



NJ Department of Environmental Protection
Division of Science and Research
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WATER MONITORING MANAGEMENT
James Mumman, Administrator

August 1996

**SEDIMENT TOXICITY TEST
USING THE AMPHIPOD
Hyaella azteca
(Saddle River, Molly Ann Brook Sediment)
August 1996**

Assay Number(s): 96H005a, 96H005b, 96H005c, 96H005d

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EXECUTIVE SUMMARY

A toxicity test using the amphipod *Hyalella azteca* was performed on sediments collected from two sites on the Saddle River (AN0279-reference site, AN0291- test site) and one site on Molly Ann Brook (AN0276) in the Northeast Basin. A reference was selected on the Saddle River which was assessed as "non-impaired" by the Ambient Biomonitoring Network (AMNET). Sites on the Saddle River and Molly Ann Brook were chosen because they were suspect of toxicity due to a "severely impaired" assessment by the AMNET program. The Saddle River test site exhibited acute toxicity as a significant difference in survival results when statistically compared to the reference station. Growth data showed no significant difference when compared to the reference. Since toxicity test results substantiate AMNET bioassessments, it is recommended that further biological and chemical monitoring be conducted at this site to determine the source and identities of the contamination present.

The Molly Ann Brook site exhibited no significant difference from the reference site in either survival or growth. This site may be undergoing biological recovery, or toxicity may be chronic in nature and not detectable in this test. Future AMNET assessments will show if impairment still exists, and additional testing will be considered at that time.

INTRODUCTION

The Ambient Biomonitoring Network (AMNET) program is designed to establish biologically impaired stream segments throughout the state using EPA's Rapid Bioassessment Protocol (RBP). The RBP assesses impairment through the collection, identification, and classification of macroinvertebrates. Although the RBP is an excellent way in which to assess impairment, it may sometimes be difficult to distinguish if impairment is due to water quality or habitat destruction. Sediment Toxicity Testing is an additional tool to narrow down the cause of impairment to an acute toxicity problem before resorting to costly chemical monitoring.

Hyalella azteca is an epibenthic detritovore reported to also digest bacteria and algae from ingested sediment particles (Hargrave, 1970). This amphipod burrows into the sediment surface and inhabits lakes, ponds, and streams throughout North and South America (de March, 1981; Pennak, 1989). *H. azteca* is a sensitive benchmark species that can be cultured in the laboratory with relative ease.

METHODS

Sample sites were selected based on available AMNET data (see appendix a) and proximity to NJPDES facilities.

The sites selected are as follows (see map):

<u>AMNET STATION#</u>	<u>BIOLOGICAL ASSESSMENT</u>	<u>LOCATION</u> (see map)
AN0276	severely impaired	Molly Ann Brook @ Totowa Ave. Bridge, West Side Park
AN0279	non-impaired	Saddle River @ Old Stone Church Rd.
AN0291	severely impaired	Saddle River @ Marcellus Place and Saddle River Ave.

Sediment samples were collected from these sites AN0276 and AN0291 on August 14, 1996 at 11:00 and 12:00 hours respectively. A sediment sample was collected from site AN0279 on August 15, 1996 at 12:00. At each station the sediment was collected in the stream channel using a stainless steel scoop sampler and placed into two one liter amber glass bottles and stored at less than 4EC until the start of the test (NJDEP, 1992).

Prior to test initiation the sample sites were assigned assay numbers as follows:

96H005a = control
96H005b = AN0279
96H005c = AN0276
96H005d = AN0291

Testing methodology followed the Bureau of Water Monitoring Standard Operating Procedures (NJDEP, SM001.0795, 1995). 24 hours prior to the start of the test, the sediment from each station was mixed to provide a homogeneous sample and hand picked of any visible indigenous organism. For each site, 100 ml of sediment was added to each of the five 300 ml replicate test vessels and topped with laboratory grade freshwater to the 250 ml mark. The test vessels were then held at the test temperature (23EC) for 24 hours to allow the sediment to settle (NJDEP, SM001.0795, 1995). After this time period, the overlying water was syphoned, and fresh water was added. A control set of replicates was also set up using 250 ml of overlying water only.

