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DATA QUALITY OBJECTIVES SUMMARY, WORK PLAN, AND SAMPLING AND ANALYSIS PLAN

NAS PENSACOLA
SITE 2 (OPERABLE UNIT 3)
WATERFRONT SEDIMENTS

Prepared by:

NAS PENSCOLA
TIER 1 PARTNERING TEAM

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Pensacola Site 2 Data Quality Objectives Summary
(2-14-00)

DQO Step 0. Establish an Effective Planning Team

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DQO Step 1. State the Problem

Assumptions:

- Cost is a significant factor in this investigation.

Background and Initial Conceptual Site Model:

Untreated plating shop (Bldg. 71) liquid discharges have entered the Pensacola Bay Site 2 area through outfalls. The bay sediments along the shoreline that may have been affected by these discharges have been sampled previously on a rectangular grid oriented along the shoreline. Some of the sediments within a few hundred feet of the shore have generated a hazard index (HI) greater than 10 for the benthic communities, presumably a consequence of accumulated chemicals from the discharges. Despite the observed HI values for the benthic communities, the **U.S.** EPA Region IV, FDEP and the Navy agree a human health risk does not exist in the Site 2 area. The HI values were computed across all chemicals of concern because such an approach simplifies the hazard assessment involving multiple samples and/or locations. The hazard quotients (HQs) are summed across all chemicals to yield an HI for comparative purposes, which could be viewed as a programmatic HI. This approach, which normalizes chemical concentrations to common consensus toxicity benchmarks, is not specifically prohibited by EPA guidance. The HI> 10 cut point was used because the chemical concentrations generally fell into two classes — one with HI< 1 and one with HI > 10, although some exceptions to this condition do exist. A reduction in the HI values > 10 is viewed as an earnest attempt at risk reduction that is protective of the environment.

The five areas with HI> 10 appear to be relatively localized as a result of rotational flow in the bay. This is evident from siltation patterns, flow patterns and chemistry data themselves that are documented in the latest RI report. This oval region is approximately bounded by grid nodes FO, F4, L4 and LO. There also appears to be a general westward flow. However, Site A2 to the east of Site 2 does not appear to be a source term for Site 2 because of flow patterns and the fact that the contaminant distributions at the two sites are significantly different. At Site **2,** metals and the SVOC bis(2-ethylhexyl)pthalate drive the elevated HI values; at site A2 PAHs drive the elevated HI values. Copper detected at elevated levels at Site A2 may be associated with boat traffic and is not expected to be associated with Site 2 operations.

Two hurricanes (Erin and Opal) were experienced in the bay in 1995 (the same time frame as past data collection activities), and the hurricanes were observed to have relocated some of the sediment. The relocation amounted to about a 200-foot movement to the west (note: R. Joyner can provide documentation to support this 200-foot estimate). In September 1998, a third hurricane (Georges) was experienced and there is some uncertainty concerning its effect on sediments. In addition, past data collection efforts focused on the top six inches of sediment where the benthic community lives, and there is now concern about the chemical concentrations at greater depths. This concern derives in part from recognition that dredging has the potential to uncover contaminated sediments. The top six inches of sediment is effectively viewed as a cap on deeper sediments, even though knowledge about chemical concentrations at greater depths is of interest for establishing the extent of contamination. Although some sediment transport is possible or even likely, any major transport phenomena (i.e., to depths greater than 6") are expected to be rare and do not warrant protection against at this time. If such an event should occur, the bay area will likely have other, more acute problems with which to deal.

Note:

The short video (filmed within the past year but after Hurricane Georges) which was shown 16 Dec 99 during the Partnering meeting was apparently taped at Site 2, in the immediate area within which this group is concerned. The video showed a silty bottom devoid of any flora or habitat. Pock marks and fecal matter dotted the area, indicating burrowing organisms. The area is affected by tidal influence as was evident when the diver disturbed the bottom and the current carried away the disturbed water column rather quickly. The diver handled the bottom in several areas in which clay and silt were evident components but sand dominated, as was clear when it was observed falling through the water column (despite the current) to the seafloor.

At one location, the diver handled a darker sediment which may have contained less sand, and more organic matter (difficult to ascertain from video). Although the viewer has no way of orienting the divers' position to the specific sites in question, by looking at the data, a

small eddie (current) appears to have developed in the area of **F3** and **H3** which has concentrated organic matter. Site F3 and H3 resulted in **49%** mortality in the exposed *Mysid* sediment toxicity test and had some of the highest TOC levels in this area.

The lack of flora (seagrasses) and habitat (whole or fragmented shells) are indications that this area may not support a "grand" diversity composed of crustaceans (i.e., shrimp, crabs, amphipods, etc.), or bivalves (oysters) and snails. This being the case, a reference station similar in composition may be a bit more difficult to locate.

Problem Statement:

It has been five years since the last data collection and a hurricane has been experienced at Pensacola during that time period. Past data indicate localized areas of adverse or potential adverse effects on benthic communities (HI > 10). If conditions adverse to benthic communities in the Pensacola Bay Site **2** area exist today, the conditions will need to be rendered acceptable. In addition, information about chemical nature and extent is desired to support any feasibility study (FS) that might follow this investigation. The criteria for establishing extent of contamination are to be determined.

DQO Step 2. State the Decision

Primary Study Question:

Are chemicals in Pensacola Bay Site **2** sediments creating a condition adverse to benthic communities and, if so, do they warrant remedial action?

Primary Potential Remedial Actions:

- Monitored natural attenuation **(MNA)**
- Dredging only

- Dredging with possible recapping of the sediments with clean sediment (this would include extending the sea wall and back-filling the landward area)

- In-situ remediation

- Cap as is (recommendation from Barbara Albrecht)

Note: Dredging to only 6" depth is not practical. However, dredging to greater than 6" with recapping with clean sediment, or simply dredging deep enough to encounter acceptable chemical concentrations would be feasible. The fluidity of the sediments will have to be considered when evaluating remedial options. The depth resolution of dredging is likely to only be approximately one foot.

Alternate Potential Remedial Actions:

- No further action (no remediation)

Secondary Study Questions:

1. To support any follow-on **FS,** what is the nature and extent of chemical concentrations in the vertical and horizontal directions over the yet to be determined decision unit areas?

2. To identify concentration gradients to support the development of site-specific chemical concentrations protective of the environment, what is the relationship between chemical concentration and toxicity for each COPEC?

Decision Statement:

Based on measured chemical concentrations, toxicity testing and benthic assessments in the Site **2** sediments as compared to established acceptance levels, determine whether remediation is required. If site conditions are acceptable, no remediation is required; if they are unacceptable, proceed to an **FS** (i.e., evaluate remedial options and implement the option that is the most cost-effective and protective of human health and the environment).

DQO Step 3. Identify Inputs to the Decision

Assumptions:

- The assessment end point is maintaining a viable benthic community typical of the lower Pensacola Bay. *("An Inventory of the Estuarine Fauna in the Vicinity of Pensacola, Florida" by Nelson Cooley, 1978; data from 1960-1968. This was the most comprehensive study conducted in this area).*

- Chemical/physical testing methodologies should be consistent with past testing to maintain comparability. The methodologies will be selected to support the objectives of this investigation. The selected chemical/physical test methods will exhibit detection limits and other analytical figures of merit consistent with project needs. For example, the detection limits of chemical analysis methods will be low enough to measure chemical at concentrations at least as low as action levels.

- **A** minimum of three samples from each sampling area in an **AOC** are needed for benthic community assessment. The actual numbers of samples/organisms for benthic community assessment will be addressed by the test methodology.

- In-situ toxicity testing is not practical.

Acceptance Criteria:

Refer to Attachments **4** and 5.

Biological Test Species:

Leptocheirus plumulosus will be used for toxicity evaluations; *Mysid* shrimp will be used for toxicity, fecundity and growth evaluations/endpoints. Methodology consistent with past toxicity testing methodology will be used to maintain comparisons of results with past evaluations. The 10-day toxicity test will be used on *Leptocheirus plumulosus* and the 7-day toxicity test will be used on the shrimp, *Mysidopsis bahia.*

Toxicity Testing Inputs:

Refer to Attachments **4** and ***5;*** see toxicity acceptance criteria. The two bioassays will be evaluated independently and results treated with equal weight.

Chemistry Inputs:

- Acid volatile sulfides **(AVS)**
- Simultaneously extracted metals
- Total metals (hot HNO_3/HCl leach)
- Herbicides
- Organochlorine Pesticides
- **SVOCS**

- Sediment chemistry Quality criteria: defined in the SQAGs and EPA's action levels (SSVs)

- TOC

- Inorganic and organic tin

- Grain size

Biology Inputs:

- Toxicty (pH, NH3, salinity, etc., to be controlled as per the test methodology)
- Fecundity
- Growth
- Biodiversity

Attachments 1 through 3 list the target analytes.

Physical Inputs:

While sediment core lithology will not be used for determining risk, it will provide additional valuable information for understanding deposition at the site.

Note: *Important information concerning the purpose of toxicity testing and toxicity testing parameter specifications is provided in Attachment 4.*

DQO Step 4. Establish Decision Unit Boundaries

Assumptions:

- Upper trophic levels are not exposed in a significant way to the benthic community sediments. Bioaccumulators were not measured at unacceptable concentrations in the top **6**" of sediment, thus posing no threat to upper trophic levels. Therefore, higher trophic levels are not of interest.

- Habitats span only the top **6**" in sediment (that's where the benthic communities are). Thus, contaminants in this region exhibit a pathway to benthic communities.

- Acceptable sediment chemistry in the top **6**" would effectively constitute a cap on the deeper sediments.

- Based on calculations of sedimentation rates (maximum estimate = 12 mm/yr), up to **24**" of sediment have accumulated in the past 50 years. A **36**" depth should provide at least a 50% margin of error in sediment depth estimates and appears to be a reasonable maximum depth to which chemical concentrations should be measured. This depth also coincides with the length of a core sampling tube. Any chemicals deeper than **36**" in sediment are not likely to generate unacceptable environmental risks because they are much deeper than the typical benthic communities. Even dredging to remove any chemicals is not likely to expose sediments at depths of **236**" to the benthic communities.

- Site A2 (east of Site 2) is not part of this problem for the following reasons. The bottom of Site **A2** is rocky with limited sediment accumulation and significant sediment migration from site A2 to Site 2 is not likely, based on water flow patterns. Furthermore, mortality rates at Site A2 *(to Mysids)* were approximately 20% and any sediment causing this level of mortality would be

reduced significantly in lethality via dilution associated with migration. Finally, chemistry at Site A2 is significantly different from that at Site 2.

- Depths greater than ***6"*** will be used to evaluate sedimentation rates and potential remedial actions, and will be useful for the FS, but they are not directly related to establishing a problem condition at Site **2.**

The five locations exhibiting HI> 10 five years ago may not exist today because sediment has likely been redistributed within this general region. Therefore, the five hot spots simply represent a general area of contamination bounded by grid nodes FO, **F4,** LA and LO. For various reasons, it is useful to subdivide this area into smaller subunits called decision units. One reason is *to* facilitate the generation of concentration gradients to establish effects levels. Another reason is that it could facilitate the initial evaluation of remedial alternatives.

Combining depth boundaries with chemistry inputs from Step **3** yields the following associations:

— Top ***6"*** of sediment:

- TAL metals
- Cyanide
- Inorganic tin
- Organic tin
- Grain size
- TOC
- **AVS**
- SEM
- Herbicides
- Organochlorine Pesticides
- **SVOCS**
- Toxicity

- Biodiversity
- Fecundity
- Growth

- Sediment depths >6"
  - **TAL** metals
  - Cyanide
  - .Inorganic tin
  - Organic tin
  - Grain size
  - Herbicides
  - Organochlorine Pesticides
  - SVOCS

Sediment concentrations of interest below 6" will be the remainder of the core length (i.e., **30**") divided equally to yield two 15-inch core intervals below 6" depth. However, some sediment may be lost from the bottom of the coring tube during sampling so the bottom interval will be from 21" to the bottom of the sediment in the coring tube.

Reference stations should emulate the decision units of the site with regard to grain size, chemistry and toxicity. Therefore, it is desirable to select two reference stations, one with approximately **20%** sand content and one with approximately **80%** sand content, as sand content is a common denominator. Lower Pensacola Bay areas might be suitable back-up reference stations if no others can be identified.

U.S. EPA Pensacola Bay Stations 18 and 22 were selected as the reference stations for Site 2 based on similar sand (%) components, high amphipod survival rates when exposed to sediments for 10 days, and healthy benthic indices in past studies (1992 & 1996). The average depth of Station 18 is twice that expected at Site 2, but phone conversations with several benthic ecologists (Gary Gaston (University of Mississippi), Richard Heard (Gulf Coast Research Laboratory), Tony Martin (Barry Vittor and Associates), and Virgina Engle

(U.S. EPA Environmental Monitoring and Assessment Program Coordinator) indicated that the fauna in this shallow bay system would be similar, and that sand, silt, and clay are the factors that drive habitat recruitment and not depth.

