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FINAL REMEDIAL INVESTIGATION REPORT ADDENDUM 2 FOR SEDIMENT AND FISH SAMPLING AT SITE 40 NAS PENSACOLA FL

8/9/2002

ENSAFE/ALLEN AND HOSHALL

FINAL REMEDIAL INVESTIGATION REPORT ADDENDUM 2
SITE 40 – BAYOU GRANDE
NAVAL AIR STATION
PENSACOLA, FLORIDA

SOUTHNAVFACENGCOM
CONTRACT NUMBER: N62467-89-D-0318

CTO — 036

Prepared for:

Comprehensive Long-Term
Environmental Action Navy
Naval Air Station
Pensacola, Florida

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

August 9, 2002

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The contractor, EnSafe Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 are complete, accurate, and comply with all requirements of the contract.

Date: August 9, 2002
Signature: _____
Name: Allison Harris
Title: Task Order Manager

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19. Abstract

This report presents results from a 2001 investigation of mercury contamination in forage fish in Bayou Grande (Site 40), Operable Unit 15, at the Naval Air Station (NAS) Pensacola, Florida. The additional sediment and fish sampling at Site 40 was conducted to reduce the uncertainty within the upper trophic level fish model presented in the Site 40 *Final RI Report Addendum* (EnSafe, April 24, 2000). This fish model is the Red Drum *(Sciaenops ocellatus)* Mercury Bioaccumulation Model developed by Evans and Engel (May, 1994), which estimates the transfer of mercury from sediment to forage fish to the red drum (predatory fish). Seven Phase II sample locations (1996 samples) from the Site 40 RI were selected for re-sampling. Sediment samples were collected from these locations for mercury and TOC analyses. Forage fish were also collected from these locations for whole tissue analyses for mercury and percent lipids.

Sediment mercury results were compared to the USEPA/FDEP sediment benchmark level of 0.13 ppm. HQs were calculated for each location. Sediment mercury results showed decreases at four 1996 sample locations to HQs below 1 in 2001. Two 2001 sample locations had sediment mercury HQs greater than 1; one of these showed an increase from 1996.

Forage fish were collected from six of the seven sample locations (one location did not have an appropriate habitat for forage fish). Both sediment and whole fish-tissue mercury results were used to estimate predatory fish mercury concentrations using the Evans and Engel Model. Both 1996 and 2001 sediment results are presented in this document. The sediment mercury results were modeled to estimate the methyl mercury tissue concentration in predatory fish, while the prey fish tissue mercury results provided an exact measurement for use in the Model. The modeled results were compared to the USEPA NOAEL of 0.15 ppm and the LOAEL of 0.30 ppm (Appendix A).

In comparing the HQs based on sediment mercury detections in 1996 and 2001, risk predicted for red drum has decreased at six of the seven sample locations, with an increase at one location. The maximum NOAEL HQ based on model results from sediment concentrations decreased from 37.69 in 1996 to 4.45 in 2001. HQs based on the results from the actual forage fish data indicate a maximum NOAEL HQ of 1.68 and a maximum LOAEL HQ of 0.86. This indicates that the model conservatively estimated risk to predatory fish from sediment concentrations.

The NOAEL HQs based on sediment concentrations have decreased substantially from 1996 to 2001. Only two locations (040MZ216 and 040MZ247) have HQs greater than 1 from the measured prey fish concentrations. All of the LOAEL HQs are below 1 from the 2001 sampling event. None of the IRP sites investigated at NAS Pensacola have been associated with mercury contamination. This study conservatively estimates the risk to the red drum by assuming the fish will spend all of their life in Bayou Grande and at Site 40. Therefore, excess risk is not predicted for predatory fish based on the detected concentrations at Site 40.

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EXECUTIVE SUMMARY

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The NOAEL HQs based on sediment concentrations have decreased substantially from 1996 to 2001. Only two locations (040MZ216 and 040MZ247) have HQs greater than 1 from the measured prey fish concentrations. All of the LOAEL HQs are below 1 from the 2001 sampling event. None of the IRP sites investigated at NAS Pensacola have been associated with mercury contamination. This study conservatively estimates the risk to the red drum by assuming the fish will spend all of their life in Bayou Grande and at Site 40. Therefore, excess risk is not predicted for predatory fish based on the detected concentrations at Site 40.

1.0 INTRODUCTION

This report presents results from an investigation for mercury contamination in forage fish in Bayou Grande (Site 40), Operable Unit 15, at the Naval Air Station (NAS) Pensacola, Florida.

