

US EPA ARCHIVE DOCUMENT

6. CRAYFISH ANALYSES

6.1 Crayfish Statistics

Species	Tissue	Reach	Category	Specific Sampling Location	# individuals in sample	Sample Length (in)	Sample Weight (g)	Average Weight (g)	Sample Label	Sample ID	Analyses
crayfish	hole bod	1	crayfish	S of Olympia Rd	13	2.8	124.5	9.6	CF-RV-06	DAB-981	metals, pesticides/PCBs
crayfish	hole bod	1	crayfish	N of Olympia Rd	24	2.8	273.1	11.4	CF-RV-07	DAB-982	metals, pesticides/PCBs
crayfish	hole bod	2	crayfish	Washington Circle	10	2.5	105.2	10.5	CF-RV-03	DAB-936	metals, pesticides/PCBs
crayfish	hole bod	2	crayfish	North Montvale	8	3.2	141.4	17.7	CF-RV-04	DAB-937	metals, pesticides/PCBs
crayfish	hole bod	3	crayfish	Adjacent to Textron	14	3.4	323.4	23.1	CF-RV-01	DAB-900	metals, pesticides/PCBs
crayfish	hole bod	3	crayfish	South Davidson Pond	13	2.6	122.1	9.4	CF-RV-02	DAB-901	metals, pesticides/PCBs
crayfish	hole bod	3	crayfish	Davidson Pond	11	3.1	169.2	15.4	CF-RV-01	DAB-902	metals, pesticides/PCBs
crayfish	hole bod	5	crayfish	n/a	9	2.7	83.3	9.3	CF-RV-05	DAB-948	metals, pesticides/PCBs

6.2 SOVCs

Wells G 1 Site, OU III
Crayfish Detected Compounds
Semivolatile Organics (ug/Kg -wet weight)

No semivolatile organic compounds were detected in the crayfish samples.

6.3 PCBs/Pesticides

Wells G Site, OU III
 Crayfish Summary Statistics
 Pesticide - PCBs (ug/Kg - wet weight)

PARAMETER	NO. DETECTED	NO. SAMPLES	MIN DETECTED	MAX	MEAN	StdDev	UCL MEAN	LOG MEAN	UCL LOG MEAN
gamma-BHC (lindane)	2	11	0.24	0.39	0.29	0.06	0.32	0.29	0.33
Aldrin	4	11	0.25	0.31	0.29	0.05	0.32	0.29	0.32
Heptachlor epoxide	2	11	0.36	0.85	0.34	0.18	0.44	0.34	0.43
Endosulfan I	1	11	0.54	0.54	0.36	0.16	0.44	0.36	0.46
Dieldrin	7	11	0.81	2.4	1.17	0.63	1.51	1.19	1.78
4,4'-DDE	9	11	3.5	8.2	4.9	2.4	6.2	5.4	10.1
Endrin	3	11	1.1	1.7	0.8	0.4	1	0.8	1.1
4,4'-DDD	9	11	0.63	4.1	2.04	1.33	2.76	2.15	4.05
Endosulfan sulfate	4	11	0.54	1.4	0.71	0.31	0.88	0.71	0.91
4,4'-DDT	8	11	0.71	2.2	0.99	0.48	1.25	1	1.35
Endrin ketone	1	11	0.71	0.71	0.55	0.11	0.61	0.55	0.62
Endrin aldehyde	9	11	0.61	3.1	1.74	1.08	2.32	1.84	3.46
alpha-Chlordane	7	11	0.52	1.8	0.78	0.47	1.03	0.8	1.29
gamma-Chlordane	5	11	0.25	0.83	0.37	0.18	0.47	0.37	0.49
Aroclor-1254	8	11	11	24	13.1	8	17.4	15	35.7
Aroclor-1260	11	11	5.1	41	20.7	13.3	27.8	21.9	41

Wells Groundwater Site, OU III
 Crayfish Detected Compounds
 Pesticide - PCBs (ug/Kg - wet weight)

SAMPLE ID	CF-LK-01	CF-RB-02	CF-RB-03	CF-RV-01	CF-RV-02	CF-RV-03	CF-RV-04
LAB ID	DAB902	DAB682	DAB683	DAB900	DAB901	DAB936	DAB937
SAMPLE DATE	7/31/95	9/5/95	9/5/95	7/31/95	7/31/95	8/1/95	8/1/95
COMMENTS							
gamma-BHC (lindane)	0.51 U	0.5 U	0.51 U	0.51 U	0.5 U	0.5 U	0.5 U
Aldrin	0.51 U	0.5 U	0.51 U	0.51 U	0.5 U	0.29 J	0.25 J
Heptachlor epoxide	0.36 J	0.5 U	0.51 U	0.51 U	0.85 J	0.5 U	0.5 U
Endosulfan I	0.51 U	0.5 U	0.51 U	0.51 U	0.5 U	0.5 U	0.5 U
Dieldrin	1.6	0.98 U	0.98 U	1.6 J	1.3 J	1.9 J	2.4 J
4,4'-DDE	5.4	4	5.3	7	4.9	7.8 J	8.2 J
Endrin	0.98 U	0.98 U	0.98 U	0.99 UJ	0.98 U	1.4 J	1.7 J
4,4'-DDD	3.5 J	0.63 J	0.94 J	4.1	2.2 J	2.8 J	3.8 J
Endosulfan sulfate	0.98 U	0.98 U	0.98 U	1.1 J	0.98 U	0.54 J	0.89 J
4,4'-DDT	1 J	0.98 U	0.98 U	2.2 J	1.1 J	1.1 J	1 J
Endrin ketone	0.98 U	0.98 U	0.98 U	0.99 U	0.71 J	0.98 U	0.98 U
Endrin aldehyde	0.61 J	0.98 U	0.98 U	2.9 J	0.74 J	2.8 J	3.1 J
alpha-Chlordane	1.8	0.5 U	0.51 U	1.3 J	1.2	0.52 J	0.72 J
gamma-Chlordane	0.83 J	0.5 U	0.51 U	0.4 J	0.55 J	0.25 J	0.5 U
Aroclor-1254	14 J	5 U	5 U	5 U	12 J	21 J	23 J
Aroclor-1260	15	5.1	5.2	31	25	41 J	41 J

Wells G Site, OU III
 Crayfish Detected Compounds
 Pesticide - PCBs (ug/Kg - wet weight)

SAMPLE ID	CF-RV-05	CF-RV-06	CF-RV-07	CF-RV-08
LAB ID	DAB948	DAB981	DAB982	DAB662
SAMPLE DATE	8/1/95	8/2/95	8/2/95	8/8/95
COMMENTS				
gamma-BHC (lindane)	0.8 U	0.24 J	0.39 J	0.73 U
Aldrin	0.8 U	0.3 J	0.31 J	0.73 U
Heptachlor epoxide	0.8 U	0.51 U	0.51 U	0.73 U
Endosulfan I	0.54 J	1.1 U	1.4 U	0.73 U
Dieldrin	1.5 U	0.88 J	0.81 J	1.4 U
4,4'-DDE	5.7	1.7 U	2.2 U	3.5
Endrin	1.1 J	0.98 U	1.1 U	1.4 U
4,4'-DDD	1.9	0.98 U	1.6 U	1.3 J
Endosulfan sulfate	1.5 U	0.98 U	1.4	1.4 U
4,4'-DDT	0.71 J	0.85 J	1.3	1.4 U
Endrin ketone	1.5 U	0.98 U	0.98 U	1.4 U
Endrin aldehyde	2.3	1.5	2.9	1.3 J
alpha-Chlordane	0.72 J	1.1 U	1.4 U	0.56 J
gamma-Chlordane	0.8 U	0.51 U	0.51 U	0.4 J
Aroclor-1254	17	15	24	11 J
Aroclor-1260	12	15	28	9.1

6.4 Inorganics

Wells G a Site, OU III
Crayfish Tissue Summary Statistics
Inorganics (mg/Kg - wet weight)

PARAMETER	NO. DETECTED	NO. SAMPLES	MIN DETECTED	MAX	MEAN	StdDev	UCL MEAN	LOG MEAN	UCL LOG MEAN
Aluminum	11	11	9.4	72.8	40.3	20.7	51.4	43.3	78.4
Arsenic	7	11	1.1	4.4	1.7	1.4	2.4	2.1	8
Barium	4	11	12.5	18.3	10.9	4.7	13.4	11.5	18.4
Cadmium	10	10	0.043	0.16	0.071	0.034	0.09	0.071	0.092
Calcium	9	11	23700	44300	26327	12131	32845	28994	53142
Chromium	9	10	0.18	2.5	0.94	0.77	1.37	1.06	2.93
Cobalt	11	11	0.23	0.65	0.42	0.13	0.49	0.42	0.52
Copper	11	11	19.2	65.1	43.5	15.3	51.7	44.1	58.6
Iron	11	11	54.7	645	271	195	375.8	292.1	625.6
Lead	8	11	0.35	1.5	0.59	0.47	0.85	0.87	5.12
Manganese	11	11	40.2	146	98.41	34.22	116.8	100.39	134.97
Mercury	1	11	0.02	0.02	0.009	0.004	0.011	0.009	0.011
Potassium	11	11	2010	2280	2125	95	2176	2126	2180
Selenium	10	11	0.24	0.61	0.37	0.15	0.45	0.39	0.58
Silver	3	11	0.056	0.21	0.057	0.061	0.09	0.057	0.124
Thallium	1	11	0.19	0.19	0.08	0.04	0.1	0.08	0.1
Zinc	11	11	17.3	29.1	23.4	4.6	25.9	23.5	26.6

Wells G a. Site, OU III
 Crayfish Tissue Detected Compounds
 Inorganics (mg/Kg - wet weight)