DQO Step 5. State the Decision Rule

See flow chart. Mean COC concentrations ([COC]), toxicity and benthic assessments identified as "Condition *x*" in the flow chart refer to conditions within the top ***6"*** of sediment in each 150 **sq.** ft. decision unit, validation area and the reference area, as appropriate. Eight decision units will be sampled and the decisions will be made about these eight areas. Three additional validation areas will be used to validate the notion that the area of contamination is localized within the area of eddy flow. These validation regions may provide additional information on extent of contamination if perimeter decision units are contaminated at unacceptable levels. Two reference areas will be sampled as a benchmark against which to evaluate decision unit conditions. Decision units and reference areas that will be compared for decision-making will exhibit similar physical characteristics that validate their comparability. Chemistry data will be needed at depths greater than **6"** for evaluating remedial options during the **FS.**

Decision-making will be staged and will apply to each decision unit. The first test to perform is an evaluation of chemistry in the top 6" of sediment. If surface chemistry is acceptable, an evaluation of deeper sediments will be conducted, with a possibility of **NFA** if chemistry to depth is acceptable. If chemistry is unacceptable in either the surface or at greater depths, additional evaluations will ensue. If surface chemistry is acceptable but the subsurface chemistry is unacceptable, the need for an FS will be evaluated by comparing the detected concentrations at depth to the site-specific remedial goals. If the surface chemistry is unacceptable, the benthic assessment and toxicity will be evaluated according to the decision matrices below with incorporation of sub-evaluations of fecundity, etc. In all cases, even if a decision unit is declared not to pose a problem based on chemistry alone, evaluation of toxicity and benthic diversity will occur. This evaluation may be used to explain any cases in which adverse biological effects are observed when chemistry appears to be acceptable.

Decision-Making Triads

Decision-making will proceed based on the triads or assessment results presented in the matrices below. First, biological decision making triads will be used to assess biological test results. These will be fed into the Project Decision Making Triad to establish decisions at the project level.

"Hits" and "Adverse effects" (terms used below) mean "statistically different" using methods accompanying each test protocol. "OK" = results were not statistically significant.

For weighting purposes, "Hits" on survival are considered twice as important as "Hits" on reproduction or growth because survival (i.e., mortality) is irreversible whereas reproduction and growth endpoints are potentially reversible; 2 sublethal hits = 1 lethal hit.

After the bioassays are considered individually, their results will be combined for input to the triad matrix assuming additivity of cumulative adverse effects.

The triad matrix accommodates multiple +'s and –'s within each box to reflect the continuum of chemistry, toxicity, and benthic community response one normally encounters, The "interpretation" description currently in the triad matrix will remain unchanged. The multiple +'s will better reflect the strength one should associate with that interpretation.

Possible Outcomes from the *Leptocheirus* Test:

Survival	Growth	Scoring
OK	OK	–
OK	Hit	+
Hit	OK	++
Hit	Hit	+++

Possible Outcomes from the *Mysidopsis* Test:

Survival	Growth	Reproduction	Scoring
OK	OK	OK	-
OK	OK	Hit	+
OK	Hit	Hit	++
Hit	OK	OK	++
Hit	OK	Hit	+++
Hit	Hit	OK	+++
Hit	Hit	Hit	++++

Biological Decision-Making Triad

Integrate results from each test by combining scores in an additive fashion.

Combined Score	Biological Interpretation Considering both Bioassays	Input to Triad Matrix
-	No adverse effects	- = -
+	No survival hits in either species. 1 sublethal hit in one species.	- = -
++	1 survival hit in one species or 2 sublethal hits.	+ = +
+++	1 survival hit in one species and/or adverse sublethal effects.	+ = +
++++	Survival hits in 1-2 species and/or adverse sublethal endpoints.	++ = +
+++++	Survival hits in 1-2 species and/or adverse sublethal effects.	++ = +
++++++	Survival hits in both test species and adverse sublethal endpoints.	+++ = +
+++++++	Survival hits in both test species and adverse sublethal endpoints.	+++ = +

Condition	Sediment Chemistry	Toxicity Tests	Benthic Assessment	Interpretation
1	+	+	+	Strong evidence for pollution-induced degradation.
2				Strong evidence for absence of pollution-induced degradation.
3	+			Contaminants are not bioavailable.

Project Decision Making Triad Matrix				
Condition	**Sediment Chemistry**	**Toxicity Tests**	**Benthic Assessment**	**Interpretation**
4	-	+	-	Unmeasured contaminants or conditions exist that have the potential to cause degradation.
5	-	-	+	Alteration of benthic community is probably not due to toxic chemical contamination.
6	+	+	-	Toxic chemicals are probably stressing the system.
7	-	+	+	Unmeasured toxic chemicals are causing degradation.
8	+	-	+	Benthic community degraded by toxic chemicals but toxicity tests not sensitive to toxic chemicals present or chemicals are not bioavailable or alteration is not due to toxic chemicals.

Notes:
+ = **Measured difference between test and control** or **reference conditions.**
- = No **measurable difference between test and control or reference conditions.**

DQO Step 6. Establish Quantitative Tolerances for Decision Errors

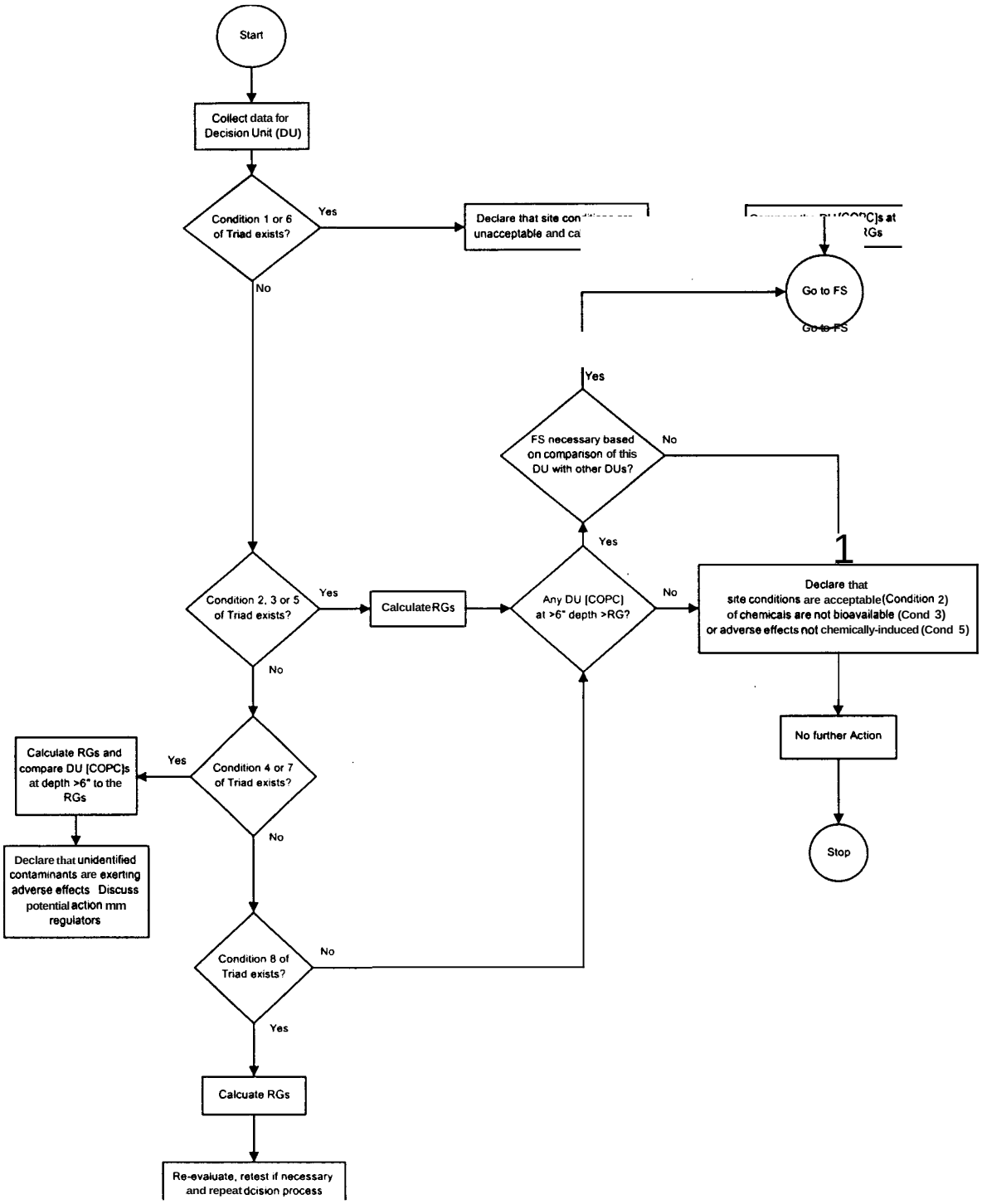
Given the advanced status of the project prior to initiating these DQOs, this step of the DQO process was used primarily as a means of introducing and reinforcing the concept of quantified error tolerances to the planning team. The outputs from this DQO step were used only as a rough guide to establish numbers of samples to be collected.

There are two types of decision error — rejecting the null hypothesis when it is true; and failing to reject the null hypothesis when it is false. Establishment of the null hypothesis rests on establishing the severity of consequences for making each type of error.

Site-Specijic Errors and Consequences:

Walk away from a dirty site ⇒ more severe consequence.

Clean up a clean site ⇒ less severe consequence.


Start
Collect data for Decision Unit (DU)
Condition 1 or 6 of Triad exists?
Yes
No
Go to FS
Yes
FS necessary based on comparison of this DU with other DUs?
No
Yes
1
Condition 2, 3 or 5 of Triad exists?
Yes
CalculateRGs
Any DU [COPC] at >6" depth >RG?
No
Declare that site conditions are acceptable(Condition 2) of chemicals are not bioavailable (Cond 3) or adverse effects not chemically-induced (Cond 5)
No
No further Action
Stop
Calculate RGs and compare DU [COPC]s at depth >6" to the RGs
Yes
Condition 4 or 7 of Triad exists?
Declare that unidentified contaminants are exerting adverse effects Discuss potential action mm regulators
No
Condition 8 of Triad exists?
No
Yes
Calcuate RGs
Re-evaluate, retest if necessary and repeat dcision process

Establish the Null Hypothesis:

The null hypothesis is the true state of nature that exists when the error having the more severe consequence is made. The error with the more severe consequence is to walk away from a dirty site, so the null hypothesis is that the site is dirty:

H_0 = site **is** dirty.

Then the alternative hypothesis is:

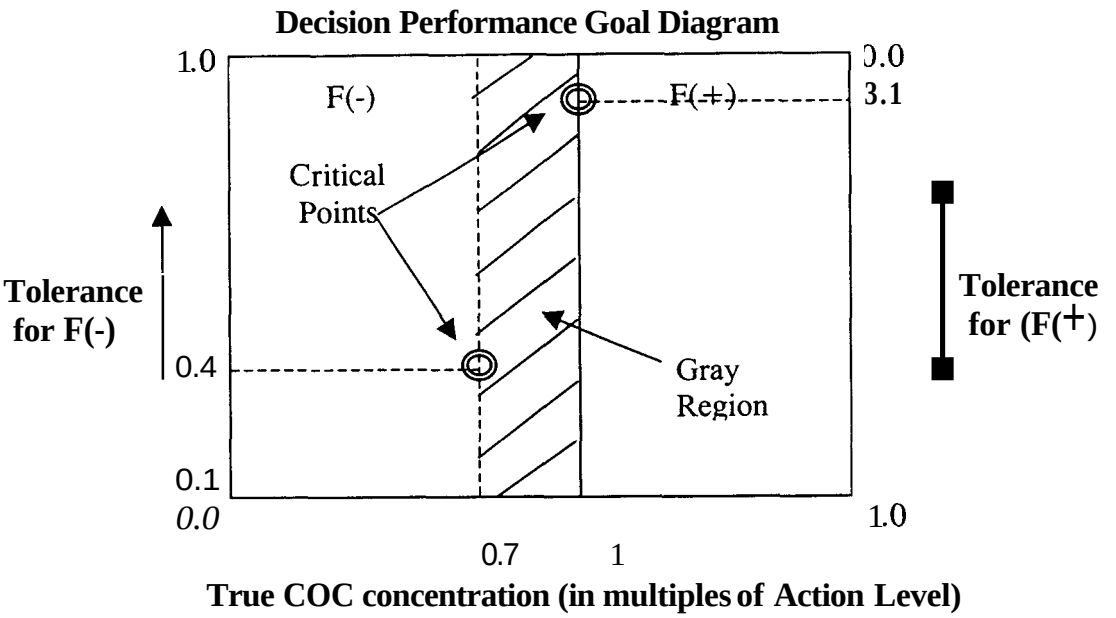
H_a = site is clean.

The Type I error (false positive) is rejecting Ho when it is true. Therefore, the type I error is: Walk away from a dirty site.

Then the Type II error (false negative) is: Clean up a clean site.

True Concentration	**Error Type**	**Tolerance**
0.7* Action Level	II: False Negative [F(-)]	**0.4 (40%** probability)
Action Level	I: False Positive [F(+)]	0.1 (10% probability)

Note:
These specifications are contrary to the proclaimed tolerances for decision errors because they indicate a greater tolerance for making the Type II Error. Generate the performance goal diagram, anyway, to indicate this decision performance



Based on the above specifications, the following numbers of samples were computed:

DQO Specifications:	
Ho	Site is Dirty
H_a	Site is Clean
Action Level	SSV
Gray Region Boundary	0.7SSV
Probability of F(+)	0.1 (walk away from dirty site)
Probability of F(–)	**0.4** (clean up clean site)

Metal	Standard Dev.	Screening Value	Null Condition: Site is Dirty	
			Gray Region	No. Samples
Arsenic	8.35	**7.24**	5.1	36
Cadmium	7.67	0.68	0.48	**> 1000**
Chromium	68.1	**52.3**	36.6	46
Zinc	59.3	**124**	86.8	6

These calculations assume normally distributed data, independent samples, and random sample collection. We do not expect the data to be normally distributed, and the standard deviations used in the calculations are only estimates based on approximately nine samples. The actual variances are likely to be greater than those used in these computations, which would cause the number of samples to increase for each metal.

