September 24, 2010

Mr. Philip Allen
Remedial Project Manager
USEPA
1445 Ross Ave.
Suite 1200
Dallas, TX 75202-2733

RE: Submittal of Draft BERA Work Plan
Patrick Bayou Superfund Site – Deer Park, TX

Dear Mr. Allen:

On behalf of the Patrick Bayou Joint Defense Group (JDG) and pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) for Remedial Investigation/Feasibility Study (RI/FS) at the Patrick Bayou Superfund Site in Deer Park, TX, attached please find the Draft Baseline Ecological Risk Assessment Work Plan for your review.

Should you have any questions please feel free to contact me at 919-435-0934.

Sincerely,

s/R Piniewski

Robert Piniewski
Project Coordinator

cc: Agency Distribution List
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DRAFT

BASELINE ECOLOGICAL RISK ASSESSMENT WORK PLAN
PATRICK BAYOU SUPERFUND SITE

Prepared for

Patrick Bayou Joint Defense Group

Prepared by

Anchor QEA, LLC
614 Magnolia Avenue
Ocean Springs, Mississippi 39564

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TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 General Project Approach 1
1.1.1 Preliminary Remedial Action Objectives 1
1.1.2 Risk Assessment Approach 3
1.2 Completed Scoping, Planning, and RI Tasks 3
1.3 Overview of Document 5
2 REFINEMENT OF COPCS 6
2.1 Update to the Sediment and Surface Water Dataset 9
2.2 Initial Screen of Surface Water COI 10
2.3 Identification of Surface Water COPC 11
2.3.1 Bioaccumulative Surface Water COPCs 13
2.4 Frequency and Magnitude of Detection Evaluation 14
2.4.1 Surface Water 14
2.4.2 Sediment 14
2.5 Evaluation of Nutrients as Surface Water COPCs 15
2.6 Sediment COPC Refinement for Aquatic Receptors 15
2.6.1 Aquatic Plants 15
2.6.2 Benthic Invertebrates 16
2.6.2.1 Refinement of COPCs Based on Their Exceedance of the Midpoint Screening Value Only 17
2.6.2.2 COPCs without Benchmarks 17
2.6.2.3 Benthic Invertebrate COPC Summary 18
2.6.3 Fish 19
2.6.3.1 Direct Contact COPCs 19
2.6.3.2 Bioaccumulative COPCs 19
2.7 Aquatic-Dependent Wildlife 20
2.7.1 Review of Representative Wildlife Receptors 20
2.7.1.1 Status of the Brown Pelican as a Species of Special Concern 21
2.7.1.2 Relevance of Piscivorous Mammals as Receptors 21
2.7.2 Sediment COPC Refinement for Aquatic-Dependent Wildlife 22
2.7.2.1 Refined Effects Assessment 23

2.7.2.2 Refined Exposure Assessment 24
2.7.2.3 COPC Identification 25
2.8 Summary of Sediment COPCs Refinement 26
2.9 Summary of COPC Refinement 26
3 BASELINE PROBLEM FORMULATION 27
3.1.1 Representative Receptors 27
3.1.2 Benthic Invertebrates 28
3.1.3 Fish 29
3.1.4 Birds 29
3.1.4.1 Herbivorous/Omnivorous Birds 29
3.1.4.2 Sediment-Probing Birds 30
3.1.4.3 Carnivorous Wading Birds 30
3.1.4.4 Piscivorous Birds 30
3.1.5 Herbivorous and Omnivorous Mammals 31
3.1.6 Summary of Representative Receptor Selection 31
3.2 Ecological Risk Conceptual Site Model 31
3.2.1 Sources and Release Mechanisms 32
3.2.1.1 Sediment 32
3.2.1.2 Surface Water 33
3.2.1.3 Groundwater 33
3.2.1.4 Air Particulates 33
3.2.1.5 Soil 33
3.2.2 Exposure Media 34
3.2.3 Exposure Pathways 34
3.2.3.1 Benthic Invertebrates 35
3.2.3.2 Fish 35
3.2.3.3 Birds 36
3.2.3.4 Mammals 37
3.3 Assessment Endpoints, Risk Questions, and Measurement Endpoints 37
3.3.1 Benthic Invertebrate Receptor Group 38
3.3.1.1 Assessment Endpoint and Risk Questions 38
3.3.1.2 Measurement Endpoints 38
3.3.2 Fish Receptor Group 39

3.3.2.1 Assessment Endpoint and Risk Questions 39
3.3.2.2 Measurement Endpoints 40
3.3.3 Aquatic-Dependent Wildlife Receptor Group 41
3.3.3.1 Assessment Endpoint and Risk Questions 41
3.3.3.2 Measurement Endpoints 41
3.3.4 Risk Analysis, Characterization, and Uncertainty Assessment 41

4 BENTHIC INVERTEBRATES RISK ANALYSIS AND CHARACTERIZATION 42
4.1 Surface Water Toxicity 42
4.2 Sediment Toxicity 42
4.3 Model Data 44
4.3.1 Chemistry Data 44
4.3.1.1 Calculation of Total or Sum Values 45
4.3.1.2 Calculation of SQG Quotients 45
4.3.1.3 Calculation of Equilibrium Sediment Benchmarks 46
4.3.1.4 Use of Split Sample Results as Proxy Data 48
4.3.2 Toxicity Data 48
4.3.2.1 Acute Response Compared to Chronic Endpoints 50
4.3.2.2 Summary of Toxicity Data 52
4.4 Predictive Model Evaluation 53
4.4.1 Methods 53
4.4.2 Model Optimization and Calibration 54
4.4.3 Summary of Predictive Model 56
4.5 Risk Characterization 57
4.6 Model Uncertainty Analysis 57
4.6.1 Non-Ionic Organic COPCs 57
4.6.2 Metals Bioavailability 58
4.6.3 COPCs that Exceed Their PEL but are Not Model Variables 58
4.6.4 COPCs Without SQG Values 61
4.6.5 Uncertainty Analysis Summary 62

5 FISH RISK ANALYSIS AND CHARACTERIZATION 64
5.1 Surface Water Toxicity 64
5.2 Sediment Toxicity 64

5.3 Bioaccumulation 64
5.3.1 Exposure Assessment 64
5.3.2 Effects Assessment 66
5.3.3 Risk Characterization 67

6 AQUATIC-DEPENDENT WILDLIFE RISK ANALYSIS AND CHARACTERIZATION .. 68
6.1 Measures of Exposure 68
6.1.1 Total Daily Intake Through Ingestion of Biota 69
6.1.1.1 Contaminant Concentration in the kth Type of Food (C_k) 71
6.1.1.2 Fraction of kth Type of Food that is Contaminated (FR_k) 72
6.1.1.3 Normalized Ingestion Rate (NIR_k) and Normalized Free Metabolic Rate ($NFMR_k$) 72
6.1.1.4 Gross Energies (GE_k) and Assimilation Efficiencies (AE_k) 73
6.1.1.5 Proportion of Diet for Prey Groups (P_k) 73
6.1.2 Incidental Ingestion of Sediment 74
6.1.2.1 Concentration in Sediment within Foraging Areas (C_k) 74
6.1.2.2 Fraction of Sediment Ingested (FS) 75
6.1.2.3 Food Ingestion Rate on Dry Weight Basis (IR_{total}) 75
6.1.2.4 Number of Foraging Areas (m) 76
6.1.3 Total Daily Intake from Water 76
6.2 Receptor-Specific Model Input Parameters 76
6.2.1 Spotted Sandpiper 77
6.2.1.1 Area Use Factor 79
6.2.2 Carnivorous Birds 80
6.2.2.1 Area Use Factor 82
6.2.3 Belted Kingfisher 83
6.2.3.1 Area Use Factor 85
6.2.4 Raccoon 86
6.2.4.1 Area Use Factor 88
6.2.5 Site Use Uncertainties 89
6.3 Measures of Effect 89
6.4 Risk Characterization 90

7 UNCERTAINTY ANALYSIS 91

8 DATA GAPS 92
8.1 Characterization of Tissue Chemistry 92
9 REFERENCES 93

List of Tables

Table 1 Surface Water Screening Criteria
Table 2 Comparison of Surface Water Data to Screening Values
Table 3 Non-Detect Surface Water COI Screening Values
Table 4 Bioaccumulative Surface Water COPCs
Table 5 Sediment COPCs Removed Due to Low Frequency of Detection
Table 6 Comparison of Selected Sediment COPC 95th Percentile to Screening Values
Table 7 Benthic Invertebrate Sediment COPCs
Table 8 Fish Whole Body TRVs for COPC Refinement
Table 9 Refined Fish Bioaccumulative Sediment COPC Hazard Quotients
Table 10 Revisions to TRVs for Wildlife COPC Refinement
Table 11 Wildlife TRVs for COPC Refinement
Table 12 Refined Wildlife Total Daily Intake Model Exposure Parameters
Table 13 Refined Wildlife COPC Hazard Quotients
Table 14 Summary of COPC Refinement
Table 15 COPCs in Benthic Toxicity Model Dataset with Less Than Full Representation
Table 16 Description of Sediment Quality Guidelines
Table 17 Summary of Bioassay Data Used in Benthic Toxicity Model Development
Table 18 Comparison of Incidence of Toxicity in 10-day and 28-day Bioassay Tests Evaluated by McGee et al. (2004)
Table 19 Sensitivity Comparison of Sublethal and Lethal Bioassay Test Endpoints Performed by Greenstein et al. (2008)
Table 20 Sensitivity Comparison of Acute and Chronic Bioassay Tests Performed by Steevens et al. (2008)
Table 21 Initial Reliability Analysis Results for Mean ERM-Q, Mean PEC-Q, Mean PEL-Q, PAH ESBTU, NOC ESBTU, and Metals ESBTU
Table 22 Results of Hypothesis Testing to Identify COPCs with a Significant Relationship Between Toxic and Non-Toxic Sample Groups

Table 23 Reliability Analysis Results for Initial and Optimized Mean PEL-Q and PEC-Q
Table 24 Comparison of NOC ESBTU and Metals ESBTU Values for Predicted Toxicity Using the Optimized Mean PEL-Q Model
Table 25 Comparison of PEL-Q Values for COPCs Not Included in the Predictive Model to Predicted Toxicity Using the Optimized Mean PEL-Q Model
Table 26 Comparison of COPCs Without SQGs to Predicted Toxicity Using the Optimized Mean PEL-Q Model
Table 27 Prey Group Classification of Wildlife Diets
Table 28 Exposure Variables for Wildlife Total Daily Intake Models
Table 29 Avian LOAEL TRVs
Table 30 Mammalian LOAEL TRVs

List of Figures

Figure 1 Aquatic Receptor COPC Selection Process Flowchart
Figure 2 Sources, Transport, and Media in Relation to Physical Features of the Site
Figure 3 Baseline Ecological Risk Assessment Conceptual Site Model
Figure 4 PAH ESBTU Site-Specific Scaling Factor for Samples with Less Than 34 PAH
Figure 5 Comparison of Magnitude of Toxicity in 10-day and 28-day Bioassay Tests Evaluated by McGee et al. (2004)
Figure 6a Error Rates and Reliability of ERM-Q and PEC-Q Models Across a Range of Values
Figure 6b Error Rates and Reliability of PEL-Q and PAH ESBTU Models Across a Range of Values
Figure 6c Error Rates and Reliability of Two ESBTU Models Across a Range of Values
Figure 7 Error Rates and Reliability of the Optimized Mean PEL-Q and PEC-Q Models

List of Appendices

Appendix A Supporting Information for COPC Refinement
Appendix B Supporting Information for Toxicity Model Evaluations
Appendix C Ecological Representative Receptor Species Profiles

List of Attachments

Attachment 1 Tissue Sampling and Analysis Plan

LIST OF ACRONYMS AND ABBREVIATIONS

µg	microgram
AE	assimilation efficiency
AOC	Administrative Order on Consent
ARAR	applicable and relevant or appropriate requirement
AUF	area use factor
AVS	acid volatile sulfide
BCF	bioconcentration factor
BEHP	bis(2-ethylhexyl)phthalate
BERA	Baseline Ecological Risk Assessment
BSAF	biota-sediment accumulation factor
CCC	Criteria Continuous Concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
COC	contaminant of concern
COI	chemical of interest
COPC	chemical of potential concern
DCA	Decision Consequence Analysis
DL	detection limit
DQO	Data Quality Objective
EC	exposure concentration
Eco-SSL	ecological soil screening level
EqP	equilibrium partitioning
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERM	effects range median
ESB	equilibrium screening benchmark
ESBTU	Equilibrium Screening Benchmark Toxic Unit
EPC	exposure point concentration
FCV	final chronic value
FMR	free metabolic rate

FS	Feasibility Study
g	gram
GE	gross energy
HCCPD	hexachlorocyclopentadiene
HQ	Hazard Quotient
HSC	Houston Ship Channel
JDG	Joint Defense Group
kcal	kilocalorie
kg	kilogram
km	kilometer
L	liter
LOAEL	lowest observed apparent effects level
LOED	lowest observable effects dose
MSDS	material safety data sheet
ME	metabolizable energy
mg	milligram
NAWQC	National Ambient Water Quality Criteria
NFMR	normalized free-living metabolic rate
ng	nanogram
NIR	normalized ingestion rate
NOAEC	no observed adverse effects concentration
NOAEL	no observed apparent effects level
NOED	no observed effects dose
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effects concentration
PEC-Q	probable effects concentration quotient
PEL	probable effect level
PEL-Q	probable effect level quotient
PMP	Project Management Plan

PRAO	preliminary remedial action objective
RI	Remedial Investigation
RL	reporting limit
SAP	Sampling and Analysis Plan
SCV	secondary chronic value
SEM	simultaneously extracted metals
Site	Patrick Bayou Superfund Site
SOW	Statement of Work
SQG	sediment quality guideline
SQG-Q	sediment quality guideline quotient
SVOC	semivolatile organic compound
SWAC	surface weighted average concentration
TBC	to be considered
TCEQ	Texas Commission on Environmental Quality
TDI	total daily intake
TEC	total effects concentration
TIE	toxicity identification evaluation
TMDL	total maximum daily load
TOC	total organic carbon
TRRP	Texas Risk Reduction Program
TRV	toxicity reference value
TU	toxic unit
TxPDES	Texas Pollutant Discharge Elimination System
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WMW	Wilcoxon-Mann-Whitney
WQC	Water Quality Criteria

1 INTRODUCTION

This Baseline Ecological Risk Assessment (BERA) Work Plan outlines the approach and methods for use in the baseline risk assessment for ecological receptors required in Task 4 of the Statement of Work (SOW) of the Administrative Order on Consent (AOC) for Remedial Investigation/Feasibility Study (RI/FS) of the Patrick Bayou Superfund Site (Site) dated January 31, 2006. This Work Plan also corresponds to Work Package 3 described in the Project Management Plan (PMP) of the *Remedial Investigation Work Plan* (Anchor 2007a).

1.1 General Project Approach

As outlined in the *Remedial Investigation Work Plan* (Anchor 2007a), an adaptive management approach is being used to complete the RI/FS process on behalf of the Patrick Bayou Joint Defense Group (JDG). In this approach, work is being completed and evaluated in a step-wise and prioritized fashion so that the conceptual site models for contaminant sources and distribution, site hydrology, exposure pathways, and risk analyses are continually updated as new information becomes available. As data gaps are recognized in these evaluations, work plans are developed as appropriate. The work completed to date, and into the future, is being performed so that existing and new data are complementary and contribute to building a better conceptual understanding of and remedial solution for the Site.

1.1.1 Preliminary Remedial Action Objectives

Development of preliminary remedial action objectives (PRAOs) was an important task completed as part of the RI scoping phase. Development of the Site PRAOs involved the use of existing studies and evaluations of Patrick Bayou as the basis of information in a pre-RI/FS decision-making effort known as a Decision Consequence Analysis (DCA). This DCA process included JDG, stakeholder, and agency representative participation as part of a Patrick Bayou DCA Working Group. This group and the DCA process evaluated the current conditions of the bayou, controllable and uncontrollable stressors to the bayou, and current and future uses of the bayou, and attempted to identify the long-term goals for improving the functions of the Site (e.g., industrial and municipal discharge watercourse and ecological habitat). Part of the process focused on achieving consensus among the stakeholders in

defining the Site objectives for the remediation of the bayou, and those objectives are now carried forward as the PRAOs for the RI/FS. Those PRAOs include the following:

- Primary PRAO:
  - Prevent adverse effects on wildlife species that may feed at the Site and prevent measurable degradation of downstream ecosystems as a result of the transport of contaminated sediment from Patrick Bayou
- Secondary PRAOs:
  - Achieve measurable improvements in total ecological system functions
  - Maintain remedy flexibility in response to remedy monitoring data
  - Minimize long-term institutional controls to maintain the remedied system

The primary PRAO focuses on managing controllable ecological stressors in Patrick Bayou. The beneficial uses of the bayou as defined by the Texas Commission on Environmental Quality (TCEQ) include industrial discharge and navigation; however, it is also recognized that the bayou provides ecological habitat to a variety of receptors (e.g., benthos, fish, birds, and small mammals). The physical conditions of the bayou, including natural variations in streambed configuration and substrate, hydraulic gradient, salinity, grain size, and the bayou's land uses will prevent restoration of the Site to a uniform measure of ecological function. Because of these limitations, the ultimate focus of the RI/FS is to develop a strategy for producing beneficial changes by identifying and managing the controllable stressors on the Site ecosystem.

The secondary PRAOs focus on ensuring a positive rate of improvement with regard to system function and lowering ecological risks through an efficient process. Efficiency is measured based on time, area, money, and overall effort in both the investigation and remediation of the Site.

1.1.2 Risk Assessment Approach

The BERA will be performed following standard U.S. Environmental Protection Agency (USEPA) and TCEQ guidance for ERAs including:

- *Ecological Risk Assessment Guidance for Superfund: Process for designing and conducting ecological risk assessments* (ERAGS; USEPA 1997)
- *Guidelines for Ecological Risk Assessment* (USEPA 1998)
- Relevant and appropriate updated USEPA guidance material (e.g., USEPA's Eco Updates)
- *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas* (TCEQ 2006)
- Other regional information, as applicable

ERAGS (USEPA 1997) is composed of eight steps. The screening-level problem formulation and ecological effects evaluation (Steps 1 and 2 of the USEPA framework) are part of the initial ecological risk screening assessment, which have been completed along with portions of Steps 3 through 6 (revised problem formulation, study design and Data Quality Objective (DQO) process, field sampling planning, and site investigation) through the RI/FS documents described in Section 1.2. Steps 3 through 6 will be refined in this Work Plan. Step 7 (risk characterization) will be performed in the BERA. Step 8 (risk management) is the stage where remedial actions are considered and is part of the FS.

1.2 Completed Scoping, Planning, and RI Tasks

To date, the JDG has completed and prepared the following evaluations and reports as part the Site adaptive management process related to scoping, planning, and RI tasks:

- *Preliminary Site Characterization Report* (Anchor 2006). This document provides a description of:
  - The physical setting of the Site
  - A summary of existing information from previous Site investigations and the Patrick Bayou total maximum daily load (TMDL) investigations
  - Preliminary conceptual site models for chemical sources and media, and ecological and human health exposure pathways

  - Identification of Site PRAOs
  - Identification of critical uncertainties and data needs
  - A preliminary list of applicable and relevant or appropriate requirements (ARARs) and to be considereds (TBCs)

- *Remedial Investigation Work Plan* (Anchor 2007a). This document provides the PMP, Quality Assurance Project Plan, Data Management Plan, and Health and Safety Plan, and lays the foundation of the RI approach.
- *Performance and Acceptance Criteria for Existing Data* and *Preliminary Contaminant of Potential Concern Selection* (Work Package 1 of the *Remedial Investigation Work Plan*; Anchor 2007b and 2007c). These documents assessed the usability of historical Site data for the RI/FS. Usable data were included in the identification of preliminary chemicals of potential concern (COPCs) for the ERA.
- *Vertical Profiling Hydrodynamic Field Data Collection and Contaminant Source Evaluation* (Work Package 2 of the *Remedial Investigation Work Plan*; Anchor 2007d). This evaluation included a vertical characterization of contaminants in sediment, sediment age dating, hydrodynamic data collection, and characterization of upstream sediment quality in the City of Deer Park and the East Fork tributary to Patrick Bayou.
- *Supplemental Work Plan* (Anchor 2007e). Based on the results of Work Package 2 evaluations, several data gaps were identified related to our understanding of the potential susceptibility of Site sediments to erosional forces, the geotechnical characteristics of the Site sediments, ongoing sediment accretion rates, and surface sediment porewater chemistry. Field investigations were completed in September 2007. Data evaluation and preparation of Technical Memoranda describing the findings is ongoing and will be presented in the Draft RI document (in preparation).
- *Selection of Contaminants of Potential Concern for Ecological Risk Assessment* (Anchor 2008a) and *Selection of Contaminants of Potential Concern for Ecological Risk Assessment Amendment* (Anchor 2008b). Preliminary COPCs identified in Work Package 1 (Anchor 2007c) were screened using risk-based methods to identify COPCs for additional investigations. The initial draft report was submitted to the USEPA in May 2008. An amendment was issued in October 2008 and approved by the USEPA.

- *Mixing-Zone Evaluation Work Plan* (Anchor 2008c). The fieldwork for this effort was performed in the fall of 2008. High vertical resolution cores were analyzed to identify the mixing zone depth for calibration of the sediment model.
- Sediment Transport Model (Anchor QEA 2009a). This study is focused on a quantitative evaluation of the physical transport of sediment and evaluates the transport and fate of particle-associated COPCs.
- *Surface Sediment Contaminant of Potential Concern Delineation and Surface Water Sampling Data Report* (Anchor QEA 2010). This report provides the results of sediment and surface water samples collected at the Site to delineate the distribution of COPCs for ecological receptors and to identify surface water COPCs.

In addition to the documents described above, meeting notes for the Patrick Bayou Technical Work Group have been compiled and are part of the project record.

1.3 Overview of Document

The remainder of this BERA Work Plan describes the approach and information needed to fulfill the requirements of the BERA and to incorporate ecological considerations into the Site remedial process. It describes:

- Refinement of the current list of ecological COPCs to be carried forward into the BERA (Section 2)
- An overview and background of the Site including the Site's physical setting, ecology, and historical use (Section 3)
- A Site conceptual model, including an identification of representative receptors, potential exposure pathways selected for analysis, the assessment endpoints and questions or testable hypotheses, and the measurement endpoints selected for analysis (Section 3)
- Approaches to estimate and interpret risk for representative receptors (Sections 4 through 6)
- A description of assumptions used and the major sources of uncertainty in the Site conceptual model and existing information (Section 7)
- The identification of additional Site investigations needed to conduct the BERA (Section 8)

2 REFINEMENT OF COPCs

In ERAGS (USEPA 1997), the first part of the BERA problem formulation is the "refinement" of the COPC list using more realistic, yet still conservative, assumptions. This refinement, covered in Section 3.2 of ERAGS, is informally known as Step 3A. The USEPA does not provide detail on specific methodologies and direction that can be used to focus the list of COPCs, but does provide a general discussion of the process. USEPA (1997a) states simply that Step 3A "should consider how the HQs [hazard quotients] would change if more realistic conservative assumptions were used instead," and that for those constituents for which the HQs are less than 1 using the new assumptions, "the lead risk assessor and risk manager should discuss and agree on which can be eliminated from further consideration."

In addition, the USEPA's *ECO Update: The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (2001) provides additional guidance on the refinement of COPCs. That document addresses how background, frequency and magnitude of detection, and dietary considerations may be used to reduce the list of COPCs carried forward into the BERA. It also describes a process referred to as sub-tiering, in which an incremental iteration of the exposure, effects, or risk characterizations being conducted within the BERA may occur. This iteration may be performed at any point within Steps 3 through 7 of the eight-step ERA process described in ERAGS (USEPA 1997). Sub-tiering has the goal of focusing the evaluation of COPCs, so resources can be more effectively applied to the ERA process. Sub-tiering is considered particularly appropriate when new information or new results from completed studies become available.

To efficiently focus the BERA and any additional Site investigations, a combined refinement/sub-tiering step will be performed as part of the baseline problem formulation step. The results of this refinement are included in this Work Plan to: 1) to inform and focus the BERA to be performed; and 2) support the scope of additional proposed sampling activities. There are several reasons to include this step as part of the Work Plan. They are:

1. This approach is consistent with the adaptive management approach that has been agreed to for this Site. Work is being completed and evaluated in a step-wise and prioritized fashion so that the conceptual site models for contaminant sources and

distribution, site hydrology, exposure pathways, and risk analyses are continually updated as new information becomes available (Anchor 2007a).

2. Additional site-specific information has become available for the Site. Sediment and surface water sampling was performed subsequent to the COPC Report and Amendment (Anchor 2008a, 2008b). This additional sampling represents a temporally and spatially robust characterization of the Site COPCs in these media and should be incorporated into the ERA process prior to the BERA. These additional data will reduce uncertainty and provide a higher degree of confidence in the list of COPCs to be evaluated in the BERA.
3. The current COPC list is exhaustive and should be focused so resources can be used effectively to characterize risk. The current list of target analytes based on the COPC Report and Amendment (Anchor 2008a, 2008b) contains 100 different chemicals.[1] This list is unwieldy and in all likelihood does not reflect the list of chemicals that pose a significant unacceptable risk for adverse effects on ecological receptors. According to USEPA (1988) guidance for conducting an RI/FS under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), selection of 'indicator chemicals'[2] can serve to simplify and focus much of the investigation, the required analyses, and the evaluation of remedial alternatives. The purpose of the screening level assessment was to provide a general indication of the potential for ecological risk and not to necessarily identify those specific chemicals driving risk. As such, a refinement of the chemicals carried into the BERA is warranted to focus on indicator chemicals and to avoid diverting resources in pursuit of chemicals with little likely incremental or measureable contribution to significant unacceptable risks to ecological receptors.

The refinement of COPCs in Step 3A of the problem formulation will consist of the following elements:

- Update to sediment and surface water dataset – Subsequent to the COPC Report and Amendment for ecological receptors, additional sampling of sediment and surface water was performed (Anchor QEA 2010). The purpose of this sampling effort was to

1 Not including all 209 PCB Congeners, which are treated as one analyte for purposes of the tally.

2 An indicator chemical or chemical group is one that is the most toxic, persistent, and/or mobile among those substances likely to contribute significantly to the overall risk at the Site.

provide a robust, spatially representative characterization of sediment COPCs and surface water COPCs/chemicals of interest (COIs). These data were collected with the explicit purpose of supporting the risk assessment. As such, these data will be used to refine the selection of COPCs.

- Initial screen of surface water COIs – For surface water, some chemicals had not been adequately characterized to select COPCs prior to the most recent sampling event described above.[3] These chemicals were identified as COIs because their status as COPCs has not been evaluated to date. Surface water COIs for ecological receptors will be screened against appropriate benchmarks to identify a complete list of surface water COPCs.
- Frequency and magnitude of detection – USEPA (2001) provides for further reduction in COPCs in the refinement step by considering these elements. COPCs with limited frequency of detection, low magnitude of detection, and no localized distribution (e.g., 'hotspot') will be considered for elimination as COPC.
- Evaluation of nutrients as COPCs – Two COPCs, nitrate and total kjeldahl nitrogen, were identified previously as COPCs. The status of these nutrients as COPCs will be re-evaluated in light of additional data collected subsequent to the initial screening and selection as COPCs.
- Re-evaluation of representative receptors – Subsequent to the COPC Report and Amendment (Anchor 2008a, 2008b), new information regarding the status and relevance of representative receptors has become available. As such, the status of the brown pelican as a special status species will be re-evaluated. In addition, home range analysis of mink and river otter will be evaluated to determine their continued relevance to the Site as representative receptors.
- Use of more realistic exposure parameters – More realistic but conservative exposure parameters will be considered for both aquatic receptors (e.g., benthos, fish) and aquatic-dependent wildlife. In the screening of COPCs (Anchor 2008a, 2008b), highly conservative exposure estimates (e.g., upper-bound sediment concentrations, wildlife ingestion rates, etc.) were intentionally used. In the refinement, more realistic exposure parameters will be considered. A refined effects assessment also will be completed as part of this evaluation.

3 Nutrients and metals are the only chemical groups for which COPC screening has been performed. See the COPC Report and Amendment (Anchor 2008a, 2008b).

The following sections describe the refinement of COPCs based on the elements previously described.

2.1 Update to the Sediment and Surface Water Dataset

Additional surface sediment and surface water sampling was performed at the Site in October and November of 2009. In a systematic grid pattern across the Site, 46 surface sediment samples (sample interval was 0 to 10 centimeters (cm) depth in the sediment layer) were collected and analyzed for the list of COPCs identified in the COPC Report Amendment (Anchor 2008b). At four stations at the Site,[4] 14 surface water samples were collected and analyzed for surface water COPCs and COIs identified in the COPC Report Amendment (Anchor 2008b). The objective of this sampling was to collect a spatially representative sediment and surface water dataset for use in the exposure assessment of the BERA. Detailed results of this sampling are provided in the *Draft Sediment and Surface Water COPC Delineation Data Report* (Anchor QEA 2010).

The data collected during this event will be used to refine the exposure assessment performed as part of the previous COPC screening (Anchor 2008a, 2008b). Use of this recently collected dataset will reduce the overall uncertainty in the selection of COPCs for the following reasons:

1. These data represent the most recent, comprehensive assessment of the conditions at the Site. Previous investigations include data collected between 2000 and 2006.
2. These data provide a spatially robust characterization of the distribution of COPCs at the Site. In previous investigations, sampling was focused on determining the vertical profile of contamination and the depth of the mixing zone. The sample stations in these earlier sampling events were often located within the main channel of the Site, and margins of the channel and Site were not assessed. The 2009 sampling was completed over a grid pattern throughout the entire Site, and provides a synchronous set of Site-wide data to develop surface concentration maps that can be used in the risk assessment and feasibility study. Data from sampling events prior to 2009 may be utilized as required to supplement the 2009 data.