SAMPLE ID	CF-LK-01	CF-RB-02	CF-RB-03	CF-RV-01	CF-RV-02	CF-RV-03	CF-RV-04
LAB ID	DAB902	DAB682	DAB683	DAB900	DAB901	DAB936	DAB937
SAMPLE DATE	7/31/95	9/5/95	9/5/95	7/31/95	7/31/95	8/1/95	8/1/95
COMMENTS							
Aluminum	72.8 J	9.4 J	10.1 J	46.9 J	55.3 J	57.6 J	47.8 J
Arsenic	2.1	0.36 U	0.41 U	1.1 J	1.4	2.7 J	2.7 J
Barium	13	18.3	12.5	21.8 U	18	20.8 U	19.1 U
Cadmium	0.043 J	0.07 J	0.09 J	0 R	0.05 J	0.16 J	0.061 J
Calcium	25800	43300	27300	44300 J	23700	25500 J	25600 J
Chromium	1.2 J	0 R	0.18 J	0.72 J	0.75 J	2.5 J	1.9 J
Cobalt	0.23 J	0.4 J	0.44 J	0.41 J	0.55 J	0.65 J	0.43 J
Copper	30 J	19.2 J	21 J	44.1 J	49.5 J	59.4 J	65.1 J
Iron	388	54.7	78	193 J	251	315 J	370 J
Lead	1.5 J	0.066 UJ	0.067 UJ	0.54 J	1 J	1 J	0.94 J
Manganese	44.9 J	108 J	104 J	104 J	146 J	135 J	105 J
Mercury	0.014 UJ	0.01 UJ	0.012 UJ	0.015 UJ	0.01 UJ	0.02 J	0.016 UJ
Potassium	2280	2200	2220	2030 J	2160	2010 J	2050 J
Selenium	0.38 J	0.16 UJ	0.24 J	0.56 J	0.35 J	0.28 J	0.51 J
Silver	0.043 UJ	0.2 UJ	0.21 J	0.063 U	0.058 UJ	0.039 UJ	0.039 UJ
Thallium	0.11 U	0.13 U	0.13 U	0.15 U	0.13 U	0.15 U	0.19
Zinc	25.9 J	18.3 J	18 J	22.7 J	23.2 J	28 J	27.5 J

Wells G . Site, OU III
Crayfish Tissue Detected Compounds
Inorganics (mg/Kg - wet weight)

SAMPLE ID	CF-RV-05	CF-RV-06	CF-RV-07	CF-RV-08
LAB ID	DAB948	DAB981	DAB982	DAB662
SAMPLE DATE	8/1/95	8/2/95	8/2/95	8/8/95
COMMENTS				
Aluminum	17.9 J	49.1 J	46.7 J	29.8 J
Arsenic	0.48 U	3.1 J	4.4 J	0.68 UJ
Barium	4 UJ	14 UJ	21.2 UJ	15.3 U
Cadmium	0.059	0.05 J	0.064 J	0.066 J
Calcium	7000 UJ	20000 UJ	26300 J	34300 J
Chromium	0.2 J	0.79 J	1 J	0.3 UJ
Cobalt	0.25 J	0.41 J	0.56 J	0.29 J
Copper	40.7	49.1 J	59.6 J	40.4 J
Iron	72.5 J	510 J	645 J	104 J
Lead	0.35 J	0.48 J	0.55 J	0.15 UJ
Manganese	40.2	65.4 J	112 J	118 J
Mercury	0.02 UJ	0.016 UJ	0.02 UJ	0.016 UJ
Potassium	2190 J	2070 J	2160 J	2010 J
Selenium	0.61 J	0.35 J	0.31 J	0.42 J
Silver	0.11	0.036 UJ	0.056 J	0.034 UJ
Thallium	0.15 U	0.13 U	0.14 U	0.13 U
Zinc	17.3	29.1 J	28.4 J	19.4 J

6.5 Percent Moisture and Lipids

Wells G Site, OU III
 Crayfish Detected Compounds
 Percent Moisture and Lipids (%)

SAMPLE ID	CF-LK-01	CF-RB-02	CF-RB-03	CF-RV-01	CF-RV-02	CF-RV-03	CF-RV-04
LAB ID	DAB902	DAB682	DAB683	DAB900	DAB901	DAB936	DAB937
SAMPLE DATE	7/31/95	9/5/95	9/5/95	7/31/95	7/31/95	8/1/95	8/1/95
COMMENTS							
% MOISTURE	78.4	75	76.8	72.2	75	78.4	75.9
PERCENT LIPIDS	0.9	0.8	1.3	1.1	0.7	0.7	0.9

Wells G Site, OU III
Crayfish Detected Compounds
Percent Moisture and Lipids (%)

SAMPLE ID	CF-RV-05	CF-RV-06	CF-RV-07	CF-RV-08
LAB ID	DAB948	DAB981	DAB982	DAB662
SAMPLE DATE	8/1/95	8/2/95	8/2/95	8/8/95
COMMENTS				
% MOISTURE	78.6	76	76.7	82.8
PERCENT LIPIDS	0.9	0.6	0.9	0.9

7. PLANT TISSUE ANALYSES

7.1 Description of Composite Samples

8/29/95 Plant Sampling ✓
Robert O'Brien
Jay Enret
High Donaghey
location 18 1030-1230 pm
am

5 species collected
common reed
cattail
arrowhead
spikerush
burush

sample location comprised
of cattails, a reed,
with understory of arrow-
head and spikerush
spikerush, burush
and spikerush around
ponded area. Other
species included purple
loosestrife and touch-me-not.

sample ID PL-18-01
PL-18-02
FORNELLSON

Location 20 130-400pm

4 species
cattail
burreed
arrowhead
spikerush

Cattail, purple loosestrife
and tough meadow were
dominant species
dry wetland except
at stream. Burreed
had been eaten. Raccoon
tracks nearby.

Sample IDs
PL-20-01
PL-20-02

~~R. B. B. B. B.~~

PL-21-01 & 02

1230 pm

floating bog dry
and could walk over
with no problem
surrounded by common
reed. Within bog
area was cattail,
spikerush, arrowhead,
grasses, sedges, rush

4 plants collected

cattail
common reed
arrowhead
spikerush - abundant
in bog area

Fabrizio

0800: ON SITE: SUNNY 60'S
1750000. HIGH IN WASHED
C. FORTIA
B. OLSEN

HAS LEVEL D UNLESS NOTED

0930: LOCATE TO SITE 23. (Reference
Stream)

collected catfish
pondweed
pickersweed
elodea

1100: Locate to Site 21

collected catfish
spikerush
reed
arrowweed

ROBERT BROWN

7.2 SVOCs

Wells G... H Site, OU III
 Plant Tissue Summary Statistics
 Semivolatile Organics (ug/Kg - wet weight)

PARAMETER	NO. DETECTED	NO. SAMPLES	MIN DETECTED	MAX	MEAN	StdDev	UCL MEAN	LOG MEAN	UCL LOG MEAN
Phenanthrene	2	8	25	38	131.6	61.9	171.7	147.6	354.2
Fluoranthene	6	8	31	120	81.9	59	120.1	84.6	190.9
Pyrene	5	8	33	110	106.8	55.3	142.6	113.2	225.2
Chrysene	3	8	54	98	130.4	49.3	162.3	133.9	203.3
Benzo(b)fluoranthene	4	8	55	100	118.6	51.6	152	121.6	189.2
Benzo(k)fluoranthene	3	8	52	120	133.1	47.9	164.2	137	207.5
Benzo(a)pyrene	1	8	77	77	154	31.1	174.2	155.6	191.8
Indeno(1,2,3-cd)pyrene	1	8	63	63	152.3	36.1	175.6	155	205.6

Wells G : Site, OU III
 Plant Tissue Detected Compounds
 Semivolatile Organics (ug/Kg - wet weight)

SAMPLE ID	PL-18-01	PL-18-02	PL-20-01	PL-20-02	PL-21-01	PL-21-02	PL-23-01
LAB ID	DAB672	DAB673	DAB674	DAB675	DAB678	DAB679	DAB676
SAMPLE DATE	8/29/95	8/29/95	8/29/95	8/29/95	9/6/95	9/6/95	9/6/95
PERCENT MOISTURE	88	86	88	89	88	84	87
COMMENTS							dup of DAB677
Phenanthrene	330 U	330 U	38 J	25 J	330 U	330 U	330 U
Fluoranthene	36 J	43 J	120 J	64 J	31 J	31 J	330 U
Pyrene	88 J	330 U	110 J	94 J	34 J	33 J	330 U
Chrysene	330 U	54 J	98 J	66 J	330 U	330 U	330 U
Benzo(b)fluoranthene	55 J	79 J	100 J	55 J	330 U	330 U	330 U
Benzo(k)fluoranthene	52 J	68 J	120 J	330 UJ	330 U	330 U	330 U
Benzo(a)pyrene	330 U	330 U	77 J	330 UJ	330 U	330 U	330 U
Indeno(1,2,3-cd)pyrene	330 U	330 U	63 J	330 UJ	330 U	330 U	330 U

Wells G Site, OU III
Plant Tissue Detected Compounds
Semivolatile Organics (ug/Kg - wet weight)

SAMPLE ID PL-23-02
LAB ID DAB677
SAMPLE DATE 9/6/95
PERCENT MOISTURE 87
COMMENTS dup of DAB676

Phenanthrene	330	U
Fluoranthene	330	U
Pyrene	330	U
Chrysene	330	U
Benzo(b)fluoranthene	330	U
Benzo(k)fluoranthene	330	U
Benzo(a)pyrene	330	U
indeno(1,2,3-cd)pyrene	330	U

7.3 PCBs/Pesticides

Wells G . . . Site, OU III
 Plant Tissue Summary Statistics
 Pesticide - PCBs (ug/Kg - wet weight)

PARAMETER	NO. DETECTED	NO. SAMPLES	MIN DETECTED	MAX	MEAN	StdDev	UCL MEAN	LOG MEAN	UCL LOG MEAN
alpha-BHC	1	8	0.27	0.27	0.25	0.01	0.26	0.25	0.26
Heptachlor	3	8	0.28	0.37	0.28	0.05	0.31	0.28	0.31
Heptachlor epoxide	1	8	0.44	0.44	0.28	0.07	0.32	0.28	0.32
Endosulfan I	1	8	0.43	0.43	0.27	0.06	0.32	0.27	0.32
4,4'-DDE	8	8	0.36	1.2	0.74	0.25	0.9	0.75	1.01
Endosulfan II	1	8	1.1	1.1	0.6	0.2	0.7	0.6	0.7
4,4'-DDD	5	8	0.58	5.2	1.71	2.01	3.02	1.7	8.03
4,4'-DDT	2	8	0.56	0.78	0.54	0.1	0.6	0.54	0.6
Endrin aldehyde	4	8	0.63	2.9	0.89	0.83	1.43	0.87	1.63
alpha-Chlordane	8	8	0.43	2.3	1.15	0.74	1.63	1.18	2.26
gamma-Chlordane	6	8	0.32	0.56	0.41	0.12	0.49	0.42	0.55
Aroclor-1260	6	8	5.6	8.9	5.9	2.5	7.5	6	9.8

Wells G a Site, OU III
 Plant Tissue Detected Compounds
 Pesticide/PCBs (ug/Kg - wet weight)