The numbers of samples required is greater than can be afforded. So, compute the numbers of samples required when the tolerance for both decision error types is equal and more liberal (i.e., **45%).** Also consider both possibilities for the null hypothesis:

DQO Specifications		
	Case 1	**Case 2**
H_0	Site is Dirty	Site is Clean
H_a	Site is Clean	Site is Dirty
Action Level	SSV	SSV
Gray Region Boundary	0.7SSV	(1/0.7)SSV
Probability of F(+)	0.45 (walk away from dirty site)	0.45 (clean up clean site)
Probability of F(–)	0.45 (clean up clean site)	0.45 (walk away from dirty site)

Numbers of Samples						
		Screening	**Case 1 (Assume site is dirty)**		**Case 2 (Assume site is clean)**	
Metal	**Standard Dev.**	**Value**	**Gray Region**	**No. Samples**	**Gray Region**	**No. Samples**
Arsenic	8.35	7.24	5.1	2	10.5	2
Cadmium	7.67	0.68	0.48	93	1	37
Chromium	68.1	52.3	36.6	2	75	2
Zinc	59.3	124	86.8	2	180	2

Still, in the case of cadmium, the number of samples is prohibitively large. That's because the smallest detectable difference is small relative to the standard deviation of the data.

If only the areas with HI> 10 are used in the calculations, the standard deviations generally increase and the means and action levels become a little more different. These factors offset each other and the required numbers of samples using these new means and standard deviations with the **45%** tolerance for F(+) and F(–) above are: **As=** 2, Cd = 201, Cr = 3, and Zn = 2. Using the same factors with an error tolerance of F(+) = F(–) =35% yields: **As=** 10, Cd = 872, Cr = 21, and Zn = 2.

In the above calculations the number of samples required is computed using the difference between the gray region boundary and the action level as the minimum detectable concentration difference. This causes the number of samples required to achieve the specified decision performance to be limited by cadmium.

If the actual mean concentration computed from the **1997** Site **2** data is used for each analyte, the situation changes because the mean cadmium concentration is significantly greater than the computed gray region boundary. Using these mean concentrations, we can ask the question, "What statistical power is achieved if we wish to detect a difference between the observed mean analyte concentration and the action level?" To determine this, the problem is reversed to yield the probability of making a F(–) error when we specify a given number of samples ***(n)*** and fixed values of mean concentration (mean), standard deviation (std. dev.), Screening Value, and the Probability of false positive error, F(+). The results of these calculations are shown in the tables below.

Probability of F(–) with n = 9.

Metal (mean)	Std Dev.	Screening Value	Mean Concentration	Δx	n	Prob. of F(+)	Prob. of F(–)
Arsenic	8.37	7.24	9.98	2.74	9	50%	16%
						35%	31%
						20%	54
Cadmium	8.10	0.68	4.11	3.43	9	50%	10%
						35%	21%
						20%	40%
Chromium	70.7	52.3	58.9	6.6	9	50%	39%
						35%	UD
						20%	UD
Zinc	59.6	124	68.1	55.9	9	50%	0.2%
						35%	0.8%
						20%	2.9%

Note:
UD = undefined

Probability of F(–) with n = 15.							
Metal (mean)	**Std Dev.**	**Screening Value**	**Mean Concentration**	**Δx**	**n**	**Prob. of F(+)**	**Prob. of F(–)**
Arsenic	8.37	7.24	9.98	2.74	15	50%	10%
						35%	21%
						20%	40%
Cadmium	8.10	0.68	4.11	3.43	15	50%	5.0%
						35%	12%
						20%	25%
Chromium	70.7	52.3	58.9	6.6	15	50%	36%
						35%	UD
						20%	UD
Zinc	59.6	124	68.1	55.9	15	50%	0.0%
						35%	0.1%
						20%	0.3%

Note:
UD = undefined

Conclusion:

Using the above information, it appears that about 15 samples should provide acceptable statistical power for decision making (false positive and negative rates near 35% or better). Chromium stands out as an exception, however, a review of chromium date reveals that a single concentration of 220 ppm is contributing to this exception. Removing that single value from the data set renders the decision performance between that for cadmium and zinc, a significant improvement. This conclusion is caveated because analyte distributions are likely not Gaussian and the statistical calculations assume Gaussian distributions and because sediments are relatively mobile. Mobile sediments imply that concentration hot spots may move and be redistributed over time. Therefore, standard deviations observed for past data could be considerably different than current standard deviations, so it does not pay to invest much more time into power calculations.

DQO Step 7. Optimize the Design

The site will be subdivided into eight decision units (DUs), 150' x 150' square. Each DU will be sampled in an identical manner, as follows:

- One core sample at the center of the DU. The top 6" will be removed and the remaining 30" will be divided equally into two samples, yielding a total of three samples. The top 6" will be used as a point of reference for sediment depth profiling only. Its concentration relative to the composite samples described below will not affect decision making. That is, a surface core sample that is of greater or lesser concentration than the composite samples will have no bearing on decisions. This approach should limit "knee-jerk" reactions to hot spots which may arise as a consequence of statistical fluctuations or heterogeneity of the surface sediment.

- Eight grab samples from the top 6" of sediment will be composited into a single sample that will be split for toxicity testing and chemical analysis. One grab sample will be collected from each corner of the DU and four grab samples arranged in a diamond pattern will be collected closer to the center of the DU. The samples will be arranged to provide relatively even coverage of the DU area.

- Three sediment diversity samples will be collected along the water flow direction: one sample in the NE corner of the DU, one near the center of the DU, and one from the SW corner of the DU.

It will be important to collect sediment samples such that any sediment lost from coring tubes does not contaminate nearby sediment that is yet to be sampled. Therefore, the following sampling sequence will be used for each DU:

1. Mark the coring location with a buoy
2. Collect sediment diversity samples
3. Collect grabs for compositing
4. Collect the core sample

A map identifying the Site 2 area and the 150' x 150' areas of concern is included in the appendix. Reference stations and validation units will be sampled and analyzed in a manner identical to that of the DUs. A Map of these stations is also included in the appendix of this document.

Attachment 1. TAL Metals Plus Cyanide Analyte List

ANALYTE	CAS No.	CRQL, WATER (μg/L)
Aluminum	7429-90-5	200
Antimony	7440-36-0	60
Arsenic	7440-38-2	10
Barium	7440-39-3	200
Beryllium	7440-41-7	5
Cadmium	7440-43-9	5
Calcium	7440-70-2	5000
Chromium	7440-47-3	10
Cobalt	7440-48-4	50
Copper	7440-50-8	25
Iron	7439-89-6	100
Lead	7439-92-1	3
Magnesium	7439-95-4	5000
Manganese	7439-96-5	15
Mercury	7439-97-6	0.2
Nickel	7440-02-0	40
Potassium	7440-09-7	5000
Selenium	7782-49-2	5
Silver	7440-22-4	10
Sodium	7440-23-5	5000
Thallium	7440-28-0	10
Vanadium	7440-62-2	50
Zinc	7440-66-6	20
Cyanide	57-12-5	10

Attachment 2. SVOC Analyte List (EPA CLP OLM 3.2)

COMPOUND	CAS No.	Water, (μg/L)	Soil, (μg/kg)	Med. Soil, μg/kg	On Column (ng)
1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
2,2'-oxybis(1-Chloropropane)	108-60-1	10	330	10000	(20)
2,4,5-Trichlorophenol	95-95-4	25	830	25000	(50)
2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
2,4-Dinitrophenol	51-28-5	25	830	25000	(50)
2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
2-Chloronapthalene	91-58-7	10	330	10000	(20)
2-Chlorophenol	95-57-8	10	330	10000	(20)
2-Methylnaphthalene	91-57-6	10	330	10000	(20)
2-Methylphenol	95-48-7	10	330	10000	(20)
2-Nitroaniline	88-74-4	25	830	25000	(50)
2-Nitrophenol	88-75-5	10	330	10000	(20)
3,3'-Dichlorobenzidine	91-94-1	10	330	10000	(20)
3-Nitroaniline	99-09-2	25	830	25000	(50)
4,6-Dinitro-2-methylphenol	534-52-1	25	830	25000	(50)
4-Bromophenyl-phenyl ether	101-55-3	10	330	10000	(20)
4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
4-Chloroaniline	106-47-8	10	330	10000	(20)
4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000	(20)
4-Methylphenol	106-44-5	10	330	10000	(20)
4-Nitroaniline	100-01-6	25	830	25000	(50)
4-Nitrophenol	100-02-7	25	830	25000	(50)
Acenaphthene	83-32-9	10	330	10000	(20)
Acenaphthylene	208-96-8	10	330	10000	(20)
Anthracene	120-12-7	10	330	10000	(20)
Benzo(a)anthracene	56-55-3	10	330	10000	(20)
Benzo(a)pyrene	50-32-8	10	330	10000	(20)
Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)
Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)
bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
bis-(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
Butylbenzylphthalate	85-68-7	10	330	10000	(20)
Carbazole	86-74-8	10	330	10000	(20)
Chrysene	218-01-9	10	330	10000	(20)
Dibenz(a,h)anthracene	53-70-3	10	330	10000	(20)
Dibenzofuran	132-64-9	10	330	10000	(20)
Diethylphthalate	84-66-2	10	330	10000	(20)

COMPOUND	CAS No.	Water, (μg/L)	Soil, (μg/kg)	Med. Soil, μg/kg	On Column (ng)
Dimethylphthlate	131-11-3	10	330	10000	(20)
Di-n-butylphthalate	84-74-2	10	330	10000	(20)
Di-n-octylphthalate	117-84-0	10	330	10000	(20)
Fluoranthene	206-44-0	10	330	10000	(20)
Fluorene	86-73-7	10	330	10000	(20)
Hexachlorobenzene	118-74-1	10	330	10000	(20)
Hexachlorobutadiene	87-68-3	10	330	10000	(20)
Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
Hexachloroethane	67-72-1	10	330	10000	(20)
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
Isophorone	78-59-1	10	330	10000	(20)
Naphthalene	91-20-3	10	330	10000	(20)
Nitrobenzene	98-95-3	10	330	10000	(20)
N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
N-Nitrosodiphenylamine	86-30-6	10	330	10000	(20)
Pentachlorophenol	87-86-5	25	830	25000	(50)
Phenanthrene	85-01-8	10	330	10000	(20)
Phenol	108-95-2	10	330	10000	(20)
Pyrene	129-00-0	10	330	10000	(20)

Attachment 3. Organochlorine Pesticide Analyte List

COMPOUND	CAS No.	Water, (μg/L)	Soil, (μg/kg)	On Column, (pg)
4,4'-DDD	72-54-8	0.1	3.3	10
4,4'-DDE	72-55-9	0.1	3.3	10
4,4'-DDT	50-29-3	0.1	3.3	10
Aldrin	309-00-2	0.05	1.7	5
alpha-BHC	319-84-6	0.05	1.7	5
alpha-Chlordane	5103-71-9	0.05	1.7	5
beta-BHC	319-85-7	0.05	1.7	5
delta-BHC	319-86-8	0.05	1.7	5
Dieldrin	60-57-1	0.1	3.3	10
Endosulfan I	959-98-8	0.05	1.7	5
Endosulfan II	33213-65-9	0.1	3.3	10
Endosulfan sulfate	1031-07-8	0.1	3.3	10
Endrin	72-20-8	0.1	3.3	10
Endrin aldehyde	7421-93-4	0.1	3.3	10
Endrin ketone	53494-70-5	0.1	3.3	10
gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
gamma-Chlordane	5103-74-2	0.05	1.7	5
Heptachlor	76-44-8	0.05	1.7	5
Heptachlor epoxide	1024-57-3	0.05	1.7	5
Methoxychlor	72-43-5	0.5	17	50
Toxaphene	8001-35-2	5	170	500

Attachment 4. Toxicity Testing Background and Specifications

Toxicity tests are designed to determine whether toxic chemicals are present in toxic amounts. Toxicity tests are not designed to be quantitative predictors of ecosystem responses — though many studies have demonstrated significant associations between toxicity test results and ecosystem impacts.

V. deVlaming and T. Norberg-King (draft) identified 10 studies from the literature in which marine sediment toxicity tests were compared to ecological effects on marine benthos. In all ten of these studies, laboratory sediment tests were reliable qualitative predictors of benthic community effects, although the laboratory tests tended to underestimate the extent of the benthic community impacts.

Each toxicity test is designed with test acceptability criteria (TAC), which determine the validity and acceptability of the test based on control survival and other test endpoints. In addition to control criteria, a toxicity test may set limits on minimum growth requirements in weight or length, reproduction, fertilization, etc.

Another acceptance criterion is based on the performance of a specific batch of animals. Stressed organisms will not be suitable predictors of what is actually occurring within a toxicity test, so to insure that the population of organisms is sensitive (but not stressed) to toxicants reference toxicant tests are preformed.

Reference toxicant tests are multi-dilution tests with a known chemical that gauges the sensitivity of a pool of organisms. Reference toxicant tests are set up prior to the test or concurrent with the compliance test and utilize organisms from the same brood (when cultured in-house) or same batch when organisms are purchased. The reference toxicant is tested using the same concentrations from test to test under the same conditions (i.e., the same test duration, type of dilution water, age of test organisms, and feeding regime) and the same statistical analysis as the effluent test.