4 Three additional stations (represented by eight samples) were collected off site during the same investigation.

3. Samples were collected, analyzed, and validated in a consistent manner, resulting in data of known quality. Sample collection methods, field protocols, and quality control protocols often differed between sampling events in the pre-2009 dataset due to the different objectives (e.g., TMDL, RI/FS) and sampling entities. These differences represent a potential source of variability in the dataset that is absent or largely controlled in the recently collected data.
4. Specific sources of variability and uncertainty were addressed in the recently collected dataset. Previous datasets included different and alternative methods of analysis (i.e., polychlorinated biphenyls [PCBs]), making comparisons or pooling of data a potential source of uncertainty while the recent dataset included congener-specific analysis of all samples. In addition, confirmatory analysis of DDT data addressed the potential matrix inference issues with PCBs that was suspected in previous sampling efforts. Finally, acid volatile sulfide/simultaneously extracted metals (AVS/SEM) analysis was performed on the 2 cm interval to avoid bias due to anoxic conditions in deeper sediments.

The 2009 dataset will be used in the subsequent refinement according to the methods described in the following sections.

2.2 Initial Screen of Surface Water COI

The COPC Report and Amendment (Anchor 2008a, 2008b) conceptual site model identified exposure to chemicals in surface water as a complete exposure pathway for benthic invertebrates and fish. However, insufficient surface water data were available to screen and identify COPCs with the exception of metals and nutrients. This data gap was addressed during the October-November 2009 sampling effort. Surface water samples were collected at several locations within the Site on two separate dates for a comprehensive list of COIs (see Anchor QEA 2010 for details); these data were used to screen for direct contact and bioaccumulative surface water COPCs described below.

The Texas marine ecological surface water benchmark (TCEQ 2006) was selected as the direct contact screening effect value, or in the absence of a state marine benchmark, the most current federal National Ambient Water Quality Criteria (NAWQC; marine Criteria

Continuous Concentration [CCC]) was used (USEPA 2009). If no Texas marine benchmark or NAWQC was available for a COI, the secondary chronic values (SCVs)[5] published by the National Oceanic and Atmospheric Administration (Buchman 2008) were used. Screening values are listed in Table 1. In two instances, a COI was detected but did not have a screening value. For these cases, a structurally similar chemical with a screening value was chosen as a surrogate.[6]

To identify COPCs, the maximum detected concentration of each COI was compared to its respective screening value using a HQ approach (Table 2). Use of the maximum concentration is appropriate in this case as it the first evaluation of COIs in surface water and is a very conservative approach to identify COPCs. COIs that were not detected were compared to their benchmark using the maximum detection limit (DL).

Several COIs that were not detected have no published benchmarks from the sources considered (Table 3). These COI are not evaluated further and are not considered COPCs.

Fourteen chemicals had screening HQs in Table 2 exceeding 1.0. Eight of those chemicals had maximum detected values above their respective screening value. Six chemicals were not detected in surface water but had maximum DL above their respective screening values.

2.3 Identification of Surface Water COPC

Table 2 presents eight detected chemicals that have HQs greater than 1.0 and six non-detect chemicals where the maximum DL was higher than the screening values. These chemicals are discussed further here to identify surface water COPCs.

Several organochlorine pesticides in Table 2 (alpha-chlordane, total chlordane, dieldrin, heptachlor epoxide, heptachlor, toxaphene, 4,4'-DDT, 2,4'-DDT, and endrin ketone), had detected concentrations or maximum DL above their respective screening values. However, no pesticide manufacturing or formulation facilities are known to have operated at the Site and a number of studies have shown that pesticides are a common contaminant in urban

5 The Marine SCV was the preferred SCV. If no Marine SCV was reported, the Freshwater SCV was used, if available.

6 Endrin was chosen as a surrogate for endrin ketone and alpha-BHC was used a surrogate for delta-BHC.

settings (e.g., Sprague and Nowell 2008). Rather, concentrations in surface water are more suggestive of a non-point source, upstream urban runoff condition. Toxaphene is a pesticide that has been banned in the United States since 1982. Given that there was no known manufacture of this pesticide at any of the facilities adjacent to the Site, its absence in Site sediments, and lack of detection in surface water, toxaphene is not considered a surface water COPC. In addition, organochlorine pesticides are not considered indicator chemicals for this Site. According to USEPA (1988) guidance for conducting an RI/FS under CERCLA, it may be appropriate to select one or more indicator chemicals to focus the assessment on those chemicals likely to be of greatest concern. An indicator chemical or chemical group is one that is the most toxic, persistent, and/or mobile among those substances likely to contribute significantly to the overall risk at the Site. Consistent with this guidance, lack of a discrete source at the Site, and other more appropriate indicator chemicals (i.e., PCBs), these pesticides are not considered COPCs for Site surface water.

Anthracene, pyrene, hexachlorobutadiene, and hexachlorocyclopentadiene (HCCPD) also were not detected in surface water but had maximum DL greater than their screening values. Anthracene and pyrene were the only polycyclic aromatic hydrocarbons (PAHs) with reporting limits (RLs) exceeding their screening values. All other PAHs were not detected and had RL less than their screening values. This indicates that PAHs in surface water are generally not present at concentrations in excess of screening values and anthracene and pyrene should not be considered surface water COPCs based on their maximum RL. HCCPD is used in the manufacture of pesticides and flame retardants and has a very short (e.g., minutes) half-life in water when exposed to sunlight (ATSDR 1999). Given its short half life, absence in Site sediments, and small difference (i.e., less than an order of magnitude) between the RL and screening values, HCCPD is not considered a surface water COPC. Hexachlorobutadiene had a maximum RL of 0.65 µg/L and a screening value of 0.32 µg/L, indicating that even if it is present at one-half the RL, it would be at a concentration near or below the screening value and would pose negligible risk. Thus, none of these four non-pesticide COIs with RL exceeding the screening value are considered COPCs for surface water.

Two COIs, dioxin/furan congeners and caprolactam, were detected in surface water but did not have an available screening value.[7] Because of uncertainties in establishing the bioavailability of dioxin/furan congeners in aqueous solutions, measured concentrations in test organisms, as opposed to aqueous concentrations, are a more useful metric of expressing aquatic toxicity dose-response relationships (USEPA 1993). As such, risks from dioxin/furan congeners in surface water will be assessed as a bioaccumulative COPC using a body burden approach for fish (see Section 3.3.2.2).

Aquatic toxicity data for Caprolactam are sparse. A review of the open literature identified one relevant study. Murin et al. (1997) reported a 48-hour LC50 of 2,430 for *Daphnia magna*. Only two records for aquatic toxicity from a single study are available in the USEPA's ECOTOX database (USEPA 2003a). They include an EC50 of 7,000 mg/L for *Daphnia magna* and an LC50 of 1,450 mg/L for the fish *Leuciscus idus* (ECOTOX Ref No. 10936). A review of the 'grey' literature (e.g., material safety data sheets [MSDS]) has reported aquatic LC50 values in the thousands of mg per liter as well. Compared to these few reported values, the maximum detected concentration in surface water (0.6 µg/L) is orders of magnitude less and is not considered a COPC for surface water.

Based on the above evaluations, total PCBs are considered direct contact surface water COPC. Specifically, PCBs were detected in surface water at concentrations exceeding available screening levels.

2.3.1 Bioaccumulative Surface Water COPCs

In addition to comparing COIs to direct contact screening criteria, detected COIs in surface water were compared to the list of potentially bioaccumulative chemicals in surface water in TCEQ's *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas* update (2006). Chemicals detected in surface water that were included in this list were identified as bioaccumulative surface water COPC (Table 4). They include mercury, selenium, PCBs, and dioxin/furans.

7 Although some screening values for dioxin/furans have been established, they are generally based on endpoints that are not clearly connected with growth, reproduction, or survival (e.g., 'marketability of fish') and were not considered relevant.

2.4 Frequency and Magnitude of Detection Evaluation

USEPA (2001) provides conditions under which chemicals may be removed from further assessment based on frequency and magnitude of detection. To remove COPCs based on low frequency of detection, the following conditions must be met:

1. The COPC must have been detected in less than 5 percent of the samples (this requires a minimum of 20 samples).
2. The total number of detects plus the total number of laboratory reported DLs exceeding the screening value must be less than 5 percent of the total samples.
3. The detected constituent concentrations and spatial distribution must not be indicative of a potential "hotspot" or localized release (e.g., data/findings are confirmed by other adjacent data/findings).

2.4.1 Surface Water

Refinement of surface water COPCs based on frequency and magnitude of detection was not performed because all three required conditions were not met; only 14 surface water samples were available, which is less than the minimum of 20 required for this step.

2.4.2 Sediment

Based on these requirements, four previously identified sediment COPCs[8] (Anchor QEA 2008b) met these criteria (Table 5): aldrin, methoxychlor, 1,2-dichlorobenzene, and di-n-octyl phthalate. These chemicals also lack an associated Midpoint Screening Value.[9] Thus, these COPCs will be eliminated from the final list of direct contact and bioaccumulative COPCs for the BERA.

8 Three individual PCB Congeners (PCB-169, -88, and -160) and one DDT isomer (2,4'-DDT) were also detected at less than 5 percent frequency. These analytes are typically included in a 'Total' format and their 'Total' values exceeded their respective screening values. Therefore, these analytes were not considered for elimination as COPCs based on frequency of detection.

9 Midpoint Screening Value is the mean of the Texas marine sediment ecological benchmark and Secondary Effects Level (TCEQ 2006; see Anchor 2008b).

2.5 Evaluation of Nutrients as Surface Water COPCs

Two COPCs, nitrate and total kjeldahl nitrogen, were identified as COPCs in the initial surface water screening (Anchor 2008a, 2008b). These two COPCs are not generally considered toxic to benthic invertebrates or fish; rather, they have an indirect effect on aquatic receptors through nutrient enrichment and eutrophication effects (i.e., ecosystem level effects). No federal or state water quality criteria (WQC) have been established for these COPCs. Given the lack of any applicable WQC for these COPCs, a quantitative risk evaluation based on a HQ approach is not possible. Instead, a semi-quantitative assessment will be performed as part of the uncertainty analysis in the BERA. The range of observed values at the Site will be compared to the range of values measured within the 1005 and 1006 segments of the Houston Ship Channel (HSC) as part of TCEQ's routine surface water monitoring program.

2.6 Sediment COPC Refinement for Aquatic Receptors

2.6.1 Aquatic Plants

Exposure of rooted aquatic plants to sediment COPCs through porewater was evaluated quantitatively to the extent possible in the COPC Report and Amendment (Anchor 2008a, 2008b). The 95th percentile of the measured porewater concentration was compared to the Aquatic Plant Lowest Chronic Value (Suter and Tsao 1996). Five COPCs (mercury,[10] copper, nickel, acenapthene, DDT, and total PCBs) were identified for aquatic plants based on this screen (Anchor QEA 2008a, 2008b).

However, the Aquatic Plant Lowest Chronic Value is based on algae tests of short duration; thus, effects data to assess the sensitivity of rooted aquatic plants at the Site to sediment-based chemicals are limited. Extrapolation of these tests to chronic effects in rooted aquatic plants is highly uncertain. Therefore, the risk assessment will not attempt to further quantify risk to rooted aquatic plants in this manner. Rather, a qualitative assessment of risk to plants from the COPCs for this group will be performed in the uncertainty assessment of the BERA. Risks due to surface water exposure for benthic invertebrates and fish, which will

10 Both total and methylated forms

be performed using WQC,[11] will be assumed to be protective of surface water exposure for plants.

2.6.2 Benthic Invertebrates

For the screening assessment, a multiple lines-of-evidence approach was used in the COPC Report and Amendment (Anchor 2008a, 2008b) to identify COPCs for benthic invertebrates and fish (Figure 1). For the first line of evidence, the 95th percentile of the concentration of chemicals detected in sediment was compared to their respective Midpoint Screening Value. Any preliminary COPCs that exceeded the Midpoint Screening Value were identified as a COPC. For the second line of evidence, the distribution of the concentration of chemicals in sediments identified as toxic on the basis of sediment bioassays was compared to the distribution in non-toxic sediments. Any chemical with an elevated concentration in toxic sediments relative to non-toxic sediments was retained as a COPC.[12] For the third and final line of evidence, the 95th percentile of the concentration of chemicals detected in porewater was compared to their respective surface water quality benchmarks; a chemical with 95th percentile concentration exceeding the surface water quality benchmark was identified as a COPC. In this multiple lines-of-evidence approach, a chemical was identified as a COPC if it exceeded the criteria for any of the three lines of evidence.

In the refinement step performed here, the COPCs identified in the COPC Report and Amendment (Anchor 2008a, 2008b) were re-evaluated based on the additional sediment data collected. Two types of COPCs were considered: 1) COPCs that were identified as a COPC based on their exceedance of the Midpoint Screening Value only (i.e., not elevated in toxic samples and did not exceed the porewater benchmark)[13]; and 2) chemicals that lacked marine screening benchmarks and were not analyzed in sediments associated with bioassays or in porewater. Refinement of each group of COPCs is described below.

11 Federal and state WQC are, by narrative definition, protective of aquatic plants and animals.

12 Chemicals were considered elevated in toxic sediments if the 75th percentile sediment concentration exceeded 2 times the 75th percentile of the chemical in non-toxic sediments.

13 No update to these lines of evidence was performed because there was no new sediment toxicity or porewater chemistry data collected subsequent to the COPC Report Amendment (Anchor 2008b). COPCs identified based on either of these lines of evidence will be carried forward as COPC (i.e. no refinement of these COPCs were performed).

2.6.2.1 Refinement of COPCs Based on Their Exceedance of the Midpoint Screening Value Only

To refine these sediment COPCs for benthic invertebrates, the 95th percentile[14] for these COPCs were recalculated using the sediment data collected in 2009 and compared to the Midpoint Screening Value.[15] This list of COPCs included:

- Arsenic
- Copper
- Zinc
- Benzo(a)pyrene
- Chlordane, alpha-
- Chlordane, gamma-
- Chlordane, total
- Hexachloroethane
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene

Table 6 compares the updated 95th percentile sediment concentration of each COPC listed above to its respective Midpoint Screening Value. Arsenic, copper, hexachloroethane, 1,3-dichlorobenzene, and 1,4-dichlorobenzene had 95th percentile values less than their respective screening values and were eliminated as sediment COPCs for benthic invertebrates.

2.6.2.2 COPCs without Benchmarks

Several chemicals detected in sediment could not be evaluated using any of the lines of evidence in Figure 1. These chemicals were identified as uncertain COPCs and include ammonia, benzo(e)pyrene, indeno(1,2,3-cd)pyrene, perlyene, endosulfan I, endosulfan II, 4-isopropyltoluene, and endrin. To further evaluate their status as COPC, alternative screening values were considered, if available. Ammonia in sediments is a direct result of bacterial

14 The 95th percentile of the concentration was used here to be consistent with the method used for sediment and porewater exposures in the COPC Report and Amendment (Anchor 2008a, 2008b).

15 Total DDx was excluded from this analysis because its components (DDD, DDE, and DDT) were identified as COPCs based on other lines of evidence and it would therefore be included by default as a COPC.

action on decaying organic matter and is a natural component of sediment ecosystems. The presence of ammonia in sediments is not due to any releases of anthropogenic chemicals to the Site and no sediment screening values have been established for in-situ sediments. As such, ammonia will not be considered further as a COPC for sediments. Benzo(e)pyrene, indeno(1,2,3-cd)pyrene, and perylene are high molecular weight PAHs similar in molecular weight and structure to benzo(a)pyrene. Thus, the Midpoint Screening Value for benzo(a)pyrene was chosen as a surrogate. No marine sediment screening values were identified for 4-isopropyltoluene or endrin in the literature. As such, the average of the TCEQ freshwater sediment screening benchmark and second effects level[16] (TCEQ 2006) were used as the Midpoint Screening Value for these chemicals. A review of the available literature did not identify any sediment screening values for endosulfan I and endosulfan II. The USEPA (2007a) identified a no observed adverse effects concentration (NOAEC) for endosulfan sulfate of 480 µg/kg based on a 28-day spiked sediment test using *Leptocheirus plumulosus* with growth and reproduction as endpoints. Thus, the NOAEC for endosulfan sulfate was taken as a surrogate screening value for endosulfan I and II.

Table 6 compares the updated 95th percentile sediment concentration of each COPC listed above to its respective Midpoint Screening Value or derived SV. 4-isopropyltoluene and endrin had 95th percentile values less than their respective screening values and were eliminated as sediment COPCs for benthic invertebrates.

2.6.2.3 Benthic Invertebrate COPC Summary

Only the first line of evidence (the 95th percentile of the concentration of chemicals detected in sediment compared to their respective Midpoint Screening Value) was able to be re-evaluated based on the additional sediment data collected. Zinc, benzo(a)pyrene, benzo(e)pyrene, indeno(1,2,3-cd)pyrene, and perylene exceeded their respective screening values and were retained as COPCs for the BERA (Table 6). Alpha-chlordane, gamma-chlordane and total chlordane also exceeded their respective screening values. However, these pesticides were not retained as COPCs as no pesticide manufacturing or formulation facilities are known to have operated at the Site and these pesticides are a common

16 Equivalent to the total effects concentration (TEC) and probable effects concentration (PEC) of MacDonald et al. 2000.

contaminant in urban settings (e.g., Sprague and Nowell 2008). Additional data pertaining to the second and third lines of evidence (i.e., sediment toxicity and porewater data) were not collected. Therefore, chemicals identified as COPCs in the COPC Report and Amendment (Anchor 2008a, 2008b) based on the second and third lines of evidence were automatically retained as COPCs for the BERA. Table 7 provides a complete list of benthic invertebrate sediment COPCs, including the chemicals identified as COPCs based on the re-evaluation of the first line of evidence and the chemicals determined to be COPCs using the second and third lines of evidence from the COPC Report and Amendment (Anchor 2008a, 2008b). The pesticides, DDD, DDE, DDT, and gamma-BHC (Lindane) that were initially retained using the second and third lines of evidence from the COPC Report and Amendment will not remain as COPCs as they are also not Site chemicals (Anchor 2008a, 2008b). However, all pesticides will be evaluated in the benthic invertebrate risk analysis (see Section 4.3.1.2) to assess the incremental risk these chemicals pose to benthic invertebrates.

2.6.3 Fish

2.6.3.1 Direct Contact COPCs

Per the COPC Report and Amendment, sediment COPCs identified for benthic invertebrates will serve as a proxy for identifying direct sediment exposure COPC for fish (Anchor 2008a, 2008b).

2.6.3.2 Bioaccumulative COPCs

To assess the effects to fish from bioaccumulative chemicals in sediment, COPCs were initially identified in the COPC Report and Amendment (Anchor 2008a, 2008b) by comparing estimated whole body tissue concentrations to tissue-based toxicity reference values (TRVs). In the initial screen, whole body concentrations were estimated using a biota-sediment accumulation factor (BSAF) approach, which included a Site specific estimate of sediment concentration multiplied by a whole body BSAF value derived from field and laboratory studies performed at other sites (see Anchor 2008b for a full description of the BSAF approach). For the refinement screen, more realistic but still conservative exposure and effects values were considered.

In this refinement, a single TRV based on the arithmetic average of the NOAEL and lowest observed apparent effects level (LOAEL) was used (i.e., Midpoint TRV). A COPC was retained for the BERA if the Midpoint TRV-based HQ (HQ_{mTRV}) exceeded 1.0 based on the refined exposure assessment; otherwise, it will not be considered further. NOAEL and LOAEL TRVs identified in the COPC Report and Amendment were used to derive the Midpoint TRV. NOAEL, LOAEL, and Midpoint TRV values for fish COPCs are provided in Table 8.

Next, the estimated tissue concentration of each COPC was calculated using the 95 percent upper confidence limit of the mean[17] (95 UCL[18]) of the updated sediment dataset and the geometric mean BSAF. This estimated mean whole body concentration was then compared to the Midpoint TRV using a HQ approach. Results of this refined screening step for fish bioaccumulative COPCs are provided in Table 9.

Based on the refined exposure and effects assessment, mercury and total PCBs have HQ greater than 1.0 and are identified as bioaccumulative sediment COPCs for fish and will be carried forward into the BERA.

2.7 Aquatic-Dependent Wildlife

Refinement of aquatic-dependent wildlife COPCs included: 1) a review of representative receptors; and 2) consideration of more realistic exposure and effects values for exposure to sediment COPCs.

2.7.1 Review of Representative Wildlife Receptors

The relevance of the brown pelican, mink, and river otter as representative receptors was reviewed in lieu of information that has become available or been developed subsequent to the COPC Report and Amendment (Anchor 2008a, 2008b). Results of these reviews are provided in the following subsections.

17 The upper 95 percent confidence limit on the mean is an appropriate statistic for calculating a conservative estimate of the exposure point concentration (EPC) in ecological risk assessments (USEPA 2002).

18 95 UCL values and supporting calculations are provided in Appendix A.

2.7.1.1 Status of the Brown Pelican as a Species of Special Concern

The brown pelican was originally selected as a representative receptor given its status as a federally- and state-listed endangered species. However, on November 17, 2009, the brown pelican was removed from the federal list of endangered and threatened wildlife due to recovery[19] (50 CFR Part 17, Volume 74, Number 220). Although the brown pelican is still currently listed as state endangered (Texas Administrative Code Title 31 Part 2 Texas Parks and Wildlife Code Chapter 65 Subchapter G Rule 65.176), as per Chapter 68 of the Code, if a federally listed endangered species is listed by state rule, whenever the federal government modifies the list of endangered species, the executive director is required to file an order with the secretary of state accepting any modification.[20]

Given the change in status of the brown pelican from endangered to recovered and the Texas statute requirement to accept modifications to the federal endangered species list, the relevance of the brown pelican as a representative receptor for threatened and endangered species is no longer valid. Therefore, the risk assessment will not attempt to further quantify risk to the brown pelican, specifically. Rather, assessment of surrogate species (i.e., cormorant, kingfisher) will be protective of population-level effects for this species.

2.7.1.2 Relevance of Piscivorous Mammals as Receptors

Mink and river otter are the only two species of semi-aquatic carnivores in this region of Texas. Both species are generally territorial and are tireless wanderers with large home ranges; both of these characteristics limit the ability of the Site to support populations of these species due to its relatively small size. Average reported home ranges for river otter are approximately 37 linear kilometers (km) while average mink home ranges are reported as 4.5 km (males) and 2.2 km (females; see Appendix A for home range analysis). Based on the size of the Site (3.3 km), river otter would not be expected to use the Site for a significant proportion of its foraging range. Male mink home range would not fit within the Site while

19 According to the federal register, delisting of the brown pelican "was based on a review of the best available scientific and commercial data, which indicated that the species is no longer in danger of extinction, or likely to become so within the foreseeable future."

20 As of the writing of this report, no notice of intent to file an order with the Texas Secretary of State had been filed to remove the brown pelican from the state endangered list consistent with the federal modification.

one individual female could theoretically have a home range completely within the Site boundary. Both species are territorial in nature and the use of the Site by more than one or two individuals is unlikely given its small size relative to their home ranges.

Although they are opportunistic feeders, both species have specific habitat requirements that are scarce or absent from the Site. The amount and quality of shoreline cover is a critical component describing the quality of habitat for mink (Allen 1986). Shoreline with a high degree of cover, which may be provided by overhanging or emergent vegetation, exposed roots, debris, log jams, undercut banks, boulders, or rock crevices are considered high quality for mink. Conversely, shorelines that are straight, open, exposed, have little structural cover, and have an abrupt, monotypic edge are considered poor quality. River otter have similar habitat requirements as well. Both species (particularly mink) are not adapted to human activity and prefer aquatic habitats adjacent to forested areas, which are both factors that would significantly reduce likelihood of potential exposure due to avoidance behavior.

Shoreline with a high degree of cover is absent from the Site, and much of the shoreline is modified by riprap and other armoring. In addition, human activity within the surrounding industrial areas of the Site is common. Because of these factors, suitable habitat for mink and otter is scarce and unlikely to be present at the Site to a degree that could support populations of these species. Based on the available information, exposure of this receptor group to Site COPCs would be minor and the ecological relevance of these species to the Site is therefore low.

Given the low ecological relevance of this receptor group to the Site, the risk assessment will not attempt to further quantify risk to piscivorous mammals.

2.7.2 Sediment COPC Refinement for Aquatic-Dependent Wildlife

The primary route of exposure for aquatic-dependent wildlife is through the ingestion of biota. For some receptors, incidental ingestion of sediment is considered a complete and significant pathway as well. To assess the effects to wildlife from bioaccumulative chemicals in sediment and tissue, COPCs were initially identified in the COPC Report and Amendment (Anchor 2008a, 2008b) by comparing estimated total daily intake (TDI) of chemicals in

sediment and biota to dietary-based TRV values. In the initial screen, chemical concentrations in biota were estimated using a BSAF approach, which included a Site-specific estimate of sediment concentration multiplied by a whole body BSAF value derived from field and laboratory studies performed at other sites (see Anchor 2008b for a full description of the BSAF approach). For the refinement screen, more realistic but still conservative exposure and effects values were considered.

2.7.2.1 Refined Effects Assessment

Both dietary-based LOAEL and NOAEL TRV values were included in the screening-level COPC selection. Chemicals with HQ_{LOAEL} exceeding 1.0 were identified as COPCs while chemicals with HQ_{NOAEL} greater than 1.0 (but HQ_{LOAEL} less than 1.0) were identified as uncertain COPCs.

TRV Review

During the refinement step, TRVs were reviewed to ensure recent toxicological data were considered. Specifically, the USEPA's ecological soil screening level (Eco-SSL) documents (USEPA 2005b, 2005c, 2008a, 2007b, 2005d, 2007c, 2007d, 2007e) were reviewed for arsenic, cadmium, chromium, copper, lead, zinc, DDT and metabolites, and PAHs; respectively. The Eco-SSL TRV compilation, screening, and selection use a standardized and comprehensive approach to identify TRVs for birds and mammals (USEPA 2003b). TRVs identified using this approach are considered to have a lower degree of uncertainty relative to individual studies.

Thus, where available, the recommended NOAEL from the USEPA's Eco-SSL documents was selected. If the Eco-SSL NOAEL is from a single study, the corresponding LOAEL (when reported) was selected. If the Eco-SSL recommended NOAEL is based on a geomean, a LOAEL was calculated using the same dataset using an uncertainty factor of five.[21] Revisions to TRV values for the refinement step are summarized in Table 10.

21 Application of the uncertainty factor for LOAEL calculation is consistent with the approach used in the COPC Report and Amendment (Anchor 2008a, 2008b).

Calculation of the Midpoint TRV

In the refinement step, a single TRV based on the arithmetic average of the NOAEL and LOAEL was used (i.e., Midpoint TRV). A COPC was retained for the BERA if the Midpoint TRV based HQ (HQ_{mTRV}) exceeded 1.0 based on the refined exposure assessment; otherwise, it will not be considered further. The Midpoint TRV values for wildlife COPCs are provided in Table 11.

2.7.2.2 Refined Exposure Assessment

The Site-wide 95 UCL[22] of the sediment data collected in 2009 was calculated and used as the exposure concentration for incidental sediment ingestion and was the basis to estimate tissue concentrations using the BSAF approach.[23] Tissue exposure concentrations were estimated using previously calculated geometric mean BSAFs (COPC Report and Amendment; Anchor 2008a, 2008b) in conjunction with the updated Site-wide 95 UCL.

The assimilation efficiency (AE) and gross energy (GE) terms in the TDI equation for ingestion of biota were adjusted to reflect the average value reported in the literature (see Appendix A for derivation).

With one exception, all other intake model variable values were unchanged. Consistent with the agreement between JDG, the USEPA, TCEQ, and Trustees, a 'composite' receptor will be used to represent carnivorous wading birds in the BERA (Anchor QEA 2009b). As such, the intake model variables for the COPC refinement were adjusted to reflect this agreement. The primary effect of this change was to assume a lower body weight[24] and is therefore a conservative adjustment to this receptor. Table 12 summarizes the TDI model variable inputs.

The TDI model equations were modified from the equations presented in the COPC Report and Amendment (Anchor 2008a, 2008b) to reflect agreements between JDG, the USEPA, TCEQ, and Trustees regarding their format. These modifications do not substantially affect

22 The upper 95 percent confidence limit on the mean is an appropriate statistic for calculating a conservative estimate of the EPC in ecological risk assessments (USEPA 2002).

23 95 UCL values and supporting calculations are provided in Appendix A.

24 This change results in a higher normalized ingestion rate.

the TDI estimates but were done to be more consistent with the equations provided in the USEPA's *Wildlife Exposure Factors Handbook* (1993). The TDI estimates in this refinement step reflect these modifications. TDI calculation worksheets in Appendix A provide the modified form of the equations and the intermediate variable calculations. More detail regarding the equations can be found in the *Response to Comments on Amendment to the Selection of COPCs for Ecological Risk Assessment Technical Memorandum, Patrick Bayou Superfund Site, Deer Park, Texas* (Anchor QEA 2009c), which compares the previous TDI equations with the current form, and in Section 6 of this document, which describes the parameterization of the TDI models for the BERA.

Finally, corrections to the BSAF values for mercury were made during preparation of this document. Some benthic invertebrate BSAF values for mercury included sediment-tissue chemistry pairs based on inconsistent units (i.e., sediment values in mg/kg while corresponding tissue values were in ng/kg). These values were corrected and the geometric mean of the mercury BSAF for benthic invertebrates was recalculated. Results of this correction are summarized in Appendix A.

