Benthic Macrofaunal Communities in the Vicinity of a Groundwater Contamination Site in St. Petersburg, Florida

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Environmental Protection Commission of Hillsborough County

A technical memorandum submitted to:

Pinellas County Department of Environmental Management

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Acknowledgements

Mark Flock and Melissa Harrison from the Pinellas County Department of Environmental Management conducted the field sampling. Kieley Hurff and Matt Kolmann from the Environmental Protection Commission of Hillsborough County assisted with sample processing and data entry.

Introduction

This technical memorandum presents results from benthic macrofauna samples collected near the area of groundwater contamination associated with the Raytheon facility in St. Petersburg, Florida. The Raytheon property was previously owned by E-Systems which was bought out by Raytheon in 1995 (FDEP 2008). Soil and groundwater contamination from volatile organic compounds (VOCs), primarily 1,4-dioxane and trichloroethene (TCE), was first discovered on the property in 1991 when the site was still owned by E-Systems (FDEP 2008). Removal of the contaminated soil was done in 1992 and 1994 and subsequent groundwater monitoring has been ongoing since 1994 (FDEP 2008). The groundwater contamination had seemed to have been restricted to the property boundaries until 2005, when monitoring wells first indicated the contaminant plume had migrated off site (FDEP 2008). Monitoring data collected by Raytheon's environmental consultant ARCADIS in 2008 found VOCs above the FDEPs Groundwater Cleanup Target Level (GCTL) in water samples from surrounding storm sewers (ARCADIS 2008). This finding raises the concern that the ground water contamination could soon reach nearby surface waters. This current study was commissioned by the Pinellas County Department of Environmental Management to address concerns that these contaminates found in the storm sewers may have reached the adjacent drainage canal emptying into Boca Ciega Bay and further may have accumulated in the surrounding sediments and affected the benthic community.

Material and Methods

Samples were collected at three stations in a small bayou on Boca Ciega Bay adjacent to the Admiral Farragut Academy (AFA) in St. Petersburg, Florida (Figure 1). The bayou is connected to a drainage canal that runs adjacent to the Raytheon site and could potentially receive contaminated stormwater flow from the Raytheon site. Field collection was done on December 5, 2008 by the Pinellas County Department of Environmental - Management Watershed Management Section. Surface and bottom water quality measurements were taken in the field at each station using a Hydrolab MS-5. A sediment sample was collected at each station using a Young grab sampler (sample area = $0.04m^2$) for benthic macrofaunal community analysis. The sediment was sieved through a 500µm sieve and the retained sediment and organisms were fixed in 10% buffered formalin with Rose Bengal stain. The benthic sample processing and data analysis were conducted by the Environmental Protection Commission of Hillsborough County - Benthic Monitoring Section. Identification and raw count data are presented in Appendix A. Benthic community analysis was done using PRIMER v6 statistical software (PRIMER-E 2006). An additional sediment sample was collected for analysis of 1, 4-dioxane at each station. These samples were analyzed by TestAmerica Laboratories, Inc. Tampa, Florida; methods and test results are presented in Appendix B.

Figure 1 Admiral Farragut Academy benthic sampling stations - 05 December 2008.

Results

The surface and bottom water quality field measurements are presented in Table 1. All three stations were shallow, with depth of 0.2 meters or less. Salinities were euhaline (> 30 psu), with the exception of the surface reading at 08AFA01, which was only 19 psu. This site was also characterized by reduced pH at the surface. Dissolved oxygen levels at all three sites were above the normoxic level of 4 mg/l. Samples for percent silt+clay analysis were not collected, but field observations described the sediments at 08AFA01 as consisting of sand and black silt while the other two stations (08AFA02 and 08AFA03) had a layer of muck on top of sand. The presence of hydrogen sulfide (H_2S) was also noted at 08AFA03. Sediment concentrations of 1, 4-dioxane were below the detectable limits at all three sites (Appendix B).

Table 1 Surface and bottom water quality measurements.