Reference toxicant tests indicate the relative sensitivity of the test organisms being used and demonstrate a laboratory's ability to obtain consistent test results with the test method. It is the laboratory's responsibility to demonstrate its ability to obtain consistent, precise results with reference toxicants before the laboratory performs toxicity tests with effluents for permit compliance purposes. Reference toxicants should be verified analytically and stock solutions should be replaced when concentrations show signs of degradation.

The frequency of reference toxicant testing depends on whether the organisms are cultured in-house or obtained from an outside source. If the laboratory obtains the test organisms from an outside source, the reference toxicant test must be conducted concurrently with the effluent test. If the laboratory facility maintains in-house cultures, a reference toxicant test must be conducted at least once a month. It is preferred that this reference toxicant test be performed concurrently with an effluent toxicity test.

Toxicity test conditions are outlined in Tables 1 and **2** for the mysid shrimp and the amphipod *Leptochinos plumulosus*. Both test methods have been tailored to address the concerns unique to sediments at Site **2.**

Traditionally, scientists have set the nominal error rate for biological studies at 0.01 to 0.1 (1% to 10%). The 0.01 level, at one extreme, provides a conservative error rate for false positives and the 0.10, at the other extreme, provides a more liberal rate for false positives. The WET test method manuals recommend a nominal error rate of 0.05 for hypothesis testing, striking a balance between the two extremes. **A** nominal error rate of 0.05 means a 5% probability of making a Type I error and is associated with a 95% level of significance.

Toxicity tests will be statistically analyzed at test termination. Figure 1 provides a glimpse of the statistical programs utilized when analyzing data with multiple endpoints. Figure **2** illustrates the steps which one takes to analyze data from a screening type test. (Single exposure).

Figure 1. Flowchart for statistical analysis of test data for *Mysidopsis bahia.*

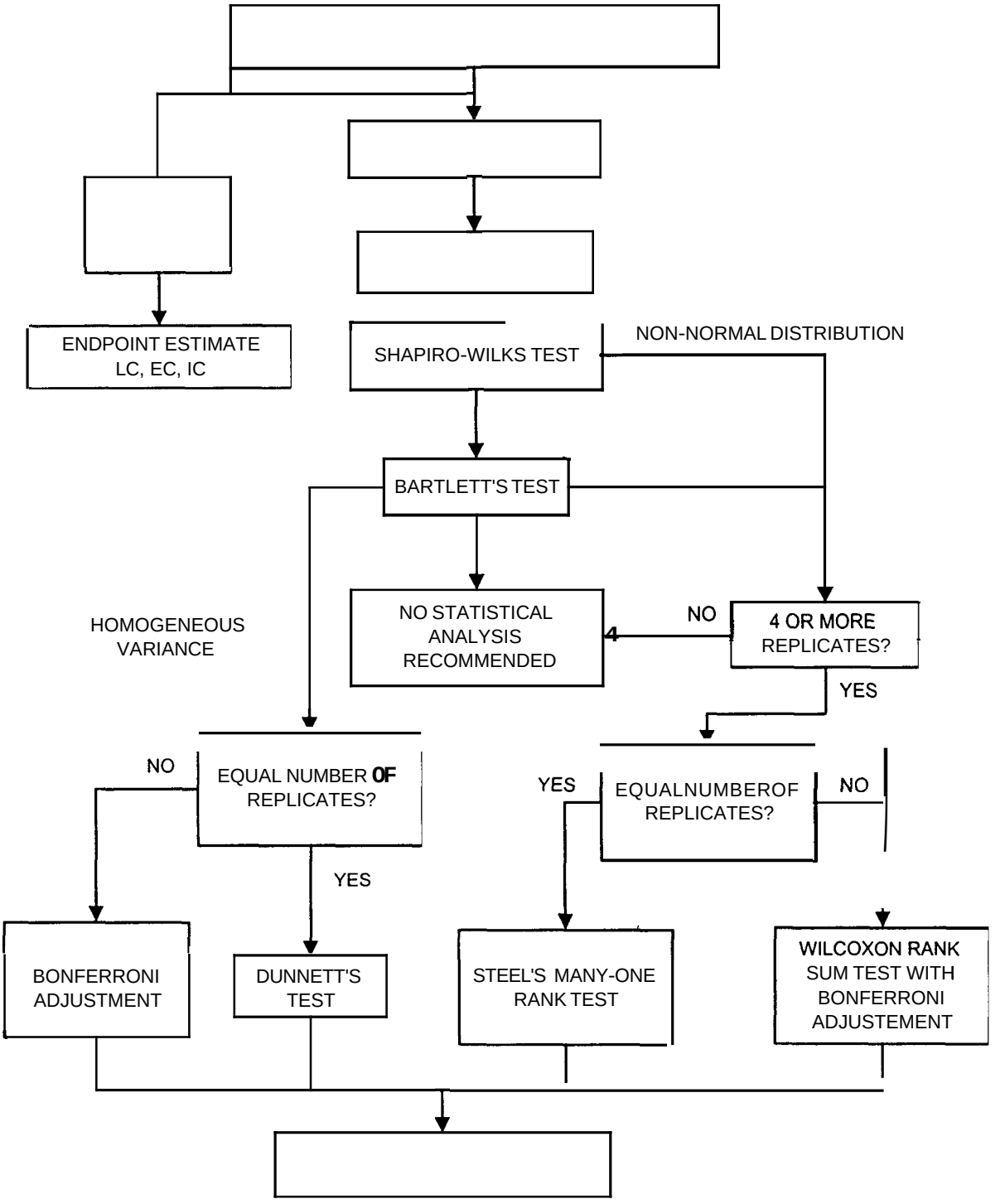


Figure 2. Determination of pass or fail from a single sediment exposure with *Leptocheirus plumulosus.*

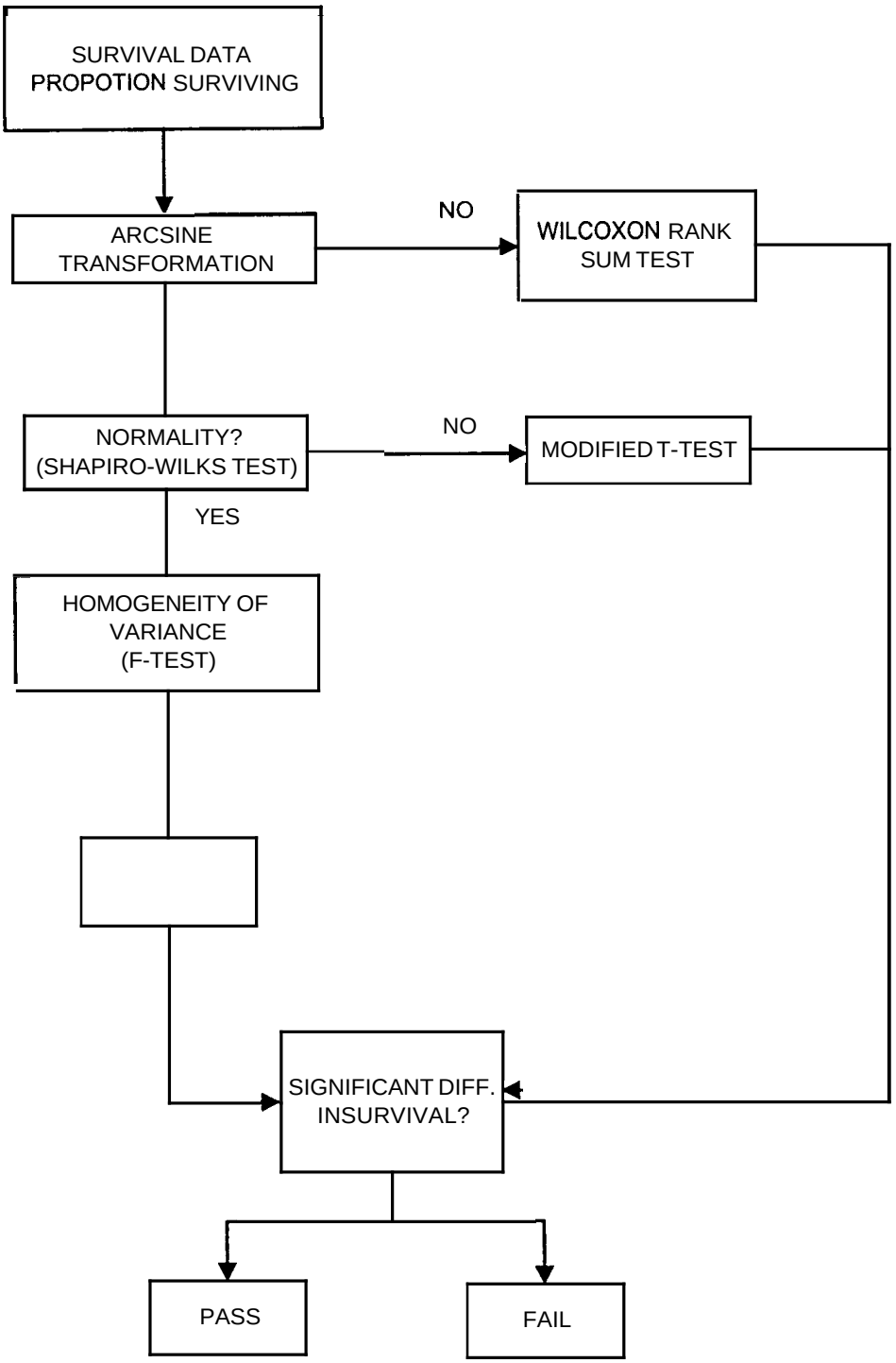


TABLE 1 SUMMARY OF TEST CONDITIONS AND T EST ACCEPTABILITY CRITERIA FOR THE MYSID, *MYSZDOPSZS BAHIA*, SEVEN DAY SURVIVAL, GROWTH, AND FECUNDITY TEST WITH EDLMENTS	
1. Test type:	Static renewal
2. Salinity:	20% to 30% (± 2% of the selected test salinity).
3. Temperature:	26 ± 1 C
4. Light quality:	Ambient laboratory illumination.
5. Light intensity:	10-20 E/m²/s (50-100 ft-c.)(ambient laboratory levels).
6. Photoperiod:	16 h light, 8 h darkness, with phase in/out period.
7. Test chamber:	8-oz plastic disposable cups, or 400-mL glass beakers.
8. Sediment volume:	2 cm
9. Overlying water volume:	150 mL per replicate.
10. Renewal of overlying water:	Daily
11. Age of test organisms:	7 days
12. No. organisms per test chamber:	5 (minimum)
13. No. replicate chambers per concentration:	8 (minimum)
14. No. larvae per concentration:	40 (minimum)
15. Source of food:	Newly hatched *Artemia* nauplii (less than 24 h old).
16. Feeding regime:	Feed 150 24 h old nauplii per mysid daily, half after test solution renewal and half after 8-12 h.
17. Cleaning:	Pipette excess food from cups daily immediately before test solution renewal and feeding.
18. Aeration:	None unless DO falls below 4.0 mg/L, then gently aerate in all cups.
19. Overlying water:	Clean sea water, natural or reconstituted water.
20. Test concentrations:	Sediments: Minimum of 3 and a control sediment.
21. Sediment concentrations:	Sediments to be serially diluted with clean sediment. Sediment concentrations will be 100, 50, and 25%.
22. Test duration:	7 days
23. Endpoints:	Survival, growth, and egg development.
24. Test acceptability criteria:	80% or greater survival, average dry weight 0.20 mg or greater in controls; fecundity may be used if 50% or more of females in controls produce eggs.

Note:
Modified from: U.S. **EPA.** 1991. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Environmental Monitoring and Support Laboratory, Cincinnati, OH. EPA/600/4-91/028.

TABLE 2 TEST CONDITIONS FOR CONDUCTING A 10-D SEDIMENT TOXICITY TEST WITH THE AMPHIPOD, *LEPTOCHEIRUS PLUMULOSUS*	
1. Test type:	Whole sediment toxicity test, static.
2, Temperature:	25% C
3. Salinity:	20%
4. Light quality:	Wide-spectrum fluorescent lights
5. Illuminance:	500 - 1000 lux
6. Photoperiod:	24L:0D
7. Test chamber:	1-L glass beaker or jar with - 10 cm I.D.
8. Sediment volume:	175 mL (2 cm)
9. Overlying water volume:	800 mL
10. Renewal of overlying water:	None
11. Size and life stage of amphipods:	2 - 4 mm (no mature males or females).
12. No. of organisms/chamber:	20 per test chamber.
13. No. of replicate chambers/treatment:	Depends on objective of test. At a minimum, four replicates must be used.
14. Source of food:	GORP – U.S. EPA recipe.
15. Feeding:	Twice during test duration; day 2 and day 6.
16. Aeration:	Water in each test chamber should be aerated overnight before start of test, and throughout the test; aeration at rate that maintains 90% saturation of dissolved oxygen concentration.
17. Overlying water:	Clean sea water, natural or reconstituted water.
18. Overlying water quality:	Temperature daily. pH, ammonia, salinity, and DO of overlying water at least at test start and end. Salinity, ammonia, and pH of pore water.
19. Test duration:	10 days
20. Endpoints:	Survival and growth.
21. Test acceptability criteria:	Minimum mean control survival of 90% in the control exposure. Growth endpoint will be determined by subsampling the population at test initiation to establish a baseline weight. Organism weight at test termination will be compared to the control exposures and calculated using a T-test.