2.7.2.3 COPC Identification

The refined TDI estimates for spotted sandpiper, carnivorous wading birds, belted kingfisher, and raccoon COPCs were compared to their respective Midpoint TRV using a HQ approach. Table 13 summarizes the HQ for wildlife receptors using the refined exposure and effects assessment (Appendix A provides calculation sheets for each receptor). Receptor/COPC pairs with HQ less than 1.0 were eliminated from the risk assessment. Based on the refined risk characterization, the following wildlife COPCs will be carried forward into the BERA:

- Mercury
- PAHs
- PCBs
- Dioxin/furans
- Hexachlorobenzene
- Hexachlorbutadiene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene

2.8 Summary of Sediment COPCs Refinement

The refinement of aquatic receptor and aquatic-dependent wildlife COPCs was performed using realistic but still conservative assumptions to focus the list of COPCs to be assessed in the BERA. The remainder of this Work Plan will document the assumptions and information required to complete the characterization of potential Site-related risks to ecological receptors resulting from the presence of these COPCs in Site media.

2.9 Summary of COPC Refinement

The list of target analytes from the COPC Report and Amendment (Anchor 2008a, 2008b) was exhaustive and required additional refinement so that a focused list of indicator chemicals could be determined to characterize risk. Also, additional Site-specific data were collected subsequent to the COPC Report and Amendment (Anchor 2008a, 2008b), which provided a higher degree of confidence in the list of COPCs to be evaluated in the BERA. The additional screening and refinement of aquatic receptor and aquatic-dependent wildlife COPCs for surface water and sediment discussed in this section succeeded in focusing the list of COPCs assessed in the BERA. Table 14 provides a summary of the COPCs to be assessed in the BERA by matrix.

3 BASELINE PROBLEM FORMULATION

Refinement of COPCs was performed in Section 2. This section addresses the remaining steps of the baseline problem formulation. According to ERAGS (USEPA 1997), the remaining elements of problem formulation generally consist of:

- Further characterization of the potential ecological effects of COPCs at the Site
- Review and refinement of information on the fate and transport of COPCs, potential exposure pathways, and the receptors potentially at risk
- Selection of assessment and measurement endpoints
- Development of a conceptual model with testable hypotheses (or risk questions) that the Site investigation will address

The JDG has already developed elements of the problem formulation in the Preliminary Site Characterization Report (Anchor 2006), Preliminary Contaminant of Potential Concern Selection (Anchor 2007c), COPC Report (Anchor 2008a), and Amendment to the Draft COPC Report (Anchor 2008b). Elements of the problem formulation addressed in these documents include fate and transport, exposure pathways, and receptors at risk. Effects characterization was also addressed in these previous documents and will continue to be refined in this Work Plan (i.e., predictive sediment toxicity modeling). In addition, the Patrick Bayou Technical Work Group has discussed and agreed to several elements of the BERA problem formulation subsequent to the submittals previously described. Agreements reached during Technical Work Group sessions are described in the meeting minutes of these sessions.

Elements of the BERA problem formulation for the Site are presented in the following sections. The purpose of these subsections is not to incorporate all material previously presented and discussed, but to summarize this material, highlight salient elements, and discuss any new elements that have not been previously presented.

3.1.1 Representative Receptors

Representative receptors for the BERA were selected based on the following criteria:

- Ecological relevance

- Potential level of exposure to COPCs
- Social or economic importance
- Sensitivity to COPCs
- Availability of sufficient natural history information to allow meaningful assessment of exposure and risk

Reptiles and amphibians were not selected as receptors of concern due to the insufficient toxicological data for detailed quantitative evaluation of potential adverse effects on this group. This is recognized as a potentially significant uncertainty, as the relatively sedentary behavior of many amphibians and reptiles may increase their vulnerability to exposures (compared to birds and mammals). As ectothermic vertebrates, reptiles and amphibians may have different anatomies, physiologies, metabolisms, behaviors, and responses to environmental contaminants than birds and (even more distantly related) mammals that would, by necessity, be used as surrogates for reptiles in the BERA due to the lack of availability of oral toxicity reference values for these receptors. However, the few data that are available (Meyers-Schone 2000) for reptiles and amphibians suggest that they would not be as sensitive as most birds and mammals. Therefore, risks to reptiles and amphibians will not be quantitatively assessed in the BERA. Rather, risk characterization for avian receptors (and to a lesser extent mammalian receptors) will serve as a surrogate for reptiles and amphibians and will be considered protective of this receptor group. The uncertainty in this assumption will be assessed to the extent possible in the BERA.

The status and selection rationale for representative receptors in the BERA are discussed in the following sections.

3.1.2 Benthic Invertebrates

The diversity and abundance of benthic invertebrates are important components of aquatic ecosystems. Benthic invertebrates have a close association with sediment, have limited home ranges, and use various feeding strategies (e.g., filter feeders, detritus scavenger, etc.); therefore, they can be susceptible to sediment-associated chemicals.

3.1.3 Fish

Fish and shellfish are key elements of freshwater, estuarine, and marine ecosystems for a number of reasons. As one of the most diverse groups of vertebrates, fish are able to occupy a wide range of ecological niches and habitats (Hoese and Moore 1998). As such, fish represent important components of aquatic food webs by processing energy from aquatic plants (i.e., primary producers), zooplankton and benthic macroinvertebrate species (i.e., primary consumers), or detrivores. Fish also represent important prey species for piscivorous (fish-eating) wildlife, including reptiles, birds, and mammals.

Fish were classified into two main representative receptor groups based primarily on their likelihood and routes of exposure to COPCs at the Site:

1. Planktivorous, omnivorous, herbivorous, and detritivorous fish that eat lower trophic foods such as phytoplankton and detritus. Examples of this receptor that may be found in Patrick Bayou are mullet and menhaden.
2. Carnivorous species that feed on higher trophic level species and may be at increased risk from bioaccumulative COPCs. Examples of this receptor group that may be found in Patrick Bayou are black drum and croaker.

3.1.4 Birds

Birds are the principal aquatic-dependent wildlife species that occur in the project area. Based on previously presented information (Anchor 2006), the aquatic-dependent birds that may occur at the Site can be classified into four feeding guilds: herbivores/omnivores, benthivores (sediment-probing), carnivores, and piscivores. The following subsections describe the selection of representative receptors for each guild.

3.1.4.1 Herbivorous/Omnivorous Birds

Although some herbivores and omnivores may ingest sediment while feeding, they do not ingest as much as sediment-probing birds (i.e., benthivores). Because of the high potential exposure through direct ingestion of sediment, the spotted sandpiper (see Section 6) will act as a representative species for both omnivorous/herbivorous and benthivorous sediment-probing birds. The estimated exposure of sediment-probing birds represents a conservative estimate for this guild.

3.1.4.2 Sediment-Probing Birds

The spotted sandpiper was chosen as the representative receptor for the benthivorous feeding guild. The spotted sandpiper is a shorebird that obtains much of its diet by probing or "mining" soft sediments along shorelines. Spotted sandpipers feed on a wide variety of benthic invertebrates and are relatively common winter residents in some of the local habitats in and around the Site (NGS 2002). Although several other shorebirds may typically obtain a greater fraction of their diets from aquatic sediments, the spotted sandpiper was selected as a representative of its feeding guild primarily because it is a conservative receptor (protective of other similar species).

3.1.4.3 Carnivorous Wading Birds

Consistent with agreements reached within the Patrick Bayou Technical Workgroup (Anchor QEA 2009b), a composite receptor representing the range of species that may occur within the carnivorous guild was chosen for the BERA. This approach was considered appropriate to represent the range of sizes and diet for this group. This composite receptor will reflect the central tendency of exposure parameters (e.g., average body weight, proportion of items in diet) for the range of species found in this guild. The composite receptor will reflect behavioral and physiological characteristics of great blue heron, great egret, roseate spoonbill, white ibis, and green heron.

3.1.4.4 Piscivorous Birds

The belted kingfisher was chosen to represent piscivorous birds. Belted kingfishers are one of the most widespread land birds in North America. This species is common in coastal swamps, brackish lagoons, oxbows, and bayous with suitable perches (e.g., trees, power lines and poles, and piers) for detecting prey. This species generally preys on small to medium size fish that inhabit shallow water or swim near the surface. Characteristics of this species are well documented and it is frequently used as a receptor of concern in ERAs. Body weight is similar to other small, fish-eating birds (i.e., Forster's and least terns) that occur in this region of Texas and would be considered protective of other small, fish-eating birds.

3.1.5 Herbivorous and Omnivorous Mammals

Due to the industrialized and disturbed nature of the upland areas surrounding the Site, habitat to support terrestrial mammals is limited. Species that may be present would most likely include species with limited ranges and urban-adapted species.

The raccoon was chosen as the representative receptor for this feeding guild. The selection of the raccoon is considered protective of other semi-aquatic omnivorous and herbivorous mammals (i.e., muskrat, nutria, and marsh rice rat) due to the equal or higher proportion of animal matter in its diet, increasing the probability of exposure through biomagnification relative to other omnivorous or herbivorous mammals.

3.1.6 Summary of Representative Receptor Selection

In summary, the following species were selected as representative receptors to characterize the range of organisms exposed to sediment and surface water associated chemicals at the Site:

- Benthic invertebrate community
- Omnivorous/planktivorous/detritivorous fish
- Carnivorous fish
- Spotted sandpiper – sediment-probing birds and omnivorous/herbivorous birds
- Composite receptor – carnivorous wading birds
- Belted kingfisher – piscivorous birds
- Raccoon – omnivorous/herbivorous mammals

3.2 Ecological Risk Conceptual Site Model

A conceptual site model describes predicted relationships between receptors potentially at risk and the stressors to which they may be exposed. Elements of the conceptual site model include information about sources, transport pathways, exposure pathways, and receptors. In addition, the conceptual site model provides a basis for identifying assessment endpoints and measures of effect and exposure for representative receptors.

3.2.1 Sources and Release Mechanisms

Sources, release mechanisms, and transport pathways are shown in Figure 2 and summarized here. Primary sources that may affect or have historically affected sediment and surface water quality at the Site include current and historical industrial and urban activities (e.g., spills, releases, and waste disposal) including areas upstream and downstream of the Site. Potential historical sources at the Site include industry-associated discharges that may have occurred prior to regulation under the Clean Water Act and Texas Water Code. Potential sources located upstream not associated with the JDG facilities include industrial, commercial, municipal, and residential activities that may release chemicals to the watershed drainage network that are eventually transported to the Site. Downstream sources, due to tidally influenced flow reversals, include industrial and urban sources not associated with the JDG facilities that may release chemicals to the HSC system that may be transported to the Site.

3.2.1.1 Sediment

Sediment transport is considered the primary mechanism affecting the distribution of COPCs at the Site. Sediments (and sediment-associated contaminants) can be resuspended and redeposited within the Site due to dynamic flow conditions caused by hydrologic and tidal influences. Inputs of sediment both containing and not containing chemicals from upstream and Site sources modify the concentrations of chemicals in sediment as they are incorporated into the system.

The physical and hydrologic features of the Site result in areas of erosion and deposition within the Site under various flow regimes. Based on the findings of the *Draft Sediment Transport Modeling Report* (Anchor QEA 2009a), the Site itself is generally a net depositional environment. During high-flow (e.g., storm) events, off-site suspended sediments are transported onto the Site, and existing sediments within the Site may be resuspended due to bed scour and bank erosion processes. Off-site and resuspended sediments may accumulate in depositional areas within the Site or be transported off site.

Sediment transport within the Site has a significant effect on the fate and transport of contaminants within the system through mixing and may act to expose or cover existing sediment, depending on the hydrologic characteristics of different areas of the Site.

3.2.1.2 Surface Water

Chemicals may be transported in surface water as suspended particulates and dissolved constituents. Chemicals in surface water may originate from upstream sources, deposition from the air due to wind erosion or emissions from off-site sources, resuspension of sediment, and/or direct discharge to surface water from point sources (i.e., outfalls). Direct discharges to the Site are permitted, regulated, and monitored under the Texas Pollutant Discharge Elimination System (TxPDES) program. Chemicals and suspended sediment in surface water from the HSC may be introduced into Patrick Bayou by tidal fluxes and from HSC waters used as non-contact once-through industrial process water that is discharged into the Site.

3.2.1.3 Groundwater

Groundwater can transport chemicals to sediment and sediment porewater and, under some circumstances, from the porewater to surface water. Groundwater evaluations and/or remedial efforts, including determination of potential discharges and impacts to Patrick Bayou, are ongoing or completed at all three JDG facilities through the Texas Risk Reduction Program (TRRP) and Voluntary Cleanup Program (VCP) programs.

3.2.1.4 Air Particulates

Contaminants may enter the Site through direct atmospheric deposition to surface water from off-site air emissions or wind-driven erosion of off-site soils.

3.2.1.5 Soil

Soil can act as a secondary source for contaminants through erosion and runoff containing soil associated contaminants to surface water, both adjacent to the Site or within the larger watershed. Infiltration and/or leaching to groundwater and wind erosion are also potential release mechanisms for movement of contaminants into Site exposure media.

3.2.2 Exposure Media

Exposure media are those media through which an ecological receptor is directly exposed to contaminants at the Site. The exposure media at the Site depends on the distribution and environmental fate of chemicals and their partitioning into Site media. Based on the environmental fate of chemicals at the Site, four potential exposure media can be identified for the Site. They are:

- Sediment (including porewater)
- Surface water
- Biota
- Air

The following section describes the potential and expected significance of the exposure of ecological receptors to Site contaminants in these media.

3.2.3 Exposure Pathways

This section describes the potential exposure pathways to receptors at the Site and discusses which pathways will be evaluated for these receptors in the BERA. An exposure pathway is considered complete if a COPC can travel from a source to ecological receptors and is available to the receptors via one or more exposure routes (USEPA 1997). Complete pathways can be of varying importance, so it is important to identify key pathways that reflect the greatest potential exposures to ecological receptors sensitive to that COPC (USEPA 1997).

Exposure pathways for COPCs at the Site were designated in one of four ways: complete and significant, complete and significance unknown, complete and minor, or incomplete (Figure 3). Each of the four designations is defined below to provide an explanation of how it will be addressed in the BERA process.

- Complete and significant: There is a direct link between receptor and pathway, and the specific pathway is considered a potentially important driver for risk. Concentrations of COPCs that a receptor is exposed to due to this pathway would be expected to be near or at a level that may cause adverse effects. This pathway will be quantitatively addressed in the BERA.

- Complete and minor: There is a direct link between receptor and the pathway; however, the significance of this pathway in terms of overall exposure is not considered significant or is negligible relative to other exposure pathways. These pathways will not be assessed quantitatively in the BERA. Rather, they will be qualitatively discussed in the risk characterization and uncertainty assessment.
- Complete and uncertain: There is a direct link between receptor and pathway; however, there are insufficient scientific data available to quantify the significance of the pathway in overall assessment of exposure. These pathways will be addressed qualitatively to a level of certainty dependent on available studies during the BERA process. If uncertainty is due to a site-specific data gap, collection of appropriate information to permit a quantitative evaluation of these pathways will be considered and will be discussed in the data gaps analysis (Section 7). If additional data to assess the status of these pathways become available as a result of additional data collection, the status and assessment level will be adjusted accordingly in the BERA.
- Incomplete: There is no direct link between the receptor and pathway. Further assessment of these pathways will not be performed.

3.2.3.1 Benthic Invertebrates

Benthic invertebrates may be exposed to contaminants through direct contact with sediment and sediment porewater. Therefore, direct sediment contact is considered a complete and significant pathway for exposure. In addition, benthic invertebrates routinely ingest sediment and biota; these pathways are considered complete and significant. Many benthic invertebrates may also have direct contact with surface water (e.g., burrow irrigation, swimming), and this pathway is considered complete and significant.

3.2.3.2 Fish

Fish may be exposed to contaminants through direct contact with Site media and ingestion of biota. Direct contact with surface water and ingestion of biota are complete and significant exposure pathways for fish. Some fish (e.g., demersal species) may have significant exposure to contaminants in sediment and sediment porewater via direct contact. Ingestion of contaminated biota and incidental ingestion of contaminated sediment ingestion is considered a complete and significant pathway for fish.

3.2.3.3 Birds

Potential routes of exposure for birds include:

- Ingestion of biota
- Ingestion of drinking water
- Incidental ingestion of sediment and surface water
- Direct contact with sediment and surface water
- Inhalation of vapor phase chemicals and particulates

Ingestion of biota (through the diet) is the primary route of exposure for all avian receptors and is considered a significant and complete pathway. Sediment-probing birds may have significant incidental ingestion of sediments during foraging, and this pathway is considered complete and significant. For carnivorous wading birds, incidental sediment ingestion while feeding may occur but at considerably lower rates. However, this exposure pathway will be considered complete and significant to account for incidental ingestion of sediment during feeding and preening. For piscivorous birds, this exposure pathway is considered complete and minor because incidental sediment ingestion is low relative to biota ingestion and/or foraging/nesting strategies do not include activities resulting in significant exposure through this pathway. Incidental ingestion of surface water during foraging or other activities may occur, but is considered a minor route of exposure for avian receptors.

Likewise, dermal exposure to sediment and surface water is complete for avian species but considered uncertain due to the lack of accepted chronic exposure models for this pathway. In addition, feathers for these receptors likely affords protection and limits exposure from these pathways.

Exposure to surface water through drinking is considered incomplete. The brackish nature of the water renders it generally unsuitable for drinking by wildlife.

Finally, inhalation of vapor phase COPCs is unlikely to be a significant exposure pathway because of the low vapor pressure for persistent and bioaccumulative chemicals. Volatile organic compounds (VOC) and some semivolatile organic compounds (SVOC) may volatilize

from surface water and porewater (when sediments are exposed). Therefore, this exposure pathway is considered complete and minor.

3.2.3.4 Mammals

Potential routes of exposure for mammals include:

- Ingestion of biota
- Ingestion of drinking water
- Incidental ingestion of sediment and surface water
- Direct contact with sediment and surface water
- Inhalation of vapor phase chemicals and particulates

Similar to avian receptors, ingestion of contaminated biota is a significant and complete pathway for mammalian receptors. Incidental ingestion of sediment is a less significant source of exposure relative to biota, but is still considered complete and significant pathway of exposure. Incidental ingestion of surface water is considered complete and minor. Direct contact with surface water and sediment is considered complete but uncertain due to the lack of appropriate exposure models to assess this pathway. Finally, inhalation of vapor phase chemicals, while possible, is considered unlikely to contribute to overall exposure and is considered complete and minor.

3.3 Assessment Endpoints, Risk Questions, and Measurement Endpoints

Assessment endpoints are the valued attributes of ecological entities upon which risk management actions are focused (USEPA 1998). More specifically, assessment endpoints are "an explicit expression of the environmental value to be protected, operationally defined as an ecological entity and its attributes" (USEPA 1998). The selection criteria for assessment endpoints include: ecological relevance, susceptibility (exposure plus sensitivity), and relevance to management goals (USEPA 2003c). The assessment endpoints discussed below were selected based on their relevance to population or community levels rather than individual effects.

Risk questions hypothesize proposed or suspected relationships between assessment endpoints and their predicted responses when exposed to contaminants. Risk questions also

provide the basis for defining measurement endpoints in the analysis phase, which are evaluated with information collected during ecological studies designed and performed as part of the RI of the Site.

Measurement endpoints are measurable ecological characteristics that are used to test risk hypotheses and evaluate if the assessment endpoint is protected. Measurement endpoints are evaluated with one or more lines of evidence. A line of evidence is a set of data and associated analyses that can be used to estimate ecological risks.

The remaining subsections below describe the assessment endpoints, risk questions, and measurement endpoints for each receptor group.

3.3.1 Benthic Invertebrate Receptor Group

3.3.1.1 Assessment Endpoint and Risk Questions

The assessment endpoint to be evaluated for benthic invertebrates in the risk assessment includes:

- Survival, growth, and reproduction of benthic invertebrate communities

To evaluate the assessment endpoint, the following risk questions will be considered:

- Is the survival of benthic invertebrates observed or predicted (using predictive toxicity models) from sediment COPCs below acceptable thresholds?
- Do COPCs contaminant concentrations in surface water exceed benchmarks for the survival, reproduction, and growth of benthic invertebrates?

3.3.1.2 Measurement Endpoints

Estimated Toxicity Using Predictive Models

Paired empirical sediment toxicity and sediment chemistry data from the Site will be used to develop a Site-specific predictive sediment toxicity model. This information can then be used directly to estimate risks to the benthic invertebrate community throughout the Site using maps showing the distribution of COPCs in surface sediments. Several models have been evaluated as part of this BERA Work Plan and a preliminary model has been selected

based on comparisons of candidate model performance using the Site-specific bioassay data and is presented in the analysis plan for this receptor (Section 4).

The predictive sediment toxicity model will be the primary measurement endpoint used to assess risks to the benthic invertebrate community on a Site-wide basis. This endpoint was selected as the primary measurement endpoint because: 1) it incorporates Site-specific exposure (chemistry) and response (toxicity) data; 2) it can be applied uniformly throughout the Site in an effective and unbiased manner; and 3) it provides an opportunity to derive a quantitative metric that can be applied to different risk management scenarios (e.g., provides a tool that quantifies risk at different acceptable thresholds of risk and uncertainty).

Surface Water Exposure Concentrations Compared to Water Quality Criteria

Surface water chemistry data will be used to determine if chemical concentrations in Site surface water are high enough to cause toxicity to benthic invertebrates. Measured concentrations will be compared to WQC identified as protective of benthic macroinvertebrate survival, growth, and reproduction.

3.3.2 Fish Receptor Group

3.3.2.1 Assessment Endpoint and Risk Questions

The assessment endpoint to be evaluated for fish receptor group in the risk assessment includes:

- Survival, growth, and reproduction of fish communities

To evaluate the assessment endpoint, the following risk questions will be considered:

- Do COPC concentrations in surface water exceed TRVs for the survival, reproduction, and growth of fish?
- Are COPC concentrations in whole body tissues of fish higher than tissue residue TRVs for survival, reproduction, and growth?
- Do COPC concentrations in sediment exceed TRVs for the survival, reproduction, and growth of fish?

3.3.2.2 Measurement Endpoints

Surface Water Exposure Concentrations Compared to WQC

Surface water chemistry data will be used to determine if chemical concentrations in Site surface water are high enough to cause toxicity to fish. Measured concentrations will be compared to WQC identified as protective of fish survival, growth, and reproduction.

Whole Body Tissue Concentrations Compared to TRVs

Site-specific tissue data will be collected to evaluate if COPCs in fish tissue exceed fish-specific tissue-residue TRVs.

Estimated Toxicity Using Predictive Models

Similar to the Calcasieu Estuary RI/FS (MESL 2002), the toxicity model developed for protection of benthic invertebrates will be used as a surrogate model for predicting potential fish toxicity. For whole sediment, a review of the literature indicated that sediment quality guidelines (SQGs) for the protection of fish have been established only infrequently. As the sensitivities of sediment-dwelling organisms to COPCs has been shown to be similar to those of water column species (i.e., fish; Di Toro et al. 1991), it is not unreasonable to conclude that COPCs at levels that adversely affect the survival, growth, and reproduction of benthic invertebrates would have similar effects on the benthic fish community exposed to contaminated sediments. In addition, empirically-derived SQG, including effects range median (ERM; Long and Morgan 1990, Long et al. 1995), probable effects level (PEL; MacDonald et al. 1996), and equilibrium partitioning (EqP) equilibrium screening benchmarks (ESBs) for metals, PAH, and non-ionic organics (USEPA 2005a, 2003d, e, f, and g, and 2008b) are based on effects to fish and benthic invertebrates. These SQGs and ESBs are the primary candidate metrics used to develop the predictive sediment toxicity model for benthic invertebrates (see Section 5). Therefore, predictive sediment toxicity models developed for benthic invertebrates will be considered a proxy for assessing risks to benthic fish due to direct contact with Site sediments. The uncertainty associated with this assumption will be discussed in the BERA.

3.3.3 Aquatic-Dependent Wildlife Receptor Group

3.3.3.1 Assessment Endpoint and Risk Questions

The assessment endpoint to be evaluated for aquatic-dependent wildlife in the risk assessment includes:

- Survival, growth, and reproduction of aquatic-dependent wildlife

To evaluate the assessment endpoint, the following risk questions will be considered:

- Does the ingested dose of COPCs received by sediment-probing birds, carnivorous birds, piscivorous birds, or omnivorous mammals due to consumption of prey species captured at the Site, as well as incidental ingestion of Site sediment, exceed the respective TRVs for survival, growth, and reproduction?

3.3.3.2 Measurement Endpoints

Ingested Dietary Dose of Contaminants Compared to Dietary TRV

Ecological risks to aquatic-dependent wildlife will be evaluated using measured or modeled sediment and prey item concentrations, foraging and home range information, allometric scaling data (e.g., metabolic rate), and dietary composition for each representative receptor species to estimate the daily intake of COPCs. This estimated TDI will be compared to relevant ingestion-based TRV to characterize risk for this receptor group.

3.3.4 Risk Analysis, Characterization, and Uncertainty Assessment

Sections 4 through 6 describe the risk analysis, risk characterization, and uncertainty assessment steps for benthic invertebrates, fish, and aquatic-dependent wildlife. The risk analysis plan describes: 1) the exposure and effects data that will be assessed for each receptor group and measurement endpoint and how these data will be integrated into risk estimates; and 2) how risk estimates will be interpreted and risk thresholds defined. The uncertainty assessment describes the potential sources of uncertainty in the risk characterization, how each source of uncertainty will be assessed (i.e., quantitatively or qualitatively), and how the results of the uncertainty assessment will be interpreted.

4 BENTHIC INVERTEBRATES RISK ANALYSIS AND CHARACTERIZATION

This section describes the risk analysis and characterization for each measurement endpoint identified for the benthic invertebrate receptor group.

4.1 Surface Water Toxicity

The 95 UCL concentrations of the surface water dataset for the selected site COPCs (see Section 2.3) will be compared to WQC using a HQ approach. The toxicity value for Total PCBs was taken as the USEPA NAWQC Saltwater CCC (USEPA 2009), which is 0.03 µg/L.

An HQ exceeding 1.0 will be considered sufficient to result in adverse effects to benthic invertebrates.

4.2 Sediment Toxicity

Sediment toxicity test results and synoptic sediment chemistry analyses from previous studies at specific locations within the Site provide insight into potential causes of sediment toxicity at a specific location and time during the study, but these findings provide a foundation for the development of a site-specific predictive model to assess potential sediment toxicity risk from bulk sediment chemical data at any point and time for the Site. Although such a tool does not consider the potential effect of confounding factors, such as wide variations in salinity, temperature, and porewater ammonia levels, it does provide a reliable tool for evaluating toxicity associated with a response to concentrations of COPCs at the Site. The relationship of confounding factors with site-specific predictive models is discussed in Section 4.6.5.

To develop a predictive model that can be used to assess risk to benthic invertebrates at the Site, both Site-specific data (bioassay and chemistry) and generalized models developed using data from an aggregate of sources were considered. The general approach was to use predictive models developed on general principles and 'generic' sediment quality guidelines to develop an initial model, then to evaluate its performance and reliability relative to the Site-specific data, and finally to use the Site-specific data to calibrate the model, if warranted. The ultimate result would be a reliable and robust predictor of Site toxicity based on peer-reviewed approaches and models.

The objective of the predictive model is to identify potentially toxic sediments using sediment chemistry alone with the highest predictive reliability possible. The list of COPCs for benthic invertebrates to be used in the predictive model is provided in Table 7. However, for two main reasons, only a subset of these chemicals will be considered for the model. First, if all COPCs at the Site are included in the model, they may not contribute to or may actually hurt model performance, increasing the probability that a sample will be incorrectly classified as toxic or non-toxic. Second, it is likely that the subsets of these COPCs are responsible for the observed toxicity at the Site and focusing the model on these COPCs should increase the predictive ability of the model. Therefore, only COPCs that contribute significantly to the model's performance will be identified (see Section 4.4.2 for a complete explanation of how these COPCs were identified). These chemicals are expected to provide a sufficient surrogate for predicting benthic toxicity (see Section 4.6).

Several predictive toxicity models were considered to define the relationship between surface sediment chemistry and toxicity responses observed at the Site. The models identify the predictive relationship from different perspectives, although the goals of the models are similar: to develop a predictive relationship based on empirical data (i.e., sediment chemistry and toxicity test data) and to identify the principal chemical(s) that appear to best predict the relationship between sediment quality and toxicity. The models generally fall into two groups: 1) generic sediment quality guideline quotient (SQG-Q) models (Long et al 1998; Ingersoll et al 2001; MacDonald et al. 1996); and 2) mechanistic models (USEPA 2003d, 2005a, 2008b).

The generic SQG-Q models rely on the use of threshold effect concentration (e.g., effects range median [ERM], probable effects concentration [PEC], and probable effect level [PEL]) quotients of mixtures of COPCs. Briefly, the quotient is the ratio of each chemical concentration to its threshold effect concentration (i.e., ERM, PEC, and PEL). Individual quotients can then be summed or averaged to evaluate the likelihood that a sediment sample would be expected to be toxic or non-toxic based on the narrative intent of the SQG. Mechanistic models such as EqP are used to estimate threshold benchmarks (i.e., ESB) to determine if a sample would be toxic based on partitioning between sediment and porewater, which represents the bioavailable fraction. ESB models have been developed for PAH, non-ionic organics, and divalent metals.

