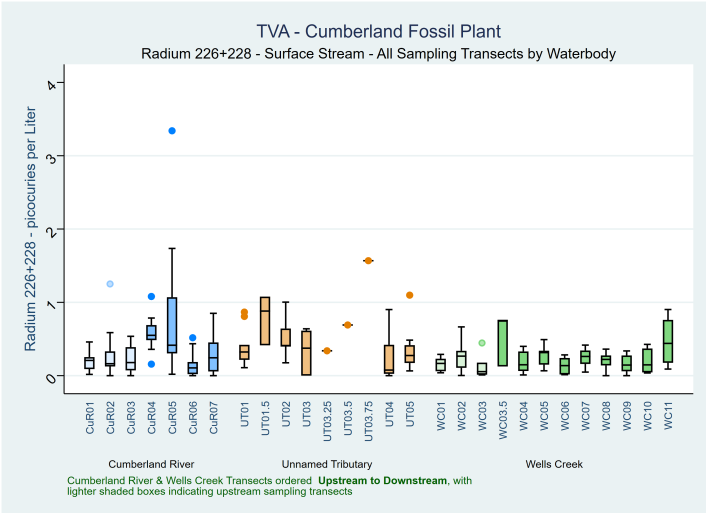


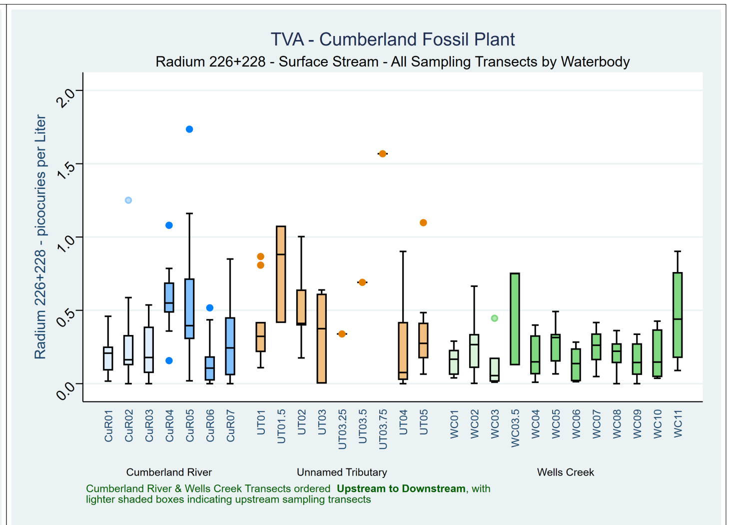


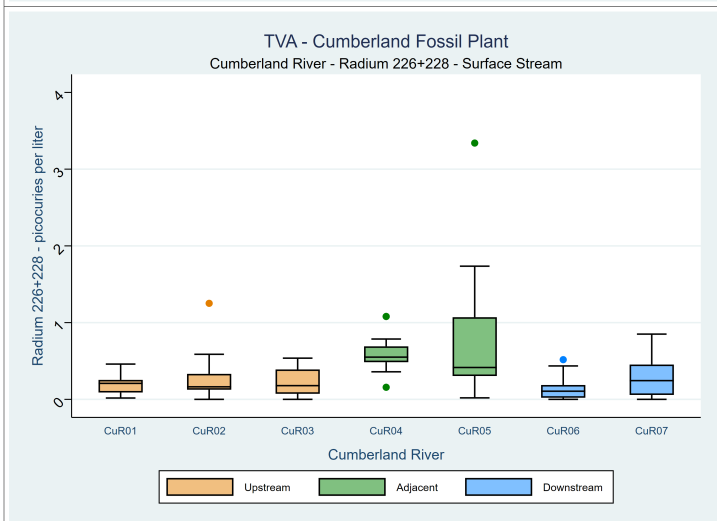


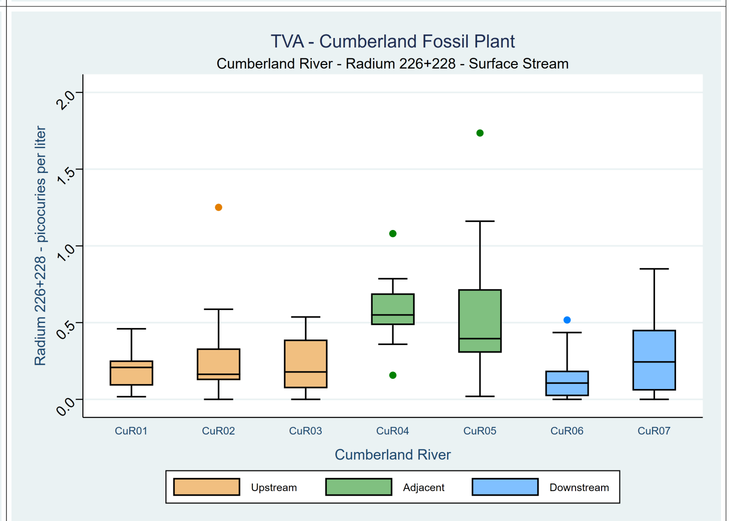


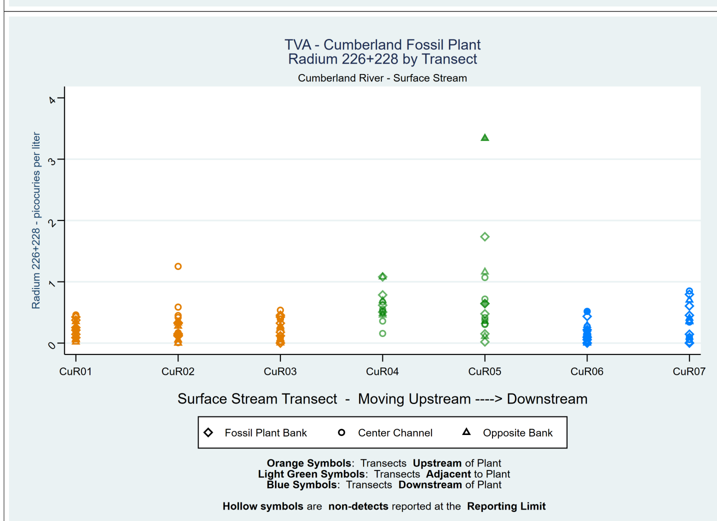
Box and Transect Plots - Statistical Outliers
Cumberland River
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

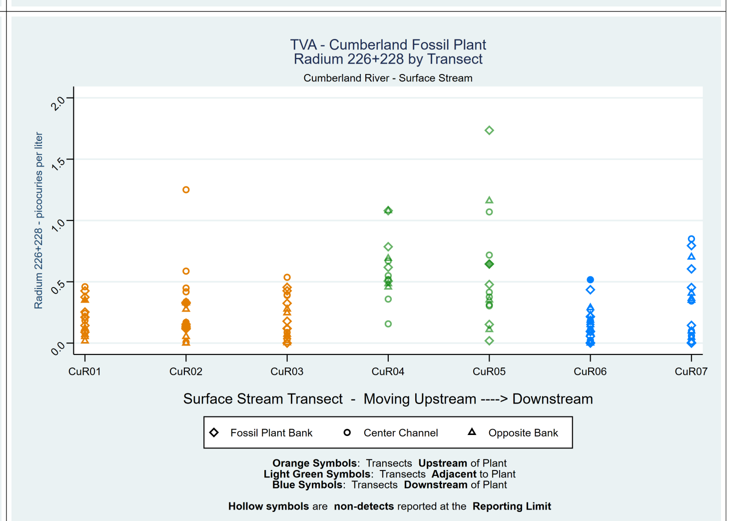




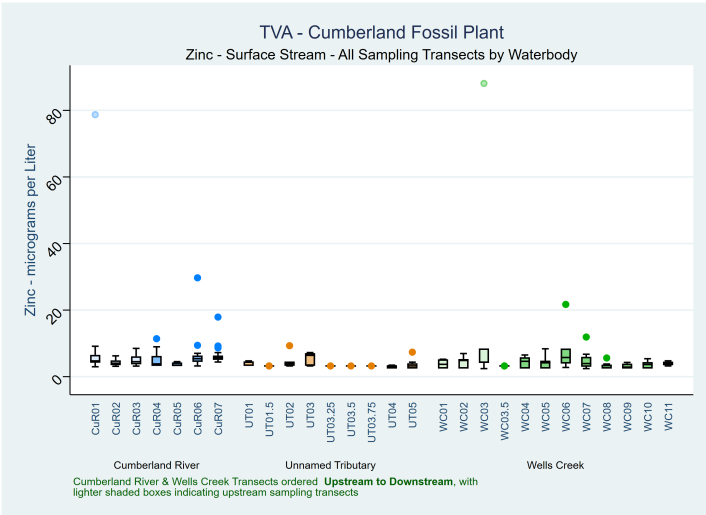


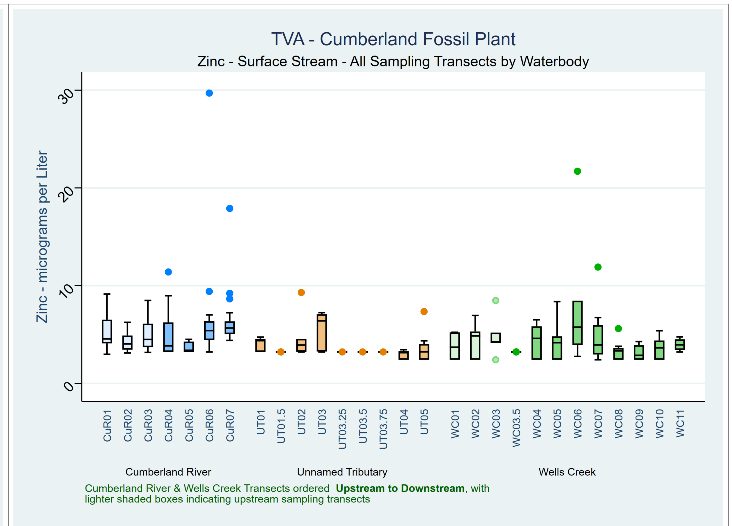


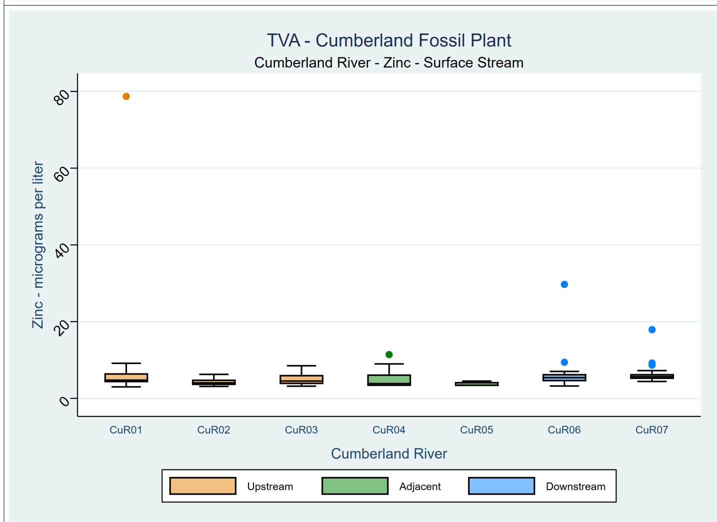


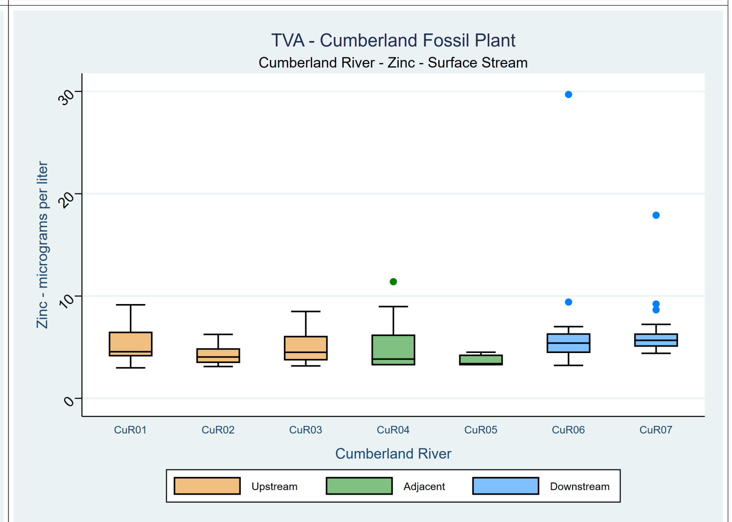


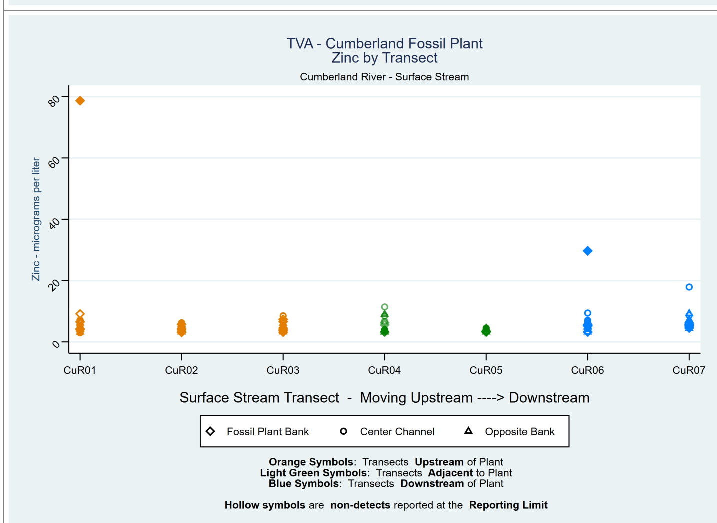
Box and Transect Plots - Statistical Outliers
Cumberland River
Surface Stream Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

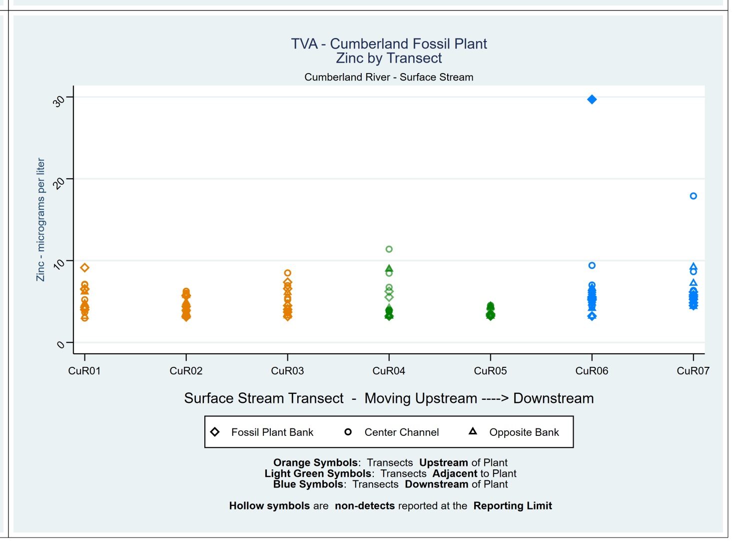












APPENDIX E.6

STATISTICAL ANALYSIS OF SEDIMENT DATA

Appendix E.6 - Statistical Analysis of Sediment Data

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

Revision Log

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022 TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023 TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Statistical Analysis of Sediment Data was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________

Chris La Londe, Senior Risk Assessor

Reviewed by ______________________

Melissa Whitfield Aslund, PhD, Environmental Scientist

Approved by ______________________

Rebekah Brooks, PG, Senior Principal Hydrogeologist

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

Abbreviations

CUF Plant	Cumberland Fossil Plant
CCR	Coal Combustion Residuals
CCR Parameters	The Constituents listed in Appendices III and IV of 40 CFR 257 and five inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04
EAR	Environmental Assessment Report
EI	Environmental Investigation
ESV	Ecological Screening Level
IQR	Interquartile Range
MDL	Method Detection Limit
Mg/kg	milligrams per kilogram
%	Percent
PCA	Principal Component Analysis
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority

APPENDIX E.6 STATISTICAL ANALYSIS OF SEDIMENT DATA

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to summarize the statistical analyses performed on sediment data to support evaluations conducted for the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. The sediment samples were collected between October 2018 and December 2019 in five water bodies in proximity to the CUF Plant. Further details regarding the sediment sampling, and laboratory data results are presented in Appendix J.3 and the CUF Plant *Benthic Investigation Sampling and Analysis Report* (Appendix J.4)**.** Phase 2 supplemental surface stream and sediment sampling was performed in the Unnamed Tributary and immediately downstream of its confluence with Wells Creek in June/July 2021. Results from the Phase 2 supplemental sampling are included in this EAR

For the Environmental Investigation (EI), sediment samples were collected from locations along sample transects or individual locations from five water bodies proximal to the CUF Plant coal combustion residual (CCR) management units: Cumberland River, Wells Creek, Unnamed Tributary, Discharge Channel, and the TVA Embayment. Sample transects/location names and locations relative to CUF Plant CCR management units and the numbers of samples collected from each water body are presented in Table E.6-1. Four samples were collected from one transect in the Discharge Channel; however, these samples were not included in the statistical analysis because conditions in the Discharge Channel are not representative of natural surface stream conditions and the Discharge Channel is regulated under a National Pollutant Discharge Elimination System permit (#TN0005789). The constituents listed in Appendices III and IV of 40 CFR 257 and five additional inorganic constituents included in Appendix I of Tennessee Rule 0400-11-01-.04 (CCR Parameters) included in the statistical analysis are presented in Table E.6-2.

Table E.6-1 – Sediment Sample Transect/Locations

Water body	Transect/Location Name	Location Relative to CUF Plant CCR Management Units	Number of Samples
Cumberland River	CuR01, CuR02, CuR03	Upstream	7
	CuR04, CuR05	Adjacent	6
	CuR06, CuR07	Downstream	6
Wells Creek	WC01, WC02, WC03	Upstream	8
	WC03.5, WC04, WC05, WC06, WC07, WC08, WC09, WC10	Adjacent	24
Unnamed Tributary	UT0.5, UT01, UT01.5, UT02, UT03, UT03.25, UT03.5, UT03.75, UT04, UT05	Adjacent	34
TVA Embayment	PO01	Adjacent	4

Notes: Four samples collected from the Discharge Channel were not included in the statistical analysis; conditions in the Discharge Channel do not represent natural stream conditions and the Discharge Channel is regulated under a NPDES permit.

Table E.6-2 – CCR Parameters Evaluated in Statistical Analysis

CCR Parameter	CASRN
CCR Rule Appendix III Parameters	
Boron	7440-42-8
Calcium	7440-70-2
Chloride	16887-00-6
Fluoride[1] (also Appendix IV)	16984-48-8
pH	NA
Sulfate	14808-79-8
CCR Rule Appendix IV Parameters	
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Cadmium	7440-43-9
Chromium	7440-47-3
Cobalt	7440-48-4
Lead	7439-92-1
Lithium	7439-93-2
Mercury	7439-97-6
Molybdenum	7439-98-7
Radium-226+228	13982-63-3/ 15262-20-1
Selenium	7782-49-2
Thallium	7440-28-0
TDEC Appendix I Parameters	
Copper	7440-50-8
Nickel	7440-02-0
Silver	7440-22-4
Vanadium	7440-62-2
Zinc	7440-66-6
Other	
% Ash	NA
Strontium	7439-89-6

Notes: CASRN - Chemical Abstracts Service Registry Number; CCR Rule - Title 40, Code of Federal Regulations, Part 257; NA – Not available; TDEC - Tennessee Department of Environment and Conservation
[1]Fluoride is both a CCR Rule Appendix III and CCR Rule Appendix IV CCR parameter. In this table, and in the results figures and tables for this report, fluoride has been grouped with the Appendix III CCR parameters only to avoid duplication.

The following sections present the methods and results from the general exploratory data analysis using summary statistics, data plots, and outlier screening, and a comparison of sediment results to Ecological Screening Levels (ESVs) that were developed for the EAR. The ESVs for the sediment data are provided in Appendix A.2.

Additional statistical analyses (principal component analysis [PCA] and hypothesis testing) were performed if the following conditions were met: 1) CCR Parameter concentrations were above ESVs, and 2) data were collected from transects/locations adjacent, and from transects/locations either upstream or downstream to the CUF Plant CCR management units.

2.0 METHODS

The statistical evaluation for the EI sediment data collected at the CUF Plant was conducted in three parts: 1) exploratory data analysis, 2) comparison of results to EAR screening levels, and 3) additional statistical analysis, when warranted.

2.1 EXPLORATORY DATA ANALYSIS

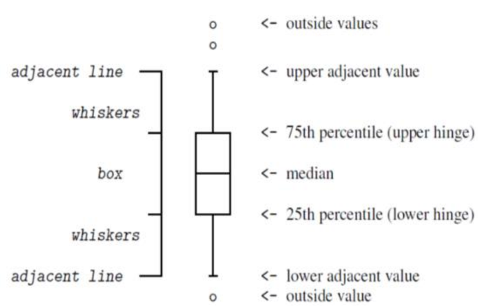
Exploratory data analysis is the initial step of statistical analysis. It utilizes simple summary statistics (e.g. mean, median, standard deviation, and percentiles) and graphical representations to identify important characteristics of an analytical dataset, such as the center of the data (mean, median), variation, distribution, spatial or temporal patterns, presence of outliers, and randomness.

2.1.1 Summary Statistics

Summary statistics were calculated for each CCR parameter grouped by water body and aggregated by the transect position relative to the CUF Plant CCR management units (upstream, adjacent, and downstream). Summary statistics also were calculated for percent (%) ash and strontium. Summary statistics include information such as the total numbers of available samples, the frequencies of detection, ranges of reporting limits, minimum and maximum detected concentrations, mean concentrations, standard deviations, median concentrations and the 95th percentile concentrations. Summary statistics tables are presented in Attachment E.6-A.

2.1.2 Exploratory Data Plots

Exploratory data plots (box plots and transect plots) were constructed using the sediment results to support a visual review of the data. Box plots are used to identify the center of the data, distribution, and variability, and to visually identify potential outliers. The diagram below graphically depicts the basics of the construction of the box plots (StataCorp LLC 2017).



The box portion of the plot is the interquartile range (IQR), which represents the middle 50% of data, with the bottom of the box being the 25th percentile and the top of the box being the 75th percentile. The line inside the box is the median concentration. The top of the upper “whisker” represents the first observed concentration above the 75th percentile, whereas the bottom of the lower “whisker” represents the first observed concentration below the 25th percentile (upper adjacent value and lower adjacent value, respectively). Values that lie outside of the adjacent values represent outside (potential outlier) concentrations (i.e. concentrations at the upper and lower ends of the distribution of the data). The method detection limit (MDL) was used as the reported value in order to construct the box plot when analytical results were reported as non-detects.

Side-by-side box plots were constructed for the sediment data aggregated by transect and water body. These box plots were useful in identifying differences in CCR Parameter concentrations among transects and water bodies and were especially useful for visually identifying potential outliers.

Box plots were also prepared that compared results by transect in an individual water body. Transects ordered by relative location to the CUF Plant CCR management units (upstream, adjacent, downstream) were useful in assessing upstream to downstream patterns within a given water body, as well as data distribution and variability. This type of box plot was not constructed for the TVA embayment since there were only four samples collected from one transect. Box plots are presented for CCR Rule Appendix III, CCR Rule Appendix IV, and TDEC Appendix I CCR parameters in Attachment E.6-B.

Transect plots were constructed for each water body and show individual sample results aggregated by transect position relative to the CUF Plant CCR management units (upstream, adjacent, or downstream) and relative position within the water body (right bank, center channel, or left bank).

- Cumberland River: Left Bank = Fossil Plant Bank; Right Bank = Opposite Bank
- Wells Creek and Unnamed Tributary: Left Bank = Opposite Bank; Right Bank = Fossil Plant Bank

The symbols used in the transect plots indicate whether the reported result is a detected concentration (solid symbol) or a non-detect reported at the MDL (hollow symbol). No transect plots were constructed for the TVA embayment since there are only four samples collected from one transect.

Two transect plots were constructed for each CCR Parameter. One was a plot that included a reference line for the ESV for that parameter. In many cases, the sample results were much lower than the ESVs, so including the reference line induced a scaling effect that obscured patterns in the data. A second plot was produced for each CCR Parameter without a reference line in order to better identify patterns.

Transect plots provide more detailed information than side-by-side box plots and allow a more rigorous evaluation of the data. These plots are particularly useful in identifying potential patterns in the dataset (trends), frequency of detection, outliers, spatial differences relative to the CUF Plant CCR management units (upstream, adjacent, and downstream), and differences relative to the position in the water body (right bank, center channel, or left bank). The transect plots are presented in Attachment E.6-C.

2.1.3 Outlier Screening

Outliers are data points that are abnormally high or low as compared to other measurements and may represent anomalous data or data errors. Outliers may also represent natural variations of CCR Parameter concentrations in environmental systems. Screening for outliers is a critical step because outliers can bias statistical estimates, statistical testing results, and inferences.

Outlier values were initially screened visually using the side-by-side box plots. If suspected visual outliers were identified, then Tukey's procedure was used to identify extreme outliers (Tukey 1977). This method relies on the IQR, which is defined as the 75th percentile value minus the 25th percentile value. Values were identified as potential outliers as follows:

- **Lower extreme outliers** are less than the 25th percentile minus 3 x IQR
- **Upper extreme outliers** are greater than the 75th percentile plus 3 x IQR.

Finally, when the potential outliers were identified visually and by Tukey's procedure, then statistical testing for outliers (Dixon or Rosner's Test) was conducted to determine if those data points were statistically significant outliers.

Following confirmation of the outliers as statistically significant, a desktop evaluation was conducted to verify that the data points were not errors, (e.g., laboratory or transcriptional errors). Field forms, data validation reports, and other variables in the dataset that could influence analytical results also were evaluated at this point. If a verifiable error was discovered, the outlier was removed and, if possible, replaced with a corrected value.

In the absence of a verifiable error, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability). If an outlier was identified as suitable for removal from further statistical analysis, a clear and defensible rationale based on multiple lines of evidence was provided. In addition, values that were identified as outliers and removed from further evaluation in the present statistical analysis were retained in the historical database and will be reevaluated for inclusion or exclusion in future statistical analyses of this dataset. The results of the outlier screening for the CUF Plant sediment dataset are provided in Section 3.1.

2.2 COMPARISON OF SEDIMENT RESULTS TO ESVS

The analytical results for the sediment dataset were compared to ESVs, as provided in Appendix A.2. Comparisons were done graphically using transect plots for sample results from the Cumberland River, Wells Creek, and the Unnamed Tributary (Attachment E.6-C). Analytical results were also compared to ESVs in tabular format for these water bodies as well as the TVA Embayment and are presented in Tables in Appendix J.3.

Additional statistical analyses were performed if the following conditions were met: 1) CCR Parameter concentrations were above ESVs and 2) data were collected from transects/locations adjacent, and from transects/locations either upstream or downstream to the CUF Plant CCR management units.

This additional statistical evaluation included:

- Formal hypothesis testing to identify differences between upstream, adjacent, and downstream results, and
- PCA to identify the variables and individual samples that explain the greatest proportion of variability (provide the greatest amount of information) in the datasets.

3.0 RESULTS AND DISCUSSION

3.1 SUMMARY STATISTICS, EXPLORATORY DATA PLOTS, AND OUTLIER SCREENING

Summary statistics tables are presented in Attachment E.6-A, box plots are presented in Attachment E.6-B, and transect plots are presented in Attachment E.6-C. Box plots and transect plots that were used to identify the potential statistical outliers are presented in Attachment E.6-D. The summary statistics and exploratory data plots were aggregated by water body and transect location relative to the CUF Plant CCR management units (upstream, adjacent, downstream) and sample position in the water body (right bank, center channel, and left bank).

The outlier screening method described in Section 2.1.3 identified two outliers that were determined to be suitable for removal from further statistical analysis (Table E.6-3). These outliers were initially identified using exploratory data plots (see Attachment E.6-D) and confirmed as statistical outliers using Rosner's Outlier Test (p-value<0.01) and the Tukey's Extreme Outlier Test. Subsequently, additional lines of evidence were reviewed to determine final outlier disposition (e.g., frequency of detection, spatial and temporal variability).

For each of the outliers identified for exclusion from further statistical analysis in Table E.6-3, this exclusion was supported by a spatial review that compared the magnitude of the outlier result to the distribution of concentrations for that parameter in sediment at the sampled locations in Cumberland River, Wells Creek, the TVA Embayment, and the Unnamed Tributary. This spatial comparison was supported by a visual review of the box-plots and transect plots for these parameters in sediment samples as presented in Appendix E.6-D. The results of this spatial review indicated that the outliers in Table E.6-3 represent values that are considerably separated from all other sediment concentrations for that parameter for samples collected in the vicinity of the CUF plant from Cumberland River, Wells Creek, the TVA Embayment, and the Unnamed Tributary. As such, these results were outliers not only for the individual sampling locations where they were collected but were also outliers in the context of a much larger dataset. Inclusion of outliers that are well-separated from the dominant data in statistical analysis can distort calculated decision statistics, which may in turn lead to incorrect remediation decisions (USEPA 2022). It is preferable to compute environmental statistics based on datasets that represent the main population (USEPA 2022).

Furthermore, since both of the outliers identified in Table E.6-3 were collected in Wells Creek at location WC09 in 2018, this location was resampled in 2019 and the 2019 results were not statistical outliers in comparison to other sediment concentration results for these parameters collected in the vicinity of the CUF plant from Cumberland River, Wells Creek, the TVA Embayment, and the Unnamed Tributary. This provides evidence that the outliers identified in the 2018 dataset are not representative of conditions at the Site. Therefore, the outlier results identified in Table E.6-3 were removed from further statistical analysis in the EAR (i.e., excluded from the summary statistics, box-plots, and transect plots presented in Attachments E.6-A, E.6-B, and E.6-C, respectively) and replaced with values from the 2019 analysis.

However, these outliers remain in the historical dataset and will require reevaluation for inclusion/ exclusion if these data are analyzed in future reports.

Table E.6-3. Statistically Significant Outliers – CUF Plant, Sediment

CCR Parameter	Water body	Sample Location	Sample ID	Lowest Applicable Ecological Screening Value (ESV)	Does Outlier Exceed Lowest Applicable ESV?	Outlier Value (2018)	Resample Result (2019)
Arsenic	Wells Creek	WC09 (Adjacent to CUF Plant)	CUF-SED-WC09-CORCC-0.0/0.5-20181011	9.8 mg/kg (Chronic ESV)	No	29.7 mg/kg	4.69 mg/kg
Molybdenum	Wells Creek	WC09 (Adjacent to CUF Plant)	CUF-SED-WC09-CORCC-0.0/0.5-20181011	38 mg/kg (Chronic ESV)	No	29.9 mg/kg	0.810 mg/kg

3.2 COMPARISON OF SEDIMENT RESULTS TO ESVs

A summary of sediment result comparisons to ESVs for each water body included in the statistical evaluations is provided below. This comparison excludes sample results determined to be statistical outliers as described in Section 3.1.

Cumberland River

- No sample results were above chronic ESVs or acute ESVs.

Wells Creek

- Beryllium – two samples (CUF-SED-WC08-CORCC-0.0/0.5-20181011 [1.36 mg/kg] and CUF-SED-WC09-CORCC-0.0/0.5-20181011 [1.52 mg/kg]) had concentrations above the chronic ESV (1.2 mg/kg)
- No sediment sample results collected from Wells Creek were above the acute ESV.

Unnamed Tributary

- % ash was above the 20% Phase 2 trigger level in 12 samples collected from the Unnamed Tributary, with results ranging from 21% to 41%. Nine of the sample results were collected during Phase 1 sampling and three were collected during Phase 2 sampling.
- Two % ash sample results were equal to or above the acute ESV (40%):
    - CUF-SED-UT02-CORCC-0.0/0.5-20190821 - 41% (Phase 1 sampling event)

    - CUF-SED-UT0.5-CORLB-0.0/0.3-20210729 - 40% (Phase 2 sampling event).
- Arsenic - four samples had concentrations above the chronic ESV (9.8 mg/kg):
    - CUF-SED-UT02-CORCC-0.0/0.5-20190821 - 12.3 mg/kg (Phase 1 sampling event)
    - CUF-SED-UT0.5-CORLB-0.0/0.3-20210729 - 10.3 mg/kg (Phase 2 sampling event)
    - CUF-SED-UT0.5-CORRB-0.0/0.5-20210729 - 12.7mg/kg (Phase 2 sampling event)
    - CUF-SED-UT01-CORRB-0.0/0.5-20210625 - 14.9 mg/kg (Phase 2 sampling event).
- Barium - four samples had concentrations above the chronic ESV (240 mg/kg):
    - CUF-SED-UT02-CORCC-0.0/0.5-20190821 - 448 mg/kg (Phase 1 sampling event)
    - CUF-SED-UT01.5-CORLB-0.0/0.5-20210623 – 265 mg/kg (Phase 2 sampling event)
    - CUF-SED-UT01-CORRB-0.0/0.5-20210625 – 618 mg/kg (Phase 2 sampling event)
    - CUF-SED-UT0.5-CORRB-0.0/0.5-20210729 – 348 mg/kg (Phase 2 sampling event).
- Molybdenum – 21 samples had concentrations above the chronic ESV (38 mg/kg), with concentrations ranging from 42 mg/kg to 1,090 mg/kg. Nine of the sample results were collected during Phase 1 sampling and 12 were collected during Phase 2 sampling.
- Selenium - two samples had concentrations above the chronic ESVs (2 mg/kg):
    - CUF-SED-UT01.5-CORCC-0.0/0.5-20190821 - 2.51 mg/kg (Phase 1 sampling event)
    - CUF-SED-UT02-CORCC-0.0/0.5-20190821 - 2.56 mg/kg (Phase 1 sampling event).

Additional statistical evaluation of CCR parameters identified above ESVs are described in the following section. Additional evaluation of CCR parameters above ESVs will also be provided in the context of the Corrective Action/Risk Assessment Plan.

3.3 ADDITIONAL STATISTICAL ANALYSES

3.3.1 Formal Hypothesis Testing

A summary of the results of hypothesis testing applied to identify differences between upstream, adjacent, and downstream results for each water body evaluated in the statistical analyses is provided below. Differences were considered statistically significant if the p-value of the test was below 0.05. No results are provided for Cumberland River given that there were no sample results above chronic ESVs or acute ESVs in sediment in Cumberland River that warranted further evaluation.

Wells Creek

- Two results for beryllium in Wells Creek were above ESVs. Sediment data from Wells Creek were collected from adjacent and upstream transects, so upstream concentrations of beryllium were compared to adjacent concentrations using a parametric two-sided two-sample t-test. Prior to statistical testing, the statistical assumptions of the two-sample t-test (normality and equality of variances) were evaluated visually using Normal Q-Q plots and statistically with Goodness of Fit testing (normality) and Bartlett's Test for Equal Variance. Both the upstream and adjacent datasets were normally distributed with unequal variance. The Welch-Satterthwaite adjustment to the degrees of freedom of the test was used to account for unequal variance between the two datasets. The results of the two-sample t-tests for beryllium in Wells Creek sediment (adjacent vs. upstream) are summarized below:
    - The mean beryllium concentration adjacent to the CUF Plant CCR management units (0.915 mg/kg) was statistically significantly greater than the mean upstream concentration (0.532 mg/kg) (p-value<0.05).

Unnamed Tributary

- There were CCR Parameter concentrations above ESVs in the Unnamed Tributary; however, the sampled transects in the Unnamed Tributary were all adjacent to the CUF Plant CCR management units, therefore, formal statistical testing to identify differences in CCR Parameter concentrations upstream, adjacent, and downstream was not used.

3.3.2 Principal Component Analysis

PCA is an exploratory statistical method used to summarize and condense the information in large multivariate datasets to a small subset of components/dimensions without losing important information. PCA was used to identify the key CCR Parameters accounting for most of the variation in the dataset and to identify individual samples or sample groups that explain the greatest proportion of variability (information) in the sediment data from Wells Creek. PCA was not applied to the sediment data from Cumberland River given that there were no sample results above chronic ESVs or acute ESVs in sediment in Cumberland River that warranted further evaluation. PCA was not applied to data collected from the Unnamed Tributary because all samples were collected adjacent to the CUF Plant CCR management units.

As part of the PCA, three types of plots were produced. The scree plot shows the percentage of variation in the dataset explained by variables associated with the principal component. The key variables are presented in a bar chart for the first two principal components/dimensions. The key individual samples are presented on a bi-plot. In that plot, samples that explain more variation are more distant from the intersection of the dimension 1 and dimension 2 axes. Attachment E.6-E presents these plots for sediment data collected from Wells Creek; the findings are described below.

Wells Creek

- The first two principal components/dimensions explain 71.9% of the variability in the Wells Creek sediment dataset (i.e. 71.9% of the information in the dataset is retained in the first two components). The PCA identified beryllium as a key CCR Parameter that, alone, explains greater than 6% of the variability in dimension 1. Beryllium was the only CCR Parameter with concentrations above its ESV in Wells Creek sediment.
- The key individual samples were identified as CUF-SED-WC09-CORCC-0.0/0.5-20181011 (bi-plot #24) and CUF-SED-WC08-CORCC-0.0/0.5-20181011 (bi-plot #21). These sample locations correspond to the two beryllium results that were above the ESV.
- The 95% confidence ellipses comparing adjacent to upstream CCR Parameter concentrations do not overlap across dimension 1, which provides statistical evidence that mean CCR Parameter concentrations adjacent to the CUF CCR Management Units are higher compared to upstream CCR Parameter concentrations.

4.0 REFERENCES

StataCorp. (2017). Stata Graphics Reference Manual Stata: Release 15. Statistical Software. College Station, Texas: StataCorp LLC.

Tukey, J.W. (1977). *Exploratory Data Analysis*. Reading, Massachusetts: Addison-Wesley. 1977.

United States Environmental Protection Agency (USEPA) (2022). ProUCL Version 5.2.0 Technical Guide: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Washington DC. USEPA Office of Research and Development.

ATTACHMENT E.6-A
SUMMARY STATISTICS

Summary Statistics - Sediment Investigation Cumberland Fossil Plant - Cumberland City, Tennessee Water body: Cumberland River										
Parameter	Gradient	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Percent Ash										
Ash	Upstream	6/13	(1 - 1)	53.9%	1	2	1.1	0.27	1	1.4
	Adjacent	5/13	(1 - 1)	61.5%	1	3	1.2	0.53	1	1.8
	Downstream	8/13	(1 - 1)	38.5%	1	3	1.4	0.63	1	2.4
CCR Rule Appendix III Parameters										
Boron	Upstream	7/7	--	0.0%	1.09	3	2.24	0.661	2.33	2.91
	Adjacent	6/6	--	0.0%	1.7	3.62	2.56	0.652	2.39	3.45
	Downstream	6/6	--	0.0%	2.08	4.76	2.9	0.958	2.58	4.31
Calcium	Upstream	7/7	--	0.0%	5,280	9,900	6,670	1,720	5,790	9,360
	Adjacent	6/6	--	0.0%	6,200	7,830	7,060	589	7,010	7,760
	Downstream	6/6	--	0.0%	5,340	6,980	5,930	588	5,840	6,770
Chloride	Upstream	0/7	(9.39 - 14.4)	100.0%	--	--	--	--	12.2	14
	Adjacent	0/6	(9.87 - 11.4)	100.0%	--	--	--	--	10.7	11.3
	Downstream	0/6	(10.5 - 26.6)	100.0%	--	--	--	--	11	23
pH(Lab)	Upstream	7/7	--	0.0%	6.7	7.5	7.16	0.299	7.2	7.47
	Adjacent	6/6	--	0.0%	6.8	7.1	7	0.126	7.05	7.1
	Downstream	6/6	--	0.0%	6.8	7.1	6.92	0.0983	6.9	7.05
Sulfate	Upstream	4/7	(14.2 - 43.8)	42.9%	70.1	156	70.3	55	70.1	149
	Adjacent	6/6	--	0.0%	33.8	127	73.8	35.5	68.1	121
	Downstream	5/6	(38.1 - 38.1)	16.7%	82.7	219	118	55.8	111	200
CCR Rule Appendix IV Parameters										
Antimony	Upstream	7/7	--	0.0%	0.103	0.241	0.187	0.0533	0.209	0.236
	Adjacent	6/6	--	0.0%	0.104	0.394	0.208	0.0973	0.186	0.345
	Downstream	6/6	--	0.0%	0.184	0.357	0.249	0.0737	0.217	0.35
Arsenic	Upstream	7/7	--	0.0%	2.74	5.38	4.02	0.895	4.22	5.07
	Adjacent	6/6	--	0.0%	2.72	5.45	3.85	0.929	3.86	5.1
	Downstream	6/6	--	0.0%	3.65	6.08	4.98	0.99	4.92	6.07
Barium	Upstream	7/7	--	0.0%	26.2	85.2	60.9	23.6	65.7	84.5
	Adjacent	6/6	--	0.0%	35.6	66.3	54	13.2	59	65.9
	Downstream	6/6	--	0.0%	60.3	115	80.6	19.1	77.2	108
Beryllium	Upstream	7/7	--	0.0%	0.353	0.846	0.636	0.194	0.67	0.842
	Adjacent	6/6	--	0.0%	0.38	0.663	0.56	0.108	0.59	0.659
	Downstream	6/6	--	0.0%	0.588	0.951	0.74	0.121	0.725	0.907
Cadmium	Upstream	7/7	--	0.0%	0.196	0.856	0.463	0.226	0.387	0.774
	Adjacent	6/6	--	0.0%	0.192	0.54	0.425	0.131	0.455	0.537
	Downstream	6/6	--	0.0%	0.509	0.75	0.609	0.0794	0.602	0.718
Chromium	Upstream	7/7	--	0.0%	7.14	12.6	10.4	1.75	10.9	12.2
	Adjacent	6/6	--	0.0%	7.68	11	9.51	1.31	9.74	10.9
	Downstream	6/6	--	0.0%	10.4	17.6	12.6	2.56	11.9	16.4
Cobalt	Upstream	7/7	--	0.0%	3.44	8.37	6.42	2	7.06	8.26
	Adjacent	6/6	--	0.0%	4.17	7.63	6.05	1.42	6.39	7.5
	Downstream	6/6	--	0.0%	6.87	10.5	8.16	1.32	7.66	10.1
Fluoride	Upstream	0/7	(1.07 - 1.65)	100.0%	--	--	--	--	1.4	1.6
	Adjacent	0/6	(1.13 - 1.34)	100.0%	--	--	--	--	1.23	1.34
	Downstream	0/6	(1.36 - 2.1)	100.0%	--	--	--	--	1.54	2.02
Lead	Upstream	7/7	--	0.0%	6.53	16.1	11.8	3.31	12.7	15.5
	Adjacent	6/6	--	0.0%	8.02	12.7	10.9	1.92	11.3	12.7
	Downstream	6/6	--	0.0%	12.3	27.1	16.9	5.64	14.7	25.3
Lithium	Upstream	7/7	--	0.0%	2.75	10.9	7.38	3.15	7.51	10.8
	Adjacent	6/6	--	0.0%	4.5	7.97	6.34	1.3	6.67	7.75
	Downstream	6/6	--	0.0%	6.65	9.76	8.03	1	7.91	9.37
Mercury	Upstream	1/7	(0.0398 - 0.0588)	85.7%	0.0565	0.0565	0.0426	0.00622	0.0525	0.0581
	Adjacent	0/6	(0.0411 - 0.0491)	100.0%	--	--	--	--	0.045	0.0489
	Downstream	4/6	(0.0505 - 0.0513)	33.3%	0.0488	0.0702	0.0563	0.00815	0.0558	0.0679
Molybdenum	Upstream	6/7	(0.488 - 0.488)	14.3%	0.69	1.12	0.786	0.184	0.757	1.07
	Adjacent	4/6	(0.825 - 0.89)	33.3%	0.482	1.15	0.755	0.277	0.858	1.14
	Downstream	2/6	(0.852 - 0.99)	66.7%	1.34	1.96	1.12	0.417	0.945	1.81
Radium-226+228	Upstream	7/7	--	0.0%	0.537	2.61	1.79	0.824	2.07	2.57
	Adjacent	6/6	--	0.0%	1.33	2.12	1.79	0.354	1.87	2.12
	Downstream	6/6	--	0.0%	1.89	3.08	2.4	0.406	2.42	2.94
Selenium	Upstream	7/7	--	0.0%	0.239	0.544	0.417	0.117	0.467	0.534
	Adjacent	6/6	--	0.0%	0.184	0.495	0.367	0.115	0.389	0.485
	Downstream	6/6	--	0.0%	0.441	0.695	0.539	0.0929	0.53	0.665
Thallium	Upstream	7/7	--	0.0%	0.0561	0.21	0.152	0.0542	0.139	0.21
	Adjacent	6/6	--	0.0%	0.0787	0.206	0.14	0.0513	0.131	0.204
	Downstream	6/6	--	0.0%	0.134	0.293	0.174	0.0594	0.156	0.261

Summary Statistics - Sediment Investigation Cumberland Fossil Plant - Cumberland City, Tennessee Water body: Cumberland River										
Parameter	Gradient	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
TDEC Appendix I Parameters										
Copper	Upstream	7/7	--	0.0%	2.32	10.6	7.17	3.2	8.36	10.3
	Adjacent	6/6	--	0.0%	4.26	9.33	7.25	2.02	7.68	9.25
	Downstream	6/6	--	0.0%	9.89	13.5	11.7	1.23	11.5	13.3
Nickel	Upstream	7/7	--	0.0%	5.21	14	10.1	3.3	10.7	13.6
	Adjacent	6/6	--	0.0%	6.93	11.5	9.43	1.85	9.71	11.4
	Downstream	6/6	--	0.0%	10.4	16	12.4	1.91	12	15.1
Silver	Upstream	7/7	--	0.0%	0.0214	0.051	0.04	0.0117	0.0443	0.0506
	Adjacent	6/6	--	0.0%	0.0313	0.0708	0.0453	0.0145	0.0435	0.0657
	Downstream	6/6	--	0.0%	0.0515	0.324	0.121	0.107	0.0698	0.282
Vanadium	Upstream	7/7	--	0.0%	5.5	16	11.8	4.09	13.4	15.8
	Adjacent	6/6	--	0.0%	7.25	12.7	10.4	2.23	11.2	12.5
	Downstream	6/6	--	0.0%	11.6	20.5	15	3.16	14.2	19.5
Zinc	Upstream	7/7	--	0.0%	25.2	110	55.8	26.9	52.4	96.1
	Adjacent	6/6	--	0.0%	28.3	57.8	47	11	49.9	57.3
	Downstream	6/6	--	0.0%	57.6	76.6	63.9	7.95	60.1	75.2
Other Constituents										
Strontium	Upstream	7/7	--	0.0%	19.3	25.9	22.1	2.56	21.7	25.7
	Adjacent	6/6	--	0.0%	17.2	23.4	21.3	2.43	22.3	23.3
	Downstream	6/6	--	0.0%	20.2	28.6	23.2	3.43	21.6	28
Temp	Upstream	7/7	--	0.0%	20.3	20.8	20.6	0.19	20.6	20.8
	Adjacent	6/6	--	0.0%	20.2	21.4	20.5	0.467	20.3	21.2
	Downstream	6/6	--	0.0%	19.9	20.1	20	0.0753	20	20.1

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

Statistical datasets were aggregated by location of transect relative to the CCR management units (upstream, adjacent, downstream)

Except for Ash, pH & Radium 226 + 228, all units milligrams per kilogram (mg/kg)

Units for Ash are percent (%)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per gram (pCi/g)