SAMPLE ID	PL-18-01	PL-18-02	PL-20-01	PL-20-02	PL-21-01	PL-21-02	PL-23-01
LAB ID	DAB672	DAB673	DAB674	DAB675	DAB678	DAB679	DAB676
SAMPLE DATE	8/29/95	8/29/95	8/29/95	8/29/95	9/6/95	9/6/95	9/6/95
PERCENT MOISTURE	88	86	88	89	88	84	87
COMMENTS							dup of DAB677
alpha-BHC	0.51 U	0.51 U	0.27 J	0.5 U	0.5 U	0.5 U	0.51 U
Heptachlor	0.51 U	0.51 U	0.37 J	0.5 U	0.33 J	0.5 U	0.28 J
Heptachlor epoxide	0.51 U	0.51 U	0.44 J	0.5 U	0.5 U	0.5 U	0.51 U
Endosulfan I	0.51 U	0.51 U	0.43 J	0.5 U	0.5 U	0.5 U	0.51 U
4,4'-DDE	1.2	0.36 J	0.63 J	0.57 J	0.62 J	0.81 J	0.87 J
Endosulfan II	0.99 U	0.99 U	0.98 U	0.98 U	1.1 J	0.98 U	0.98 U
4,4'-DDD	1.1 J	0.58 J	0.64 J	0.98 U	0.98 U	0.98 U	5.2
4,4'-DDT	0.56 J	0.99 U	0.98 U	0.98 U	0.98 U	0.98 U	0.78 J
Endrin aldehyde	0.99 U	0.67 J	0.98 J	0.98 U	0.63 J	2.9 J	0.98 U
alpha-Chlordane	0.91	1 J	0.99 J	0.84 J	2.3 J	2.3 J	0.43 J
gamma-Chlordane	0.51	0.43 J	0.56	0.32 J	0.53	0.46 J	0.51 U
Aroclor-1260	7.1	5.6 J	5.8 J	5.6 J	8.9	8.9	5 U

Wells G Site, OU III
Plant Tissue Detected Compounds
Pesticide/PCBs (ug/Kg - wet weight)

SAMPLE ID	PL-23-02
LAB ID	DAB677
SAMPLE DATE	9/6/95
PERCENT MOISTURE	87
COMMENTS	dup of DAB676
alpha-BHC	0.5 U
Heptachlor	0.5 UJ
Heptachlor epoxide	0.5 U
Endosulfan I	0.5 U
4,4'-DDE	0.85 J
Endosulfan II	0.98 U
4,4'-DDD	4.7
4,4'-DDT	0.98 U
Endrin aldehyde	0.98 U
alpha-Chlordane	0.45 J
gamma-Chlordane	0.5 U
Aroclor-1260	5 U

7.4 Inorganics

Wells G Site, OU III
 Plant Tissue Summary Statistics
 Inorganics (mg/Kg - wet weight)

PARAMETER	NO. DETECTED	NO. SAMPLES	MIN DETECTED	MAX	MEAN	StdDev	UCL MEAN	LOG MEAN	UCL LOG MEAN
Aluminum	8	8	69.3	348	210.9	110.1	282.2	220.1	416.6
Arsenic	8	8	1.4	15.9	8	6.2	12	9.2	44.5
Barium	8	8	2.5	5.2	3.8	0.9	4.3	3.8	4.5
Cadmium	8	8	0.11	0.78	0.42	0.22	0.56	0.45	0.99
Calcium	8	8	1040	1420	1208	119	1285	1208	1294
Chromium	8	8	0.41	71.2	23.65	22.63	38.31	63.79	5622.54
Cobalt	8	8	0.46	2.2	0.84	0.56	1.21	0.84	1.28
Copper	8	8	0.97	27.1	12.29	9.69	18.57	17.63	191.72
Iron	8	8	828	2270	1329.3	531.9	1673.9	1337.1	1824.5
Lead	8	8	3	13.9	9.4	4.2	12.1	9.9	18.7
Magnesium	8	8	171	238	202.3	25.8	219	202.5	222.5
Manganese	8	8	29	158	84	49.8	116.3	87.6	174.1
Mercury	6	8	0.04	0.29	0.084	0.097	0.146	0.119	1.636
Nickel	7	8	0.17	1.5	0.56	0.43	0.84	0.63	1.85
Potassium	8	8	500	1620	988	378	1233	999	1379
Selenium	1	8	0.55	0.55	0.25	0.13	0.34	0.25	0.38
Sodium	8	8	568	1420	926	313.8	1129.3	931	1218.5
Vanadium	8	8	0.61	2.1	1.25	0.52	1.58	1.27	1.85
Zinc	8	8	19.7	149	85.2	45.5	114.7	93.8	221.6

Wells G Site, OU III
 Plant Tissue Detected Compounds
 Inorganics (mg/Kg - wet weight)

SAMPLE ID	PL-18-01	PL-18-02	PL-20-01	PL-20-02	PL-21-01	PL-21-02	PL-23-01
LAB ID	DAB672	DAB673	DAB674	DAB675	DAB678	DAB679	DAB676
SAMPLE DATE	8/29/95	8/29/95	8/29/95	8/29/95	9/6/95	9/6/95	9/6/95
PERCENT MOISTURE	88	86	88	89	88	84	87
COMMENTS							dup of DAB677
Aluminum	348 J	235 J	348 J	283 J	166 J	154 J	83.9 J
Arsenic	14.7	10.2	13.4	15.9	4.2	2.9	1.5
Barium	4.1	3.4	2.51	3.6	3.5	3.3	5.2
Cadmium	0.78	0.42	0.53	0.45	0.47	0.44	0.12
Calcium	1420	1220	1290	1260	1160	1180	1040
Chromium	71.2 J	34.2 J	28.7 J	18 J	21.1 J	15 J	0.56 J
Cobalt	2.2 J	0.68 J	0.87 J	0.76 J	0.61 J	0.65 J	0.53 J
Copper	27.1 J	16.1 J	21.6 J	17.4 J	7.8 J	6.4 J	0.97 J
Iron	2270	1880	1120	1640	828	948	938
Lead	13.6 J	9.4 J	13.9 J	9.8 J	10.9 J	11.4 J	3.3 J
Magnesium	218	197	238	226	216 J	177	175
Manganese	49.8	59.6	93.4	109	30	29	158
Mercury	0.04 J	0.04 J	0.07 J	0.06 J	0.29 J	0.16 J	0.01 UJ
Nickel	1.5 J	0.65	0.6	0.501	0.53	0.48	0.17
Potassium	899	718	1390	1620	687	500	940
Selenium	0.52 UJ	0.5 UJ	0.54 UJ	0.251 UJ	0.55 J	0.3 UJ	0.42 UJ
Sodium	812	568	918	642	1420	1380	825
Vanadium	2.1	1.7	1.6	1.3	1	0.9	0.78
Zinc	149 J	76 J	103 J	81.9 J	117 J	113 J	19.7 J

Wells G Site, OU III
Plant Tissue Detected Compounds
Inorganics (mg/Kg - wet weight)

SAMPLE ID	PL-23-02
LAB ID	DAB677
SAMPLE DATE	9/6/95
PERCENT MOISTURE	87
COMMENTS	dup of DAB676
Aluminum	69.3 J
Arsenic	1.4
Barium	4.7
Cadmium	0.11
Calcium	1090
Chromium	0.406 J
Cobalt	0.457 J
Copper	0.978 J
Iron	1010
Lead	3 J
Magnesium	171
Manganese	143
Mercury	0.01 UJ
Nickel	0.16 U
Potassium	1150
Selenium	0.42 UJ
Sodium	843
Vanadium	0.61
Zinc	22.3 J

7.5 Percent Moisture

Wells G Site, OU III
Plant Tissue Detected Compounds
Percent Moisture (%)

SAMPLE ID	PL-18-01	PL-18-02	PL-20-01	PL-20-02	PL-21-01	PL-21-02	PL-23-01
LAB ID	DAB672	DAB673	DAB674	DAB675	DAB678	DAB679	DAB676
SAMPLE DATE	8/29/95	8/29/95	8/29/95	8/29/95	9/6/95	9/6/95	9/6/95
COMMENTS							dup of DAB677
% MOISTURE	88	86.5	88.2	89.1	87.5	84.2	86.7

Wells G Site, OU III
Plant Tissue Detected Compounds
Percent Moisture (%)

SAMPLE ID	PL-23-02
LAB ID	DAB677
SAMPLE DATE	9/6/95
COMMENTS	dup of DAB676
% MOISTURE	87.3

8. SEDIMENT BIOASSAY REPORT

WELLS G&H SEDIMENT TOXICITY TEST REPORT

Hyalella azteca
Chironomus tentans

EPA NEW ENGLAND
OFFICE OF ECOSYSTEM ASSESSMENT

FEBRUARY 13, 1996

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INTRODUCTION

Sediment toxicity testing was conducted with the two freshwater invertebrates: the amphipod, *Hyalella azteca* and midge, *Chironomus tentans* to evaluate the potential impact from exposure of sediment related contaminants to the benthic community in the Aberjona River. Sediments were collected from seven sampling locations which included five locations from potentially contaminated areas (SED-07, SED-16, SED-12, SED-18 and SED-19) and two reference locations (SED-23 and SED-24). Since sediments were collected from either riverine or wetland systems, one reference sediment was collected from a riverine system (SED-23) and another reference sediment was collected from a wetland system (SED-24) for purposes of biological and statistical comparison. In addition, a field duplicate sediment sample was collected at SED-19 (SED-19-02) for quality assurance and an artificial sediment was formulated and tested as the laboratory control. Young *H. azteca* and *C. tentans* were exposed to sediment samples for ten days and at the conclusion of the test, organisms were recovered from each test chamber and survival and growth were recorded as endpoints. Impacts on growth of surviving organisms were assessed by drying recovered individuals from each replicate at 75° F to a constant weight. Samples were brought to room temperature in a desiccator and weighed to the nearest 0.01 mg to obtain mean weight per replicate. Statistical comparisons were performed between survival and growth endpoints from the site locations and two site reference locations and laboratory control.

MATERIALS AND METHODS

References

- The procedures used followed those outlined in the EPA document, *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*, (June 1994, EPA/600/R-94/024).
- EPA Region I ESD Biology Section SOP #13.1.2, Sediment Toxicity Testing Procedures for the Preparation of Sediments.

Overlying Water

The overlying water consisted of 25% Perrier/75% 80 mg/L CaCO₃ culture water (150 mg/L CaCO₃) for *H. azteca* and aerated tap water for *C. tentans*. The sediment and water were allowed to settle overnight before inoculation of test organisms.

Test Chemistry

Initial and final overlying water quality measurements included pH, specific

conductance, temperature, and dissolved oxygen (DO). DO, pH and temperature were monitored every 24 hours.

Test Food

C. tentans:

- * Tetramin shake; 1.0 ml (12 g Tetramin/300 ml deionized water) daily to each test beaker.

H. azteca:

- * Tetramin shake; 0.2 ml (20 g Tetramin/L deionized water) daily to each test beaker.