Each of these approaches are considered 'generalized' models in the sense that they rely on data from a compilation of sites and/or studies performed under a wide range of locations and conditions. Thus, they are intended to be representative of a broad range of conditions but may not account for potentially unique or confounding conditions that may be present at a Site to which the model is extrapolated. Thus, it is important to evaluate a potential model's performance using Site-specific data (i.e., bioassay data) in order to determine if a model provides an adequate degree of confidence in its interpretation of sediment toxicity at the Site. Existing bioassay data for the Site will be used for this purpose and as needed, additional data collection during the BERA may be warranted for model refinement (see Section 4.6.5).

The details of the benthic interpretive models are presented as follows:

- Section 4.3 describes the data included in the model evaluation.
- Section 4.4 presents the results of the model evaluations.
- Sections 4.5 and 4.6 present the risk characterization and uncertainty analysis for the predictive model approach.

4.3 Model Data

Model data included samples with both whole sediment bioassay data and surface sediment chemistry collected primarily in support of TMDL studies for Patrick Bayou (Parsons et al. 2002, 2004). Data in this evaluation include the same dataset used in the selection of ecological COPCs (Anchor 2008a, 2008b; further details on the data can be referenced in that document). This dataset provides the basis for the dose-response modeling of the predictive toxicity model. Inherent in this dataset may be confounding factors, and additional data collection may be warranted (see Sections 4.3.2 and 4.6.5). Below is a brief summary of the data, treatments in the models, and any modifications that were made to the data.

4.3.1 Chemistry Data

The predictive models were developed using 51 samples with co-located sediment chemistry and toxicity test data. Of these surface sediment samples, 44 samples were collected within the Site, three samples were collected downstream of the Site in the HSC, and four samples were collected upstream of the Site boundary. All sample locations in this dataset were

retained for use in the model development. Samples were collected between September 2000 and August 2006.

The list of COPCs for benthic invertebrates is provided in Table 7. While most COPCs were analyzed in all 51 samples, some COPC results were only available in a subset of these samples. COPCs with missing values are summarized in Table 15. Results included in the model dataset are provided in Appendix B.

4.3.1.1 Calculation of Total or Sum Values

Summing only detected values, non-detected values were valued at zero for the predictive model development. The same method was applied in the calculation of total quotient, average quotient, and TU values (e.g., PAH Equilibrium Screening Benchmark Toxic Unit [ESBTU], and mean PEC-Q) as well. The use of the detection limit or other estimated values lead to artificial conflation of the relationship between analytes and toxicity (i.e., a relationship between an analyte and biological response may be observed on the basis of detection limits only and/or may obscure relationships between response and detected values). The effect of this approach on the outcome of the predictive models will be assessed in the uncertainty section of the BERA.

4.3.1.2 Calculation of SQG Quotients

Three sets of SQGs were considered in the model development: the ERM, PEC, and PEL. These SQGs were chosen because they: 1) are derived from a compilation of bioassay tests performed nationwide; 2) are frequently used to assess sediment quality at contaminated sediment sites; and 3) have narrative intents consistent with the assessment endpoint for benthic invertebrates. The derivation and narrative intent of each set of SQGs are summarized in Table 16.

SQGs can be used on a chemical-by-chemical basis or across a suite of chemicals. The latter involves calculating the SQG-Q (ratio of sediment concentration to the SQG) for each chemical in the compendium (e.g., pesticides) for a particular sediment sample and then averaging to get the mean SQG-Q (or sum for a total SQG-Q). The Site has multiple COPCs therefore the mean SQG-Qs was included in the threshold model evaluation as it is

considered to be a better measure of sediment quality than individual chemical SQGs because they integrate multiple chemicals (as suggested by Long et al. 2006). Mean SQG-Q were calculated for chemical groups (e.g., metals, PAHs, pesticides, etc.) and overall for each sample. To calculate the mean SQG-Q, the list of COPCs for each quotient model was refined *a priori* to a more relevant list using the following criteria:

- Chemicals not summed into any totals were included (e.g., metals and phthalates).
- Chemicals represented as totals or sums were included (i.e., total PAHs, total chlordane, and total DDT[25]).
- Chemicals already included in totals or sums were excluded (i.e., individual PAHs, DDD, DDE, DDD, alpha-chlordane, and gamma-chlordane).

This refinement was considered appropriate as it retained the primary classes of COPCs and all results for individual COPCs were retained within the total values included. Results of SQG-Q calculations are provided in Appendix B for all samples included in the predictive model development phase.

4.3.1.3 Calculation of Equilibrium Sediment Benchmarks

EqP models have gained recognition for their ability to correctly predict the bioavailability of toxic substances to benthic invertebrates. Because these models provide a method to estimate the biologically available concentrations in sediments, it was deemed important to include EqP models for consideration for use at the Site. Overall, this approach has the advantage in that it provides an additional framework to evaluate the toxicity of mixtures in sediment, a frequent condition at contaminated sediment sites. EqP models include metals, PAHs, and non-ionic organics (USEPA 2003g, 2005a, 2008b).

The metals mixture ESB includes the following calculation for solid-phase metals:

$$ESB_{AVS:WQC} = \sum SEM/AVS \qquad \text{(Equation 4-1)}$$

25 Although pesticides have not been retained as COPCs for sediment, they are evaluated here to assess the incremental risk these chemicals pose to benthic invertebrates.

Where:

∑SEM = Sum of simultaneously extracted metals (µmol/g)

AVS = Acid volatile sulfide (µmol/g)

The PAH mixture model includes the following calculations for all PAHs in a sample:

$$ESBTU_{PAH} = \sum_{i=1}^{34} C_{OC,PAH_i,FCV_i} \qquad \text{(Equation 4-2)}$$

Where:

PAH ESBTU = Sum of EqP PAH benchmark toxic units based on FCVs

$C_{OC,PAHi,FCV}$ = Quotient of the ith organic carbon normalized PAH concentration in sediment and its respective FCV

The $C_{OC,PAHi,FCVi}$ quotient for all PAHs in a sample is summed to create the overall ESBTU for the PAH mixture (USEPA 2003g) in a sample. For a subset of the Site sediment data, analytical laboratory results were not available for all 34 PAH included in the ESB model. However, these samples did have 16 PAHs quantified, and a scaling factor was applied based on regressions performed on data having all 34 PAHs (scaling factor of 1.849) to estimate the scaled equivalent to the 34 PAH Total PAH ESBTU (Figure 4).

Similarly, quotients of non-ionic organics with a narcosis mode of action as identified by USEPA (2008b) were summed:

$$ESBTU_{NOC} = \sum_{i=1}^{n} \left(C_{OC,Nonionic_i,SCV_{Narcosis,i}} \right) \qquad \text{(Equation 4-3)}$$

Where:

$ESBTU_{NOC}$: = Sum of EqP benchmark toxic units for non-ionic COPC

$C_{OC,NONIOINICi,SCVnarcosis,I}$ = Quotient of the ith organic carbon normalized non-ionic chemical concentration in sediment and its respective narcosis-based secondary chronic value

Sum quotients of non-ionic ESB ($ESBTU_{TIER2}$) included only those chemicals with a marine narcosis final chronic value (FCV) reported in USEPA (2008a) that were selected as COPCs for the BERA.

Results of ESB calculations for sediment samples included in the predictive model development are summarized in Appendix B.

4.3.1.4 Use of Split Sample Results as Proxy Data

Several samples collected in August of 2003 as part of the TMDL study series performed by Parsons Engineering (2004) were split with TCEQ and the USEPA. Parsons Engineering performed analytical chemistry, sediment bioassay testing, and sediment toxicity identification evaluation (TIE) studies. TCEQ and the USEPA also conducted independent analytical chemistry, bioassay testing, and sediment TIE studies. There were differences between the target analyte lists included in the analytical programs of each group, as well as differences in the bioassay testing organisms and testing protocols. Because results from both testing programs came from the same aliquot of sediment, results from these programs were used as proxy data for each other to provide a more complete dataset. For instance, TCEQ and the USEPA performed PCB analytical chemistry on their sample splits, while Parsons Engineering did not. In this instance, PCB results from the USEPA/TCEQ study were used as proxy results when analyzing the response of organisms tested by Parsons Engineering. Likewise, metals results from the Parsons Engineering testing program were used as proxy data in the evaluation of bioassay tests performed by the USEPA (TCEQ/USEPA metals data were not included in the database due to lack of documentation). Thus, more complete chemistry datasets could be constructed for evaluating the response in the bioassays tests. Samples and analytes that used proxy data are summarized in Appendix B. Proxy data are not maintained in the project database but were compiled for the predictive model analysis.

4.3.2 Toxicity Data

Whole sediment bioassay tests used in the predictive model evaluation included samples used in the selection of COPCs for the BERA. Methods and results of these tests are described elsewhere (Anchor 2008a, 2008b). Results of the tests are summarized in Table 17.

The approach of Thursby et al. (1997) was used to identify individual samples as toxic. Samples that were significantly different from negative controls and had a control-adjusted survival less than 80 percent relative to the negative control were identified as toxic.

Predictive model development focused on survival of *Leptocheirus plumulosus* in 10-day whole sediment bioassay tests as the effect endpoint for the model. This decision is based on:

1. Number of samples – This species was the most frequently used in bioassay testing for the Site; the *L. plumulosus* dataset consists of 43 individual tests at 19 unique locations. Bioassay tests with *Neanthes arenaceodentata* were performed on 37 samples, but all other test species had six or fewer test results each.
2. Observed sensitivity – Generally, *L. plumulosus* demonstrated similar or greater sensitivity to Site sediments, based on frequency of observed toxicity, as other species tested in three of four species tested.
   a. *L. plumulosus* and *Americamysis bahia:* Comparing samples that were tested using both test organisms, *L. plumulosus* demonstrated good concordance with *A. bahia*; none of the samples tested with both species was toxic to *A. bahia* but not to *L. plumulosus* (100 percent agreement; equal sensitivity).
   b. *L. plumulosus* and *N. arenaceodentata:* Four of 37 samples tested with *L. plumulosus* and *N. arenaceodentata* were toxic to the latter but not the former. Overall however, *L. plumulosus* was the more sensitive of the two species (42 percent of samples tested using *L. plumulosus* were toxic compared to 22 percent for *N. arenaceodentata*).
   c. *L. plumulosus* and *Mercinaria mercinaria*: No significant differences in *M. mercinaria* growth or survival from the negative controls were observed in any tests performed; thus these were considered much less sensitive than *L. plumulosus*.
3. *L. plumulosus* and *Ampelisca abdita*: *A. abdita* did show more frequent toxicity in samples when both species were tested compared to *L. plumulosus.* Four of six samples tested with both species were toxic to *A. abdita* (in 10-day tests) but not *L.*

plumulosus (7-day test with *A. abdita* were toxic only in one instance where toxicity to *L. plumulosus* was not observed).[26]

4.3.2.1 Acute Response Compared to Chronic Endpoints

All bioassay tests included in the model development were either 10-day or 7-day tests with mortality as the test endpoint, with the exception of *M. mercinaria,* which included growth as the test endpoint. During discussions among members of the Patrick Bayou Technical Work Group, questions were raised regarding the application of 'acute' bioassay tests as measurement endpoints for protection of the benthic invertebrate community. To address this concern, a review of the available literature comparing the relative sensitivity of acute and chronic whole sediment bioassay tests was performed. Additionally, the results of the Calcasieu BERA (MESL 2002) were analyzed to review the differences between acute and chronic tests performed for that site.

A review of the literature identified three recent, relevant studies that compared the effect of acute vs. chronic and lethal vs. sublethal endpoints in whole sediment bioassays using common test organisms and established test protocols. In the first study (McGee et al. 2004), 11 sediment samples were analyzed using 10-day acute toxicity tests and 28-day chronic test protocols with the amphipod *L. plumulosus*. The 10-day tests evaluated survival as the test endpoint, while the 28-day test evaluated survival, growth, and reproduction. The 28-day test was repeated using the same conditions with different feeding regimes to evaluate the effect feeding may have on the test outcomes. The incidence of toxicity in the 10-day test exceeded the incidence of toxicity for all endpoints in the 28-day test (Table 18).
The magnitude of toxicity (i.e., percent mortality) in the 10-day bioassay exceeded or was comparable (difference less than 10 percent) for all but one sample (Figure 5). Thus, the 10-day survival endpoint for *L. plumulosus* was identified as a more sensitive endpoint than both lethal and sublethal endpoints in the 28-day test. The reasons for this increased

26 Reasons for increased frequency of toxicity in *A. abdita* compared to *L. plumulosus* are not fully understood but are most likely due to differences in species sensitivities to particular chemical stressors and/or grain size and porewater ammonia concentrations. Both Parsons Engineering and the USEPA (which performed testing on sample splits from August 2003) identified ammonia as a potential confounding factor in the *A. abdita* tests (Parsons et al. 2002, 2004; USEPA no date). Generally, *A. abdita* is more sensitive to ammonia than *L. plumulosus*.

sensitivity in the acute test are not clear, but the authors speculated that differences in feeding regime and renewal of overlying water (both of which are not typically performed for the acute test) may have been contributing factors.

The second study (Greenstein et al. 2008), compared six sublethal whole sediment bioassay tests ranging from 2 to 20 days in length to the 10-day survival (lethal) endpoints for *L. plumulosus* and *Eohaustorius estuarius*. A pair-wise comparison of the acute tests to each of the sublethal tests was performed with 10 to 15 sediment samples collected from the California coast. With one exception, *L. plumulosus* had the highest incidence of toxicity compared to the sublethal endpoints (Table 19).

A third study (Steevens et al. 2008), described acute and chronic sediment bioassays performed with dredged material in New York Harbor and surrounding areas to assess potential risk to specific disposal locations. A series of three acute (10-day) and two chronic (28-day) tests were performed. Acute tests were performed with *A. bahia*, *A. abdita,* and *L. plumulosus*. Chronic tests were performed using *N. arenaceodentata* and *L. plumulosus* species. The acute 10-day *L. plumulosus* test had the highest incidence of toxicity (seven of nine sediments) among the tests performed (Table 20). No statistically significant difference was observed (using Kendall's concordance test) between the acute survival, chronic survival, and chronic growth and reproduction endpoints for *L. plumulosus*. On the basis of these tests, the authors recommended that acute testing with *L. plumulosus,* rather than chronic tests, be continued for evaluating the suitability of dredged material for disposal due to their greater sensitivity, simplicity, and overall performance.

Finally, results of paired 28-day and 10-day whole sediment bioassays performed with *Hyallela azteca* as part of the *Calcasieu Estuary Remedial Investigation/Feasibility Study: Baseline Ecological Risk Assessment* (MESL 2002; Lake Charles, Louisiana) were evaluated to identify differences in sensitivity of the two tests. This study site shares many characteristics similar to the Patrick Bayou Site, including similar COPCs, substrates, and general water quality (e.g., salinity). Growth (as the change in length normalized to test duration) and survival endpoints were evaluated. A total of 96 samples were included in the evaluation. For the survival endpoint, the 10-day test had a greater incidence of toxicity (53 percent) compared to the 28-day test (42 percent). Agreement between the tests (concordance) was

high (74 percent) and of the samples where the test results did not agree (i.e., one indicating toxicity, the other no toxicity), only 7of 96 tests (7 percent) were toxic in the 28-day test but not toxic in the 10-day test. For samples that were toxic, the magnitude of the response was similar or higher in the 10-day test. For the growth endpoint, the 10-day test had a greater incidence of toxicity (46 percent) compared to the 28-day test (36 percent). Agreement between the tests (concordance) was high (68 percent) and of the samples where the test results did not agree (i.e., one indicating toxicity, the other no toxicity), only 11 of 96 tests (11 percent) were toxic in the 28-day test but not toxic in the 10-day test. For samples that were toxic, the magnitude of the response was similar or higher in the 10-day test.

4.3.2.2 Summary of Toxicity Data

Based on the review above, classification of a bioassay test as acute or chronic is not a reliable indicator of the relative sensitivity of the test. Often, the acute lethal endpoint was more sensitive than chronic and/or sublethal endpoints. The reasons for the apparent differences in sensitivity among test endpoints is not clear but may be due to differences in test parameters and exposure modes, species specific sensitivity, or bioavailability. Nonetheless, the use of the acute tests to develop the Site predictive toxicity model is a protective choice for the assessment endpoint, and the use of chronic tests or additional sublethal endpoint bioassays would not be expected to provide a more conservative or reliable model. Additional toxicity data may be gathered to refine the predictive toxicity model (see Section 4.6.5).

4.4 Predictive Model Evaluation

4.4.1 Methods

The predictive ability of SQG-Q and ESBTU models were evaluated by comparing the observed toxicity in the *L. plumulosus* bioassay test and the predicted toxicity based on chemistry data for each sample. Initially, the mean ERM-Q, mean PEC-Q, mean PEL-Q, PAH ESBTU, non-ionic COPCs ESBTU, and metals ESBTU were included in the predictive ability analysis. Initially, all COPCs with SQGs available were included in the respective models. To evaluate the predictive ability of each, the following statistics were calculated initially assuming the effects threshold equal to 1.0:

- **False negative frequency**: number of samples incorrectly predicted as non-toxic/number of toxic samples
- **False positive frequency**: number of samples incorrectly predicted as toxic/number of non-toxic samples
- **Reliability**: number of samples correctly predicted/total number of samples

An SQG-Q or ESBTU was deemed acceptable for use in the risk characterization using the following acceptability criteria applied in similar evaluations of model performance (Long et al. 1998; MacDonald et al. 2000):

- False negative and false positive rates were less than 25 percent
- Overall reliability greater than or equal to 75 percent

Table 21 presents the acceptability criteria results for ERM-Q, PEC-Q, PEL-Q, PAH ESBTU, non-ionic COPC ESBTU, and metals ESBTU. All SQG-Qs and ESBTUs had false negative rates below or near the acceptability criteria of 25 percent (0 to 28 percent) but only one, the PEC-Q, had a false positive rate (16 percent) within the acceptability criteria limit. In addition, the PEC-Q was the only quotient or ESBTU with a reliability exceeding 75 percent. The non-ionic COPC ESBTU did not exceed 1.0 for any sample (false negative rate = 100 percent), indicating low risk of toxicity due to non-ionic organic COPCs.

Because three of the four SQG-Q or ESBTU models using the default threshold of 1.0 did not meet the acceptability criterion of less than 30 percent false positives, use of higher thresholds was evaluated. Similar to the approach used in other studies (Long et al. 2006),

the thresholds were adjusted in an attempt to achieve acceptable error rates in the comparison to toxicity test results for the Site. Effect thresholds were raised until acceptable error rates were achieved, if possible, and then were compared to bioassay results. The acceptability criterion was met for the mean PEL-Q by increasing the effects threshold to 2.44 but could not be met for any other metric at any potential effect threshold. Improvement in the error rates and reliability of the mean PEC-Q was not observed by increases in the effect threshold but were nearly acceptable at a threshold of 1.0. Graphs showing the error rates and reliability of the various SQG-Q- and ESBTU-based models across a range of observed values are provided in Figures 6a, 6b, and 6c.

4.4.2 Model Optimization and Calibration

Ultimately, the objective of the predictive model is to identify potentially toxic sediments using sediment chemistry alone with the highest predictive reliability possible. This is achieved by identifying the simplest model that provides the lowest error rates. Initially, all COPCs with SQGs available were included in the respective models; however, it is likely that subsets of these COPCs are responsible for the observed toxicity at the Site and focusing the model on these COPCs should increase the predictive ability of the model. Likewise, COPCs at the Site that are included in the model may not contribute to or may actually hurt model performance, increasing the probability that a sample will be incorrectly classified as toxic or non-toxic. This may be due to several factors such as covariance with other COPCs driving risk, bioavailability, or generally low concentrations relative to their respective SQGs.

To optimize the mean quotient models that met the acceptability criteria (PEC-Q and PEL-Q), steps were taken to identify the COPCs that contributed significantly to the predictive ability of the model and to remove COPCs that did not, with the ultimate goal of improving the model's performance compared to the initial mean quotient model.

Several steps were taken to identify COPCs that contribute significantly to the model's performance. First, COPCs that did not show a significant difference between chemical concentrations in toxic and non-toxic sample groups were removed from the model. The reasoning for this step is that only COPCs that show some positive relationship with observed toxicity are likely to be significant contributors to toxicity at the Site.

To determine which COPCs did not show a significant difference between toxic and non-toxic sample groups, hypothesis testing was performed using methods described by the USEPA's ProUCL Version 4.0 Technical Guide (2007f). Non-parametric hypothesis testing methods (Wilcoxon-Mann-Whitney [WMW] and Gehan's Test) were chosen over parametric tests for several reasons. Non-parametric tests do not require that the data fit a parametric distribution (e.g., normal or lognormal). Parametric tests (e.g., t-test) are adversely affected by outliers and non-detect values while non-parametric methods generally are not. Finally, non-parametric tests can be used even when the underlying distribution is parametric, and are nearly as powerful as parametric tests in such cases.

COPCs with greater than 40 percent frequency of detection were tested using the WMW test while COPCs with less than 40 percent frequency of detection were tested using the Gehan Test. Both tests use ranks of the data to test whether the measurements from one sample group tend to be consistently larger than those from the second group. For each test, α was set at 0.05 and the null and alternative hypotheses are:

$$H_O : \tilde{\mu}_{TOXIC} \leq \tilde{\mu}_{NONTOXIC} \qquad \text{(Equation 4-4)}$$

$$H_A : \tilde{\mu}_{TOXIC} > \tilde{\mu}_{NONTOXIC} \qquad \text{(Equation 4-5)}$$

Where:

H_o = null hypothesis

H_A = alternative hypothesis

$\tilde{\mu}_{TOXIC}$ = Toxic sample group median

$\tilde{\mu}_{NONTOXIC}$ = Non-toxic sample group median

Results of the hypothesis testing are summarized in Table 22. The hypothesis testing was performed on 13 COPCs (eight metals, one pesticide, bis(2-ethylhexyl) phthalate [BEHP], total PAH, and one PCB Aroclor). Lindane was not included due to the low numbers of results available in the dataset (n=5). Based on this analysis, lead, silver, total PAH, BEHP, and one PCB Aroclor were identified as having significant differences between toxic and non-toxic distributions. Of these six analytes, all had several individual quotient values

exceeding 1.0 with the exception of silver, which had a maximum individual PEL-Q value of 0.89. On this basis, silver was dropped from the optimized mean PEL-Q model (there is no PEC for silver).

Next, mean quotients for PEC-Q and PEL-Q were recalculated using only those COPCs identified as having a significant difference between toxic and non-toxic datasets. The PEC-Q was recalculated as the mean of the individual PEC-Q for total PAH, total PCB, and lead (no PEC is available for BEHP). The PEL-Q was recalculated using the mean of the individual PEL-Q for total PAH, total PCB, lead, and BEHP.

Graphs showing the change in error rates across observed range of the optimized mean PEC-Q and PEL-Q are provided in Figure 7. Both optimized models have lower error rates and higher reliability than their respective full mean quotient models (Table 23). The optimized mean PEC-Q at a threshold of 1.21 had a higher overall reliability (88 percent vs. 79 percent) rate as the full model, a lower false negative rate (22 percent vs. 28 percent), and a lower false positive rate (4 percent vs. 16 percent). The optimized mean PEL-Q at a threshold of 1.56 had a higher overall reliability (81 percent vs. 79 percent), lower false negative (17 percent vs. 22 percent), and same false positive (20 percent) rate as the full mean PEL-Q model.

4.4.3 Summary of Predictive Model

Using mean quotient models, two sets of SQGs—the PEC and PEL—met the acceptability criteria for predicting toxicity in Site sediments. The predictive ability of both quotient models was increased by removing those COPCs within the model that showed a poor relationship with empirically measured toxicity. Overall, the optimized mean PEL-Q model is considered the most appropriate predictive model for characterizing risk to benthic invertebrates. This model was preferred over the optimized mean PEC-Q model due to its lower false negative rate and inclusion of all four COPCs (total PAHs, total PCBs, lead, and BEHP) with significant association with toxic samples in the Site dataset.

4.5 Risk Characterization

The most recent surface sediment chemistry data (Anchor QEA 2010) will be used to calculate the optimized mean PEL-Q value for each sediment sample location. Locations that exceed the optimized mean PEL-Q threshold of 1.56 will be identified as having a high probability for adverse effects to benthic invertebrates. Locations with threshold values less than 1.56 will be identified has having a low probability of adverse effects. Because the benthic risk assessment will be performed on a sample-by-sample basis, maps will be generated showing the spatial distribution of low and high probability risk locations.

4.6 Model Uncertainty Analysis

As evidenced by the reliability analyses that have been conducted, the chemicals represented in the optimized mean PEL-Q are expected to provide a sufficient surrogate for predicting benthic toxicity. Nonetheless, it is possible that there are unique locations within the Site where COPCs that were not included in the predictive models are responsible for, or are correlated with, benthic toxicity. The potential uncertainty and methods to characterize this uncertainty are described in the following sections.

4.6.1 Non-Ionic Organic COPCs

The non-ionic COPCs ESBTU for all samples in the predictive model dataset were less than 1.0 and showed no concordance with observed toxicity, indicating a low probability of toxicity from COPCs included in this mechanistic approach to toxicity prediction. In addition, non-ionic COPCs ESBTU values from other locations (n=13) within the Site collected as part of the initial RI activities (Anchor 2008a; Table 24) did not exceed the effect threshold of 1.0. Thus, it is expected that the following COPCs have a low probability of toxicity at the Site, and that the uncertainty associated with this conclusion is considered low:

- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- Benzene
- Chlorobenzene
- Endosulfan, alpha
- Endosulfan, beta

- Ethylbenzene
- Hexachloroethane
- Toluene

4.6.2 Metals Bioavailability

The bioavailability of the metals copper, lead, nickel, silver, and zinc was assessed by calculating the metals ESBTU and comparing these values to the empirical sediment toxicity. As described in Section 5.3.1, the metals ESBTU could not meet the minimum acceptance criteria for predicting sediment toxicity. However, several metals ESBTU values exceeded 1.0, the assumed effects threshold identified by the USEPA (2005a). To assess the potential for these metals to exceed the default effects threshold at locations where the optimized mean PEL-Q would predict sediments to be non-toxic, the metals ESBTU was compared to the optimized mean PEL-Q for each sample in the model dataset, as well as surface sediments collected as part of the initial RI/FS activities (Anchor 2008a; Table 24). Of the 56 samples, only four (7 percent) had a metals ESBTU exceeding 1.0, but they are predicted to be non-toxic according to the optimized mean PEL-Q model. Of these four locations, two stations are located in the gunnite-lined channel portion of the Site. This portion of the Site is much different than the rest of the Site due to differences in grain size, substrate (line channel vs. unconsolidated sediment), and its proximity to upstream sources and is generally not considered representative of other areas of the Site. Thus, with the exception of the gunnite-lined channel portion of the Site, the optimized mean PEL-Q model is a reliable surrogate for identifying any potential toxicity due to the combined effects of copper, lead, nickel, silver, and zinc.

4.6.3 COPCs that Exceed Their PEL but are Not Model Variables

Several COPCs, including arsenic, cadmium, chromium, mercury, silver, total DDT, and total chlordane have SQGs but were ultimately not included in the model. These COPCs were not included due to the lack of significant difference between toxic and non-toxic sample groups for these COPCs. In addition to showing no relationship to observed toxicity, most of these COPCs did not exceed their respective PEL values and would not be considered potential drivers of toxicity (Table 25). Cadmium, silver, and total chlordane did not exceed their respective PEL in any sample from the model dataset or in the surface sediment samples

collected during initial RI activities. Arsenic and chromium each exceeded their PEL at two locations that would not be identified as toxic in the optimized mean PEL-Q model; however, each sample was located within the gunnite-lined channel and not in downstream, unconsolidated sediments. Mercury and total DDT were the only two COPCs that exceeded their PELs at locations not predicted to be toxic with any regular frequency.

Mercury exceeded its PEL in 12 samples that were not predicted to be toxic. The most likely reason for this observation is related to potential bioavailability of mercury. Because the PEL is derived from a national database based on total mercury, differences in bioavailability of this analyte are not explicitly accounted for in the development of this SQG. However, it has been demonstrated that bioavailability and toxicity of mercury in sediments can be strongly influenced by site-specific conditions such as redox potential and sulfide content. To better characterize potential bioavailability of mercury at the Site, mercury speciation analysis of Site porewater was performed at 10 locations using high resolution coring methods (2 cm increments from 0 to 20 cm; n=100). This work was performed as part of the S*upplemental Remedial Investigation Work Plan* (Anchor 2007e). Analysis of these data is currently in progress but initial analysis indicates that most porewater mercury (approximately 80 percent) is present as insoluble mercury sulfide and that the highly toxic and bioavailable methyl mercury is present as a low proportion (less than 10 percent) of total mercury. In such a case, total mercury is expected to be a poor indicator of potential toxicity, and the lack of correspondence between total mercury and observed toxicity is to be expected. Mercury speciation analysis and further discussion regarding potential toxicity at the Site will be presented in the RI. On this basis, the uncertainty due to relatively elevated mercury and low observed or expected toxicity is considered low. A full discussion of the mercury bioavailability data for the Site will be provided in the RI.

Similarly, total DDT exceeded its PEL in 12 samples that were not predicted to be toxic, primarily due to elevated 4,4'-DDT in the total value. However, numerous field studies have shown that SQGs including the PEL and ERM for DDT are conservative values that likely overestimate predicted toxicity to amphipods. For the amphipod *Eohaustorius estuarius* in Richmond Harbor, California, the field-derived 10 day median lethal concentration (LC50) for total DDT was 41,600 µg/kg (2,500 µg/g OC), with the lowest effect threshold at 4,980 µg/kg (Swartz et al. 1994). This is comparable to other field-derived LC50s for other

amphipod species with similar test protocols; the 10 day LC50 for *Rhepoxynius abronius* exposed to Palos Verdes Shelf sediment was 20,800 µg/kg (1,040 µg/g OC; Swartz et al. 1985)[27] and the 10 day LC50 for *Hyalella azteca* exposed to sediment from a freshwater stream system near Huntsville, Alabama was 63,500 µg/kg (2,580 µg/g OC; Hoke et al. 1994).[28] The concentrations of the LC50s in these studies are several orders of magnitude higher than the marine SQGs (i.e., PEL = 51.7 µg/kg and ERM = 46.1 µg/kg) and an order of magnitude higher than the freshwater SQGs (i.e., PEL = 4,450 µg/kg and PEC = 572 µg/kg). The similarity among LC50s across these studies is notable even though there were differences in sediment type, species, and concentrations of each DDT derivative.