All non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

Summary Statistics - Sediment Investigation Cumberland Fossil Plant - Cumberland City, Tennessee Water body: Wells Creek										
Parameter	**Gradient**	**Frequency of Detection**	**Range of Reporting Limits**	**% Non Detect**	**Statistics using Detected Data Only**		**Statistics using all Detects & Non-Detects**			
					Minimum Detect	**Maximum Detect**	**Mean**	**Standard Deviation**	**50th Percentile**	**95th Percentile**
Percent Ash										
Ash	Upstream	15/21	(1 - 1)	28.5%	1	3	1.333	0.563	1	2
	Adjacent	11/36	(1 - 1)	69.4%	1	4	1.389	0.756	1	3
CCR Rule Appendix III Parameters										
Boron	Upstream	8/8	--	0.0%	0.663	2.37	1.347	0.501	1.285	2.097
	Adjacent	22/24	(4.77-13.2)	8.3%	2.12	21.7	6.159	4.961	4.115	17.79
Calcium	Upstream	8/8	--	0.0%	667	5,950	3,580	1,740	4,055	5,541
	Adjacent	24/24	--	0.0%	3,380	17,700	10,712	3,775	11,000	15,880
Chloride	Upstream	1/8	(9.43-22.5)	87.5%	90.5	90.5	19.56	26.81	10.7	66.7
	Adjacent	8/24	(7.82-41.6)	66.7%	63.6	395	52.03	86.35	16.75	177.1
pH(Lab)	Upstream	8/8	--	0.0%	7	7.3	7.163	0.106	7.15	7.3
	Adjacent	24/24	--	0.0%	6.7	7.7	7.138	0.245	7.1	7.585
Sulfate	Upstream	3/8	(12.3-21.5)	62.5%	37.8	60.1	25.31	17.78	18.55	54.15
	Adjacent	24/24	--	0.0%	26	665	212.5	185.2	162.5	577.4
CCR Rule Appendix IV Parameters										
Antimony	Upstream	8/8	--	0.0%	0.133	0.215	0.175	0.0278	0.175	0.209
	Adjacent	24/24	--	0.0%	0.152	1.48	0.299	0.257	0.243	0.422
Arsenic	Upstream	8/8	--	0.0%	2.53	3.78	3.009	0.443	2.935	3.633
	Adjacent	24/24	--	0.0%	2.33	29.7	5.336	5.396	4.115	8.877
Barium	Upstream	8/8	--	0.0%	19.8	57.8	39.9	13.39	38.6	57.28
	Adjacent	24/24	--	0.0%	29.8	101	70.97	17.64	70.05	100.5
Beryllium	Upstream	8/8	--	0.0%	0.446	0.684	0.532	0.089	0.517	0.653
	Adjacent	24/24	--	0.0%	0.54	1.52	0.875	0.221	0.806	1.317
Cadmium	Upstream	8/8	--	0.0%	0.259	0.533	0.423	0.0859	0.417	0.531
	Adjacent	24/24	--	0.0%	0.404	0.736	0.605	0.0848	0.609	0.724
Chromium	Upstream	8/8	--	0.0%	15.7	30.9	19.58	4.82	18.15	27.33
	Adjacent	24/24	--	0.0%	10.9	29.6	16.06	4.154	15.05	23.67
Cobalt	Upstream	8/8	--	0.0%	5.87	9.96	7.913	1.521	7.995	9.848
	Adjacent	24/24	--	0.0%	6.4	14.3	9.823	2.079	9.655	13.87
Fluoride	Upstream	0/8	(1.08-1.59)	100.0%	N/A	N/A	N/A	N/A	1.29	1.587
	Adjacent	0/24	(1.1-2.49)	100.0%	N/A	N/A	N/A	N/A	1.665	1.988
Lead	Upstream	8/8	--	0.0%	5.02	13.7	9.471	3.073	9.21	13.32
	Adjacent	24/24	--	0.0%	8.66	29	14.64	3.964	13.6	19.79
Lithium	Upstream	8/8	--	0.0%	1.12	4.58	3.16	1.063	3.225	4.423
	Adjacent	24/24	--	0.0%	3.57	10	6.53	1.627	6.63	8.902
Mercury	Upstream	4/8	(0.0419-0.0475)	50.0%	0.0487	0.0641	0.0503	0.0094	0.0481	0.0634
	Adjacent	20/24	(0.0634-0.0715)	16.7%	0.0369	0.0816	0.0641	0.0116	0.068	0.0782
Molybdenum	Upstream	8/8	--	0.0%	0.422	0.61	0.493	0.0742	0.476	0.601
	Adjacent	24/24	--	0.0%	0.353	29.9	1.92	5.966	0.645	1.524
Radium-226+228	Upstream	8/8	--	0.0%	0.523	2.28	1.50	0.568	1.361	2.266
	Adjacent	20/20	--	0.0%	1.845	4.15	2.78	0.603	2.765	3.533
Selenium	Upstream	8/8	--	0.0%	0.164	0.587	0.375	0.129	0.368	0.552
	Adjacent	24/24	--	0.0%	0.228	1.81	0.677	0.383	0.573	1.589
Thallium	Upstream	8/8	--	0.0%	0.0606	0.154	0.117	0.0299	0.124	0.149
	Adjacent	24/24	--	0.0%	0.134	0.278	0.2	0.0339	0.2	0.255
TDEC Appendix I Parameters										
Copper	Upstream	8/8	--	0.0%	2.87	11.5	7.264	2.753	7.22	10.83
	Adjacent	24/24	--	0.0%	5.32	16.3	10.52	2.412	10.3	13.99
Nickel	Upstream	8/8	--	0.0%	8.58	14.1	11.16	1.962	11.4	13.58
	Adjacent	24/24	--	0.0%	9.47	18.5	13.43	2.559	13.45	16.96
Silver	Upstream	8/8	--	0.0%	0.0611	0.141	0.0957	0.0288	0.0915	0.138
	Adjacent	24/24	--	0.0%	0.037	0.0858	0.0561	0.0102	0.056	0.0676
Vanadium	Upstream	8/8	--	0.0%	14.3	23.1	18.49	3.542	18.45	23
	Adjacent	24/24	--	0.0%	14.2	50.9	21.1	7.364	19.8	26.82
Zinc	Upstream	8/8	--	0.0%	32.3	57.4	44.99	8.687	46.3	55.3
	Adjacent	24/24	--	0.0%	43.4	79.6	58.58	9.592	57.95	72.39
Other Constituents										
Strontium	Upstream	8/8	--	0.0%	2.56	12.7	8.621	3.126	9.02	12.07
	Adjacent	24/24	--	0.0%	9.55	43	19.39	7.146	18.7	28.97

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

"--" - Not Applicable

% - Percent

Statistical datasets were aggregated by location of transect relative to the CCR management units (upstream, adjacent, downstream)

Except for Ash, pH & Radium 226 + 228, all units milligrams per kilogram (mg/kg)

Units for Ash are percent (%)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per gram (pCi/g)

All non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

Summary Statistics - Sediment Investigation Cumberland Fossil Plant - Cumberland City, Tennessee Water body: Unnamed Tributary										
Parameter	Gradient	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Percent Ash										
Ash	Adjacent	34/38	(1 - 1)	10.5%	1	41	12.6	11.7	7	33.2
CCR Rule Appendix III Parameters										
Boron	Adjacent	27/34	(12.2-24.7)	20.6%	14.6	204	45.52	42.38	31.7	114.8
Calcium	Adjacent	34/34	--	0.0%	7,780	112,000	54,849	27,182	50,450	99,980
Chloride	Adjacent	33/34	(12.6-12.6)	2.9%	36.3	1050	240	263.3	114	768.3
pH(Lab)	Adjacent	34/34	--	0.0%	7.1	8.2	7.456	0.229	7.4	7.835
Sulfate	Adjacent	34/34	--	0.0%	43.3	18600	1956	3157	1160	3881
CCR Rule Appendix IV Parameters										
Antimony	Adjacent	34/34	--	0.0%	0.108	0.515	0.237	0.0787	0.23	0.35
Arsenic	Adjacent	34/34	--	0.0%	3.01	14.9	6.744	2.711	6.155	12.44
Barium	Adjacent	34/34	--	0.0%	43.3	618	160.3	119.5	136	383
Beryllium	Adjacent	34/34	--	0.0%	0.458	1.26	0.919	0.189	0.952	1.151
Cadmium	Adjacent	34/34	--	0.0%	0.139	0.539	0.328	0.0998	0.31	0.498
Chromium	Adjacent	34/34	--	0.0%	10	21.9	15.41	3.017	14.8	21.48
Cobalt	Adjacent	34/34	--	0.0%	5.26	25.7	10.57	3.707	10.15	16.62
Fluoride	Adjacent	26/34	(1.71-4.3)	23.5%	2.06	8.68	4.366	1.891	4.295	7.478
Lead	Adjacent	34/34	--	0.0%	7.93	20	14.43	3.183	14.55	19.57
Lithium	Adjacent	34/34	--	0.0%	5.14	16.4	9.542	2.916	9.02	15.27
Mercury	Adjacent	28/34	(0.0547-0.0744)	17.7%	0.0225	0.0821	0.0502	0.0141	0.054	0.0765
Molybdenum	Adjacent	34/34	--	0.0%	6.38	1090	161.7	240.5	73.05	664.8
Radium-226+228	Adjacent	16/16	--	0.0%	1.229	3.12	2.058	0.571	2.043	3.06
Selenium	Adjacent	34/34	--	0.0%	0.308	2.56	1.106	0.608	0.856	2.153
Thallium	Adjacent	34/34	--	0.0%	0.199	0.711	0.361	0.111	0.371	0.554
TDEC Appendix I Parameters										
Copper	Adjacent	34/34	--	0.0%	6.98	16.2	11.95	2.174	11.8	15.21
Nickel	Adjacent	34/34	--	0.0%	9.1	24.1	15.47	3.647	15	21.07
Silver	Adjacent	25/34	(0.0339-0.0713)	26.5%	0.0362	0.0821	0.0448	0.0101	0.0442	0.0686
Vanadium	Adjacent	34/34	--	0.0%	14.8	39.5	27.06	5.64	26.1	35.69
Zinc	Adjacent	34/34	--	0.0%	26.1	91.5	57.35	16.44	55.1	85.77
Other Constituents										
Strontium	Adjacent	34/34	--	0.0%	18.8	132	73.52	33.53	67.85	128.1

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

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Units for Ash are percent (%)

Units for pH are Standard Units (S.U.)

Units for Radium 226+228 are picocuries per gram (pCi/g)

All non-detects reported at the method detection limit

For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

Summary Statistics - Sediment Investigation Cumberland Fossil Plant - Cumberland City, Tennessee Water body: TVA Embayment										
Parameter	Gradient	Frequency of Detection	Range of Reporting Limits	% Non Detect	Statistics using Detected Data Only		Statistics using all Detects & Non-Detects			
					Minimum Detect	Maximum Detect	Mean	Standard Deviation	50th Percentile	95th Percentile
Percent Ash										
Ash	Adjacent	5/6	(1 - 1)	16.7%	1	3	1.3	0.75	1	2.5
CCR Rule Appendix III Parameters										
Boron	Adjacent	4/4	--	0.0%	3.16	4.85	4.14	0.763	4.27	4.82
Calcium	Adjacent	4/4	--	0.0%	5,820	16,400	13,000	4,860	14,900	16,300
Chloride	Adjacent	4/4	--	0.0%	25.9	47	35.8	11.1	35.1	46.5
pH(Lab)	Adjacent	4/4	--	0.0%	7	7.2	7.13	0.0957	7.15	7.2
Sulfate	Adjacent	4/4	--	0.0%	43.5	1050	429	443	311	956
CCR Rule Appendix IV Parameters										
Antimony	Adjacent	4/4	--	0.0%	0.125	0.251	0.198	0.0562	0.209	0.248
Arsenic	Adjacent	4/4	--	0.0%	3.95	8.01	6.17	1.82	6.36	7.89
Barium	Adjacent	4/4	--	0.0%	38.9	81.9	67.2	19.9	74.1	81.7
Beryllium	Adjacent	4/4	--	0.0%	0.38	0.914	0.675	0.224	0.703	0.89
Cadmium	Adjacent	4/4	--	0.0%	0.22	0.43	0.329	0.0858	0.333	0.415
Chromium	Adjacent	4/4	--	0.0%	9.32	18.5	14.6	3.85	15.3	18.1
Cobalt	Adjacent	4/4	--	0.0%	7.15	14	10.2	2.83	9.91	13.4
Fluoride	Adjacent	0/4	(1.28 - 2.45)	100.0%	--	--	--	--	2.11	2.45
Lead	Adjacent	4/4	--	0.0%	8.53	18.3	14.4	4.35	15.4	18.1
Lithium	Adjacent	4/4	--	0.0%	3.8	8.77	6.89	2.15	7.49	8.58
Mercury	Adjacent	4/4	--	0.0%	0.0479	0.0693	0.0621	0.0096	0.0655	0.0687
Molybdenum	Adjacent	4/4	--	0.0%	0.515	1.18	0.897	0.29	0.947	1.16
Selenium	Adjacent	4/4	--	0.0%	0.431	0.648	0.525	0.0903	0.51	0.628
Thallium	Adjacent	4/4	--	0.0%	0.154	0.283	0.222	0.0529	0.225	0.275
TDEC Appendix I Parameters										
Copper	Adjacent	4/4	--	0.0%	8.51	15.7	13.3	3.27	14.4	15.6
Nickel	Adjacent	4/4	--	0.0%	9.69	19.5	15.2	4.08	15.7	19
Silver	Adjacent	4/4	--	0.0%	0.0343	0.0699	0.0566	0.0155	0.0612	0.0689
Vanadium	Adjacent	4/4	--	0.0%	15.7	28.6	22.7	5.45	23.3	28
Zinc	Adjacent	4/4	--	0.0%	34.7	64.6	52	12.5	54.4	63.2
Other Constituents										
Strontium	Adjacent	4/4	--	0.0%	22.8	34.7	28.4	5.73	28.1	34.3

Notes:

CCR Rule - Title 40, Code of Federal Regulations, Part 257

TDEC - Tennessee Department of Environment and Conservation

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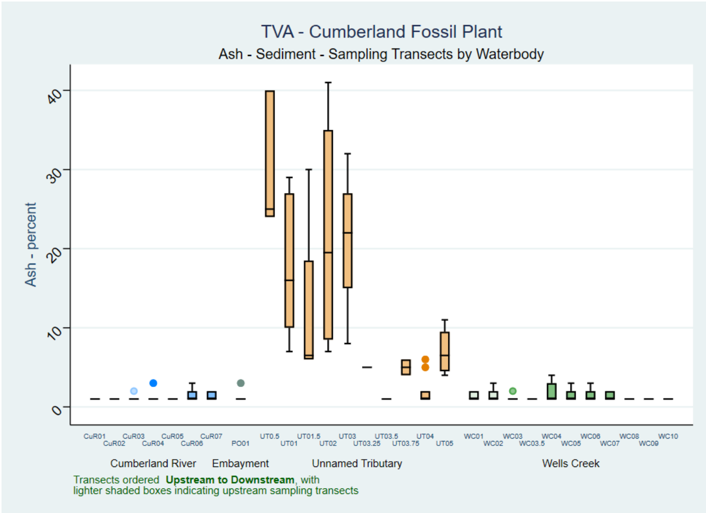
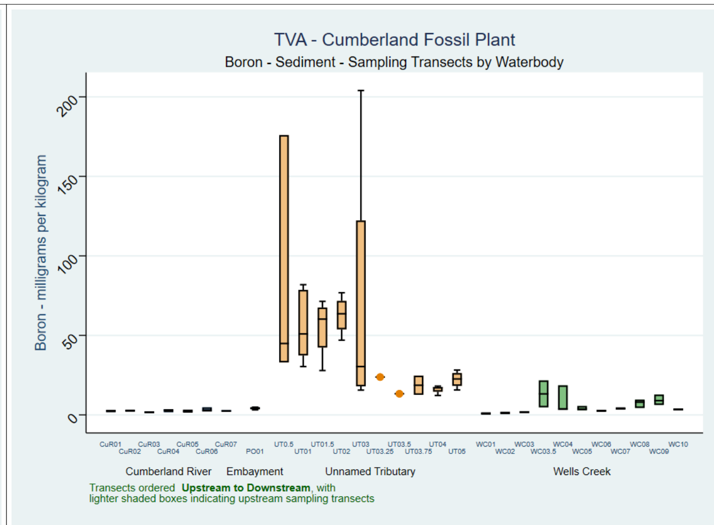
% - Percent

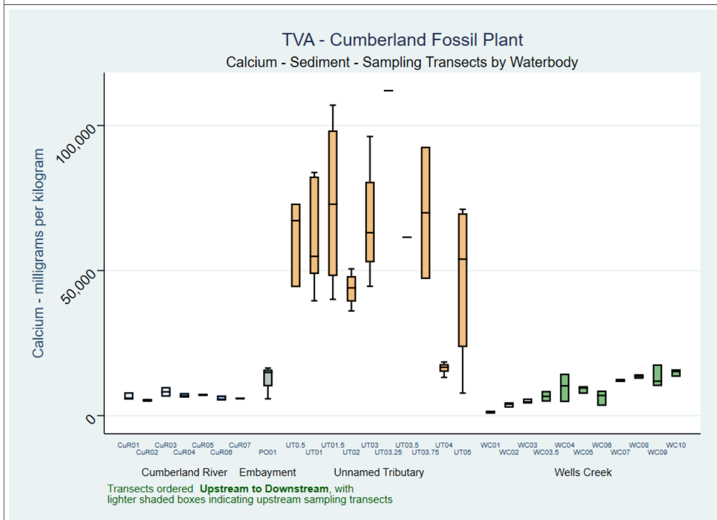
Except for Ash, pH & Radium 226 + 228, all units milligrams per kilogram (mg/kg)
Units for Ash are percent (%)
Units for pH are Standard Units (S.U.)
Units for Radium 226+228 are picocuries per gram (pCi/g)
All non-detects reported at the method detection limit
For Parameters with non-detects reported at the method detection limit, the mean and standard deviation were calculated using Kaplan-Meier methods (KM).

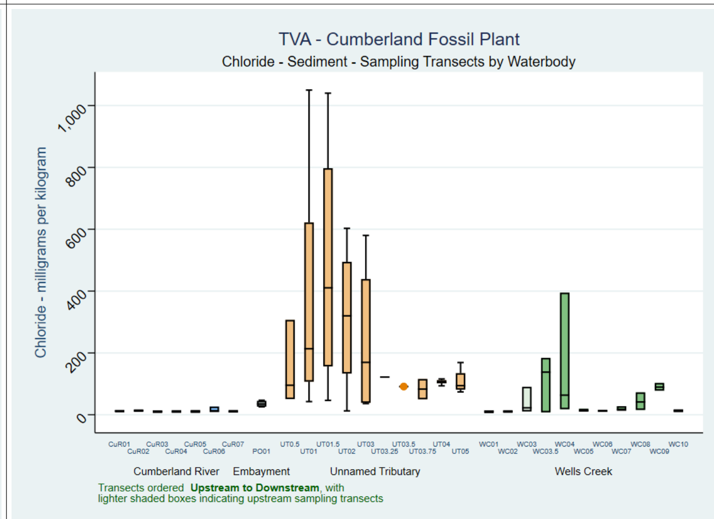
ATTACHMENT E.6-B
BOX PLOTS

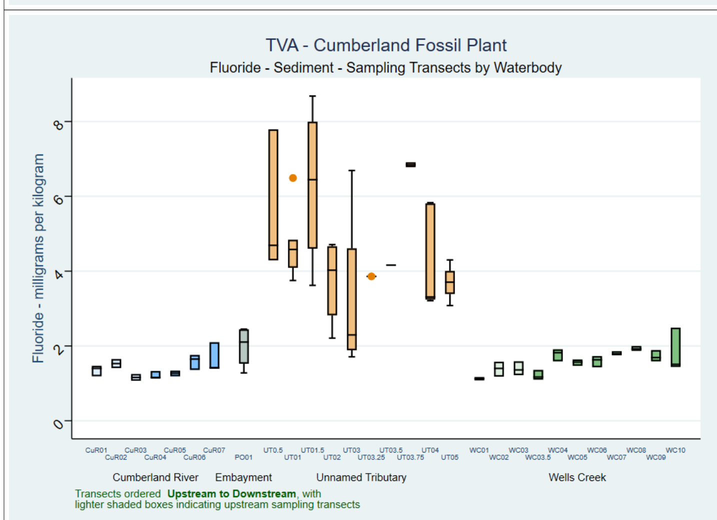
Box Plots
All Transects - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee

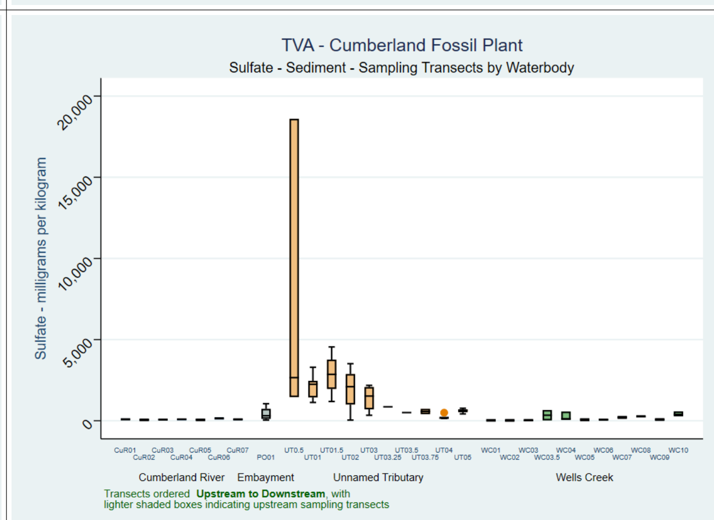


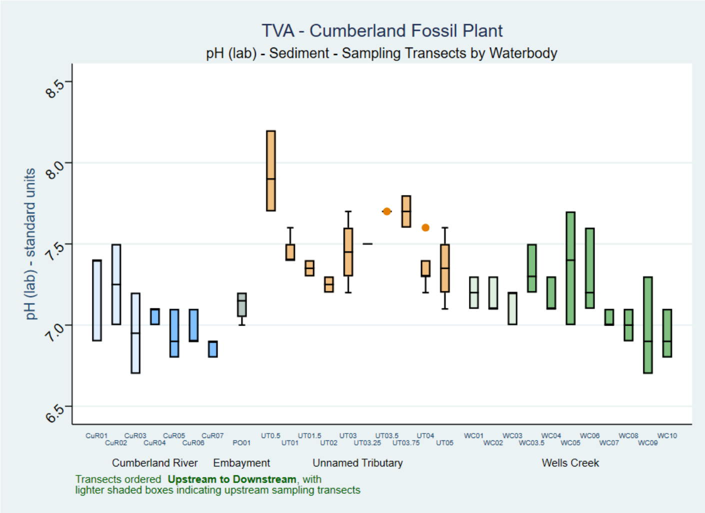












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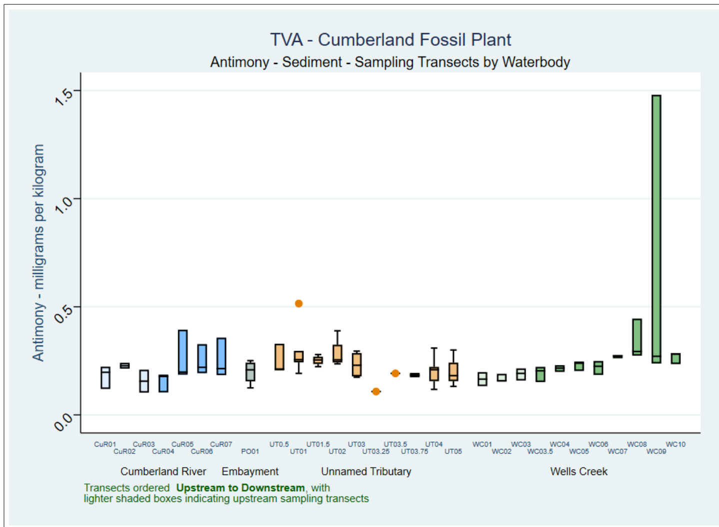
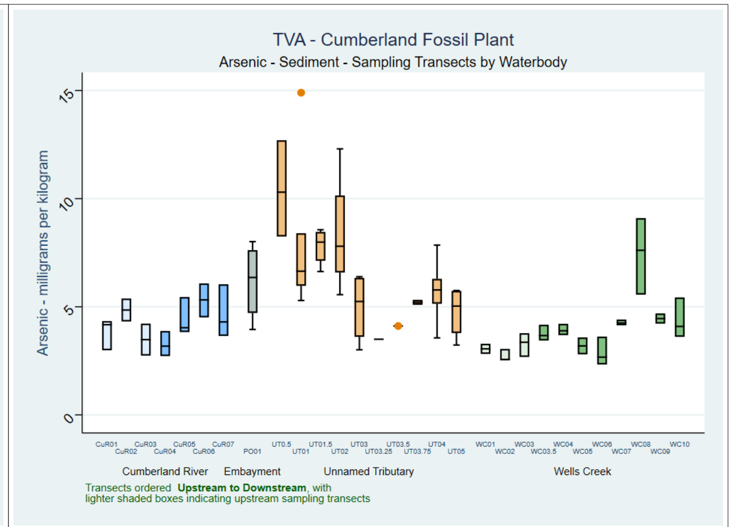
Box Plots

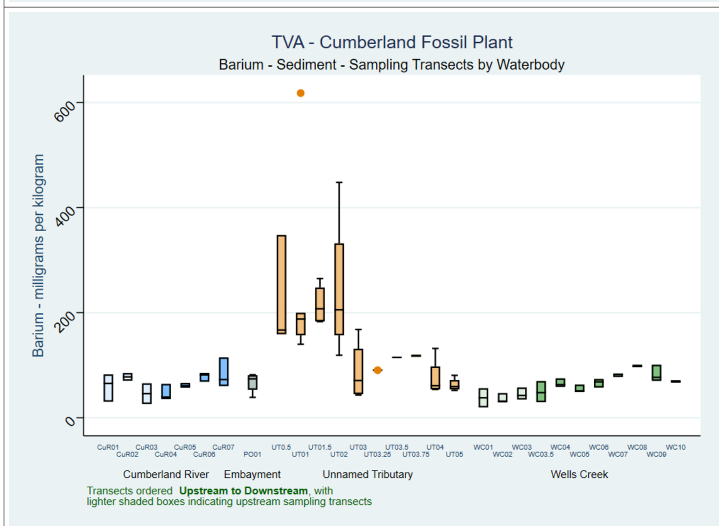
All Transects - CCR Rule Appendix IV Parameters

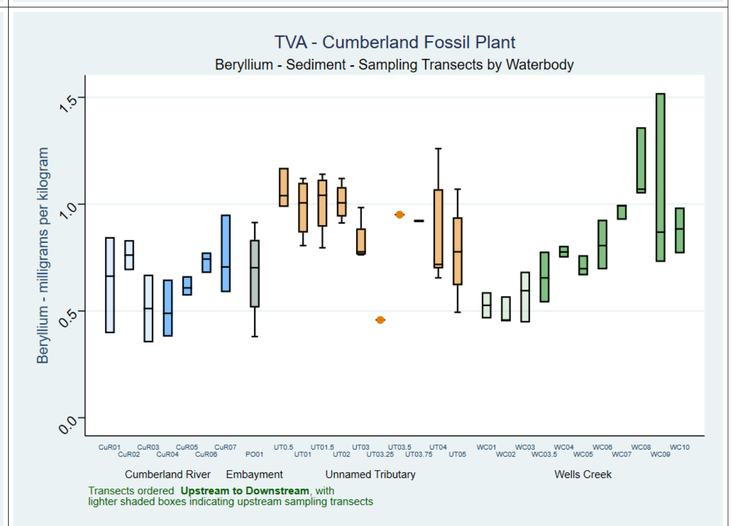
Sediment and Benthic Investigation - EI and Phase II Sampling Results

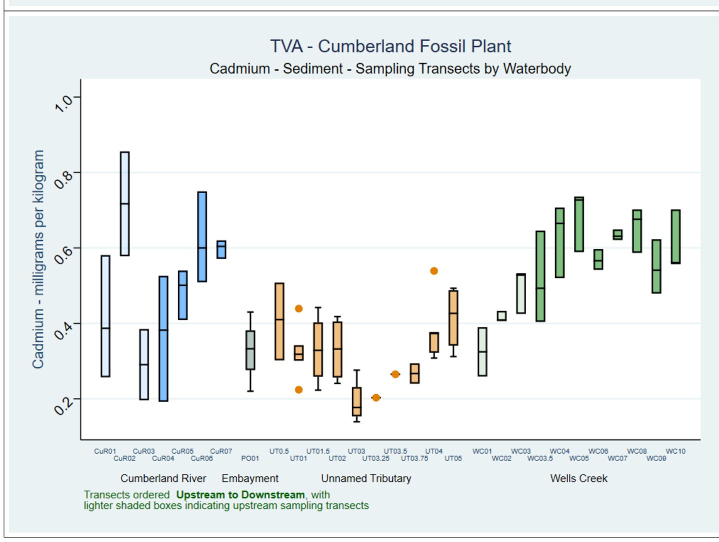
Cumberland Fossil Plant, Cumberland City, Tennessee

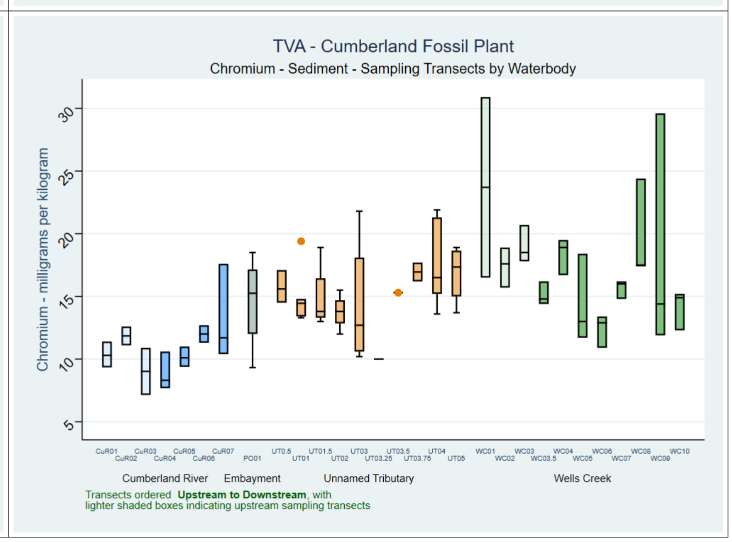


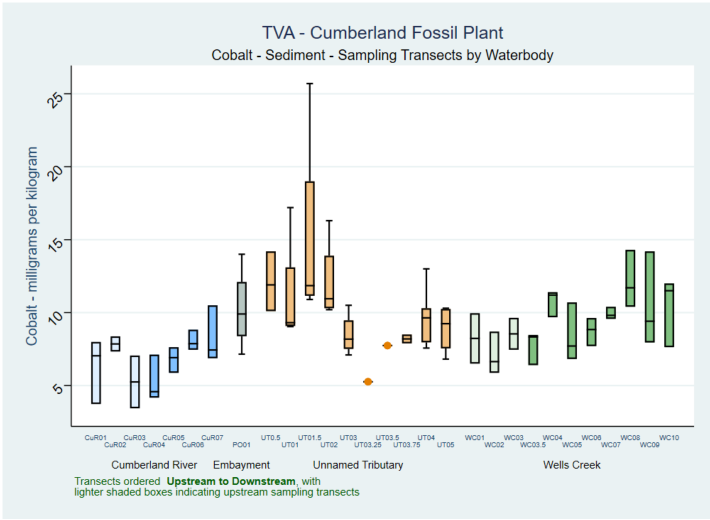


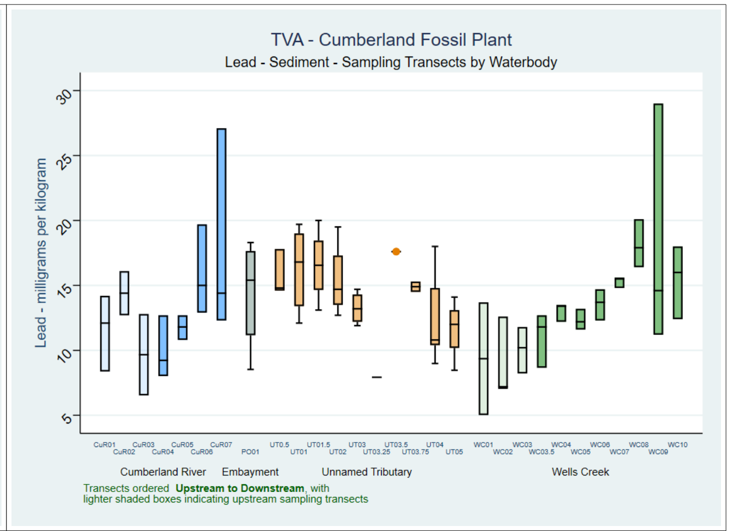


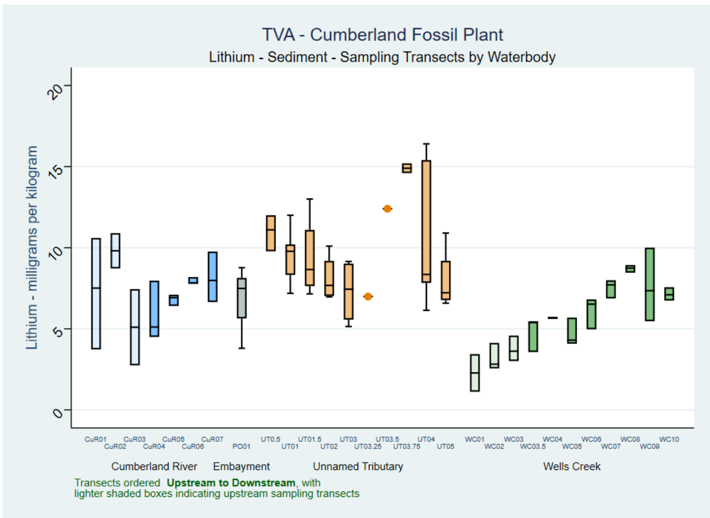


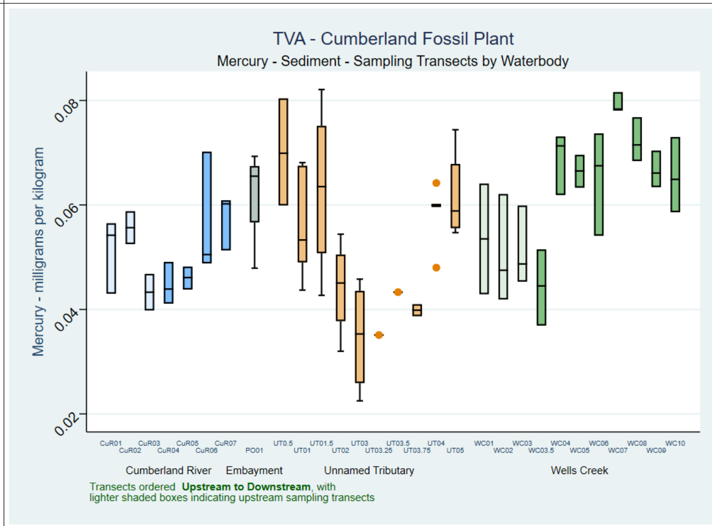


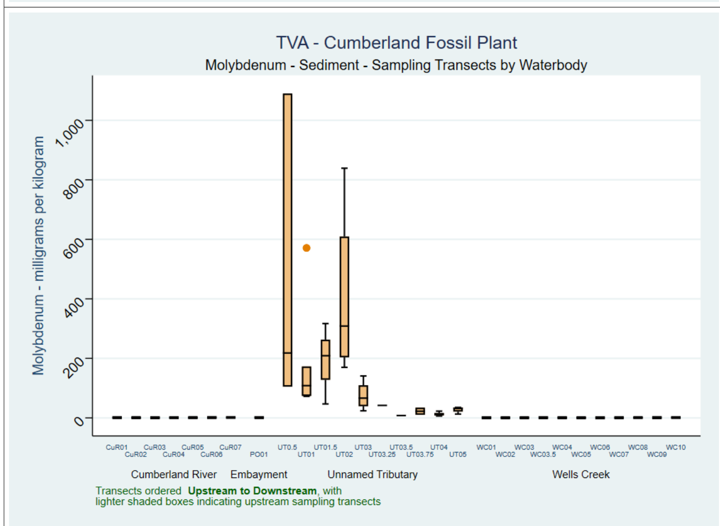


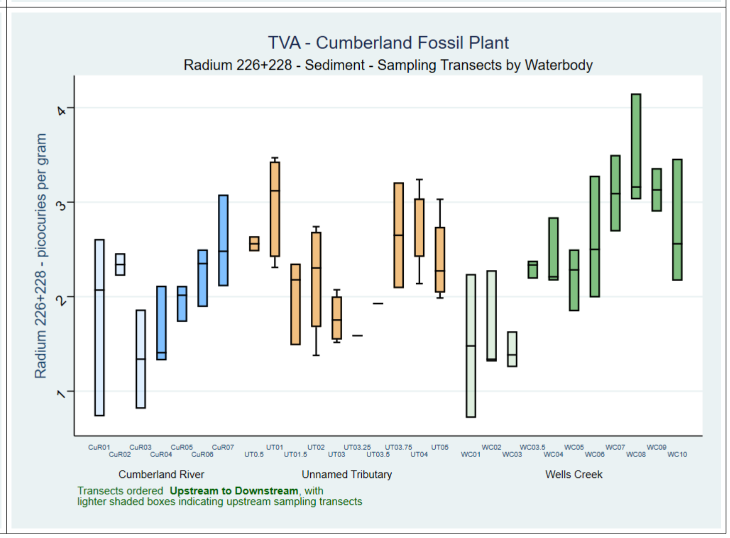

TVA - Cumberland Fossil Plant
Cobalt - Sediment - Sampling Transects by Waterbody
Cobalt - milligrams per kilogram
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects

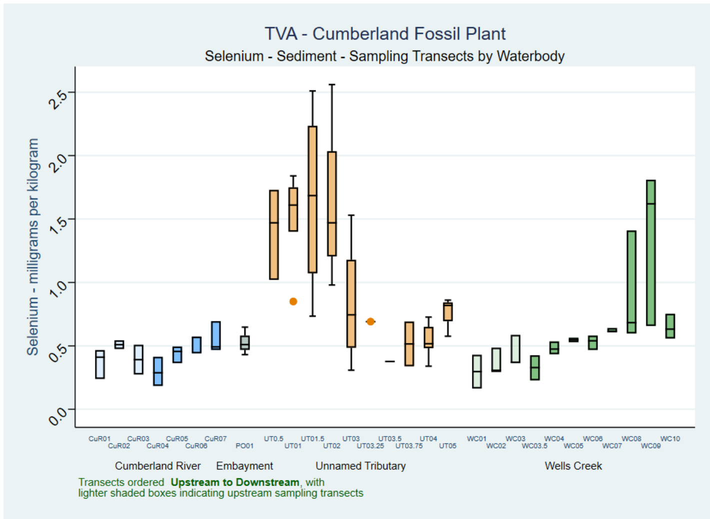

TVA - Cumberland Fossil Plant
Lead - Sediment - Sampling Transects by Waterbody
Lead - milligrams per kilogram
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Lithium - Sediment - Sampling Transects by Waterbody
Lithium - milligrams per kilogram
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects

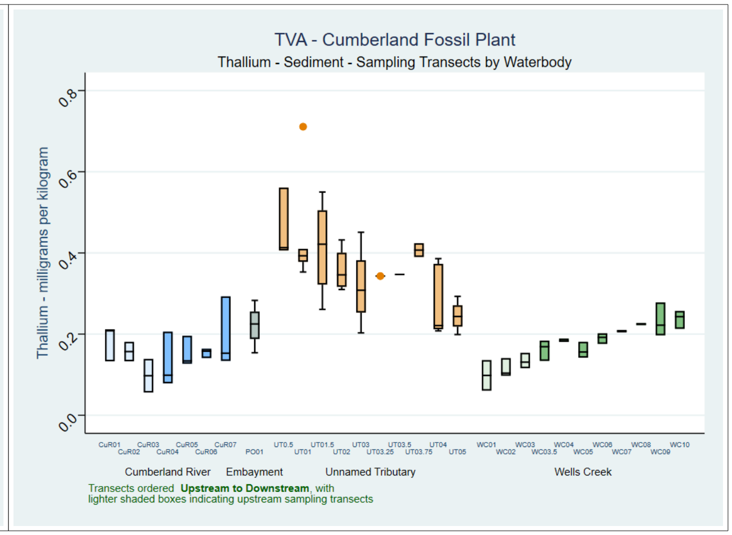

TVA - Cumberland Fossil Plant
Mercury - Sediment - Sampling Transects by Waterbody
Mercury - milligrams per kilogram
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Molybdenum - Sediment - Sampling Transects by Waterbody
Molybdenum - milligrams per kilogram
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects


TVA - Cumberland Fossil Plant
Radium 226+228 - Sediment - Sampling Transects by Waterbody
Radium 226+228 - picocuries per gram
Cumberland River
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects

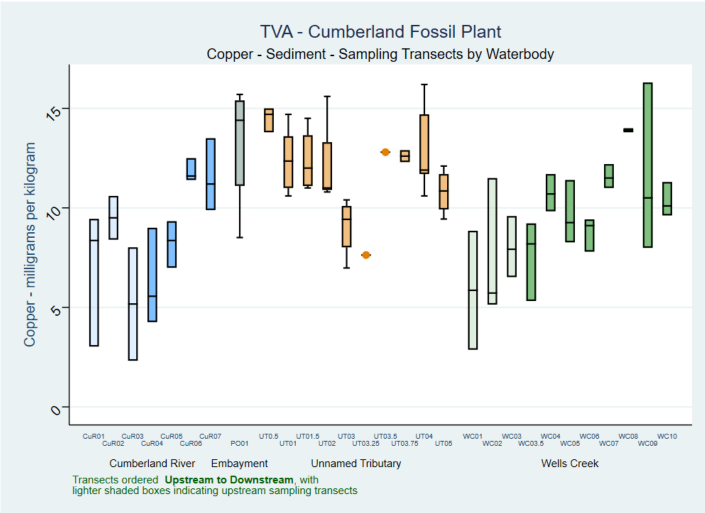


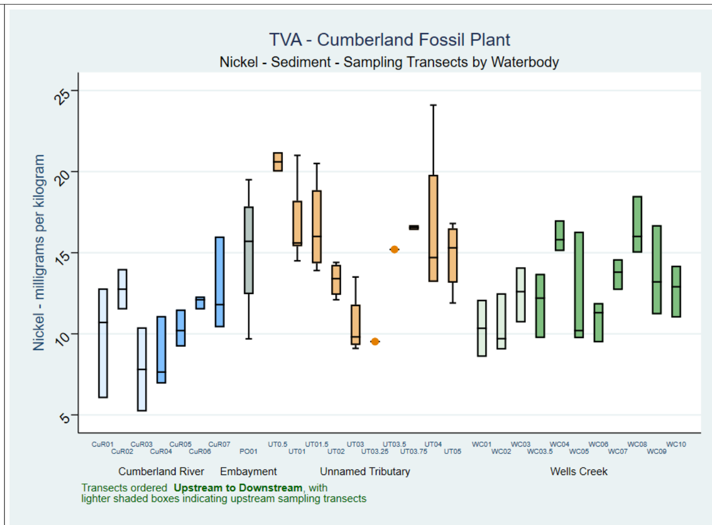
TVA - Cumberland Fossil Plant
Selenium - Sediment - Sampling Transects by Waterbody
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
2.5
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 PO01 UT0.5 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects

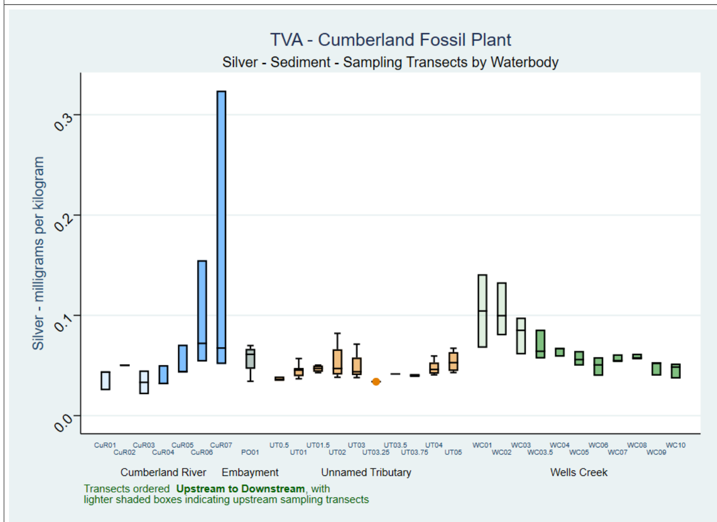


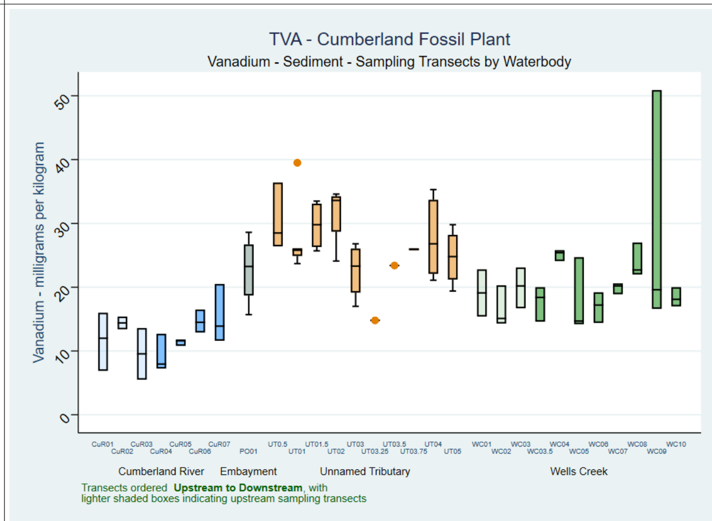
TVA - Cumberland Fossil Plant
Thallium - Sediment - Sampling Transects by Waterbody
Thallium - milligrams per kilogram
0.0
0.2
0.4
0.6
0.8
CuR01 CuR02 CuR03 CuR04 CuR05 CuR06 CuR07 PO01 UT0.5 UT01 UT01.5 UT02 UT03 UT03.25 UT03.5 UT03.75 UT04 UT05 WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Cumberland River
Embayment
Unnamed Tributary
Wells Creek
Transects ordered Upstream to Downstream, with
lighter shaded boxes indicating upstream sampling transects

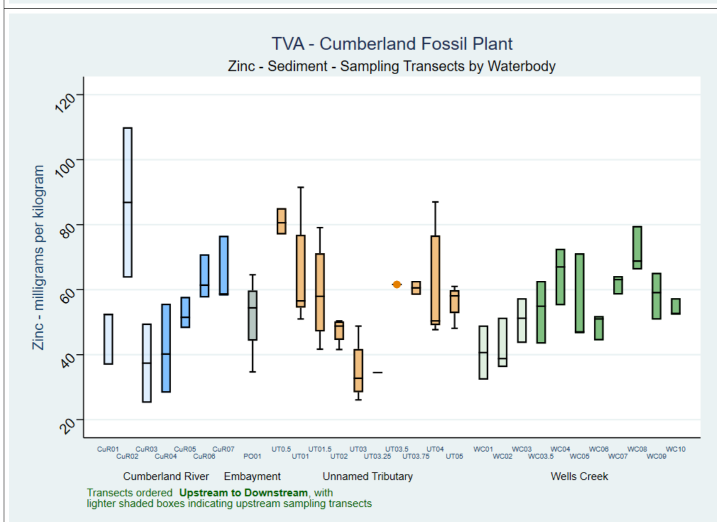
Box Plots
All Transects - TDEC Appendix I Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee











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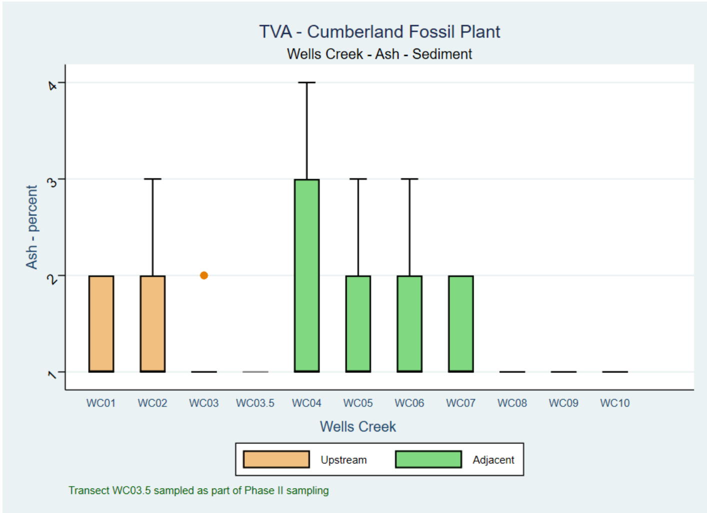
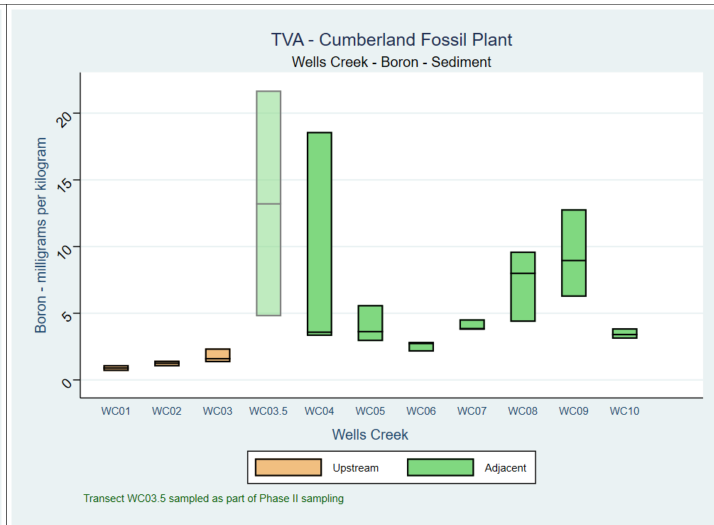
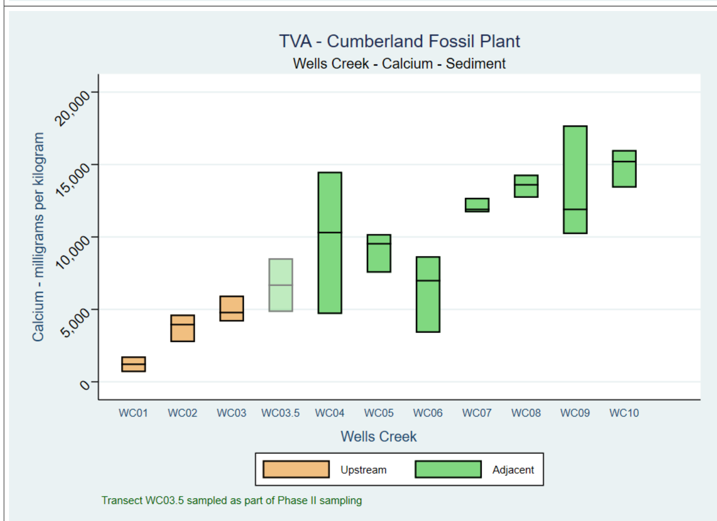
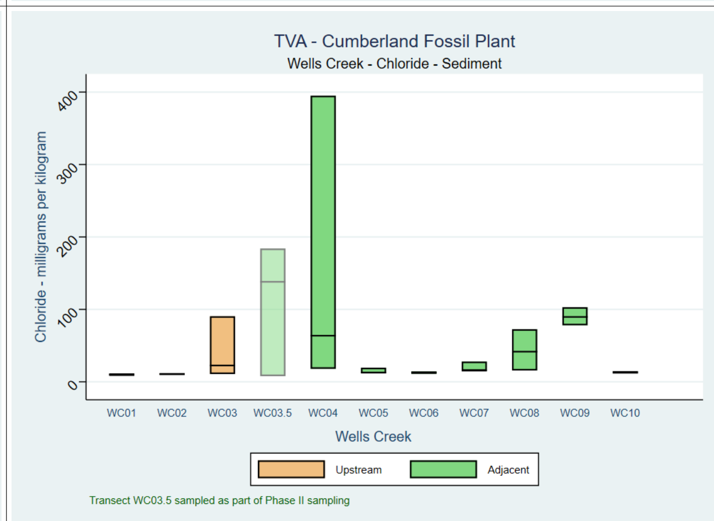
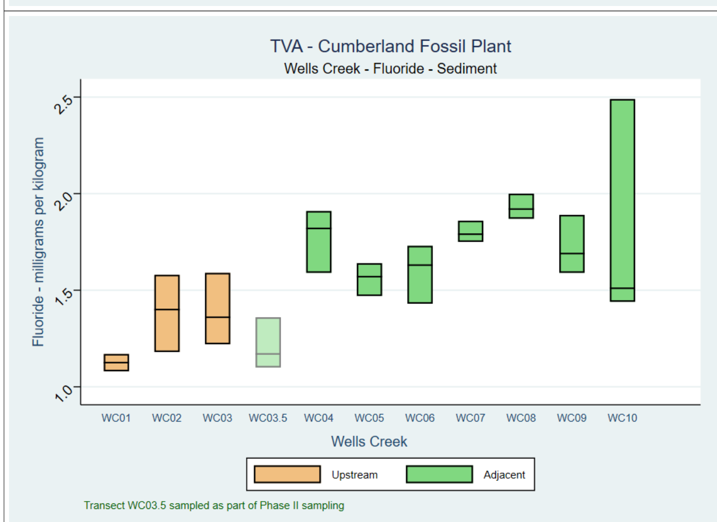
Box Plots
Wells Creek - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee

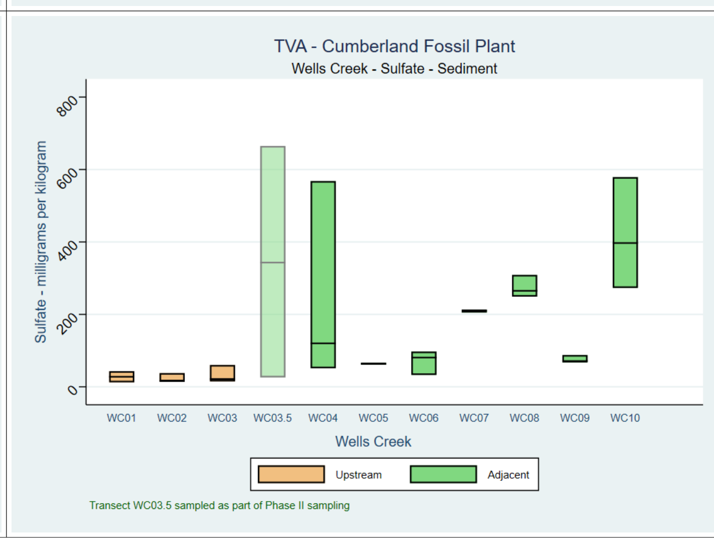


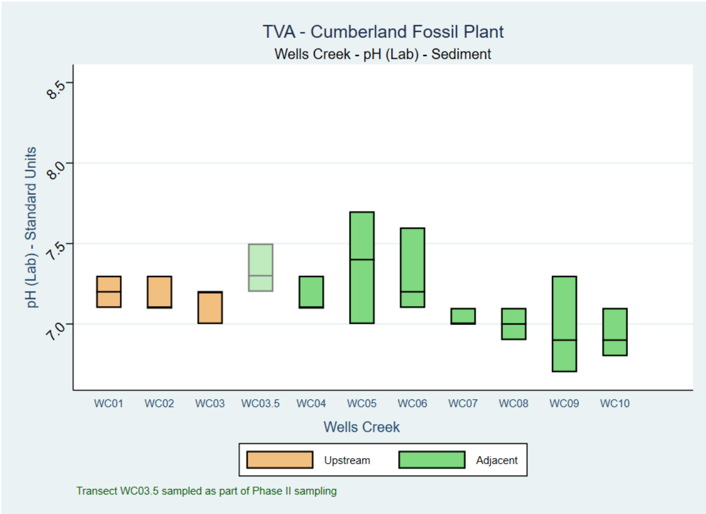












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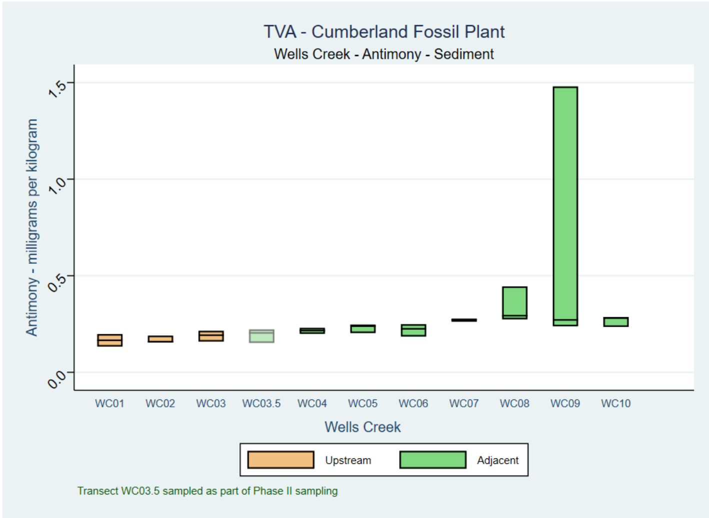
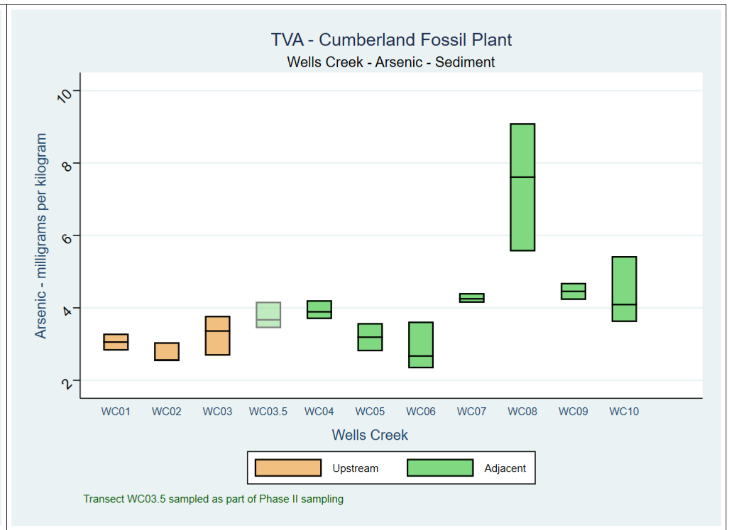
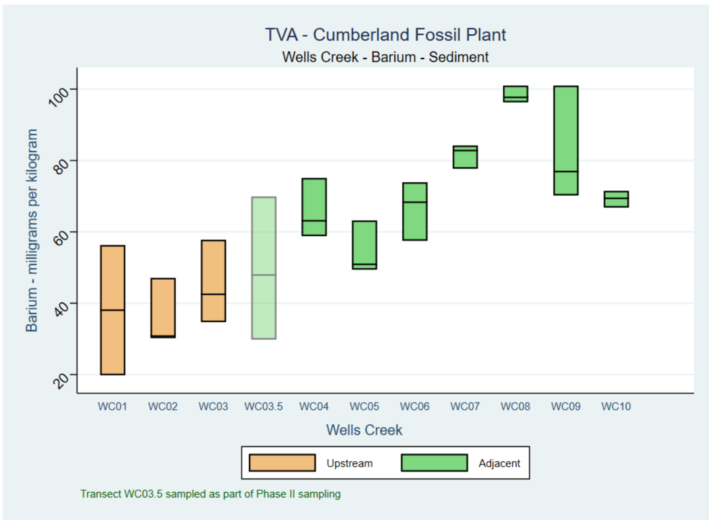
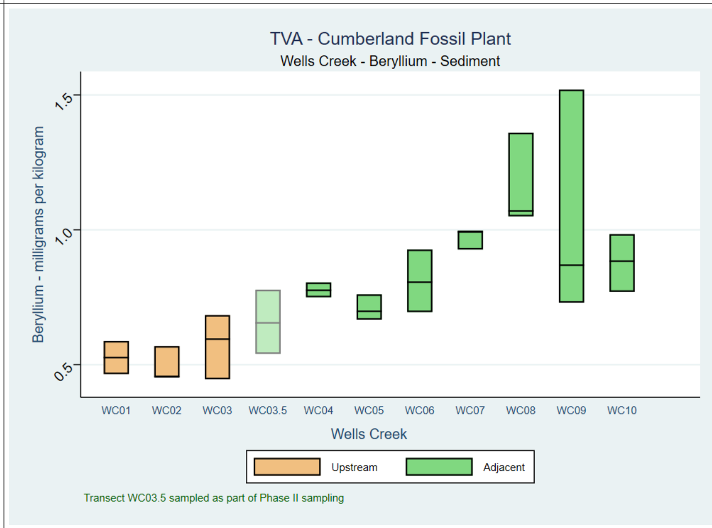
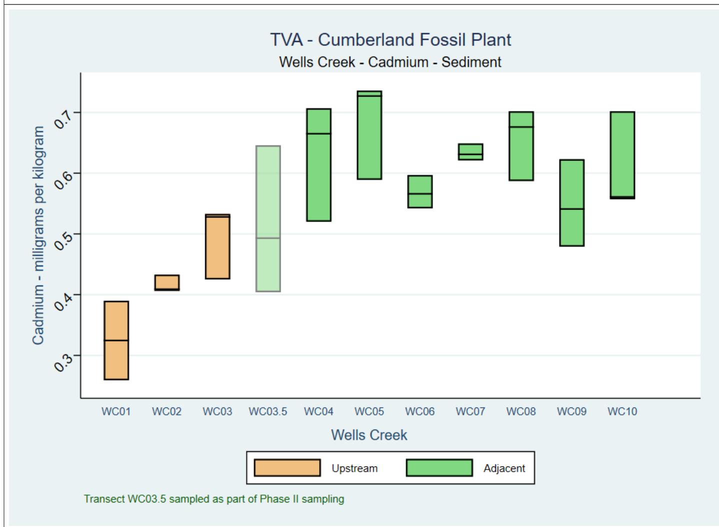
Box Plots
Wells Creek - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee

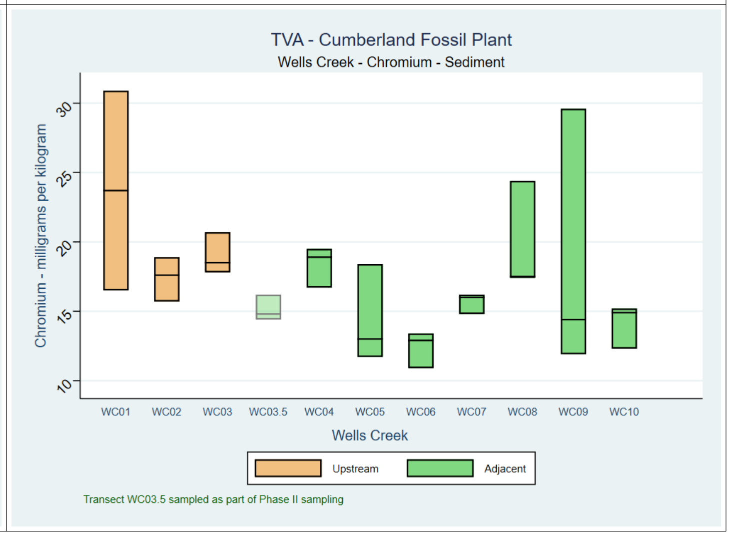


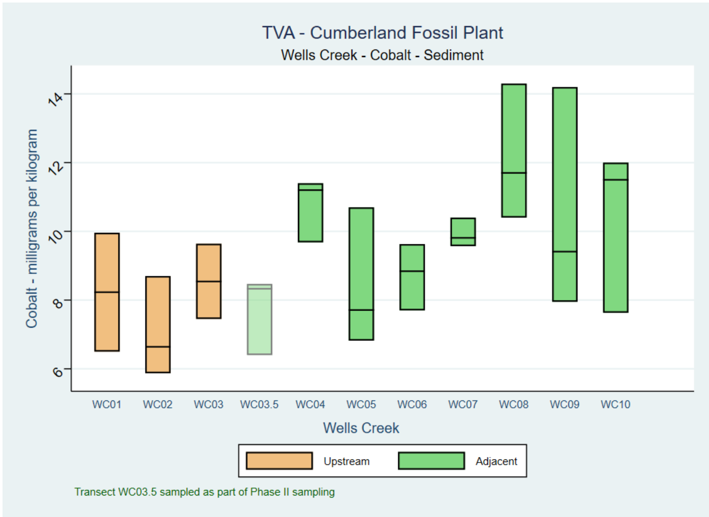


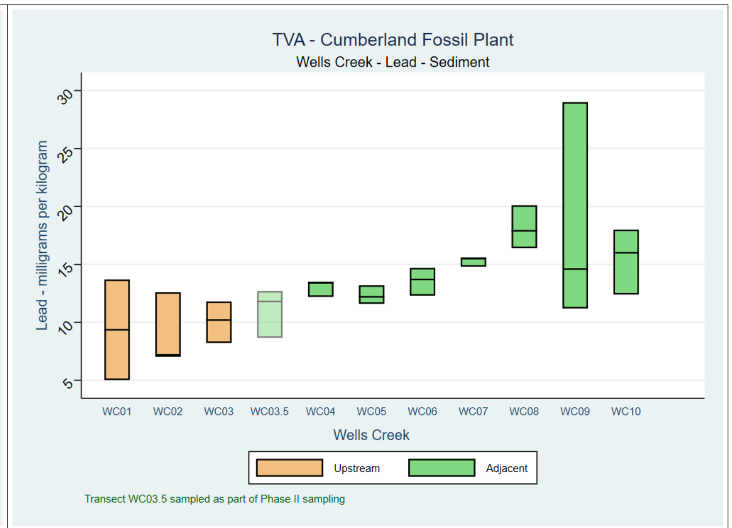


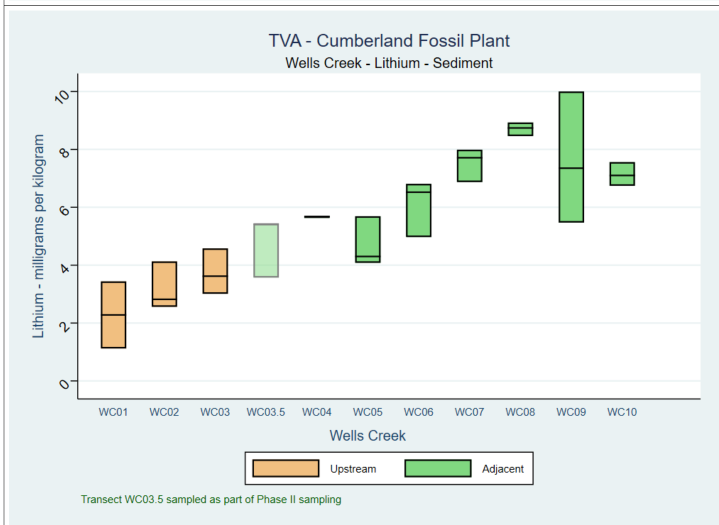


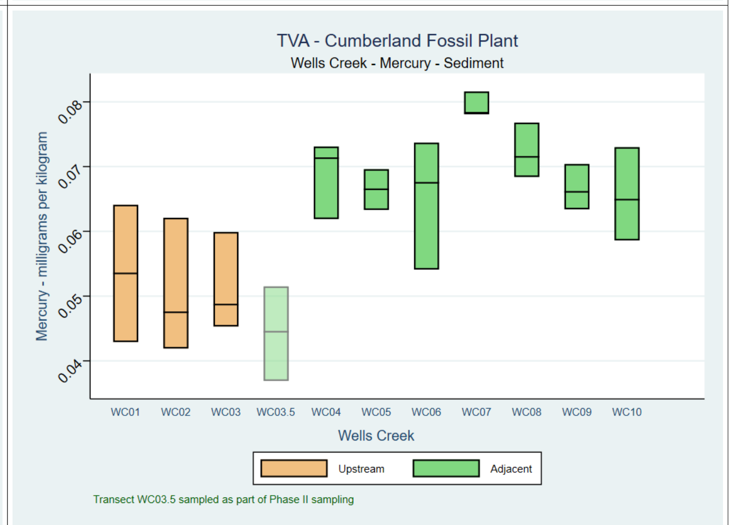


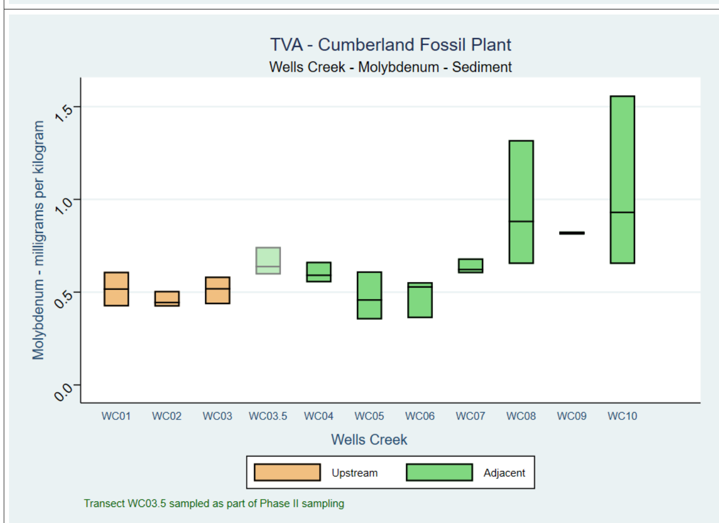


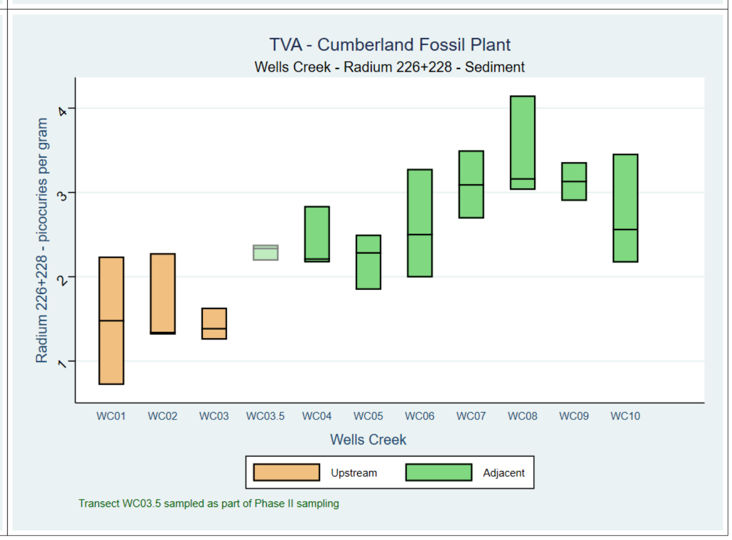

TVA - Cumberland Fossil Plant
Wells Creek - Cobalt - Sediment
Cobalt - milligrams per kilogram
6
8
10
12
14
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

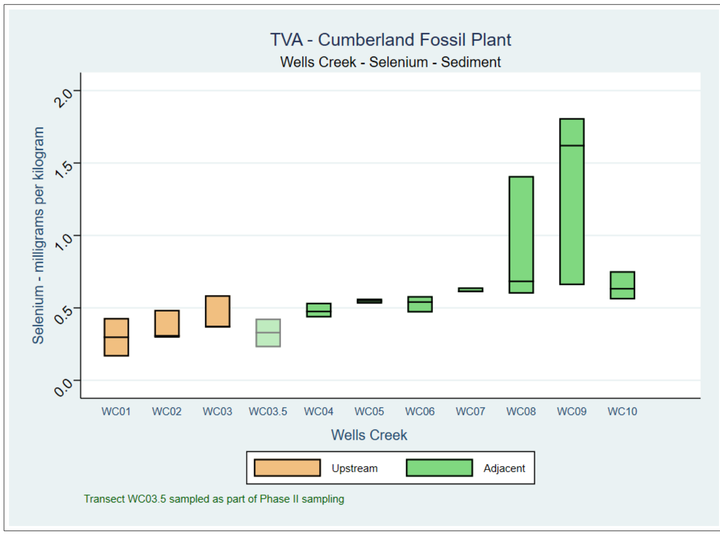

TVA - Cumberland Fossil Plant
Wells Creek - Lead - Sediment
Lead - milligrams per kilogram
5
10
15
20
25
30
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

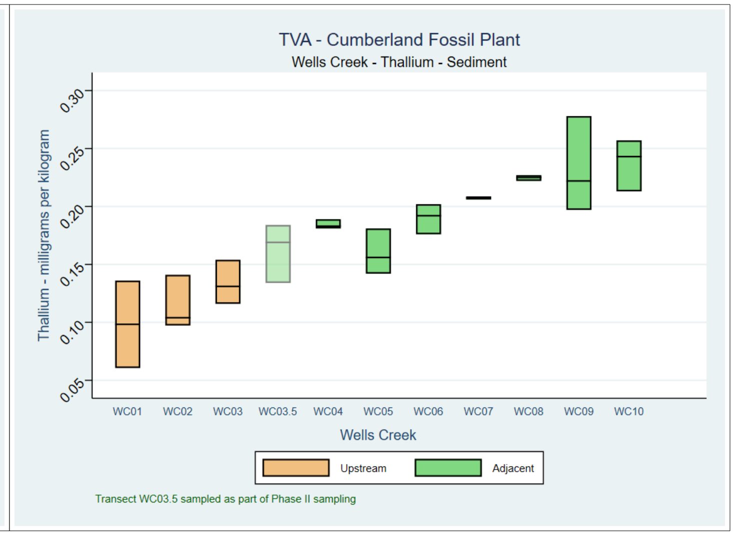

TVA - Cumberland Fossil Plant
Wells Creek - Lithium - Sediment
Lithium - milligrams per kilogram
0
2
4
6
8
10
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling


TVA - Cumberland Fossil Plant
Wells Creek - Mercury - Sediment
Mercury - milligrams per kilogram
0.04
0.05
0.06
0.07
0.08
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

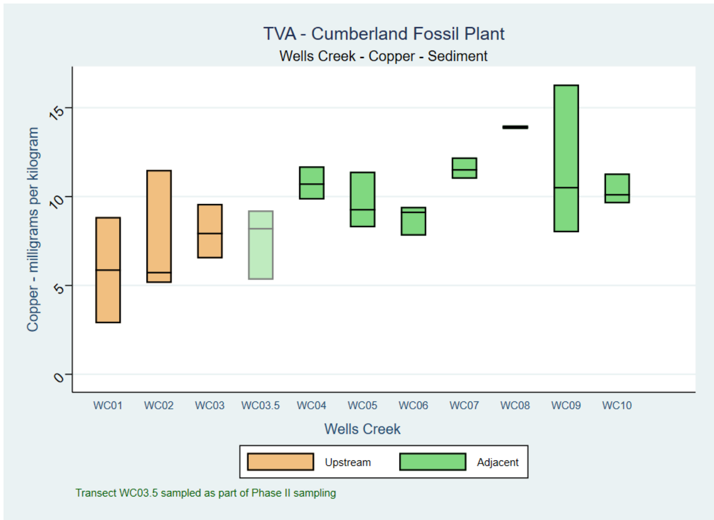

TVA - Cumberland Fossil Plant
Wells Creek - Molybdenum - Sediment
Molybdenum - milligrams per kilogram
0.0
0.5
1.0
1.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

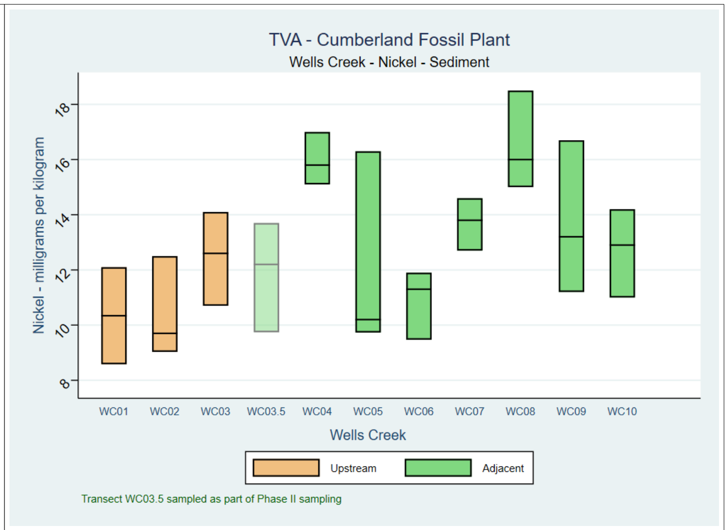

TVA - Cumberland Fossil Plant
Wells Creek - Radium 226+228 - Sediment
Radium 226+228 - picocuries per gram
1
2
3
4
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

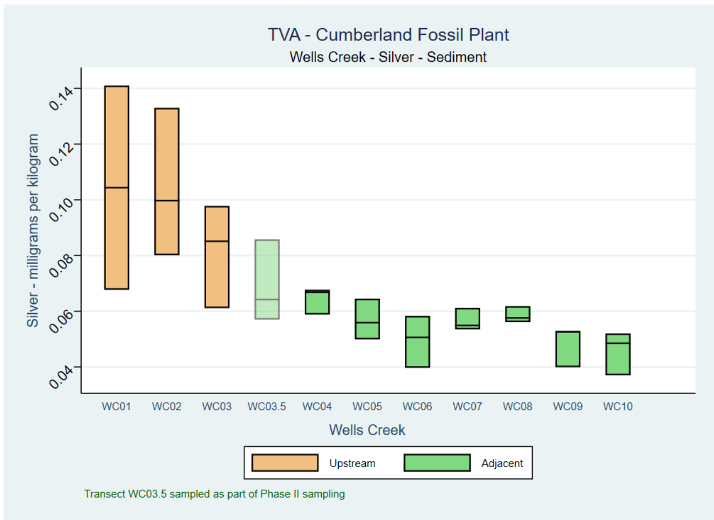

TVA - Cumberland Fossil Plant
Wells Creek - Selenium - Sediment
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

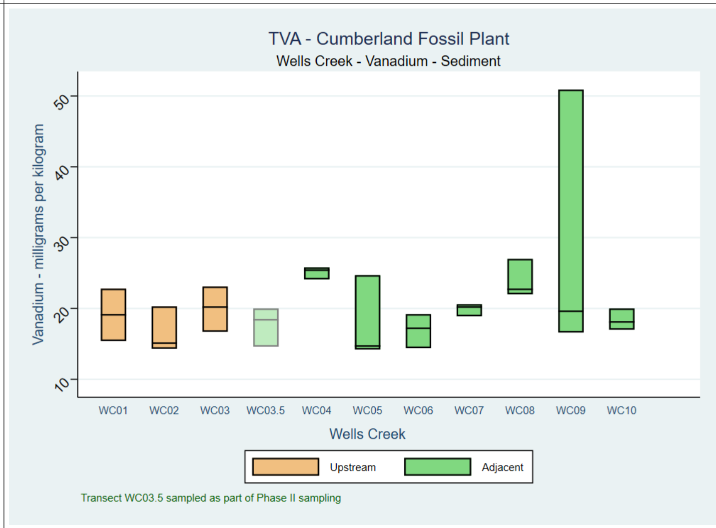

TVA - Cumberland Fossil Plant
Wells Creek - Thallium - Sediment
Thallium - milligrams per kilogram
0.05
0.10
0.15
0.20
0.25
0.30
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Wells Creek
Upstream
Adjacent
Transect WC03.5 sampled as part of Phase II sampling

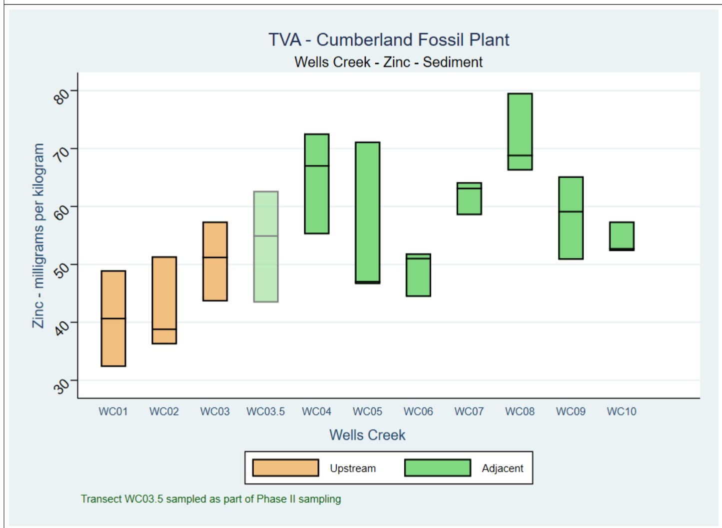
Box Plots
Wells Creek - TDEC Appendix I Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee











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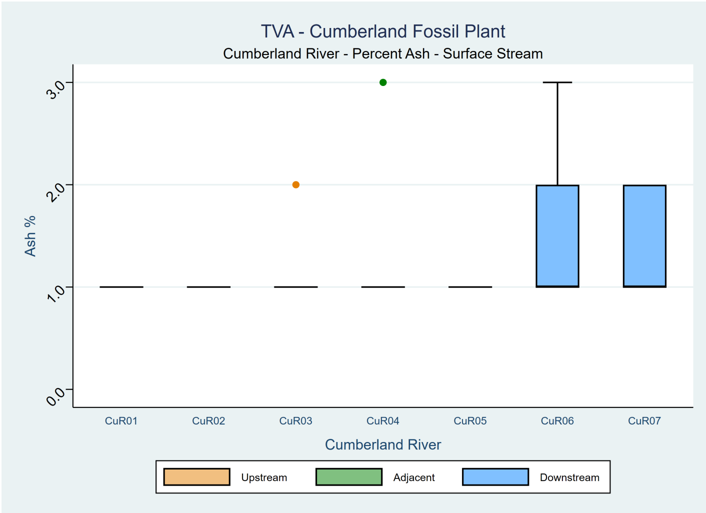
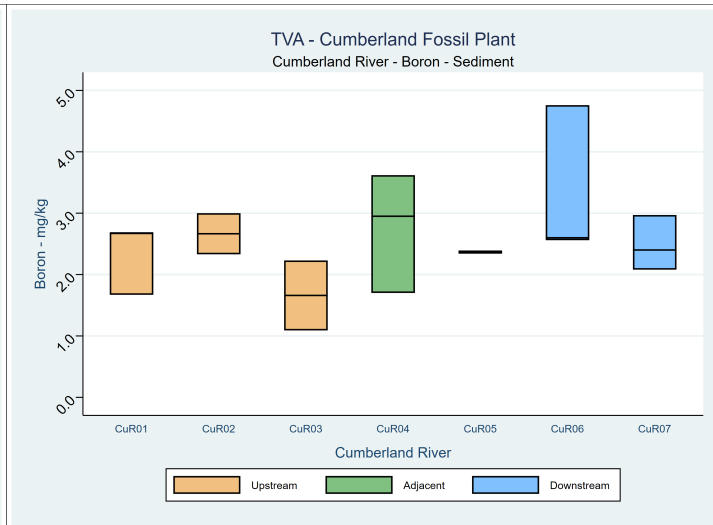
Box Plots

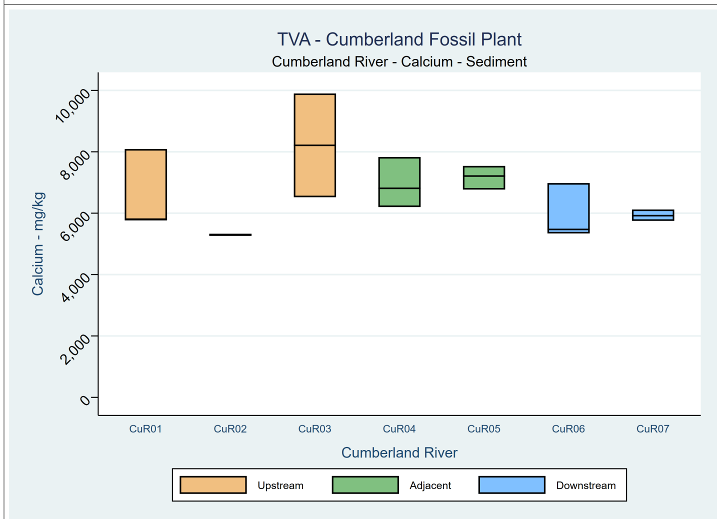
Cumberland River - CCR Rule Appendix III Parameters

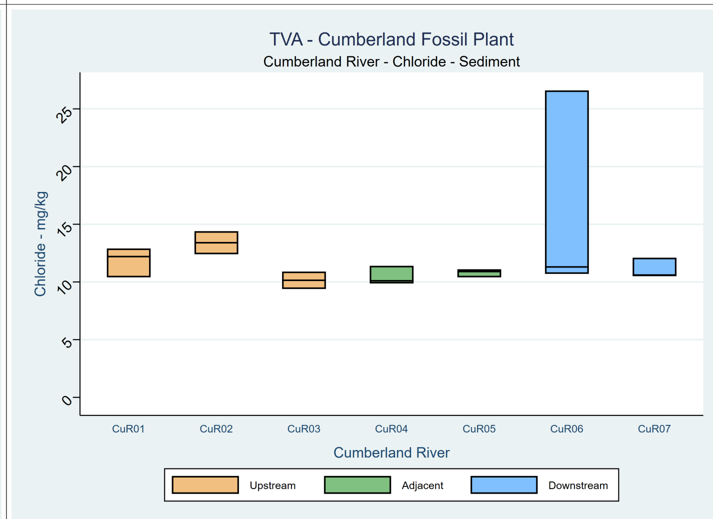
Sediment and Benthic Investigation

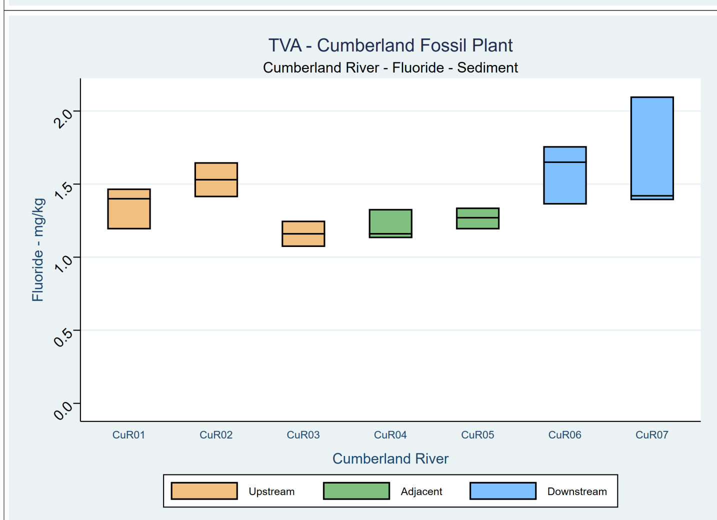
Cumberland Fossil Plant, Cumberland City, Tennessee

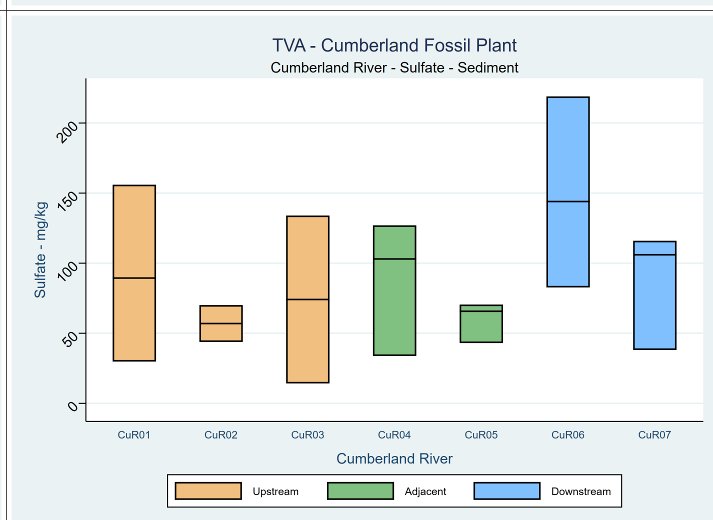


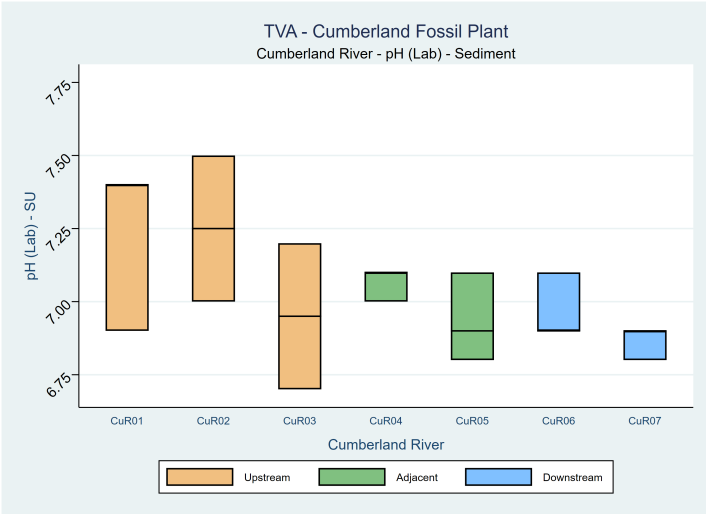












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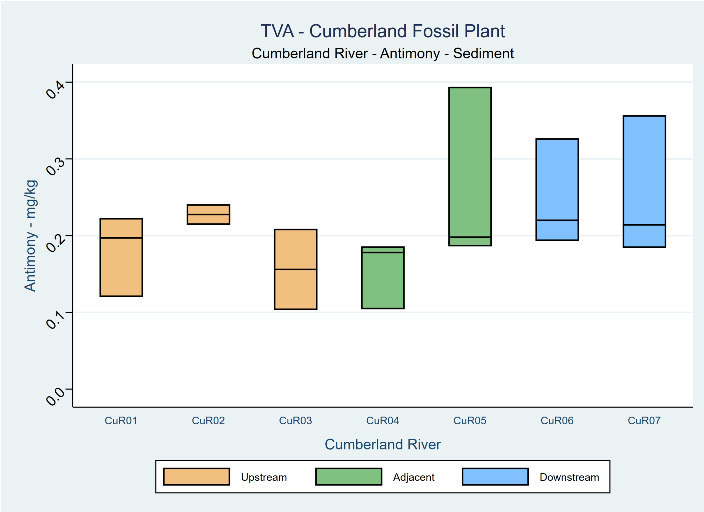
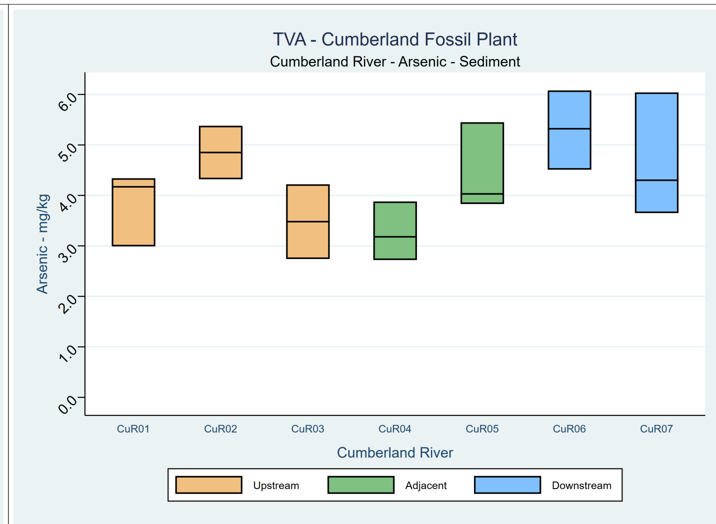
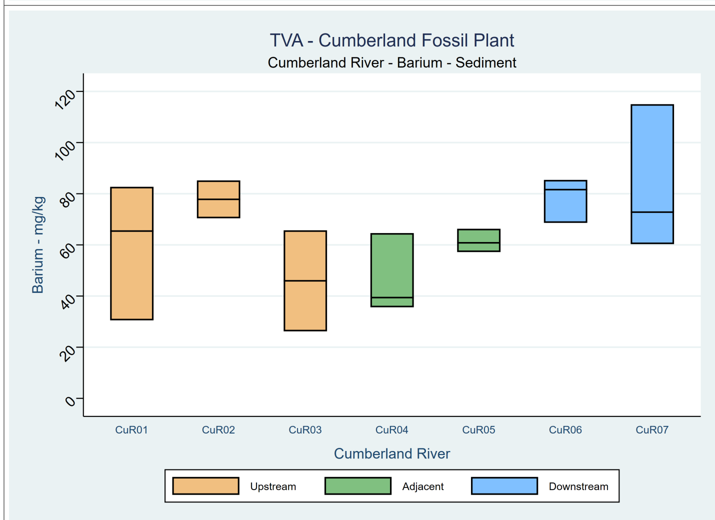
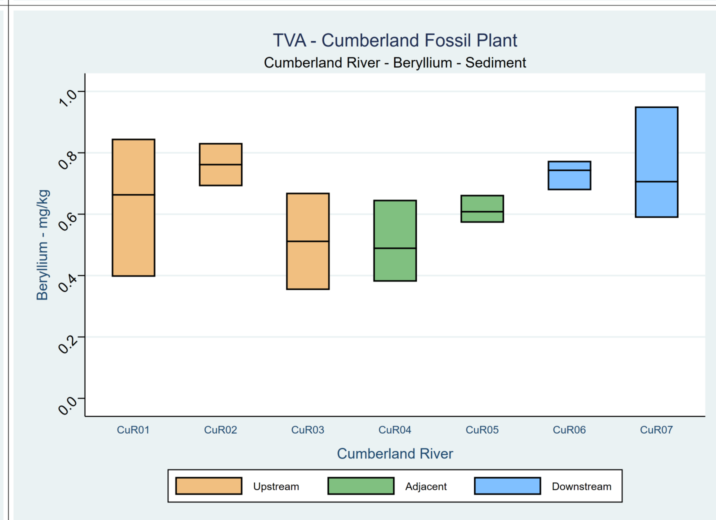
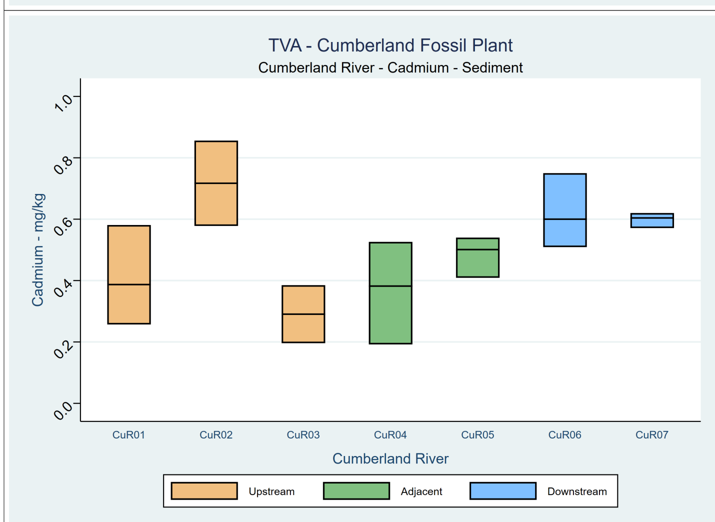
Box Plots
Cumberland River - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