Equipment and Test Chambers

- * #10, #45, #50 and #60 sieves
- * plastic scoops
- * 250 ml beakers (*H. azteca* test chambers)
- * 1 liter beakers (*C. tentans* test chambers)
- * 1 ml plastic disposable pipets
- * Parafilm
- * Tygon tubing
- * Nalgene trays

Statistical Analyses

The purpose of the sediment toxicity tests was to determine whether a biological response (survival or growth) from a site related sediment sample was significantly different than the site reference or laboratory control sediment. This difference is identified through statistical analysis. Prior to conducting the statistical analysis, a null hypothesis was developed as no difference in biological responses between the site related sediment samples and site reference and laboratory control sediments. The alternative hypothesis was that site related sediments contain contaminants in concentrations affecting survival and growth in comparison to the site reference or laboratory control sediments.

Following the decision tree (Figure 14.7) in EPA/600/R-94/024, growth and survival data were tested for normality and homogeneity of variance prior to conducting hypothesis testing. Appendix A provides the statistics performed on this data and illustrate the final statistical results obtained through hypothesis testing.

PROCEDURES

Introduction

Less than seven day old *H. azteca* and 2nd instar *C. tentans* were exposed to sediment samples from five (plus a duplicate) on-site sampling stations, two site related reference stations and a formulated sediment laboratory control (Appendix A). On the 10th day of the test, organisms were recovered from each test chamber and tallied as alive or dead. Live organisms were dried at 75° F overnight and weighed to the nearest 0.01 to obtain mean weight per replicate. Comparison of survival and growth data were performed between the following stations as illustrated in Table 1, 2 and 3: 1) *C. tentans* survival and growth in the artificial sediment in comparison to the five on-site stations, in addition to a field duplicate for station 19 and the wetland reference station; 2) The riverine reference station (SED-23) was evaluated against all other riverine stations (7, 12 and 16) for *C. tentans* growth and survival; Unfortunately no statistical comparisons could be completed for the wetland reference station (SED-24) against the other wetland stations (18, 19.01 and 19.02) due to low survival (36%). 3) *H. azteca* survival was analyzed for the wetland reference station (SED-24) and compared against the other wetland stations (18, 19.01 and 19.02); 4) *H. azteca* growth from wetland reference location SED-24 was compared to other wetland stations (19.01 and 19.02). Unfortunately no statistical comparisons could be completed for *C. tentans* in the wetland reference station (SED-24) against the other wetland stations (18, 19.01 and 19.02) due to low survival (36%). In addition, statistical analysis for *H. azteca* could not be performed using the riverine reference stations since survival was very low (0.8%). The laboratory control (artificial sediment) was not suitable to make comparisons against all other stations since *H. azteca* survival was very low (16.6%).

Table 1: *C. tentans* Survival and Growth Comparisons

STATION	VERSUS THE FOLLOWING LOCATIONS
SED-23	7, 12, 16, 18, 19.01, 19.02, 24
ART SED	7, 12, 16, 18, 19.01, 19.02, 24

Table 2: *H. azteca* Survival Comparisons

STATION	VERSUS THE FOLLOWING LOCATIONS
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SED-24	18, 19.01, 19.02
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Table 3: *H. azteca* Growth Comparisons

STATION	VERSUS THE FOLLOWING LOCATIONS
SED-24	19.01, 19.02

Sample Handling

The following sediment samples were received at EPA-New England's Regional Laboratory on August 29th and 30th, 1995: SED-7, SED-12, SED-16, SED-18, SED-19.01 and SED-19.02 (field duplicate), SED-23 and SED-24. Sediments were received up to 7 days prior to the initiation of the test and stored at 4° C until the time of testing on September 8, 1995.

Organism Origin

EPA-New England's Biology Laboratory provided the *C. tentans* and *H. azteca* organisms for the sediment tests. The *C. tentans* were 7 to 10 days old and *H. azteca* were 2nd and 3rd instar or 2-3 millimeters in length.

Initial Test Set-Up

On September 6 & 7, 1995, the sediments were homogenized then screened with #10 Tyler sieves. Sediments, followed by overlying water, were added to the clean test chambers in the following quantities. For *H. azteca* 50 ml of sediment was added to each 250 ml beaker with approximately 200 ml of overlying water per replicate. For *C. tentans*, 200 ml of sediment was added to each 1 liter beaker followed by 800 ml of overlying water. Eight laboratory replicates per test species were run for each sediment sample location. All test chambers were aerated during the test period. Prior to introduction of *H. azteca* and *C. tentans*, and following the addition of overlying water, the sediments were allowed to settle overnight. On September 8th, ten *C. tentans* and fifteen *H. azteca* were introduced to each test chambers. The test was performed in a walk-in environmental chamber located at EPA New England's Biology Laboratory. All test chambers were maintained at 25 degrees Celsius +/- 1 degree and 16:8 hour light/dark cycle.

Feeding

C. tentans was fed 1.0 ml 12 g Tetramin/300 ml suspension per day. *H. azteca* was

fed 0.2 ml of 20 g Tetramin/L suspension daily.

Test Chemistry

Initial chemistry was performed on the overlying water and monitored every 24 hours. All chemistry results were recorded in wet chemistry laboratory log book and are included as Appendix B. Initial chemistry included the following: pH, specific conductance, hardness, temperature and dissolved oxygen (DO). Daily monitored chemistry included pH, DO and temperature. The environmental chamber temperature was monitored daily.

RESULTS

The survival rate for *C. tentans* in the artificial sediment (ART SED) was 70% which indicates the test meets the performance criteria for an acceptable test (Table 4). Survival ranged from 36% in SED-24 (wetland reference) to 86.2% in SED-12. In the riverine reference, SED-23, the survival rate was 81.2%. For *C. tentans* survival data, there was no statistically significant difference between the ART SED and any other station location (Appendix C). The riverine reference location, SED-23, was also used in comparison against the other riverine locations, with no significant difference identified. All sediment locations had similar or greater than 70 % survival except for SED-16 and SED-24 (Table 4).

For growth results for *C. tentans*, when ART SED is compared to all other samples, the statistical results indicated that all of the locations, except SED-24, were statistically significantly lower in weight. However, SED-24 had a greater weight measurement with only 36% survival. When site reference SED-23 is compared to the other riverine samples, SED-7, 12, 16; station location SED-16 was found to differ significantly from the control with respect to a decrease in weight. Noting that SED-16 contained considerable amount of coarse sediment (0.14% Total Combustible Organics), the significance may be due to physical characteristics of the sediment rather than from contaminants. When comparing the wetland reference sediment SED-24 to wetland locations SED-18 and 19, growth was seen to be better in the site related location.

The survival rate for *H. azteca* in the ART SED control was 16.6% (Table 5) which would render this test unacceptable under current sediment test guidelines. The recommended survival rate for *H. azteca* is 80%. The reason for the low survival rate in the laboratory control is unexplainable at this time. In order to obtain some useable information from these test results, the survival rate in the two site reference locations (wetlands and riverine) were scrutinized to estimate whether or not they could substitute for site specific comparisons. The wetland and riverine reference locations, SED-24 & SED-23, had recovery rates of 78.1% and 0.8%, respectively. Even though survival was extremely low in SED-23, this sample had the highest

average weight (Table 5). Due to the poor recoveries in ART SED and SED-23, an attempt was made to use SED-24 for comparison. A comparison was made to the other wetland locations: SED-18, SED-19-01, and SED-19-02. Location SED-18 was determined to differ significantly from SED-24 with a survival rate of only 10.8%, and a 60% decrease in growth. Location SED-23 was excluded from any statistical analyses due to the extremely low survival.

As part of the quality control for this test, the station location, SED-19.01, had a duplicate sample collected SED-19.02. There was a 14% relative percent difference (RPD) between each other for the *C. tentans* in the survival category. For growth there was an 18% RPD. For *H. azteca*, there is a 10% RPD difference from the mean when survival and growth are considered.

Table 4: *C. tentans* Sediment Toxicity Test Results

SEDIMENT TOXICITY TEST RESULTS WELLS G&H, WOBURN, MA <i>Chironomus tentans</i>		
Station location	Survival %	Avg. weight (mg)
ART SED ^a	70	0.0033
SED-7 ^d	82.5	0.0014*
SED-12 ^d	86.2	0.0012*
SED-16 ^d	68.6	0.0008*
SED-18 ^e	70	0.0013*
SED-19-01 ^e	70	0.0010*
SED-19-02 ^e	81.1	0.0009*
SED-23 ^b	81.2	0.0017*
SED-24 ^c	36	0.0021
^a designates laboratory control i.e. artificial sediment ^b designates riverine reference ^c designates wetland reference ^d designates riverine locations ^e designates wetland locations * designates statistical significance ($\alpha=0.05$)		

Table 5: *H. azteca* Sediment Toxicity Results

SEDIMENT TOXICITY RESULTS WELLS G&H, WOBURN, MA <i>Hyalella azteca</i>		
Station location	Survival %	Avg. weight (mg)
ART SED ^a	16.6	0.00007
SED-7 ^d	50	0.00009
SED-12 ^d	74.2	0.00011
SED-16 ^d	93.3	0.00014
SED-18 ^e	10.8*	0.00004*
SED-19-01 ^e	56.6	0.00011
SED-19-02 ^e	62.5	0.00010
SED-23 ^b	0.8	0.00030
SED-24 ^c	78.1	0.00010
^a designates laboratory control i.e. artificial sediment ^b designates riverine reference ^c designates wetland reference ^d designates riverine locations ^e designates wetland locations * designates statistical significance ($\alpha=0.05$)		

Unvalidated sediment chemistry data was compared to sediment benchmarks developed by NOAA (Long et al., 1995) and Ontario Ministry of the Environment (OMOE) (Persaud et al., 1992) to evaluate the toxicity test results against contaminant concentrations and determine whether a causal relationship between chemistry and toxicity could be supported.

Through NOAA's National Status and Trends Program Long and Morgan (1990) developed Effects Range Low (ER-L) and Effects Range Median (ER-M) values. These biological effects were obtained from modeling studies, field and laboratory tests with more emphasis placed on marine and estuarine systems. For each chemical, data was gathered to correspond with adverse biological effects. ER-L values represent the lower 10th percentile concentration associated with observation of biological effects and ER-M values represent the 50th percentile concentration associated with the observation of biological effects. Chemical concentrations below ER-L values should have a low probability of being associated with adverse biological effects.

OMOE Sediment Quality Guidelines were originally developed to determine whether dredged material was appropriate for open water disposal. The two levels used for comparison are the Lowest Effect Level (LEL) and Severe Effect Level (SEL). The LEL *"indicates a level of contamination which has no effect on the majority of the sediment-dwelling organisms and the sediment is considered clean to marginally polluted."* Contaminant concentrations that exceed LEL values may require further testing and the development of a management plan. In contrast, SEL concentrations are *"considered heavily polluted and likely to affect the health of sediment-dwelling organisms. If the level of contamination exceeds the SEL then testing is required to determine whether or not the sediment is acutely toxic."* Since sediments collected from the Aberjona River are freshwater more emphasis was placed on the comparison to OMOE LEL and SEL guidelines. However, NOAA guidelines are listed for comparison.