Additionally, laboratory studies assessing toxicity to amphipods in reference sediment spiked with DDTs also provide evidence of the conservative nature of SQGs. The 10 day LC50 was 6,180 µg/kg (583 µg/g OC) for the amphipod *R. abronius* exposed to reference sediment (collected from the Northern tip of Palos Verdes Shelf, California) spiked with DDTs (Murdoch et al. 1997). Similarly, the 10-day and 28-day LC50s for *L. plumulosus* exposed to reference sediment (collected from Sequim Bay, Washington) spiked with DDT were 1,980 µg/kg and 2,270 µg/kg, respectively while the lowest effect threshold in this study was 1,490 µg/kg (Lotufo et al. 2001). In a laboratory study in which *H. azteca* were exposed to Oregon reference sediments spiked with DDT, the LC50s were found to range from 11,000 µg/kg to 49,700 µg/kg, depending on total organic carbon (TOC) content (i.e., ranged from 3 to 10.5 percent, respectively; Nebeker et al. 1989). Similar to the field studies described above, the LC50s and lowest effect threshold determined in the laboratory studies using marine species are two orders of magnitude above marine SQGs and the LC50 determined in the laboratory study using the freshwater amphipod was approximately one order of magnitude above the freshwater SQGs.

Given the highly conservative nature of the SQGs for DDT, they are considered unreliable predictors of toxicity due to DDT. In addition, observed concentrations of DDT in samples predicted to be non-toxic generally fall below the effect thresholds observed in the above studies, indicating that the likelihood for adverse effects to benthic invertebrates due to DDT

27 Assumes TOC is 2 percent
28 Based on an average TOC concentration of 2.46 percent

in Site sediments is low. On these bases, the uncertainty in the model due to the exclusion of DDT is considered low.

4.6.4 COPCs Without SQG Values

At locations where toxicity is not predicted based on the optimized mean PEL-Q model, the presence of COPCs without an SQG at high concentrations may lead to a Type I error (i.e., predicting no toxicity in a sample that is toxic) and may confound the outcome of the analysis for that location. Therefore, the importance of chemicals that were not included in the predictive model reliability analysis to the overall risk to benthic invertebrate communities was evaluated by identifying locations where the maximum detected concentration of each of these chemicals is greater than ten times its average detected concentration. A factor of 10 was arbitrarily selected to identify location with relatively high concentrations of the chemicals without SQGs. Mindful that this evaluation is not risk-based (i.e., the effect threshold relative to the average concentration is not known), it does provide some metric to assess uncertainty associated with these COPCs. COPCs included in this uncertainty analysis include:

- Ammonia
- Barium
- Endrin
- Hexachlorobutadiene
- Benzidine
- bis(2-Chloroisopropyl)ether
- Hexachlorobenzene
- Total xylene
- 4-Isopropyltoluene
- Isopropylbenzene
- n-Butylbenzene
- n-Propylbenzene
- sec-Butylbenzene
- tert-Butylbenzene

Of the samples where the optimized mean PEL-Q model does not predict toxicity, only one result (hexachlorobenzene at Station G) had a result in excess of ten times its average detected concentration (Table 26). As a result, the uncertainty associated with identifying a sample as non-toxic but with elevated COPCs without SQGs is considered low.

4.6.5 Uncertainty Analysis Summary

In general, the optimized mean PEL-Q model developed to predict potential sediment toxicity is valid and calibrates well with the COPC concentrations and toxicity to test organisms observed in these data. Several lines of evidence indicate that the rate of false negatives in the predictive model due to COPCs is low. One factor currently unaccounted for in the predictive model is the impact of confounding factors (CFs) on the observed sediment toxicity in the original 2000 and 2001 sediment toxicity data. As has previously been discussed and presented to the agency representatives, the original sediment toxicity tests did not account for CFs, which may impact the toxicity test results. These CFs include temperature, salinity, ammonia, and acclimation period. As a result, the predictive model may over-predict the dose response for a given concentration of COPCs, resulting in an over-prediction of risk at the Site.

During the BERA, based on this evaluation and in consideration of other risk evaluation results, the need for refinement of the predictive model will be evaluated. Further refinement may be completed at that time, including additional sediment toxicity tests conducted at the Site. It is anticipated that the primary objectives of any future testing would include:

- Quantify the affects of CFs on the sediment toxicity results
- Refine the predictive model's chemical dose-response relationship
- Support calibration of the predictive model
- Support the risk assessment of benthic invertebrates in the BERA

Should it be determined that additional testing is warranted, a detailed work plan will be developed based on the results of the risk evaluation. The work plan would outline the number and location of samples, test organisms and test durations, and testing procedures to quantify the CFs. The work plan would be prepared and submitted to the agency

representatives for approval at a later date should the JDG implement this adaptive management approach to the further evaluation of sediment toxicity during the BERA.

5 FISH RISK ANALYSIS AND CHARACTERIZATION

This section describes the risk analysis and characterization for each measurement endpoint identified for the fish receptor group. Measures of effect, measures of exposure, and risk estimation methods are described for each fish measurement endpoint.

5.1 Surface Water Toxicity

The 95 UCL concentrations of the surface water dataset for the selected site COPCs (see Section 2.3) will be compared to WQC using a HQ approach. The toxicity value for Total PCBs was taken as the USEPA NAWQC Saltwater CCC (USEPA 2009), which is 0.03 µg/L.

COPCs with an HQ exceeding 1.0 will be considered sufficient to result in adverse effects to fish and will be considered contaminants of concern (COCs) for this media.

5.2 Sediment Toxicity

Per the COPC Report and Amendment (Anchor 2008a, 2008b), sediment COPCs identified for benthic invertebrates will serve as a proxy for identifying direct sediment exposure COPC for fish. Specifically, the toxicity model developed for protection of benthic invertebrates will be used as a surrogate model for predicting potential fish toxicity. The uncertainty associated with this assumption will be discussed in the BERA.

5.3 Bioaccumulation

Bioaccumulation will be assessed using a body burden approach for fish. Although this measurement endpoint takes into account every route of exposure, it is assumed that the primary route of exposure is through ingestion of contaminated biota. Secondary routes of exposure may include uptake from surface water (i.e., gill uptake) or incidental ingestion of sediment for demersal fish.

5.3.1 Exposure Assessment

The lack of site-specific tissue data is considered a primary source of uncertainty in the exposure assessment for fish. Application of the BSAF approach to estimate tissue concentrations in fish was considered a conservative approach for identification of COPCs.

For the BERA, a more site-specific assessment is considered appropriate to reduce uncertainty in the exposure assessment. Therefore, potentially bioaccumulative COPCs will be evaluated in the BERA using empirically measured tissue concentrations in Site fish tissue. To address this data gap, a Sampling and Analysis Plan (SAP) has been developed (Attachment 1), which describes the study design and methodology.

Briefly, fish will be targeted for collection at the Site and analyzed for the list of bioaccumulative COPCs identified for this receptor group. Collection and analysis of fish measuring less than or equal to 15 cm in length will be targeted; fish larger than this size class will likely average their exposure over a range larger than the Site and their exposure duration (i.e., age) would result in body burdens that do not reflect Site exposure. Within the target size class, specific trophic levels and size classes will also be targeted to collect representative data for the different feeding guilds, site fidelity, and age of fish at the Site. Approximately 65 fish tissue samples are targeted for collection. As the assessment endpoint is based on the fish community as a whole, results of these tissue samples will initially be pooled to estimate exposure within the fish community.

For the assessment of exposure using the empirically collected tissue data, exploratory data analysis will be performed prior to development of exposure concentrations. Given the variety of ecological niches and physiology, distinct subpopulations of exposure profiles for fish may be present at the Site. The exploratory analysis will be used to identify any significant differences in potential exposure among fish species, guilds, trophic levels, etc. If significant and distinct differences are observed, the exposure assessment may be performed among the different groups identified; each group would be considered a line of evidence to support this measurement endpoint. This 'sub-receptor group' classification would be implemented if pooling all the tissue data would result in extreme bias in the exposure assessment for this receptor group.

Summary statistics for each COPC will be generated using the pooled data. Summary statistics of interest will include, but not be limited to, mean, standard deviation, coefficient of variation, percentiles, and confidence limits for different measures. Specifically, the 95 UCL will be estimated using current statistical methodology (USEPA 2006, 2007f). The 95

UCL will be used as the exposure concentration (EC) for the risk estimation for this receptor group.

5.3.2 Effects Assessment

For fish, the measure of effect for this measurement endpoint will be tissue-based threshold effect concentrations. The primary source of tissue-based effects concentrations is the ERED database (http://el.erdc.usace.army.mil/ered/). The ERED is a compilation of literature effects data from over 2,000 studies published between 1964 and 2007 where tissue concentrations were measured in carnivorous fish for the targeted effect. A copy of the most current database (last updated September 2007) was obtained from the U.S. Army Corps of Engineers (USACE). At present, the database contains only those results where an observed effect is reported as being directly related to a chemical in the tissue. The ERED includes the effects data presented in Jarvinen and Ankley (1999), as well as multiple other sources. This database was compiled by the JDG and used to screen and select effect thresholds for the selection of COPCs (Anchor 2008a, 2008b). This will be the primary source for selection of effects thresholds for the BERA. A review of the ERED database sources, as well as other literature sources, will be performed during the BERA to identify any additional studies that could add to the body of information currently available for selecting measures of effect.

The geometric mean of the derived or measured Lowest Observable Effects Dose (LOED) values from the final list of studies will be used as the TRV for the effects endpoint. If a LOED result is not available for a chemical, an LOED-equivalent will be derived using the geometric mean of available no observable effects dose (NOED) results multiplied by an uncertainty factor of five. An uncertainty factor of five applied to no effects data to derive low effect concentrations was determined appropriate as a conservative approach when starting with a no effect level and extrapolating along an assumed dose response curve (Weil and McCollister 1963; Dourson and Stara 1983; ABT Associates 1995).

5.3.3 Risk Characterization

Risk due to uptake from surface water and sediment/biota exposure pathways will be characterized using an HQ approach. The HQ will be expressed as the ratio of the estimated EC to the TRV. HQ will be estimated for both surface water uptake and sediment/biota uptake pathways. COPCs with an HQ greater than 1.0 will be identified as COCs in the BERA.

6 AQUATIC-DEPENDENT WILDLIFE RISK ANALYSIS AND CHARACTERIZATION

The potential risks to each receptor group (sediment-probing birds, carnivorous birds, piscivorous birds, and omnivorous mammals) will be evaluated using measured or estimated COPC concentrations in prey tissue and sediments at the Site. The ingested dose received by each representative receptor will be estimated by multiplying species-specific food and incidental sediment ingestion rates (normalized to body weight) by the concentrations of COPCs in prey species (fish and invertebrates), and sediment. Appropriate modifications based on behavioral factors (i.e., foraging range) will be applied where appropriate. Estimated ingested doses will be compared to TRV doses for survival, growth, or reproduction. If the ingested dose of one or more COPCs is equal to or in excess of their respective TRV for a representative receptor, (i.e., HQ greater than 1.0), members of the receptor group (e.g., carnivorous birds) will be considered to be potentially at risk and COCs will be identified for that group.

This section describes the measures of exposure, measures of effect, and risk characterization that will be used to evaluate the measurement endpoints of the BERA for wildlife.

6.1 Measures of Exposure

The primary exposure pathway for aquatic-dependent wildlife identified in the problem formulation (Section 3) is through the ingestion of contaminated sediment and/or biota. The measure of exposure selected for aquatic-dependent wildlife is the dietary ingestion route of exposure.

Ingestion exposure will be characterized using a TDI model of the COPC on a body weight-normalized basis (mg of COPC/kg body weight/day). The exposure model representing TDI from environmental media is expressed as:

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota} \qquad \text{(Equation 6-1)}$$

Where:

TDI_{all} = total daily intake of COPCs from all sources (e.g., mg COPC/kg body weight/day)

TDI_{water} = total daily intake of COPCs from incidental and/or drinking water ingestion; assumed to be zero based on the problem formulation exposure pathways

$TDI_{sediment}$ = total daily intake of COPCs from incidental sediment ingestion

TDI_{biota} = total daily intake of COPCs from ingestion of food items

Exposure models to calculate TDI for different media are discussed in the following subsections.

6.1.1 Total Daily Intake Through Ingestion of Biota

The exposure model for biota ingestion is adapted from the USEPA (1993; Equation 4-8) and is represented as:

$$TDI_{biota} = \sum_{k=1}^{m} (C_k \times FR_k \times NIR_k) \qquad \text{(Equation 6-2)}$$

Where:

TDI_{biota} = potential average daily dose (mg COPC/kg body weight/day)

C_k = Contaminant concentration in k^{th} type of food (mg COPC/kg food)

FR_k = Fraction of kth type of food that is contaminated

NIR_k = normalized ingestion rate of kth type of food on wet weight basis (kg food/kg body weight/day)

m = Number of contaminated food types

For receptors with more than one distinct type of food (i.e., k greater than 1), the NIR term can be calculated using the following equations (USEPA 1993; Equation 4-11):

$$NIR_{total} = \frac{NFMR}{ME_{avg}} \qquad \text{(Equation 6-3)}$$

Where:

NIR_{total} = Total normalized ingestion rate (kg food/kg body weight/day)

NFMR = Free-living metabolic rate normalized to body weight (kcal/kg body weight/day)

ME_{avg} = Average metabolizable energy of the total diet on a wet weight basis (kcal/kg food)

The ME_{avg} term is calculated according to USEPA (1993) Equation 4-12:

$$ME_{avg} = \sum_{k=1}^{m} (P_k \times ME_k) \qquad \text{(Equation 6-4)}$$

Where:

P_k = Proportion of the diet consisting of the kth food type on a wet weight basis (unitless)

ME_k = Metabolizable energy of the kth food type on a wet weight basis (kcal/kg food)

ME_k term can be calculated using Equation 4-13 in Figure 4-4 of USEPA (1993):

$$ME_k = GE_k \times AE_k \qquad \text{(Equation 6-5)}$$

Where:

GE_k = Gross energy content of kth food type in wet weight (kcal/kg food)

AE_k = Assimilation efficiency for the kth species (unitless)

Finally NIR_k is calculated by USEPA (1993) Equation 4-10:

$$NIR_k = P_k \times NIR_{total} \qquad \text{(Equation 6-6)}$$

Each input variable is discussed in more detail below. Parameterization of each variable for representative receptors is discussed in the following subsections.

6.1.1.1 Contaminant Concentration in the kth Type of Food (C_k)

Concentrations of COPCs in the diet will be estimated using field-collected tissue data. This term will be specifically defined for each representative receptor depending on their diet. The number of prey groups (k) will be a function of the diet composition of the representative receptor, including consideration of specific prey species and size of prey (see Table 27 and Section 6.2 below), and the availability of empirical Site data for different prey groups.

The lack of site-specific prey tissue data is considered a primary source of uncertainty in the exposure assessment for wildlife. For the selection of COPCs for the BERA, application of a BSAF approach to estimate tissue concentrations in prey items was considered a conservative approach for identification of COPCs. For the BERA, a more site-specific assessment is considered appropriate to reduce uncertainty in the exposure assessment. Therefore, potentially bioaccumulative COPCs will be evaluated in the BERA using empirically measured tissue concentrations in Site prey tissue (fish and aquatic invertebrates). To address this data gap, a SAP has been attached to this BERA Work Plan (Attachment 1), which describes the study design and methodology.

Fish and aquatic invertebrates will be targeted for collection at the Site and analyzed for the list of COPCs identified for this receptor group. Collection and analysis of fish less than or equal to 15 cm in length and invertebrates less than or equal to 12.5 cm will be targeted; fish and aquatic invertebrates larger than this size class will rarely, if ever, be consumed by representative receptors and larger class sizes of prey may not reflect exposure due to Site COPCs, as larger individuals have a higher likelihood of averaging their exposure at spatial scales larger than the Site. Within the overall target size classes (≤15 cm fish; ≤12.5 cm invertebrates), specific trophic levels and size classes will also be targeted to collect representative data for the different feeding guilds and diet compositions of the wildlife representative receptors.

Summary statistics for each prey group (k) and COPC will be generated using tissue data results. Summary statistics of interest will include, but not be limited to, mean, standard deviation, coefficient of variation, percentiles, and confidence limits for different measures. Specifically, the 95 UCL will be estimated using current statistical methodology (USEPA

2006, 2007f). This statistic will represent the concentration term (C) for the kth prey group for this measurement endpoint.

6.1.1.2 Fraction of kth Type of Food that is Contaminated (FR_k)

This term represents the proportion of a specific prey item/group (k) that is contaminated in the diet of the receptor. For example, if the kth item in the diet is mullet and 50 percent of the mullet in the diet were contaminated, FR_k would be set to 0.5. If all the mullet in the diet is contaminated at the same concentration (C_k), then the FR term would be set to 1. In the BERA, this term will not initially be varied (i.e., FR_k=1.0). For a given prey group, the C_k term will be considered representative of all prey items within that group.

6.1.1.3 Normalized Ingestion Rate (NIR_k) and Normalized Free Metabolic Rate ($NFMR_k$)

Normalized ingestion rate (NIR) represents the amount of the kth type food ingested on a daily basis per unit of body weight of the receptor (total amount of food ingested divided by the body weight of the receptor). Normalized free-living metabolic rate (NFMR) represents the amount of energy (e.g., kilocalories [Kcal]) that a receptor must ingest to meet its daily metabolic requirements and is expressed on a per body weight basis. Nagy (1999, 1987) and others have directly measured the metabolic rate of free-living individuals. From this dataset, the allometric relationship between free-living metabolic rate and body weight has been identified for different groups of animals (e.g., birds and mammals).

Free-living metabolic rates were estimated for each receptor using body weight information from the literature and the allometric relationships described in Nagy et al. (1999). When measured free metabolic rates (FMRs) were not available for receptors (as is often the case), the following allometric equation was used to estimate NFMR on a kcal/g body weight/day basis:

$$NFMR = \frac{\left(\left(a \times BW^{b}\right) \times CF_1\right)}{BW \times CF_2} \qquad \text{(Equation 6-7)}$$

Where:

a	=	FMR-slope
b	=	FMR-power
BW	=	Body weight (g)
CF_1	=	Conversion factor (1 kcal/4.186 kJ)
CF_2	=	Conversion factor (1 kg/1000 g)

Power and slope terms are based on allometric analysis done using log-transformed FMR values regressed on corresponding mean body weights for several species of mammals and birds (Nagy et al. 1999). The power and slope terms used to estimate the NFMR term were selected on a receptor of concern specific-basis. Estimates of NFMR for each receptor are discussed in Section 6.2.

Body weights will be estimated using the average body weight for each representative receptor. Average body weight will be determined using relevant guidance (i.e., USEPA 1993) and the open literature. Studies of body weights for adults of both sexes will be considered. Body weights for each receptor are discussed in Section 6.2.

6.1.1.4 Gross Energies (GE_k) and Assimilation Efficiencies (AE_k)

The product of the GE and AE for a prey group represents the 'usable' energy available to the receptor after accounting for energy excreted (metabolizable energy [ME]). The GE and AE of prey species used in the exposure model are obtained from reported values in USEPA (1993). In the BERA exposure assessment, point estimates of the GE and AE terms will be based on the average for these values derived in Appendix A. The ME term will be the product of these two averages and will be calculated on a prey group (fish or aquatic invertebrate) and receptor (e.g., sediment-probing bird, omnivorous mammal) specific basis for each representative receptor.

6.1.1.5 Proportion of Diet for Prey Groups (P_k)

This term represents the relative proportion (from 0 to 1.0) that a specific prey group (e.g., fish) constitutes in the overall diet of the receptor. Fish and benthic invertebrates are considered the primary dietary source of potential exposure to Site COPCs for aquatic-

dependent wildlife. The proportion of different prey items in the diet varies according to the receptor of concern and will be a function of the behavioral and physiological characteristics of representative receptors, as well as the presence of preferred dietary items at the Site. Similar to the Calcasieu BERA (MESL 2002), prey items have been grouped according to size class, type, and trophic level (Table 27). For receptors, the proportion of diet will be based on these general size classes. Proportions of dietary items for each receptor are described in Section 6.2.

6.1.2 Incidental Ingestion of Sediment

To account for incidental sediment ingestion, the following equation will be adopted from USEPA (1993; Equation 4-23):

$$TDI_{sediment} = \left(\sum_{k=1}^{m} \left(C_k \times FS \times IR_{total} \times FR_k \right) \right) \Big/ BW \qquad \text{(Equation 6-8)}$$

Where:

$TDI_{sediment}$	=	Total daily intake of COPCs through incidental ingestion of sediment (mg/kg body weight/day)
C_k	=	Concentration in the kth foraging area sediment on a dry weight basis (mg/kg)
FS	=	Faction of sediment in diet (as percentage of diet on a dry weight basis; unitless)
IR_{total}	=	Food ingestion rate on a dry weight basis. For equations using estimating IR_{total} on a wet weight basis, conversion to dry weight ingestion rates would be necessary (mg food/kg body weight/day)
FR_k	=	Fraction of total food intake from k^{th} foraging area (unitless)
BW	=	Body weight (kg)
m	=	Number of foraging areas

6.1.2.1 Concentration in Sediment within Foraging Areas (C_k)

This term represents the concentration of a COPC in sediment that a receptor would incidentally ingest while at the Site. Incidental ingestion may occur while foraging,

handling prey items with sediment on them, or during preening activities. This term will be calculated using whole sediment chemistry data collected at the Site. Spatial characterization of sediments to which a receptor may be exposed (i.e., k^{th} foraging area) will be performed on a receptor-specific basis. Some areas of the Site may not be available to specific receptors depending on their foraging behavior and other factors (wading by birds in subtidal areas). These specific spatial factors controlling exposure are discussed on a receptor-specific basis in Section 6.2.

Within the defined foraging area, it is anticipated that receptors will be assumed to average their exposure (i.e., incidental ingestion) over the entire area. Estimates of exposure within a foraging area will be calculated using a surface weighted average concentration (SWAC).

6.1.2.2 Fraction of Sediment Ingested (FS)

Fraction of sediment ingested will represent the incidental ingestion of sediment during feeding, preening, and other activities. Models are not available to estimate incidental ingestion by wildlife species, and empirical measurements of sediment ingestion are sparse (USEPA 1993; Beyer et al. 1994). Given the uncertainty in this parameter, conservative values will be considered. The primary source for fraction sediment ingested calculations will be USEPA (1993) and Beyer et al. (1994). For receptors without a reported fraction of sediment ingestion, best professional judgment will be used. Fraction of sediment ingested for each receptor is discussed in Section 6.2.

6.1.2.3 Food Ingestion Rate on Dry Weight Basis (IR_{total})

This value is calculated using the NIR_{total}, body weight, and percent moisture to get a total daily ingestion rate using the following equation:

$$IR_{Total} = \left(NIR_{Total} \times BW\right) \times \left(1 - P_{Moisture}\right) \qquad \text{(Equation 6-9)}$$

Where:

IR_{total} = Total daily ingestion of food on a dry weight basis (mg food/day)

NIR_{total} = Normalized total daily ingestion rate of food (mg food/kg body weight/day)

BW = Body weight (kg)

$P_{moisture}$ = Proportion of moisture in food (unitless)

Dry weight conversion will be performed using average percent moisture values for organisms collected as part of the field tissue sampling program described in Attachment 1.

6.1.2.4 Number of Foraging Areas (m)

Foraging subareas for the Site may be identified for receptors based on their behavioral characteristics relative to the habitat setting of the Site. Generally, it is expected that receptors will average their exposure over all foraging areas that are available to them at the Site. However, if fragmented habitat occurs within the Site and COPC concentrations (C_k) vary significantly across foraging subareas, the number of foraging areas may be greater than 1.

6.1.3 Total Daily Intake from Water

Due to the brackish nature of Patrick Bayou, ingestion of surface water as drinking water to satisfy the metabolic needs of birds and mammals is expected to be minimal. Incidental ingestion during feeding and preening may occur but is assumed to be a negligible amount. Therefore, the TDI_{water} term is assumed to be zero.

6.2 Receptor-Specific Model Input Parameters

This section discusses and identifies receptor-specific parameters for representative aquatic-dependent wildlife receptors identified in Section 3. Further detailed information on representative receptors can be found in the species profiles included in Appendix C. Relevant information used to identify model variable inputs is summarized here. For each receptor, the following receptor-specific values were identified:

- Body weight
- Field-metabolic rate (including power and slope terms)
- Composition of diet
- GE of prey items
- AE

- Fraction of sediment in diet
- Area use factor (AUF)

All other terms are products of one or more variables above or are based on site-specific values. Each receptor is discussed below. General and receptor-specific variable values are summarized in Table 28. The TDI calculations presented in equations 6-1, 6-2, and 6-8 above assume that a receptor spends 100 percent of its time foraging at the Site (i.e., the AUF is equal to 1). For many receptors, this assumption may be overly conservative, particularly if the size of the Site is small relative to the foraging area requirements of a particular receptor. The TDI calculations can be modified by the use of AUF values that are less than 1, if this is a valid assumption for the receptor under consideration.

The AUF is function of a number of different habitat quality and use factors for each of the aquatic-dependent wildlife receptors (sediment-probing birds, carnivorous birds, piscivorous birds, and omnivorous mammals). For example, site usage by aquatic-dependent wildlife receptors is affected by the overall size and quality of the habitat at the Site, the availability of food, competition with other feeding guilds for food, and the potential to migrate or move away from the Site. For all the aquatic-dependent wildlife receptors, the available habitat at the Site is not optimal, which may preclude nesting for birds and den building for raccoons near the Site. The factors that affect the AUF for each receptor are discussed in the following subsections.

6.2.1 Spotted Sandpiper

The spotted sandpiper is the representative receptor for the sediment-probing bird guild. The average body weight of spotted sandpipers is set at 42.5 grams. This represents the average body of weight of adult males and females in USEPA (1993). NFMR was calculated using Equation 6-7. Slope (a) and power (b) terms for this receptor were set at 8.13 and 0.77, respectively. These values represent the terms calculated for *Charadriiformes* in Nagy et al. (1999). *Charadriiformes* is an order of the class Aves and includes sandpipers. Based on these terms and the average body weight, the NFMR term is estimated at 815 kcal/kg body weight/day.

Spotted sandpipers are very generalist and opportunistic in their diet, consuming primarily terrestrial and aquatic invertebrates. Available literature does not explicitly discuss either the relative proportion of diet items or size classes of prey. Given that this receptor is to be protective of other receptors with diets that may include a higher proportion of aquatic species in their diet, the diet of this receptor is assumed to be 100 percent aquatic invertebrates. Based on the description of diet (USEPA 1993; Oring et al. 1997), it is expected that this receptor would not ingest aquatic invertebrates exceeding 7.5 cm in length. This corresponds to Group 1 invertebrates using the classification system proposed in Table 27.

The GE of shrimp, isopods, and crabs, which are dietary food items consumed by sediment-probing birds, were available from the literature. The GE of these organisms were reported as follows in USEPA (1993): shrimp = 1,100 Kcal/kg (standard deviation = 240; Thayer et al. 1973); isopods/amphipods = 1,100 Kcal/kg (Jorgensen et al. 1991); and crabs = 1,000 Kcal/kg (standard deviation = 210; Thayer et al. 1973). For benthic invertebrates consumed by sediment-probing birds, the mean GE for invertebrates was set to 1,070 Kcal/kg (standard deviation = 220).

AE for this receptor is set at the average value of 79 percent reported in USEPA (1993). This value represents the assimilation efficiencies of waterfowl consuming aquatic invertebrates studied by Karasov (1990).

The proportion of sediment ingested relative to food intake is set at 30 percent based on a reported value for a semipalmated sandpiper (USEPA 1993). This value is based on a single composite measurement for this species; other reported values range between 7 percent and 18 percent (USEPA 1993) based on single measurements for these species. Hui and Beyer (1998) reported incidental sediment ingestion rates of 29 percent and 3 percent for black-bellied plover and willet, respectively. As expected, there is significant uncertainty in the value assumed for this variable.

6.2.1.1 Area Use Factor

Spotted sandpipers are relatively sedentary birds with a mean territory size of 0.55 acres (0.22 hectares; Miller and Miller 1948; Hays 1972; Heldeman and Oring 1976; Maxson and Oring 1980; Oring et al. 1983), including upland and surface water based foraging habitat and nesting habitat. Foraging habitat inland of coastal areas is characterized as sandy and muddy edges of inlets and creeks where the spotted sandpiper obtains prey items (insects, crustaceans, leeches, and molluscs) by probing in soft sediments along the shorelines and wading for small fish. Therefore, for sediment probing birds, the intertidal habitat within Patrick Bayou is the surface water based foraging habitat at the Site. Based on review of tidal levels and a bathymetric survey data for the Site, the intertidal zone (habitat) was estimated to cover 4.4 hectares. All small sediment probing shorebirds that would be expected to use the Site for foraging would also be expected to spend some time foraging in nearby upland areas for terrestrial food items, particularly if they are year round residents (Bent 1929 *in* USEPA 1993; Baker and Baker 1973; Ntiamoa-Daidu et al. 1998; Silveira 1998). Although most Texas shorebirds are migratory, including the spotted sandpiper, some species may be resident year round. Therefore, to be conservative, it is assumed that the sandpiper would not migrate.