Note:
Modified from: **U.S. EPA.** Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA/600/R-94/025.

Attachment 5. Statistical Specifications for Toxicity Testing

Data Acceptance Criteria:

- Toxicity, fecundity, growth: Survival rates will be dictated by the test methodology; an ***alpha*** $= 5\%$ significance level (95% confidence level) will be used. The *Mysid* test will use 40 organisms per replicate; the ***Leptocheirus*** test will use 100 organism per replicate.

- Biodiversity: Species diversity will be assessed utilizing the triad matrix (overall) and comparisons between reference stations and site locations (individually). Site **2** diversity data will be compared to the **US EPA** Stations 18 and **22** (reference location) data.

Note: Much of the acceptance criteria for toxicity and biodiversity may be incorporated into the decision matrix.

- Sediment Chemistry: Threshold Effects Levels (TELs) and Sediment Screening Values (SSVs)

Volume 2

Final Work Plan for Pensacola Naval Air Station Sediment Survey Operable Unit

FINAL WORK PLAN FOR PENSACOLA NAVAL AIR STATION SEDIMENT SURVEY OPERABLE UNIT 3

PENSACOLA NAVAL AIR STATION
PENSACOLA, FLORIDA

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Enforcement and Investigations Branch
Hazardous Waste Section

OCTOBER 2000

WORK PLAN
USEPA REGION 4

Title and Approval Sheet

FINAL WORK PLAN FOR PENSACOLA NAVAL AIR STATION
SEDIMENT SURVEY OPERABLE UNIT 3

EPA PROJECT # 00-0026

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SECTION 1.0 INTRODUCTION

This sampling and analysis plan (SAP) for completing a Remedial Investigation of Operable Unit 3 (Site **2,** Waterfront Sediments) at the Pensacola Naval Air Station, Superfund site was developed by the United States Environmental Protection Agency (EPA), Region IV, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, amended by the Superfund Amendments and Reauthorization Act (SARA), of **1986** (Ref.1). The plan generally follows a detailed scope of work and technical approach outlined in the AGuidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final.

This Work Plan is design to support the completion of the Record of Decision for Site **2** (Operable Unit 3), Waterfront Sediments. This study will conduct an assessment of the vertical nature and extent of sediment contamination in the Waterfront area. The sediment Quality ATriad approach will be utilized to assess sediment contamination at Site **2** (OU3). The triad uses three different methods of characterizing sediment; sediment chemistry, sediment toxicity, and benthic community structure. All three lines of evidence will be used to assess sediment contamination of Site **2** and will be used by the risk manager for decision-making. This Sampling and Analysis (Volume **2)** focuses on the sediment chemistry part for the triad. The other two legs of the triad, benthic community surveys, and sediment toxicity, will be addressed in the SAP/QAPP provided by the Navy (Volume 3). Both of these documents will fulfill the requirements of the Data Quality Objective document contained in Volume 1.

1.1 Background

The Pensacola Naval Air Station (NAS) was placed on U.S. EPA's National Priority List 1989. Operable Unit 3 (OU3), or Site **2,** is located on the southeastern shoreline of the NAS along Pensacola Bay (Figure 1.1). From 1939-1973untreated industrial wastes from base facilities were routinely discharged into Pensacola Bay, near Site **2.** An estimated **83** million gallons of industrial waste was disposed of in the Bay. The waste consisted of waste containing paint, paint solvents, thinners, ketones, trichloroethylene, alodine, mercury, and concentrated plating waste (primarily chromium, cadmium, lead, nickel, and cyanide).

The Remedial Investigation (EnSafe, 1996) of the site showed the presence of metals, PAHs, pesticides, and polychlorinated biphenyls (PCBs) in the sediments. The results of the RI and baseline ecological risk assessment also described five areas where contaminated sediment posed unacceptable risk to the environment and remedial alternatives should be developed for these areas.

1.2 Problem

The initial **RI** (EnSafe, 1996) did not adequately describe the vertical extent of contamination in the sediments. If a remedial alternative that requires removal is selected, it is unclear how much sediment needs to be removed to achieve cleanup goals. In addition, there may have been a significant change in site conditions since last investigated. There have been two hurricanes and a few tropical storms that have passed through the area in recent years. This storm activity may have caused some sediment redistribution. It is unclear what the current nature and extent of contaminated sediment is in the Waterfront area (OU3). Before any remedial action is selected and implemented, sediment contamination in OU3 needs to be reevaluated and vertical extent defined. The additional sediment characterization is necessary to complete the ROD and selection of a remedial alternative.

1.3 Technical Approach

Based on the results of the initial RI (EnSafe, 1996) five locations where the Hazard Index (HI) was greater than 10 were identified and targeted for remedial action. These five locations and the surrounding area will be the focus of this investigation. A total of 11 grids will be sampled in the vicinity of the previous investigations. Five of these locations had HI> 10 in the previous investigation. Two background locations will also be sampled. At each location surface and subsurface sediment will be collected to assess the vertical and horizontal extent of contamination. Analytical results will be compared to the lower of the USEPA Region IV's ecological benchmark values or the Florida Department of Environmental Protection Sediment Quality Assessment Guidelines.

The sediment Quality Atriad approach will be utilized to assess sediment contamination at Site 2 (OU3). The triad uses three different methods of characterizing sediment; sediment chemistry, sediment toxicity and benthic community surveys. All three lines of evidence will be used to assess sediment contamination of Site 2 and will be used by the risk manager for decision-making. This SAP focuses on the sediment chemistry part for the triad. The data will be compared to ecological benchmark screening values and effects values, discussed in the Analytical section of this document. The other two legs of the triad, benthic community surveys and sediment toxicity, will be addressed in another QAPP and SAP provided the Pensacola Naval Air Station. The Navy will provide the appropriate Data Quality Objectives for all three legs of the triad.

SECTION 2.0 QUALITY ASSURANCE PROJECT PLAN

The following sections identify the individuals or organizations participating in the project and discuss specific roles and responsibilities of personnel. This section also discusses the quality objectives for measurement data and discusses the special training requirements for the staff.

2.1 Project Management

This section addresses the basic area of project management and ensures that the project has a defined goal, that the participants understand the goal and the approach to be used and that the planned outputs have been appropriately documented.

2.1.1 Project/Task Organization

The overall field investigation/sampling phase of the project and any field decisions will be the responsibility of the Field Project Leader. The Field Project Leader will be responsible for the following field activities:

- Insuring that all field activities are communicated and coordinated with the Project Manager (Gena Townsend).
- Monitoring overall field project quality control.
- Coordinating field scheduling of work with other section activities.
- Overseeing and managing field technical resources including non-sampling field activities.
- Monitoring health and safety of the sampling/investigative personnel.
- Coordinating sample analyses with the laboratory.

The following is a partial listing of the personnel that will be involved in the field operations for the Pensacola OU3 investigation and their responsibilities:

- Gena Townsend — Project Manager
- Bobby Lewis — Field Project Leader
- Philip Murphy — USEPA Lead Diver
- Peter Kalla — USEPA Diver
- Candace Halbrook — USEPA Diver
- Bruce Pruitt — USEPA Diver

This list of personnel will be supplemented by other resources, including RESAT contract personnel, that may be provided on an as-needed basis. In addition, the Project Manager will arrange for additional personnel (EPA contractors and/or Waste Management Division staff) to be on site to participate in the data collection activities. Contract personnel may be dedicated solely to this investigation for the duration of field activities.

2.1.2 Problem Definition/Background

Background information about the site and a definition of the problem are provided in Section 1.

2.1.3 Project/Task Description

A detailed description of the sampling strategy is provided in Section **3** of this document.

2.1.4 Quality Objectives and Criteria for Measurement Data

Data quality requirements were derived as part of the DQO process provided by the Pensacola Naval Air Station. All samples **will** be analyzed in accordance with the USEPA, Region **IV,** SESD, Analytical Support Branch Laboratory Operations and Quality Control Manual (1997b) or as specified by the **USEPA** Region IV, SESD Quality Assurance Program Statement of Work for Contract Laboratory Program (CLP).

2.1.5 Project Narrative

EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations is provided in the following sections. Section 1.3 provides a description of the hypothesis and attended use of the data. Requirements related to analytical methods, quality control, and sample handling and custody are discussed in Section 2.2.

2.1.6 Special Training Requirements/Certification

All sediment samples will be collected by the USEPA SESD Dive Team. All divers must be certified by the **USEPA** dive program. In addition, all divers and sample handlers must have completed the Occupational Safety and Health Administration 40-hour Hazardous Waste Worker training.

2.1.7 Documentation and Records

Sample collection, handling, documentation and custody procedures will be done in accordance with the USEPA Region IV, SESD, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM, May, 1996).

2.2 Measurement/Data Acquisition

The following section provides discussion on the sampling process design and the requirements for:

- sampling methods,
- sampling handling and custody,
- analytical methods,
- field and laboratory quality control,
- instrument calibration, and
- data acquisition and management.

2.2.1 Sampling Process Design/Sampling Methods Requirements

The sampling strategy, number and type of samples to be collected, and sample locations are presented in Section 3.0 of this document.

2.2.2 Sample Handling and Custody Requirements

All samples will be collected, handled and documented in accordance with Sections 11.0 and 3.0, respectively, of the USEPA, Region IV, SESD, EISOPQAM (1996). A copy of the appropriate sections of the manual, in addition to the project Work Plan and Field Health and Safety Plan, will be maintained in each sampling vessel and onshore command post for reference during all phases of the field sampling activities. If any deviations in sampling procedures are used, these deviations will be recorded in the field logbooks.

2.2.3 Sample Preservation, Containers and Holding Times

All samples will be preserved in accordance with Appendix A of the EISOPQAM (1996) or as determined by the USEPA, SESD Quality Assurance Program Statement of Work (SOW). Holding times and containers are presented in Table 2.1. The containers required for analyses are subject to change depending on the selection of the appropriate laboratory.

2.2.4 Analytical Method Requirements

Detection limits or quantitation limits for metals and extractable organics must be below the lower of the EPA Region IV's ecological screening values or effects values (Table **2.2)** or the FDEP threshold effects values (Table 2.3). To meet these limits samples will be analyzed by methods specified in the SOW provided by The USEPA Region IV, SESD, Quality Assurance Program. The SOW will determine and describe the methods needed to achieve required detection limits for all analyses.

Parameter	Container	Preservation	Holding Times
Organic Compounds	8 oz. glass with Teflon lid	Cool, 4 C	7 days to extraction 40 days after ext.
Metals	8-oz. glass with Teflon lid	Cool, 4 C	6 months
Cyanide	8-oz. glass with Teflon lid	Cool, 4 C	14 days
Organotins	8-oz. glass with Teflon lid	Cool, 4 C	7 days to extraction 40 days after ext.
AVS SEM	1-quart glass with Teflon lid	Cool, 4 C	Not specified
TOC/Particle Size Analysis	8-oz. glass with Teflon lid	Cool, 4 C	28 days
Grain Size	8-oz. glass with Teflon lid	Cool, 4 C	Not specified

Table 2.2
Region 4 Ecological Screening Values for TCL and TAL Sediment

Semi-Volatiles and Pesticides	Effects Value (µg/kg)	Screening Values (µg/kg)	Target Analyte List	Effects Value (mg/kg)	Screening Value (mg/kg
Naphthalene	34.60	330.0	ANTIMONY	2	12
alpha-Chlordane	0.50	1.7	ARSENIC	7.24	7.24
Gamma-Chlordane	0.50	1.7	CADMIUM	0.68	1
4,4'-DDD	1.22	3.3	CHROMIUM	52.3	52.3
4,4'-DDE	2.00	3.3	COPPER	18.7	18.7
4,4'-DDT	1.58	3.3	LEAD	30.2	30.2
Dieldrin	0.02	3.3	MERCURY	0.13	0.13
Endrin	0.02	3.3	NICKEL	15.9	15.9
Gamma-BHC (Lindane)	0.32	3.3	SILVER	0.733	2
Aroclor-1221		21.6	ZINC	124	124
Aroclor-1232		21.6			
Aroclor-1242		21.6			

Table 2.2 Region 4 Ecological Screening Values for TCL and TAL Sediment					
Semi-Volatiles and Pesticides	**Effects Value (μg/kg)**	**Screening Values (μg/kg)**	**Target Analyte List**	**Effects Value (mg/kg)**	**Screening Value (mg/kg**
Aroclor-1248		21.6			
Aroclor-1254		21.6			
Aroclor-1260		21.6			
Aroclor-1016	21.60	33.0			
bis(2-Ethylhexyl) phthalate	182.0	182.0			
Acenaphthene	6.71	330.0			
Acenaphthylene	5.87	330.0			
Anthracene	46.90	330.0			
Benzo(a)anthracene	74.8	330.0			
Benzo(a)pyrene	88.80	330.0			
Chrysene	108.00	330.0			
Dibenzo(a,h)-anthracene	6.2	330.0			
Fluoranthene	113.00	330.0			
Fluorene	21.20	330.0			
1,1'-Biphenyl		1100.0			
4-Bromophenyl-phenylether	1300.0	1300.00			

Parameters	TEL
Arsenic	7.24
Cadmium	0.676
Chromium	52.3
Copper	18.7
Lead	30.2
Mercurv	0.13
Nickel	15.9
Silver	0.733
Zinc	124
PCBs	21.6
Acenaphthene	6.71
Acenaphthylene	5.87
Anthracene	46.9
Fluorene	21.2
2-methynapthalene	20.2
Naphthalene	34.6
Phenanthrene	86.7
Benzo(a)anthracene	74.8
Benzo(a)pyrene	88.8
Chrysene	108
Dibenzo(a,h)anthracene	6.22
Fluroanthene	113
Pvrene	153
Chlordane	2.26
DDD	1.22
DDE	2.07
DDT	1.19
Dieldrin	0.715
Lindane	0.32
Bis(2-ethylhexyl)phthalate	182

Notes:

TEL = threshold effects level
mg/kg = milligrams per kilogram or parts per million (ppm)
μg/kg = micrograms per kilogram or parts per billion (ppb)

2.2.5 Quality Control Requirements

Quality control **(QC)** measures will be made in the field and laboratory to ensure that reliable data are obtained.