Table 6 list the inorganics that exceed OMOE guidelines for the various sampling locations. The site that had the most inorganic exceedances was SED-19. All inorganics except for nickel exceeded OMOE SEL levels in SED-19-01 and SED-19-02 (field duplicate). For example, the concentration of arsenic in SED-19-02 (5510 mg/kg) exceeds the SEL by 166 times and copper by 13 times (1490 mg/kg) (Table 6). Zinc in SED-19 sediments is a factor of three times greater than the SEL. In contrast the sampling locations with the least number of inorganic exceedances was SED-23, the riverine reference location, in which chromium at 29.1 mg/kg slightly exceeded the OMOE LEL value and SED-24 of 26 mg/kg. At SED-24, the wetland reference location, there were LEL exceedances for copper and lead (Table 6). Arsenic, chromium, copper, lead and zinc were identified in SED-07 as exceeding the

OMOE SEL values.

Table 7 lists those organic compounds (polycyclic aromatic hydrocarbons and pesticides) that exceed either the OMOE LEL or SEL concentrations. SED-7 had the most exceedances (10) of OMOE LEL values for polycyclic aromatic hydrocarbons (PAHs) and SED-24 had 7 compounds with concentrations that were greater than the OMOE LEL (Table 7). SED-18 did not possess any organic constituents that exceeded OMOE guidelines since no organic compounds that were detected in SED-18 sediment sample. After adjusting the OMOE SEL (Table 7) to the site specific TCOs there were no sediment locations that exceeded the SEL values (Table 8).

TABLE 6. INORGANIC CONCENTRATIONS (MG/KG) IN SEDIMENT SAMPLES IN COMPARISON TO SEDIMENT BENCHMARKS.

Compound (mg/kg)	SED-07	SED-16	SED-12	SED-18	SED-19-01	SED-19-02	SED-23	SED-24	OMOE LEL ¹	OMOE SEL ²	NOAA ER-L ³	NOAA ER-M ⁴
Arsenic	75.5 †	<u>13.6</u>	38.4	34.9	2070	5510	5.2	3.8	6	33	8.2	70
Cadmium	<u>5.0</u>	.18	<u>1.3</u>	<u>1.9</u>	11.6	14.1	.09	.24	0.6	10	1.2	9.6
Chromium	207	20.9	<u>42.1</u>	<u>109</u>	2960	1710	<u>29.1</u>	10.3	26	110	81	370
Copper	209	<u>24.8</u>	<u>40.5</u>	158	1170	1490	1.9	<u>19.8</u>	16	110	34	270
Iron (%)	<u>2</u>	.5	.7	.4	14	18	.2	.4	2	4		
Lead	480	10.1	16.8	<u>55.4</u>	609	669	6.5	<u>81.3</u>	31	250	46.7	218
Manganese	<u>595</u>	93.3	<u>610</u>	93	1140	1180	12.6	50.4	460	1100		
Mercury	<u>94</u>	<u>37</u>	.15	<u>69</u>	9.5	4.7	.07	.03	0.2	2	0.15	0.71
Nickel	<u>28.3</u>	4.2	5.4	4.6	<u>37.7</u>	<u>29.4</u>	1.1	6.0	16	75	20.9	51.6
Zinc	1200	78.5	1390	<u>420</u>	2880	3040	11.5	47.6	120	820	150	410
Total Combustible Organics (%)	8.4	.14	10	6.1	26.7	38	2.4	.28				

¹Persaud et al. 1992. Ontario Ministry of the Environment(OMOE); Low Effect Level (LEL) indicates a level of sediment contamination that can be tolerated by most benthic organisms.

²Persaud et al. 1992. OMOE Severe Effects Level (SEL) represents a contaminant concentration that would be detrimental to most organisms.

³Long et al. 1995. NOAA Effects Range Low (ER-L). The lower 10th percentile of the effects data.

⁴Long et al. 1995. NOAA Effects Range Median (ER-M). The 50th percentile of the effects data.

Underlined numbers represent those that exceed OMOE LEL values.

Bolded numbers represent those that exceed OMOE SEL values.

TABLE 7.1. 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Compound	SED-07	SED-16	SED-12	SED-18	SED-19 -01	SED-19 -02	SED-23	SED-24	OMOE LEL ¹	OMOE SEL ²	NOAA ER-L ³	NOAA ER-M ⁴
Anthracene	<u>.470</u>							.098	.220	370		
Benzo(a) anthracene	<u>2.80</u>		.160		.240	.250		<u>.440</u>	.320	1480		
Benzo(a) pyrene	<u>3.20</u>		.160		.320	.270		<u>.400</u>	.370	1440	0.43	1.6
Benzo(k) fluoranthene	<u>5.3</u>		<u>.350</u>		<u>.940</u>	<u>.880</u>		<u>.690</u>	.240	1340		
Chlordane						.005			.007	6		
Chrysene	<u>4.4</u>		.200		.340	<u>.390</u>		<u>.550</u>	.340	460		
DDD	<u>.064</u>	<u>.011</u>			.008	.007	<u>.060</u>	<u>.035</u>	.008	6		
DDE	<u>.037</u>	.002			<u>.01</u>	.001	<u>.011</u>		.005	19		
DDT		.001			.002	.001			.007	12	0.0016	0.046
Dieldrin	.001					<u>.006</u>			.002	91		
Endrin					.003	<u>.005</u>			.003	130		
Fluoranthene	<u>6.20</u>	.088				.500	.071	<u>.880</u>	.750	1020		
Fluorene	<u>.330</u>							.091	.190	160		
Phenanthrene	<u>2.70</u>							.460	.560	950	0.24	1.5
Pyrene	<u>4.50</u>	.110	.420			.430	.081	<u>.680</u>	.490	850	0.665	2.6
Total Combustible Organics (%)	8.4	.14	10	6.1	26.7	38	2.4	.28				

¹Persaud et al. 1992. Ontario Ministry of the Environment(OMOE); Low Effect Level (LEL) indicates a level of sediment contamination that can be tolerated by most benthic organisms.

²Persaud et al. 1992. OMOE Severe Effects Level (SEL) represents a contaminant concentration that would be detrimental to most organisms.

³Long et al. 1995. NOAA Effects Range Low (ER-L). The lower 10th percentile of the effects data.

⁴Long et al. 1995. NOAA Effects Range Median (ER-M). The 50th percentile of the effects data.

Underlined numbers represent those that exceed OMOE LEL values. Bolded numbers represent those that exceed OMOE SEL values.

TOTAL COMBI BLE ORGANICS.

Compound	SED-07	OMOE SEL 8 %	SED-24	SED-16	OMOE SEL 1 %	SED-12	SED-19 -01	SED-19 -02	OMOE SEL 10 %	SED-23	OMOE SEL 2.4 %
Anthracene	.470	29.60	.098		3.7						
Benzo(a) anthracene	2.80	118.40	.440		1.48	.160	.240	.250	148		
Benzo(a) pyrene	3.20	115.20	.400		14.40	.160	.320	.270	144		
Benzo(k) fluoranthene	5.3	107.	.690		1.34	.350	.940	.880	134		
Chlordane								.005	.6		
Chrysene	4.4	36.80	.550		4.6	.200	.340	.390	46		
DDD	.064	.48	.035	.011	.06		.008	.007	.6	.060	.144
DDE	.037	1.52		.002	.19		.01	.001	1.9	.011	.456
DDT				.001	.12		.002	.001	1.2		
Dieldrin	.001	1.52						.006	1.9		
Endrin							.003	.005	13		
Fluoranthene	6.20	81.60	.880	.088	1.02			.500	102	.071	24.48
Fluorene	.330	12.8	.091		.16						
Phenanthrene	2.70	76	.460		9.5						
Pyrene	4.50	68	.680	.110	8.5	.420		.430	85	.081	20.4

*OMOE SEL numbers listed in Table 7 are multiplied by site specific TCO to calculate site specific SELs which are then used to make comparison between chemical concentrations and adjusted SELs.

DISCUSSION

Station location SED-24 (wetland reference) had low survival for *C. tentans* (36%) which could be a result of very low TCO at 0.28% and seven exceedances of PAHs and pesticides in comparison to OMOE LEL values (Table 7). Recognizing the role of organic carbon in predicting bioavailability OMOE SEL benchmarks were adjusted with site specific TCO values and SED-24 in addition to all the other sediment sample locations did not have PAHs or pesticides that exceeded the OMOE SEL concentration (Table 8). Based on ten day water only tests conducted on the three freshwater species, *H. azteca*, *C. tentans* and *Lumbriculus variegatus* (oligochaete), the midge *C. tentans* was generally more sensitive or had similar sensitivity than the amphipod *H. azteca* with exposure to pesticides (Phipps et al. 1995). SED-16 also had a lower survival rate of 68.6% and this sediment also had a low TCO level of 0.14% with OMOE LEL exceedances for both inorganics and organics.

Station locations SED-18 and SED-23 had very low *H. azteca* survival rates of 10.8% & 0.8% respectively. In SED-18 there were OMOE SEL exceedances of both arsenic and copper, concentrations approximately twice the SEL concentration and survival was statistically significantly different when compared to the site specific wetland control location, SED-24. However, there were no PAHs or pesticides in this sediment that exceeded OMOE LEL or SEL levels. *H. azteca* survival was lower in SED-7 at 50% and this sediment had elevated levels of the inorganics, arsenic, chromium, copper, lead and zinc that exceeded OMOE SEL concentrations. Kemble et al. (1994) determined that *H. azteca* was the most sensitive species with respect to metal contaminated sediments from Great Lakes when compared against the three species *C. riparius*, *Oncorhynchus mykiss* (rainbow trout) and *Daphnia magna*. This sensitivity may also account for the survival differences observed for the two species exposed to SED-19. In general, *H. azteca* had lower survival than *C. tentans* in SED-19. Neither species has been reported in the literature to be more sensitive than the other for all chemicals. This supports the rationale in the use of both species in sediment toxicity testing.

Exposure to site related contaminants from sediments collected from location SED-18 indicates the potential for adverse biological impacts to benthic invertebrate survival and growth when compared to the wetland reference site (SD-24). The low recovery rates for SED-23 could be due to the proximity of the sampling location to Lubbers Brook and Concord Street. It is possible that surface runoff may adversely affect this test organism. In addition, since SED-23 is a riverine reference location upgradient of the site, and is not likely to be impacted by site related contamination, further investigation based on test results is not warranted.

The limitation in comparing sediment contaminant concentrations to biological effects benchmarks only utilizes a chemical by chemical evaluation of the potential for toxicity but the sediment toxicity testing results allow for an assessment of the

additive exposure to a mixture of contaminants. It is recognized that other abiotic factors (i.e. grain size) may influence toxicity but exposing burrowing invertebrates to contaminated sediments is considered a worst case scenario with respect to routes of exposure.