STATION	08AFA01		08AFA02		08AFA03	
	Surface	Bottom	Surface	Bottom	Surface	Bottom
Depth (meters)	0.04	0.11	NA	0.1	0.06	0.21
Temperature (°C)	17.85	17.39	NA	21.18	19.00	19.00
Salinity (psu)	19.02	33.93	NA	33.95	34.00	33.90
pH	7.83	8.01	NA	8.21	8.16	8.03
Dissolved Oxygen (mg/l)	6.84	5.10	NA	8.55	7.21	6.58

Complete taxonomic identification and raw data are shown in Appendix A. Benthic community indices including the number of taxa (*S*), abundance (*N* = #/m^2), Pielou's evenness index (*J'*), the Shannon diversity index (*H'*) and Simpson's diversity index (1-λ) are presented in Table 2. Station 08AFA01 had the fewest number of taxa present and was intermediate for all of the other community indices. Station 08AFA02 had 16 taxa present and had the highest abundance, but lowest diversity and evenness measures. Station 08AFA03 had the lowest abundance but the most taxa and the highest evenness and diversity of the three sites.

Table 2 Benthic community indices.

	08AFA01	08AFA02	08AFA03
Number of Taxa (*S*)	14	16	19
Abundance (*N*) #/m^2	8000	10250	3800
Pielou's Evenness Index (*J'*)	0.56	0.44	0.80
Shannon Diversity Index [$H'_{(loge)}$]	1.47	1.22	2.36
Simpson's Diversity Index (1-*λ'*)	0.65	0.52	0.86

Both stations 08AFA01 and 08AFA02 had similar species compositions (Table 3). These stations were dominated by the capitellid polychaete *Capitella capitata* and the amphipod *Grandidierella bonnieroides*. *Capitella capitata* accounted for over 50% and 67% of the relative abundance respectively. The top five ranked taxa comprised over 93% of the cumulative abundance at these two stations (Table 3). The abundances at station 08AFA03 were more evenly distributed with the top five ranked taxa making up 67% of the cumulative abundance (Table 3). This station was dominated by annelids. The top ranked taxa at station 08AFA03 included the spionid polychaete *Streblospio* spp., and the capitellid polychaete *Mediomastus* spp. (predominately *Mediomastus ambiseta*). The other top ranked taxa at this site included *C. capitata* and the oligochaetes *Tubificoides wasselli* and unidentified juvenile tubificinae (Table 3). *Capitella capitata* was the only species in the top five ranked taxa found at all stations (Table 3).

Table 3 Relative and cumulative abundance of dominant benthic taxa.

08AFA01 **N = 8000/m^2**	**08AFA02** **N = 10250/m^2**	**08AFA03** **N = 3800/m^2**
Capitella capitata spp. complex 52.19% (52.19%)	*Capitella capitata* spp. complex 67.32% (67.32%)	*Streblospio* spp. 30.26% (30.26%)
Grandidierella bonnieroides 25.31% (77.50%)	*Grandidierella bonnieroides* 14.39% (81.71%)	*Mediomastus* spp. 16.45% (46.71%)
Polydora cornuta 6.88% (84.38%)	*Polydora cornuta* 5.61% (87.32%)	TUBIFICINAE 7.24% (53.95%)
Streblospio spp. 4.69% (89.06%)	*Leptochelia* sp. 5.12% (92.44%)	*Capitella capitata* spp. complex 6.58% (60.53%)
Leptochelia sp. 4.38% (93.44%)	*Dipolydora socialis* 1.46% (93.90%)	*Tubificoides wasselli* 6.58% (67.11%)

N = total abundance. Cumulative abundances are shown in parenthesis.

Discussion and Conclusions

Conclusions regarding the benthic habitat quality at the Admiral Farragut Academy bayou are difficult to make due to the lack of control samples in this study and the lack of seasonally relevant historical data. All three sites were characterized by shallow depths and euhaline salinities. Station 08AFA01, which was near the mouth of the drainage canal was influenced by lower salinity inflows from the canal as evidenced by the reduced salinity and pH at the surface. This station also had the fewest taxa recorded, but was between the other two sites for the other benthic community metrics. Stations 08AFA01 and 08AFA02 had similar species compositions and were dominated by relatively few taxa. The dominant taxa (*Capitella capitata* and *Grandidierella bonnieroides*) at these sites are typical for organically enriched sediments and physiologically stressful environments that are not unusual for shallow bayou systems Grassle and Grassle 1974; LeCroy 2002; Grabe *et al*. 2006). Station 08AFA03 was relatively healthier than the other two sites as shown by its higher number of taxa and higher diversity measures. This site also had a more unique benthic assemblage, which may be due to its close proximity to Boca Ciega Bay.