2.0 BACKGROUND

Site 40, also known as Bayou Grande, is an estuarine water body adjacent to the northern border of NAS Pensacola in Escambia County. Bayou Grande extends roughly east to west approximately 5 miles inland into the south-southwestern portion of Escambia County. The northern and central portions of NAS Pensacola, and the areas of west Warrington adjacent to the bayou, drain into the bayou. Bayou Grande flows eastward into Pensacola Bay near NAS Pensacola's Magazine Point. The total surface area covered by Site 40 is currently used for swimming, fishing, and other boating activities. Seasonal water temperatures limit swimming to the warmer months, while fishing is generally a year-round activity.

Previous investigations at Site 40 included a Phase II assessment of nearshore sediments in 1996. In 1998, prey fish were collected and analyzed for pesticides and polychlorinated biphenyls (PCBs). Based on the results of the Site 40 baseline risk assessment as presented in the *Final Remedial Investigation (RI) Report* (EnSafe, 1999), these compounds were found to pose a potential risk to human health as a result of ingestion of contaminated fish species that inhabit Bayou Grande. A more detailed risk assessment was conducted for the fish ingestion pathway using site-specific values. The results of the site-specific risk assessment for the fish ingestion exposure pathway at Site 40 was presented in the *Final RI Report Addendum* (EnSafe, April 24, 2000). The *Final RI Report Addendum* determined that risks associated with the ingestion of contaminated fish are within acceptable limits. However, mercury concentrations in predatory fish were not based on measured results, but were estimated based on detections in sediment. The modeled results indicated a potential excess risk to predatory fish. Therefore, an agreement was reached to sample forage fish and sediment for mercury to validate the model results.

The *Technical Memorandum* of June 27, 2001 presented the rationale and procedures to address the previously identified data gaps. The memorandum presented a plan to conduct further sediment and fish sampling at Site 40 to reduce the uncertainty within the upper trophic level fish model presented in the Site 40 *Final RI Report Addendum* and the uncertainty within the ecological risk assessment for predatory fish. This fish model is the Red Drum *(Sciaenops ocellatus)* Mercury Bioaccumulation Model developed by Evans and Engel (May, 1994), which estimates the transfer of mercury from sediment to forage fish to predatory fish.

3.0 FIELD SAMPLING

Field sampling was conducted during August of 2001. The *Technical Memorandum* outlines how seven Phase II sample locations from the Site 40 RI were selected for re-sampling based on an evaluation of Phase II mercury and total organic carbon (TOC) results. Locations were selected to represent a range of low-to-high mercury and TOC detections. Sediment samples from each location were collected and analyzed for total mercury, and TOC analyses. Forage fish samples were also collected for whole tissue analysis of mercury and percent lipids. Figure 1 shows the sample locations. Table 1 summarizes the samples collected and the analyses performed.

Table 1
Site 40 Sample Locations and Analyses

Sample Location	Sediment Analyses	Fish Tissue Analyses	Remarks
040MZ130	Hg; TOC	Hg; % Lipids	
040MZ216	Hg; TOC	Hg; % Lipids	Duplicate also collected.
040MZ237	Hg; TOC	Hg; % Lipids	
040MZ244	Hg; TOC	Hg; % Lipids	
040MZ247	Hg; TOC	Hg; % Lipids	
040MZ316	Hg; TOC	Hg; % Lipids	
040MZ401	Hg; TOC	No fish available	

Notes:
TOC = Total organic carbon.
% Lipids = Percent lipids in fish tissue.

Figure 1 Sample Locations, Site 40

Table 2 presents the sediment mercury results for the 2001 sampling, and compares these to the Site 40 Phase II sediment results (1996 results) for the same sample locations. Using a sediment benchmark level of 0.13 parts per million (ppm) (McDonald, D.D., 1994; United States Environmental Protection Agency [USEPA], 1995), hazard quotients (HQs) were calculated for each location. An HQ exceeding 1 indicates a potential for excess risk from mercury in sediment. As shown in Table 2, mercury concentrations in sediment decreased from 1996 to 2001 (the table reflects ½ the detection limit for those samples where mercury was non-detect). Four sample locations with mercury HQs greater than 1 in 1996 (040MZ130, 040MZ244, 040MZ316, and 040MZ401) had HQs below 1 in 2001. Only two 2001 sample locations (040MZ216 and 040MZ247) had HQs greater than 1 (1.85 and 2) and only one sample 040MZ216 showed an increase from 1996 (1996 mercury HQ — 0.23; 2001 mercury HQ — 1.85).