1 - 7 day *H. azteca* juveniles were collected and held for one week prior to the start of the test (NJDEP, 1995).

The test was initiated on August 20, 1996 at 10:00 hours, by adding ten 7 - 14 day old organisms from the holding chamber to each test series replicate. Each day the overlying water was exchanged, and each test replicate was fed 1.5 ml of YCT and 1.5 ml of the green algae *Selenastrum capricornutum* at a concentration of 35×10^6 cells/ml. Mortalities were noted if visible. pH, dissolved oxygen, and conductivity were measured from aliquots of each test series; measurements were made at the start of the test and after each 24 hour period (see table 3).

The test was concluded after ten days (August 30, 1996). Live organisms were counted (see table 1) and the dry weights measured (see table 2). Statistical analysis was performed, following EPA guidelines (U.S.E.P.A., 1991). The reference test was compared against the control and the remaining tests compared to the reference, providing the reference and the control were statistically the same.

RESULTS

The test was valid by meeting the acceptability requirements of $\geq 80\%$ survival (see table 1) in the control test series (NJDEP, SM001.0795, 1995). The survival data of the reference site was not normally distributed when analyzed by the Shapiro-Wilks test for normality, and therefore the Wilcoxon Rank Sum Test was used when comparing test survival results. There was no significant difference between the reference test, 96H005b, survival results and the control survival results. The survival data for test 96H005c was not normally distributed when analyzed by the Shapiro-Wilks test for normality, and therefore the Wilcoxon Rank Sum Test was used when comparing test survival results. The survival data for test 96H005d was normally distributed when analyzed by the Shapiro-Wilks test for normality, and therefore an F-Test and T-Test was used when comparing test survival results. Test 96H005c and 96H005d survival data was then compared to the reference test. 96H005c had no significant differences from the reference test. 96H005d was significantly different from the reference test for mortality.

Growth data (see table 2) was normally distributed when comparing the control and reference station and also when comparing the reference test with 96H005c and 96H005d. Normality was analyzed using the Shapiro-Wilks test for normality, and an F-test and T-test was performed when comparing tests. There was no significant differences between the control and the reference test 96H005b. 96H005c and 96H005d exhibited no significant difference from the reference test for growth. (see appendix b for statistical printout)

In test 96H005c dead chironomids and several worms were seen swimming in the test chambers. Both organisms are indicative of poor water quality.

At the end of the test the dissolved oxygen level dropped below the 40 % saturation protocol requirements in two test series. In test 96H005c the D.O. dropped to 25 % saturation at test termination, and the D.O. dropped to 36 % saturation in test 96H005d at test termination.

DISCUSSION

The sample sites on the Saddle River and Molly Ann Brook were chosen based on the results of macroinvertebrate studies and the proximity of NJPDES facilities and urbanization. Sites AN0276 and AN0291 had severely impaired bioassessment results as analyzed in AMNET. The reference site, AN0279, was chosen because it had a nonimpaired bioassessment based on results from the AMNET programs and was within the same major drainage basin as the test sites. Similar stream morphology and similar ecological region designation to the sample sites suspected of toxicity also factored into choosing the reference site.

Site AN0291, on the Saddle River, had a very strong sewage odor at the time of collection which remained constant in intensity throughout the test and at test completion.

Survival results showed no significant differences between the control treatment and reference test, or between the reference test and 96H005c, Molly Ann Brook. Toxicity may not have been exhibited at this site if Molly Ann Brook is in the process of undergoing biological recovery, or the severe impairment, demonstrated by the AMNET program, may be due to a chronic toxicity problem not detectable in this test. The drop in dissolved oxygen at the end of the test did not effect the final test results. Future macroinvertebrate bioassessments will show if biological impairment still exists in the stream and additional testing will be considered at that time.