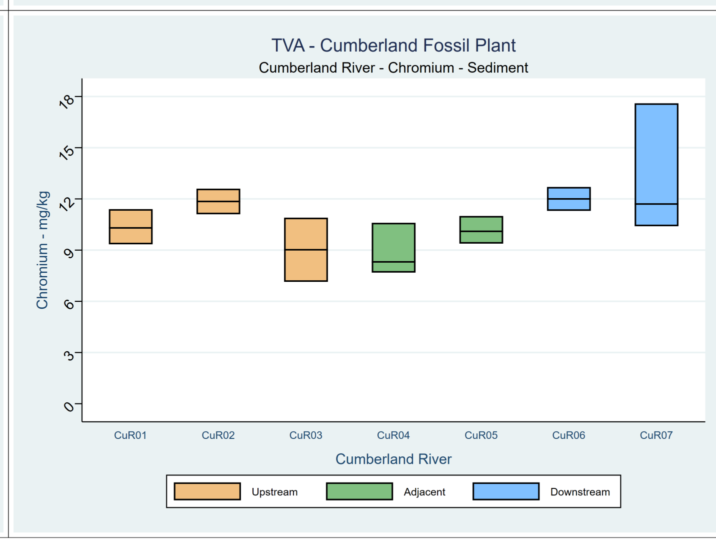


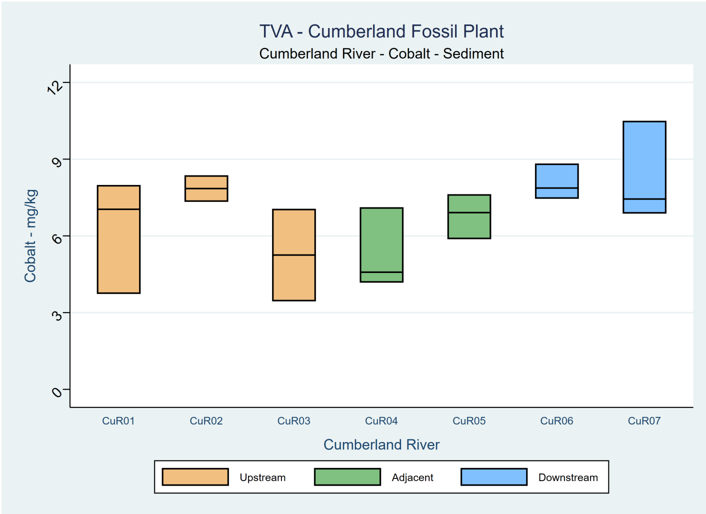


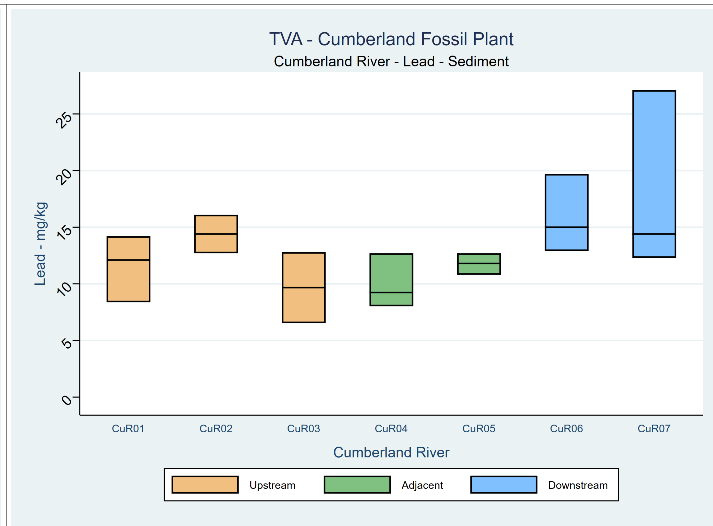


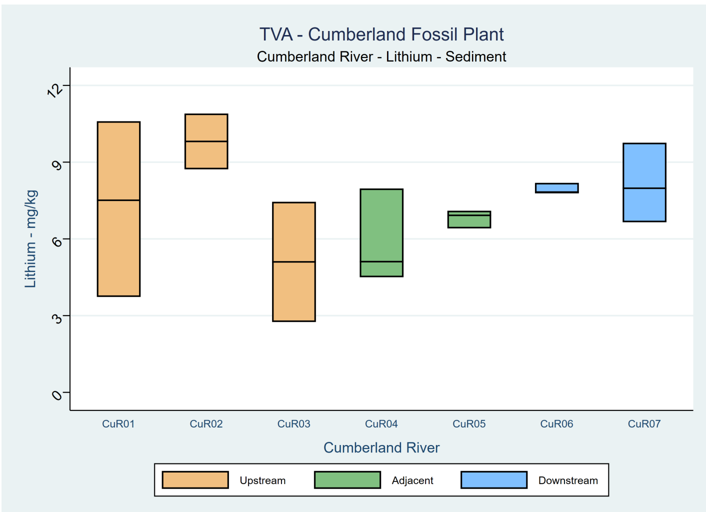


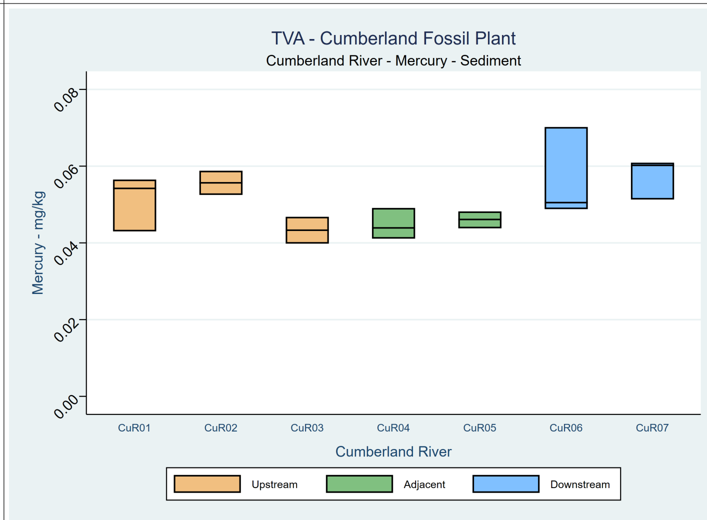


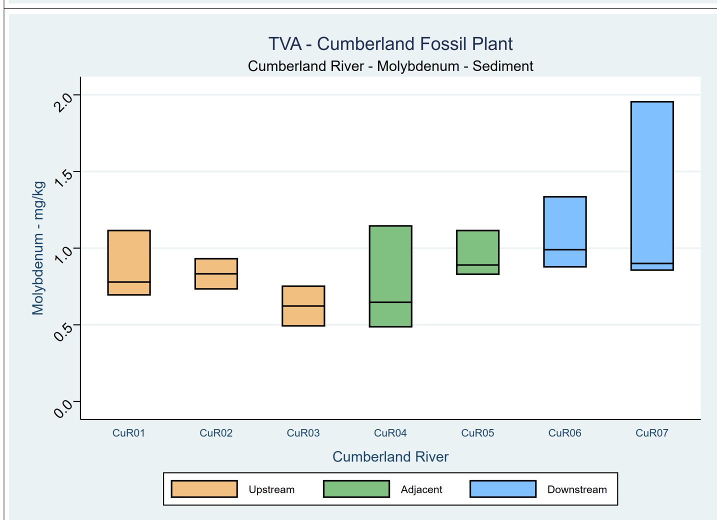


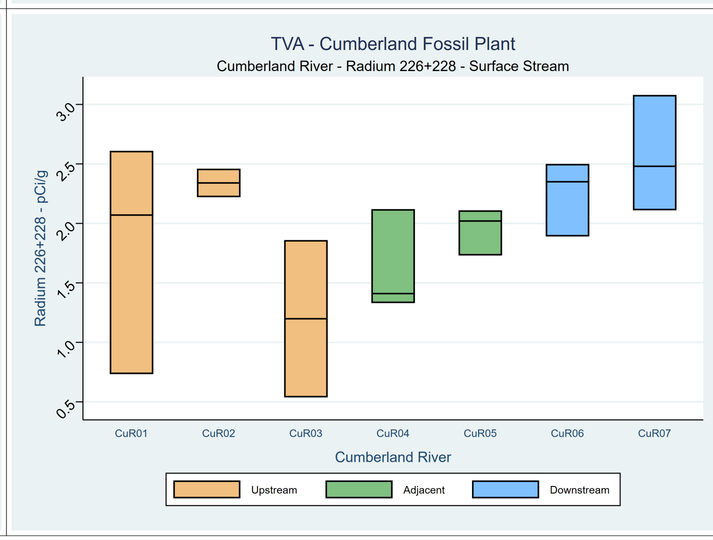

TVA - Cumberland Fossil Plant
Cumberland River - Cobalt - Sediment
Cobalt - mg/kg
0
3
6
9
12
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

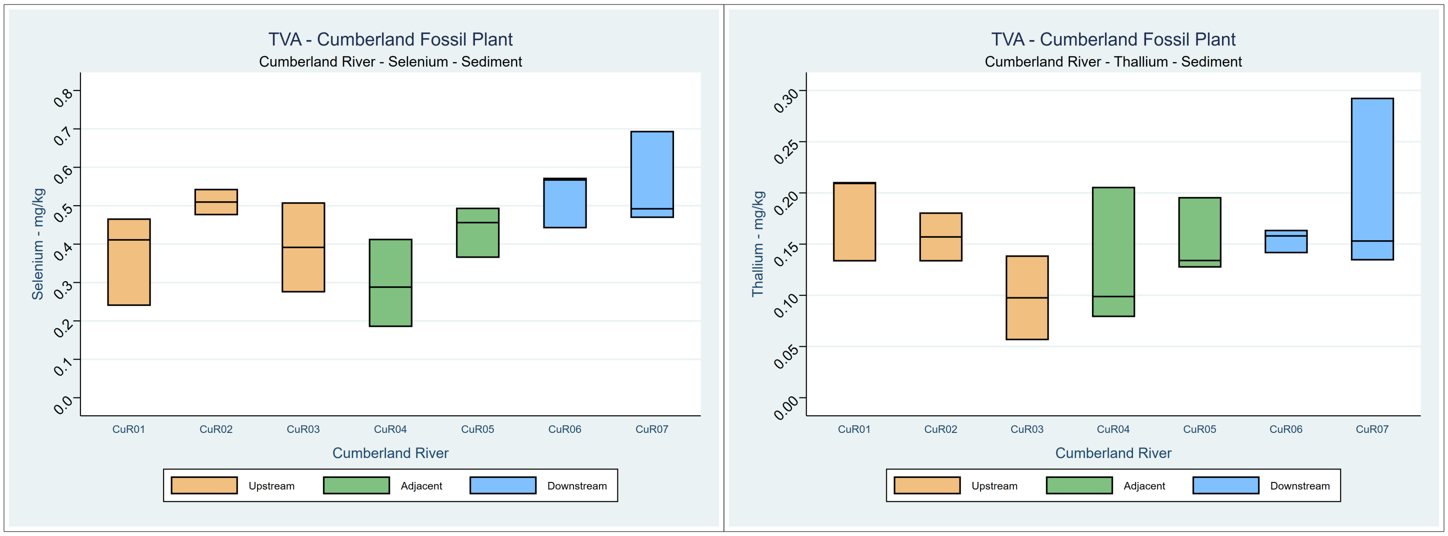

TVA - Cumberland Fossil Plant
Cumberland River - Lead - Sediment
Lead - mg/kg
0
5
10
15
20
25
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream


TVA - Cumberland Fossil Plant
Cumberland River - Lithium - Sediment
Lithium - mg/kg
0
3
6
9
12
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

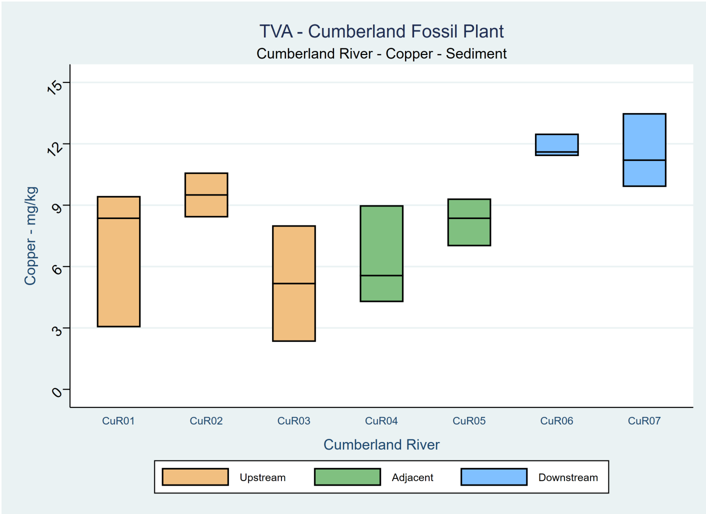

TVA - Cumberland Fossil Plant
Cumberland River - Mercury - Sediment
Mercury - mg/kg
0.00
0.02
0.04
0.06
0.08
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

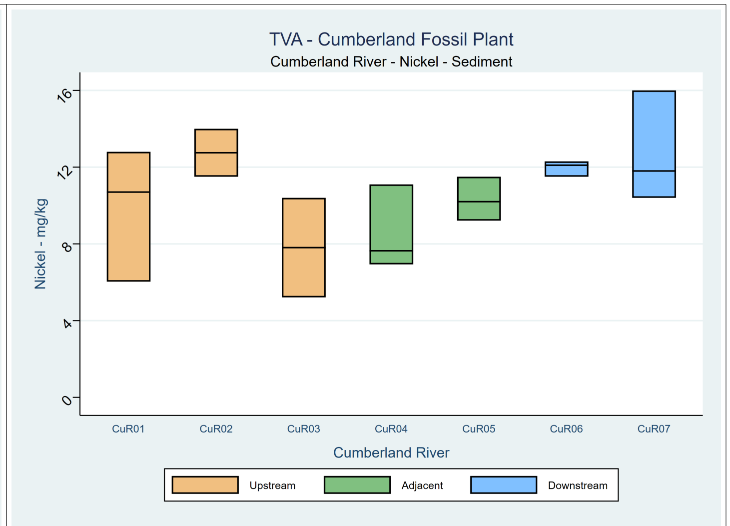

TVA - Cumberland Fossil Plant
Cumberland River - Molybdenum - Sediment
Molybdenum - mg/kg
0.0
0.5
1.0
1.5
2.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

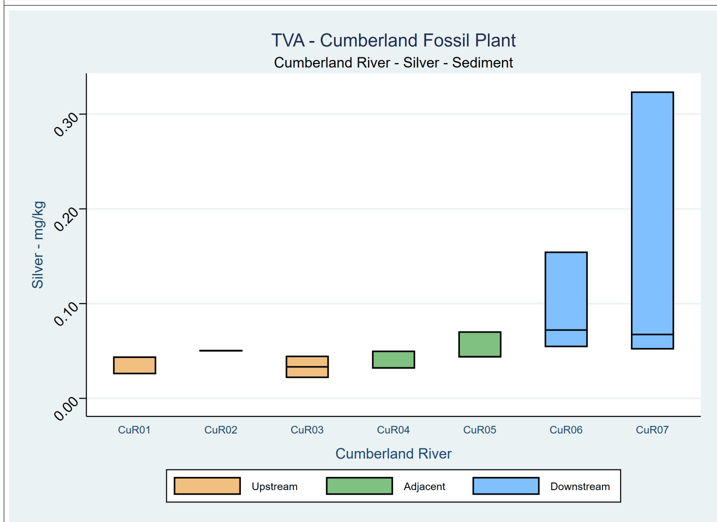

TVA - Cumberland Fossil Plant
Cumberland River - Radium 226+228 - Surface Stream
Radium 226+228 - pCi/g
0.5
1.0
1.5
2.0
2.5
3.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

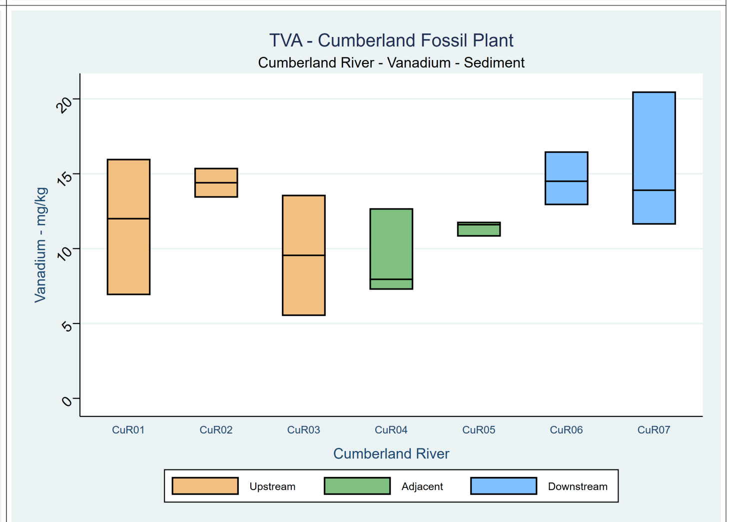

TVA - Cumberland Fossil Plant
Cumberland River - Selenium - Sediment
Selenium - mg/kg
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream
TVA - Cumberland Fossil Plant
Cumberland River - Thallium - Sediment
Thallium - mg/kg
0.00
0.05
0.10
0.15
0.20
0.25
0.30
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Cumberland River
Upstream
Adjacent
Downstream

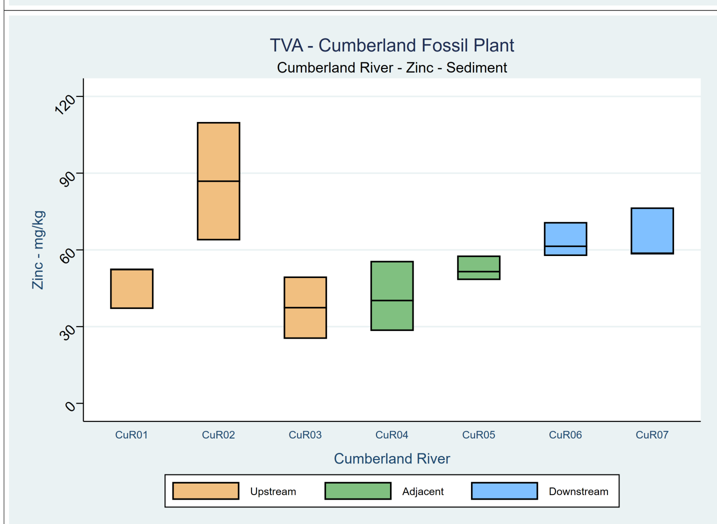
Box Plots
Cumberland River - TDEC Appendix I Parameters
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee











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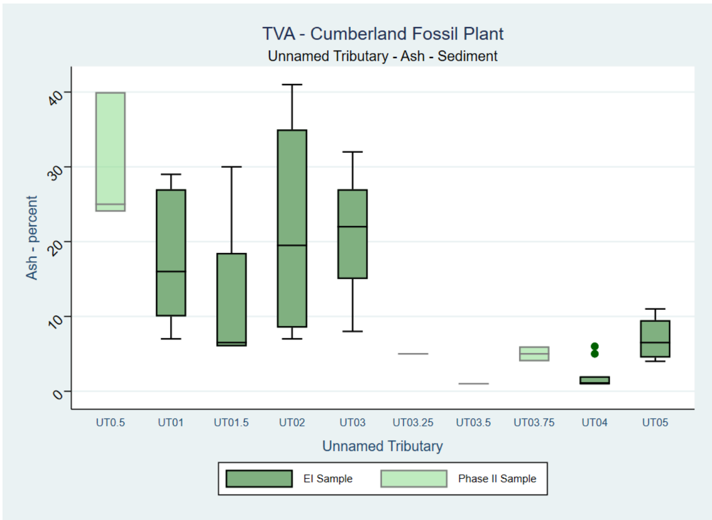
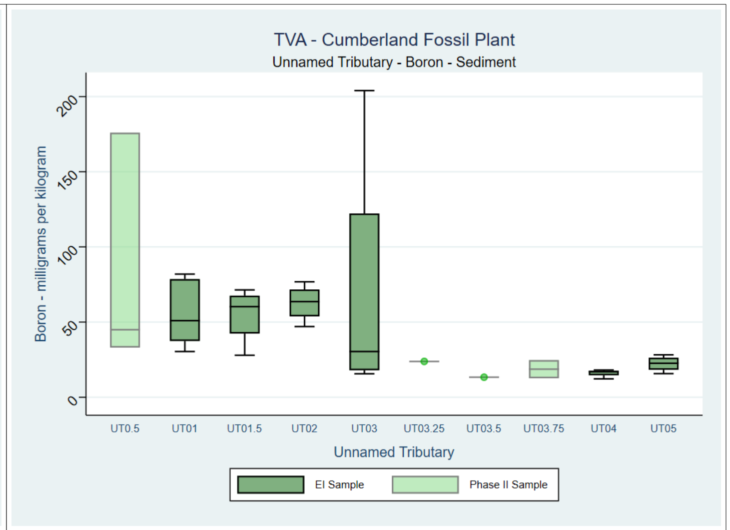
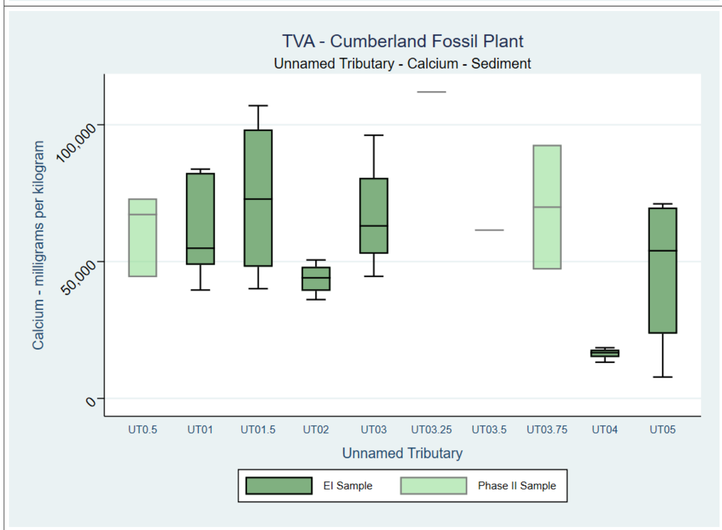
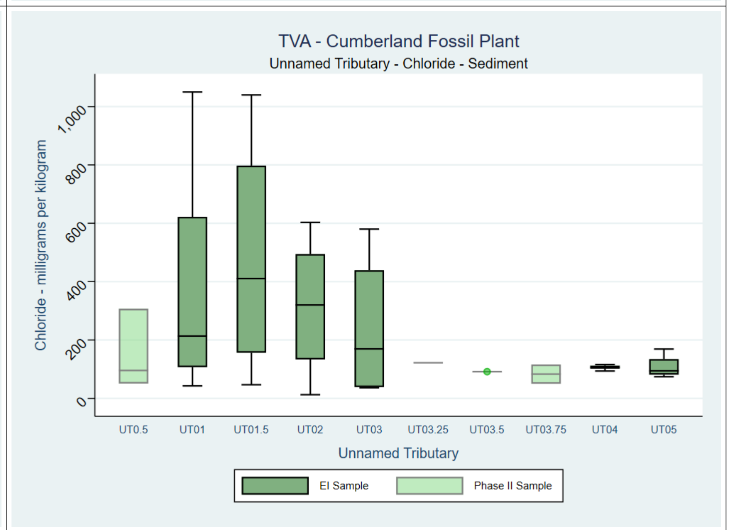
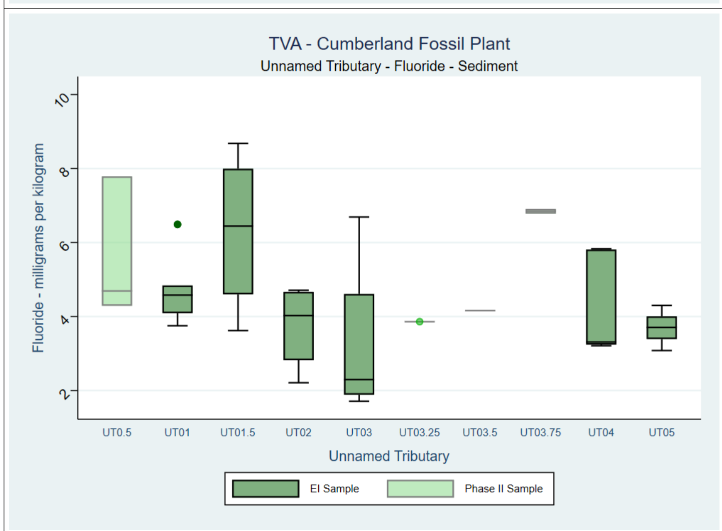
Box Plots
Unnamed Tributary - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee

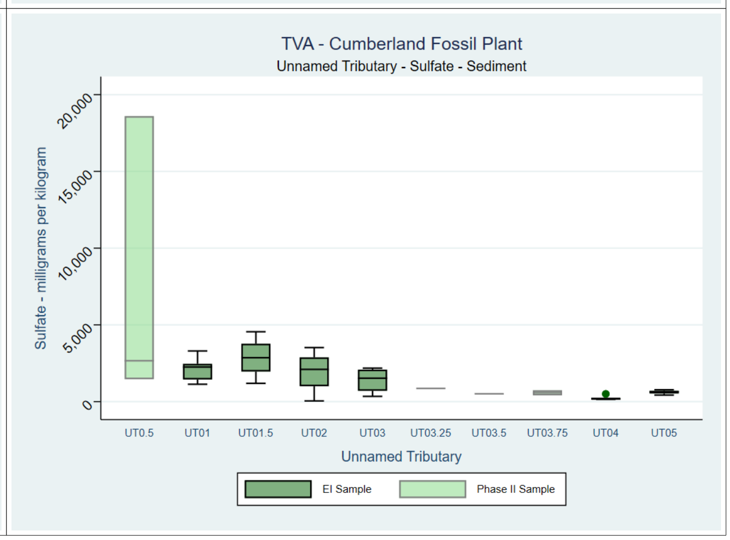


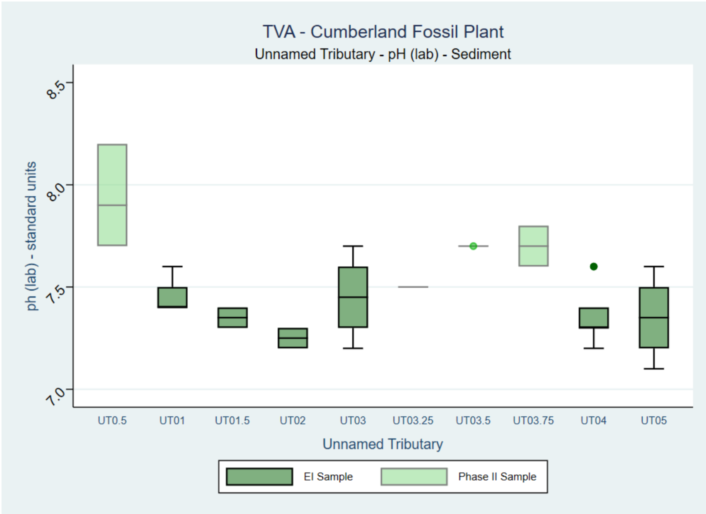












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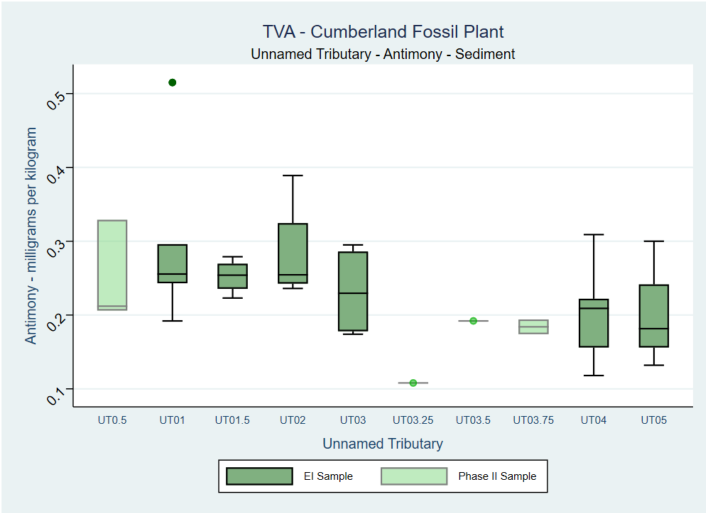
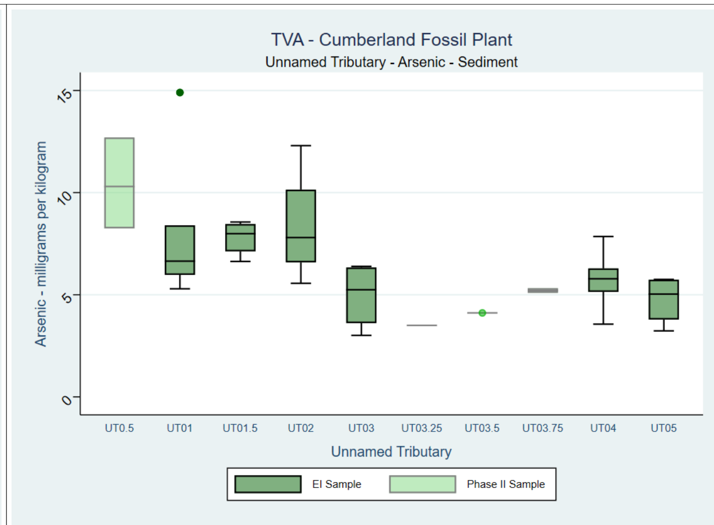
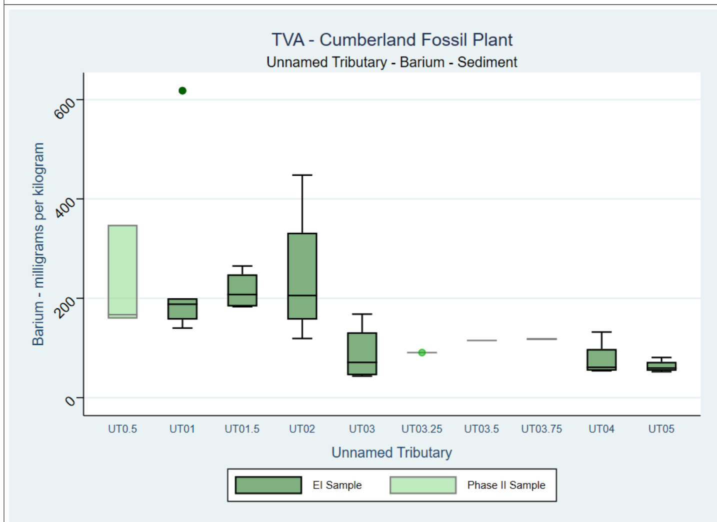
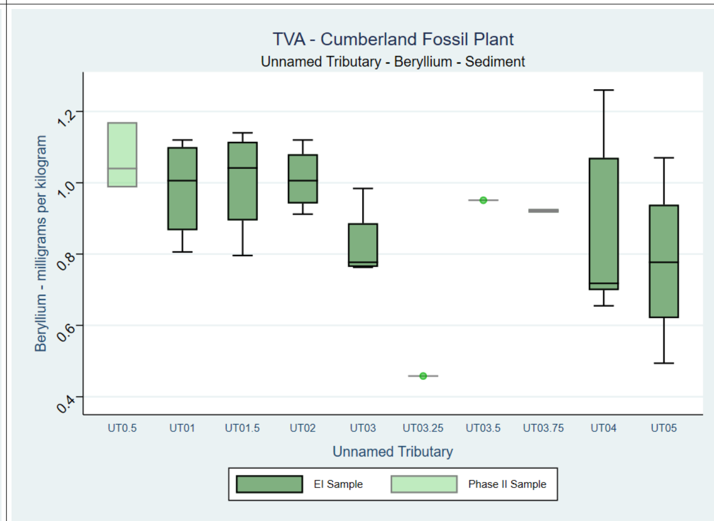
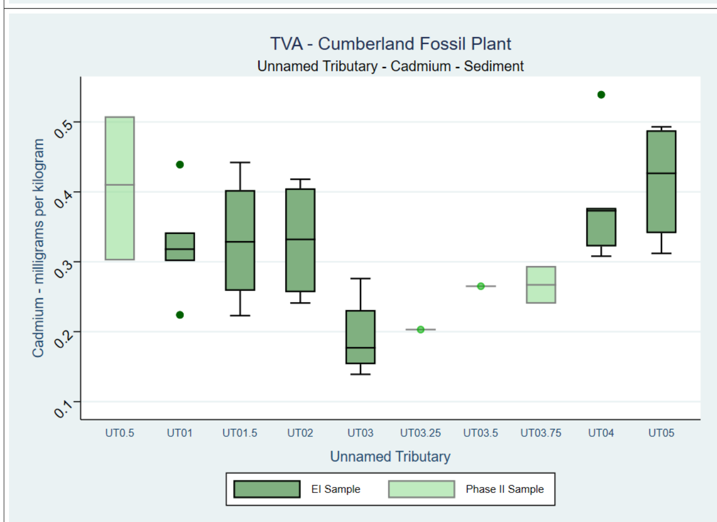
Box Plots
Unnamed Tributary - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee

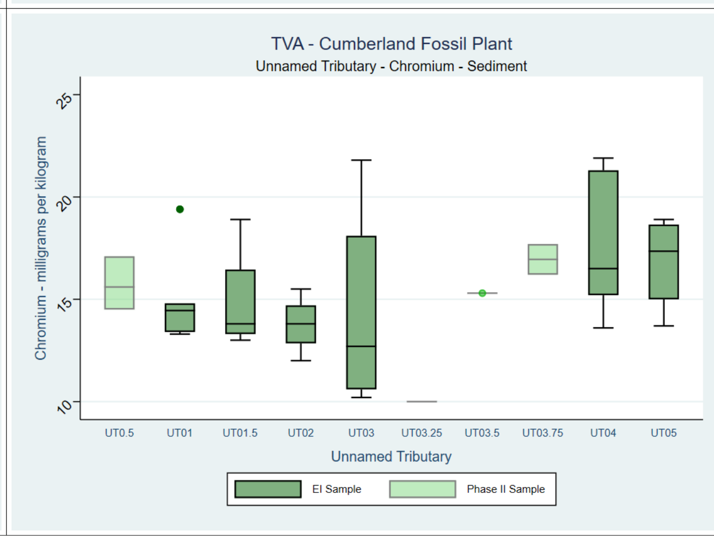


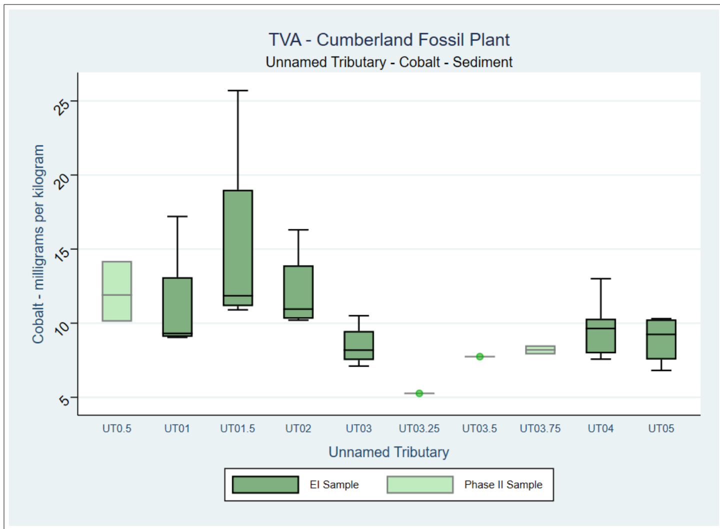


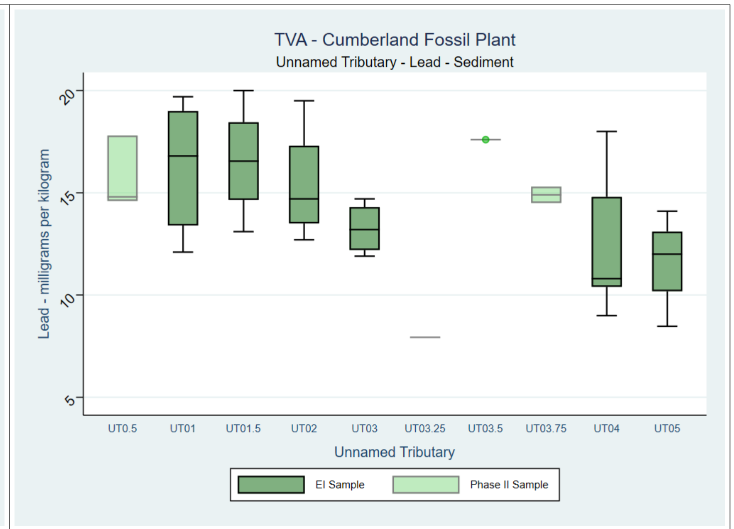


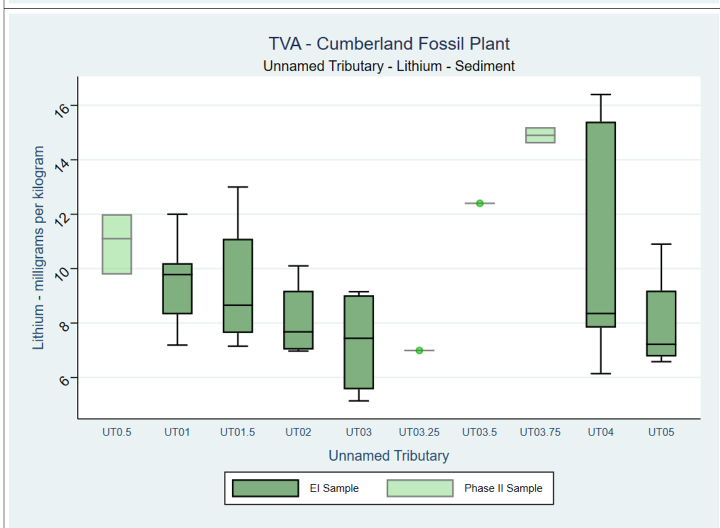


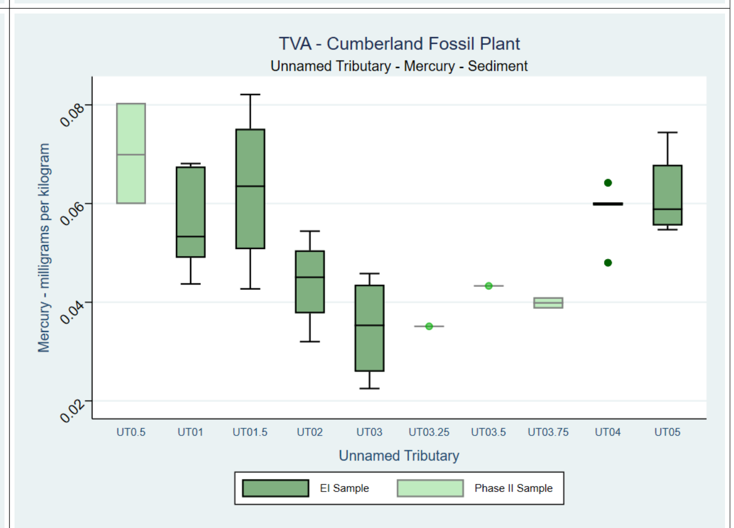


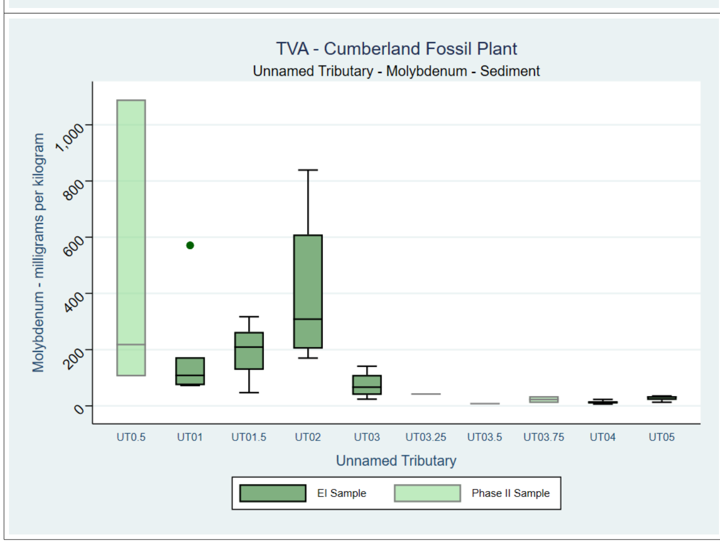


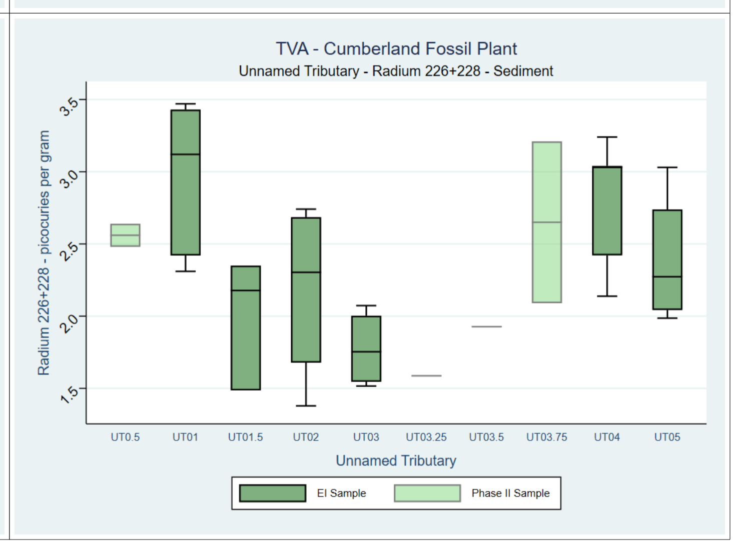

TVA - Cumberland Fossil Plant
Unnamed Tributary - Cobalt - Sediment
Cobalt - milligrams per kilogram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample

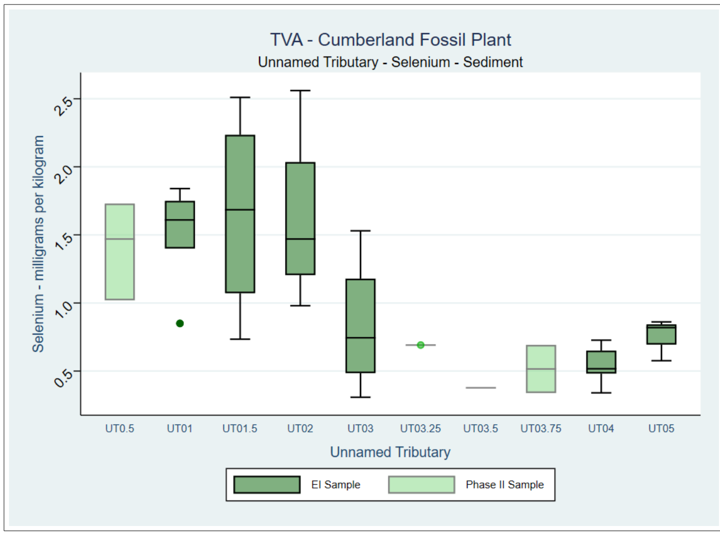

TVA - Cumberland Fossil Plant
Unnamed Tributary - Lead - Sediment
Lead - milligrams per kilogram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample

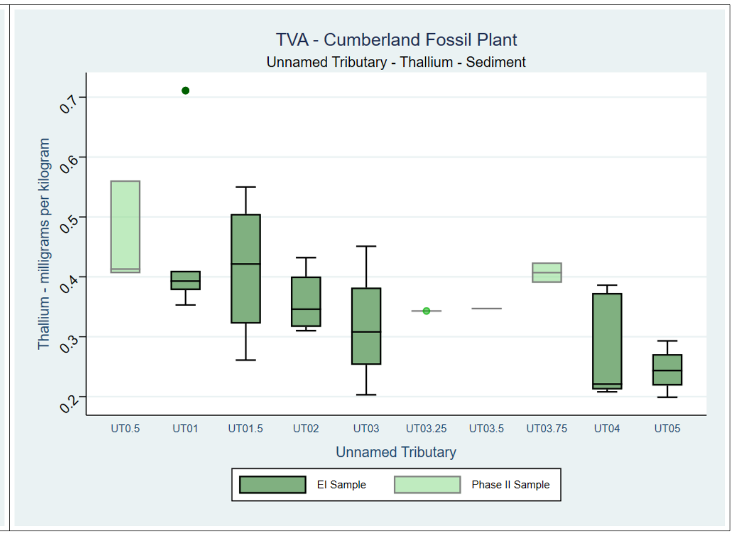

TVA - Cumberland Fossil Plant
Unnamed Tributary - Lithium - Sediment
Lithium - milligrams per kilogram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample


TVA - Cumberland Fossil Plant
Unnamed Tributary - Mercury - Sediment
Mercury - milligrams per kilogram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample

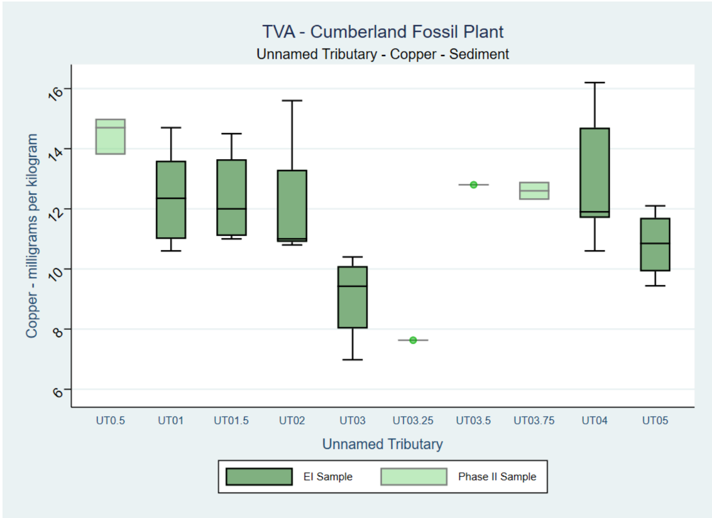

TVA - Cumberland Fossil Plant
Unnamed Tributary - Molybdenum - Sediment
Molybdenum - milligrams per kilogram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample

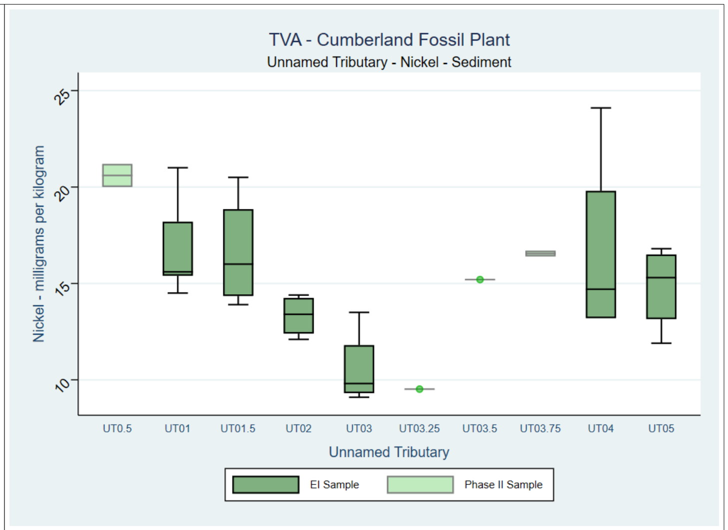

TVA - Cumberland Fossil Plant
Unnamed Tributary - Radium 226+228 - Sediment
Radium 226+228 - picocuries per gram
Unnamed Tributary
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
EI Sample
Phase II Sample

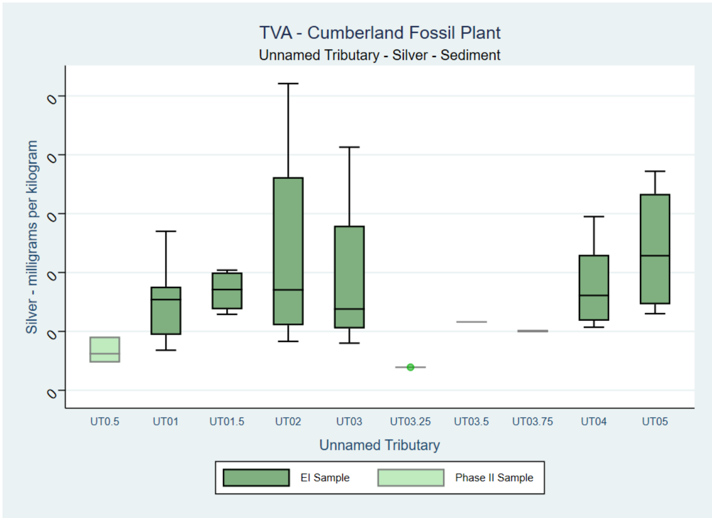

TVA - Cumberland Fossil Plant
Unnamed Tributary - Selenium - Sediment
Selenium - milligrams per kilogram
0.5
1.0
1.5
2.0
2.5
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Unnamed Tributary
EI Sample
Phase II Sample