Table 2
Comparison of Mercury Results in Sediment
Site 40

Sample Location	1996 Results (ppm)	HQ[a]	2001 Results (ppm)	HQ[a]
040MZ130	2.2	16.92	0.0025[b]	0.019
040MZ216	0.03[b]	0.23	0.24	1.85
040MZ237	0.08	0.62	0.01	0.077
040MZ244	0.64	4.92	0.0031[b]	0.02
040MZ247	0.28	2.15	0.26	2.0
040MZ316	0.14	1.08	0.0027[b]	0.02
040MZ401	0.155[b]	1.19	0.0028[b]	0.02

Notes:
a = HQs based on a sediment benchmark level of 0.13 ppm.
b = Results were non-detect; number reflects ½ the non-detect value.
ppm = Parts per million.

Fish Tissue

Fish sampling was conducted as outlined in the *Technical Memorandum.* Pinfish *(Lagodon rhomboides)* were collected from four sample locations, while striped mullet *(Mugil cephalus)* were collected from two locations. At all locations, the smallest size pinfish or mullet were selected to represent forage fish. No fish were collected at sample location 040MZ401; attributed to a lack of appropriate habitat for forage fish at this location. Table 3 presents the fish tissue mercury results for the Site 40 samples. The table also presents the percent lipid analyses and supplementary information related to the fish sampling.

Table 3
Fish Tissue Mercury Results
Site 40

Sample Location	Fish Species Collected	Number/Size of Fish Collected	Mercury in Fish Tissue (ppm)	Percent Lipids
040MZ130	Pinfish	Approx. 30/1.5"	0.042	0.59
040MZ216	Striped Mullet	2 ea./2"	0.033	0.34
040MZ237	Pinfish	Approx. 30/1.5"	0.06	0.38
040MZ244	Striped Mullet	2 ea./2"	0.01[a]	0.47
040MZ247	Pinfish	Approx. 30/1.5"	0.026	1.3
040MZ316	Pinfish	Approx. 30/1.5"	0.052	1.1
040MZ401	No fish collected	—	—	—

Notes:
a = Results were non-detect; number reflects ½ the non-detect value.
ppm = Parts per million.

4.0 RED DRUM MERCURY EXPOSURE MODEL

4.1 Background

A model was performed which predicts mercury tissue concentrations in the red drum based on concentrations of mercury in the sediment of Site 40. This model is based on the red drum mercury bioaccumulation model developed by Evans and Engel. The model assumes that mercury uptake into the red drum occurs via prey ingestion exclusively. The three prey sources are forage fish, crustaceans, and infaunal invertebrates. The Site 40 *Final RI Report Addendum* and Evans and Engel explain this model in detail.

The equation used in the model is briefly explained below:

$$= \left(\frac{a * R}{g + K} \right) * \left[(Cf)(\%Cf) + (Ccr)(\%Ccr) + (Cinv)(\%Cinv) \right]$$

where:

a	=	Assimilation efficiency of mercury from food, or 0.8.
R	=	Feeding rate of the red drum, or 0.02/day.
g	=	growth rate coefficient, or 0.003/day.
K	=	Methyl mercury excretion rate from the red drum, or 0.00035/day.
Cf	=	Methyl mercury tissue concentration in forage fish.
%Cf	=	Percent of red drum diet composed of forage fish, or 0.3.
Ccr	=	Methyl mercury tissue concentration in crustaceans.
%Ccr	=	Percent of red drum diet composed of crustaceans, or 0.6.
Cinv	=	Methyl mercury tissue concentrations in infaunal benthic invertebrates.
%Cinv	=	Percent of red drum diet composed of benthic invertebrates, or 0.1.

The first part of the mercury model equation calculates the bioaccumulation factor for methyl mercury, adjusting for input and excretion of this metal (which are assumed to be in balance at steady state). The second portion of the equation estimates the accumulation of methyl mercury from the prey pathway, based on the assumption of a diet comprised of 30% forage fish, 60% crustaceans, and 10% infaunal invertebrates. The Site 40 *Final RI Report Addendum* and Evans and Engel also explain how *Cf*, *Ccr*, and *Cinv* are calculated. These are briefly reviewed below:

$$Cf = (1.2)(Cs)$$

$$Cinv = \left[\frac{(Cs * 2)}{5}\right] * (0.25)$$

$$Ccr = \left[\frac{(Cs * 2)}{5}\right] * (0.70)$$

Where: Cs = the total mercury (in ppm) in sediment. The Site 40 *Final RI Report* and Evans and Engel explain the other coefficients used in the above formulae.