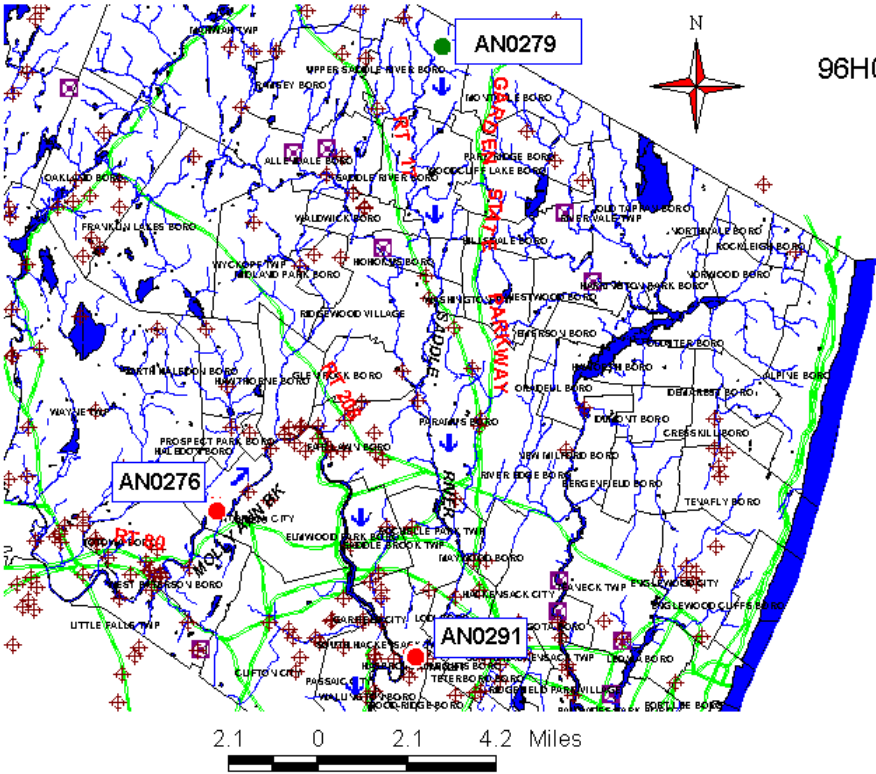
Acute toxicity was exhibited, as a significant difference, when comparing the reference test mortality results with survival results from 96H005d, the Saddle River. The Saddle River, upstream of the sampling location, is subject to numerous dischargers, and, being in an urban environment is likely impacted by nonpoint sources. Since the dissolved oxygen was maintained above 40 % saturation until test termination, it is unlikely that the drop in D.O. to 36 % saturation at test termination effected the outcome. As observed in test 96H005c, the D.O. dropped to 25 % saturation with no significant effects on the test organisms.

Impairment of site AN0291 as assessed in the AMNET program, was indicative of significant organic pollution. The severe impairment assessed in the AMNET program along with the acute toxicity demonstrated in the sediment suggests an impact due to the additive effects of the numerous discharges and/or nonpoint sources, likely due to urbanization, which influence the Saddle River, and probably not the result of a single source. Chemical sampling should be performed to determine the sources and identities of the contamination present.

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SEDIMENT TOXICITY TEST
 96H005a,96H005b,96H005c,96H005c



NJDEP
 DIVISION OF SCIENCE & RESEARCH
 WATER MONITORING MANAGEMENT
 BUREAU OF WATER MONITORING

- NONIMPAIRED AMNET SITE
- SEVERELY IMPAIRED AMNET SITE
- ➔ FLOW
- ~ STREAMS
- ~ MAJOR ROADS
- ⊕ NJPDES SITES
- ⊠ SOLID WASTE LANDFILLS

TABLE 1
MORTALITY DATA
(number surviving)

ASSAY #	REP. A	REP. B	REP. C	REP. D	REP. E	%survival
Control	10	8	10	10	9	94
96H005b	10	10	9	9	10	96
96H005c	10	10	9	10	10	98
96H005d	8	9	8	4	7	72

Statistical Analysis

Test Endpoint: Survival

Test Used: Wilcoxon Rank Sum Test

Results: 96H005b - no significant difference from control
96H005c - no significant difference from reference station