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APPENDIX A

FORMULATED REFERENCE SEDIMENT RECIPE

ARTIFICIAL SEDIMENT

Sand 77%: "Mystic White" medium to fine grain

Silt/Clay 17%: ASP 400 (31.5% silt and 68.5% clay)

Organic Matter 5%: peat (47% C, 4 mg/g N, 0.4 ug/g P)
cow manure (30% C, 11 mg/g N, 8.2 ug/g P)

Buffer (CaCO₃) 1%

The artificial sediment recipe listed above is the one selected for further testing. The sand component, 77%, consists of both a fine grain portion, (0.25-0.05 mm) and a medium grain portion (0.5-0.25 mm). A source of this material, known as "Mystic White", is New England Silica, Inc. South Windsor, CT. The second component, silt/clay at 17%, can be purchased under the name of ASP 400 from the Engelhard Corp. Edison, NJ. A third component is the buffer, CaCO₃. This should be added at a rate of 1% and can be purchased from any reputable chemical supply house.

The last, and most critical, organic matter component of this mixture, should make up 5% of the artificial sediment. The following source list associated with this component has been developed because they have been shown to have the ability to produce large quantities of consistent quality. However, a more local source of these materials could be developed by investigating analysis results and QA/QC protocols associated with the product. Peat can reliably be purchased from D.L. Browning Co. Mathers, WI or Mellingers, North Lima, OH. Humus can be purchased from Sims Bark Co., Inc. Tuscumbia, AL. Composted cow manure can be acquired from A.H. Hoffman, Inc. Landisville, PA. Potting soil is another source of organic matter but care should be taken to select a reliable source. If the application were strictly to be used "in house" at ESD the use of potting soil may be acceptable if reliability could be maintained.

All components should be mixed on a dry weight basis. Reagents where applicable i.e. CaCO₃, should be reagent grade or better. The sand should be sieved to the above mentioned particle size and mixed at a ratio of 2:1, fine:medium. The organic matter should be dried, milled and passed through a 0.84 mm sieve.

Compatibility between the mixture and the use of test organisms *Hyalella azteca* and *Chironomus tentans*, particularly relating to grain size and organic carbon content, was checked and it is not anticipated to be a problem.

APPENDIX B

INITIAL, DAILY, AND FINAL WET CHEMISTRY RESULTS

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 8, 1995

Station location	pH	DO	Cond	Temp	NH ₄ (ppm)
ART SED	8.1	7.4	345	25.9	7.4
SED-7	6.9	7.4	127	25.9	6.6
SED-12	7.3	7.1	120	25.7	7.0
SED-16	7.1	7.2	100	25.8	4.6
SED-18	6.9	7.6	140	25.8	7.2
SED-19-01	6.6	6.6	109	26.2	6.6
SED-19-02	7.1	7.1	105	25.7	8.4
SED-23	6.8	7.3	79	25.7	5.8
SED-24	7.0	7.7	113	25.8	6.4

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallolela azteca
 September 8, 1995

Station location	pH	DO	Cond	Temp
ART SED	8.4	7.3	256	25.6
SED-7	7.7	7.1	317	25.4
SED-12	8.3	7.0	327	25.2
SED-16	8.1	7.0	302	25.3
SED-18	8.2	7.6	308	24.6
SED-19-01	6.6	7.3	334	25.4
SED-19-02	8.0	7.2	295	24.7
SED-23	7.2	6.3	216	25.3
SED-24	8.1	7.1	331	25.3

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 9, 1995

Station location	pH	DO	Temp
ART SED	7.1	5.5	25.6
SED-7	7.1	5.5	25.9
SED-12	7.3	4.6	25.2
SED-16	7.1	4.8	25.7
SED-18	7.3	5.5	25.1
SED-19-01	7.4	5.5	25.8
SED-19-02	7.1	5.1	25.5
SED-23	7.3	4.8	25.7
SED-24	7.1	5.0	25.8

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallolela azteca
 September 9, 1995

Station location	pH	DO	Temp
ART SED	8.2	5.7	24.6
SED-7	7.9	6.1	25.1
SED-12	7.9	5.9	25.0
SED-16	8.2	5.8	25.3
SED-18	8.0	5.9	25.2
SED-19-01	7.5	5.7	25.1
SED-19-02	7.5	6.3	25.2
SED-23	8.1	5.9	25.1
SED-24	7.9	6.5	24.6

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Chironomus tentans
September 10, 1995

Station location	pH	DO	Temp
ART SED	8.2	5.6	25.3
SED-7	7.1	5.7	25.3
SED-12	7.3	4.6	25.5
SED-16	7.0	6.0	24.8
SED-18	6.9	5.9	25.4
SED-19-01	6.8	5.8	25.3
SED-19-02	6.7	6.0	25.5
SED-23	7.3	5.6	25.4
SED-24	7.3	5.6	25.4

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Hyallela azteca
September 10, 1995

Station location	pH	DO	Temp
ART SED	8.3	5.6	22.1
SED-7	7.7	6.1	24.5
SED-12	8.0	6.1	24.5
SED-16	8.0	5.7	25.4
SED-18	7.8	5.8	25.0
SED-19-01	7.9	5.6	24.7
SED-19-02	7.5	6.3	24.8
SED-23	8.1	6.1	24.9
SED-24	8.3	6.1	24.9

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 11, 1995

Station location	pH	DO	Temp
ART SED	8.4	5.1	24.7
SED-7	7.7	5.6	25.0
SED-12	7.3	4.2	25.0
SED-16	7.6	5.5	24.9
SED-18	7.3	5.1	24.9
SED-19-01	6.9	5.1	24.6
SED-19-02	6.9	5.8	24.6
SED-23	7.4	5.0	24.7
SED-24	7.6	4.6	24.7

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallolela azteca
 September 11, 1995

Station location	pH	DO	Temp
ART SED	8.7	5.3	23.8
SED-7	7.9	5.4	24.1
SED-12	7.7	6.1	23.6
SED-16	7.8	5.5	23.6
SED-18	7.9	5.7	23.8
SED-19-01	7.4	5.6	23.3
SED-19-02	7.4	5.5	23.7
SED-23	7.7	5.8	23.6
SED-24	8.0	5.5	23.4

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS WELLS G&H, WOBURN, MA <u>Chironomus tentans</u> September 12, 1995			
Station location	pH	DO	Temp
ART SED	8.2	4.4	25.1
SED-7	7.9	4.8	25.1
SED-12	7.6	5.1	25.3
SED-16	7.4	4.9	25.4
SED-18	7.5	5.9	25.2
SED-19-01	7.1	5.7	25.1
SED-19-02	7.3	4.9	25.0
SED-23	7.5	5.4	25.1
SED-24	7.4	5.2	25.0

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS WELLS G&H, WOBURN, MA <u>Hyallolella azteca</u> September 12, 1995			
Station location	pH	DO	Temp
ART SED	8.6	5.2	23.9
SED-7	8.0	5.0	24.7
SED-12	7.8	6.3	24.4
SED-16	8.0	6.0	24.0
SED-18	8.1	5.2	24.4
SED-19-01	7.9	6.2	24.0
SED-19-02	7.8	5.6	24.0
SED-23	8.3	6.0	24.1
SED-24	8.3	6.3	24.2

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Chironomus tentans
September 13, 1995

Station location	pH	DO	Temp
ART SED	8.3	5.6	25.4
SED-7	7.4	4.6	25.1
SED-12	7.5	5.6	25.2
SED-16	7.3	5.4	25.4
SED-18	7.5	5.6	25.1
SED-19-01	7.2	5.7	25.1
SED-19-02	7.3	5.5	25.2
SED-23	7.5	5.7	25.4
SED-24	7.5	5.9	25.1

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Hyallolela azteca
September 13, 1995

Station location	pH	DO	Temp
ART SED	8.6	5.8	24.8
SED-7	8.0	6.0	24.4
SED-12	7.8	6.4	24.4
SED-16	8.2	5.4	24.7
SED-18	7.9	4.4	24.7
SED-19-01	7.8	5.8	24.4
SED-19-02	7.5	5.1	24.4
SED-23	7.9	5.3	24.2
SED-24	8.6	6.0	23.6

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 14, 1995

Station location	pH	DO	Temp
ART SED	--	--	--
SED-7	7.9	5.7	25.1
SED-12	7.6	5.6	25.2
SED-16	7.1	5.4	25.4
SED-18	7.9	5.7	25.1
SED-19-01	7.5	4.6	25.1
SED-19-02	7.3	4.1	25.2
SED-23	7.8	5.4	25.4
SED-24	7.8	5.5	25.1
-- denotes chemistry measurements unavailable			

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyalalela azteca
 September 14, 1995

Station location	pH	DO	Temp
ART SED	8.9	5.5	25.0
SED-7	8.1	4.4	25.0
SED-12	8.0	5.2	25.0
SED-16	8.1	4.8	25.0
SED-18	7.8	5.5	24.9
SED-19-01	7.3	6.0	25.0
SED-19-02	7.8	5.6	25.0
SED-23	7.9	4.2	25.0
SED-24	7.9	5.2	24.6

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 15, 1995

Station location	pH	DO	Temp
ART SED	8.5	4.5	25.0
SED-7	7.7	5.3	25.0
SED-12	7.5	5.7	25.0
SED-16	7.6	5.8	25.0
SED-18	7.7	5.8	25.0
SED-19-01	7.3	5.5	25.0
SED-19-02	7.6	5.6	25.0
SED-23	7.7	5.4	25.0
SED-24	7.7	5.8	25.0

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallela azteca
 September 15, 1995

Station location	pH	DO	Temp
ART SED	8.7	5.8	25.1
SED-7	8.0	4.7	25.5
SED-12	7.9	5.4	25.6
SED-16	8.3	5.8	25.1
SED-18	7.9	5.1	23.7
SED-19-01	7.8	5.0	25.1
SED-19-02	7.7	5.3	25.3
SED-23	8.2	5.3	25.1
SED-24	7.8	5.6	25.1

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 16, 1995

Station location	pH	DO	Temp
ART SED	8.3	5.3	25.5
SED-7	6.2	1.8 ^a	25.4
SED-12	6.4	5.8	25.4
SED-16	6.9	5.7	25.4
SED-18	7.3	5.1	24.8
SED-19-01	7.5	6.1	25.2
SED-19-02	7.1	5.7	25.2
SED-23	7.4	5.5	25.4
SED-24	7.7	5.8	25.0

^a denotes replicate with no aeration at time of wet chemistry

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallela azteca
 September 16, 1995