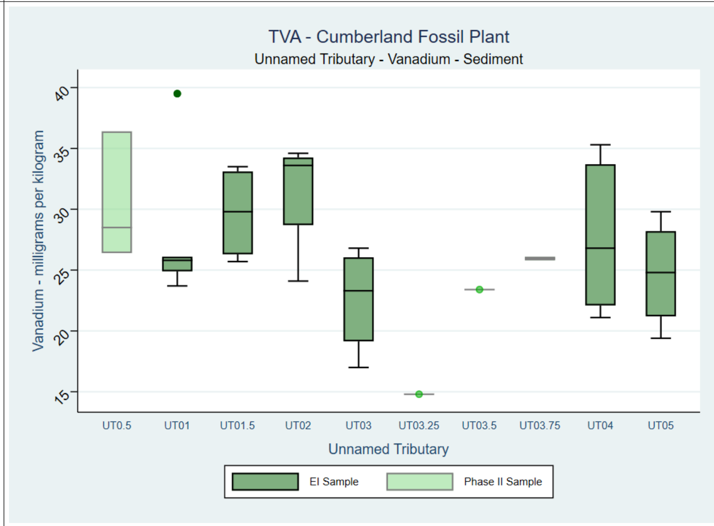

TVA - Cumberland Fossil Plant
Unnamed Tributary - Thallium - Sediment
Thallium - milligrams per kilogram
0.2
0.3
0.4
0.5
0.6
0.7
UT0.5
UT01
UT01.5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Unnamed Tributary
EI Sample
Phase II Sample

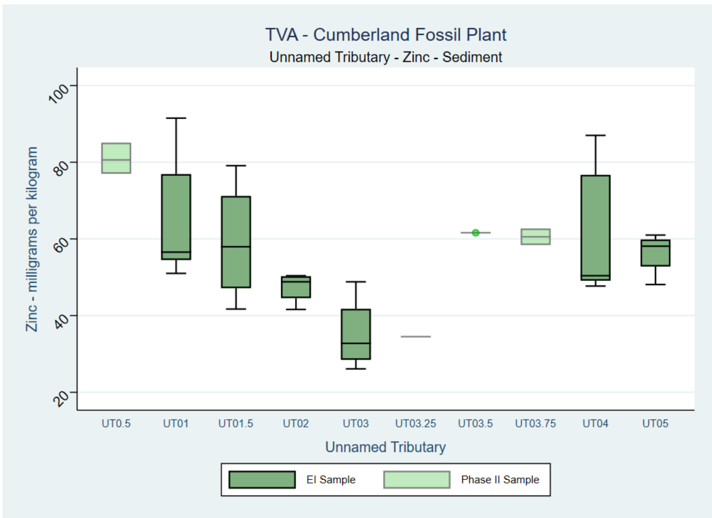
Box Plots
Unnamed Tributary - TDEC Appendix I Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling Results
Cumberland Fossil Plant, Cumberland City, Tennessee











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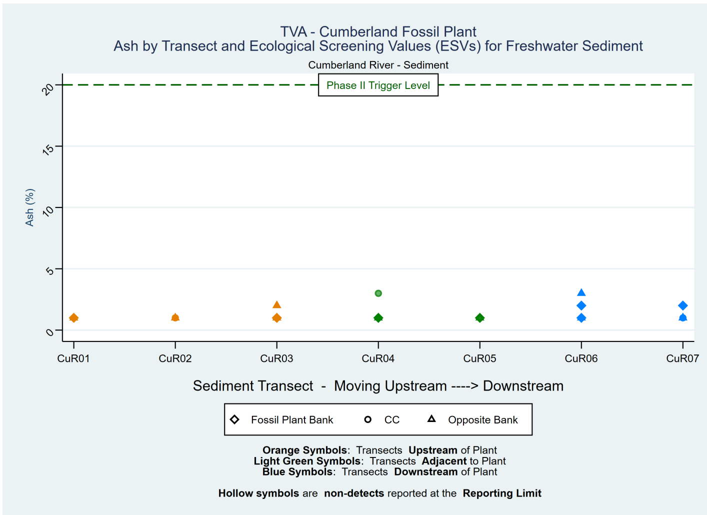
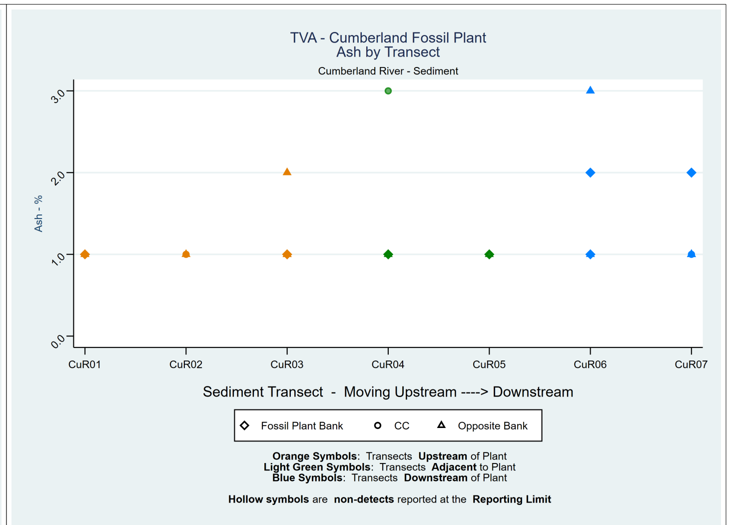
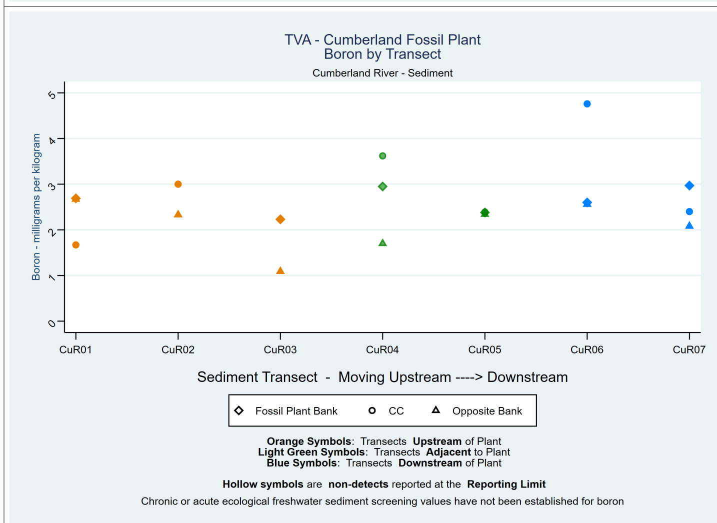
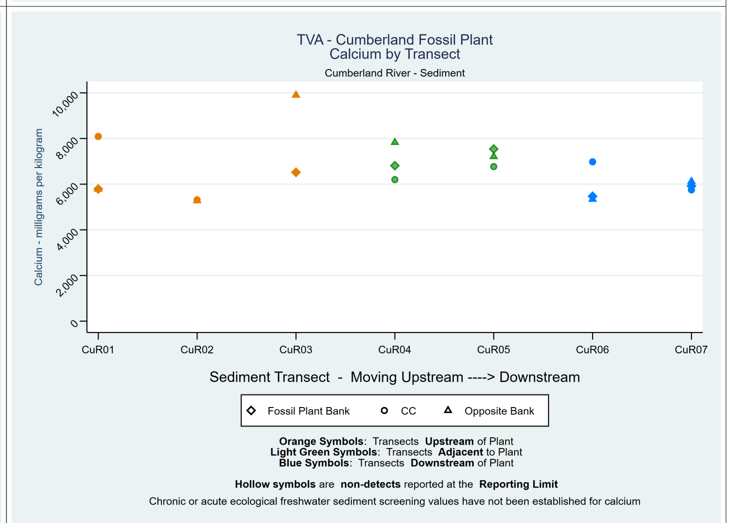
ATTACHMENT E.6-C
SEDIMENT INVESTIGATION TRANSECT PLOTS

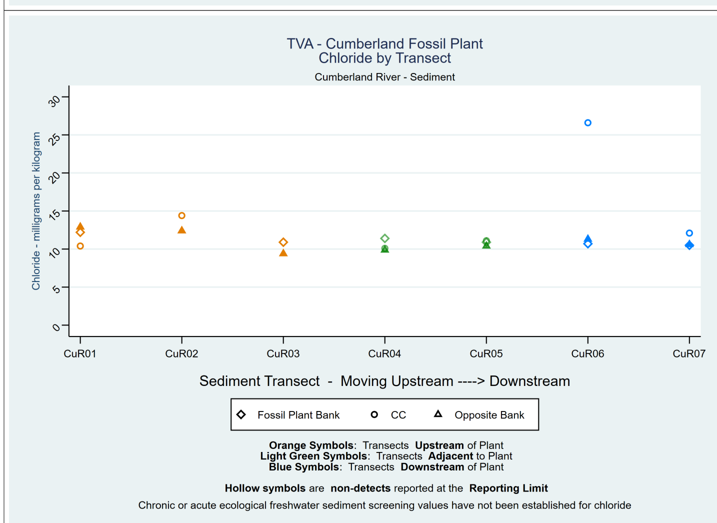
Transect Plots
Cumberland River - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

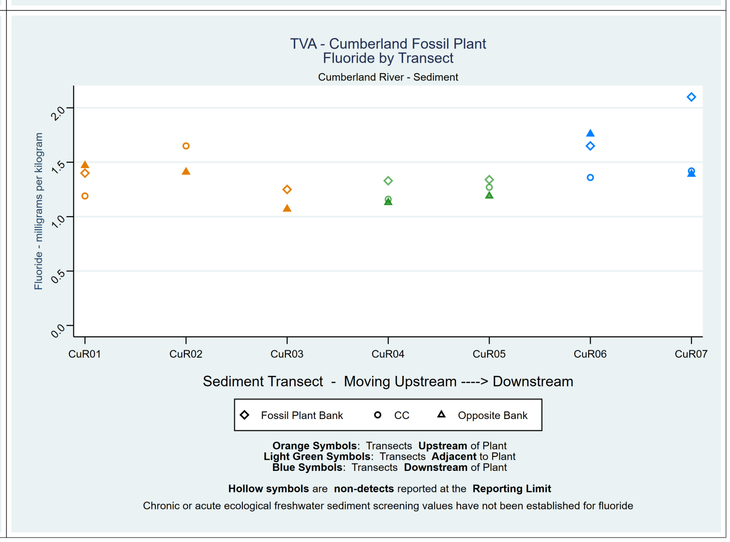


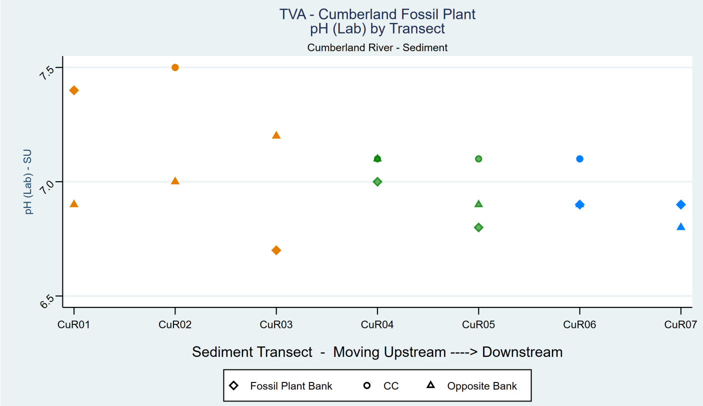












Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant

Hollow symbols are **non-detects** reported at the **Reporting Limit**

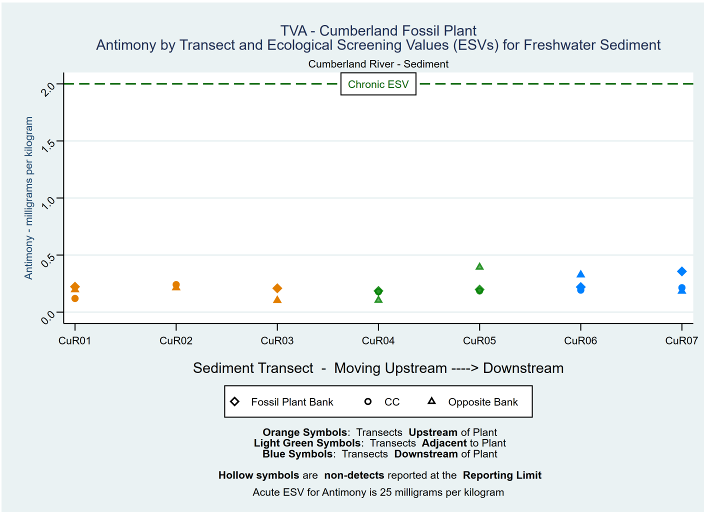
Chronic or acute ecological freshwater sediment screening values have not been established for pH

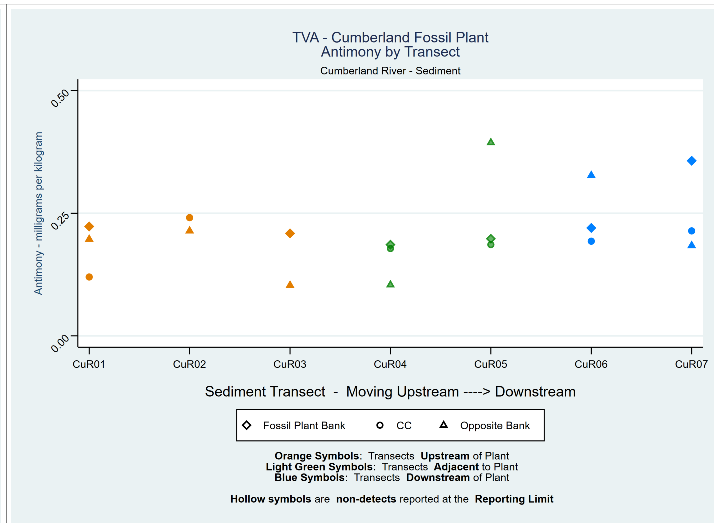
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant

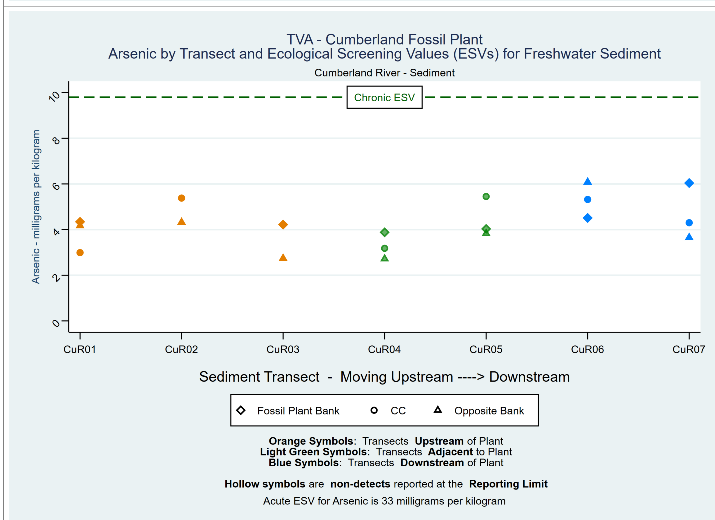
Hollow symbols are **non-detects** reported at the **Reporting Limit**

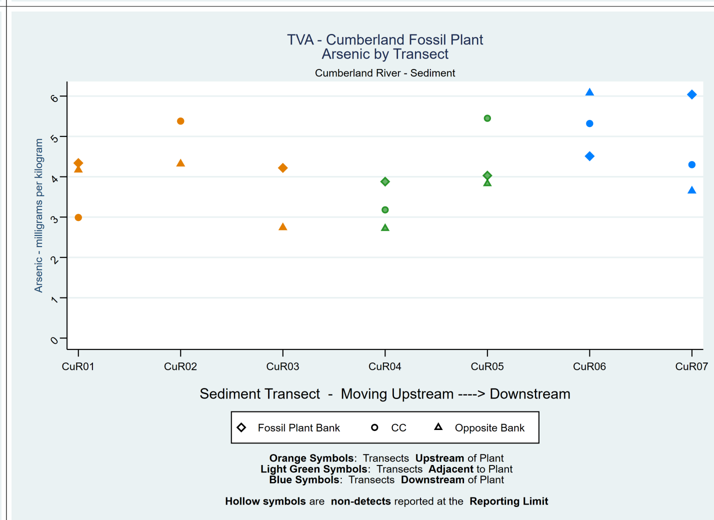
Chronic or acute ecological freshwater sediment screening values have not been established for sulfate

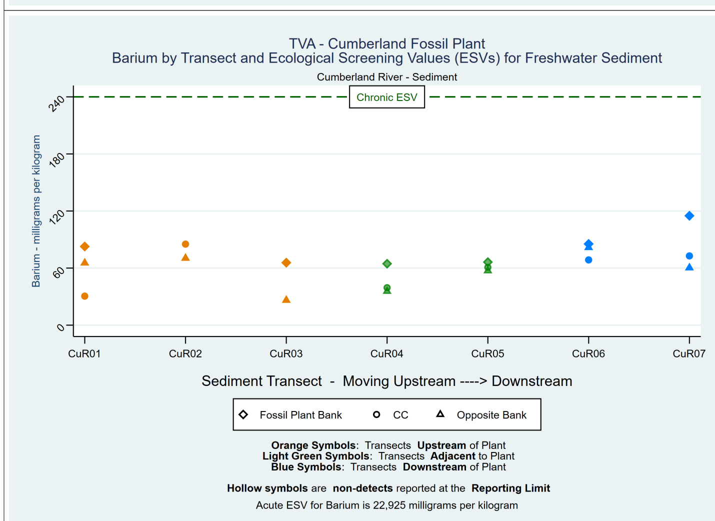
Transect Plots
Cumberland River - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

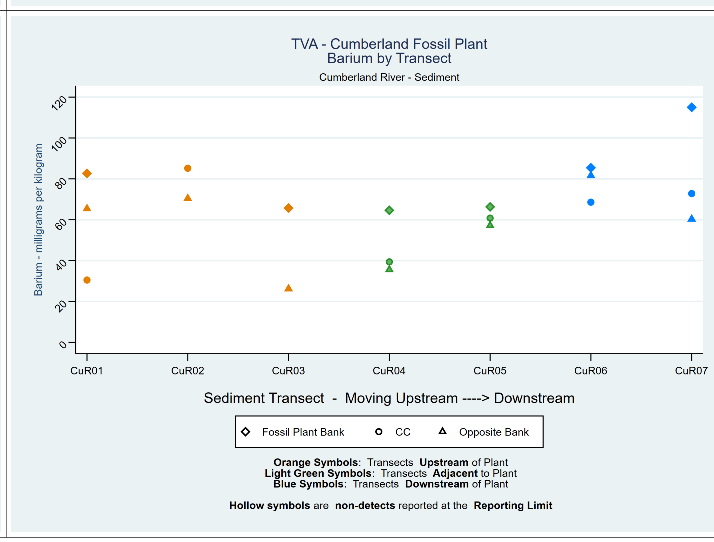


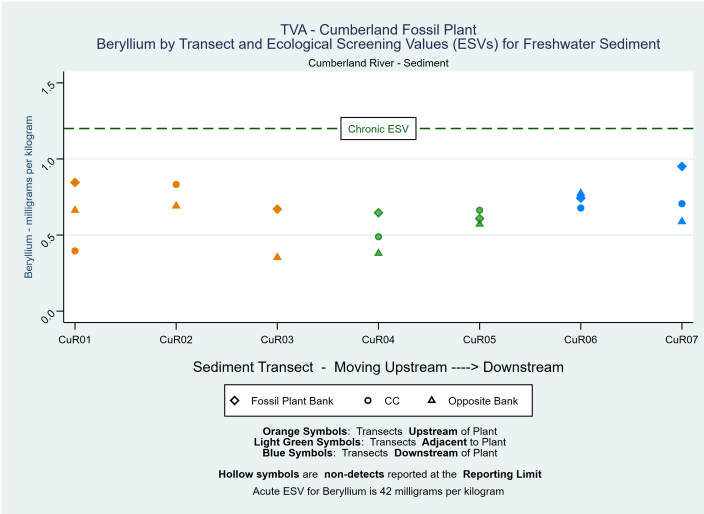


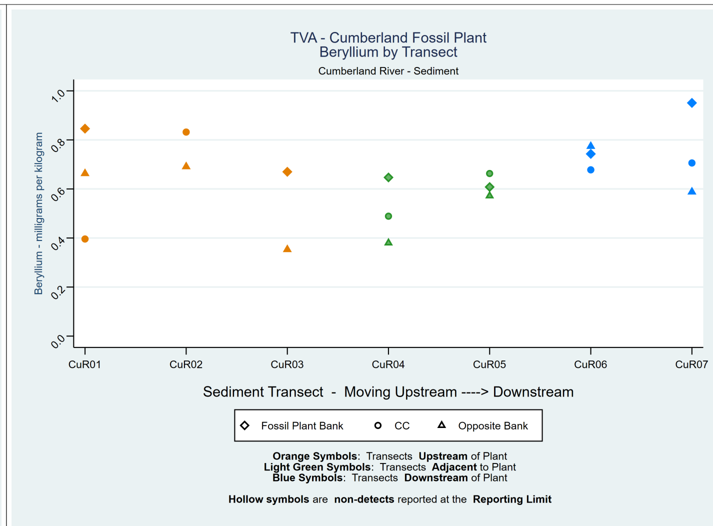


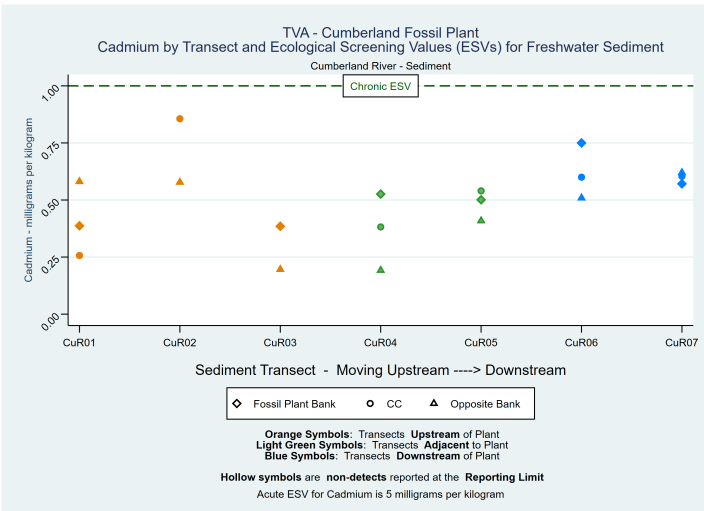


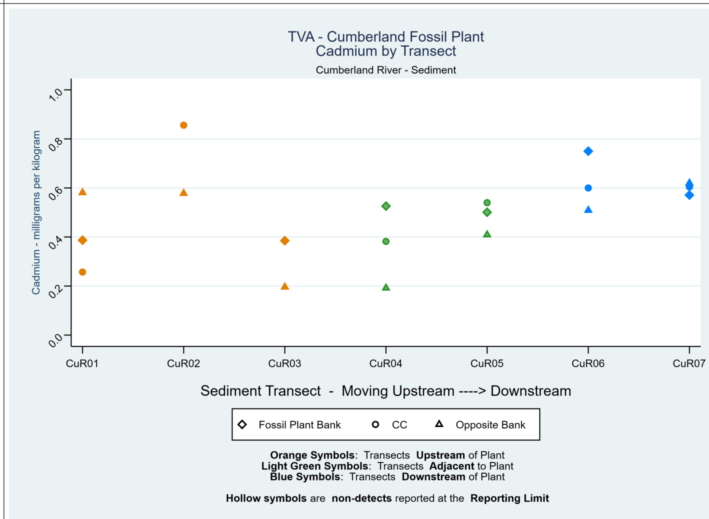


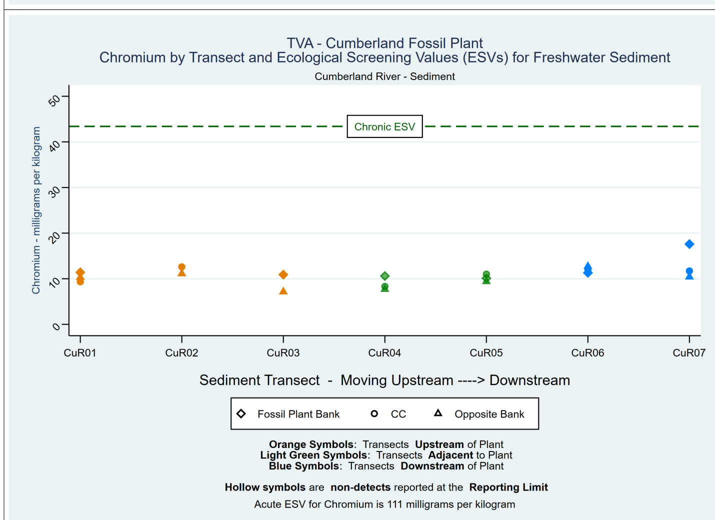


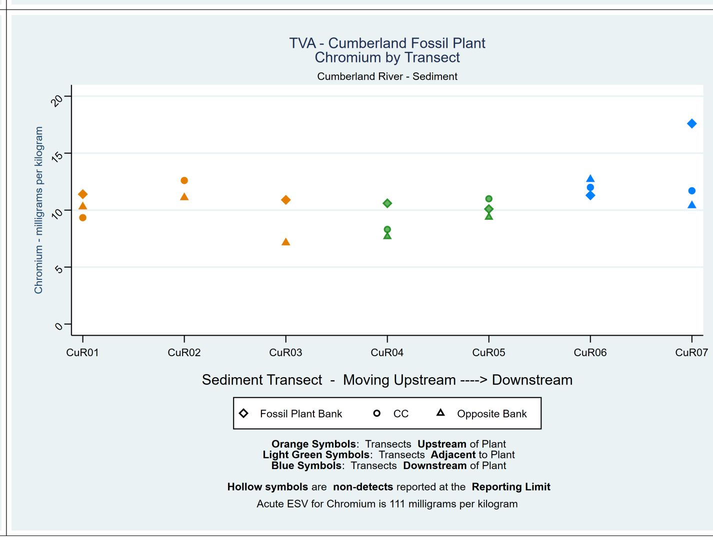

TVA - Cumberland Fossil Plant
Beryllium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Beryllium - milligrams per kilogram
Chronic ESV
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Beryllium is 42 milligrams per kilogram

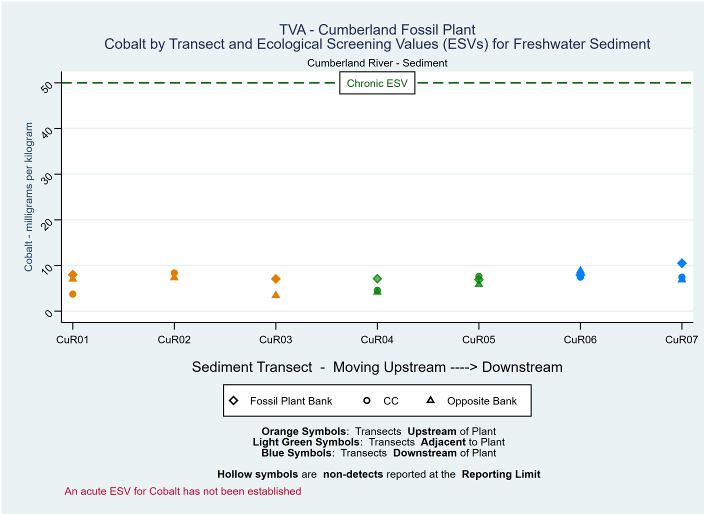

TVA - Cumberland Fossil Plant
Beryllium by Transect
Cumberland River - Sediment
Beryllium - milligrams per kilogram
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

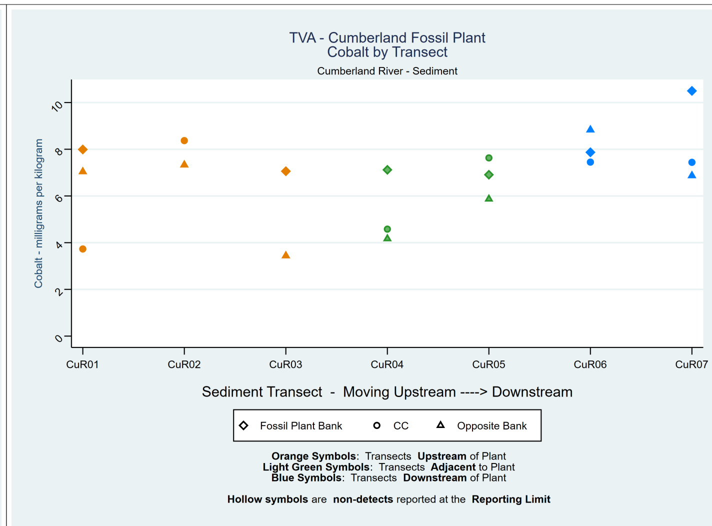

TVA - Cumberland Fossil Plant
Cadmium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Cadmium - milligrams per kilogram
Chronic ESV
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Cadmium is 5 milligrams per kilogram

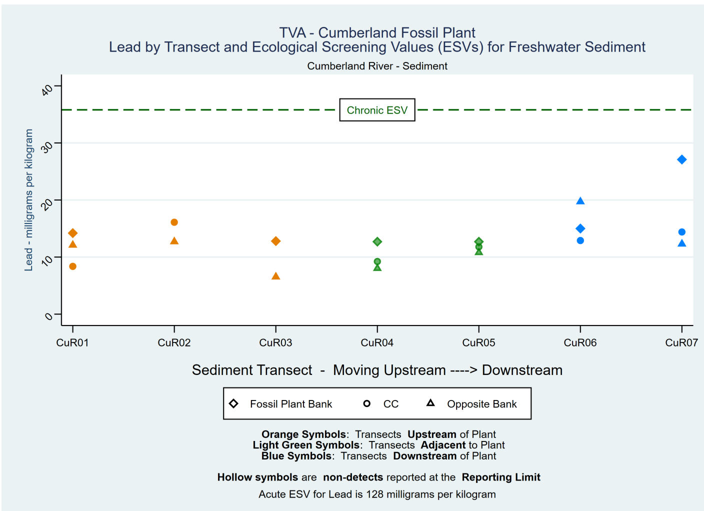

TVA - Cumberland Fossil Plant
Cadmium by Transect
Cumberland River - Sediment
Cadmium - milligrams per kilogram
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

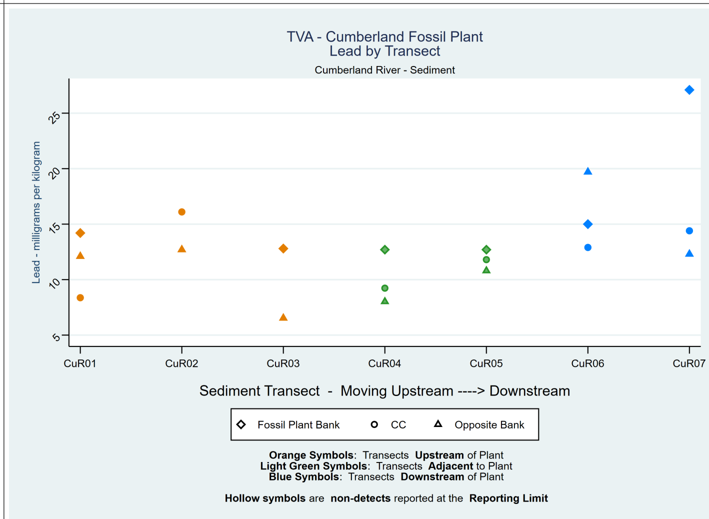

TVA - Cumberland Fossil Plant
Chromium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Chromium - milligrams per kilogram
Chronic ESV
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Chromium is 111 milligrams per kilogram


TVA - Cumberland Fossil Plant
Chromium by Transect
Cumberland River - Sediment
Chromium - milligrams per kilogram
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Chromium is 111 milligrams per kilogram

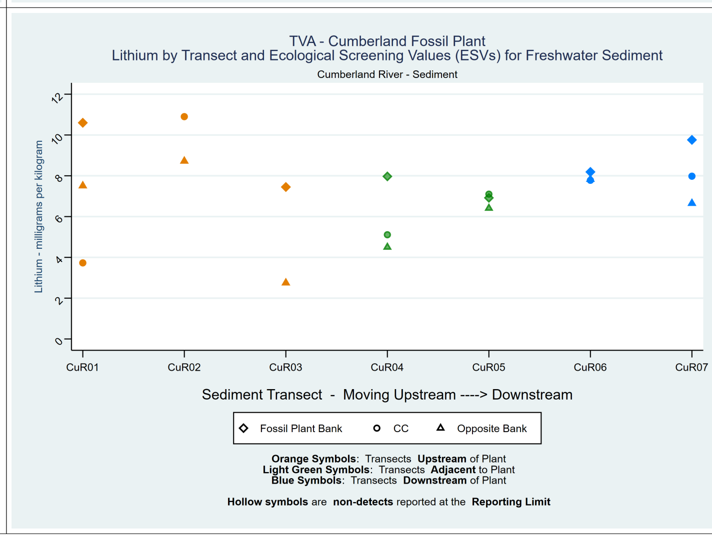


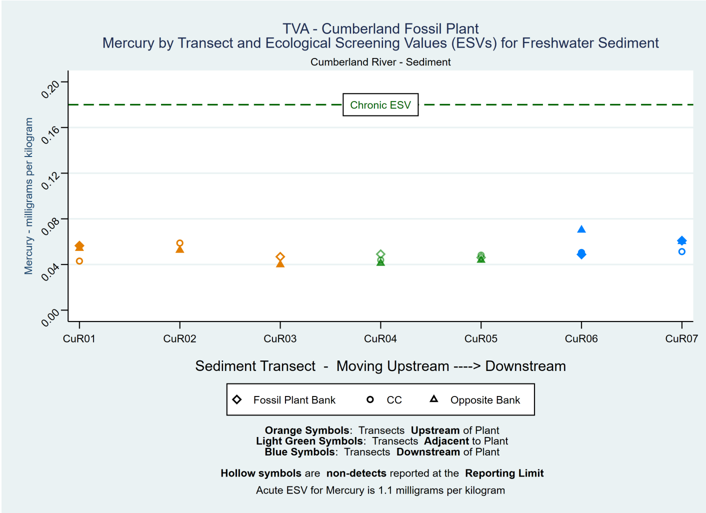


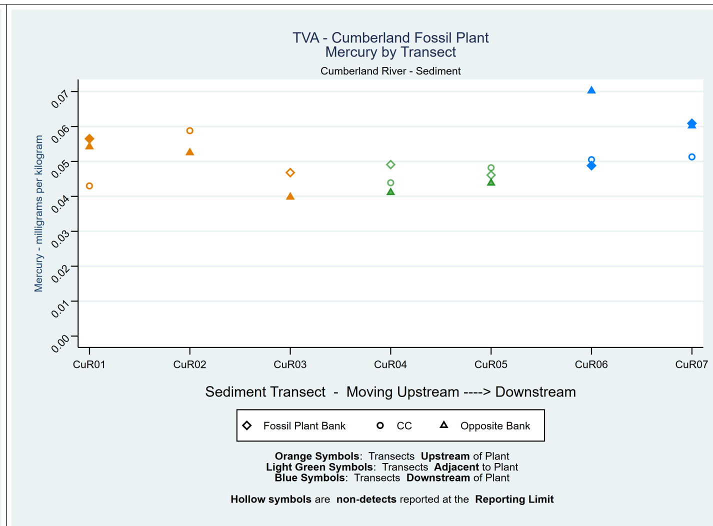


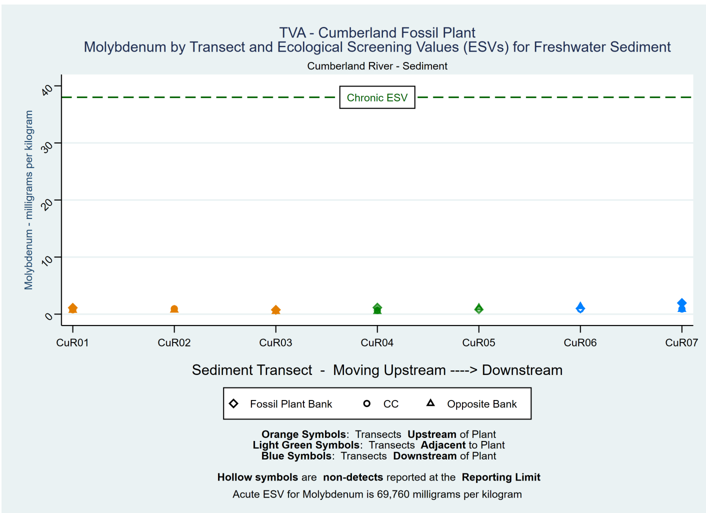


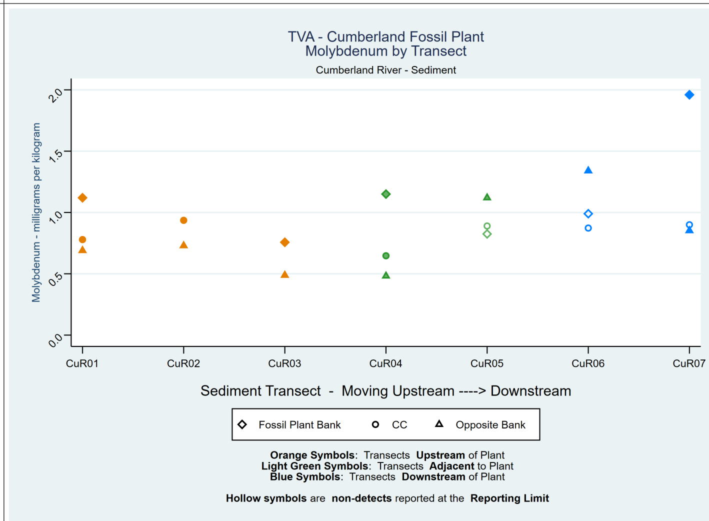
Chronic or Acute ESVs have not been established for lithium

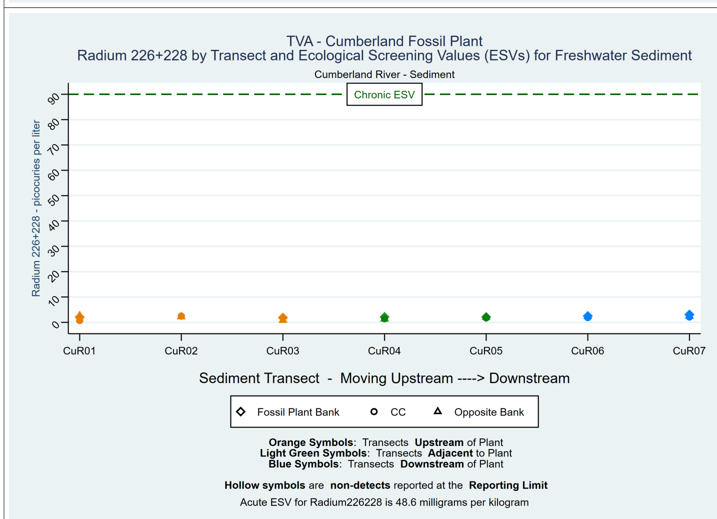


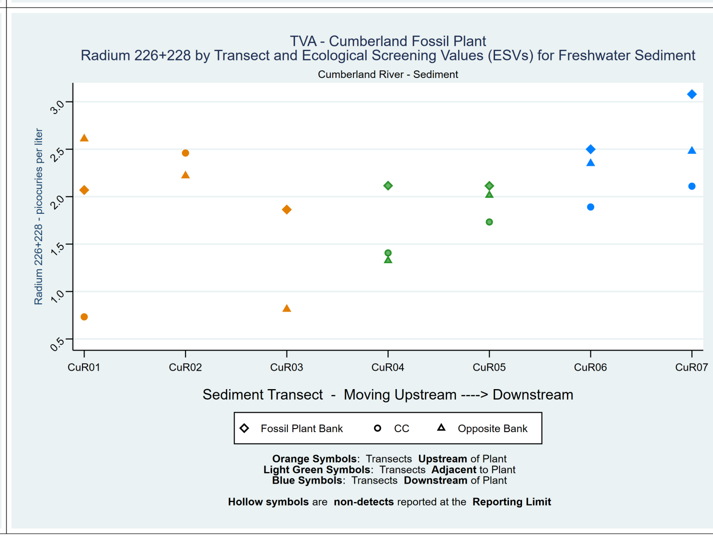

TVA - Cumberland Fossil Plant
Mercury by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Chronic ESV
Mercury - milligrams per kilogram
0.00
0.04
0.08
0.12
0.16
0.20
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Mercury is 1.1 milligrams per kilogram

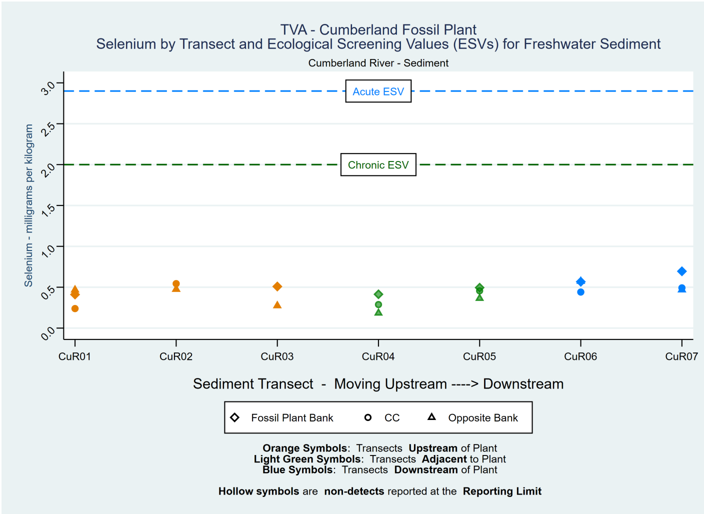

TVA - Cumberland Fossil Plant
Mercury by Transect
Cumberland River - Sediment
Mercury - milligrams per kilogram
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

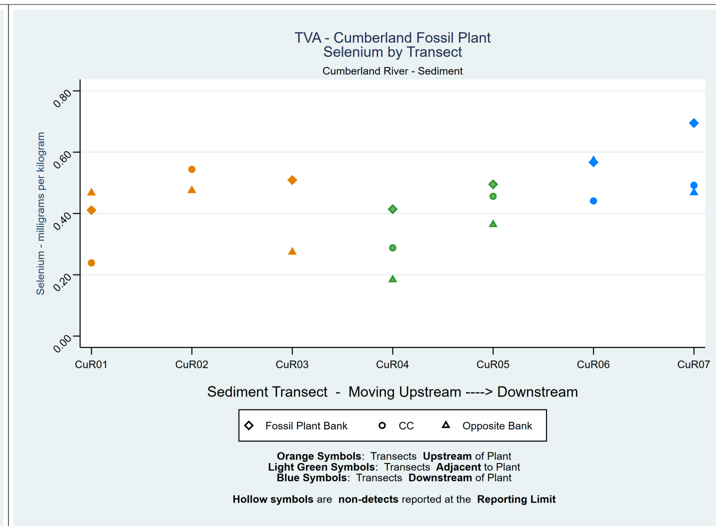

TVA - Cumberland Fossil Plant
Molybdenum by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Chronic ESV
Molybdenum - milligrams per kilogram
0
10
20
30
40
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Molybdenum is 69,760 milligrams per kilogram

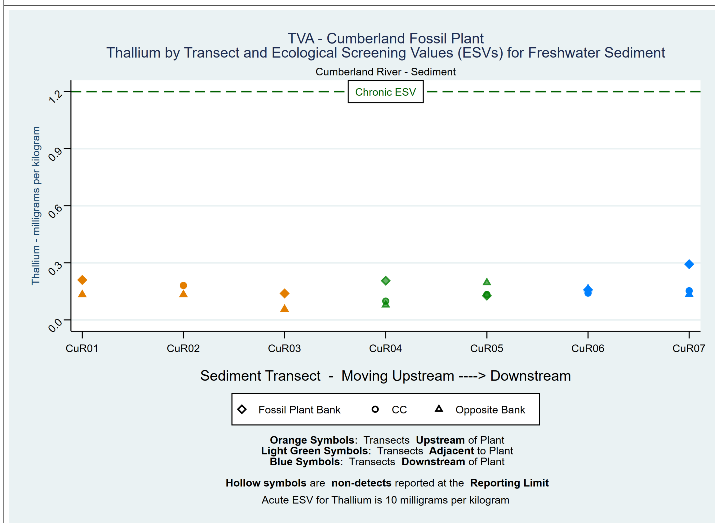

TVA - Cumberland Fossil Plant
Molybdenum by Transect
Cumberland River - Sediment
Molybdenum - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

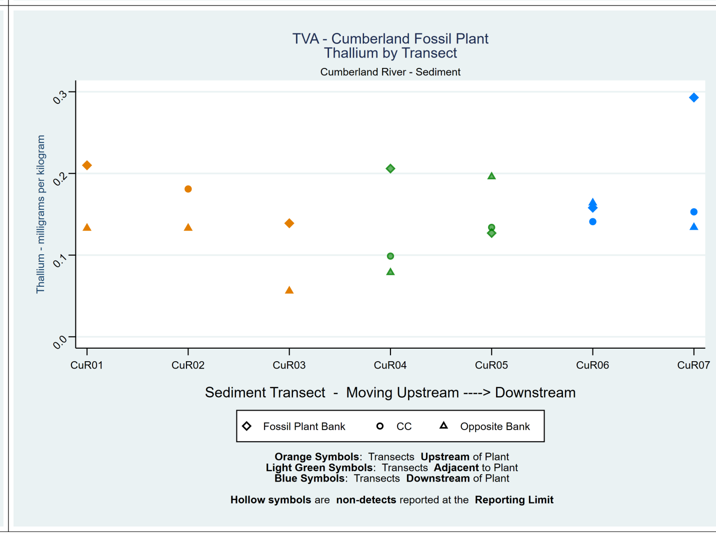

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Chronic ESV
Radium 226+228 - picocuries per liter
0
10
20
30
40
50
60
70
80
90
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Radium226228 is 48.6 milligrams per kilogram


TVA - Cumberland Fossil Plant
Radium 226+228 by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Radium 226+228 - picocuries per liter
0.5
1.0
1.5
2.0
2.5
3.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

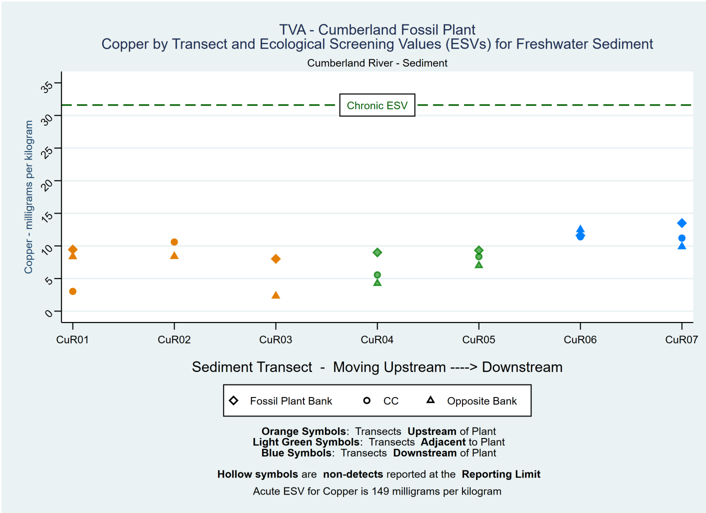

TVA - Cumberland Fossil Plant
Selenium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Acute ESV
Chronic ESV
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
2.5
3.0
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**