2.2.5.1 Field Quality Control

Field QC samples to be collected as part of the investigation include a pre-determined background location and duplicate samples as described below:

- Local background samples will be collected from an area already established from previous investigations and determined suitable for providing necessary background information.

- Field splits will be collected to provide information on analytical precision. There will be 1 split collected for every 20 analytical samples. The location of samples will be determined by the field team leader while in the field.

- Equipment rinse blanks will be collected from all sampling equipment to evaluate field decontamination procedures.

2.2.5.2 Onsite Measurements Quality Control

The QC samples prepared and analyzed of onsite measurements include split samples. Splits samples are used for indication of precision associated with the analytical process by calculating the relative percent difference (RPD between two results). As indicated above 1 split will be collected for every 20 laboratory samples collected.

2.2.5.3 Laboratory QC

Laboratory QC will be conducted in accordance with the USEPA Region IV, SESD, Analytical Support Branch Laboratory Operations and Quality Control Manual (1997b), USEPA Quality Assurance Management Plan (1998), or as is specified in the SOW for the CLP provided by the USEPA Region **IV. SESD.** Office of Quality Assurance.

2.2.6 Instrument Calibration

A Hydrolab multiprobe in-situ water quality measuring device will be used in the field to evaluate water quality conditions (DO, conductivity/salinity , pH and temperature). All field instruments shall be calibrated and maintained in accordance with the **EISOPQAM** (1996) and the manufacturer's instructions. Results from all instrument calibration procedures will be recorded in a field logbook.

2.2.7 Data Acquisition Requirements

All data acquisition requirements, including sample collection, onsite measurements, and laboratory analysis are presented in Section 3 of this document.

2.2.8 Sample Management

Data resulting from the implementation of the following Sampling and Analysis Plan (SAP) shall be managed and stored in USEPA Region IV, R4LIMS database.

2.3 Data Validation and Usability

All sampling and analytical data will be reviewed to ensure that analyses were performed and reported as required. All CLP data will be validated by OQA, in accordance with the following guidance documents:

- USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-94-012 (PB94-963501), February 1994;

- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94-013 (PB94-963502), February 1994; and

- Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services, Revision 2.1, July 1999, Office of Quality Assurance, SESD, USEPA, Region IV.

The Region 4 Office of Quality Assurance provides a data qualifier report for each set of CLP data that is validated. The project leader will review the data qualifier report to determine any data limitations and may consult with Office of Quality Assurance staff to determine the impact of any qualified data on overall data usability for this project.

SECTION 3.0 SAMPLING AND ANALYSIS PLAN

This SAP was developed to address and implement the design developed in Section 1.3. This study will conduct an assessment of the vertical nature and extent of sediment contamination in the Waterfront area. The data generated in this investigation will be used to support the completion of the Record of Decision for Site 2 (Operable Unit 3), Waterfront Sediments.

3.1 Project Schedule and Deliverables

The field investigation described in this document is scheduled for the week of March 7, 2000. Deliverables for this project will be a report consisting of text, tables, and graphs explaining analytical results. A draft report will be submitted within 30 days after receipt of all validated analytical data. Anticipated schedule is as follows:

- Field Study March 6-10, 2000.
- Receive validated analytical results April 20, 2000
- Draft Report will be delivered by May 30, 2000.

3.2 Field Investigation

All sediment samples will be collected by USEPA certified divers. Sampling vessels will be provided by USEPA, SESD.

3.2.1 Sampling Locations

The sampling locations for this investigation are based on the initial RI (Figure 3.1). Figure 3.2 shows the sampling locations for this investigation. Eleven different locations (150' X 150' grids) will be sampled in the area of concern. Two background locations will be selected during the investigation. Sampling locations will be located using real time global positioning system (GPS) equipment and marked with anchored buoys.

3.2.2 Sampling Approach

At each sampling location the vertical extent of sediment contamination will be profiled. Vertical extent will be defined by sampling sediment at three different depth intervals up to *36* inches at the

center point of each grid. The sampling intervals may change depending on field conditions. At all sampling locations the surface interval will be **0-6".** The remaining two intervals will depend on the recovered core length of sediment. For example if core penetration is only to 30 inches, then the sampling intervals would be 0-6", 6"-21" and **21**"-remaining.

At all the surface sediment (0-6") locations, samples will be analyzed for **TAL,** extractable organics, pesticides, PCBs, TOC, grain size, acid volatile sulfides with simultaneously extracted metals **(AVS** SEM), inorganic tin and organic tin (monobutyl, dibutyl, tributyl, and tetrabutyl tin), and ammonia. At the two subsurface intervals samples will be analyzed for TAL, inorganic tin and organic tin (monobutyl, dibutyl, tributyl, and tetrabutyl tin), and ammonia. At the subsurface sediments depths all samples will be analyzed for parameters listed above except for AVS SEM. A summary of samples to be co'llected **is** presented in Table **3.1.**

Analyses	Surface Sediments	Subsurface B	Subsurface C
Metal Scan/Cyanide	13	13	13
AVS SEM	13	—	—
Extractable organics/pesticides/PCBs	13	13	13
Low Level PAHs (SW)	13	13	13
Organotins	13	13	13
TOC	13	13	13
Grain Size	13	13	13

the to the surface for processing. Nine core tubes will be required at each location to produce enough sample volume for analytical and toxicological requirements. The nine core tubes will be brought to the surface and composited and homogenized in **a** clean stainless-steel bucket. Aliquots will then be collected from the homogenate and placed in the appropriate containers for chemical analysis and toxicity.

Benthic diversity samples will be collected using a **4" x** 6" stainless steel benthic core tube. Three benthic cores grabs will be collected at each location (Figure 3). Each grab will be placed in a mesh bag and brought to the surface for processing.

For the two subsurface sediment intervals a decontaminated thin walled stainless steel 36" core tube will be carefully pushed into the sediment to minimize compaction. The SS core tube will be removed from the sediment and capped at both ends and brought to the surface. The sediment will then be extruded from the core tube onto an appropriate length of aluminum foil and the two sediment intervals will be extracted and placed into glass pans for processing. The top 6 inches of each core will be discarded. Samples will be homogenized and placed into the appropriate sampling containers. It is anticipated that 2-3 core tubes will be needed at each location to produce enough sample volume for analytical requirements.

3.2.4 Surface Water Sampling

No surface water samples will be collected for analysis. However, in-situ water quality measurements will be collected. Dissolved oxygen, pH, salinity, and temperature will be measured using a Hydolab Minisonde, a multi-probe in-situ water quality-measuring device. This data will be used to assess the condition of surface water overlying the sediment. Measurements will be collected at the surface and the bottom of the water column at the surface water sediment interface.

3.3 Sample Identification

Samples collected during this investigation will be identified using a unique eight-character format such as: **YY - XXX - ZZZ** indicating media code - sample number - sample or station designator. All sample identification will start with two characters (media code) i.e., sediment (SD), surface soil (SF), etc. The middle three characters will be numeric (sample number) followed by the last three characters that will consist of three letters and/or numbers (sample or station designator).

For example, sediment samples will be identified using the sediment media code "SD". Sample location will be given an numeric number A001" and sediment depth will be indicated using a numeric number; 001 will indicate 0-6", 002 will indicate 6-21" and 003 will indicate 18-30 21-remaining" (Table 3.2).

Media Code	Sample Media YY	Sample Location XXX	Sediment Depth Code ZZZ	Sediment Depth
SW	**Surface Water**	**001-020**	**001**	0-6"
SD	**Sediment**	**001-020**	**002**	6"-21"
OT	**Other (Unknown)**	001-020	**003**	21" -?
	Split Samples	**100-120**		
QA	**All QA Samples**	200-220	—	—

The identification of samples collected for field QA/QC purposes will follow the same general format as the other samples. However, field QA/QC samples will be identified using the following format: **QA - XXX - ZZZ** indicating field QA/QC material - sample number - QA/QC sample designator. All QA/QC sample identification will start with the letters AQA for the sample to be properly identified. The middle three characters will be numeric (sample location), from Table **3.2,** followed by the last three characters which will consist of three letters (QA/QC sample designator). The following three character scheme, if applicable, in Table 3.3, will be used for the QA/QC sample designators.

Table 3.3 QA/QC Sample Designations	
QA/QC DESIGNATOR ZZZ	DESCRIPTION
TBW	TRIP BLANK – WATER
OFW	ORGANIC FREE WATER BLANK
ERB	EQUIPMENT RINSE BLANK
PRE	PRESERVATIVE BLANK

A copy of the chain-of-custody form will remain at the project leader to insure the continuation of the proper numbering sequence throughout the project is maintained. The account number that will be used by the field personnel throughout the field sampling portion of the investigation will be 50102D 04EG. Laboratory project numbers will be assigned at a later date.

3.4 Sample Collection and Handling Procedures

All samples will be collected, preserved, handled and documented in accordance with the EISOPQAM. A copy of the manual, in addition to the SAP and Field Health and Safety Plan, will be maintained with the project officer for reference during all phases of the field sampling activities. If any deviations in sampling procedures are used, these deviations will be recorded in the field logbooks.

3.4.1 Field Equipment Decontamination Procedures

All field equipment will be pre-cleaned in accordance with the USEPA Region IV, SESD, EISOPQAM (May, 1996). All field decontamination procedures will be in accordance with the EISOPQAM. It is anticipated that a small-scale decontamination area will be set up on the sampling boats to clean the SS core tubes and buckets between sampling locations.

All decontamination liquids will be collected and containerized. These wastes will be handled in accordance with a typical Investigation Derived Waste (IDW) management plan. The following identifies the types of IDW anticipated to be generated during the investigation and their disposition.

- Waste solvents generated during the cleaning of equipment will be re-contained in the original four-liter **jugs,** conspicuously labeled as IDW, placed in the factory shipping boxes and returned to the **SESD** laboratory. This material will be entered into the laboratory's hazardous waste tracking system for appropriate disposal.

- Clothing and miscellaneous trash generated during the investigation will be bagged and placed in a commercial Dumpster for appropriate disposal.

3.4.2 Instrument Calibration

All field instrumentation will be calibrated in accordance with the EISOPQAM (May 1996)

3.4.3 Management of Investigation-Derived Wastes

The **SESD** project leader will ensure that all investigation-derived wastes (IDW) are handled in accordance with Section 5.15 of the USEPA Region IV, SESD, EISOPQAM (May, 1996) (Appendix A).

SECTION 4.0 REFERENCES

EISOPQAM, **1996.** USEPA Region IV, SESD, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. 1996.

EnSafe, 1996. Remedial Investigation, Site **2,** Naval Air Station, Pensacola, Florida. EnSafe/Allen & Hoshall, Memphis, Tennessee.