It is possible, based on the reported mean territory size, for the spotted sandpiper or similar shorebirds, to forage exclusively within the Site. However, several factors make it unlikely that this receptor would spend all of its time feeding at the Site. Spotted sandpiper and other small shorebirds would be restricted to foraging along the accessible shoreline and mudflats (intertidal habitat) within the Site. Much of the shoreline, particularly the upstream 1,800 feet (i.e., gunnite channel) provides poor shoreline access and nesting habitat for spotted sandpiper due to the steepness of the banks and channelized nature of the watercourse. Based on a review of the Site habitat (Anchor 2006), it is estimated that only half of the 10,200 feet of stream channel (downstream of the gunnite channel) would have suitable shoreline foraging habitat. In addition, nesting habitat adjacent to the Site is of poor quality, lacking sufficient escape and brood cover, indicating that individuals would likely move off site for portions of the year for breeding purposes. Sandpipers need nesting cover that is 10 to 50 percent herbaceous and less than 2 feet tall and the nesting habitat needs to be less than 25 meters from water (Allard 2001). These habitat requirements for nesting purposes are very limited within 25 meters of Patrick Bayou, as much of the shoreline is modified by

riprap and other armoring and much of the upland area is managed with mowed grass. Finally, the Site is located within a larger area with other similar or higher quality nesting habitats, making the assumption of preferential use of the Site by this group of receptors questionable. With numerous rivers, tributaries, creeks, natural marsh, and constructed impoundments within a short distance (e.g., 3-mile radius), shoreline and intertidal areas are not limiting for this group. Therefore, it is assumed that sandpipers or similar species would not use the Site for nesting and likely would have limited feeding at the Site during this time period. The time period for sandpiper breeding and fledging would occur from May through July period (Oring et al. 1983; Lank et al. 1985 *in* USEPA 1993). It is assumed this receptor would have limited use the Site during this time period.

The spotted sandpiper's Site use may be limited, because this group of receptor's diet is not exclusively aquatic. They are unlikely to utilize the Site to meet all of their life history requirements (i.e., nesting and brooding), and they have the availability of alternative foraging and nesting areas nearby. Therefore, an AUF will be determined during the BERA assessment process for the spotted sandpiper.

6.2.2 Carnivorous Birds

The receptor for this group is a composite receptor representing members of this guild (Anchor QEA 2009b). A composite receptor was chosen as members of this guild are highly diverse in terms of physiology (i.e., weight) and behavior (i.e., diet). The average body weight for the composite receptor is assumed to be the mean of the average reported body weights of great blue heron (2.229 kg; USEPA 1993), great egret (0.935 kg; Mccrimmon et al. 2001), roseate spoonbill (1.490 kg; Dumas 2000), white ibis (0.750 kg; Kushlan and Bildstein 1992), and green heron (0.241 kg; Davis and Kushlan 1994). Thus, the average body weight for the composite receptor is 0.870 kg.

NFMR is estimated using 14.25 for the slope (a) and 0.659 for the power (b) terms in Equation 6-7 resulting in a value of 339 kcal/kg bw/day. These represent the values reported for marine birds in Nagy et al. (1999).

Diet composition for the composite receptor has been selected to represent the greatest number of species in this guild. Dietary habits of species within this guild are quite diverse. For example, great blue heron take mostly fish but also amphibians, invertebrates, reptiles, mammals, and birds (Butler 1992). In contrast, yellow-crowned night heron consume 50 to 80 percent crustaceans (Watts 1995). As such, a composite diet for this receptor was assumed to consist of 33 percent aquatic invertebrates, 33 percent fish, and 33 percent terrestrial prey. Within the aquatic invertebrate prey group, small to medium sized crustaceans less than 12.5 cm in total length (Group 1B and 2A invertebrates) will comprise the primary diet components. This group would include fiddler crabs, small blue crabs, crayfish, and shrimp. Although some larger species (i.e., great blue heron) have been reported to take fish up to 30 cm, most receptors are assumed to take fish less than 15 cm in length (Group 1 and 2 fish).

To estimate indirect exposure to COPCs for this receptor due to ingestion of contaminated terrestrial animal matter, the COPC concentrations in these food components will be estimated using the methods described in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA 1999). The concentration of COPCs in terrestrial animal matter that is in the carnivorous birds' diet will be estimated using a bioconcentration factor (BCF) approach. It will be assumed that half of the terrestrial animal matter consumed by a carnivorous bird has been exposed to the Site (i.e., FR_{animal}=0.5). The marsh rice rat will be used as a hypothetical terrestrial prey item for the purposes of estimating exposure concentrations due to animal matter. The marsh rice rat is a small (approximately 55 g), semi-aquatic omnivore that inhabits marshy areas and is common in eastern Texas. They typically consume equal parts vegetation and animal matter (including fiddler crabs and small fish). In addition, the marsh rice rat is often used as target receptors or prey items in risk assessment. The concentration of COPCs in marsh rice rate tissue will be estimated using Equation 5-12 in USEPA (1999). Default exposure factors for the rice rat will be used as presented in that document. Other variables will use site-specific information (e.g., COPC concentrations in sediment) or estimated using best professional judgment.

The GE of invertebrates consumed is set at 1,070 kcal/kg as described in Section 6.2.1. For fish, GE is set at 1,200 kcal/kg, which is the average value of bony fishes reported by Thayer et al. (1973; as reported in USEPA 1993). The GE for small mammals is 1,700 kcal/kg (USEPA 1993; average of mice, voles, and rabbits). AE is set at 77 percent for fish consumed,

79 percent for aquatic invertebrates, and 78 percent for mammals (as reported in USEPA 1993).

Reports of incidental ingestion of sediment for species within this guild are generally not available. Species within this guild that are perch and strike surface feeders would likely have little sediment exposure, but other species that may feed on benthic invertebrates may have some sediment exposure during feeding. Therefore, the rate of incidental sediment ingestion for this receptor group is conservatively set at 3 percent of ingestion rate (on a dry weight basis). This value is selected based on best professional judgment of life history of species in this group and is assumed to account for ingestion due to feeding and preening activities.

6.2.2.1 Area Use Factor

All species represented by the composite receptor are both widely distributed in saltwater and freshwater environments and are year-round residents in southeast Texas (Benson and Arnold 2001). Great blue heron feeding territories have been reported to be, on average, from approximately 3.1 to 7 or 8 km and do not exceed 20 km (USEPA 1993). Home range data for other species is generally lacking but would be expected to be similar to the great blue heron for the great egret and roseate spoonbill based on similar body size and somewhat smaller for the white ibis and green heron. Conservatively assuming that there is 2 km of foraging habitat at the Site, this area is less than the estimated minimum habitat required (3.1 km) for the great blue heron.

Great blue herons tend to nest in dense colonies and require stands of mature trees capable of supporting multiple stick nests up to a meter wide and one-half meter deep and in close proximity to water (Eissinger 2006, 2007). Roseate spoonbills, white ibis, and green herons generally breed as either solitary pairs or widely spread in small colonies. Nests are built in trees or tall shrubs ranging from 3.5 to 35 meters above the ground, usually at the water's edge but can be found as far as 0.8 km from water (Fraser and Ramsey 1996). Because most green herons are solitary nesters and are dispersed widely through marine and freshwater habitats, few data exist on nest or colony sites. The proximity of prime foraging areas is central to breeding colony locations (Eissinger 2007) with all species requiring shallow water habitat in close proximity to breeding sites for foraging. Great blue herons, white ibis, and

great egrets generally feed in flocks in areas of high prey density (Short and Cooper 1985); green herons are typically solitary feeders (Fraser and Ramsey 1996). Upland foraging habitat is important to great blue herons (and to a lesser extent the great egret), concentrating in meadows, fallow fields, and grassy margins along roadways and ditches (Eissinger 2007). White ibis and roseate spoonbills forage only in inundated areas. The green heron prefers thick vegetation throughout its home range; however, it will feed in the open when food is available (Davis and Kushlan 1994). None of these species would be expected to nest in any significant abundance at the Site, as suitable nesting habitat is generally absent; foraging in aquatic habitats would be the primary activity. The lack of adjacent woody upland habitat makes the Site less attractive to green herons. Although there is limited nesting habitat due to large foraging distances these receptors use, these species would likely feed at the site even if they are not breeding and fledging at the Site.

Given the lack of suitable nesting habitat for all species, the small size of foraging area at the Site relative to foraging ranges for larger members of this guild (i.e., great blue heron, great egret, and roseate spoonbill), and the limited cover preferred by the green heron, Site use by this receptor group may limited. Therefore, an AUF will be determined during the BERA assessment process for the composite receptor representing the carnivorous bird guild.

6.2.3 Belted Kingfisher

The belted kingfisher is the representative receptor for the piscivorous bird guild. The average body weight of belted kingfishers is set at 0.136 kg. This represents the average body of weight of adult males and females in USEPA (1993). NFMR is estimated using 14.25 for the slope (a) and 0.659 for the power (b) terms in Equation 6-7. These represent the values reported for marine birds in Nagy et al. (1999). Based on these terms and the average body weight, the NFMR term is estimated at 637 kcal/kg body weight/day.

The principal prey of kingfishers is fish, but they also feed on berries and a variety of other small animals, including mollusks, crustaceans, insects, amphibians, reptiles, young birds, and small mammals (Hamas 1994). Most fish caught by the kingfisher are small, typically less than 10 cm in length (Prose 1985; Imhof 1962; Salyer and Lagler 1946) and as small as 2.5

cm (Salyer and Lagler 1946). Maximum prey lengths have been observed to reach 14 cm (Davis 1982) and 17.8 cm (Salyer and Lagler 1946) in different locations.

Based on the description of diet, it is expected that this receptor would ingest fish between 2.5 cm and 15 cm. This corresponds to Group 1, 2A, and 2B fish using the prey classification system. Belted kingfishers may include crustaceans in their diet as available. Kingfishers take crayfish in abundance in freshwater environments. Similar size class prey at the Site would include fiddler crabs, small blue crabs, and shrimp. As such, aquatic invertebrate prey classes for this receptor would include Group 1B and 2A invertebrates.

Combining the available data provided in USEPA (1993; Volume II), fish comprise an approximate average of 80 percent of the kingfisher diet and crustaceans comprise 10 percent, with other prey items making up the difference (i.e., 4.2 percent insects and 3.9 percent and amphibians). The latter two components were not included in the exposure analyses, however, because of their small contribution to the overall diet. For the Site, the mean proportion of fish and crustaceans in the diet of kingfishers was assumed to be 89 percent and 11 percent, respectively, based on a revised analysis of the combined literature data after exclusion of insects and amphibians.

The GE of invertebrates consumed is set at 1,070 kcal/kg as described in Section 6.2.1. For fish, GE is set at 1,200 kcal/kg, which is the average value of bony fishes reported by Thayer et al. (1973; as reported in USEPA 1993). AE is set at 77 percent for fish consumed and 79 percent for aquatic invertebrates (as reported in USEPA 1993) for eagles/seabirds consuming fish and waterfowl consuming aquatic invertebrates.

Reports of incidental ingestion of sediment for species within this guild are generally not available. Species within this guild generally catch prey on the wing and would likely have little exposure to sediments. Therefore, the rate of incidental sediment ingestion for this receptor is set at zero.

6.2.3.1 Area Use Factor

The belted kingfisher's home range is generally between 0.4 and 2.4 km of shoreline on lakes with territory on rivers usually 2.4 to 4.8 km of shoreline or more (Prose 1985). Territory size depends on nest and food availability (Davis 1982) and is related to the distribution and accessibility of food resources. The smallest territories contain the richest food resources near nests. A larger territory size is needed where food is not concentrated near the nest or where excessive vegetation, deep unfishable pools, or fast currents limit fishing areas (Prose 1985). Non-breeding territories are smaller and encompass only feeding areas (Davis 1982 *in* Landrum et al. 1993). Conservatively assuming that there is 2 km of foraging habitat at the Site, this area is midrange between what is available and the habitat required for kingfishers.

Belted kingfisher are solitary birds, except during the breeding season when pairs establish territories for besting and feeding (Roberts 1932). Adult kingfishers may be permanent residents on territories with year-round water access (e.g., coastlines, rivers, and estuaries) (Pittaway 1994; Albano 2000; Landrum et al. 1993).

The availability of suitable nesting sites (i.e., earthen banks) appears critical for the distribution and local abundance of this species (Hamas 1994). Nest sites are located in 1 to 3 m burrows excavated by the kingfisher in the open, sandy banks of bays, rivers, and lakes. Suitable nest sites include banks of suitable height for protection from predators and flood waters, but are generally 1.5 m from the base of the bank whenever possible (Cornwell 1963 *in* Prose 1985). The potential lack of nest habitat at the Site (banks for burrowing) could limit how much kingfishers use the Site for foraging to only non-breeding time periods. The time period for kingfisher breeding and fledging would occur from April through July (Benson and Arnold 2001). Due to the lack of nest habitat, it is assumed this receptor would have limited use of the Site during this time period.

Kingfishers tend to eat what is locally most available (Davis 1980, Sayler and Lagler 1946 *in* Lane et al. 2004), requiring clear water for an unobstructed view of their prey (Bent 1940 and Davis 1980 *in* Prose 1985). Fishing is confined to shallow water or near the surface in deeper water with most prey caught in water less than 60 cm deep. Although kingfishers are seldom seen on ponds or streams that are overgrown with thick vegetation that obscures vision, observation perches at the water's edge are needed for fishing (Bent 1940 and Salyer and

Lagler 1949 *in* Prose 1985). Kingfisher broods use shrub cover along water edges for concealment. Adult kingfishers are known to roost among the tops of deciduous trees where they are safe from nocturnal predators (White 1953 *in* Prose 1985). Roosts were 30.5 to 61.0 m from water and 6.1 to 7.6 m above the ground (Cornwell 1963 *in* Prose 1985).

The Site offers suitable food resources and preferred, non-obstructed views of the waterway; however, turbidity in Patrick Bayou may obstruct prey visibility for feeding kingfishers. Perches may also be limiting on the Site, both for roosting adults and for foraging individuals. The small islands in Patrick Bayou offer suitable perches within view of the water; however, given the territoriality of kingfishers, it would likely not support more than one or two individuals or breeding pairs. Most importantly, nest sites are very limited on the Site with the majority of banks within the Site armored with rock or bulkheads or low, sloping banks less than 1.5 meters high.

Based on this review, it could be expected for kingfishers to use the Site for non-breeding activities such as foraging and roosting to some extent. However, given the size of the Site and the limited amount of roosting and perching type habitat, only a few individuals would be expected to use the Site at any given time. Nesting and brooding habitat is markedly absent from the Site. As such, an AUF will be determined during the BERA assessment process for the belted kingfisher.

6.2.4 Raccoon

The raccoon is the representative receptor for the omnivorous mammal guild. Average body weight for raccoons is 3.99 kg, which is the average of adult males and females reported in USEPA (1993). NFMR is estimated using 6.03 for the slope (a) and 0.678 for the power (b) terms in Equation 6-7. These represent the values reported for omnivorous mammals in Nagy et al. (1999). Based on these terms and the average body weight, the NFMR term is estimated at 100 kcal/kg body weight/day.

Raccoons are highly opportunistic and will vary their diet according to food availability. Quantitative analysis of proportions of various food types and size classes are generally lacking and given their opportunistic foraging, would be relatively uncertain. As such,

professional judgment was required to define the diet. Based on a review of literature and values reported by the USEPA (1993), the following proportions of the diet were assumed: 30 percent plant matter, 23.3 percent terrestrial animal matter, 23.3 percent fish, and 23.3 percent aquatic invertebrates. For fish, Group 1, 2A, and 2B fish are considered to be ingested in equal proportions. For invertebrates, Group 1B and 2A were assumed to be taken in equal proportions.

To estimate indirect exposure to COPCs for this receptor due to ingestion of contaminated plant or terrestrial animal matter, the COPC concentration in these food components will be estimated using the methods described in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA 1999). To represent the plant matter portion of the diet, raccoons will be assumed to ingest half of their daily plant matter intake from the Site (i.e., FR_{plant}=0.5). The concentration in plant matter for each COPC will be estimated using the BCF approach presented in Equation 5-3 in USEPA (1999). Plant BCF values will be selected from USEPA (1999) or calculated using the methods provided.

Similarly, the concentration of COPCs in terrestrial animal matter that may be due to Site exposure of prey items in the raccoon's diet will be estimated using a BCF approach. It will be assumed that half of the terrestrial animal matter consumed by a raccoon has been exposed to the Site (i.e., FR_{animal}=0.5). The marsh rice rat will be used as a hypothetical terrestrial prey item for the purposes of estimating exposure concentrations due to animal matter. The marsh rice rat is a small (approximately 55 g), semi-aquatic omnivore that inhabits marshy areas and is common in eastern Texas. They typically consume equal parts vegetation and animal matter (including fiddler crabs and small fish). In addition, the marsh rice rat is often used as target receptors or prey items in risk assessment. The concentration of COPCs in marsh rice rate tissue will be estimated using Equation 5-12 in USEPA (1999). Default exposure factors for the rice rat will be used as presented in that document. Other variables will use site-specific information (e.g., COPC concentration in sediment) or estimated using best professional judgment.

The GE of invertebrates consumed is set at 1,070 kcal/kg as described in Section 5.3.1. For fish, GE is set at 1,200 kcal/kg, which is the average value of bony fishes reported by Thayer et al. (1973; as reported in USEPA 1993). GE for plants is estimated to be 1,300 kcal/kg

(USEPA 1993; average of monocot grasses) and 1,700 for animals (USEPA 1993; average of mice, voles, and rabbits). AE is set at 91 percent for fish and aquatic invertebrates for mammals consuming fish, 74 percent for mammals consuming plants, and 84 percent for mammals consuming birds and mammals (USEPA 1993).

Based on empirical measurements by Beyer et al. (1994), incidental sediment ingestion for this receptor is set at 9.4 percent.

6.2.4.1 Area Use Factor

Raccoons are ecological generalists, existing in diverse landscapes across the United States and most abundant near water (Tesky 1995). Home range size is extremely variable depending upon the quality of the habitat, the sex and age of the animal, and the variety of food sources. Raccoons will move long distances when food is scarce or populations are low and during the breeding season, adult males may be territorial. During this time, home ranges of these males usually do not overlap one another. Females are not territorial, and their home ranges may overlap. Generally, most raccoon home ranges vary in size between 100 and 250 acres; however, accessibility to water is the most important habitat requirement given the species dependence on aquatic habitats for a large portion of their food. Availability of den sites in proximity to water is the most important breeding habitat requirement (Yarrow 2009; Chamberlain et al. 2002). Raccoons select a variety of different types of dens to give birth and raise young. The most common den is in a tree; however, ground dens are important for raccoons, especially in areas lacking tree dens. Abandoned burrows are most often used as ground dens. Other types of dens include rock crevices, caves, drains, abandoned buildings, barns, and brushpiles. Raccoons also need brush thickets, ground dens, hollow logs, or trees for cover to escape predators and for daytime resting sites (Yarrow 2009). Conservatively assuming that the foraging area for raccoons at the Site is composed of 6,500 feet of shoreline with 200 feet of foraging habitat near the shore, the estimated 30 acres is less than the foraging area needed for raccoons.

Although the available habitat area is less than the habitat area needed for raccoons, it is possible that a raccoon or similar omnivorous mammals may use the Site for foraging; however, the lack of potential den sites, both for raising young and escape cover/daytime

resting, limits the ability of the Site to meet all life history requirements for this representative receptor. Prey availability at the Site is also limited given this representative receptor's reliance on non-aquatic food sources to supplement its diet mainly in the fall and summer (e.g., mast, berries, grains, and insects). Hardwood forests and agricultural fields that supply these food sources, as well as aquatic-related foods (e.g., fish, crayfish, and amphibians), although not available on the Site, are available nearby.

Given the availability of similar or higher quality habitat in the vicinity of the Site, it is unlikely that the Site would be selected to meet all of the foraging, breeding, and resting habitat needs. An AUF for raccoons will be determined during the BERA assessment process for this representative receptor.

6.2.5 Site Use Uncertainties

As discussed in detail in the preceding subsections the overall habitat quality at the Site is sub-optimal, and this will likely affect the use of the site by a significant number of individuals within the selected receptor guilds. Establishment of AUFs during the BERA will be based on available site-specific information previously detailed; however, during the BERA, if results of this and other risk evaluations indicate further refinement of AUFs are necessary, site-specific habitat information may be collected. An AUF work plan will be prepared and submitted to the agency representatives for approval at a later date, should the JDG implement this adaptive management approach to the further evaluation of AUFs during the BERA.

6.3 Measures of Effect

Measures of effect for aquatic-dependent wildlife include dietary-based threshold effect concentrations for COPCs. For the BERA, LOAEL-based TRV values will be used as the effects value.

As part of the selection of COPCs for the aquatic-dependent wildlife receptor group, the toxicity literature was searched and single-chemistry toxicity data for aquatic-dependent wildlife receptors were compiled. Identification of threshold effect concentrations focused on ecologically relevant effects such as survival, reproduction, and growth. Derivation of

TRVs is provided in the selection of COPC Report and Amendment (Anchor 2008a, 2008b) and in Section 2.7.2.1. This will be the primary source for selection of effects thresholds for the BERA. A review of the recent literature will be performed during the BERA to identify any additional studies that could add to the body of information currently available for selecting measures of effect. Any changes to TRV based on additional studies identified during the BERA will be discussed. Current TRVs for the BERA are provided in Table 29 and Table 30 for birds and mammals, respectively.

6.4 Risk Characterization

An HQ will be calculated for each COPC and receptor. The HQ will be expressed as the ratio of the TDI from all sources (TDI_{ALL}) to the LOAEL TRV. COPCs with an HQ greater than 1.0 for a receptor will be identified as COCs in the BERA.

7 UNCERTAINTY ANALYSIS

Uncertainty analysis is an important step in the ERA process as it increases confidence in the ERA by explicitly describing the magnitude and direction of uncertainties (USEPA 1998). There are several sources of uncertainty in ERA, which can be generally classified into the following four categories:

- Measurement error – In the measurement of physical, chemical, or biological parameters
- Extrapolation error – Extrapolation is necessary to characterize or describe a parameter or effect when collection of specific data is not achievable
- Modeling error – Associated with how well a model approximates true relationships between site-specific environmental conditions
- Data gaps – Due to a the lack of information that could conceivably be addressed through additional measurement, extrapolation, or modeling of conditions

The sources of uncertainty within these categories associated with the BERA dataset, problem formulation (including the CSM and assessment endpoints), and analysis plans (including exposure and toxicity assumptions) will be evaluated and refined in the BERA. This will include exploration of the uncertainty in exposure point concentrations, exposure factors, dietary fractions, uptake factors, AUFs, and TRVs. The emphasis of this assessment will be to focus on a quantitative assessment of uncertainty in risk to Site receptors using the following general approaches:

1. Incorporation of various exposure and effects scenarios in the risk estimation process that capture the plausible range of uncertainties in assumptions.
2. Expression of numeric risk calculations as point estimates with statistical measures of uncertainty (e.g., confidence limits, percentiles) where possible.
3. Performance of sensitivity analyses in which risk parameter values are iteratively varied to examine the effect of variability in the parameter on the risk estimate.

The BERA will address these uncertainties for each risk scenario/receptor and detail the parameter, level of uncertainty, and effect of uncertainty on the risk estimate.

8 DATA GAPS

Based on the uncertainty in the problem formulation and the data requirements for the risk analysis plan, the following data gaps were prioritized for the BERA data collection efforts:

8.1 Characterization of Tissue Chemistry

Potentially bioaccumulative COPCs have been identified for assessment in the BERA. BSAFs were used to estimate potential chemical concentrations in prey items and receptors for the purposes of identifying COPCs. For the BERA, a more specific assessment is desired to reduce the extrapolation uncertainty of the relationship between sediment and biota concentrations. Empirical measurement of COPCs in biota at the Site will reduce this uncertainty. Biota tissue data will be used to reduce the uncertainty in the exposure assessment for fish and wildlife that consume biota from the Site. Details of sampling objectives and methods are provided in Attachment 1.

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TABLES

Table 1
Surface Water Screening Criteria

Chemical	Source	Screening Value (µg/L)
1,1,1-Trichloroethane	TCEQ Marine Surface Water Benchmark	1560
1,1,2,2-Tetrachloroethane	TCEQ Marine Surface Water Benchmark	451
1,1,2-Trichloroethane	TCEQ Marine Surface Water Benchmark	275
1,1-Dichloroethene	TCEQ Marine Surface Water Benchmark	12500
1,2,4,5-Tetrachlorobenzene	TCEQ Marine Surface Water Benchmark	129
1,2,4-Trichlorobenzene	TCEQ Marine Surface Water Benchmark	22
1,2-Dichlorobenzene	TCEQ Marine Surface Water Benchmark	99
1,2-Dichloroethane	TCEQ Marine Surface Water Benchmark	5650
1,2-Dichloroethene, cis-	TCEQ Marine Surface Water Benchmark	680
1,2-Dichloroethene, trans-	TCEQ Marine Surface Water Benchmark	680
1,2-Dichloropropane	TCEQ Marine Surface Water Benchmark	2400
1,3-Dichlorobenzene	TCEQ Marine Surface Water Benchmark	142
1,3-Dichloropropene, cis-	TCEQ Marine Surface Water Benchmark	40
1,3-Dichloropropene, trans-	TCEQ Marine Surface Water Benchmark	40
1,4-Dichlorobenzene	TCEQ Marine Surface Water Benchmark	99
2,4,5-Trichlorophenol	TCEQ Marine Surface Water Benchmark	120
2,4,6-Trichlorophenol	TCEQ Marine Surface Water Benchmark	61
2,4-Dinitrophenol	TCEQ Marine Surface Water Benchmark	670
2-Chlorophenol	TCEQ Marine Surface Water Benchmark	265
2-Methylnaphthalene	TCEQ Marine Surface Water Benchmark	30
2-Methylphenol (o-Cresol)	TCEQ Marine Surface Water Benchmark	510
2-Nitrophenol	TCEQ Marine Surface Water Benchmark	1470
3,3'-Dichlorobenzidine	TCEQ Marine Surface Water Benchmark	37
4-Nitrophenol	TCEQ Marine Surface Water Benchmark	359
Acenaphthene	TCEQ Marine Surface Water Benchmark	40.4
Acetone	TCEQ Marine Surface Water Benchmark	282000
Aldrin	TCEQ Marine Surface Water Benchmark	0.13
alpha-BHC	TCEQ Marine Surface Water Benchmark	25
alpha-Chlordane (cis-Chlordane)	TCEQ Marine Surface Water Benchmark	0.004
Anthracene	TCEQ Marine Surface Water Benchmark	0.18
Benzene	TCEQ Marine Surface Water Benchmark	109
Butylbenzyl phthalate	TCEQ Marine Surface Water Benchmark	147
Carbon tetrachloride (Tetrachloromethane)	TCEQ Marine Surface Water Benchmark	1500

Table 1
Surface Water Screening Criteria

Chemical	Source	Screening Value (µg/L)
Chlorobenzene	TCEQ Marine Surface Water Benchmark	105
Chloroform	TCEQ Marine Surface Water Benchmark	4100
Chloromethane	TCEQ Marine Surface Water Benchmark	13500
Cyanide	TCEQ Marine Surface Water Benchmark	5.6
Dibenzofuran	TCEQ Marine Surface Water Benchmark	65
Dichloromethane (Methylene chloride)	TCEQ Marine Surface Water Benchmark	5420
Dieldrin	TCEQ Marine Surface Water Benchmark	0.002
Diethyl phthalate	TCEQ Marine Surface Water Benchmark	442
Dimethyl phthalate	TCEQ Marine Surface Water Benchmark	580
Di-n-butyl phthalate	TCEQ Marine Surface Water Benchmark	5
2,4'-DDD (o,p'-DDD)	TCEQ Marine Surface Water Benchmark	0.025 [c]
2,4'-DDE (o,p'-DDE)	TCEQ Marine Surface Water Benchmark	0.14 [d]
2,4'-DDT (o,p'-DDT)	TCEQ Marine Surface Water Benchmark	0.001 [e]
4,4'-DDD (p,p'-DDD)	TCEQ Marine Surface Water Benchmark	0.025
4,4'-DDE (p,p'-DDE)	TCEQ Marine Surface Water Benchmark	0.14
4,4'-DDT (p,p'-DDT)	TCEQ Marine Surface Water Benchmark	0.001
Endosulfan sulfate	TCEQ Marine Surface Water Benchmark	0.009
Endosulfan-alpha (I)	TCEQ Marine Surface Water Benchmark	0.009
Endosulfan-beta (II)	TCEQ Marine Surface Water Benchmark	0.009
Endrin	TCEQ Marine Surface Water Benchmark	0.002
Ethylbenzene	TCEQ Marine Surface Water Benchmark	249
Fluoranthene	TCEQ Marine Surface Water Benchmark	2.96
Fluorene	TCEQ Marine Surface Water Benchmark	50
gamma-BHC (Lindane)	TCEQ Marine Surface Water Benchmark	0.016
gamma-Chlordane	TCEQ Marine Surface Water Benchmark	0.004
Heptachlor epoxide	TCEQ Marine Surface Water Benchmark	0.0036
Heptachlor	TCEQ Marine Surface Water Benchmark	0.004
Hexachlorobutadiene	TCEQ Marine Surface Water Benchmark	0.32
Hexachlorocyclopentadiene	TCEQ Marine Surface Water Benchmark	0.07
Hexachloroethane	TCEQ Marine Surface Water Benchmark	9.4
Isophorone	TCEQ Marine Surface Water Benchmark	650
Mercury, dissolved	TCEQ Marine Surface Water Benchmark	1.1
Methoxychlor	TCEQ Marine Surface Water Benchmark	0.03