At the current time, there is no evidence that the ground water contaminants from the Raytheon site have reached the sediment community in the bayou. These data however will serve as an important baseline in the event that the ground water contaminates do eventually reach the bayou. These results will also further supplement the annual benthic monitoring data collected in Boca Ciega Bay since 1995 as part of the Tampa Bay Estuary Program's bay-wide monitoring efforts.

References

ARCADIS 2008. Summary of Investigation Work since SARA Submittal. Memo to FDEP dated October 17, 2008. 691pp.

Florida Department of Environmental Protection (FDEP). 2008. Raytheon Site Summary http://www.dep.state.fl.us/southwest/Raytheon/pages/Site_Summary.htm

Grabe, S.A., Karlen, D.J., Holden, C.M., Goetting, B.K,, Markham, S.E., and Dix, T.L. 2006. Gammaridean amphipoda of Tampa Bay, Florida (Gulf of Mexico): taxonomic composition, distribution, and association with abiotic variables. Tampa Bay Estuary Program Tech. Pub. 05-06. 88pp.

Grassle, J.F. and Grassle, J.P. 1974. Opportunistic life histories and genetic systems in marine benthic polychaetes. Journal of Marine Research 32: 253-284.

LeCroy, S.E. 2002. An illustrated identification guide to the nearshore marine and estuarine gammaridean amphipoda of Florida. Volume 2: Families Ampeliscidae, Amphilochidae, Ampithoidae, Aoridae, Argissidae and Haustoriidae. Florida Department of Environmental Protection. Pp 197-410.

PRIMER-E Ltd. 2006. PRIMER v6. Plymouth, U.K. http://www.primer-e.com

Appendix A: Raw count data

Taxon	08AFA01	08AFA02	08AFA03
Annelida			
Polychaeta			
Parahesione luteola	2	0	0
Laeonereis culveri	0	1	8
Diopatra cuprea	0	0	1
Dipolydora socialis	4	6	2
Polydora cornuta	22	23	6
Prionospio heterobranchia	0	0	5
Streblospio spp.	15	2	46
Capitella capitata spp. complex	167	276	10
Capitella jonesi	0	5	1
Mediomastus spp.	0	0	25
Arenicola cristata	0	0	2
Oligochaeta			
Unidentified Tubificinae	4	0	11
Tubificoides brownae	0	3	5
Tubificoides wasselli	0	1	10
Mollusca			
Gastropoda			
Nassarius vibex	2	0	0
Haminoea sp.	0	1	0
Bivalvia			
Unidentified Bivalves	1	0	1
Amygdalum papyrium	0	1	0
Macoma cerina	0	5	8
Angulus nr. *tampaensis*	0	0	3
Parastarte triquetra	3	1	5
Arthropoda			
Crustacea			
Cyclaspis cf. *varians*	0	0	2
Leptochelia sp.	14	21	0
Leptochelia (Hargeria) rapax	2	1	0
Ampelisca abdita	0	4	0
Grandidierella bonnieroides	81	59	0
Melita spp.	1	0	0
Farfantepenaeus duorarum	0	0	1
Insecta			
Collembola	2	0	0

Appendix B: Sediment 1, 4-dioxane results

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 660-26711-1

Job Description: AFA

For:
Pinellas County Utilities
1620 Ridge Road
Bldg. B
Largo, FL 33778

Attention: Mr. David Hanson

Approved for release.
Tina Fritz
Customer Service Manager
12/10/2008 4:48 PM

Tina Fritz
Customer Service Manager
tina.fritz@testamericainc.com
12/10/2008

Methods: FDEP, DOH Certification #: TestAmerica Tampa E84282; TestAmerica Savannah E97052

These test results meet all the requirements of NELAC. All questions regarding this test report should be directed to the TestAmerica Project Manager who signed this test report. The estimated uncertainty associated with these reported results is available upon request.