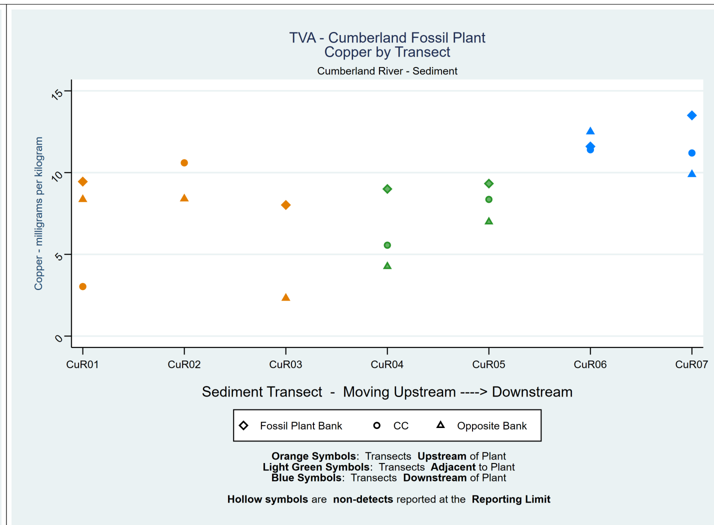

TVA - Cumberland Fossil Plant
Selenium by Transect
Cumberland River - Sediment
Selenium - milligrams per kilogram
0.00
0.20
0.40
0.60
0.80
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**

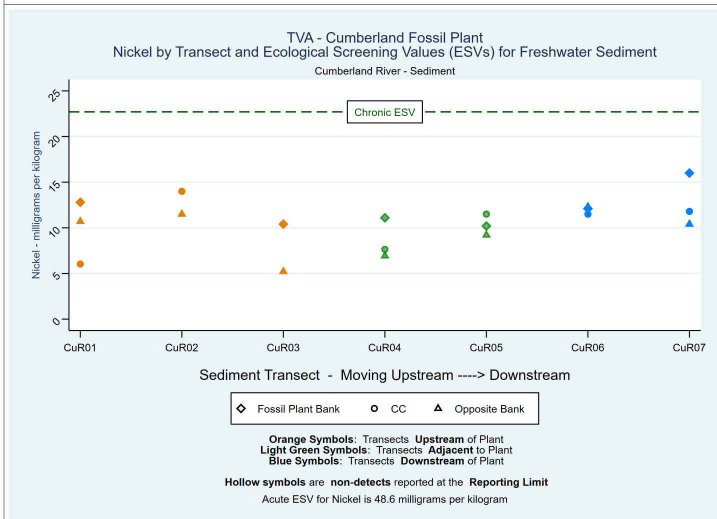

TVA - Cumberland Fossil Plant
Thallium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Chronic ESV
Thallium - milligrams per kilogram
0.0
0.3
0.6
0.9
1.2
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Acute ESV for Thallium is 10 milligrams per kilogram

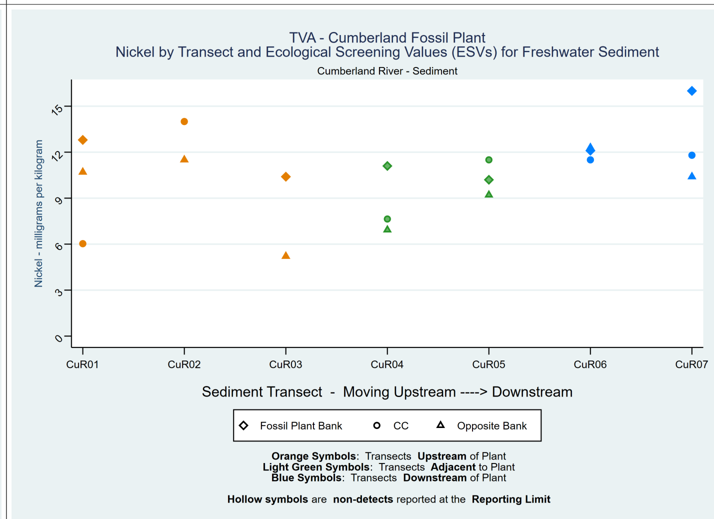

TVA - Cumberland Fossil Plant
Thallium by Transect
Cumberland River - Sediment
Thallium - milligrams per kilogram
0.0
0.1
0.2
0.3
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Blue Symbols: Transects **Downstream** of Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**

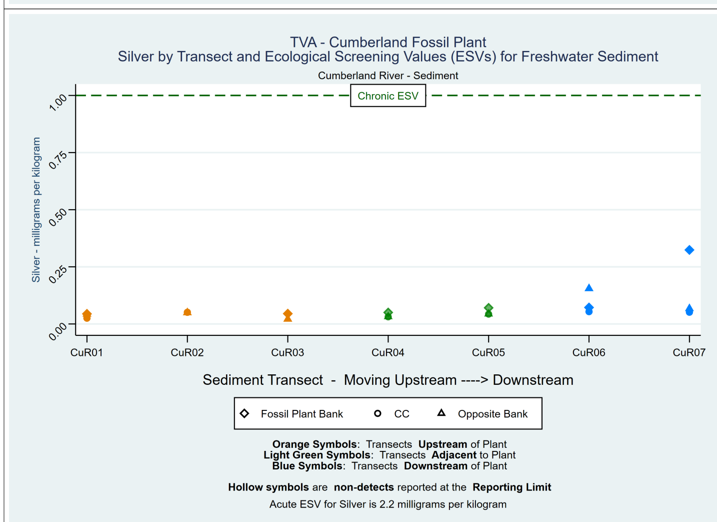
Transect Plots
Cumberland River - TDEC Appendix I Parameters
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland City, Tennessee

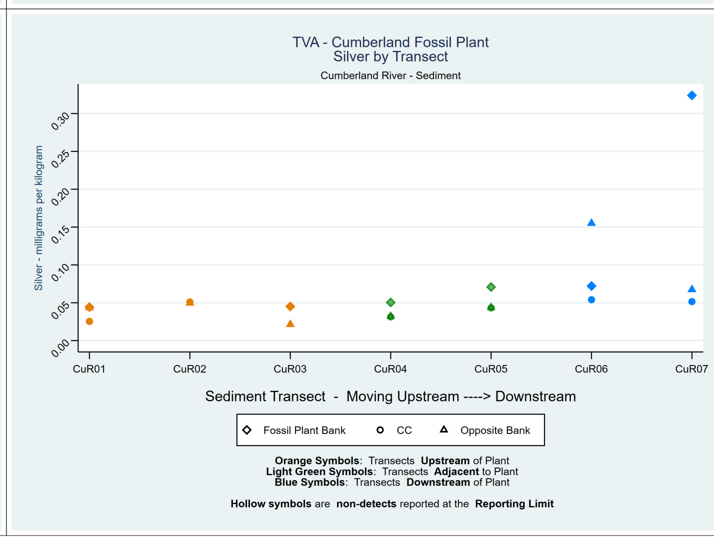


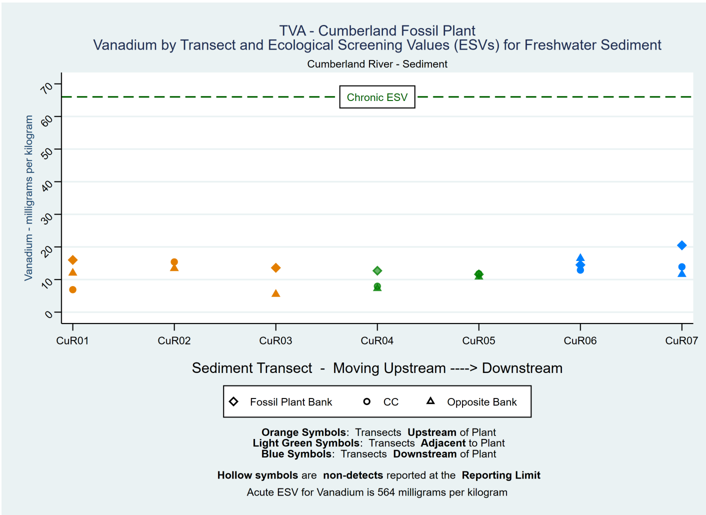


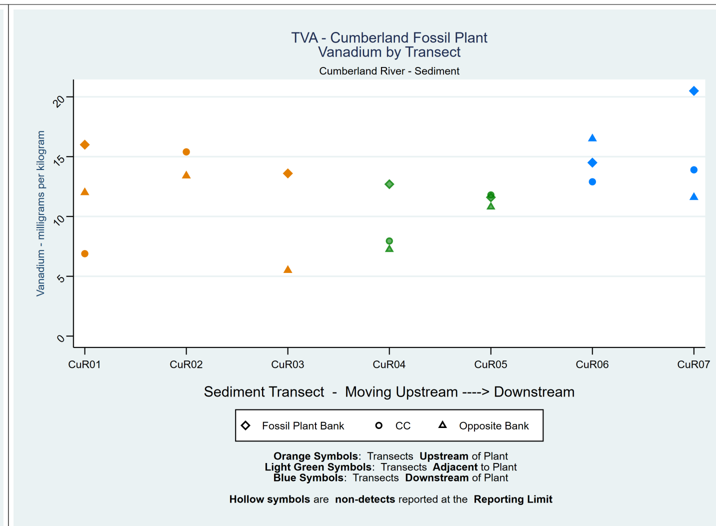


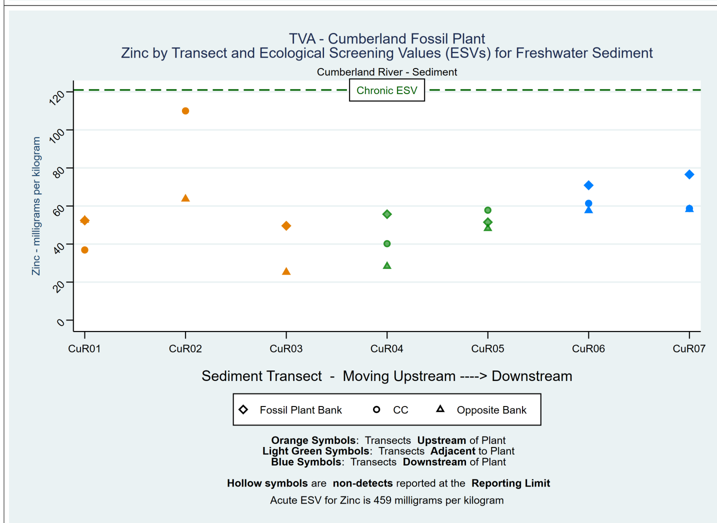


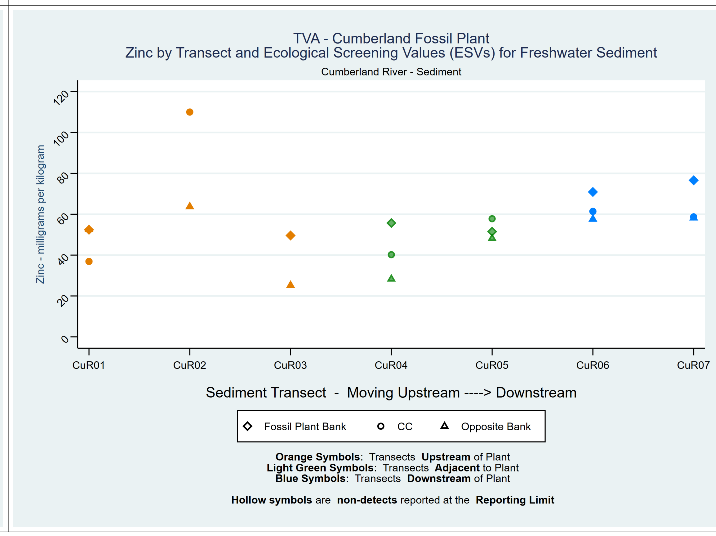




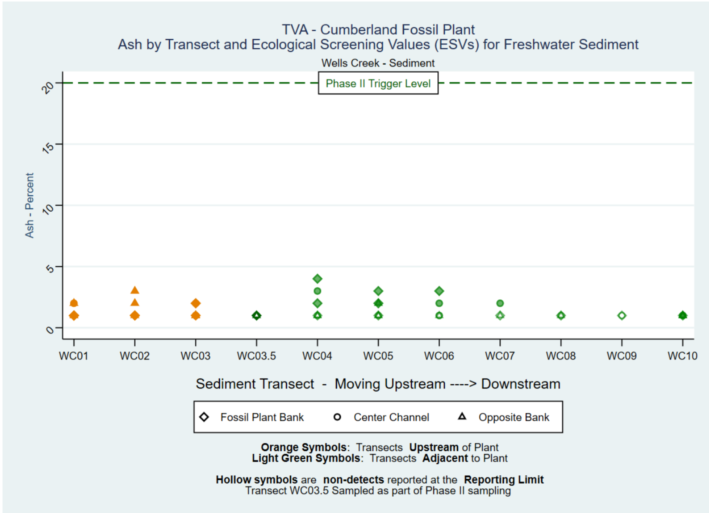

TVA - Cumberland Fossil Plant
Vanadium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Vanadium - milligrams per kilogram
0
10
20
30
40
50
60
70
Chronic ESV
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Vanadium is 564 milligrams per kilogram

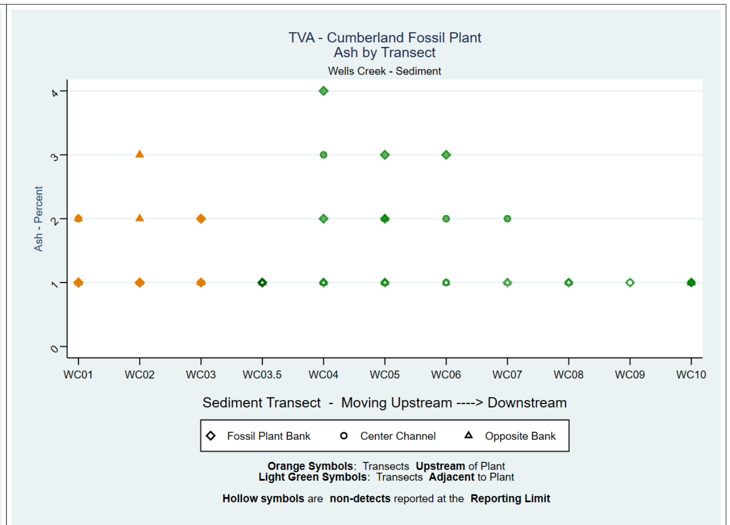

TVA - Cumberland Fossil Plant
Vanadium by Transect
Cumberland River - Sediment
Vanadium - milligrams per kilogram
0
5
10
15
20
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

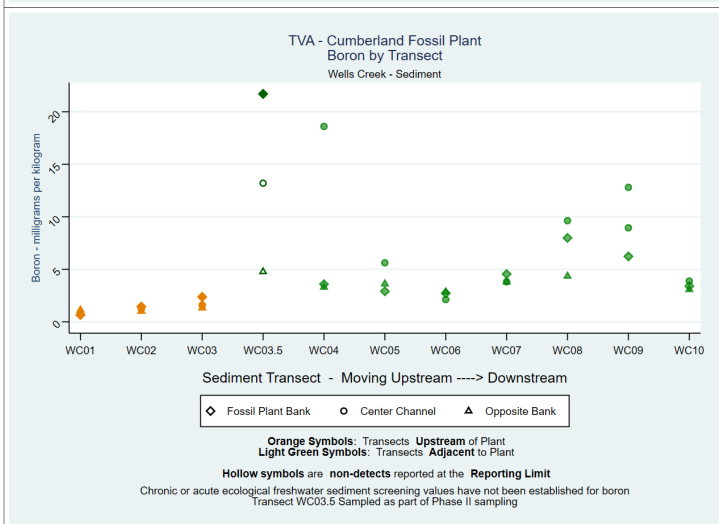

TVA - Cumberland Fossil Plant
Zinc by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Zinc - milligrams per kilogram
0
20
40
60
80
100
120
Chronic ESV
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit
Acute ESV for Zinc is 459 milligrams per kilogram

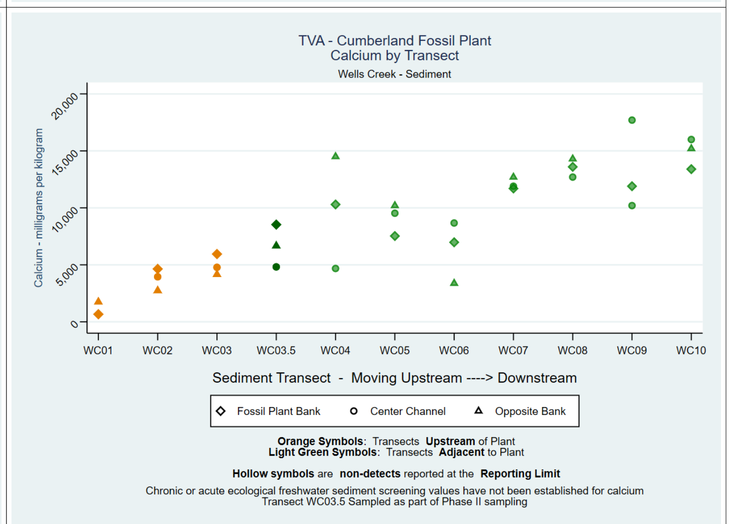

TVA - Cumberland Fossil Plant
Zinc by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Cumberland River - Sediment
Zinc - milligrams per kilogram
0
20
40
60
80
100
120
CuR01
CuR02
CuR03
CuR04
CuR05
CuR06
CuR07
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Blue Symbols: Transects Downstream of Plant
Hollow symbols are non-detects reported at the Reporting Limit

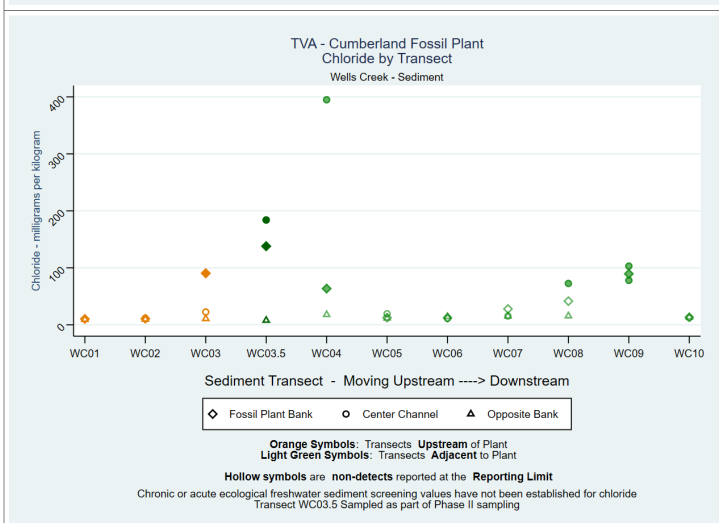
Transect Plots
Wells Creek - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee

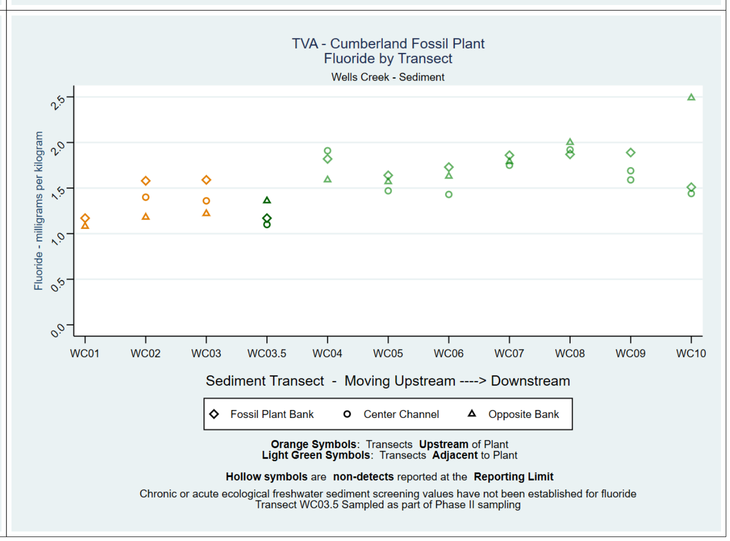


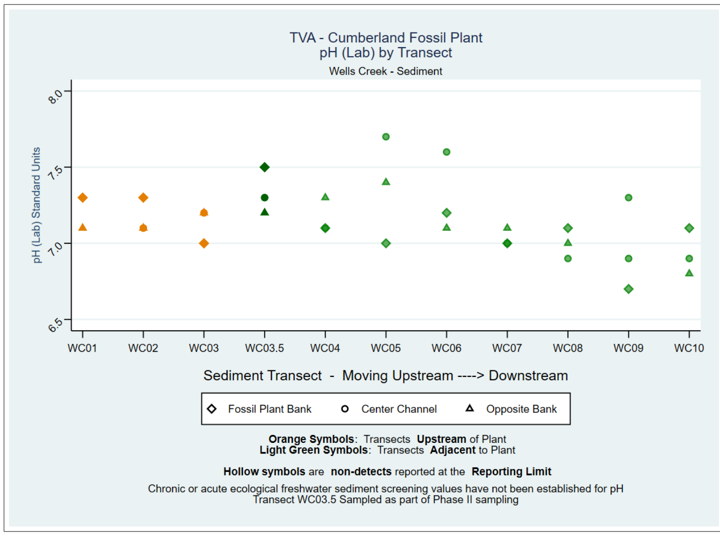


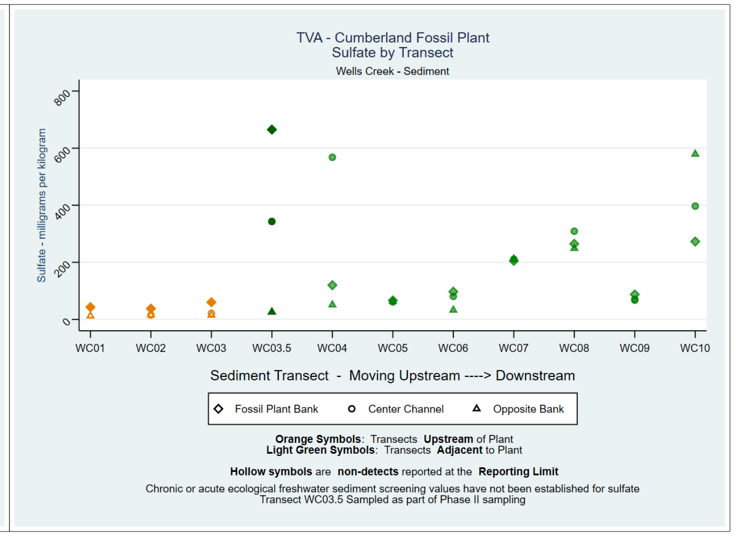




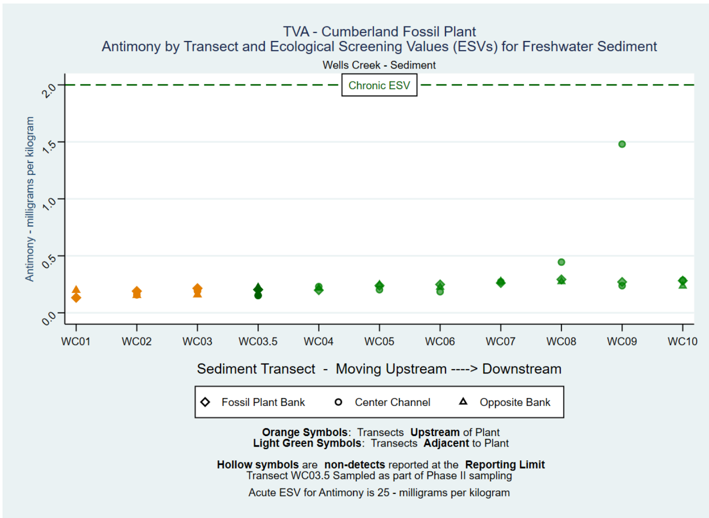


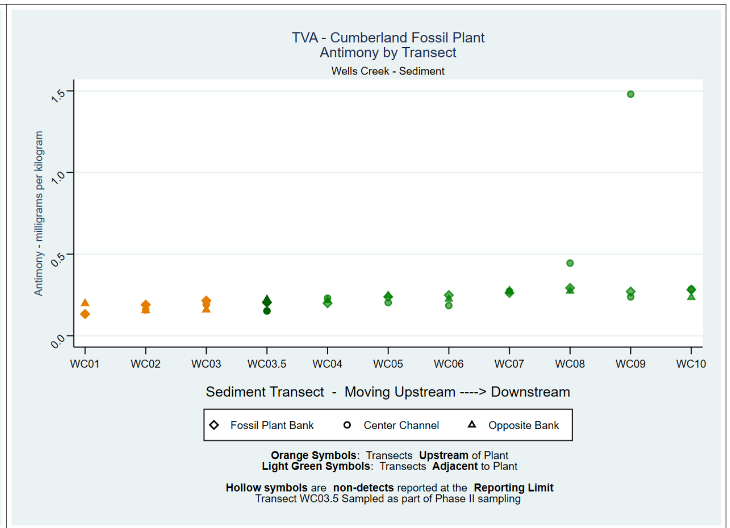


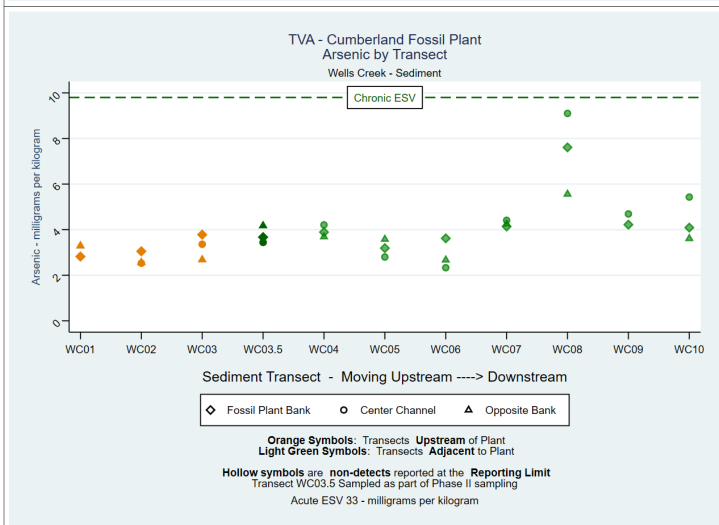

TVA - Cumberland Fossil Plant
pH (Lab) by Transect
Wells Creek - Sediment
pH (Lab) Standard Units
8.0
7.5
7.0
6.5
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Chronic or acute ecological freshwater sediment screening values have not been established for pH
Transect WC03.5 Sampled as part of Phase II sampling

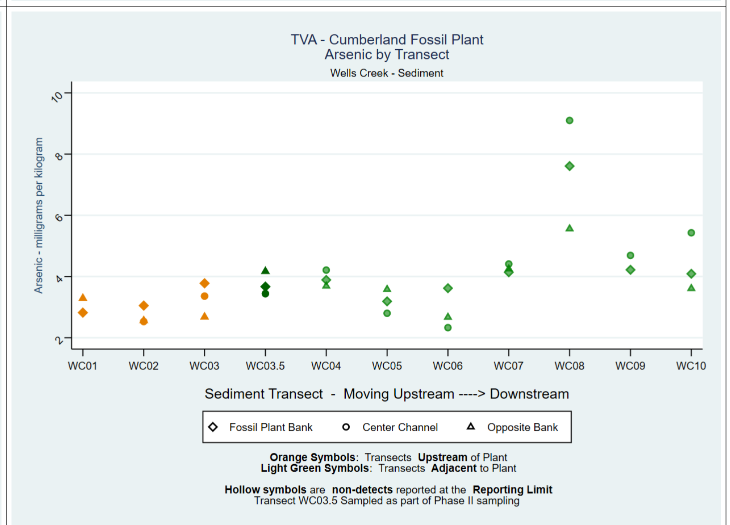

TVA - Cumberland Fossil Plant
Sulfate by Transect
Wells Creek - Sediment
Sulfate - milligrams per kilogram
800
600
400
200
0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Chronic or acute ecological freshwater sediment screening values have not been established for sulfate
Transect WC03.5 Sampled as part of Phase II sampling

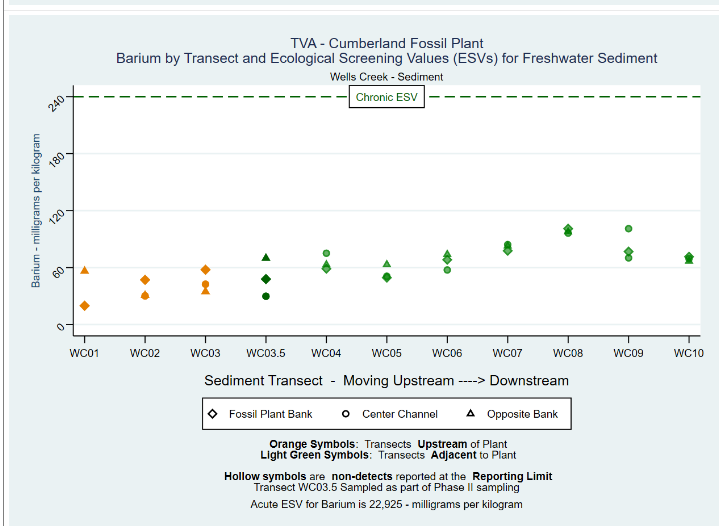
Transect Plots
Wells Creek - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee

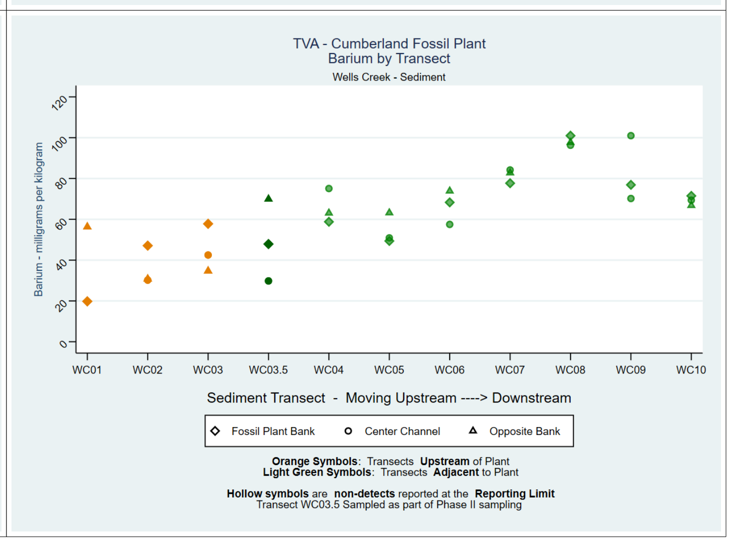


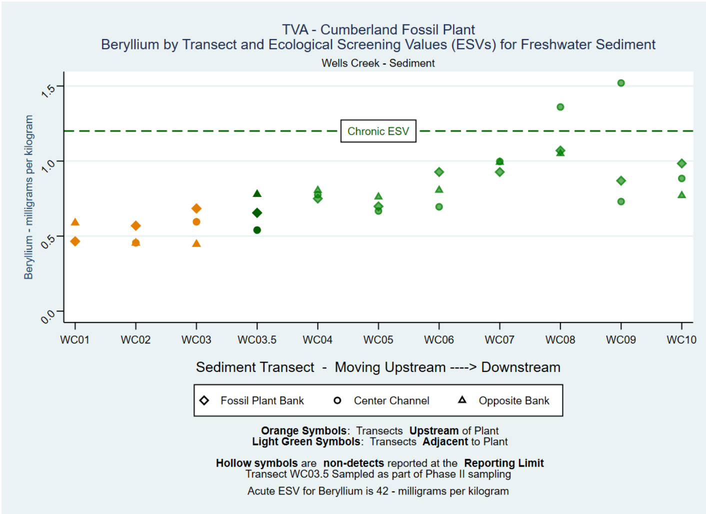


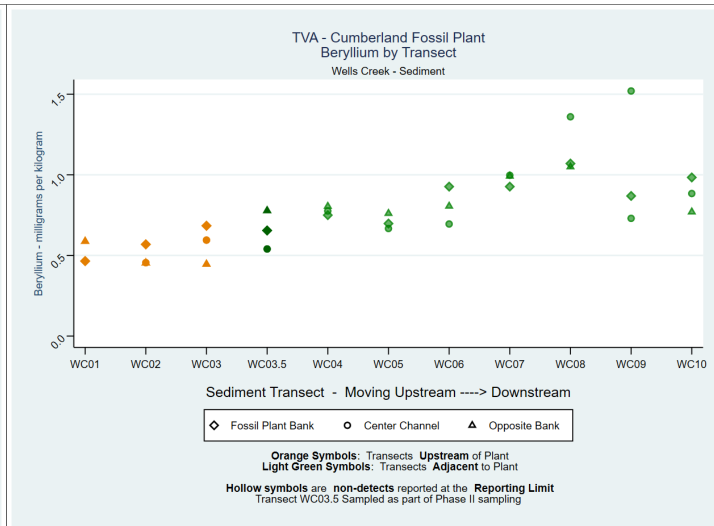


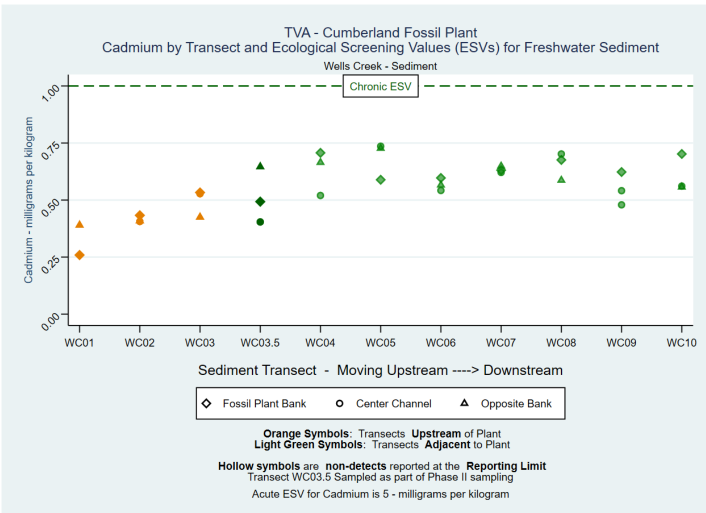


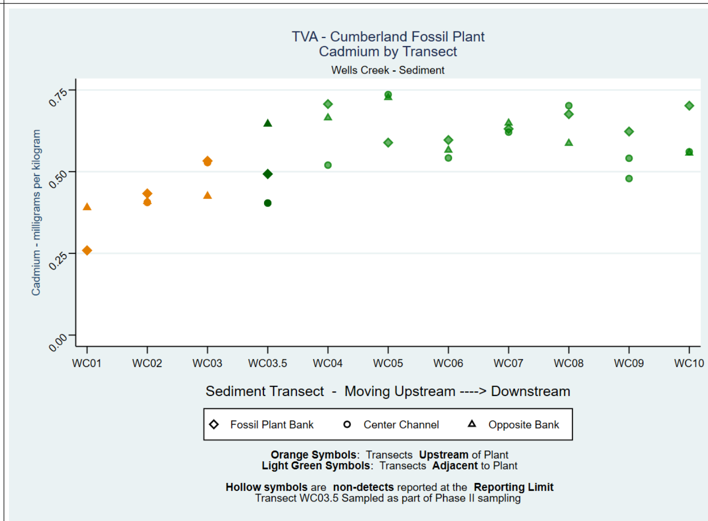


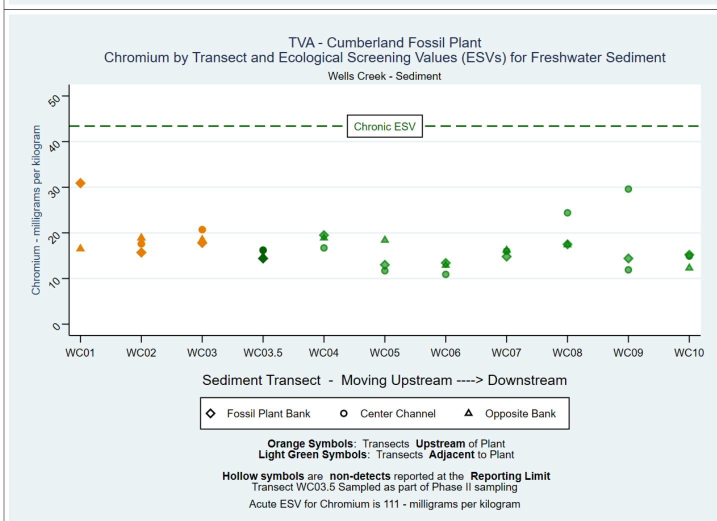


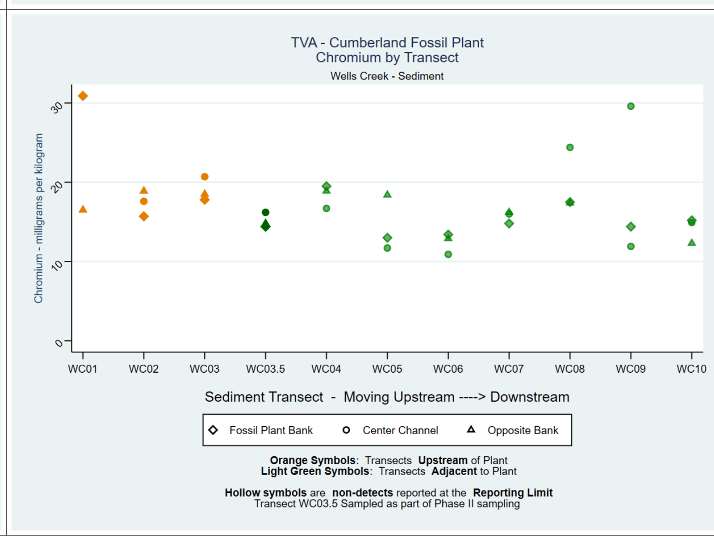

TVA - Cumberland Fossil Plant
Beryllium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Beryllium - milligrams per kilogram
0.0
0.5
1.0
1.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Beryllium is 42 - milligrams per kilogram

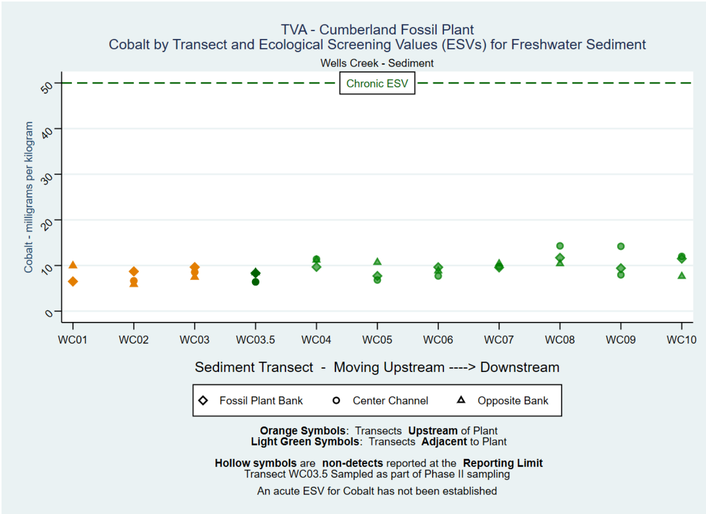

TVA - Cumberland Fossil Plant
Beryllium by Transect
Wells Creek - Sediment
Beryllium - milligrams per kilogram
0.0
0.5
1.0
1.5
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

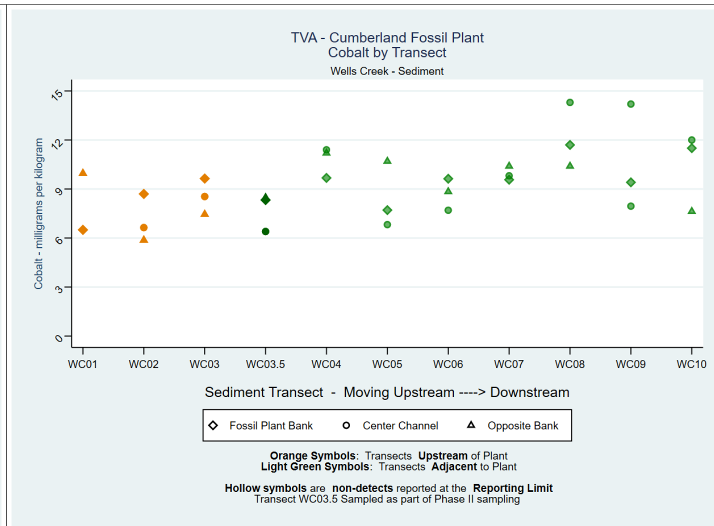

TVA - Cumberland Fossil Plant
Cadmium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Cadmium - milligrams per kilogram
0.00
0.25
0.50
0.75
1.00
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Cadmium is 5 - milligrams per kilogram

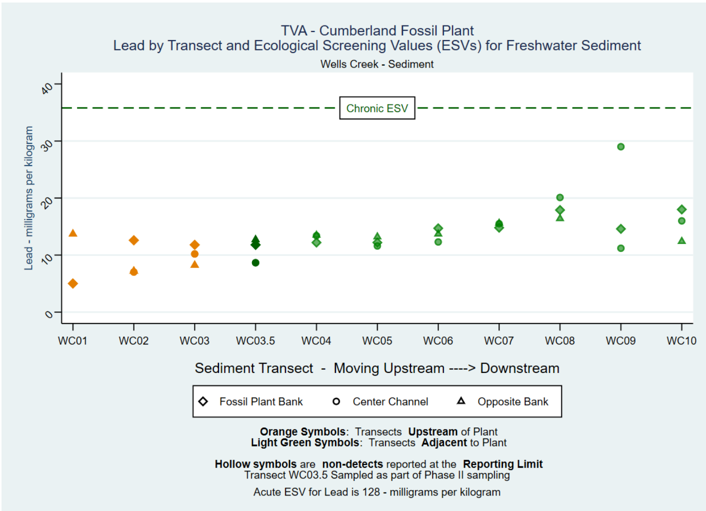

TVA - Cumberland Fossil Plant
Cadmium by Transect
Wells Creek - Sediment
Cadmium - milligrams per kilogram
0.00
0.25
0.50
0.75
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

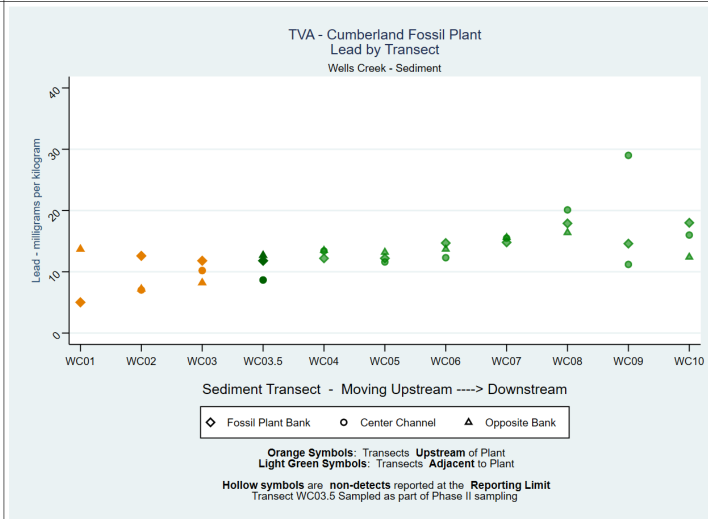

TVA - Cumberland Fossil Plant
Chromium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Chromium - milligrams per kilogram
0
10
20
30
40
50
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Chromium is 111 - milligrams per kilogram


TVA - Cumberland Fossil Plant
Chromium by Transect
Wells Creek - Sediment
Chromium - milligrams per kilogram
0
10
20
30
WC01 WC02 WC03 WC03.5 WC04 WC05 WC06 WC07 WC08 WC09 WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

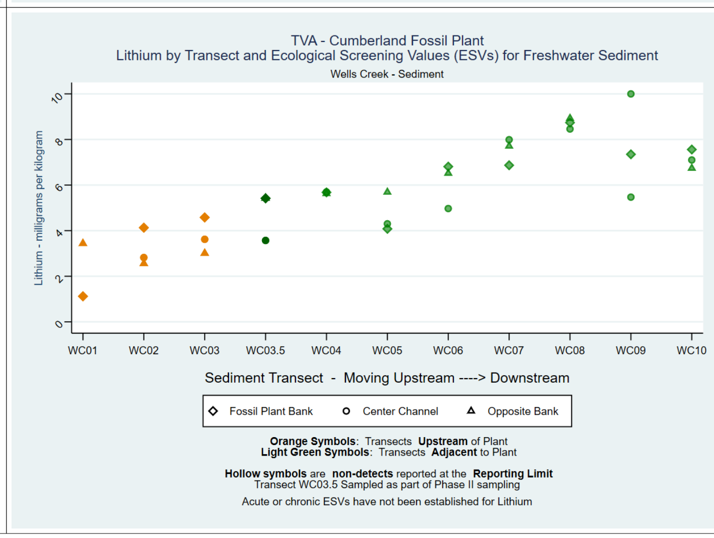


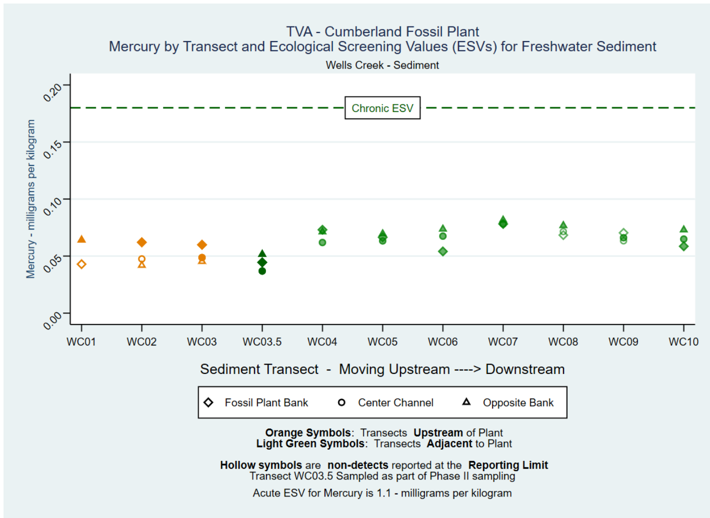


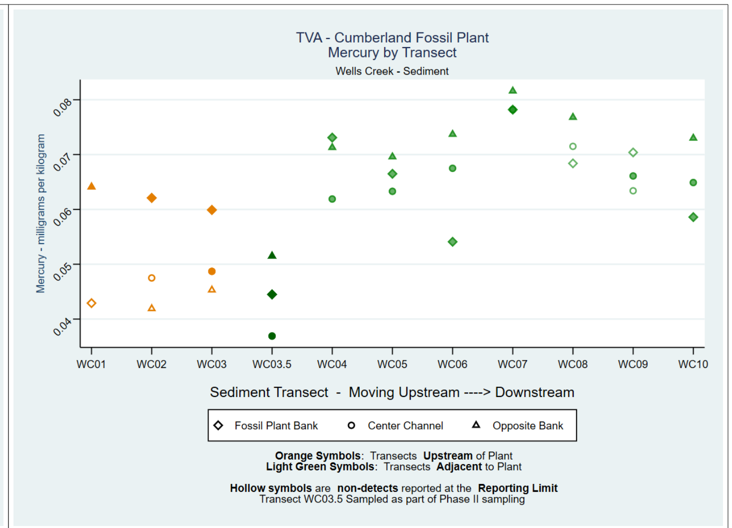


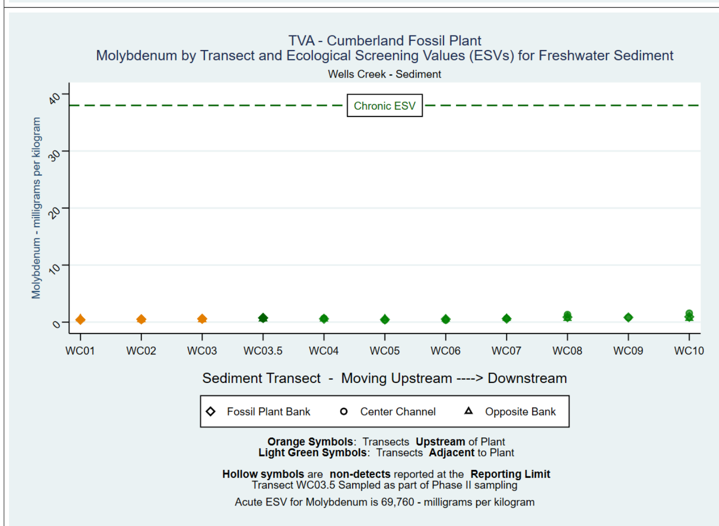


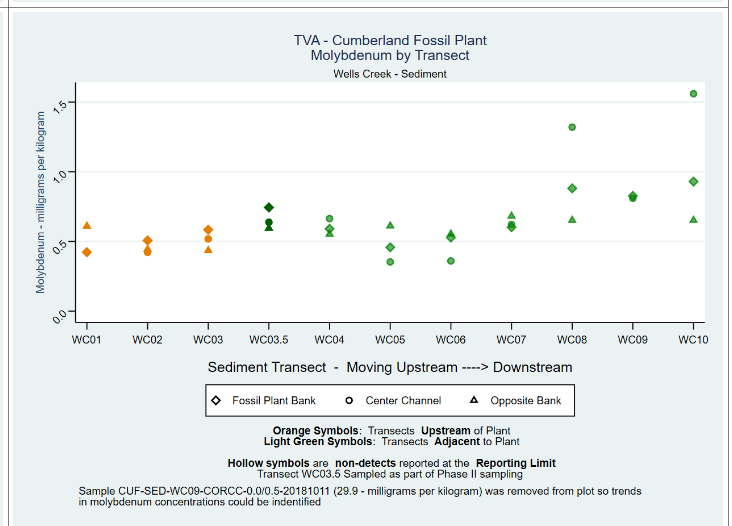
Chronic or Acute ESVs have not been established for lithium