Table 1
Surface Water Screening Criteria

Chemical	Source	Screening Value (µg/L)
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	TCEQ Marine Surface Water Benchmark	61500
Naphthalene	TCEQ Marine Surface Water Benchmark	125
Nitrobenzene	TCEQ Marine Surface Water Benchmark	66.8
N-Nitrosodi-N-propylamine	TCEQ Marine Surface Water Benchmark	120
N-Nitrosodiphenylamine	TCEQ Marine Surface Water Benchmark	165000
Pentachlorophenol	TCEQ Marine Surface Water Benchmark	9.6
Phenanthrene	TCEQ Marine Surface Water Benchmark	4.6
Phosphorus	TCEQ Marine Surface Water Benchmark	0.1
Pyrene	TCEQ Marine Surface Water Benchmark	0.24
Selenium, dissolved	TCEQ Marine Surface Water Benchmark	136
Styrene	TCEQ Marine Surface Water Benchmark	455
Tetrachloroethene (PCE)	TCEQ Marine Surface Water Benchmark	1450
Toluene	TCEQ Marine Surface Water Benchmark	480
Total Chlordane (alpha and gamma) (U = 1/2)	TCEQ Marine Surface Water Benchmark	0.004
Total PCB Congener (U = 1/2)	TCEQ Marine Surface Water Benchmark	0.03
Total Xylene (U = 1/2)	TCEQ Marine Surface Water Benchmark	850
Toxaphene	TCEQ Marine Surface Water Benchmark	0.0002
Trichloroethene (TCE)	TCEQ Marine Surface Water Benchmark	970
2,4-Dimethylphenol	NOAA Freshwater SCV	100
Atrazine	NOAA Marine SCV	10
Bis(2-ethylhexyl) phthalate	NOAA Marine SCV	360
delta-BHC	TCEQ Marine Surface Water Benchmark	25 [a]
Di-n-octyl phthalate	NOAA Marine SCV	3.4
Endrin ketone	TCEQ Marine Surface Water Benchmark	0.002 [b]
Methyl tert-butyl ether (MTBE)	NOAA Marine SCV	5000
Vinyl chloride	NOAA Freshwater SCV	930

Notes:
a TCEQ Marine Surface Water Benchmark for alpha-BHC used as surrogate screening value
b TCEQ Marine Surface Water Benchmark for Endrin used as surrogate screening value
c TCEQ Marine Surface Water Benchmark for 4,4'-DDD used as a surrogate screening value
d TCEQ Marine Surface Water Benchmark for 4,4'-DDE used as a surrogate screening value
e TCEQ Marine Surface Water Benchmark for 4,4'-DDT used as a surrogate screening value

Table 2
Comparison of Surface Water Data to Screening Values

Chemical	Units	N	Detects	Min Detect	Max Detect	Maximum Detection Limit	Average[a]	Screening Value	HQ[b]
1,1,1-Trichloroethane	µg/L	14	0	NA	NA	1	0.5	1560	0.00064
1,1,2,2-Tetrachloroethane	µg/L	14	0	NA	NA	2	1	451	0.0044
1,1,2-Trichloroethane	µg/L	14	0	NA	NA	1	0.5	275	0.0036
1,1-Dichloroethene	µg/L	14	0	NA	NA	1	0.5	12500	0.000080
1,2,4,5-Tetrachlorobenzene	µg/L	14	0	NA	NA	0.658	0.28	129	0.0051
1,2,4-Trichlorobenzene	µg/L	14	0	NA	NA	5	2.5	22	0.23
1,2-Dichlorobenzene	µg/L	14	0	NA	NA	1	0.5	99	0.010
1,2-Dichloroethane	µg/L	14	8	1.97	3.90	NA	2.00	5650	0.00069
1,2-Dichloroethene, cis-	µg/L	14	8	0.72	2.27	NA	1.09	680	0.0033
1,2-Dichloroethene, trans-	µg/L	14	0	NA	NA	1	0.5	680	0.0015
1,2-Dichloropropane	µg/L	14	0	NA	NA	1	0.5	2400	0.00042
1,3-Dichlorobenzene	µg/L	14	3	0.84	1.11	NA	0.60	142	0.0078
1,3-Dichloropropene, cis-	µg/L	14	0	NA	NA	1	0.5	40	0.025
1,3-Dichloropropene, trans-	µg/L	14	0	NA	NA	1	0.5	40	0.025
1,4-Dichlorobenzene	µg/L	14	0	NA	NA	1	0.5	99	0.010
2,4,5-Trichlorophenol	µg/L	14	0	NA	NA	0.658	0.28	120	0.0055
2,4,6-Trichlorophenol	µg/L	14	0	NA	NA	0.658	0.28	61	0.011
2,4-Dinitrophenol	µg/L	14	0	NA	NA	2.63	1.11	670	0.0039
2-Chlorophenol	µg/L	14	0	NA	NA	0.658	0.28	265	0.0025
2-Methylnaphthalene	µg/L	14	0	NA	NA	0.658	0.28	30	0.022
2-Methylphenol (o-Cresol)	µg/L	14	0	NA	NA	0.658	0.28	510	0.0013
2-Nitrophenol	µg/L	14	0	NA	NA	0.658	0.28	1470	0.00045
3,3'-Dichlorobenzidine	µg/L	14	0	NA	NA	0.658	0.28	37	0.018
4-Nitrophenol	µg/L	14	0	NA	NA	1.32	0.56	359	0.0037
Acenaphthene	µg/L	14	0	NA	NA	0.658	0.28	40.4	0.016
Acetone	µg/L	14	12	4.58	18.80	NA	12.27	282000	0.000067
Aldrin	µg/L	14	7	0.0026	0.04	NA	0.0117	0.13	0.33
alpha-BHC	µg/L	14	13	0.0037	0.12	NA	0.05	25	0.0046
alpha-Chlordane (cis-Chlordane)	µg/L	14	13	0.0018	0.04	NA	0.01	0.004	11
Anthracene	µg/L	14	0	NA	NA	0.658	0.28	0.18	3.7
Benzene	µg/L	14	0	NA	NA	1	0.5	109	0.0092
Butylbenzyl phthalate	µg/L	14	6	0.29	0.36	NA	0.30	147	0.0024
Carbon tetrachloride (Tetrachloromethane)	µg/L	14	0	NA	NA	1	0.5	1500	0.00067
Chlorobenzene	µg/L	14	0	NA	NA	1	0.5	105	0.0095
Chloroform	µg/L	14	8	0.62	0.96	NA	0.671	4100	0.00024
Chloromethane	µg/L	14	0	NA	NA	1	0.5	13500	0.000074
Cyanide	mg/l	14	3	0.00	0.00	NA	0.0026	5.6	0.00068
Dibenzofuran	µg/L	14	0	NA	NA	0.658	0.28	65	0.010
Dichloromethane (Methylene chloride)	µg/L	14	0	NA	NA	2	1	5420	0.00037
Dieldrin	µg/L	14	12	0.0042	0.04	NA	0.02	0.002	18
Diethyl phthalate	µg/L	14	2	0.27	0.39	NA	0.29	442	0.00089
Dimethyl phthalate	µg/L	14	0	NA	NA	0.658	0.28	580	0.0011
Di-n-butyl phthalate	µg/L	14	1	0.44	0.44	NA	0.29	5	0.088
2,4'-DDD (o,p'-DDD)	µg/L	14	0	NA	NA	0.0013	0.0006	0.025	0.052
2,4'-DDE (o,p'-DDE)	µg/L	14	0	NA	NA	0.0013	0.0006	0.14	0.0093
2,4'-DDT (o,p'-DDT)	µg/L	14	0	NA	NA	0.0013	0.0006	0.001	1.3
4,4'-DDD (p,p'-DDD)	µg/L	14	0	NA	NA	0.0013	0.00	0.025	0.052
4,4'-DDE (p,p'-DDE)	µg/L	14	0	NA	NA	0.0013	0.00	0.14	0.0093
4,4'-DDT (p,p'-DDT)	µg/L	14	3	0.0019	0.0032	NA	0.0010	0.001	3.2

Table 2
Comparison of Surface Water Data to Screening Values

Chemical	Units	N	Detects	Min Detect	Max Detect	Maximum Detection Limit	Average[a]	Screening Value	HQ[b]
Endosulfan sulfate	µg/L	14	0	NA	NA	0.00067	0.0003	0.009	0.074
Endosulfan-alpha (I)	µg/L	14	1	0.0020	0.0020	NA	0.0004	0.009	0.22
Endosulfan-beta (II)	µg/L	14	0	NA	NA	0.00067	0.0003	0.009	0.074
Endrin	µg/L	14	0	NA	NA	0.00067	0.0003	0.002	0.34
Ethylbenzene	µg/L	14	0	NA	NA	1	0.5	249	0.0040
Fluoranthene	µg/L	14	0	NA	NA	0.658	0.28	2.96	0.22
Fluorene	µg/L	14	0	NA	NA	0.658	0.28	50	0.013
gamma-BHC (Lindane)	µg/L	14	3	0.0033	0.01	NA	0.0013	0.016	0.37
gamma-Chlordane	µg/L	14	0	NA	NA	0.00067	0.0003	0.004	0.17
Heptachlor epoxide	µg/L	14	14	0.0009	0.02	NA	0.0068	0.0036	4.2
Heptachlor	µg/L	14	10	0.0032	0.06	NA	0.03	0.004	16
Hexachlorobutadiene	µg/L	14	0	NA	NA	0.658	0.28	0.32	2.1
Hexachlorocyclopentadiene	µg/L	14	0	NA	NA	0.658	0.28	0.07	9.4
Hexachloroethane	µg/L	14	0	NA	NA	0.658	0.28	9.4	0.070
Isophorone	µg/L	14	0	NA	NA	0.658	0.28	650	0.0010
Mercury, dissolved	µg/L	14	1	0.01	0.01	NA	0.0050	1.1	0.0046
Methoxychlor	µg/L	14	0	NA	NA	0.00067	0.0003	0.03	0.022
Methyl isobutyl ketone (4-Methyl-2-pentanone or (MIBK))	µg/L	14	0	NA	NA	5	2.5	61500	0.000081
Naphthalene	µg/L	14	0	NA	NA	0.658	0.28	125	0.0053
Nitrobenzene	µg/L	14	0	NA	NA	0.658	0.28	66.8	0.0099
N-Nitrosodi-N-propylamine	µg/L	14	0	NA	NA	0.658	0.28	120	0.0055
N-Nitrosodiphenylamine	µg/L	14	0	NA	NA	0.658	0.28	165000	0.0000040
Pentachlorophenol	µg/L	14	0	NA	NA	2.63	1.11	9.6	0.27
Phenanthrene	µg/L	14	0	NA	NA	0.658	0.28	4.6	0.14
Pyrene	µg/L	14	0	NA	NA	0.658	0.28	0.24	2.7
Selenium, dissolved	µg/L	14	8	3.80	15.00	NA	7.41	136	0.11
Styrene	µg/L	14	0	NA	NA	1	0.5	455	0.0022
Tetrachloroethene (PCE)	µg/L	14	8	0.60	1.80	NA	0.90	1450	0.0012
Toluene	µg/L	14	0	NA	NA	1	0.5	480	0.0021
Total Chlordane (alpha and gamma) (U = 1/2)	µg/L	14	13	0.00	0.04	NA	0.01	0.004	11
Total PCB Congener (U = 1/2)	ng/L	14	14	58.88	430.98	NA	158.55	0.03	14000
Total Xylene (U = 1/2)	µg/L	14	0	NA	NA	2	1	850	0.0024
Toxaphene	µg/L	14	0	NA	NA	0.0333	0.01	0.0002	170
Trichloroethene (TCE)	µg/L	14	8	0.53	1.40	NA	0.74	970	0.0014
2,4-Dimethylphenol	µg/L	14	1	0.37	0.37	NA	0.2863	100	0.0037
Atrazine	µg/L	14	6	0.268	0.325	NA	0.2857	10	0.033
Bis(2-ethylhexyl) phthalate	µg/L	14	8	0.311	201	NA	14.7	360	0.56
delta-BHC	µg/L	14	11	0.00531	0.14	NA	0.0454	25	0.0056
Di-n-octyl phthalate	µg/L	14	1	0.348	0.348	NA	0.2832	3.4	0.10
Endrin ketone	µg/L	14	6	0.00271	0.00837	NA	0.0023	0.002	4.2
Methyl tert-butyl ether (MTBE)	µg/L	14	3	0.579	0.68	NA	0.5273	5000	0.00014
Vinyl chloride	µg/L	14	6	0.56	0.94	NA	0.601	930	0.0010

Notes:

Shading indicates HQ > 1.0

NA - not applicable

a Average includes non-detect values at 1/2 reported detection limit

b To identify COPCs, the maximum detected concentration of each COI was compared to its respective screening value using a HQ approach. COIs that were not detected were compared to their benchmark using the maximum detection limit.

Table 3
Non-Detect Surface Water COI without Screening Values

Chemical	Units	N	Detects	Min Detect	Max Detect	Maximum Detection Limit
1,1,2-Trichlorotrifluoroethane	µg/L	14	0	NA	NA	2
1,1-Dichloroethane	µg/L	14	0	NA	NA	1
1,2,3-Trichlorobenzene	µg/L	14	0	NA	NA	5
1,2-Dibromo-3-chloropropane	µg/L	14	0	NA	NA	5
1,2-Dibromoethane (Ethylene dibromide)	µg/L	14	0	NA	NA	1
2,2'-Oxybis (1-chloropropane)	µg/L	14	0	NA	NA	0.658
2,3,4,6-Tetrachlorophenol	µg/L	14	0	NA	NA	0.658
2,4-Dichlorophenol	µg/L	14	0	NA	NA	0.658
2,4-Dinitrotoluene	µg/L	14	0	NA	NA	0.658
2,6-Dinitrotoluene	µg/L	14	0	NA	NA	0.658
2-Butanone (MEK)	µg/L	14	0	NA	NA	5
2-Chloronaphthalene	µg/L	14	0	NA	NA	0.658
2-Hexanone (Methyl butyl ketone)	µg/L	14	0	NA	NA	5
2-Nitroaniline	µg/L	14	0	NA	NA	0.658
3-Nitroaniline	µg/L	14	0	NA	NA	0.658
4-Bromophenyl-phenyl ether	µg/L	14	0	NA	NA	0.658
4-Chloro-3-methylphenol	µg/L	14	0	NA	NA	0.658
4-Chloroaniline	µg/L	14	0	NA	NA	0.658
4-Chlorophenyl phenyl ether	µg/L	14	0	NA	NA	0.658
4-Methylphenol (p-Cresol)	µg/L	14	0	NA	NA	0.658
4-Nitroaniline	µg/L	14	0	NA	NA	0.658
Acenaphthylene	µg/L	14	0	NA	NA	0.658
Acetophenone	µg/L	14	0	NA	NA	0.658
Benzo(a)anthracene	µg/L	14	0	NA	NA	0.658
Benzo(a)pyrene	µg/L	14	0	NA	NA	0.658
Benzo(b)fluoranthene	µg/L	14	0	NA	NA	0.658
Benzo(g,h,i)perylene	µg/L	14	0	NA	NA	0.658
Benzo(k)fluoranthene	µg/L	14	0	NA	NA	0.658
beta-BHC	µg/L	14	0	NA	NA	0.00067
Biphenyl (1,1'-Biphenyl)	µg/L	14	0	NA	NA	0.658
bis(2-Chloroethoxy)methane	µg/L	14	0	NA	NA	0.658

Table 3
Non-Detect Surface Water COI without Screening Values

Chemical	Units	N	Detects	Min Detect	Max Detect	Maximum Detection Limit
1,1,2-Trichlorotrifluoroethane	µg/L	14	0	NA	NA	2
1,1-Dichloroethane	µg/L	14	0	NA	NA	1
1,2,3-Trichlorobenzene	µg/L	14	0	NA	NA	5
1,2-Dibromo-3-chloropropane	µg/L	14	0	NA	NA	5
1,2-Dibromoethane (Ethylene dibromide)	µg/L	14	0	NA	NA	1
2,2'-Oxybis (1-chloropropane)	µg/L	14	0	NA	NA	0.658
2,3,4,6-Tetrachlorophenol	µg/L	14	0	NA	NA	0.658
2,4-Dichlorophenol	µg/L	14	0	NA	NA	0.658
2,4-Dinitrotoluene	µg/L	14	0	NA	NA	0.658
2,6-Dinitrotoluene	µg/L	14	0	NA	NA	0.658
2-Butanone (MEK)	µg/L	14	0	NA	NA	5
2-Chloronaphthalene	µg/L	14	0	NA	NA	0.658
2-Hexanone (Methyl butyl ketone)	µg/L	14	0	NA	NA	5
2-Nitroaniline	µg/L	14	0	NA	NA	0.658
3-Nitroaniline	µg/L	14	0	NA	NA	0.658
4-Bromophenyl-phenyl ether	µg/L	14	0	NA	NA	0.658
4-Chloro-3-methylphenol	µg/L	14	0	NA	NA	0.658
4-Chloroaniline	µg/L	14	0	NA	NA	0.658
4-Chlorophenyl phenyl ether	µg/L	14	0	NA	NA	0.658
4-Methylphenol (p-Cresol)	µg/L	14	0	NA	NA	0.658
4-Nitroaniline	µg/L	14	0	NA	NA	0.658
Acenaphthylene	µg/L	14	0	NA	NA	0.658
Acetophenone	µg/L	14	0	NA	NA	0.658
Benzo(a)anthracene	µg/L	14	0	NA	NA	0.658
Benzo(a)pyrene	µg/L	14	0	NA	NA	0.658
Benzo(b)fluoranthene	µg/L	14	0	NA	NA	0.658
Benzo(g,h,i)perylene	µg/L	14	0	NA	NA	0.658
Benzo(k)fluoranthene	µg/L	14	0	NA	NA	0.658
beta-BHC	µg/L	14	0	NA	NA	0.00067
Biphenyl (1,1'-Biphenyl)	µg/L	14	0	NA	NA	0.658
bis(2-Chloroethoxy)methane	µg/L	14	0	NA	NA	0.658

Table 4

Bioaccumulative Surface Water COPCs

Chemical
Mercury
Selenium
PCBs
Dioxin/Furans

Table 5

Sediment COPCs Removed Due to Low Frequency of Detection

COPC	Frequency of Detection
Aldrin	0% (0 of 49)
Methoxychlor	2% (1 of 49)
1,2-Dichlorobenzene	2% (1 of 49)
Di-n-octyl phthalate	0% (0 of 49)

Table 6
Comparison of Selected Sediment COPC 95th Percentile to Screening Values

Chemical	Units	N	Detects	Min Detect	Max Detect	95th Percentile[a]	Midpoint SV[b]	HQ
Arsenic	mg/kg	46	46	1.42	10.8	8.879	24.0	0.4
Copper	mg/kg	46	46	13.5	99.7	87.29	95.8	0.9
Zinc	mg/kg	46	46	82.4	1750	868.7	248	3.5
Benzo(a)pyrene	µg/kg	46	46	106	15100	4659	829	5.6
Chlordane, alpha-	µg/kg	46	37	1.66	146	146	3.68	39.7
Chlordane, gamma-	µg/kg	46	4	15	74.9	6.557	3.68	1.8
Chlordane, Total	µg/kg	46	37	1.66	146	146	3.68	39.7
Hexachloroethane	µg/kg	46	24	49	21000	3412	3412	1.0
1,3-Dichlorobenzene	µg/kg	46	34	0.847	7880	1411	790	1.8
1,4-Dichlorobenzene	µg/kg	46	33	0.822	6940	1133	1720	0.7
							Derived SV[c]	
Benzo(e)pyrene	µg/kg	46	46	100	6410	2986	829	3.6
Indeno(1,2,3-cd)pyrene	µg/kg	46	46	118	9910	2868	829	3.5
Perylene	µg/kg	46	46	37.8	2240	957.2	829	1.2
4-isopropyltoluene	µg/kg	46	18	1.14	1160	384	3490	0.1
Endrin	µg/kg	46	10	4	54.6	19.4	105	0.2
Endosulfan I	µg/kg	46	34	2.79	292	292	480	0.6
Endosulfan II	µg/kg	46	6	53.3	291	21.2	480	0.0

Notes:

Shading indicates HQ > 1.0

a 95th percentile includes non-detect values at 1/2 reported detection limit and assuming a lognormal distribution. Calculated using ProUCL Version 4.0

b Midpoint Screening Value (SV) is the mean of the Texas Marine Sediment Ecological Benchmark and Secondary Effects Level (TCEQ 2006)

c These chemicals lack Midpoint SV. However, screening values were derived using the methods described in Section 2.6.2.2

Table 7
Benthic Invertebrate Sediment COPCs

Chemical Class	Chemical	Rationale for COPC		
		Sediment 95th Percentile Exceeds Midpoint Screening Value	Toxic Sediments Substantially Greater than Non-Toxic[c]	Porewater 95th Percentile Exceeds Chronic WQ Benchmark[c]
Metals	Barium	NA	TRUE	FALSE
	Cadmium	NA	TRUE	FALSE
	Chromium	NA	TRUE	FALSE
	Lead	NA	TRUE	FALSE
	Mercury	NA	TRUE	TRUE
	Nickel	NA	TRUE	TRUE
	Silver	NA	TRUE	FALSE
	Zinc	TRUE	FALSE	FALSE
PAHs	2-Methylnaphthalene	NA	TRUE	TRUE
	Acenaphthene	NA	TRUE	TRUE
	Acenaphthylene	NA	TRUE	NA
	Anthracene	NA	TRUE	TRUE
	Benzo(a)anthracene	NA	TRUE	NA
	Benzo(a)pyrene	TRUE	FALSE	NA
	Benzo(b)fluoranthene	NA	FALSE	NA
	Benzo(e)pyrene	TRUE	NA	NA
	Benzo(g,h,i)perylene	NA	FALSE	NA
	Benzo(k)fluoranthene	NA	FALSE	NA
	Chrysene	NA	TRUE	NA
	Dibenzo(a,h)anthracene	NA	TRUE	NA
	Fluoranthene	NA	FALSE	TRUE
	Fluorene	NA	TRUE	TRUE
	Indeno(1,2,3-cd)pyrene	TRUE	NA	NA
	Naphthalene	NA	TRUE	TRUE
	Perylene	TRUE	NA	NA
	Phenanthrene	NA	TRUE	TRUE
	Pyrene	NA	TRUE	TRUE
	Total HMW PAH	NA	TRUE	NA
	Total LMW PAH	NA	TRUE	NA
	Total PAH	NA	TRUE	NA
PCBs	PCB Congeners[b]	TRUE	NA	NA

Table 7
Benthic Invertebrate Sediment COPCs

Chemical Class	Chemical	Rationale for COPC		
		Sediment 95th Percentile Exceeds Midpoint Screening Value	Toxic Sediments Substantially Greater than Non-Toxic[c]	Porewater 95th Percentile Exceeds Chronic WQ Benchmark[c]
SVOCs	Benzene	NA	TRUE	FALSE
	Benzidine	NA	TRUE	--
	bis(2-Chloroisopropyl)ether	NA	TRUE	--
	bis(2-Ethylhexyl)phthalate	NA	TRUE	FALSE
	Chlorobenzene	NA	TRUE	FALSE
	Ethylbenzene	NA	TRUE	NA
	Hexachlorobenzene	NA	FALSE	TRUE
	Hexachlorobutadiene	NA	FALSE	TRUE
	Isopropylbenzene	NA	TRUE	FALSE
	n-Butylbenzene	NA	TRUE	FALSE
	n-Propylbenzene	NA	TRUE	FALSE
	sec-Butylbenzene	NA	TRUE	FALSE
	tert-Butylbenzene	NA	TRUE	FALSE
	Toluene	NA	TRUE	FALSE
	Total xylene	NA	TRUE	FALSE

Notes:
NA - not applicable
a Includes 4,4' and 2,4' isomers
b PCBs will be evaluated on a congener specific basis (rather than Aroclors)
c From the COPC Report and Amendment (Anchor 2008a, 2008b)

Table 8
Fish Whole Body TRVs for COPC Refinement

Chemical Class	Chemical[a]	Midpoint TRV[b]	Low Effect Fish Tissue Benchmark (ww fish)	No Effect Fish Tissue Benchmark (ww fish)
Metals	Arsenic	1.88	3.41	0.341
	Cadmium	1.15	2.29	0.00549
	Chromium	3.20	5.33	1.07
	Copper	6.53	9.65	3.41
	Lead	2.79	4.00	1.58
	Mercury	2.47	3.37	1.56
	Selenium	1.62	1.90	1.34
	Zinc	59.7	80.0	39.4
PAH	2-Methylnaphthalene	1.97	3.29	0.659
	Acenaphthene	10.5	17.5	3.50
	Acenaphthylene	1.97	3.29	0.659
	Anthracene	1.97	3.29	0.659
	Benzo(a)anthracene	1.97	3.29	0.659
	Benzo(a)pyrene	37.0	61.7	12.3
	Benzo(b)fluoranthene	1.97	3.29	0.659
	Benzo(g,h,i)perylene	1.97	3.29	0.659
	Benzo(k)fluoranthene	1.97	3.29	0.659
	Chrysene	--	--	--
	Dibenzo(a,h)anthracene	1.97	3.29	0.659
	Fluoranthene	1.97	3.29	0.659
	Fluorene	1.97	3.29	0.659
	Naphthaleneh	9.35	17.0	1.70
	Phenanthrene	110	183	36.6
	Total HPAH 16	1.97	3.29	0.659
	Total LPAH 16	1.97	3.29	0.659
	Total PAH 16	1.97	3.29	0.659
PCB	Total PCB Congeners[c]	4.23	7.69	0.769
	PCB-077	by TEQ	by TEQ	by TEQ
	PCB-081	by TEQ	by TEQ	by TEQ
	PCB-105	by TEQ	by TEQ	by TEQ
	PCB-114	by TEQ	by TEQ	by TEQ
	PCB-118	by TEQ	by TEQ	by TEQ
	PCB-123j	by TEQ	by TEQ	by TEQ
	PCB-126	by TEQ	by TEQ	by TEQ
	PCB-156	by TEQ	by TEQ	by TEQ
	PCB-157	by TEQ	by TEQ	by TEQ
	PCB-167	by TEQ	by TEQ	by TEQ
	PCB-169	by TEQ	by TEQ	by TEQ
	PCB-189	by TEQ	by TEQ	by TEQ
	PCB congeners TEQ	0.3849	0.000878	0.769

Table 8
Fish Whole Body TRVs for COPC Refinement

Chemical Class	Chemical[a]	Midpoint TRV[b]	Low Effect Fish Tissue Benchmark (ww fish)	No Effect Fish Tissue Benchmark (ww fish)
Dioxin/Furans	1,2,3,4,6,7,8-HpCDD	by TEQ	by TEQ	by TEQ
	1,2,3,4,6,7,8-HpCDF	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8,9-HpCDF	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDD	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDF	by TEQ	by TEQ	by TEQ
	2,3,4,6,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	2,3,4,7,8-PeCDF	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDD	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDF	by TEQ	by TEQ	by TEQ
	OCDD	by TEQ	by TEQ	by TEQ
	OCDF	by TEQ	by TEQ	by TEQ
	Dioxin/furan congener TEQ	0.0005	0.000878	0.0000878
Pesticides	4,4'-DDD	0.3300	0.600	0.0600
	4,4'-DDE	0.4455	0.810	0.0810
	4,4'-DDT	8.62	11.1	6.14
	Endrin	0.3615	0.417	0.306
	Heptachlor Epoxide	4.22	8.00	0.444
	Endosulfan II	0.5850	0.975	0.195
	Total Chlordane	7.24	14.1	0.381
	Total DDT	--	--	--
SVOC	Hexachlorobenzene	--	--	--
	Hexachlorobutadiene	14.2	25.8	2.58
	Hexachloroethane	--	--	--
	1,3-Dichlorobenzene	119	170	68.8
	1,4-Dichlorobenzene	68.4	103	33.7

Notes:

a Chemicals in this screening table are those identified as COPC in the COPC Report and Addendum (Anchor QEA 2008a, 2008b)

b Arithmetic average of the low- and no-effect tissue benchmarks

c See COPC Report and Addendum for derivation of effect benchmarks

Table 9
Refined Fish Bioaccumulative Sediment COPC Hazard Quotients

Chemical Class	Chemical[a]	Estimated Fish Tissue Conc (mg/kg; ww fish)	Midpoint TRV (mg/kg)	HQ
Metals	Arsenic	0.4873	1.88	0.26
	Cadmium	0.0045	1.15	0.00
	Chromium	0.23333	3.20	0.07
	Copper	0.5596	6.53	0.09
	Lead	0.12336	2.79	0.04
	Mercury	21.906	2.47	8.89
	Selenium	0.793	1.62	0.49
	Zinc	28.159	59.7	0.47
PAH	2-Methylnaphthalene	1.1316	1.97	0.57
	Acenaphthene	0.1518	10.5	0.01
	Acenaphthylene	0.1229	1.97	0.06
	Anthracene	0.2001	1.97	0.10
	Benzo(a)anthracene	0.0460	1.97	0.02
	Benzo(a)pyrene	0.0556	37.0	0.002
	Benzo(b)fluoranthene	0.0592	1.97	0.03
	Benzo(g,h,i)perylene	0.0642	1.97	0.03
	Benzo(k)fluoranthene	0.0447	1.97	0.02
	Chrysene	0.0495	--	--
	Dibenzo(a,h)anthracene	0.0062	1.97	0.003
	Fluoranthene	0.1703	1.97	0.09
	Fluorene	0.3428	1.97	0.17
	Naphthalene[d]	1.7269	9.35	0.18
	Phenanthrene	0.913	110	0.01
	Total HPAH 16	0.488	1.97	0.25
	Total LPAH 16	1.480	1.97	0.75
	Total PAH 16	1.630	1.97	0.83
PCB	Total PCB Congeners[b]	9.524	4.23	2.25
	PCB-077[e]	by TEQ	by TEQ	by TEQ
	PCB-081[e]	by TEQ	by TEQ	by TEQ

Table 9
Refined Fish Bioaccumulative Sediment COPC Hazard Quotients

Chemical Class	Chemical[a]	Estimated Fish Tissue Conc (mg/kg; ww fish)	Midpoint TRV (mg/kg)	HQ
PCB	PCB-105	by TEQ	by TEQ	by TEQ
	PCB-114	by TEQ	by TEQ	by TEQ
	PCB-118	by TEQ	by TEQ	by TEQ
	PCB-123[f]	by TEQ	by TEQ	by TEQ
	PCB-126	by TEQ	by TEQ	by TEQ
	PCB-156	by TEQ	by TEQ	by TEQ
	PCB-157	by TEQ	by TEQ	by TEQ
	PCB-167	by TEQ	by TEQ	by TEQ
	PCB-169	by TEQ	by TEQ	by TEQ
	PCB-189	by TEQ	by TEQ	by TEQ
	PCB congeners TEQ[c]	4.51E-06	0.3849	0.00001
Dioxin/Furans	1,2,3,4,6,7,8-HpCDD	by TEQ	by TEQ	by TEQ
	1,2,3,4,6,7,8-HpCDF	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8,9-HpCDF	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDD	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDF	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDD	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDF	by TEQ	by TEQ	by TEQ
	2,3,4,6,7,8-HxCDF	by TEQ	by TEQ	by TEQ
	2,3,4,7,8-PeCDF	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDD	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDF	by TEQ	by TEQ	by TEQ
	OCDD	by TEQ	by TEQ	by TEQ
	OCDF	by TEQ	by TEQ	by TEQ
	Dioxin/furan congeners TEQ[c]	7.72E-06	0.0005	0.02

Table 9
Refined Fish Bioaccumulative Sediment COPC Hazard Quotients

Chemical Class	Chemical[a]	Estimated Fish Tissue Conc (mg/kg; ww fish)	Midpoint TRV (mg/kg)	HQ
Pesticides	4,4'-DDD	1.52E-02	0.3300	0.0459
	4,4'-DDE	1.11E-02	0.4455	0.0250
	4,4'-DDT	2.79E-02	8.62	0.0032
	Endrin	0.011	0.3615	0.03
	Heptachlor Epoxide	0.026	4.22	0.01
	Endosulfan II	0.063	0.5850	0.11
	Total Chlordane	0.160	7.24	0.02
	Total DDT	0.048	--	--
SVOC	Hexachlorobenzene	1.1824	--	--
	Hexachlorobutadiene	4.1656	14.2	0.29
	Hexachloroethane	0.0805	--	--
	1,3-Dichlorobenzene	36.7	119	0.31
	1,4-Dichlorobenzene	29.5	68.4	0.43

Notes:

Shading indicates HQ > 1.0

a Chemicals in this screening table are those identified as COPC in the COPC Report and Addendum (Anchor QEA 2008a, 2008b)

b Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

c Dioxins and PCBs are evaluated using the Toxic Equivalency Quotient (TEQ) method in this COPC refinement step. Congener UCLs were multiplied by BSAFs and toxic equivalency factors (TEF) to derive a congener-based tissue concentration. To arrive at the TEQ, the sum of these congener-specific tissue concentrations was calculated.

d No BSAF values for Naphthalene available for Prey Group; Benzo(a)pyrene BSAF used as surrogate.

e No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate.

f No BSAF values for PCB-123 available for Prey Group; PCB-126 BSAF used as surrogate.