Appendix

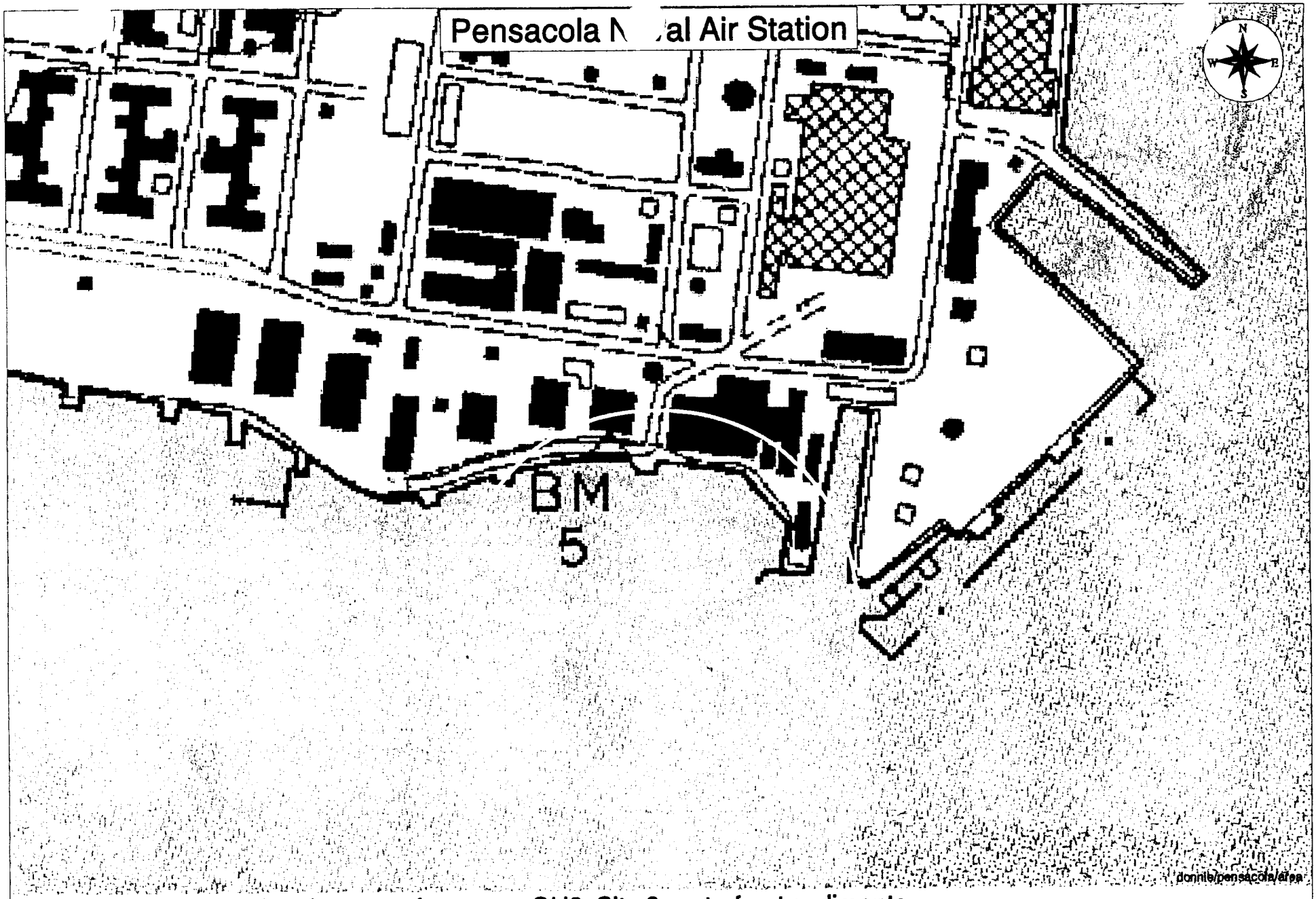

Figure 1.1 Map showing the area of concern, OU3, Site 2, waterfront sediments

LEGEND Area of concern

0 500 1000 1500 Feet

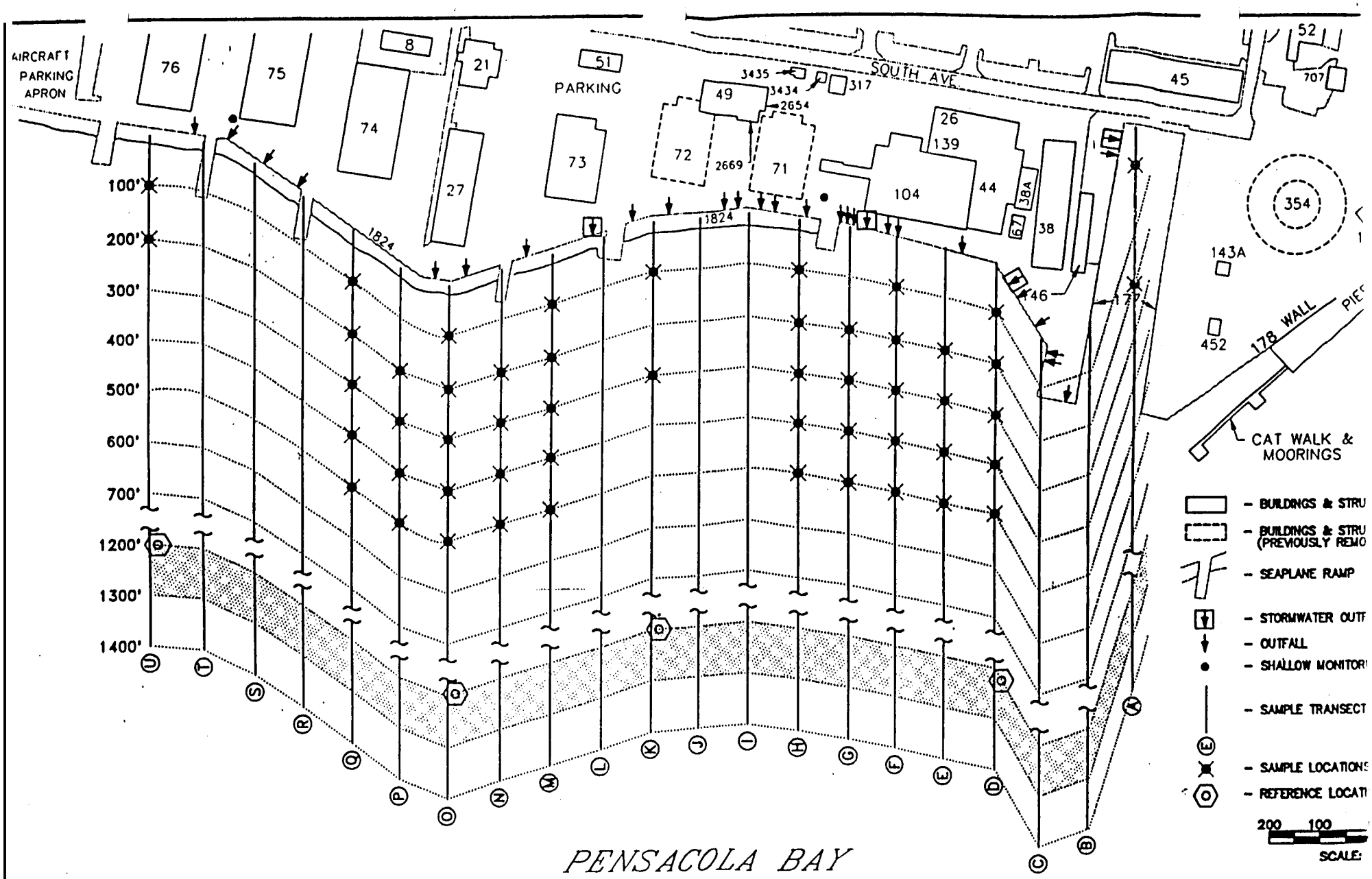

Figure 3.1 Map showing the sampling locations of the initial RI.

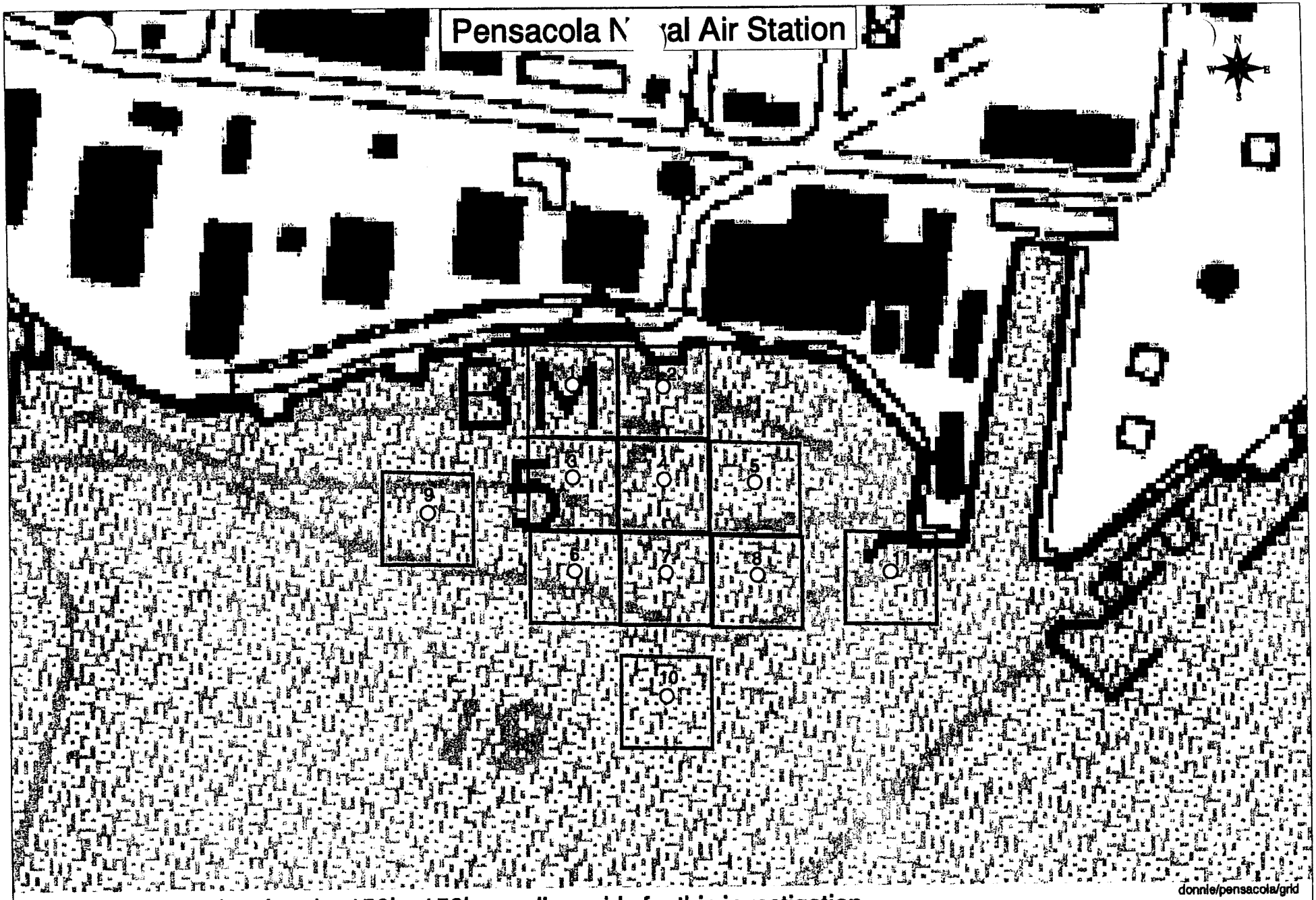

Figure 3.2 Map showing the 150' x 150' sampling grids for this investigation.

LEGEND Sampling grids

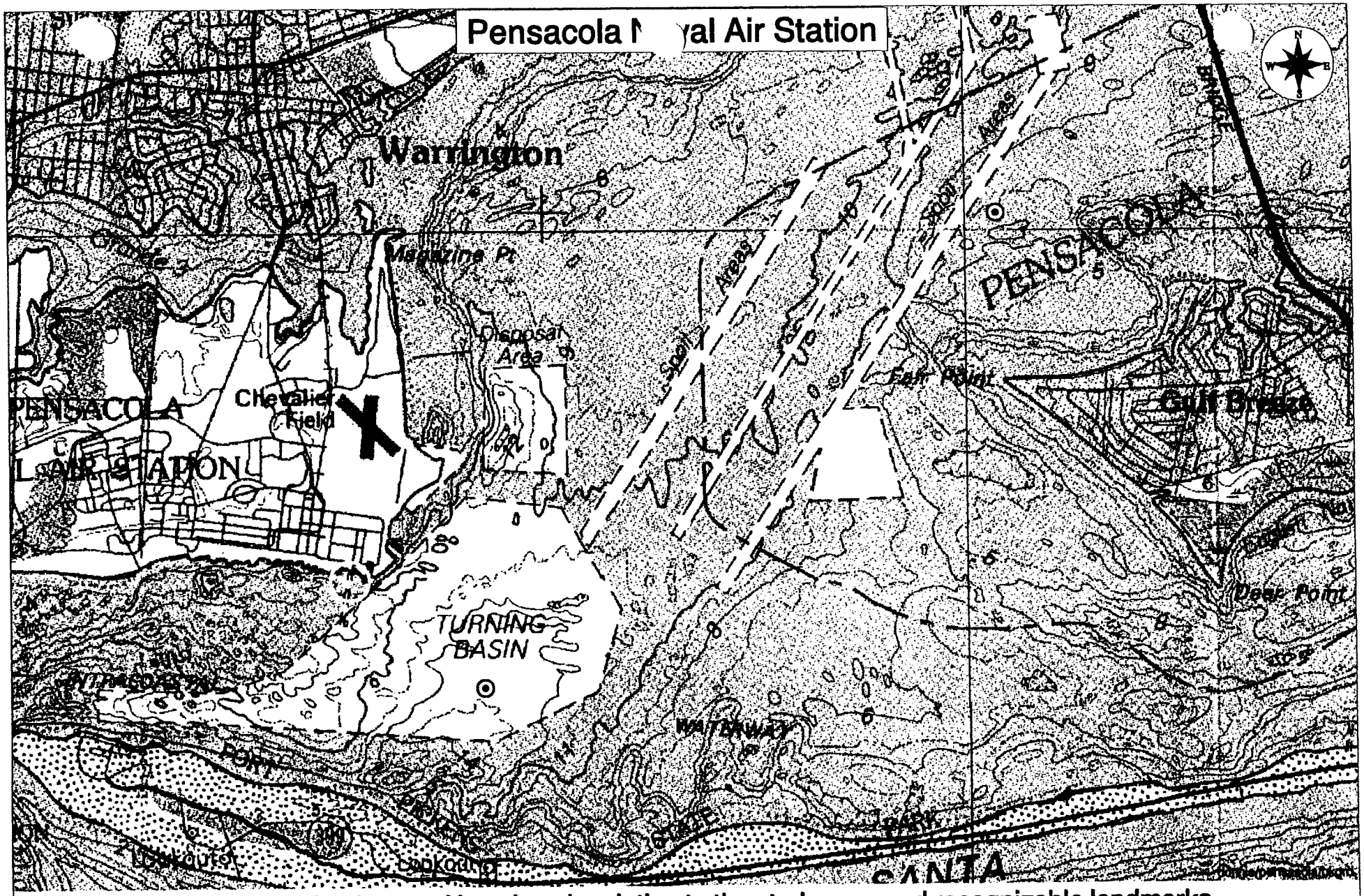

Figure 3.3 Map showing background locations in relation to the study area and recognizable landmarks.