EXECUTIVE SUMMARY - Detections

Client: Pinellas County Utilities Job Number: 660-26711-1

Lab Sample ID Analyte	Client Sample ID	Result / Qualifier	Reporting Limit	Units	Method

No Detections

METHOD SUMMARY

Client: Pinellas County Utilities | Job Number: 660-26711-1

Description	Lab Location	Method	Preparation Method
Matrix Solid			
Volatile Organic Compounds (GC/MS)	TAL TAM	SW846 8260B	
Closed System Purge and Trap	TAL TAM		SW846 5035

Lab References:

TAL TAM = TestAmerica Tampa

Method References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

METHOD / ANALYST SUMMARY

Client: Pinellas County Utilities

Job Number: 660-26711-1

Method	Analyst	Analyst ID
SW846 8260B	Mathew, Pinky	PM

SAMPLE SUMMARY

Client: Pinellas County Utilities

Job Number: 660-26711-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
660-26711-1	AFA-01	Solid	12/05/2008 1030	12/05/2008 1558
660-26711-2	AFA-03	Solid	12/05/2008 1100	12/05/2008 1558
660-26711-3	AFA-02	Solid	12/05/2008 1241	12/05/2008 1558

Client: Pinellas County Utilities | Job Number: 660-26711-1

Client Sample ID: **AFA-01**

Lab Sample ID: 660-26711-1 | Date Sampled: 12/05/2008 1030
Client Matrix: Solid | % Moisture: 51.3 | Date Received: 12/05/2008 1558

8260B Volatile Organic Compounds (GC/MS)

Method: 8260B | Analysis Batch: 660-72193 | Instrument ID: BVMJ GC/MS
Preparation: 5035 | Prep Batch: 660-72043 | Lab File ID: 1JL0919.D
Dilution: 1.0 | Initial Weight/Volume: 6.11 g
Date Analyzed: 12/09/2008 1052 | Final Weight/Volume: 1.0 g
Date Prepared: 12/08/2008 0842

Analyte	DryWt Corrected: Y	Result (ug/Kg)	Qualifier	MDL	PQL
1,4-Dioxane		2.1	U	2.1	10

Client: Pinellas County Utilities | Job Number: 660-26711-1

Client Sample ID: **AFA-03**

Lab Sample ID: 660-26711-2 | Date Sampled: 12/05/2008 1100
Client Matrix: Solid | % Moisture: 71.1 | Date Received: 12/05/2008 1558

8260B Volatile Organic Compounds (GC/MS)

Method: 8260B | Analysis Batch: 660-72193 | Instrument ID: BVMJ GC/MS
Preparation: 5035 | Prep Batch: 660-72043 | Lab File ID: 1JL0920.D
Dilution: 1.0 | Initial Weight/Volume: 6.87 g
Date Analyzed: 12/09/2008 1114 | Final Weight/Volume: 1.0 g
Date Prepared: 12/08/2008 0844

Analyte	DryWt Corrected: Y	Result (ug/Kg)	Qualifier	MDL	PQL
1,4-Dioxane		3.5	U	3.5	17

Client: Pinellas County Utilities

Job Number: 660-26711-1

Client Sample ID: **AFA-02**

Lab Sample ID: 660-26711-3
Client Matrix: Solid
% Moisture: 59.4
Date Sampled: 12/05/2008 1241
Date Received: 12/05/2008 1558

8260B Volatile Organic Compounds (GC/MS)

Method: 8260B
Preparation: 5035
Dilution: 1.0
Date Analyzed: 12/09/2008 1136
Date Prepared: 12/08/2008 0845
Analysis Batch: 660-72193
Prep Batch: 660-72043
Instrument ID: BVMJ GC/MS
Lab File ID: 1JL0921.D
Initial Weight/Volume: 5.97 g
Final Weight/Volume: 1.0 g

Analyte	DryWt Corrected: Y	Result (ug/Kg)	Qualifier	MDL	PQL
1,4-Dioxane		2.5	U	2.5	12

DATA REPORTING QUALIFIERS

Client: Pinellas County Utilities Job Number: 660-26711-1

Lab Section	Qualifier	Description
GC/MS VOA		
	U	Indicates that the compound was analyzed for but not detected.

Client: Pinellas County Utilities

Job Number: 660-26711-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 660-72043

Method: 8260B
Preparation: 5035

MS Lab Sample ID:	660-26711-1	Analysis Batch:	660-72193	Instrument ID:	BVMJ GC/MS
Client Matrix:	Solid	Prep Batch:	660-72043	Lab File ID:	1JL0922.D
Dilution:	1.0			Initial Weight/Volume:	5.27 g
Date Analyzed:	12/09/2008 1159			Final Weight/Volume:	1.0 g
Date Prepared:	12/08/2008 0845				

MSD Lab Sample ID:	660-26711-1	Analysis Batch:	660-72193	Instrument ID:	BVMJ GC/MS
Client Matrix:	Solid	Prep Batch:	660-72043	Lab File ID:	1JL0923.D
Dilution:	1.0			Initial Weight/Volume:	4.81 g
Date Analyzed:	12/09/2008 1221			Final Weight/Volume:	1.0 g
Date Prepared:	12/08/2008 0841				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
1,4-Dioxane	115	115	50 - 150	0	50		

Calculations are performed before rounding to avoid round-off errors in calculated results.