Test Endpoint: Survival

Test Used: F-Test and T-Test

Results: 96H005d - significant difference from reference station

Test Endpoint: Growth

Test Used: F-test and T-test

Results: 96H005b - no significant difference from control
96H005c - no significant difference from reference station
96H005d - no significant difference from reference station

*see appendix b for statistical printout

TABLE 2

WEIGHT DETERMINATION

Drying Oven Temperature: 105ECTime/Date Start Drying: 1415 / 8-30-96Time/Date End Drying: 1615 / 8-30-96Analyst: T. Miller

REPLICATE	WGT. OF BOAT (mg)	DRY WGT: BOAT + LARVAE (mg)	TOTAL WGT. OF LARVAE (mg)	NUMBER OF LARVAE	LARVAE AVG. DRY WGT. (mg)	GROUP AVG. (mg)
CONTROL A	15.36	16.64	1.28	10	0.128	0.141
B	16.72	17.64	0.92	8	0.115	
C	16.68	18.17	1.49	10	0.149	
D	17.38	18.96	1.58	10	0.158	
E	16.81	18.21	1.40	9	1.156	
95H005b A	14.64	18.05	3.41	10	0.341	0.278
B	12.48	15.50	3.02	10	0.302	
C	13.18	15.30	2.12	9	0.236	
D	22.15	24.31	2.16	9	0.240	
E	20.05	22.75	2.70	10	0.270	
95H005c A	14.91	17.21	2.30	10	0.230	0.242
B	13.32	15.89	2.57	10	0.257	
C	14.71	17.10	2.39	9	0.266	
D	16.84	19.07	2.23	10	0.223	
E	14.45	16.77	2.32	10	0.232	
95H005d A	13.53	16.16	2.63	8	0.329	0.238
B	16.37	18.51	2.14	9	0.238	
C	15.46	17.24	1.78	8	0.222	
D	14.60	15.27	0.67	4	0.168	
E	17.50	19.15	1.65	7	0.236	

Table 3**Test Chamber Chemical/Physical Parameters**

Control	HIGH	LOW	AVG.	STD. DEV.	% CV
pH	7.2	6.9	7.1	0.113	1.601
cond. F mhos	144	126	136	5.605	4.130
D.O. mg/L	7.4	6.8	7.1	0.382	5.389

96H005b	HIGH	LOW	AVG.	STD. DEV.	% CV
pH	7.2	6.7	6.9	0.154	2.234
cond. F mhos	185	161	169	6.682	3.946
D.O. mg/L	6.5	3.4	5.0	1.063	21.379

96H005c	HIGH	LOW	AVG.	STD. DEV.	% CV
pH	7.4	7.0	7.1	0.127	1.785
cond. F mhos	198	166	185	9.862	5.320
D.O. mg/L	5.8	2.1*	4.8	1.093	22.675

95H005d	HIGH	LOW	AVG.	STD. DEV.	% CV
pH	7.2	6.7	6.9	0.140	2.036
cond. F mhos	194	159	170	9.963	5.839
D.O. mg/L	6.2	3.1**	5.1	0.823	16.084

* 25% saturation

**36% saturation

APPENDIX A
AMNET DATA

Passaic Basin - Paterson USGS Quadrangle
 Station AN0276
 Molly Ann Brook, West Side Park, Prospect Park
 July 7, 1993

Family	Number of Individuals	Family Tolerance Value (FTV)
Tubificidae	62	10
Gammaridae	27	4
Gastropoda	4	7
Asellidae	1	8
Turbellaria	1	4
Sphaeriidae	1	8
BloodRedChironomidae	2	8
Cambarinae	1	6
Hemiptera	1	8

Statistical Analysis

Number of Taxa = 9
 Total Number of Individuals = 100
 % Contribution of Dominant Family = 62.00
 Family Biotic Index = 8.06
 Scraper/Filterer Collector Ratio = 0.00
 Shredder/Total Ratio = 0.00
 E+P+T* = 0 *(Ephemeroptera, Plecoptera and Trichoptera)
 %EPT = 0.00
 EPT/C* = 0.00 *(Chironomidae)
 NJIS Rating = 3
 Biological Condition = severely impaired
 Deficiency(s) noted: paucity of clean water organisms
 Tubificidae overwhelmingly dominant
 significant organic pollution