LEGEND

Area of concern

⊙ Background locations

0 1 2 3 Miles

Volume 3

Post-RI Sampling and Analysis Plan
Site 2 NAS Pensacola

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MEMORANDUM

To: Pensacola Tier 1 Team

From: Allison Harris, EnSafe Inc.

Date: March 3, 2000

RE: POST-RI SAMPLING AND ANALYSIS PLAN
SITE 2 NAS PENSACOLA

INTRODUCTION

This Sampling and Analysis Plan has been developed to support the completion of a Record of Decision for Site 2 — Waterfront Sediments — NAS Pensacola. Specifically, this plan is designed to complete the assessment of the nature and extent of contamination at this site, and to provide the data needed to execute a removal of contaminated sediment from the site, if necessary. The required work will entail the collection and analysis of subaqueous sediment cores, toxicity and species diversity sample collection and analysis, and the preparation of a report detailing the work conducted and the data analyses. The additional data are required to refine the contamination at the site because of a) a significant change in site conditions since the initial RI sampling (i.e., Hurricane Georges) and b) a data gap in the initial RI. Since the RI sampling, the site has experienced a hurricane and a number of tropical storms, which would suggest that sediment redistribution may have occurred. Additionally, in accordance with the approved SAP, the initial RI data assessed the upper 6 inches of sediment only; data regarding deeper intervals was not collected. The following text describes the work to **be** conducted during this sampling effort.

A complete history of the site, and a detailing of the RI sampling locations and methodologies, is included in the RI report (EnSafe, 1997). The overall goal of this sampling effort is "to conduct a one-time sampling event that will delineate the vertical/horizontal extent of contamination such that a removal may be planned and executed based on the sampling results. Confirmatory sampling after the dredging (if necessary) will provide the evidence for site closure."

This Sampling and Analysis Plan (Volume **3)** focuses on the benthic community surveys and sediment toxicity testing. The other leg of the triad, sediment chemistry, is addressed in the Sampling and Analysis Plan presented in Volume **2.** Both of these documents will fulfill the requirements of the Data Quality Objective document contained in Volume 1.

SAMPLING

The brevity of this plan reflects the anticipation that USEPA's Environmental Services Division (ESD) will conduct the sampling and will complete a separate Sampling and Analysis Plan. Sampling will be conducted in accordance with the **SOPQAM.**

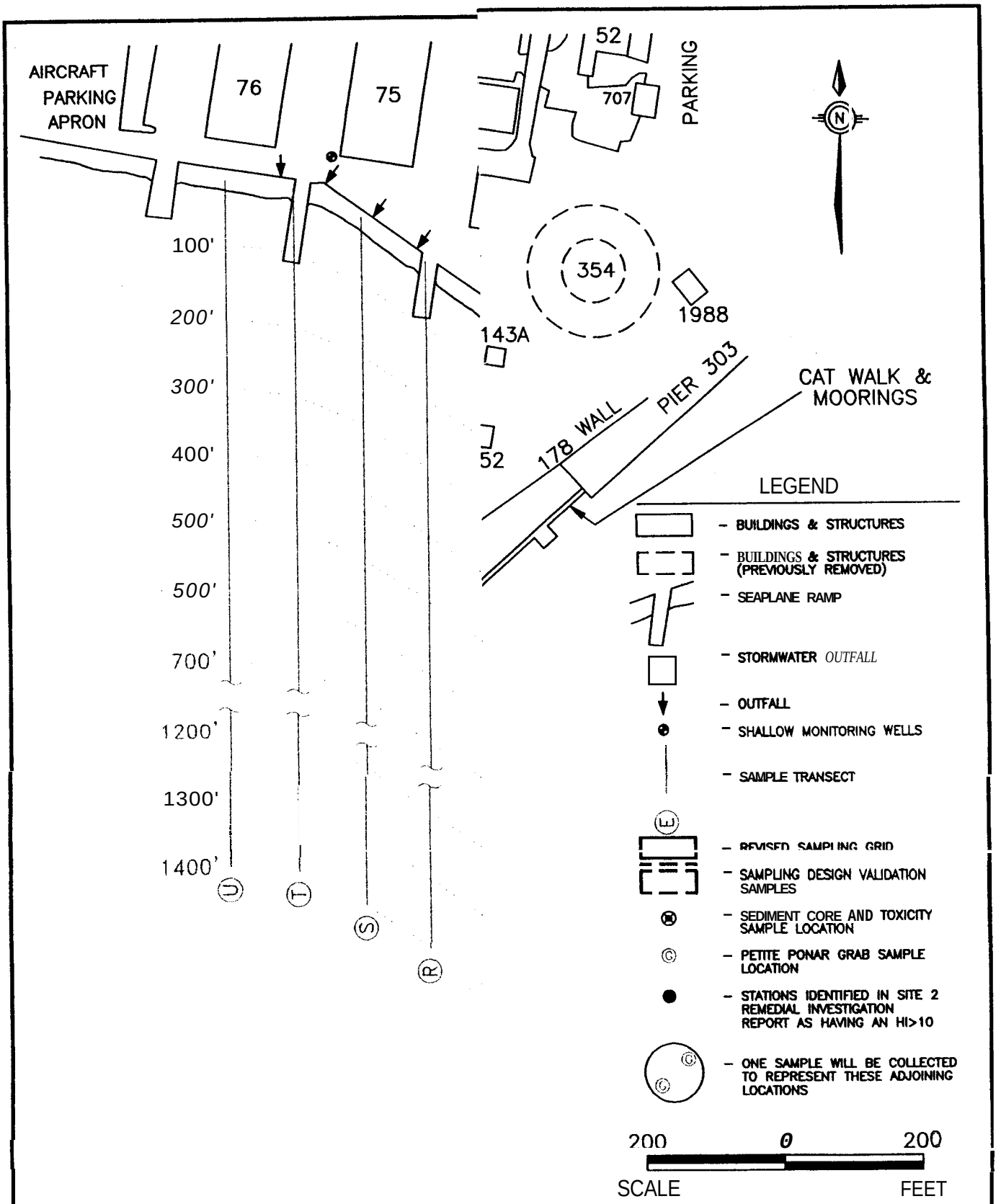
Locations:

Figure 1 presents the proposed sampling locations for this effort. In the initial RI, contamination was defined using the calculation of a Hazard Index, or HI, for the various sampling locations. The RI identified an area of HIs greater than 10 located in the eastern portion of the site. This area provides the focus for this additional sampling.

This plan calls for the collection of sediment at 13 decision units within and outside of the HI > 10 area for chemical, diversity and toxicity analyses. The assumption has been made that if a removal is to occur, it will encompass all sediment up to the seawall on the northern boundary of Site **2.** Eight decision units are in the area identified as being impacted in the RI report. Three decision units are identified outside the impacted area to validate the sampling scheme. Two other decision units are background locations. The decision units are defined in the DQO document provided in Volume 1.

Methodology:

General — Sampling at each decision unit will encompass a **36**" sediment core, a series of sediments collected from the upper 6 inches of the sediment using a decontaminated 6" long, **4"** diameter stainless-steel core tube, which will be composited for sediment chemistry characterization and sediment toxicity tests, and three discreet decontaminated **6**" long, **4**" diameter stainless-steel benthic core tubes for the species diversity.



ANALYSIS

FIGURE 1
POST-RI SAMPLING LOCATIONS

RIDA

DWG DATE:02/11/00 | DWG NAME:0083G012

Sample collection should occur in the following order at each decision unit: species diversity first, sediment chemistry and sediment toxicity composites second, and sediment core last.

Sediment samples will be collected downstream first and then proceed upstream for the next sample, and then upstream for the next (last) sample at that location. Samples will be discreet, that is each labeled, handled, and collected separate from each other for each location. There will be no cornpositing of samples for the species diversity study.

Sediments for the diversity study will be collected using decontaminated 6" long, 4" diameter stainless-steel benthic core tubes and emptied into a clean stainless-steel bowl. The diversity samples will be collected at three locations along a gradient in each decision unit as shown in Figure 1. Each grab will be sieved through a U.S. Standard No. 30 sieve (0.595 mm opening) to remove sediments and their components (sand, silt, and clay). Organisms retained on the sieve will be washed into a labeled sample jar and preserved with a solution of 10% buffered formalin or 70% ethanol.

Sediment intended for sediment chemistry and sediment toxicity will be collected at eight locations within the decision unit. At each of the eight locations, the samples will be collected from the upper 6 inches of the sediment using a decontaminated 6" long 4" diameter stainless-steel core tube (to be supplied by personnel from **USEPA** Region IV). The sediment will be composited and placed into the containers provided by the testing facility. The volume for the sediment toxicity tests should be 1 gallon (3.75 liters) composited sediment per decision unit. Core sampling is described in the Sampling and Analysis Plan provided in Volume 2. Chemistry samples will be collected in accordance with the SAP completed by USEPA in Volume 2.

Analysis — In addition to the chemical analysis performed by USEPA, toxicity (mysid and Leptocheirus) and diversity tests will be conducted by EnSafe. Toxicity test criteria are presented in Tables 1 and 2. Diversity analysis will include the following summary statistics:

- Number of each taxon per replicate/station
- Total individuals per replicate/station
- Number of taxa per replicate/station
- Individual density (#/m^2) per station
- Standard deviation of individual density per station
- Species diversity
- Species evenness
- Species equitability
- Species richness
- Phylogenetic listing

Additional Considerations:

This plan has been developed with the intent of delineating contamination quickly at Site **2** for the purposes of scoping a potential removal action. Some screening techniques for inorganics can and may be strategically employed to further refine the sampling effort, but if used, these techniques need to be identified and their use described for prior approval of their use by the Tier 1 Team.

Table 1 Test Conditions and Test Acceptability Criteria for the Mysid, *Mysidopsis Bahia,* Seven-Day Survival, Growth, and Fecundity Test with Sediments	
1. Test type:	Static renewal
2. Salinity:	**20** ppt (± 2 uut of the selected test salinity).
3. Temperature:	26" + 1" **C**
4. Lieht quality:	Ambient laboratory illumination.
5. Light intensity:	10-20 E/m²/s (50-100 ft-c.)(ambient laboratory levels).
6. Photoperiod:	16 h light, 8 h darkness, with phase in/out period.
7. Test chamber:	8 oz plastic disposable cups, or 400 ml glass beakers.
8. Sediment volume:	2 cm
9. Overlying water volume:	150 ml per replicate.
10. Renewal of overlying water:	Daily
11. Age of test organisms:	7 days
12. No. organisms per test chamber:	5 (minimum)
13. No. replicate chambers per concentration:	8 (minimum)
14. No. larvae per concentration:	40 (minimum)
15. Source of food:	Newly hatched *Artemia* nauplii (less than 24 h old).
16. Feeding regime:	Feed 150 24 h old nauplii per mysid daily, half after test solution renewal and half after 8-12 **h.**
17. Cleaning:	Pipette excess food from cups daily immediately before test solution renewal and feeding.
18. Aeration:	None unless DO falls below 4.0 mg/L, then gently aerate in all cups.
19. Overlying water:	Clean sea water, natural or reconstituted water.
20. Test concentrations:	Sediments: Minimum of **3** and a control sediment.
21. Sediment concentrations:	Sediments to be serially diluted with clean sediment. Sediment concentrations will be 100, 50, and 25% .
22. Test duration:	7 days
23. Endpoints:	Survival, growth, and egg development.
24. Test acceptability criteria:	80% or greater survival, average dry weight 0.20 mg or greater in controls; fecundity may be used if 50% or more of females in controls produce eggs.

Note:
Modified from: **U.S.** Environmental Protection Agency. (1991). *Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine **and** estuarine organisms.* Environmental Monitoring and Support Laboratory, Cincinnati, OH. EPA/600/4-91/028.

1. Test type:	Whole sediment toxicity test, static.
2. Temperature:	25" C
3. Salinity:	20 ppt (± 2 ppt of the selected test salinity)
4. Light quality:	Wide-spectrum fluorescent lights
5. Illuminance:	500 - 1000 lux
6. Photoperiod:	24L:0D
7. Test chamber:	1-L glass beaker or jar with - 10 cm I.D.
8. Sediment volume:	175 ml (2 cm)
9. Overlying water volume:	800 ml
10. Renewal of overlying water:	None
11. Size and life stage of amphipods:	2 - 4 mm (no mature males or females).
12. No. of organisms/chamber:	20 per test chamber.
13. No. of replicate chambers/treatment:	Depends on objective of test. At a minimum, four replicates must be used.
14. Source of food:	GORP - US **EPA** recipe.
15. Feeding:	Twice during test duration; day 2 and day 6.
16. Aeration:	Water in each test chamber should be aerated overnight before start of test, and throughout the test; aeration at rate that maintains 90% saturation of dissolved oxygen concentration.
17. Overlying water:	Clean sea water, natural or reconstituted water.
18. Overlying water quality:	Temperature daily. pH, ammonia, salinity, and DO of overlying water at least at test start and end. Salinity, ammonia, and pH of pore water.
19. Test duration:	10 days
20. Endpoints:	Survival and growth.
21. Test acceptability criteria:	Minimum mean control survival of 90% in the control exposure. Growth endpoint will be determined by subsampling the population at test initiation to establish a baseline weight. Organism weight at test termination will be compared to the control expo

Note:
Modified from: **U.S.** Environmental Protection Agency. *Methods for assessing the toxicity of sediment-associated contaminants with estuarine and* ***marine*** *amphipods.* EPA/600/R-94/025.