4.2.1 Site 40 Modeling Results

Table 4 presents the mercury sediment results for each of the Site 40 sampling locations to calculate the mercury in the red drum using the Evans and Engel model. The calculated concentration is then compared to the no observable adverse effects level (NOAEL) and the lowest observable adverse effects level (LOAEL). Table 4 lists the red drum mercury calculations for the 1996 sediment mercury results, and compares these to the 2001 results for the same sample locations. As shown in the table, risk predicted for the red drum in Bayou Grande from the 1996 sediment data ranged between HQs of 0.514 (040MZ216) and 37.687 (040MZ130). Risk predicted for the red drum in the bayou from the 2001 sediment data ranged between HQs of 0.043 (040MZ130) to 4.454 (040MZ247). The data show a decrease in red drum mercury HQs at six of seven sample locations from 1996 to 2001, with an increase at location 040MZ216. The maximum HQ decreases from 37.687 (040MZ130) to 4.454 (040MZ247) between these years. This decrease is attributable to the lower detections of mercury found in the 2001 sediment samples, and demonstrates a substantial decrease in predicted risk for the red drum since the 1996 sampling effort.

For the 2001 sampling, the Evans and Engel model was also run using actual forage fish tissue mercury data obtained from the fish collected at each sample location. Table 5 presents these data. As shown in the table, risk predicted for the red drum in the bayou from the actual 2001

forage fish tissue data ranged between HQs of 0.113 (040MZ244) and 1.722 (040MZ247) with the NOAEL. All HQs are below 1 when compared to the LOAEL. No fish were collected at sample location 040MZ401; however, the estimated values for this sample from Table 4 are also presented in Table 5 for comparison. As can be seen from the

Table 4
Mercury in Upper Trophic Level Fish
Red Drum Mercury Model—Mercury in Forage Fish Estimated

Sample Location	Hg in Sediment (Cs) (ppm)	Hg in Forage Fish[b] (Cf) (ppm)	Hg in Crustaceans (Ccr) (ppm)	Hg in Invertebrates (Cinv) (ppm)	Hg in Red Drum Tissue (ppm)	NOAEL HQ	LOAEL HQ
1996 Results							
040MZ130	2.2	2.64	0.616	0.22	5.653	37.69	18.8
040MZ216	0.03[a]	0.036	0.008	0.003	0.077	0.51	0.26
040MZ237	0.08	0.096	0.022	0.008	0.206	1.37	0.69
040MZ244	0.64	0.768	0.179	0.064	1.645	10.96	5.48
040MZ247	0.28	0.336	0.078	0.026	0.720	4.8	2.4
040MZ316	0.14	0.168	0.039	0.014	0.360	2.4	1.2
040MZ401	0.155[a]	0.186	0.043	0.016	0.398	2.66	8.85
2001 Results							
040MZ130	0.0025[a]	0.003	0.001	0.0003	0.006	0.04	0.02
040MZ216	0.24	0.288	0.067	0.024	0.617	4.11	2.06
040MZ237	0.01	0.012	0.001	0.001	0.026	0.17	0.09
040MZ244	0.0031[a]	0.004	0.0009	0.0003	0.008	0.05	0.03
040MZ247	0.26	0.312	0.073	0.026	0.668	4.45	2.23
040MZ316	0.0027[a]	0.0032	0.00076	0.00027	0.0069	0.05	0.02
040MZ401	0.0028[a]	0.0034	0.00078	0.00028	0.0072	0.05	0.024

Notes:
a = Results were non-detect; number reflects ½ the non-detect value.
b = Results derived by estimating the mercury concentration in forage fish using the appropriate calculation from the Red Drum Mercury Model.
HQ = Hazard Quotient.
NOAEL = No Observable Adverse Effects Level of 0.15 ppm (NOAA 2001)
LOAEL = Lowest Observable Adverse Effects Level of 0.30 ppm (NOAA 2001)
ppm = Parts per million.