Observations

Streamwater: turbid...Flow: slow...Width/Depth(ft): 20/1...
 Substrate: mud/gravel...Streambank Vegetation/Stability: fair/fair
 ...Canopy: mostly open...Other: some trees; surface oils; water
 had swampy, foul odor

Passaic Basin - Park Ridge USGS Quadrangle
 Station AN0279
 Saddle River, Old Stone Church Road, Upper Saddle River
 July 17, 1990

Family	Number of Individuals	Family Tolerance Value (FTV)
Turbellaria	10	4
Lumbriculidae	3	8
Asellidae	1	8
Heptageniidae	1	4
Baetidae	9	4
Corydalidae	1	0
Hydropsychidae	42	4
Glossosomatidae	2	0
Philopotamidae	6	3
Hydroptilidae	2	4
Psephenidae	16	4
Elmidae	5	4
Tipulidae	10	3
Simuliidae	2	6
Chironomidae	2	6

Statistical Analysis

Number of Taxa = 15
 Total Number of Individuals = 112
 % Contribution of Dominant Family = 37.50
 Family Biotic Index = 3.96
 Scraper/Filterer Collector Ratio = 0.40
 Shredder/Total Ratio = 0.18
 E+P+T* = 6 *(Ephemeroptera, Plecoptera and Trichoptera)
 %EPT = 55.36
 EPT/C* = 31.00 *(Chironomidae)
 NJIS Rating = 30
 Biological Condition = non-impaired
 Deficiency(s) noted: none

Observations

Streamwater: clear...Flow: moderate...Width/Depth(ft): 12/<1...
 Substrate: cobbles/gravel/sand...Streambank Vegetation/Stability:
 good/good...Canopy: mostly open...Other: periphyton

Passaic Basin - Hackensack USGS Quadrangle
 Station AN0291
 Saddle River, Marcellus Place, Garfield
 July 17, 1990

Family	Number of Individuals	Family Tolerance Value (FTV)
Turbellaria	4	4
Bryozoa	7	7
Naididae	1	7
Hirudinea	1	10
Asellidae	79	8
Gammaridae	1	4
Neanurinae	1	10
Hydropsychidae	4	4
Tipulidae	1	3
BloodRedChironomidae	3	8
Chironomidae	13	6

Statistical Analysis

Number of Taxa = 11
 Total Number of Individuals = 115
 % Contribution of Dominant Family = 68.70
 Family Biotic Index = 7.38
 Scraper/Filterer Collector Ratio = 0.00
 Shredder/Total Ratio = 0.03
 $E+P+T^* = 1 * (\text{Ephemeroptera, Plecoptera and Trichoptera})$
 %EPT = 3.48
 $EPT/C^* = 0.25 * (\text{Chironomidae})$
 NJIS Rating = 6
 Biological Condition = severely impaired
 Deficiency(s) noted: Asellidae overwhelmingly dominant
 paucity of clean water organisms
 significant organic pollution

Observations

Streamwater: slightly turbid...Flow: fast...Width/Depth(ft): 75/1.
 ..Substrate: boulders/cobbles/sand...Streambank Vegetation/
 Stability: good/good...Canopy: open...Other: silt; periphyton;
 macrophytes

APPENDIX B
STATISTICAL DATA

Survival Proportions with Arc-Sine Square Root Transformation

Blank	Blank Trans	AN0279	AN0279 Trans
1	1.4127	1	1.4127
0.8	1.1071	1	1.4127
1	1.4127	0.9	1.249
1	1.4127	0.9	1.249
0.9	1.249	1	1.4127