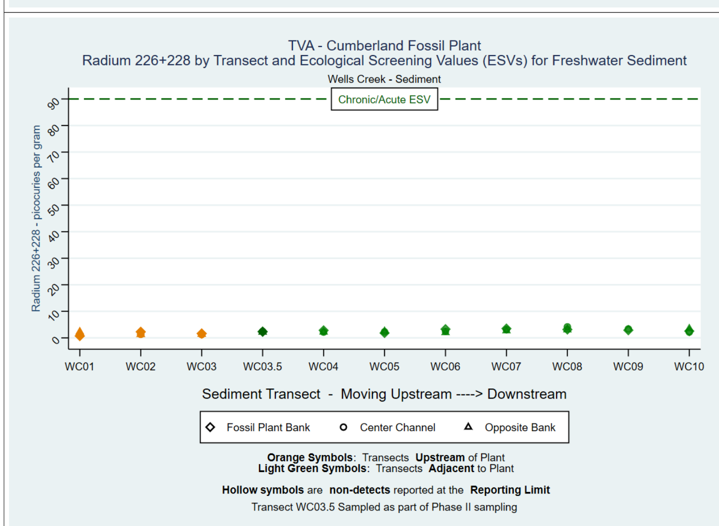



TVA - Cumberland Fossil Plant
Mercury by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Mercury - milligrams per kilogram
0.00
0.05
0.10
0.15
0.20
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Mercury is 1.1 - milligrams per kilogram

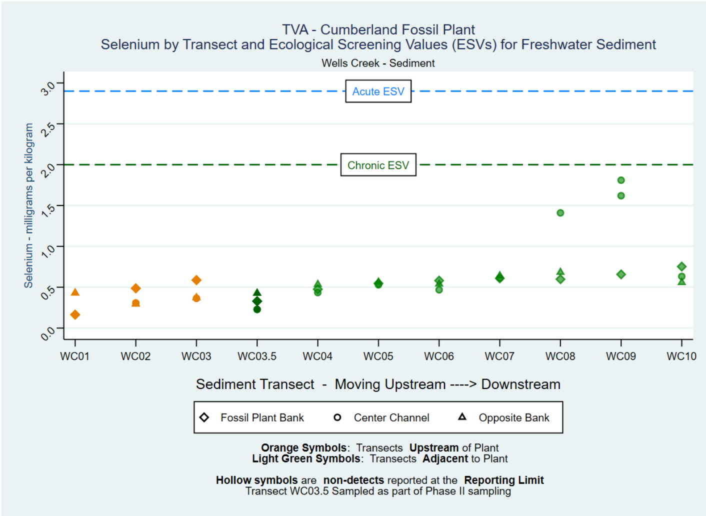

TVA - Cumberland Fossil Plant
Mercury by Transect
Wells Creek - Sediment
Mercury - milligrams per kilogram
0.04
0.05
0.06
0.07
0.08
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

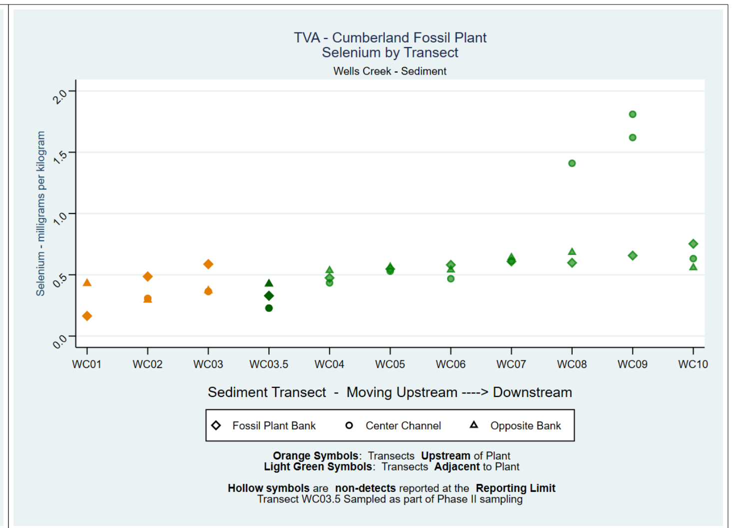

TVA - Cumberland Fossil Plant
Molybdenum by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Molybdenum - milligrams per kilogram
0
10
20
30
40
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Molybdenum is 69,760 - milligrams per kilogram

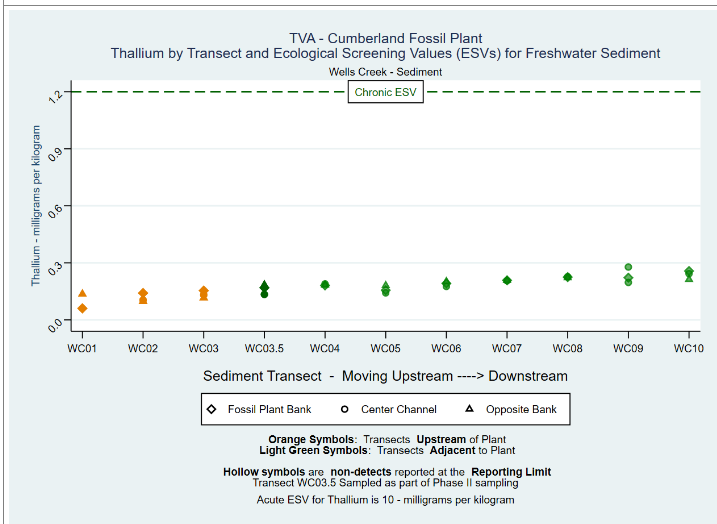

TVA - Cumberland Fossil Plant
Molybdenum by Transect
Wells Creek - Sediment
Molybdenum - milligrams per kilogram
0.0
0.5
1.0
1.5
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Sample CUF-SED-WC09-CORCC-0.0/0.5-20181011 (29.9 - milligrams per kilogram) was removed from plot so trends in molybdenum concentrations could be indentified

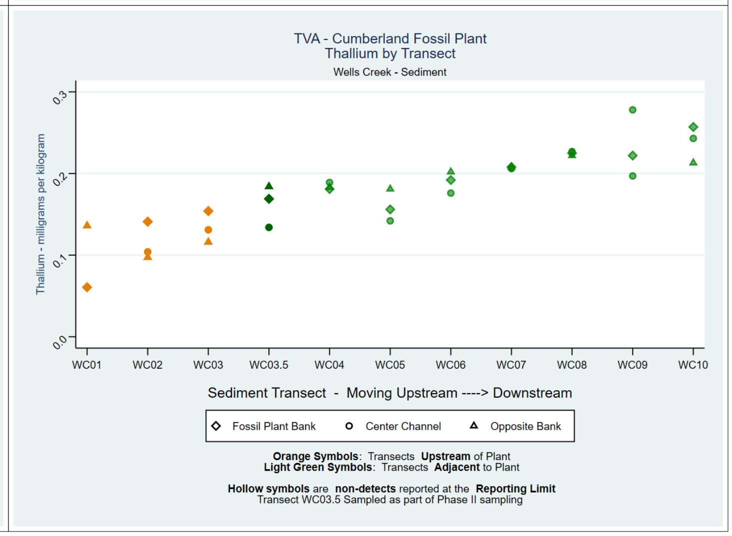

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic/Acute ESV
Radium 226+228 - picocuries per gram
0
10
20
30
40
50
60
70
80
90
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling


TVA - Cumberland Fossil Plant
Radium 226+228 by Transect
Wells Creek - Sediment
Radium 226+228 - picocuries per gram
1.0
2.0
3.0
4.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

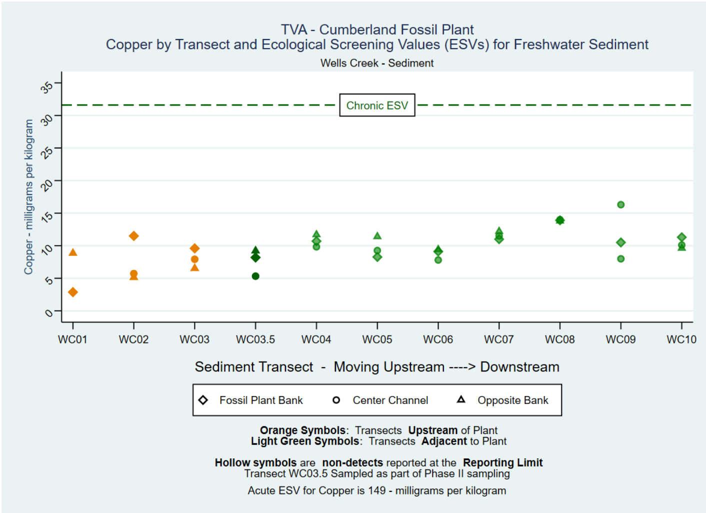

TVA - Cumberland Fossil Plant
Selenium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Acute ESV
Chronic ESV
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
2.5
3.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Transect WC03.5 Sampled as part of Phase II sampling

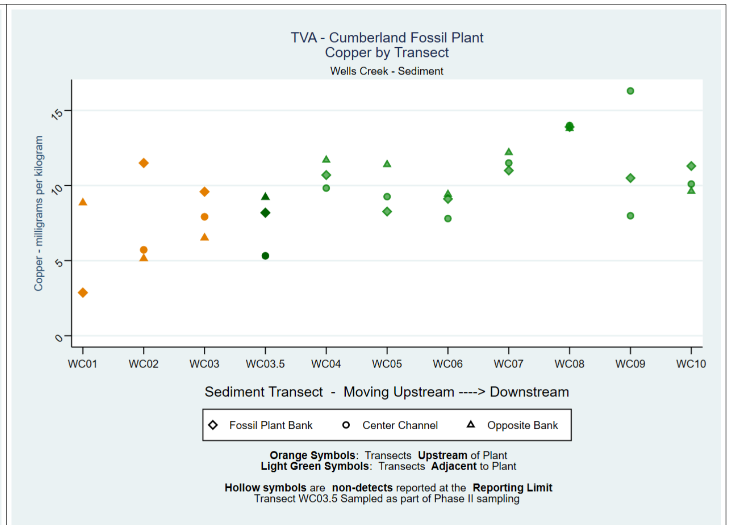

TVA - Cumberland Fossil Plant
Selenium by Transect
Wells Creek - Sediment
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Transect WC03.5 Sampled as part of Phase II sampling

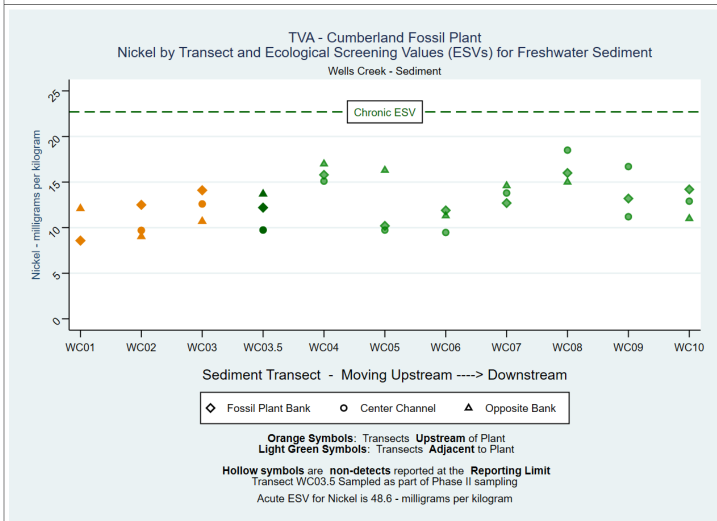

TVA - Cumberland Fossil Plant
Thallium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Thallium - milligrams per kilogram
0.0
0.3
0.6
0.9
1.2
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Thallium is 10 - milligrams per kilogram

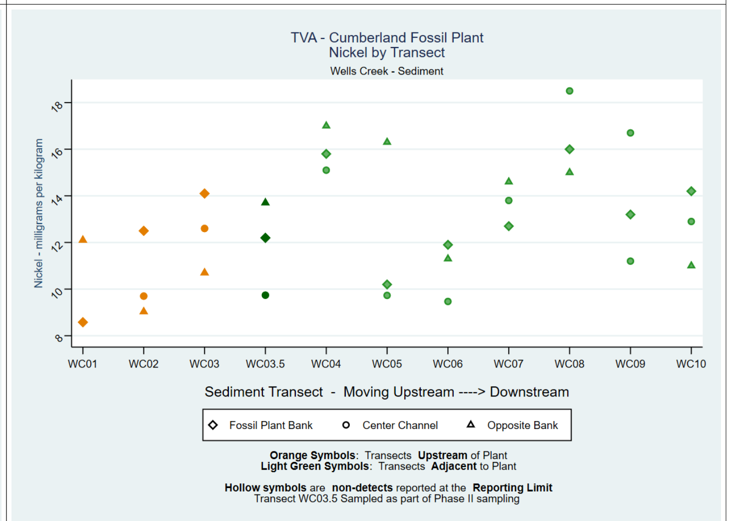

TVA - Cumberland Fossil Plant
Thallium by Transect
Wells Creek - Sediment
Thallium - milligrams per kilogram
0.0
0.1
0.2
0.3
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects **Upstream** of Plant
Light Green Symbols: Transects **Adjacent** to Plant
Hollow symbols are **non-detects** reported at the **Reporting Limit**
Transect WC03.5 Sampled as part of Phase II sampling

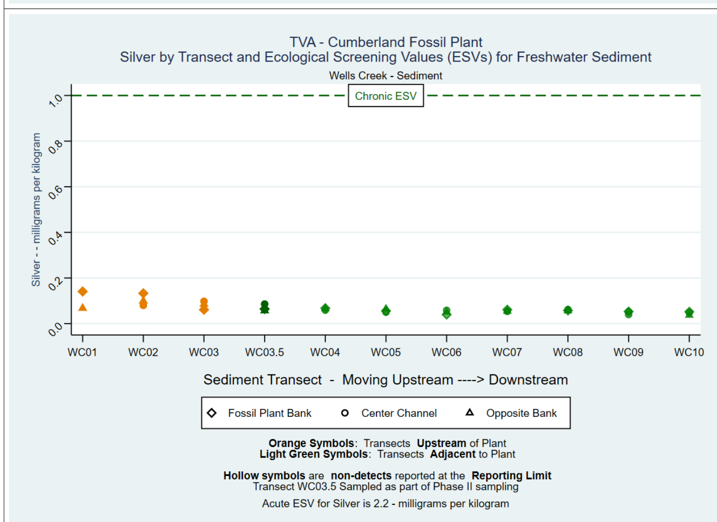
Transect Plots
Wells Creek - TDEC Appendix I Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee

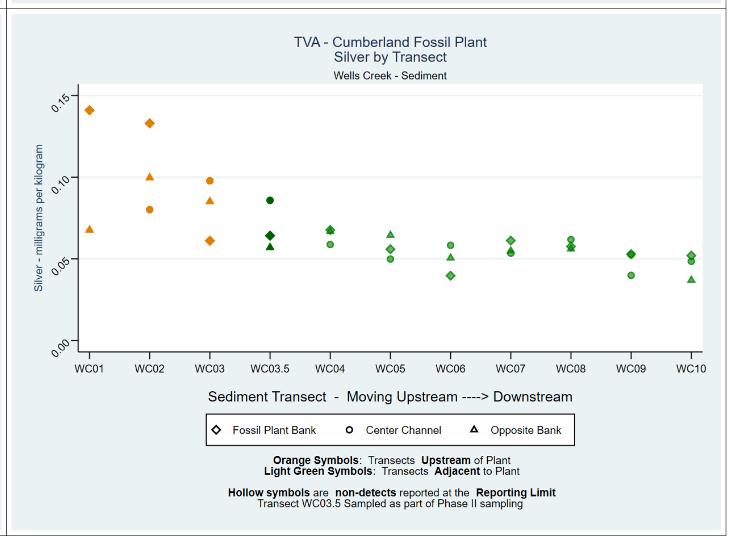


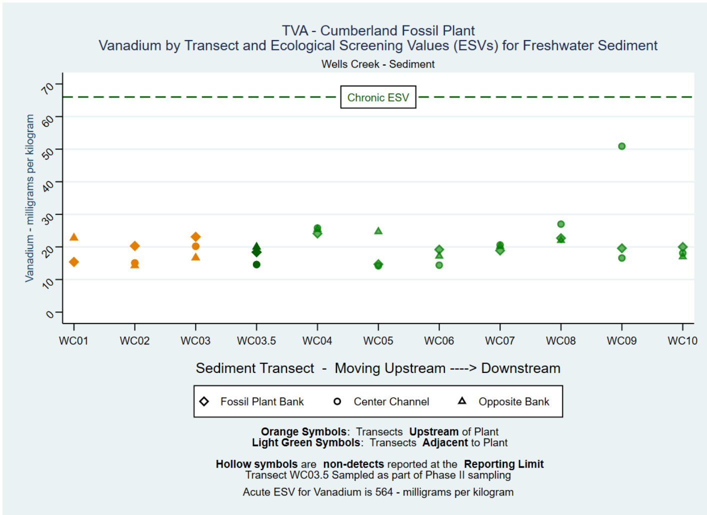


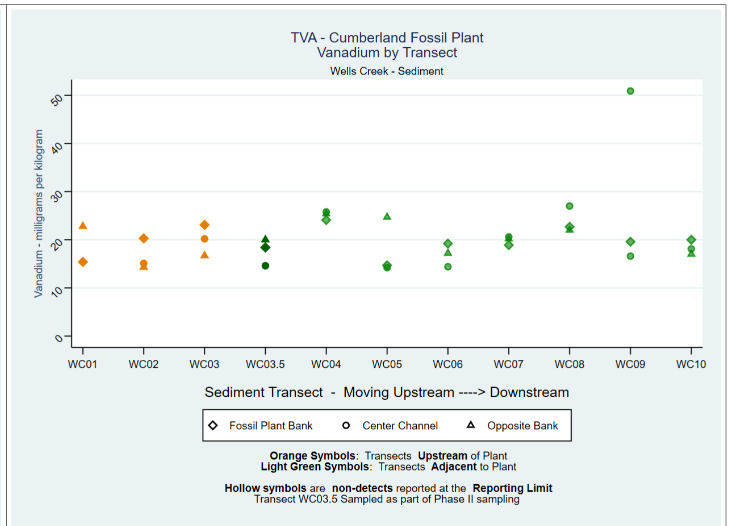


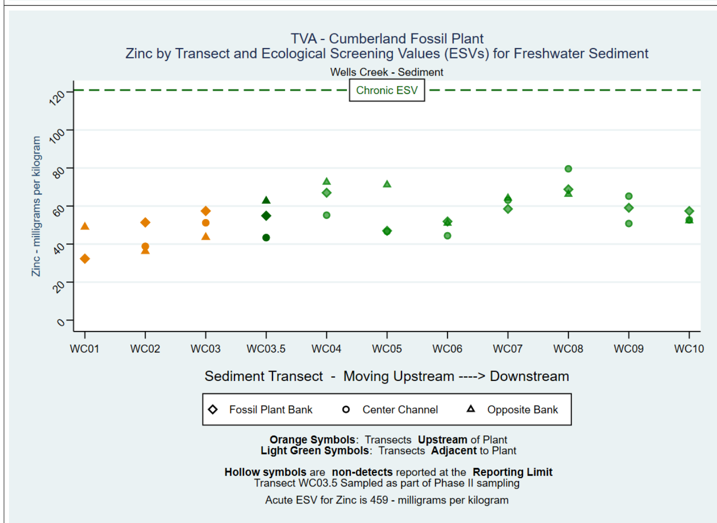


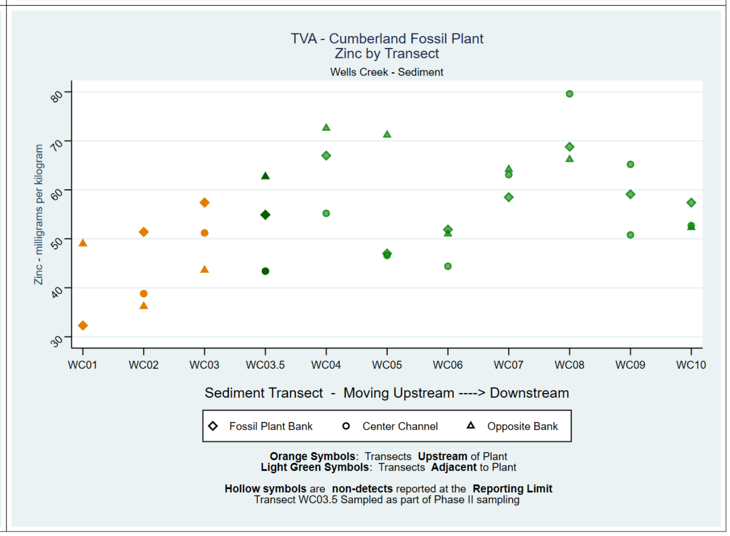




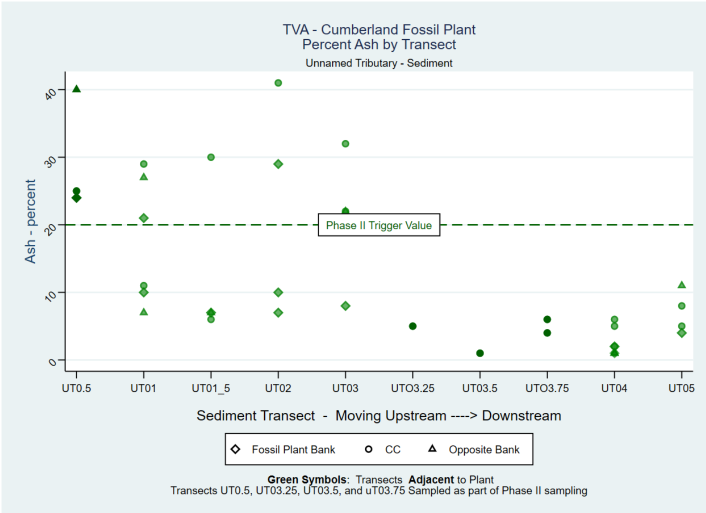

TVA - Cumberland Fossil Plant
Vanadium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Vanadium - milligrams per kilogram
0
10
20
30
40
50
60
70
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Vanadium is 564 - milligrams per kilogram

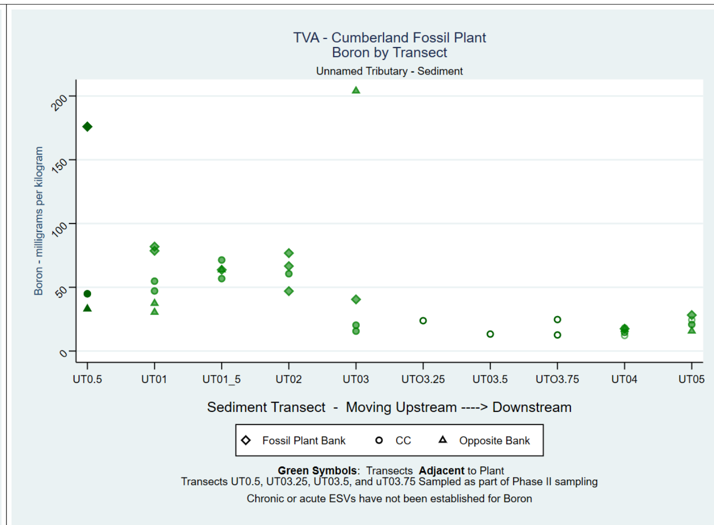

TVA - Cumberland Fossil Plant
Vanadium by Transect
Wells Creek - Sediment
Vanadium - milligrams per kilogram
0
10
20
30
40
50
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

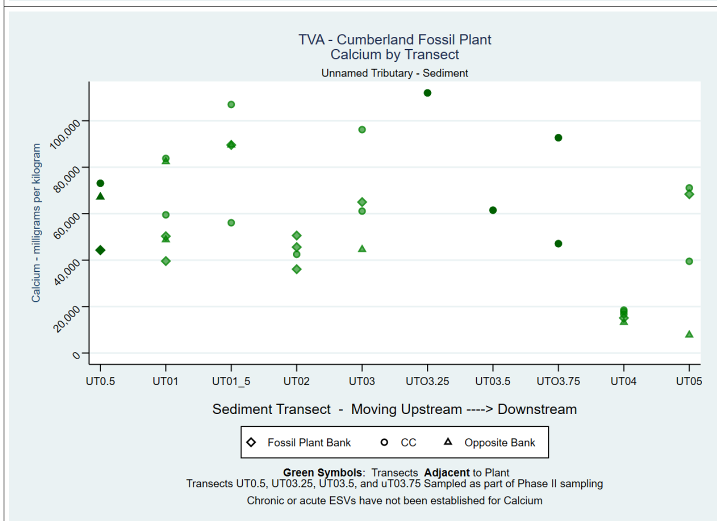

TVA - Cumberland Fossil Plant
Zinc by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Wells Creek - Sediment
Chronic ESV
Zinc - milligrams per kilogram
0
20
40
60
80
100
120
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling
Acute ESV for Zinc is 459 - milligrams per kilogram

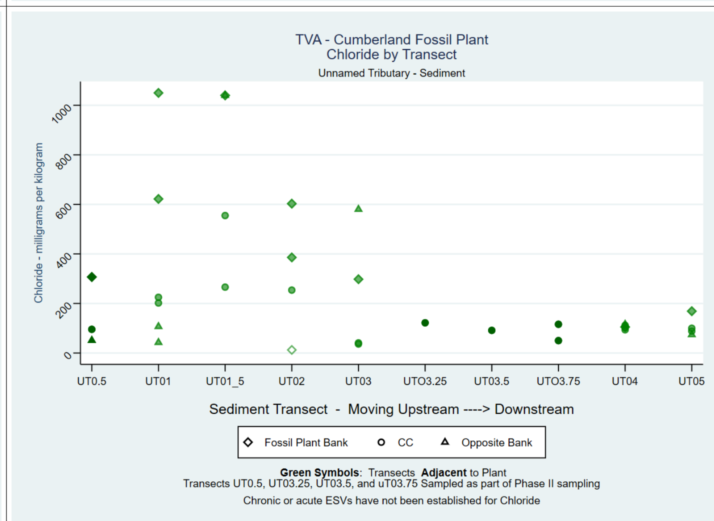

TVA - Cumberland Fossil Plant
Zinc by Transect
Wells Creek - Sediment
Zinc - milligrams per kilogram
30
40
50
60
70
80
WC01
WC02
WC03
WC03.5
WC04
WC05
WC06
WC07
WC08
WC09
WC10
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
Center Channel
Opposite Bank
Orange Symbols: Transects Upstream of Plant
Light Green Symbols: Transects Adjacent to Plant
Hollow symbols are non-detects reported at the Reporting Limit
Transect WC03.5 Sampled as part of Phase II sampling

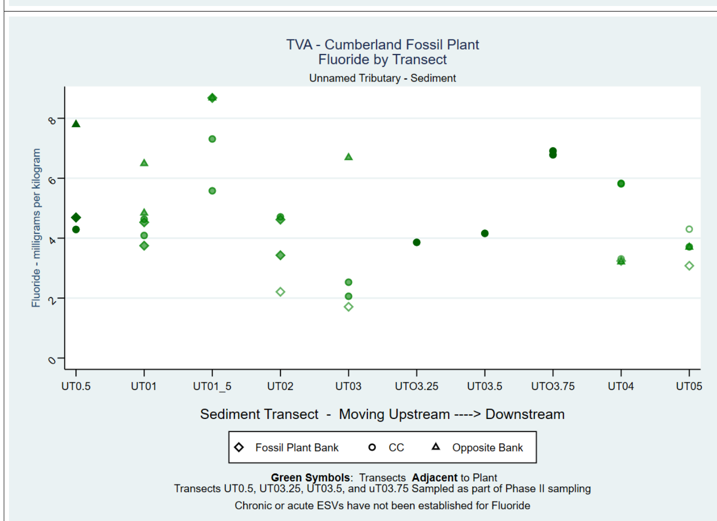
Transect Plots
Unnamed Tributary - CCR Rule Appendix III Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee

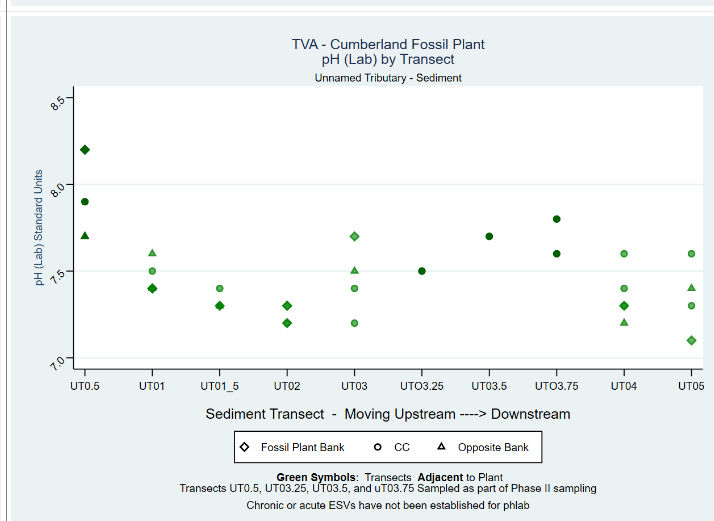


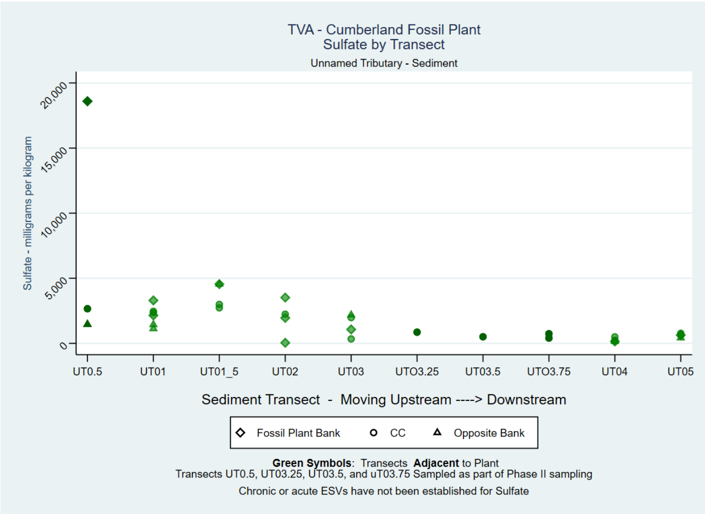












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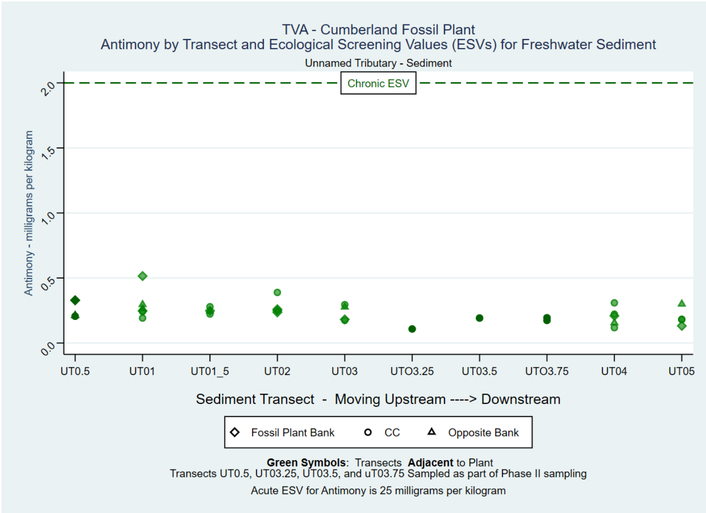
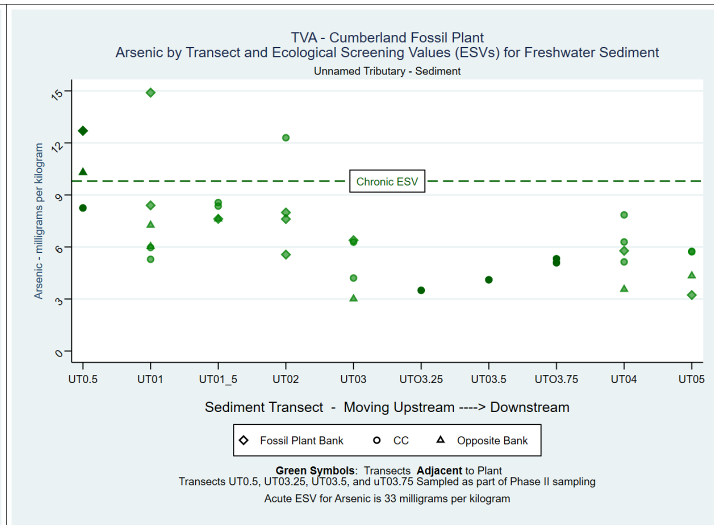
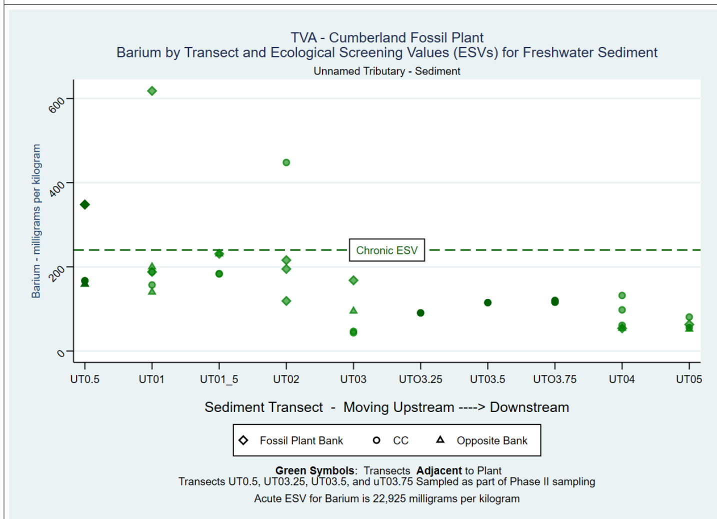
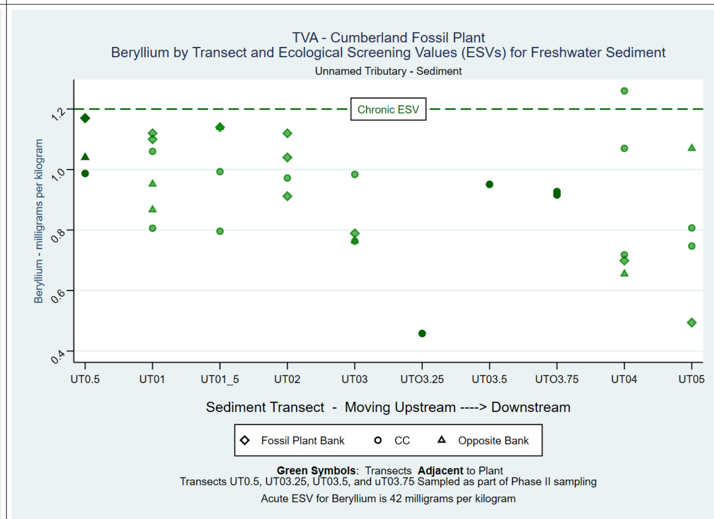
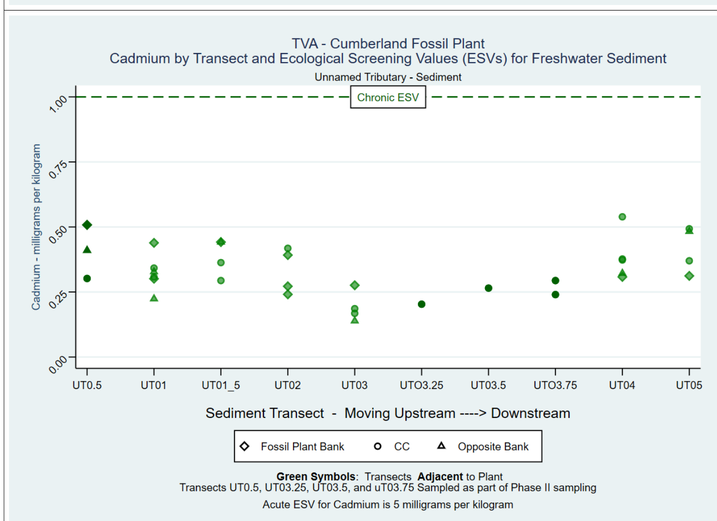
Transect Plots
Unnamed Tributary - CCR Rule Appendix IV Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee

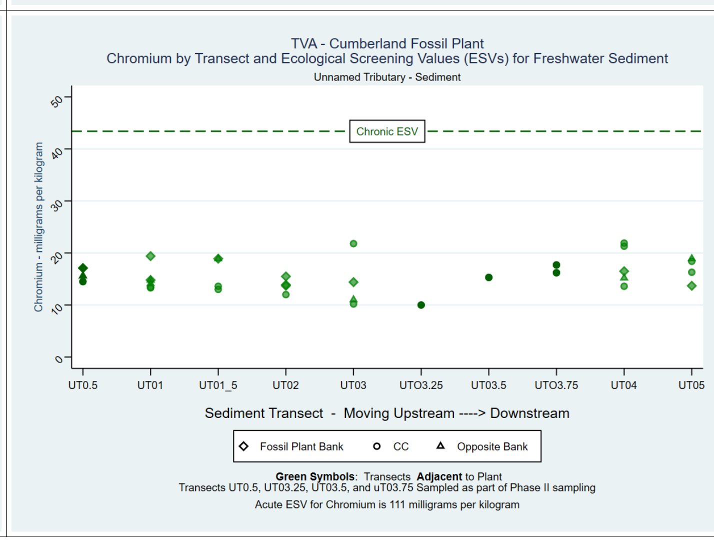


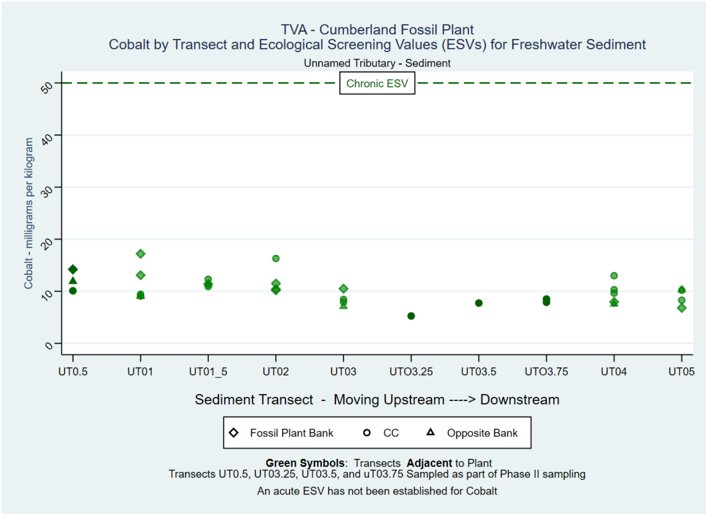


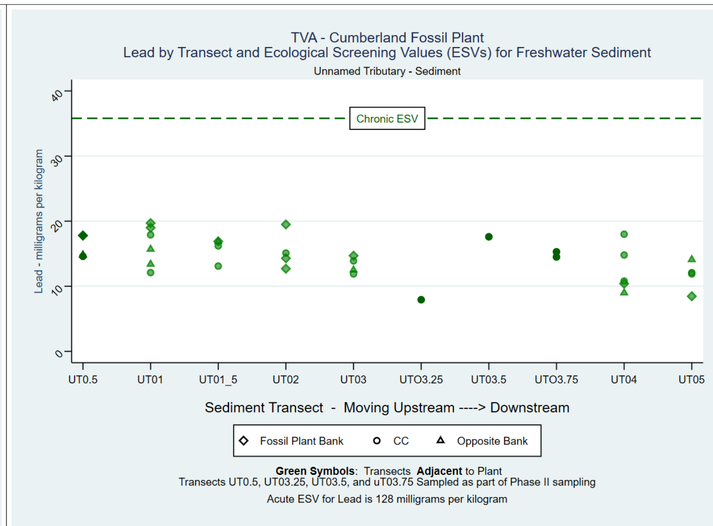


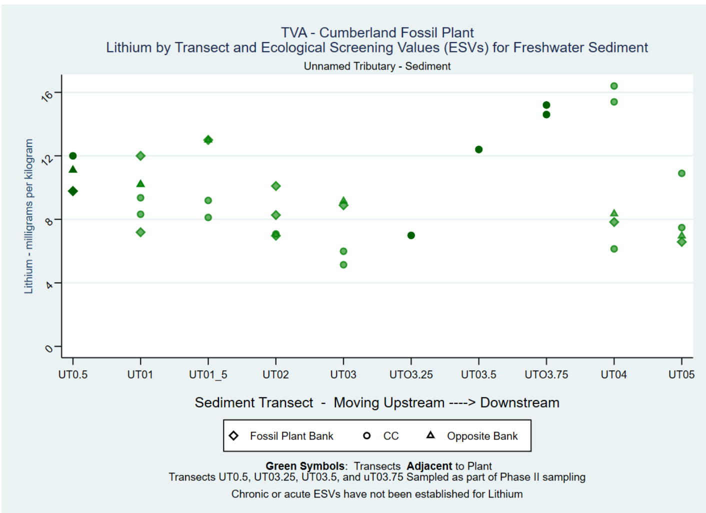


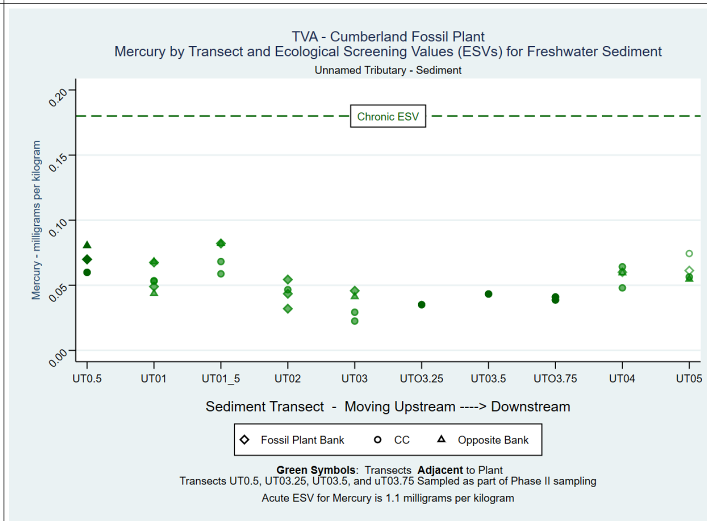


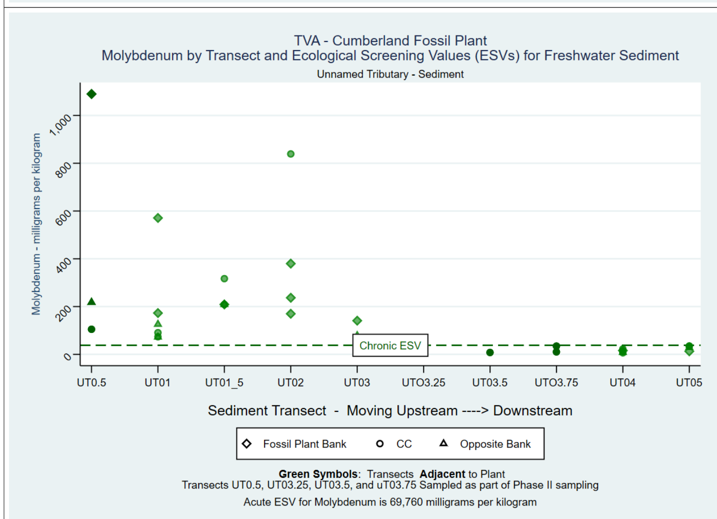


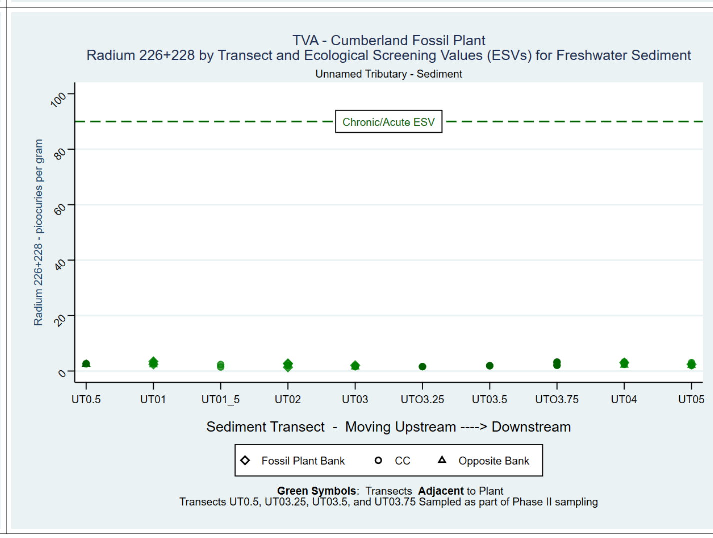

TVA - Cumberland Fossil Plant
Cobalt by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic ESV
Cobalt - milligrams per kilogram
0
10
20
30
40
50
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
An acute ESV has not been established for Cobalt