Table 5
Mercury in Upper Trophic Level Fish
Red Drum Mercury Model—Mercury in Forage Fish Measured

Sample Location	Hg in Sediment (Cs) (ppm)	Hg in Forage Fish[c] (ppm)	Hg in Crustaceans (Ccr) (ppm)	Hg in Invertebrates (Cinv) (ppm)	Hg in Red Drum Tissue (ppm)	NOAEL HQ	LOAEL HQ
040MZ130	0.0025[b]	0.042	0.001	0.0003	0.062	0.42	0.21
040MZ216	0.24	0.033	0.0672	0.024	0.251	1.66	0.84
040MZ237	0.01	0.06	0.003	0.001	0.095	0.63	0.32
040MZ244	0.0031[b]	0.01[a]	0.001	0.0003	0.017	0.11	0.06
040MZ247	0.26	0.026	0.073	0.026	0.258	1.72	0.86
040MZ316	0.0027[b]	0.052	0.0008	0.0003	0.077	0.51	0.26
040MZ401[a]	0. 0028[b]	0.003	0.0008	0.0003	0.007	0.05	0.02

Notes:

a = No forage fish were collected at location 040MZ401. The estimated value of mercury in forage fish from Table 5 for this location is substituted for comparison.
b = Results were non-detect; number reflects ½ the non-detect value.
c = Results derived from whole fish tissue analysis.
HQ = Hazard Quotient.
NOAEL = No observable Adverse Effects Level of 0.15 ppm (NOAA 2001).
LOAEL = Lowest observable Adverse Effects Level of 0.30 ppm (NOAA 2001).
ppm = parts per million.

data, the red drum model predicts a much lower risk for Site 40 using actual forage-fish tissue mercury data in place of estimated fish tissue mercury data.

The modeling of the 2001 sediment and fish tissue mercury data should substantiate the overall reduction in mercury concentrations in Bayou Grande since 1996, and the decreased risk predicted for predatory level fish at Site 40. Figure 2 shows the sediment HQs and red drum NOAEL and LOAEL HQs for each sample location at Site 40.

5.0 UNCERTAINTIES

5.1 The Lack of Mercury Sources at NAS Pensacola

Though there were some mercury detections in sediment and surface water samples from the Site 41 wetlands bordering Site 40, this mercury is not attributable to any Installation Restoration Program (IRP) site at NAS Pensacola. A review of historical environmental documents for the base revealed that there have been no process streams involving mercury at any IRP site. Field sampling at the sites investigated thus far has revealed isolated detections of mercury above USEPA and FDEP standards, but none of these investigations have required development of remedial alternatives to address mercury contamination. None of the IRP sites still under review are awaiting disposition because of mercury contamination.

5.2 Red Drum Feeding Range Within Site 40

The Site 40 *Final RI Report Addendum* (EnSafe, April 24, 2000) details how red drum are dependent on estuaries for at least the first few years of life. Larvae and juveniles are generally found in shallow waters, in areas not greatly affected by tides, with grassy or muddy bottoms and moderate salinities. Adult red drum migrate to nearshore ocean waters and only come back to the estuaries to spawn. They would therefore likely spend the majority of time in nearshore ocean waters, only coming back to Bayou Grande to spawn; primarily feeding on prey from Pensacola Bay and the Gulf of Mexico (EnSafe, April 24, 2000).

Figure 2 Sediment and Fish Tissue NOAEL and LOAEL HQs, Site 40

Further, it is assumed that red drum find all of the Bayou Grande equally attractive for foraging. Using 300 feet from the NAS Pensacola shoreline on Bayou Grande as the outer boundary for all of Site 40 corresponds to a total surface area of approximately 310 acres for Site 40 (EnSafe, April 24, 2000). Site 40 therefore comprises about one-third of Bayou Grande's surface area of approximately 960 acres. This study assumes that red drum will spend all of their life in Bayou Grande and at Site 40, thereby very conservatively overestimating the risk.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The NOAEL HQs based on sediment concentrations have decreased substantially from 1996 to 2001. Only two locations (040MZ216 and 040MZ247) have HQs greater than 1 from the measured prey fish concentrations. All of the LOAEL HQs are below 1 from the 2001 sampling event. None of the IRP sites investigated at NAS Pensacola have been associated with mercury contamination. This study conservatively estimates the risk to the red drum by assuming the fish will spend all of their life in Bayou Grande and at Site 40. Therefore, excess risk is not predicted for predatory fish based on the detected concentrations at Site 40.

7.0 REFERENCES

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Appendix A
Residue Effects of Mercury in Fish
NOAA, March 26, 2001