Shapiro-Wilks Test for Normality

Blank Trans	AN0279 Trans	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
1.4127	1.4127	1.4127		0.0797	-0.2259				
1.1071	1.4127	1.1071		-0.2259	-0.084				
1.4127	1.249	1.4127	1.333	0.0797	-0.084	0.1103	0.733	0.842	Not Normal
1.4127	1.249	1.4127		0.0797	-0.084				
1.249	1.4127	1.249		-0.084	0.0797				
		1.4127		0.0797	0.0797				
Mean	Mean	1.4127		0.0797	0.0797				
1.3188	1.3472	1.249		-0.084	0.0797				
		1.249		-0.084	0.0797				
		1.4127		0.0797	0.0797				

Wilcoxon Rank Sum Test

Pooled	Sorted	Wilcoxon Rank	Point	Blank	AN0279	Critical (from Table K=1)	Result
1.4127	1.1071	1	2	1	0	19	No Significant Difference
1.1071	1.249	3	5	3	0		
1.4127	1.249	3	8	0	3		
1.4127	1.249	3	9	0	3		
1.249	1.4127	7.5	1	7.5	0		
1.4127	1.4127	7.5	3	7.5	0		
1.4127	1.4127	7.5	4	7.5	0		
1.249	1.4127	7.5	6	0	7.5		
1.249	1.4127	7.5	7	0	7.5		
1.4127	1.4127	7.5	10	0	7.5		
				Sum	Sum		
				26.5	28.5		

Survival Proportions with Arc-Sine Square Root Transformation

AN0279	AN0279 Trans	AN0276	AN0276 Trans
1	1.4127	1	1.4127
1	1.4127	1	1.4127
0.9	1.249	0.9	1.249
0.9	1.249	1	1.4127
1	1.4127	1	1.4127

Shapiro-Wilks Test for Normality

AN0279 Trans	AN0276 Trans	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
1.4127	1.4127	1.4127		0.0491	-0.1146				
1.4127	1.4127	1.4127		0.0491	-0.1146				
1.249	1.249	1.249	1.3636	-0.1146	-0.1146	0.0563	0.594	0.842	Not Normal
1.249	1.4127	1.249		-0.1146	0.0491				
1.4127	1.4127	1.4127		0.0491	0.0491				
		1.4127		0.0491	0.0491				
Mean	Mean	1.4127		0.0491	0.0491				
1.3472	1.38	1.249		-0.1146	0.0491				
		1.4127		0.0491	0.0491				
		1.4127		0.0491	0.0491				

Wilcoxon Rank Sum Test

Pooled	Sorted	Wilcoxon Rank	Point	AN0279	AN0276	Critical (from Table K=1)	Result
1.4127	1.249	2	3	2	0	19	No Significant Difference
1.4127	1.249	2	4	2	0		
1.249	1.249	2	8	0	2		
1.249	1.4127	7	1	7	0		
1.4127	1.4127	7	2	7	0		
1.4127	1.4127	7	5	7	0		
1.4127	1.4127	7	6	0	7		
1.249	1.4127	7	7	0	7		
1.4127	1.4127	7	9	0	7		
1.4127	1.4127	7	10	0	7		
				Sum	Sum		
				25	30		

Survival Proportions with Arc-Sine Square Root Transformation

AN0279	AN0279 Trans	AN0291	AN0291 Trans
1	1.4127	0.8	1.1071
1	1.4127	0.9	1.249
0.9	1.249	0.8	1.1071
0.9	1.249	0.4	0.6847
1	1.4127	0.7	0.9912

Shapiro-Wilks Test for Normality

AN0279 Trans	AN0291 Trans	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
1.4127	1.1071	1.4127		0.2252	-0.5028				
1.4127	1.249	1.4127		0.2252	-0.1963				
1.249	1.1071	1.249	1.1875	0.0615	-0.0804	0.4678	0.8737	0.842	Normal
1.249	0.6847	1.249		0.0615	-0.0804				
1.4127	0.9912	1.4127		0.2252	0.0615				
		1.1071		-0.0804	0.0615				
Mean	Mean	1.249		0.0615	0.0615				
1.3472	1.0278	1.1071		-0.0804	0.2252				
		0.6847		-0.5028	0.2252				
		0.9912		-0.1963	0.2252				