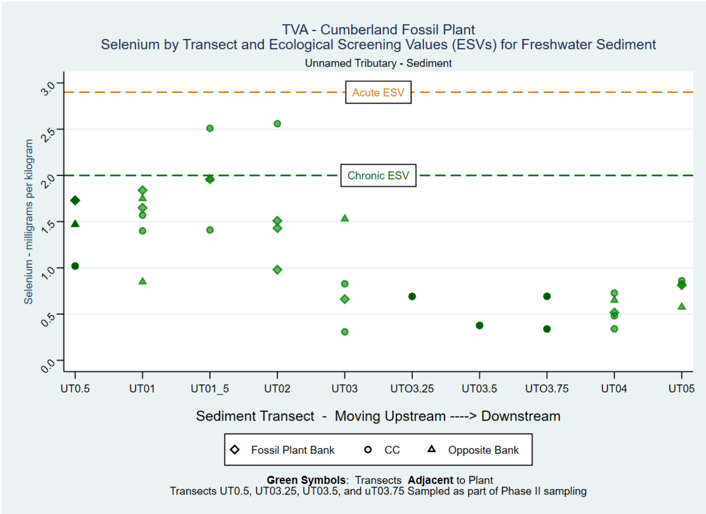

TVA - Cumberland Fossil Plant
Lead by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic ESV
Lead - milligrams per kilogram
0
10
20
30
40
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
Acute ESV for Lead is 128 milligrams per kilogram

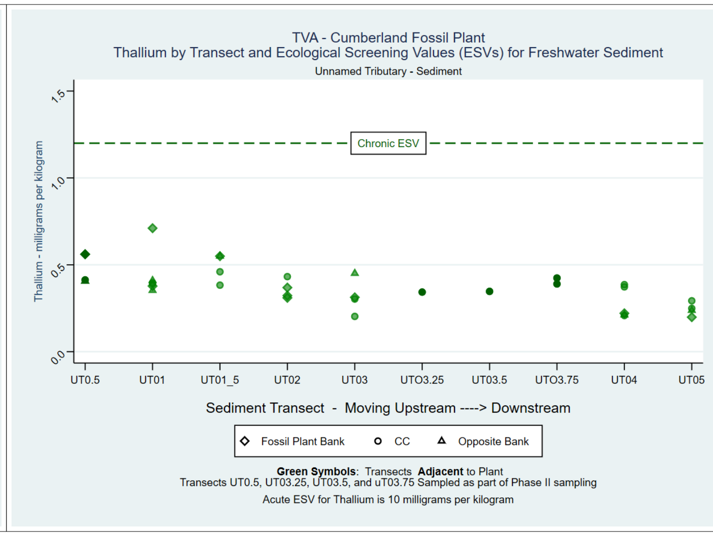

TVA - Cumberland Fossil Plant
Lithium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Lithium - milligrams per kilogram
0
4
8
12
16
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
Chronic or acute ESVs have not been established for Lithium


TVA - Cumberland Fossil Plant
Mercury by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic ESV
Mercury - milligrams per kilogram
0.00
0.05
0.10
0.15
0.20
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
Acute ESV for Mercury is 1.1 milligrams per kilogram

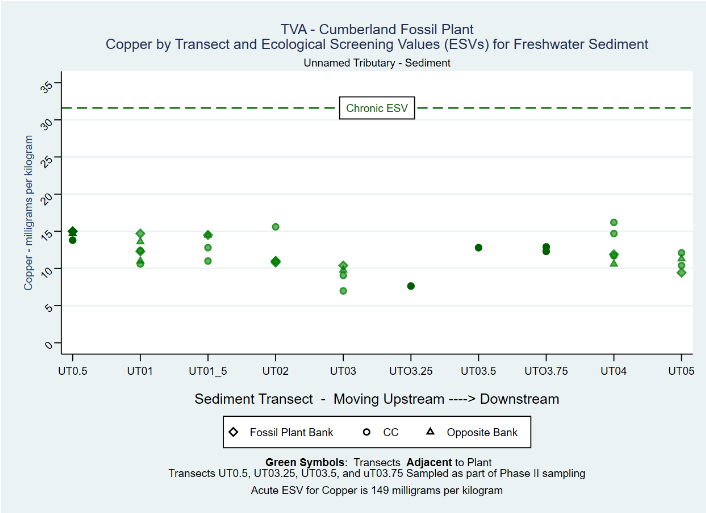

TVA - Cumberland Fossil Plant
Molybdenum by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic ESV
Molybdenum - milligrams per kilogram
0
200
400
600
800
1,000
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
Acute ESV for Molybdenum is 69,760 milligrams per kilogram

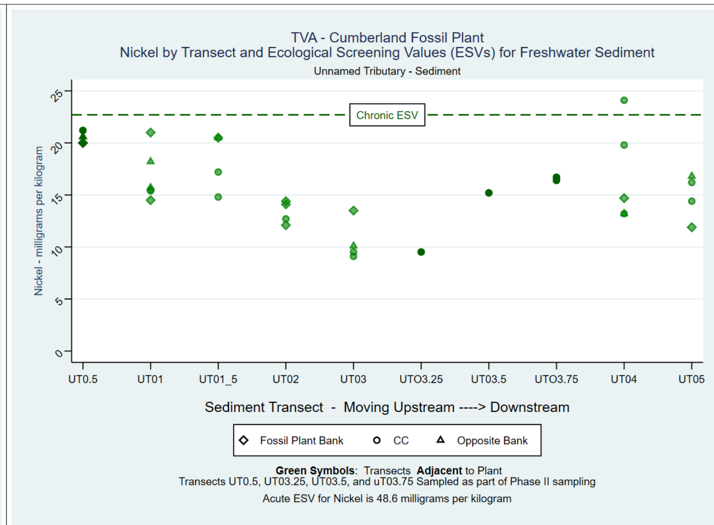

TVA - Cumberland Fossil Plant
Radium 226+228 by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic/Acute ESV
Radium 226+228 - picocuries per gram
0
20
40
60
80
100
UT0.5
UT01
UT01_5
UT02
UT03
UT03.25
UT03.5
UT03.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and UT03.75 Sampled as part of Phase II sampling

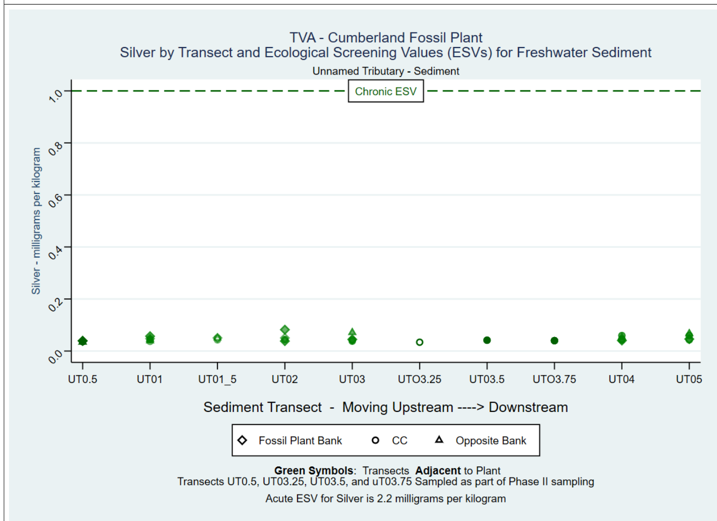

TVA - Cumberland Fossil Plant
Selenium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Acute ESV
Chronic ESV
Selenium - milligrams per kilogram
0.0
0.5
1.0
1.5
2.0
2.5
3.0
UT0.5
UT01
UT01_5
UT02
UT03
UTO3.25
UT03.5
UTO3.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling

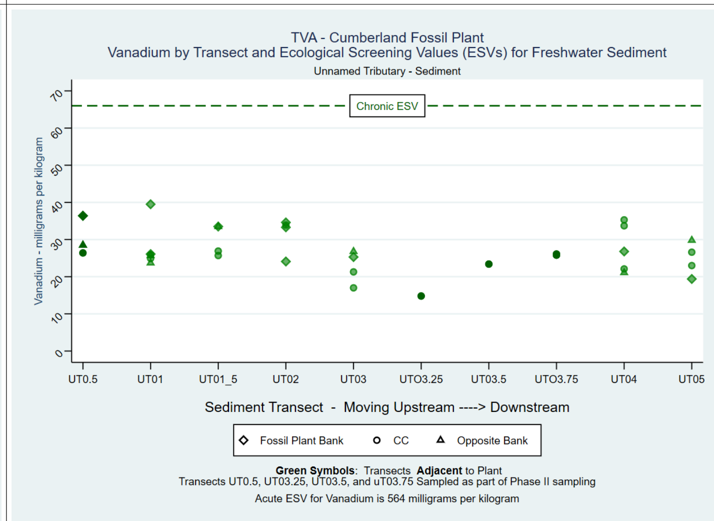

TVA - Cumberland Fossil Plant
Thallium by Transect and Ecological Screening Values (ESVs) for Freshwater Sediment
Unnamed Tributary - Sediment
Chronic ESV
Thallium - milligrams per kilogram
0.0
0.5
1.0
1.5
UT0.5
UT01
UT01_5
UT02
UT03
UTO3.25
UT03.5
UTO3.75
UT04
UT05
Sediment Transect - Moving Upstream ----> Downstream
Fossil Plant Bank
CC
Opposite Bank
Green Symbols: Transects Adjacent to Plant
Transects UT0.5, UT03.25, UT03.5, and uT03.75 Sampled as part of Phase II sampling
Acute ESV for Thallium is 10 milligrams per kilogram

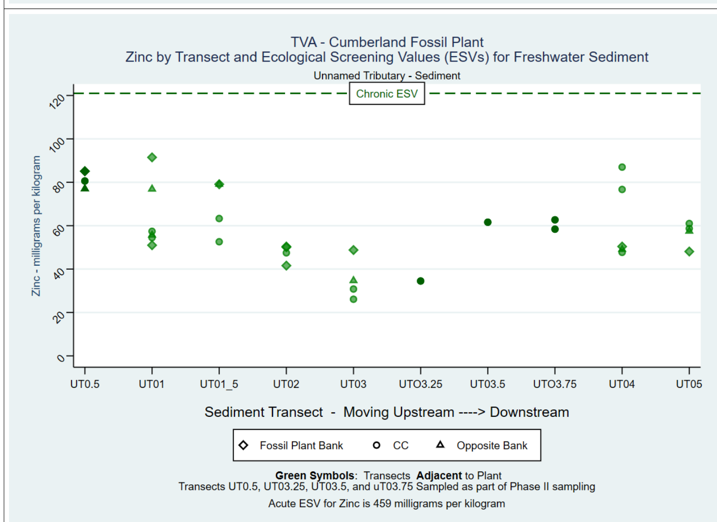
Transect Plots
Unnamed Tributary - TDEC Appendix I Parameters
Sediment and Benthic Investigation - EI and Phase II Sampling
Cumberland Fossil Plant, Cumberland City, Tennessee











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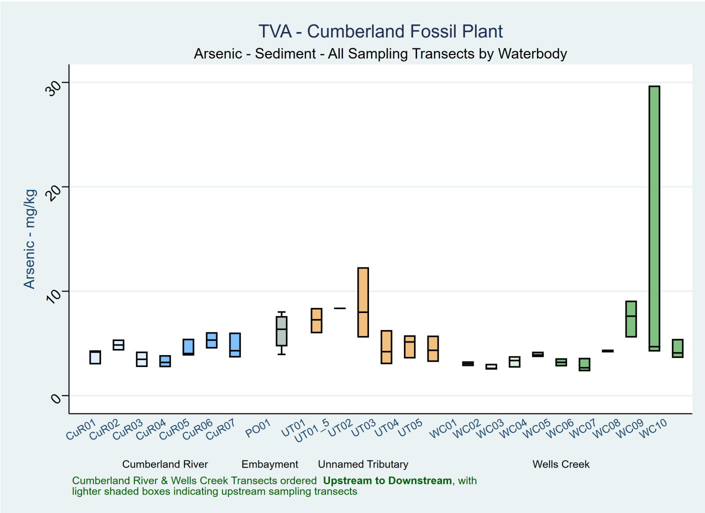
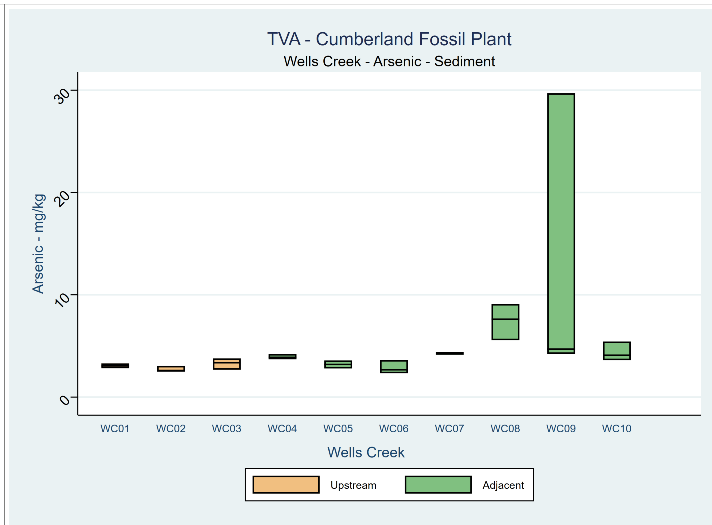
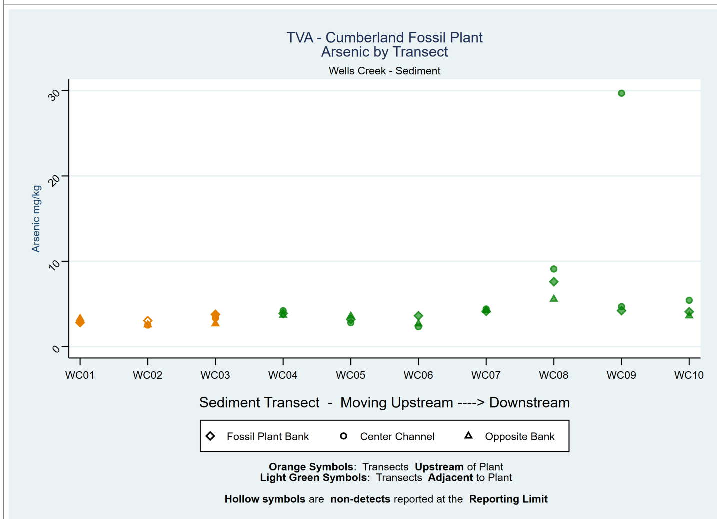
ATTACHMENT E.6-D
SEDIMENT INVESTIGATION TRANSECT PLOTS – STATISTICAL OUTLIERS

Box and Transect Plots - Statistical Outliers
Wells Creek
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland, Tennessee







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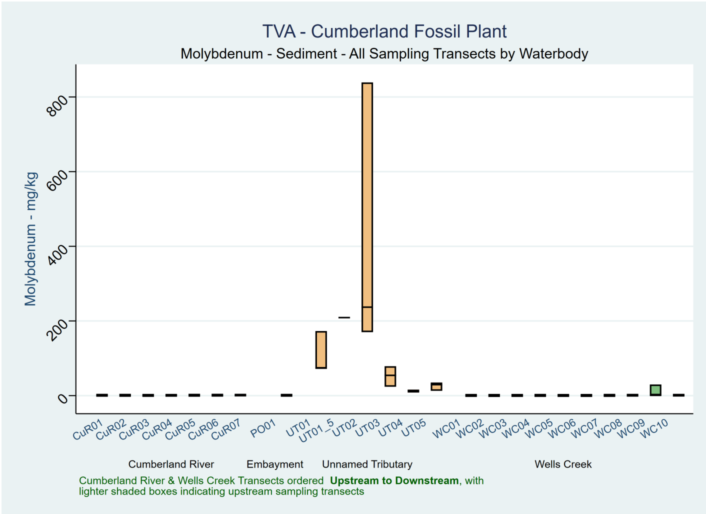

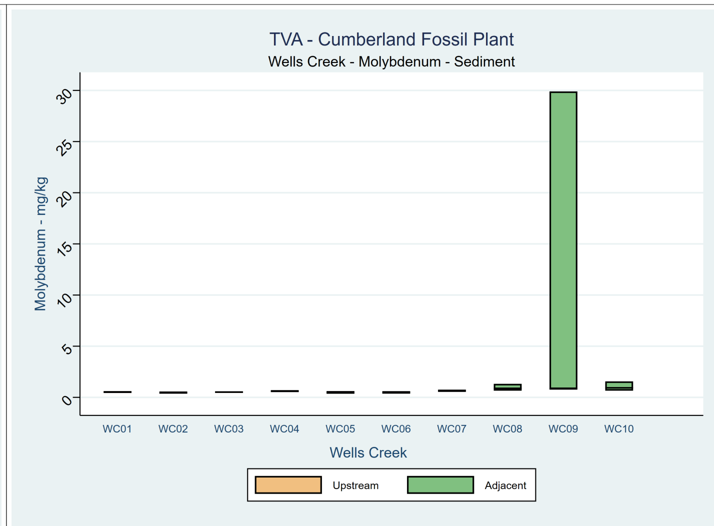

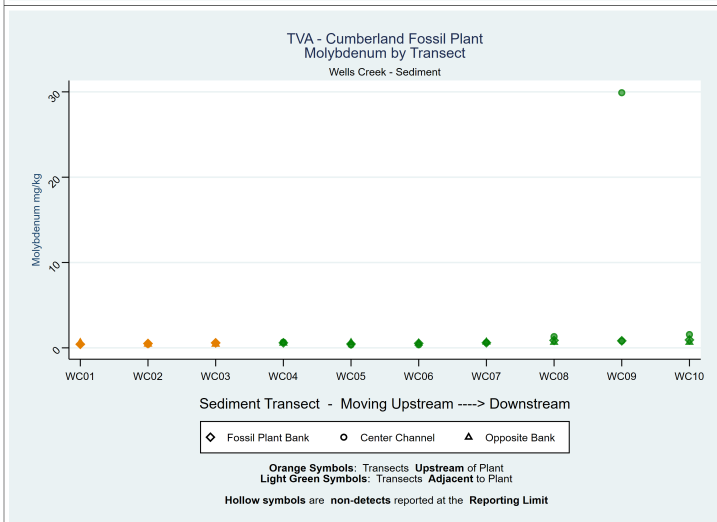

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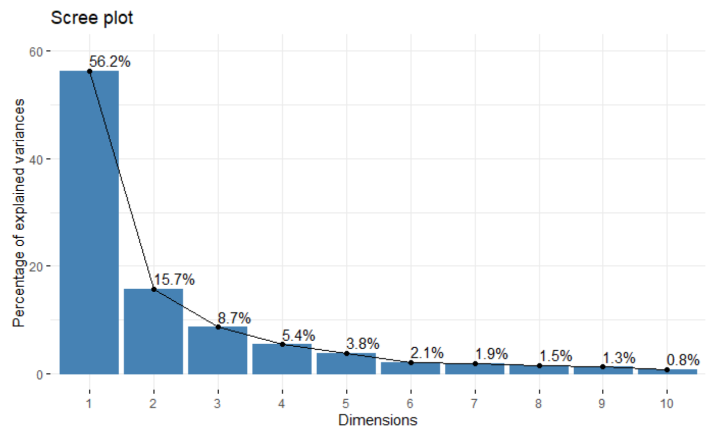
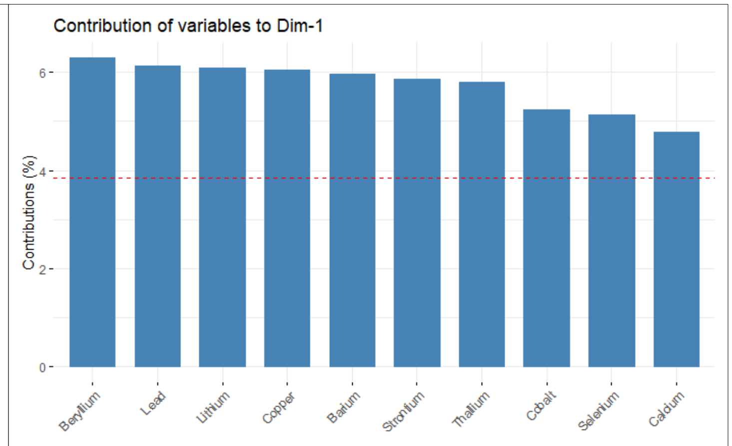
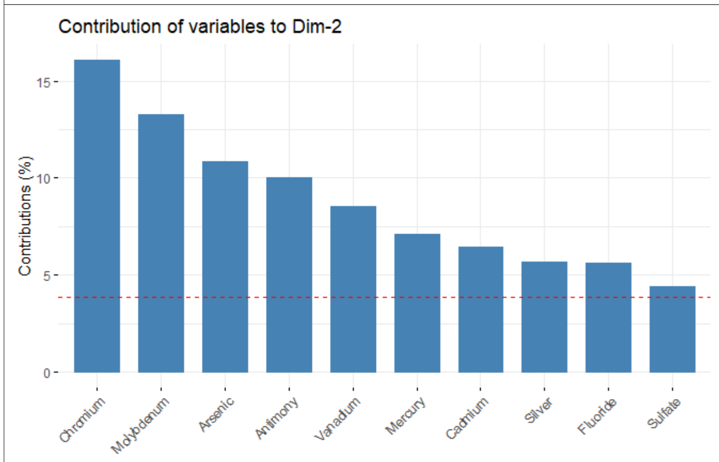
ATTACHMENT E.6-E
PRINCIPAL COMPONENT ANALYSIS

Principle Component Analysis
Wells Creek
Sediment and Benthic Investigation
Cumberland Fossil Plant, Cumberland, Tennessee







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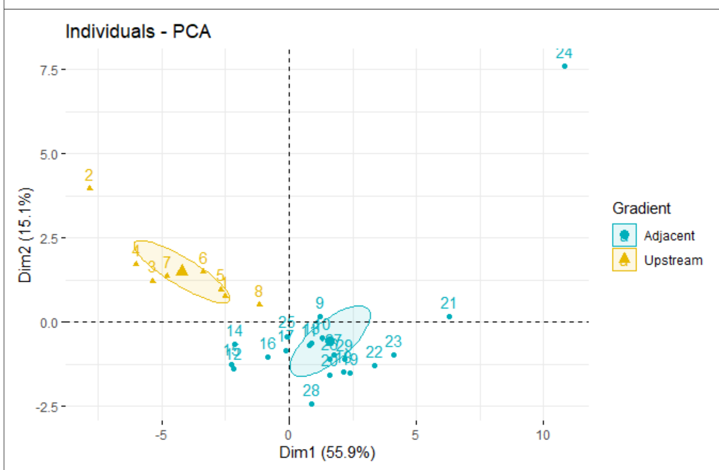

facilit	sample_numbe	sample_name	loc_nam
CUF	1	CUF-SED-WC01-CORLB-0.0/0.5-20181018	WC01
CUF	2	CUF-SED-WC01-CORRB-0.0/0.5-20181018	WC01
CUF	3	CUF-SED-WC02-CORCC-0.0/0.5-20181017	WC02
CUF	4	CUF-SED-WC02-CORLB-0.0/0.5-20181017	WC02
CUF	5	CUF-SED-WC02-CORRB-0.0/0.5-20181017	WC02
CUF	6	CUF-SED-WC03-CORCC-0.0/0.5-20181017	WC03
CUF	7	CUF-SED-WC03-CORLB-0.0/0.5-20181017	WC03
CUF	8	CUF-SED-WC03-CORRB-0.0/0.5-20181017	WC03
CUF	9	CUF-SED-WC04-CORCC-0.0/0.5-20181016	WC04
CUF	10	CUF-SED-WC04-CORLB-0.0/0.5-20181016	WC04
CUF	11	CUF-SED-WC04-CORRB-0.0/0.5-20181016	WC04
CUF	12	CUF-SED-WC05-CORCC-0.0/0.5-20181016	WC05
CUF	13	CUF-SED-WC05-CORLB-0.0/0.5-20181016	WC05
CUF	14	CUF-SED-WC05-CORRB-0.0/0.5-20181016	WC05
CUF	15	CUF-SED-WC06-CORCC-0.0/0.5-20181016	WC06
CUF	16	CUF-SED-WC06-CORLB-0.0/0.5-20181016	WC06
CUF	17	CUF-SED-WC06-CORRB-0.0/0.5-20181016	WC06
CUF	18	CUF-SED-WC07-CORCC-0.0/0.5-20181011	WC07
CUF	19	CUF-SED-WC07-CORLB-0.0/0.5-20181011	WC07
CUF	20	CUF-SED-WC07-CORRB-0.0/0.5-20181011	WC07
CUF	21	CUF-SED-WC08-CORCC-0.0/0.5-20181011	WC08
CUF	22	CUF-SED-WC08-CORLB-0.0/0.5-20181011	WC08
CUF	23	CUF-SED-WC08-CORRB-0.0/0.5-20181011	WC08
CUF	24	CUF-SED-WC09-CORCC-0.0/0.5-20181011	WC09
CUF	25	CUF-SED-WC09-CORRB-0.0/0.5-20181011	WC09
CUF	26	CUF-SED-WC10-CORCC-0.0/0.5-20181011	WC10
CUF	27	CUF-SED-WC10-CORLB-0.0/0.5-20181011	WC10
CUF	28	CUF-SED-WC10-CORRB-0.0/0.5-20181011	WC10

APPENDIX E.7

DATA EVALUATION OF MAYFLY TISSUE SAMPLE DATA

Stantec

Appendix E.7 – Data Evaluation of Mayfly Tissue Sample Data

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

TVA TENNESSEE VALLEY AUTHORITY

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

Revision Log

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022 TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023 TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Appendix E.7 – Data Evaluation of Mayfly Tissue Sample Data was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ____________________

Melissa Whitfield Aslund, PhD, Environmental Scientist

Reviewed by ____________________

Chris La Londe, Risk Assessor

Approved by ____________________

Rebekah Brooks, PG, Senior Principal Hydrogeologist

Table of Contents

LIST OF TABLES

Abbreviations

CBR	Critical Body Residue
CCR	Coal Combustion Residuals
CCR Rule	Title 40, Code of Federal Regulations, Part 257
CUF Plant	Cumberland Fossil Plant
CURA	Cumberland River Adjacent
CURD	Cumberland River Downstream
CURU	Cumberland River Upstream
EAR	Environmental Assessment Report
EI	Environmental Investigation
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	Milligrams per Kilogram
NA	Not Available
NOAEL	No Observed Adverse Effect Level
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
WCD	Wells Creek Downstream
WCU	Wells Creek Upstream
WW	Wet Weight

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to summarize the data evaluation performed on mayfly tissue data to support the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. Mayfly tissue samples were collected as part of the Tennessee Department of Environment and Conservation (TDEC) Order Environmental Investigation (EI) between June and July 2019 in Cumberland River and Wells Creek in proximity to the CUF Plant. Further details regarding the mayfly tissue sampling program and results are available in Appendix J.3 and the *CUF Plant Benthic Sampling and Analysis Report* (Appendix J.4). In addition, supplemental mayfly samples were collected prior to the EI in June 2018. Data related to these supplemental mayfly samples were also reviewed and reported herein.

The water bodies, sampling locations, and sample types included in this evaluation are summarized in Table E.7-1.

Table E.7-1 – Summary of Samples Collected and Included in Data Evaluation for Each Water Body, Sampling Location, and Tissue Type

Water Body	Sample Location	Location Relative to CUF CCR Units	Adult Mayflies[1]	Mayfly Nymphs (Non-Depurated)	Mayfly Nymphs (Depurated)
Wells Creek	WCU	Adjacent	✓	✓	✓
	WCD	Adjacent	✓	✓	✓
Cumberland River	CURU	Upstream	✓	✓	✓
	CURA	Adjacent	✓	✓	✓
	CURD	Downstream	✓	✓	✓

Notes: CCR - Coal Combustion Residuals; CURA – Cumberland River adjacent; CURD – Cumberland River downstream; CURU – Cumberland River upstream; WCD – Wells Creek downstream; WCU – Wells Creek upstream

1. Adult mayflies were collected at the WCU sampling location in 2018, but not in 2019.

For each sampled water body, this data evaluation focused on constituents from one of the following two categories:

1. Constituents for which potential risks to aquatic life have been identified based on observations of concentrations greater than applicable EAR ecological screening values (Tables 1-2, 1-3, and Appendix A.2) in surface stream or sediment, where this comparison does not include statistically significant outliers identified as suitable for removal from further statistical analysis. Detailed comparisons of constituent concentrations in surface stream and sediment to the applicable ecological screening values, including rationale for outlier disposition (if applicable), are provided in Appendices E.5 and Appendix E.6, respectively.

2. Constituents with potential to bioaccumulate as identified by United States Environmental Protection Agency (USEPA 2018).

The constituents identified for review in mayfly tissue for each sampled water body based on these criteria are summarized in Table E.7-2.

Table E.7-2 - Constituents Identified for Review in Mayfly Tissue for each Sampled Water Body

Water Body	Constituent	Rationale for Review in Fish Tissue
Wells Creek	Beryllium	Concentration greater than chronic ecological screening value observed in sediment
	Mercury	Bioaccumlative per USEPA (2018)
	Selenium	Bioaccumlative per USEPA (2018)
Cumberland River	Mercury	Bioaccumlative per USEPA (2018)
	Selenium	Bioaccumlative per USEPA (2018)

For the water bodies and constituents identified in Table E.7-2, the following sections present the methods and results from the data evaluation and comparison of mayfly tissue data to established screening levels for mayfly tissue critical body residues (CBRs), where available, (see Table 1-4 and Appendix A.2 for list of CBRs identified as EAR screening levels for mayfly tissue concentrations).

2.0 METHODS

2.1 COMPARISON OF CONSTITUENT CONCENTRATIONS IN MAYFLY TISSUES TO MAYFLY TISSUE CRITICAL BODY RESIDUES

For the constituents identified in Tables J.7-2 as requiring further review in the assessed water bodies in proximity to the CUF Plant, measured constituent concentrations (or reported detection limits, for samples where the constituent was not detected) for each analyzed mayfly tissue type were compared directly to the applicable CBRs presented in Table 1-4 and Appendix A.2.

3.0 RESULTS

3.1 WELLS CREEK

For Wells Creek, mayfly tissue sample concentrations were compared to CBRs for beryllium, mercury, and selenium. The reported mayfly tissue concentrations for these constituents at the two Wells Creek sampling reaches were summarized and compared to their applicable CBRs, as shown in Table E.7-3 below. Additional information on the mayfly tissue results comparison to CBRs in Wells Creek is included in EAR Appendix J.5.

Table E.7-3 – Mayfly Tissue Concentrations for Beryllium, Mercury, and Selenium for Samples Collected in Wells Creek

Year	Constituent Type	Constituent	Sample Location	Gradient	Sample Concentration (mg/kg ww)		
					Adult Mayflies[1]	Mayfly Nymphs (Non-Depurated)	Mayfly Nymphs (Depurated)
2018[2]	CCR Rule Appendix IV	Beryllium	WCU	Adjacent	<0.065	<0.064	<0.064
			WCD	Adjacent	<0.064	0.088	<0.066
		Mercury	WCU	Adjacent	0.045	<0.025	<0.011
			WCD	Adjacent	<0.017	<0.0034	<0.0029
		Selenium	WCU	Adjacent	0.98	0.78	0.6
			WCD	Adjacent	0.96	0.58	0.48
2019	CCR Rule Appendix IV	Beryllium	WCU	Adjacent	-	0.075	<0.031
			WCD	Adjacent	<0.033	0.05	<0.031
		Mercury	WCU	Adjacent	-	<0.016	<0.0077
			WCD	Adjacent	<0.016	<0.018	<0.0072
		Selenium	WCU	Adjacent	-	0.54	0.35
			WCD	Adjacent	0.63	0.47	0.36

Notes: LOAEL - Lowest Observed Adverse Effect Level; mg/kg-ww - milligrams per kilogram, wet weight; NA – Not Available; NOAEL - No Observed Adverse Effects Levels

1. Adult mayflies were not collected at the WCU sampling location in 2019.
2. The 2018 mayfly tissue sampling event was conducted outside the scope of the TDEC Order EI and the data are considered supplemental to the EI.

Legend
No applicable CBR
Concentration < CBR NOAEL
Concentration > CBR NOAEL
Concentration > CBR LOAEL

3.2 CUMBERLAND RIVER

For Cumberland River, mayfly tissue samples were compared to CBRs for mercury and selenium. The reported mayfly tissue concentrations for these constituents at the three Cumberland River sampling reaches are summarized and compared to their applicable CBRs in Table E.7-4 below. Additional information on the mayfly tissue results comparison to CBRs in the Cumberland River is included in Appendix J.5.

Table E.7-4 – Mayfly Tissue Concentrations for Mercury and Selenium in Cumberland River

Year	Constituent Type	Constituent	Sample Location	Gradient	Sample Concentration (mg/kg ww)		
					Adult Mayflies	Mayfly Nymphs (Non-Depurated)	Mayfly Nymphs (Depurated)
2018[1]	CCR Rule Appendix IV	Mercury	CURU	Upstream	<0.026	<0.011	<0.0057
			CURA	Adjacent	<0.026	<0.0091	<0.0038
			CURD	Downstream	<0.019	<0.014	<0.0031
		Selenium	CURU	Upstream	0.9	0.58	0.47
			CURA	Adjacent	0.75	0.67	0.42
			CURD	Downstream	0.72	0.74	0.58
2019	CCR Rule Appendix IV	Mercury	CURU	Upstream	<0.023	<0.014	<0.007
			CURA	Adjacent	<0.019	<0.012	<0.009
			CURD	Downstream	<0.022	<0.012	<0.0086
		Selenium	CURU	Upstream	0.65	0.5	0.4
			CURA	Adjacent	0.81	0.86	0.63
			CURD	Downstream	0.79	0.63	0.37

Notes:
LOAEL - Lowest Observed Adverse Effect Level; mg/kg-ww - milligrams per kilogram, wet weight; NA – Not Available; NOAEL - No Observed Adverse Effects Levels
1. The 2018 mayfly tissue sampling event was conducted outside the scope of the TDEC Order EI and the data are considered supplemental to the EI.

Legend
No applicable CBR
Concentration < CBR NOAEL
Concentration > CBR NOAEL
Concentration > CBR LOAEL

4.0 DISCUSSION

For the reviewed constituents, where mayfly tissue concentrations were higher than CBR NOAELs, there was generally minimal variability in constituent concentrations between the upstream, adjacent, and downstream sampling reaches and between the water bodies in proximity to the CUF Plant. Further interpretation of the ecological implications of these tissue concentrations will be completed in the context of the Corrective Action/Risk Assessment Plan.

5.0 REFERENCES

United States Environmental Protection Agency. (2018). *Region 4 Ecological Risk Assessment Supplemental Guidance. March 2018 Update, Screening Values.*

APPENDIX E.8

DATA EVALUATION OF FISH TISSUE SAMPLE DATA

Appendix E.8 - Data Evaluation of Fish Tissue Sample Data

TDEC Commissioner's Order:
Environmental Assessment Report
Cumberland Fossil Plant
Cumberland City, Tennessee

August 14, 2023

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.
Lexington, Kentucky

Revision Log

Revision	Description	Date
0	Submittal to TDEC	April 29, 2022
1	Addresses August 9, 2022 TDEC Review Comments and Issued for TDEC	January 26, 2023
2	Addresses May 16, 2023 TDEC Review Comments and Issued for TDEC	August 14, 2023

Sign-off Sheet

This document entitled Appendix E.8 - Data Evaluation of Fish Tissue Sample Data was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________

Melissa Whitfield Aslund, PhD, Environmental Scientist

Reviewed by ______________

Chris La Londe, Risk Assessor

Approved by ______________

Rebekah Brooks, PG, Senior Principal Hydrogeologist

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Abbreviations

BG	Bluegill
CBR	Critical Body Residue
CC	Channel Catfish
CCR	Coal Combustion Residuals
CCR Rule	Title 40, Code of Federal Regulations, Part 257
CUF Plant	Cumberland Fossil Plant
CURA	Cumberland River Adjacent
CURD	Cumberland River Downstream
CURU	Cumberland River Upstream
DW	Dry Weight
EAR	Environmental Assessment Report
EI	Environmental Investigation
ESVs	Ecological Screening Values
LB	Largemouth Bass
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	Milligrams per Kilogram
NOAEL	No Observed Adverse Effect Level
RS	Redear Sunfish
SH	Shad
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
WCD	Wells Creek Downstream
WCU	Wells Creek Upstream
WW	Wet Weight

August 14, 2023

1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) prepared this appendix on behalf of the Tennessee Valley Authority (TVA) to summarize the the data evaluation performed on fish tissue data to support the Environmental Assessment Report (EAR) at the Cumberland Fossil Plant (CUF Plant) located in Cumberland City, Tennessee. Fish tissue samples were collected as part of the Tennessee Department of Environment and Conservation (TDEC) Order Environmental Investigation (EI) between April and May 2019 in Cumberland River and Wells Creek in proximity to the CUF Plant. Further details regarding the fish tissue sampling program and results are available in Appendix J.5 and the *Fish Tissue Sampling and Analysis Report* (Appendix J.6). In addition, supplemental fish tissue samples were collected prior to the EI in April and May 2018. Data related to these supplemental fish tissue samples were also reviewed and reported herein.

The water bodies, sampling locations, fish species, and tissue types included in this evaluation are summarized in Table E.8-1.

Table E.8-1 – Summary of Samples Collected and Included in Data Evaluation for Each Waterbody, Sampling Location, Fish Species, and Tissue Type

Water Body	Sample Location	Locations Relative to CUF CCR Units	Bluegill (BG)			Channel Catfish (CC)			Largemouth Bass (LB)			Redear Sunfish (RS)			Shad (SH)
			Muscle	Liver	Ovary	Muscle	Liver	Ovary	Muscle	Liver	Ovary	Muscle	Liver	Ovary	Whole Fish
Wells Creek	WCU	Adjacent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	WCD	Adjacent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cumberland River	CURU	Upstream	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CURA	Adjacent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CURD	Downstream	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: CCR - Coal Combustion Residuals, CURU – Cumberland River Upstream, CURA – Cumberland River Adjacent, CURD – Cumberland River Downstream, WCU – Wells Creek upstream, WCD – Wells Creek downstream

For each sampled waterbody, this data evaluation focused on constituents from one of the following two categories:

1. Constituents for which potential risks to aquatic life have been identified based on observations of concentrations greater than applicable EAR ecological screening values (ESVs, see Tables 1-2, 1-3 and Appendix A.2) in surface stream or sediment , where this comparison does not include statistically significant outliers identified as suitable for removal from further statistical analysis. Detailed comparisons of constituent concentrations in surface stream and sediment to the applicable ESVs, including rationale for outlier disposition (if applicable), are provided in Appendices E.5 and E.6, respectively.

2. Constituents with potential to bioaccumulate in fish tissues as identified by the United States Environmental Protection Agency (USEPA 2018).

The constituents identified for review in fish tissue for each sampled waterbody based on these criteria are summarized in Table E.8-2.

Table E.8-2 - Constituents Identified for Review in Fish Tissue for each Sampled Waterbody

Water Body	Constituent	Rationale for Review in Fish Tissue
Wells Creek	Beryllium	Concentration greater than chronic ecological screening value observed in sediment
	Mercury	Bioaccumlative per USEPA (2018)
	Selenium	Bioaccumlative per USEPA (2018)
Cumberland River	Mercury	Bioaccumlative per USEPA (2018)
	Selenium	Bioaccumlative per USEPA (2018)

For the water bodies and constituents identified in Table E.8-2, the following sections present the methods and results from the data evaluation and comparison of fish tissue data to established screening levels for fish tissue critical body residue (CBR) No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs), where available, (see Table 1-5 and Appendix A.2 for list of CBRs identified as EAR screening levels for fish tissue concentrations).

2.0 METHODS

2.1 COMPARISON OF CONSTITUENT CONCENTRATIONS IN FISH TISSUES TO FISH TISSUE CRITICAL BODY RESIDUES

For the constituents identified in Table E.8-2 as requiring further review in the assessed water bodies in proximity to the CUF Plant, measured constituent concentrations (or reported detection limits, for samples where the constituent was not detected) for each analyzed fish species and tissue type were compared directly to the applicable CBRs presented in Table 1-5 and Appendix A.2.

3.0 RESULTS

3.1 CUMBERLAND RIVER

For Cumberland River, fish tissue samples were compared to CBR NOAELs and LOAELs for mercury and selenium. The reported fish tissue concentrations for these constituents at the three Cumberland River sampling reaches are summarized and compared to their applicable CBRs in Table E.8-3 below. Additional information on the fish tissue results comparison to CBRs in the Cumberland River is included in Appendix J.6.

Table E.8-3 – Fish Tissue Concentrations for Mercury and Selenium in Cumberland River

Year	Constituent Type	Constituent	Sample Location	Gradient	Sample Concentration (mg/kg ww)*												
					Muscle					Liver				Ovary			Whole Fish
					BG	CC	LB	RS	BG	CC	LB	RS	BG	CC	LB	RS	SH
2018[1]	CCR Rule Appendix IV	Mercury	CURU	Upstream	0.12	0.12	0.27	0.11	0.054	0.24	0.13	0.062	<0.0043	<0.003	<0.013	<0.0037	<0.014
			CURA	Adjacent	0.12	0.18	0.25	0.14	0.043	0.33	0.1	0.07	<0.005	<0.0031	<0.0044	<0.0052	<0.015
			CURD	Downstream	0.1	0.088	0.24	0.084	0.048	0.16	0.096	0.054	<0.0032	<0.0032	<0.0059	<0.0031	<0.019
		Selenium	CURU	Upstream	2.1	1.2	1.5	2.7	1	1.5	1.4	1.7	2.7	3	3	2.7	1.5
			CURA	Adjacent	2.2	0.86	1.8	3	1.3	1	1.2	2.1	3.2	2.4	2.6	4.2	2
			CURD	Downstream	1.9	1	1.7	2	1.4	1.1	1	1.6	2.5	2.9	2.6	2.3	<1.1
2019	CCR Rule Appendix IV	Mercury	CURU	Upstream	0.091	0.11	0.41	0.11	0.042	0.19	0.18	0.063	<0.007	<0.0072	0.033	<0.0071	0.016
			CURA	Adjacent	0.019	0.088	0.33	0.089	0.03	0.18	0.13	0.038	<0.0069	<0.0075	0.025	<0.0075	0.016
			CURD	Downstream	0.13	0.046	0.33	0.12	0.047	0.3	0.11	0.046	0.0074	<0.0073	0.019	<0.0071	0.02
		Selenium*	CURU	Upstream	1.8	0.85	1.7	2.7	1.2	1.1	1.2	1.4	2.8	2.8	2.8	3.3	1.8
			CURA	Adjacent	1.5	1.1	1.5	2.4	1.1	0.97	1.1	1.3	2.4	2.6	2.5	3.4	2.3
			CURD	Downstream	1.8	0.87	1.5	2.3	1.2	1.2	1.1	1.5	2.4	2.7	2.2	2.7	2

Notes: BG – Bluegill;, CC – Channel Catfish; CCR Rule - Title 40, Code of Federal Regulations, Part 257; CURA – Cumberland River Adjacent; CURD – Cumberland River Downstream; CURU – Cumberland River Upstream; LB – Largemouth Bass; LOAEL – Lowest Observed Adverse Effect Level; mg/kg – milligram per kilogram, ww – wet weight; NOAEL - No Observed Adverse Effect Level; RS - Redear Sunfish; SH – Shad
*Selenium concentrations reported as mg/kg ww for liver tissue and mg/kg dry weight for whole body, muscle, and ovary to permit direct comparison to the selenium critical body residues (CBRs) for these tissues.
1. The 2018 fish tissue sampling event was conducted outside the scope of the TDEC Order EI and the data are considered supplemental to the EI .

Legend
No applicable CBR
Concentration < CBR NOAEL
Concentration > CBR NOAEL
Concentration > CBR LOAEL

3.2 WELLS CREEK

For Wells Creek, fish tissue sample concentrations were compared to CBRs for beryllium, mercury, and selenium. The reported fish tissue concentrations for these constituents at the two Wells Creek sampling reaches were summarized and compared to their applicable CBRs, as shown in Table E.8-4 below. Additional information on the fish tissue results comparison to CBRs in Wells Creek is included in Appendix J.6.

Table E.8-4 – Fish Tissue Concentrations for Beryllium, Mercury, and Selenium for Samples Collected in Wells Creek

Year	Constituent Type	Constituent	Sample Location	Gradient	Sample Concentration (mg/kg ww)*												
					Muscle				Liver				Ovary				Whole Fish
					BG	CC	LB	RS	BG	CC	LB	RS	BG	CC	LB	RS	SH
2018[1]	CCR Rule Appendix IV	Beryllium	WCU	Adjacent	<0.031	<0.033	<0.032	<0.032	<0.065	<0.066	<0.064	<0.064	<0.064	<0.063	<0.066	<0.065	<0.032
			WCD	Adjacent	<0.032	<0.033	<0.033	<0.033	<0.065	<0.065	<0.065	<0.066	<0.062	<0.064	<0.064	<0.065	<0.032
		Mercury	WCU	Adjacent	0.082	0.18	0.32	0.16	0.055	0.38	0.14	0.078	<0.003	<0.0031	<0.0091	<0.0031	<0.018
			WCD	Adjacent	0.092	0.16	0.24	0.12	0.07	0.32	0.09	0.12	<0.0038	<0.0033	<0.0055	<0.0054	<0.02
		Selenium	WCU	Adjacent	2.2	1	1.5	3.1	1.3	1.5	1.1	2.1	2.9	3.6	2.5	3.4	2.3
			WCD	Adjacent	2.4	1.5	1.7	3.9	1.1	1.9	1	2.4	2.3	2.6	2.6	3.3	2
2019	CCR Rule Appendix IV	Beryllium	WCU	Adjacent	<0.031	<0.033	<0.031	<0.03	<0.031	<0.031	<0.03	<0.033	<0.031	<0.033	<0.031	<0.031	<0.032
			WCD	Adjacent	<0.032	<0.031	<0.033	<0.033	<0.031	<0.031	<0.032	<0.033	<0.031	<0.032	<0.03	<0.032	<0.032
		Mercury	WCU	Adjacent	0.15	0.11	0.65	0.099	0.066	0.12	0.39	0.041	0.0085	<0.0072	0.04	<0.0075	0.02
			WCD	Adjacent	0.13	0.11	0.31	0.012	0.048	0.19	0.13	0.067	<0.0073	<0.0074	0.016	<0.007	0.018
		Selenium	WCU	Adjacent	1.8	0.99	1.8	2.8	1.2	1.8	1.8	1.4	2.3	4.1	4.3	3.4	2.2
			WCD	Adjacent	2	1.1	1.8	2.9	1.2	1.6	1.2	1.6	2.6	3.6	2.8	3.1	2.1

Notes: BG – Bluegill;, CC – Channel Catfish; CCR Rule - Title 40, Code of Federal Regulations, Part 257; LB – Largemouth Bass; LOAEL – Lowest Observed Adverse Effect Level; mg/kg – milligram per kilogram, RS - Redear Sunfish; SH – Shad, ww – wet weight; NOAEL - No Observed Adverse Effect Level; WCA – Wells Creek Adjacent; WCD – Wells Creek Downstream; WCU – Wells Creek Upstream
*Selenium concentrations reported as mg/kg ww for liver tissue and mg/kg dw for whole body, muscle, and ovary to permit direct comparison to the selenium critical body residues (CBRs) for these tissues.
1. The 2018 fish tissue sampling event was conducted outside the scope of the TDEC Order EI and the data are considered supplemental to the EI.

Legend
No applicable CBR
Concentration < CBR NOAEL
Concentration > CBR NOAEL
Concentration > CBR LOAEL

4.0 DISCUSSION

For the reviewed constituents, where fish tissue concentrations were higher than CBR NOAELs, there was generally minimal variability in constituent concentrations between the upstream, adjacent, and downstream sampling reaches and between the water bodies in proximity to the CUF Plant. For the 2018 and 2019 sampling events in the Cumberland River and Wells Creek, mercury consistently had higher or equivalent concentrations than the CBR NOAELs for muscle, liver, and whole fish tissue samples; selenium consistently had higher or equivalent concentrations than the CBR NOAELs for liver tissue samples; and mercury concentrations were consistently shown to have higher or equivalent concentrations than the LOAELS for liver tissue samples. Further interpretation of the ecological implications of these tissue concentrations will be completed in the context of the Corrective Action/Risk Assessment Plan.

5.0 REFERENCES

United State Environmental Protection Agency. (2018). *Region 4 Ecological Risk Assessment Supplemental Guidance. March 2018 Update, Screening Values.*