Client: Pinellas County Utilities

Job Number: 660-26711-1

Method Blank - Batch: 660-72193

Method: 8260B
Preparation: N/A

Lab Sample ID: MB 660-72193/2
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 12/09/2008 1022
Date Prepared: N/A

Analysis Batch: 660-72193
Prep Batch: N/A
Units: ug/Kg

Instrument ID: BVMJ GC/MS
Lab File ID: 1JL0918.D
Initial Weight/Volume: 5 mL
Final Weight/Volume: 5 mL

Analyte	Result	Qual	MDL	PQL
1,4-Dioxane	1.0	U	1.0	5.0

Lab Control Spike - Batch: 660-72193

Method: 8260B
Preparation: N/A

Lab Sample ID: LCS 660-72193/1
Client Matrix: Solid
Dilution: 1.0
Date Analyzed: 12/09/2008 1000
Date Prepared: N/A

Analysis Batch: 660-72193
Prep Batch: N/A
Units: ug/Kg

Instrument ID: BVMJ GC/MS
Lab File ID: 1JL0917.D
Initial Weight/Volume: 5 mL
Final Weight/Volume: 5 mL

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
1,4-Dioxane	24.9	27.0	108	50 - 150	

Calculations are performed before rounding to avoid round-off errors in calculated results.

Serial Number 02959

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Tampa
6712 Benjamin Road, Suite 100
Tampa, FL 33634
Website: www.testamericainc.com
Phone: (813) 885-7427
Fax: (813) 885-7049

Alternate Laboratory Name/Location
Phone:
Fax:

12/10/2008

PROJECT REFERENCE	PROJECT NO.	PROJECT LOCATION (STATE)
AFA	66000256	FL
SAMPLER'S SIGNATURE	P.O. NUMBER	CONTRACT NO.
CLIENT (SITE) PM: Dave Hanson	CLIENT PHONE: 727-582-2302	CLIENT FAX
CLIENT NAME: Pinellas City Util. Lab	CLIENT E-MAIL	
CLIENT ADDRESS		
COMPANY CONTRACTING THIS WORK (if applicable)		

PAGE 1 OF 1

STANDARD REPORT DELIVERY

DATE DUE

EXPEDITED REPORT DELIVERY (SURCHARGE)

DATE DUE

NUMBER OF COOLERS SUBMITTED PER SHIPMENT:

SAMPLE DATE	SAMPLE TIME	SAMPLE IDENTIFICATION	MATRIX: COMPOSITE (C) OR GRAB (G) INDICATE	AQUEOUS (WATER)	SOLID OR SEMISOLID	AIR	NONAQUEOUS LIQUID (OIL, SOLVENT...)	REQUIRED ANALYSIS: 8260B-Sim 1,4-Dioxane	PRESERVATIVE	NUMBER OF CONTAINERS SUBMITTED	REMARKS
12/05/08	1030	AFA-01	G	Y	N	N	Y				
12/05/08	1100	AFA-03	G	Y	N	N	Y				
12/05/08	1241	AFA-02	G	Y	N	N	Y				

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	11/26/8	1700	Mark Flock	12-05-08	1440	Thomson	12/5/08	1558
RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME
Mark Flock	11/26/08	1405	Thomson	12/5/08	1440	Carol McNulty	12/5/08	1558

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	TAMPA LOG NO.	COOLER TEMP. UPON RECEIPT	LABORATORY REMARKS
[signature]	12-5-08	1558	YES ○ NO ○		660-26711	2.8°C cw-OT	

TAL8240-660 (1207)

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Login Sample Receipt Check List

Client: Pinellas County Utilities

Job Number: 660-26711-1

Login Number: 26711
List Source: TestAmerica Tampa
Creator: McNulty, Carol
List Number: 1

Question	T / F/ NA	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	2.8 degrees C CU-07
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	