Station location	pH	DO	Temp
ART SED	8.6	6.1	25.2
SED-7	8.0	6.1	24.6
SED-12	7.7	5.8	24.7
SED-16	7.8	6.1	25.3
SED-18	7.5	6.1	24.6
SED-19-01	7.8	6.0	24.7
SED-19-02	7.8	6.1	24.6
SED-23	8.2	6.1	23.7
SED-24	8.4	6.5	24.2

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Chironomus tentans
 September 17, 1995

Station location	pH	DO	Temp
ART SED	8.4	5.3	25.0
SED-7	--	---	---
SED-12	7.4	5.4	25.0
SED-16	7.2	4.6	25.0
SED-18	7.9	5.6	25.0
SED-19-01	7.8	4.5	25.0
SED-19-02	7.5	5.2	25.0
SED-23	7.8	5.7	25.0
SED-24	7.7	5.6	25.0
-- denotes chemistry measurements unavailable			

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
 WELLS G&H, WOBURN, MA
Hyallolella azteca
 September 17, 1995

Station location	pH	DO	Temp
ART SED	8.6	5.4	24.9
SED-7	8.4	5.6	24.9
SED-12	8.3	5.8	24.9
SED-16	8.2	5.4	25.1
SED-18	8.0	5.3	25.3
SED-19-01	7.9	5.6	24.9
SED-19-02	7.9	6.0	25.2
SED-23 *	7.9	4.6	25.1
SED-24	8.4	6.0	25.0

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Chironomus tentans
September 18, 1995

Station location	pH	DO	Temp	NH ₄ (ppm)
ART SED	--	--	--	--
SED-7	6.8	7.1	26.0	4.8
SED-12	6.7	6.8	26.0	5.5
SED-16	6.4	6.3	26.0	3.4
SED-18	6.2	5.7	26.0	8.1
SED-19-01	7.0	6.4	26.0	11.22
SED-19-02	7.1	6.8	26.0	12.2
SED-23	6.9	6.3	26.0	6.8
SED-24	6.7	6.8	26.0	4.4

-- denotes chemistry measurements unavailable

SEPT. '95 SEDIMENT TOXICITY TEST RESULTS
WELLS G&H, WOBURN, MA
Chironomus tentans
September 18, 1995

Station location	pH	DO	Temp	NH ₄ (ppm)
ART SED	7.8	7.7	26.0	6.3
SED-7	6.6	6.8	26.0	2.2
SED-12	6.4	7.2	26.0	1.8
SED-16	7.1	7.5	26.0	2.2
SED-18	6.6	7.5	26.0	2.1
SED-19-01	6.7	7.1	26.0	8.5
SED-19-02	6.7	7.5	26.0	6.2
SED-23	7.1	7.0	26.0	1.8
SED-24	7.6	6.9	26.0	2.1

APPENDIX C

STATISTICAL ANALYSES

A

CT SURVIVAL WITH SED03 as ctrl vs all others

WELLS G&H, CT SURVIVAL, SEDIMENT TOX TEST
e: WLCTSRV.S23 Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	4.154	15.004	23.684	15.004	4.154
OBSERVED	4	13	23	19	3

Calculated Chi-Square goodness of fit test statistic = 1.6780
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

|| Press any key to continue or Esc to return to menu ||

WELLS G&H, CT SURVIVAL, SEDIMENT TOX TEST
e: WLCTSRV.S23 Transform: NO TRANSFORMATION

Shapiro-Wilks test for normality

***** Shapiro-Wilks Test is aborted *****

This test can not be performed because total number of replicates is greater than 50.

Total number of replicates = 62

|| Press any key to continue or Esc to return to menu ||

LS G&H, CT SURVIVAL, SEDIMENT TOX TEST
File: WLCTSRV.S23 Transform: NO TRANSFORMATION

Martley test for homogeneity of variance

calculated H statistic (max Var/min Var) = 7.90
Closest, conservative, Table H statistic = 22.0 (alpha = 0.01)

Level for Table H ==> R (# groups) = 8, df (# reps-1) = 7
Unequal values ==> R (# groups) = 8, df (# avg reps-1) = 6.75
(average df used)

DATA PASS homogeneity test. Continue analysis.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

|| Press any key to continue or Esc to return to menu ||

WELLS G&H, CT SURVIVAL, SEDIMENT TOX TEST
File: WLCTSRV.S23 Transform: NO TRANSFORMATION

Hartlett's test for homogeneity of variance

Calculated B statistic = 16.86
Table Chi-square value = 18.48 (alpha = 0.01)
Table Chi-square value = 14.07 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 6.75
Used for Chi-square table value ==> df (#groups-1) = 7

DATA PASS homogeneity test at 0.01 level. Continue analysis.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

|| Press any key to continue or Esc to return to menu ||

WELLS G&H, CT SURVIVAL, SEDIMENT TOX TEST
File: WLCTSRV.S23 Transform: NO TRANSFORMATION

MILCOXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho: Control < Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
	SED-23	7.625				
	SED-7	8.250	77.50	44.00	8	
3	SED-12	8.375	77.00	44.00	8	
4	SED-16	5.875	59.50	44.00	8	
5	SED-18	7.000	61.00	44.00	8	

6	SED-19.01	7.000	69.00	44.00	8
7	SED-19.02	8.125	80.50	44.00	8
8	SED-24	3.500	28.50	26.00	6

critical values use $k = 7$, are 1 tailed, and $\alpha = 0.05$

|| Press any key to continue or Esc to return to menu ||

(B)

CT SURVIVAL W/ ART SED AS CTRL

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: wghctsrv.asd Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	4.556	16.456	25.976	16.456	4.556
OBSERVED	0	0	68	0	0

Calculated Chi-Square goodness of fit test statistic = 110.0105

Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test. Try another transformation.

Warning - The two homogeneity tests are sensitive to non-normal data and should not be performed.

|| Press any key to continue or Esc to return to menu ||

SURVIVAL

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: wghctsrv.asd Transform: NO TRANSFORMATION

Shapiro-Wilks test for normality

***** Shapiro-Wilks Test is aborted *****

This test can not be performed because total number of replicates is greater than 50.

Total number of replicates = 68

|| Press any key to continue or Esc to return to menu ||

	TOXSTAT	
--	---------	--

Zero Variance

SURVIVAL

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: wghctsrv.asd Transform: NO TRANSFORMATION

TOXSTAT

Zero Variance

ELLS G&H CT GROWTH SEDIMENT TOX TEST
file: wghctsrv.asd Transform: ARC SINE(SQUARE ROOT(Y))

artley test for homogeneity of variance
artletts test for homogeneity of variance

these two tests can not be performed because at least one group has zero variance.

data FAIL to meet homogeneity of variance assumption.
additional transformations are useless.

B

|| Press any key to continue or Esc to return to menu ||

SURVIVAL

ELLS G&H CT ~~GROWTH~~ SEDIMENT TOX TEST
file: wghctsrv.asd Transform: ARC SINE(SQUARE ROOT(Y))

COXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

ROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	ART SED	0.991				
2	SED-7	1.139	100.00	44.00	8	
3	SED-12	1.190	84.00	34.00	7	
4	SED-16	0.990	36.00	44.00	8	
5	SED-18	0.991	68.00	44.00	8	
6	SED-19.01	0.991	56.00	34.00	7	
7	SED-19.02	1.121	100.00	44.00	8	
8	SED-23	1.122	100.00	44.00	8	
9	SED-24	0.644	21.00	25.00	6	

Critical values use k = 8, are 1 tailed, and alpha = 0.05

|| Press any key to continue or Esc to return to menu ||

Bartley test for homogeneity of variance
Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

|| Press any key to continue or Esc to return to menu ||

SURVIVAL

WELLS G&H CT ~~GROWTH~~ SEDIMENT TOX TEST

File: wghctsrv.asd Transform: ARC SINE(SQUARE ROOT(Y))

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	4.556	16.456	25.976	16.456	4.556
OBSERVED	0	0	68	0	0

Calculated Chi-Square goodness of fit test statistic = 110.0105

Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test. Try another transformation.

Warning - The two homogeneity tests are sensitive to non-normal data and should not be performed.

|| Press any key to continue or Esc to return to menu ||

SURVIVAL

WELLS G&H CT ~~GROWTH~~ SEDIMENT TOX TEST

File: wghctsrv.asd Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro-Wilks test for normality

***** Shapiro-Wilks Test is aborted *****

This test can not be performed because total number of replicates is greater than 50.

Total number of replicates = 68



CT GTH SED 23 as CTRL

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.S23 Transform: NO TRANSFORMATION

-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	4.020	14.520	22.920	14.520	4.020
OBSERVED	0	20	24	12	4

Calculated Chi-Square goodness of fit test statistic = 6.5766

Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

↳ Passes, but NOT in decision tree.

|| Press any key to continue or Esc to return to menu ||

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.S23 Transform: NO TRANSFORMATION

piro-Wilks test for normality

***** Shapiro-Wilks Test is aborted *****

This test can not be performed because total number of replicates is greater than 50.

Total number of replicates = 60

|| Press any key to continue or Esc to return to menu ||

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.S23 Transform: NO TRANSFORMATION

bartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 24.33

Closest, conservative, Table H statistic = 22.0 (alpha = 0.01)

Used for Table H ==>	R (# groups) =	8,	df (# reps-1) =	7
Actual values ==>	R (# groups) =	8,	df (# avg reps-1) =	6.50
			(average df used)	

~~Data FAIL homogeneity test.~~ Try another transformation.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

|| Press any key to continue or Esc to return to menu ||

*Next, according to Method applied
The Arc-Sine Transformation*

WELLS G&H CT GROWTH SEDIMENT TOX TEST
File: C:\BIOSOFT\WELLSGTH.S23 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 21.32
Closest, conservative, Table H statistic = 22.0 (alpha = 0.01)

Used for Table H ==> R (# groups) = 8, df (# reps-1) = 7
Actual values ==> R (# groups) = 8, df (# avg reps-1) = 6.50
(average df used)

Data PASS homogeneity test. Continue analysis.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

|| Press any key to continue or Esc to return to menu ||

WELLS G&H CT GROWTH SEDIMENT TOX TEST
File: C:\BIOSOFT\WELLSGTH.S23 Transform: ARC SINE(SQUARE ROOT(Y))

Levene test for homogeneity of variance

Calculated B statistic = 18.06
Table Chi-square value = 18.48 (alpha = 0.01)
Table Chi-square value = 14.07 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 6.50
Used for Chi-square table value ==> df (#groups-1) = 7

Data PASS homogeneity test at 0.01 level. Continue analysis.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

|| Press any key to continue or Esc to return to menu ||

Next, Wilcoxon Rank Sum Test

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.S23

Transform: ARC SINE(SQUARE ROOT(Y))

LCOXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	SED-23	0.041				
2	SED-7	0.037	62.50	44.00	8	
3	SED-12	0.037	43.00	35.00	7	
4	SED-16	0.027	36.00	44.00	8	*
5	SED-18	0.035	49.50	44.00	8	
6	SED-19.01	0.034	37.00	35.00	7	
7	SED-19.02	0.031	36.00	44.00	8	*
8	SED-24	0.046	53.00	26.00	6	

Critical values use k = 7, are 1 tailed, and alpha = 0.05

|| Press any key to continue or Esc to return to menu ||

①

CT GTH W/ ART SED as CTRL
CT growth

WELLS G&H CT GROWTH SEDIMENT TOX TEST
file: C:\BTH.SED Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	4.556	16.456	25.976	16.456	4.556
OBSERVED	2	20	26	16	4

Calculated Chi-Square goodness of fit test statistic = 2.2777
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST
file: C:\BTH.SED Transform: NO TRANSFORMATION

Shapiro-Wilks test for normality

***** Shapiro-Wilks Test is aborted *****

This test can not be performed because total number of replicates is greater than 50.