F-test and T-Test

AN0279 Var	AN0291 Var	F-Value	Critical-F (Two-Tailed 0.05)	Variances	T-value	Deg. of Freedom	Critical-T (One-Tailed 0.05)	Result
0.008	0.0451	5.6375	6.3882	Equal	3.0994	5	2.015	Significantly Different

Average Dry Weight per Replicate (in mg)

Blank	AN0279
0.128	0.341
0.115	0.302
0.149	0.236
0.158	0.24
0.156	0.27

Shapiro-Wilks Test for Normality

Blank	AN0279	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
0.128	0.341	0.128		-0.0815	-0.0945				
0.115	0.302	0.115		-0.0945	-0.0815				
0.149	0.236	0.149	0.2095	-0.0605	-0.0605	0.0559	0.9158	0.842	Normal
0.158	0.24	0.158		-0.0515	-0.0535				
0.156	0.27	0.156		-0.0535	-0.0515				
		0.341		0.1315	0.0265				
Mean	Mean	0.302		0.0925	0.0305				
0.1412	0.2778	0.236		0.0265	0.0605				
		0.24		0.0305	0.0925				
		0.27		0.0605	0.1315				

F-test and T-Test

Blank Var	AN0279 Var	F-Value	Critical-F (Two-Tailed 0.05)	Variiances	T-value	Deg. of Freedom	Critical-T (One-Tailed 0.05)	Result
0.0004	0.002	5	6.3882	Equal	-6.2349	5	2.015	No Significant Difference

Average Dry Weight per Replicate (in mg)

AN0279	AN0276
0.341	0.23
0.302	0.257
0.236	0.266
0.24	0.223
0.27	0.232

Shapiro-Wilks Test for Normality

AN0279	AN0276	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
0.341	0.23	0.341		0.0813	-0.0367				
0.302	0.257	0.302		0.0423	-0.0297				
0.236	0.266	0.236	0.2597	-0.0237	-0.0277	0.0125	0.8636	0.842	Normal
0.24	0.223	0.24		-0.0197	-0.0237				
0.27	0.232	0.27		0.0103	-0.0197				
		0.23		-0.0297	-0.0027				
Mean	Mean	0.257		-0.0027	0.0063				
0.2778	0.2416	0.266		0.0063	0.0103				
		0.223		-0.0367	0.0423				
		0.232		-0.0277	0.0813				

F-test and T-Test

AN0279 Var	AN0276 Var	F-Value	Critical-F (Two-Tailed 0.05)	Variances	T-value	Deg. of Freedom	Critical-T (One-Tailed 0.05)	Result
0.002	0.0004	5	6.3882	Equal	1.6523	5	2.015	No Significant Difference

Average Dry Weight per Replicate (in mg)

AN0279	AN0291
0.341	0.329
0.302	0.238
0.236	0.222
0.24	0.168
0.27	0.236

Shapiro-Wilks Test for Normality

AN0279	AN0291	Pooled	Mean	Centered	Ordered	D-value	W-value	Critical-W (0.05)	Result
0.341	0.329	0.341		0.0828	-0.0902				
0.302	0.238	0.302		0.0438	-0.0362				
0.236	0.222	0.236	0.2582	-0.0222	-0.0222	0.0251	0.9311	0.842	Normal
0.24	0.168	0.24		-0.0182	-0.0222				
0.27	0.236	0.27		0.0118	-0.0202				
		0.329		0.0708	-0.0182				
Mean	Mean	0.238		-0.0202	0.0118				
0.2778	0.2386	0.222		-0.0362	0.0438				
		0.168		-0.0902	0.0708				
		0.236		-0.0222	0.0828				

F-Test and T-Test

AN0279 Var	AN0291 Var	F-Value	Critical-F (Two-Tailed 0.05)	Variances	T-value	Deg. of Freedom	Critical-T (One-Tailed 0.05)	Result
0.002	0.0034	1.7	6.3882	Equal	1.1928	7	1.8946	No Significant Difference