Total number of replicates = 68

ART SED } very poor
SED 24 } recovered

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST
file: C:\BTH.SED Transform: NO TRANSFORMATION

Levene's test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 31.69



conservative, Table H statistic = 23.0 (alpha = 0.01)

Used for Table H ==> R (# groups) = 9, df (# reps-1) = 7
Actual values ==> R (# groups) = 9, df (# avg reps-1) = 6.56
(average df used)

Data FAIL homogeneity test. Try another transformation.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST
File: C:\BTH.SED Transform: NO TRANSFORMATION

Bartlett's test for homogeneity of variance

Calculated B statistic = 26.77
Table Chi-square value = 20.09 (alpha = 0.01)
Table Chi-square value = 15.51 (alpha = 0.05)
Average df used in calculation ==> df (avg n - 1) = 6.56
df for Chi-square table value ==> df (#groups-1) = 8

Data FAIL homogeneity test at 0.01 level. Try another transformation.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

ART SED as before is all fine

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST
File: C:\BTH.SED Transform: NO TRANSFORMATION

WILCOXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	<i>lab control</i> ART SED	0.003				
2	SED-7	0.001	39.00	44.00	8	*
	SED-12	0.001	30.00	34.00	7	*
	SED-16	0.001	36.00	44.00	8	*
5	SED-18	0.001	37.00	44.00	8	*
6	SED-19.01	0.001	28.00	34.00	7	*
7	SED-19.02	0.001	36.00	44.00	8	*

CT GTH SED 23 vs CTRL vs 7,12,16

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.RVR

Transform: NO TRANSFORMATION

Miro Wilks test for normality

W = 0.000

L = 0.964

Critical W (P = 0.05) (n = 30) = 0.927

Critical W (P = 0.01) (n = 30) = 0.900

Data PASS normality test at P=0.01 level. Continue analysis.

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.RVR

Transform: NO TRANSFORMATION

Hartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 17.48

Closest, conservative, Table H statistic = 14.5 (alpha = 0.01)

Used for Table H ==>	R (# groups) =	4,	df (# reps-1) =	7
Actual values ==>	R (# groups) =	4,	df (# avg reps-1) =	6.50
			(average df used)	

Data FAIL homogeneity test. Try another transformation.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.RVR

Transform: NO TRANSFORMATION

Bartlett's test for homogeneity of variance

Calculated B statistic = 10.17

Table Chi-square value = 11.34 (alpha = 0.01)
Table Chi-square value = 7.81 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 6.50
df for Chi-square table value ==> df (#groups-1) = 3

Data PASS homogeneity test at 0.01 level. Continue analysis.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

Press any key to continue or Esc to return to menu

WELLS G&H CT GROWTH SEDIMENT TOX TEST

File: C:\BIOSOFT\WELLSGTH.RVR

Transform: NO TRANSFORMATION

COXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	SED-23	0.002				
2	SED-7	0.001	62.50	47.00	8	
3	SED-12	0.001	43.00	37.00	7	
4	SED-16	0.001	28.00	37.00	7	*

Critical values use k = 3, are 1 tailed, and alpha = 0.05

Press any key to continue or Esc to return to menu

G

Stats precede the transformation for TRASP-one.

azteca-survival, SEDIMENT TOX TEST
3.24 Transform: NO TRANSFORMATION

AA survival vs 18, 19-01, 19-02

K SUM TEST W/ BONFERRONI ADJUSTMENT - Ho: Control < Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	SED-24	0.781				
2	SED-18	0.108	10.00	12.00	4	*
3	SED-19.01	0.566	36.00	45.00	8	
4	SED-19.02	0.625	36.00	45.00	8	

Critical values use k = 3, are 1 tailed, and alpha = 0.05

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-survival, SEDIMENT TOX TEST
File: WLHAVS3.24 Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	1.809	6.534	10.314	6.534	1.809
OBSERVED	0	0	27	0	0

Calculated Chi-Square goodness of fit test statistic = 43.6806
Table Chi-Square value (alpha = 0.01) = 13.277

Data FAIL normality test. Try another transformation.

Warning - The two homogeneity tests are sensitive to non-normal data and should not be performed.

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-survival, SEDIMENT TOX TEST
File: WLHAVS3.24 Transform: NO TRANSFORMATION

Pierson Wilks test for normality

W = 0.000

t = 0.002

Critical W (P = 0.05) (n = 27) = 0.923
Critical W (P = 0.01) (n = 27) = 0.894

Data FAIL normality test. Try another transformation.

Warning - The two homogeneity tests are sensitive to non-normal data and should not be performed.

Press any key to continue or Esc to return to menu

TOXSTAT

Zero Variance

WELLS G&H, H. azteca-survival, SEDIMENT TOX TEST
File: WLHAVS3.24 Transform: NO TRANSFORMATION

Bartley test for homogeneity of variance
Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Press any key to continue or Esc to return to menu

(H)

G&H 24 vs 19-01, 19-02

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	1.541	5.566	8.786	5.566	1.541
OBSERVED	0	8	9	5	1

Calculated Chi-Square goodness of fit test statistic = 2.8581
Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: NO TRANSFORMATION

Lilliefors test for normality

L = 0.000

L = 0.966

Critical W (P = 0.05) (n = 23) = 0.914

Critical W (P = 0.01) (n = 23) = 0.881

Data PASS normality test at P=0.01 level. Continue analysis.

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: NO TRANSFORMATION

Martens test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 22.50

Data FAIL homogeneity test. Try another transformation.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: ARC SINE(SQUARE ROOT(Y))

Bartlett's test for homogeneity of variance

Calculated B statistic = 11.89
Table Chi-square value = 9.21 (alpha = 0.01)
Table Chi-square value = 5.99 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 6.67
Used for Chi-square table value ==> df (#groups-1) = 2

Data FAIL homogeneity test at 0.01 level. Try another transformation.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: ARC SINE(SQUARE ROOT(Y))

WILCOXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	SED-24	0.010				
2	SED-19.02	0.010	62.00	46.00	8	
3	SED-19.01	0.010	61.00	46.00	8	

Critical values use k = 2, are 1 tailed, and alpha = 0.05

*Because, SED-18 sig for survival (only 10.8%)
Can drop from stats.*

Press any key to continue or Esc to return to menu

Closest, conservative, Table H statistic = 12.1 (alpha = 0.01)

Used for Table H ==> R (# groups) = 3, df (# reps-1) = 7
unequal values ==> R (# groups) = 3, df (# avg reps-1) = 6.67
(average df used)

Data FAIL homogeneity test. Try another transformation.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: NO TRANSFORMATION

Bartlett's test for homogeneity of variance

Calculated B statistic = 11.76
Table Chi-square value = 9.21 (alpha = 0.01)
Table Chi-square value = 5.99 (alpha = 0.05)

average df used in calculation ==> df (avg n - 1) = 6.67
Used for Chi-square table value ==> df (#groups-1) = 2

Data FAIL homogeneity test at 0.01 level. Try another transformation.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

Press any key to continue or Esc to return to menu

WELLS G&H, H. azteca-growth, SEDIMENT TOX TEST
File: C:\BIO.REV Transform: ARC SINE(SQUARE ROOT(Y))

Hartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 23.83
Closest, conservative, Table H statistic = 12.1 (alpha = 0.01)

Used for Table H ==> R (# groups) = 3, df (# reps-1) = 7
unequal values ==> R (# groups) = 3, df (# avg reps-1) = 6.67
(average df used)

HA growth w/ SED24 vs 18, 19-01, 19-02

WELLS G&H H. azteca GROWTH SEDIMENT TOX TEST

File: C:\WELHAGTH.24

Transform: ARC SINE(SQUARE ROOT(Y))

MANN-COXON RANK SUM TEST W/ BONFERRONI ADJUSTMENT - Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG
1	SED-24	0.010				
2	SED-19.01	0.010	57.50	45.00	8	
3	SED-19.02	0.010	62.50	45.00	8	
4	SED-18	0.008	10.00	12.00	4	*

Critical values use k = 3, are 1 tailed, and alpha = 0.05

FIT, SED-18 not dropped from stats

Press any key to continue or Esc to return to menu

Table 4: *C. tentans* Sediment Toxicity Test Results

SEDIMENT TOXICITY TEST RESULTS WELLS G&H, WOBURN, MA <i>Chironomus tentans</i>		
Station location	Survival %	Avg. weight
ART SED ^a	70	0.0033
SED-7 ^d R	82.5	0.0014*
SED-12 ^d R	86.2	0.0012*
SED-16 ^d R	68.6	0.0008*
SED-18 ^e W	70	0.0013*
SED-19-01 ^e W	70	0.0010*
SED-19-02 ^e W	81.1	0.0009*
SED-23 ^b R	81.2	0.0017*
SED-24 ^c W	36	0.0021

^a designates laboratory control i.e. artificial sediment
^b designates riverine reference
^c designates wetland reference
^d designates riverine locations
^e designates wetland locations
* designates statistical significance ($\alpha=0.05$)

Table 5: *H. azteca* Sediment Toxicity Results

SEDIMENT TOXICITY RESULTS WELLS G&H, WOBURN, MA <i>Hyalomma azteca</i>		
Station location	Survival %	Avg. weight
ART SED ^a	16.6	0.00007
SED-7 ^d R	50	0.00009
SED-12 ^d R	74.2	0.00011
SED-16 ^d R	93.3	0.00014
SED-18 ^e W	10.8*	0.00004*
SED-19-01 ^e W	56.6	0.00011
SED-19-02 ^e W	62.5	0.00010
SED-23 ^b R	0.8	0.00030
SED-24 ^c W	78.1	0.00010

^a designates laboratory control i.e. artificial sediment
^b designates riverine reference
^c designates wetland reference
^d designates riverine locations
^e designates wetland locations
* designates statistical significance ($\alpha=0.05$)