Table 10
Revisions to TRVs for Wildlife COPC Refinement

Chemical	NOAEL				LOAEL	
	Source	Endpoint	Test Species	NOAEL (mg/kg-day)	Source (if blank; same as NOAEL)	LOAEL (mg/kg-day)
Avian TRV						
Arsenic	Eco-SSL (EPA 2005b); lowest NOAEL	Reproduction, growth, and survival	Chicken	2.24	Geomean of reported LOAELs (n=3) in Eco-SSL (EPA 2005b)	4.5
Cadmium	Eco-SSL (EPA 2005c); geomean (n=20)	Reproduction and growth	Multiple	1.47	Geomean of repro and growth LOAELs (n=27); Eco-SSL (EPA 2005c)	6.34
Chromium	Eco-SSL (EPA 2008c); geomean (n=12)	Reproduction and growth	Multiple	2.66	Geomean of reported repro and growth LOAELs (n=3) in Eco-SSL (EPA 2008c)	15.6
Copper	Eco-SSL (EPA 2007d); single value lower than lowest LOAEL	Reproduction, growth, and survival	Chicken	4.05	LOAEL from NOAEL study	12.1
Lead	Eco-SSL (EPA 2005d); single value lower than lowest LOAEL	Reproduction, growth, and survival	Chicken	1.63	LOAEL from NOAEL study	3.26
Zinc	Eco-SSL (EPA 2007e); geomean (n=34)	Reproduction and growth	Multiple	66.1	Geomean of reported repro and growth LOAELs (n=39) in Eco-SSL (EPA 2007e)	171
DDT and metabolites	Eco-SSL (EPA 2007c); single value lower than lowest LOAEL	Reproduction, growth, and survival	Chicken	0.227	LOAEL from NOAEL study	2.27
Mammalian TRV						
Arsenic	Eco-SSL (EPA 2005b); Highest bounded NOAEL lower than lowest bounded LOAEL	Growth	Dog	1.04[a]	LOAEL from NOAEL study	1.66[a]

Notes:
NOAEL = 1.16 mg/kg bw/day
LOAEL = 1.85 mg/kg bw/day
a Body weight adjusted TRV for raccoon calculated using allometric scaling (Equation 4-5 in COPC Report Addendum), test species body weight (10 kg) and raccoon body weight (3.99 kg)

Table 11
Wildlife TRVs for COPC Refinement

Chemical	Midpoint TRV[a] (mg/kg bw/day)	
	Avian	Raccoon
Arsenic	3.37	1.500
Cadmium	3.9	NA
Chromium	9.13	NA
Copper	8.1	NA
Lead	2.45	NA
Mercury	0.0352	0.0142
Selenium	5.40	0.145
Zinc	119.0	NA
2-Methylnaphthalene	3.33	NA
Acenaphthene	3.03	NA
Acenaphthylene	3.03	NA
Anthracene	3.33	NA
Fluorene	3.03	NA
Phenanthrene	3.39	NA
Total HPAH 16	24.0	1.62
Total LPAH 16	24.0	11.0
Total PAH 16	24.0	NA
Total PCB Congeners	1.23	0.0583
PCB congeners TEQ	0.000077	0.00000299
Dioxin/furan congener TEQ	0.000077	NA
4,4'-DDD	0.0154	NA
4,4'-DDE	0.0154	NA
4,4'-DDT	0.0154	NA
Endrin	0.0550	NA
Heptachlor Epoxide	1.54	NA
Total DDT	1.25	NA
Hexachlorobenzene	2.01	8.34
Hexachlorobutadiene	12.0	NA
Hexachloroethane	3.00	NA
1,3-Dichlorobenzene	88.4	NA
1,4-Dichlorobenzene	88.4	NA
bis(2-ethylhexyl)phthalate	3.30	NA

Notes:
NA - not applicable; not a COPC for that receptor
a Midpoint TRV is the arithmetic average of the NOAEL and LOAEL presented in the COPC Report and Addendum (Anchor 2008a, 2008b).

Table 12
Refined Wildlife Total Daily Intake Model Exposure Parameters

Parameter	Receptor Group: Receptor: Units	Piscivorous Birds Belted Kingfisher	Sediment-probing Birds Spotted Sandpiper	Carnivorous Birds Composite	Ominivorous Mammals Raccoon
BW	g	136 [a]	42.5 [a]	870 [f]	3,990 [a]
NFMR	kcal/day/kg BW	637 [b]	820 [b]	339 [b]	99.8 [b]
a	unitless	14.25 [g]	8.13 [h]	14.25 [g]	6.03 [i]
b	unitless	0.659 [g]	0.77 [h]	0.659 [g]	0.678 [i]
Cfish	mg/kg WW	chemical specific	NA	chemical specific	chemical specific
Cinvertebrates	mg/kg WW	NA	chemical specific	NA	NA
Csediment	mg/kg DW	NA	chemical specific	NA	NA
AEfish	unitless	0.79 [c]	NA	0.77 [c]	0.91 [c]
AEinvertebrates	unitless	NA	0.77 [c]	NA	NA
GEfish	kcal/kg	1200 [c]	NA	1200 [c]	1200 [c]
GEinvertebrates	kcal/kg	NA [c]	1070 [c]	NA [c]	NA [c]
MEAverage	kcal/kg	948 [j]	824 [j]	924 [j]	1092 [j]
Pfish	unitless	1 [k]	0 [k]	1 [k]	1 [k]
Pinvertebrates	unitless	0 [k]	1 [k]	0 [k]	0 [k]
NIRTotal	kgfood/kgBW/day WW	0.672 [l]	0.995 [l]	0.366 [l]	0.091 [l]
FS	unitless	NA	0.3 [d]	NA	0.094 [e]

Notes:

a Average for adults, both sexes (see text for derivation)
b Derived using Equation 6-7 in text
c See AE and GE derivation worksheet
d USEPA 1993. Semi-palmated sandpiper value used as surrogate
e Based on empirical data (Beyer et al. 1994)
f Reflects average body weight of receptors in this group (Anchor QEA 2009b)
g Power (b) and slope (a) terms for marine birds (Nagy 1999)
h Power (b) and slope (a) terms for Charadriiformes (Nagy 1999)
i Power (b) and slope (a) terms for omnivores (Nagy 1999)
j Derived using Equation 6-4 in text
k See text for derivation
l Derived using Equation 6-3 in text
NA - not applicable

Table 13
Refined Wildlife COPC Hazard Quotients

	Hazard Quotients			
COPC	**Kingfisher**	**Spotted Sandpiper**	**Carnivorous Wading Bird**	**Raccoon**
Arsenic	0.066	0.22	0.036	0.02
Cadmium	NA	0.060	NA	NA
Chromium	0.03	0.06	0.019	NA
Copper	NA	0.257	NA	NA
Lead	0.127	0.200	0.069	NA
Mercury	520	612	280	184
Selenium	NA	0.12	NA	0.42
Zinc	0.52	0.19	0.28	NA
2-Methylnaphthalene	0.79	0.47	0.43	NA
Acenaphthene	0.12	0.28	0.063	NA
Acenaphthylene	0.097	0.031	0.053	NA
Anthracene	0.14	0.036	0.078	NA
Fluorene	0.28	0.13	NA	NA
Phenanthrene	0.66	0.62	0.36	NA
Total HPAH 16	NA	0.78	NA	0.089
Total LPAH 16	0.27	5.5	0.15	0.079
Total PAH 16	NA	9.3	NA	0.0
Total PCB Congeners	4.0	20	2.2	12
PCB congeners TEQ	11	16	6.0	0.8
Dioxin/furan congener TEQ	0.55	3.4	0.30	NA
4,4'-DDD	0.0070	0.011	0.0038	NA
4,4'-DDE	0.0030	0.0044	0.0017	NA
4,4'-DDT	0.013	0.011	0.0071	NA
Endrin	0.14	0.12	NA	NA
Heptachlor Epoxide	NA	0.011	NA	NA
Total DDT	0.017	0.020	0.0091	NA
Hexachlorobenzene	1.2	11	0.67	0.041
Hexachlorobutadiene	0.60	7.8	NA	NA
Hexachloroethane	0.065	0.91	NA	NA
1,3-Dichlorobenzene	1.1	1.2	0.60	NA
1,4-Dichlorobenzene	0.87	1.1	0.48	NA
bis(2-ethylhexyl)phthalate	NA	0.000042	NA	NA

Notes:
Indicates HQ > 1.0
NA - not applicable

Table 14
Summary of COPC Refinement

Matrix	Pathway	Screening Method	Chemical	Rationale	COPC
Surface Water	Direct Contact	HQ calculated using TCEQ Surface Water Benchmark and maximum detected concentration (non-detects used max detection limit)	alpha-chlordane	Come from upstream urban runoff; not indicator chemicals	No
			total chlordane		No
			dieldrin		No
			heptachlor epoxide		No
			heptachlor		No
			toxaphene		No
			4,4'-DDT		No
			2,4'-DDT		No
			endrin ketone		No
			anthracene	Only PAHs with reporting limit > screening value; PAHs not present in concentrations in excess of screaning value	No
			pyrene		No
			hexachlorocyclopentadiene	Short half life in water when exposed to sunlight; not present in Site sediment; small difference between reporting limit and screening value	No
			hexachlorobutadiene	Reporting limit concentration near or below screening value	No
			dioxin/furan	Measured concentration in test organisms more useful matrix - will be assessed as bioaccumulative COPC	No
			caprolactam	Maximum detected concentration less than toxicity values	No
			PCBs	Concentration exceeds screening level	Yes
	Bioaccumulative	TCEQ's Guidance for Conducting Ecological Risk Assessments at Remediation Sites	mercury	Chemicals detected and considered to be potentially bioaccumulative according to TCEQ (2006)	Yes
			selenium		Yes
			PCBs		Yes
			dioxin/furan		Yes
	Indirect effects	No federal or state WQC have been established	nitrate	Semi-quantitative assessement will be performed as part of uncertainty analysis	No
			total Kjeldahl nitrogen		No
Sediment	Direct Contact	Frequency and Magnitude of Dectection Evaluation	aldrin	Low frequency of detection	No
			methoxychlor		No
			1,2-dichlorobenzene		No
			di-n-octyl phthalate		No
	Direct Contact - Rooted Aquatic Plants	All effects data based on algal tests of short duration	mercury	Qualitative assessment of risk to plants will be performed in the uncertainty assessment of the BERA	No
			copper		No
			nickel		No
			acenapthene		No
			DDT		No
			PCBs		No

Table 14
Summary of COPC Refinement

Matrix	Pathway	Screening Method	Chemical	Rationale	COPC
	Direct Contact - Benthic Invertebrates	Multiple lines of evidence Approach	See Table 7 for complete list of COPCs	See Table 7 for rationale	Yes
			arsenic	95th percentile less than screening value	No
			copper	95th percentile less than screening value	No
			hexachloroethane	95th percentile less than screening value	No
			1,3-dichlorobenzene	95th percentile less than screening value	No
			1,4-dichlorobenzene	95th percentile less than screening value	No
			ammonia	Not present from anothropogenic chemicals; no screening value	No
			4-isopropyltoluene	95th percentile less than screening value	No
			endrin	95th percentile less than screening value	No
			endosulfan I	95th percentile less than screening value	No
			endosulfan II	95th percentile less than screening value	No
			alpha-chlordane	Come from upstream urban runoff; not indicator chemicals	No
			gamma-chlordane	Come from upstream urban runoff; not indicator chemicals	No
			total chlordane	Come from upstream urban runoff; not indicator chemicals	No
			DDD	Come from upstream urban runoff; not indicator chemicals	No
			DDE	Come from upstream urban runoff; not indicator chemicals	No
			DDT	Come from upstream urban runoff; not indicator chemicals	No
			gamma-BHC (Lindane)	Come from upstream urban runoff; not indicator chemicals	No
	Direct Contact - Fish	Sediment COPCs	See sediment COPC list (Table 7)	Any sediment COPC identified for benthic invertebrates will be COPC for direct sediment exposure for fish	Yes
	Bioaccumulative - Fish	Midpoint TRV - HQ approach	mercury	Midpoint TRV based HQ > 1 using 95th UCL os sediment data and geometric mean of BSAF	Yes
			PCBs		Yes
	Ingestion - Wildlife Receptors	Midpoint TRV - HQ approach	mercury	TDI estimates for spotted sandpiper, carnivorous wading birds, belted kingfisher and raccoon exceed Midpoint TRV	Yes
			PAHs		Yes
			PCBs		Yes
			dioxin/furan		Yes
			hexachlorobenzene		Yes
			hexachlorobutadiene		Yes
			1,3-dichlorobenzene		Yes
			1,4-dichlorobenzene		Yes

Table 15
COPCs in Benthic Toxicity Model Dataset with Less Than Full Representation

COPC	Number of Samples Without a Result
Ammonia	47
Arsenic	5
Barium	5
Cadmium	5
Chromium	5
Copper	5
Lead	5
Mercury	5
Nickel	5
Silver	5
Zinc	5
2-Methylnaphthalene	3
Acenaphthene	0
Acenaphthylene	0
Anthracene	0
Benzo(a)anthracene	0
Benzo(a)pyrene	0
Chrysene	0
Dibenzo(a,h)anthracene	0
Fluoranthene	0
Fluorene	0
Indeno(1,2,3-cd)pyrene	43
Naphthalene	5
Phenanthrene	0
Pyrene	0
Aroclor 1248	6
Aroclor 1254	43
Aroclor 1260	43
alpha-Chlordane	9
gamma-BHC (Lindane)	43
gamma-Chlordane	9
Aldrin	43
Endosulfan I	43
Endosulfan II	43
Endrin	43
Methoxychlor	43
bis(2-Ethylhexyl)phthalate	0
Hexachlorobutadiene	0
Hexachloroethane	0
Benzidine	5
bis(2-Chloroisopropyl)ether	0
Di-n-octylphthalate	0
Hexachlorobenzene	0

Table 15
COPCs in Benthic Toxicity Model Dataset with Less Than Full Representation

COPC	Number of Samples Without a Result
1,3-Dichlorobenzene	0
1,4-Dichlorobenzene	0
Benzene	0
Chlorobenzene	0
Ethylbenzene	0
Toluene	6
Total xylene	11
4-Isopropyltoluene	14
Isopropylbenzene	9
n-Butylbenzene	14
n-Propylbenzene	14
sec-Butylbenzene	14
tert-Butylbenzene	14

Table 16
Description of Sediment Quality Guidelines

SQG	Narrative Intent	Source
PEC	The consensus-based PECs were intended to define the concentration of sediment-associated contaminants above which adverse effects on sediment-dwelling organisms are likely to occur. The PECs were derived as geometric means of SQGs in the literature with similar narrative intent.	MacDonald et al. (2000)
PEL	The PELs were intended to estimate the concentration of a chemical above which adverse biological effects frequently occurred. The PELs were derived by calculating the geometric mean of the 50th percentile of the effect dataset and the 85th percentile of the no-effect dataset.	MacDonald et al. (1996)
ERM	The concentrations equivalent to or above the ERMs represent thresholds above which effects would frequently occur. The ERMs were derived as the 50th percentile of a database composed of multiple studies, species, and effects endpoints.	Long et al. (1995)
PAH ESB TU	The PAH ESB TU is intended to represent an equilibrium partitioning screening benchmark for mixtures of 34 PAHs that will not adversely affect most benthic organisms. The combination of EqP theory, narcosis theory, and additivity provide the technical foundation for this benchmark. The Final Chronic Value (FCV) for PAHs derived using the National Water Quality Criteria (WQC) Guidelines (Stephan et al. 1985) is used as the toxicity endpoint for this ESB.	USEPA (2003)
Nonionic organic COPC (NOC) ESB TU	The NOC ESB TU is intended to represent an EqP screening benchmark for mixtures of up to 32 NOC chemicals that will not adversely affect most benthic organisms. The combination of EqP theory, narcosis theory, and additivity provide the technical foundation for this benchmark. The Final Chronic Value (FCV) for PAHs derived using the National Water Quality Criteria (WQC) Guidelines (Stephan et al. 1985) is used as the toxicity endpoint for this ESB.	USEPA (2008)
Metals mixture ESB TU	The Metals ESB TU is intended to represent an EqP screening benchmark for mixtures of the metals cadmium, copper, lead, nickel, silver, and zinc that will not adversely affect most organisms. EqP theory predicts that these metals partition in sediment primarily between acid volatile sulfide (AVS, principally iron monosulfide) and interstitial (pore) water. The FCV for PAHs derived using the National WQC Guidelines (Stephan et al. 1985) is used as the toxicity endpoint for this ESB.	USEPA (2005)

Notes:
AVS – acid volatile sulfide
EqP – equilibrium partitioning
ERM – effects range – median
ESB – equilibrium screening benchmark
FCV – Final Chronic Value
PEC – probable effects concentration
PEL – probable effects level
TU – toxic unit
WQC – National Water Quality Criteria

Table 17
Summary of Bioassay Data Used in Benthic Toxicity Model Development

						Lephtocheirus plumulosus Duration: 10 d Endpoint: Mortality		*Neanthes arenaceodentata* Duration: 10 d Endpoint: Mortality		*Americamysis bahia* Duration: 10 d Endpoint: Mortality		*Ampelisca abdita* Duration: 10 d Endpoint: Mortality		*Americamysis bahia* Duration: 7 d Endpoint: Mortality		*Amplesica abdita* Duration: 7 d Endpoint: Mortality	
Agency/Entity	**Activity**	**Station ID**	**Sample ID**	**Matrix**	**Sample Date**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**
TCEQ/USEPA	SS	3	3-8/12/2003-EPA/TCEQ	Whole Sediment	8/12/2003	--	--	--	--	--	--	--	--	92.8	No	87	No
TCEQ/USEPA	SS	3	3-8/31/2006-TCEQ	Whole Sediment	8/31/2006	--	--	--	--	--	--	--	--	10	Yes	0	Yes
TCEQ/USEPA	SS	4A	4A-8/12/2003-EPA/TCEQ	Whole Sediment	8/12/2003	--	--	--	--	--	--	--	--	79.4	Yes	0	Yes
TCEQ/USEPA	SS	4A	4A-8/31/2006-TCEQ	Whole Sediment	8/12/2003	--	--	--	--	--	--	--	--	93	No	0	Yes
TCEQ/USEPA	SS	6A	6A-8/12/2003-EPA/TCEQ	Whole Sediment	8/31/2006	--	--	--	--	--	--	--	--	20.6	Yes	0	Yes
TCEQ/USEPA	SS	6A	6A-8/31/2006-TCEQ	Whole Sediment	8/12/2003	--	--	--	--	--	--	--	--	100	No	67	Yes
TCEQ/USEPA	SS	7	7-8/12/2003-EPA/TCEQ	Whole Sediment	8/31/2006	--	--	--	--	--	--	--	--	100	No	60	Yes
TCEQ/USEPA	SS	9	9-8/12/2003-TCEQ	Whole Sediment	8/12/2003	--	--	--	--	--	--	--	--	69.1	Yes	77	Yes
PBLO	TMDL	2	2-4/23/2001	Whole Sediment	4/23/2001	88	No	82	No	--	--	--	--	--	--	--	--
PBLO	TMDL	2	2-9/5/2000	Whole Sediment	9/5/2001	94	No	96	No	--	--	--	--	--	--	--	--
PBLO	TMDL	2.5	2.5-4/23/2001	Whole Sediment	4/23/2001	83	No	92	No	--	--	--	--	--	--	--	--
PBLO	TMDL	2.5	2.5-9/5/2000	Whole Sediment	9/5/2000	87	No	88	No	--	--	--	--	--	--	--	--
PBLO	TMDL	3	3-4/24/2001	Whole Sediment	4/24/2001	0	Yes	84	No	--	--	--	--	--	--	--	--
PBLO	TMDL	3	3-8/12/2003	Whole Sediment	8/12/2003	95	No	--	--	86	No	31	Yes	96	No	82	No
PBLO	TMDL	3	3-9/6/2000	Whole Sediment	9/6/2000	73	Yes	100	No	--	--	--	--	--	--	--	--
PBLO	TMDL	5	5-4/24/2001	Whole Sediment	4/24/2001	0	Yes	92	No	--	--	--	--	--	--	--	--
PBLO	TMDL	5	5-9/5/2000	Whole Sediment	9/5/2000	99	No	76	No	--	--	--	--	--	--	--	--
PBLO	TMDL	7	7-4/26/2001	Whole Sediment	4/26/2001	88	No	80	No	--	--	--	--	--	--	--	--
PBLO	TMDL	7	7-8/12/2003	Whole Sediment	8/12/2003	91	No	--	--	96	No	51	Yes	90	No	68	Yes
PBLO	TMDL	7	7-9/6/2000	Whole Sediment	9/6/2000	5	Yes	100	No	--	--	--	--	--	--	--	--
PBLO	TMDL	8	8-4/25/2001	Whole Sediment	4/25/2001	0	Yes	102	No	--	--	--	--	--	--	--	--
PBLO	TMDL	8	8-9/6/2000	Whole Sediment	9/6/2000	94	No	116	No	--	--	--	--	--	--	--	--
PBLO	TMDL	9	9-8/12/2003	Whole Sediment	8/12/2003	92	No	--	--	--	No	--	Yes	--	No	--	Yes
PBLO	TMDL	9	9-9/6/2000	Whole Sediment	9/6/2000	53	Yes	121	No	--	--	--	--	--	--	--	--
PBLO	TMDL	10	10-4/25/2001	Whole Sediment	4/25/2001	85	No	86	No	--	--	--	--	--	--	--	--
PBLO	TMDL	10	10-9/5/2000	Whole Sediment	9/5/2001	98	No	48	Yes	--	--	--	--	--	--	--	--
PBLO	TMDL	4A	4A-4/24/2001	Whole Sediment	4/24/2001	6	Yes	68	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	4A	4A-8/12/2003	Whole Sediment	8/12/2003	30	Yes	--	--	70	Yes	1	Yes	44	Yes	0	Yes
PBLO	TMDL	4A	4a-9/5/2000	Whole Sediment	9/5/2000	86	No	88	No	--	--	--	--	--	--	--	.
PBLO	TMDL	6A	6A-4/25/2001	Whole Sediment	4/25/2001	0	Yes	60	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	6A	6A-8/12/2003	Whole Sediment	8/12/2003	31	Yes	--	--	38	Yes	0	Yes	22	Yes	0	Yes
PBLO	TMDL	6A	6a-9/5/2000	Whole Sediment	9/5/2000	24	Yes	100	No	--	--	--	--	--	--	--	.
PBLO	TMDL	E	E-4/23/2001	Whole Sediment	4/23/2001	55	Yes	96	No	--	--	--	--	--	--	--	.
PBLO	TMDL	E	E-9/6/2000	Whole Sediment	9/6/2000	100	No	80	No	--	--	--	--	--	--	--	.
PBLO	TMDL	G	G-4/24/2001	Whole Sediment	4/24/2001	89	No	36	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	G	G-9/6/2000	Whole Sediment	9/6/2000	100	No	84	No	--	--	--	--	--	--	--	.
PBLO	TMDL	Q	Q-4/25/2001	Whole Sediment	4/25/2001	4	Yes	80	No	--	--	--	--	--	--	--	.
PBLO	TMDL	Q	Q-9/5/2000	Whole Sediment	9/5/2000	77	No	92	No	--	--	--	--	--	--	--	.
PBLO	TMDL	R	R-4/26/2001	Whole Sediment	4/26/2001	75	Yes	68	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	R	R-8/12/2003	Whole Sediment	8/12/2003	98	No	--	--	90	No	65	Yes	80	No	76	No
PBLO	TMDL	R	R-9/5/2000	Whole Sediment	9/5/2000	84	No	72	No	--	--	--	--	--	--	--	.

Table 17
Summary of Bioassay Data Used in Benthic Toxicity Model Development

						Lephtocheirus plumulosus Duration: 10 d Endpoint: Mortality		*Neanthes arenaceodentata* Duration: 10 d Endpoint: Mortality		*Americamysis bahia* Duration: 10 d Endpoint: Mortality		*Ampelisca abdita* Duration: 10 d Endpoint: Mortality		*Americamysis bahia* Duration: 7 d Endpoint: Mortality		*Amplesica abdita* Duration: 7 d Endpoint: Mortality	
Agency/Entity	**Activity**	**Station ID**	**Sample ID**	**Matrix**	**Sample Date**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**	**% Survival**	**Toxic[a]**
PBLO	TMDL	S	S-4/24/2001	Whole Sediment	4/24/2001	63	Yes	84	No	--	--	--	--	--	--	--	.
PBLO	TMDL	S	S-9/5/2000	Whole Sediment	9/5/2000	96	No	84	No	--	--	--	--	--	--	--	.
PBLO	TMDL	T	T-4/25/2001	Whole Sediment	4/25/2001	72	Yes	78	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	T	T-9/5/2000	Whole Sediment	9/5/2000	91	No	104	No	--	--	--	--	--	--	--	.
PBLO	TMDL	U	U-4/24/2001	Whole Sediment	4/24/2001	79	No	68	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	U	U-9/6/2000	Whole Sediment	9/6/2000	95	No	84	No	--	--	--	--	--	--	--	.
PBLO	TMDL	V	V-4/23/2001	Whole Sediment	4/23/2001	76	Yes	92	No	--	--	--	--	--	--	--	.
PBLO	TMDL	V	V-9/5/2000	Whole Sediment	9/5/2000	98	No	64	Yes	--	--	--	--	--	--	--	.
PBLO	TMDL	Y	Y-4/26/2001	Whole Sediment	4/26/2001	91	No	84	No	--	--	--	--	--	--	--	.
PBLO	TMDL	Y	Y-9/6/2000	Whole Sediment	9/6/2000	0	Yes	0	Yes	--	--	--	--	--	--	--	.

Notes:
-- No Testing Performed
TMDL - Total Maximum Daily Load
PBLO - Patrick Bayou Lead Organization
TCEQ - Texas Commission on Environmental Quality
USEPA - U.S. Environmental Protection Agency
SS - Special Study
a Samples that were significantly different from negative controls and had a control-adjusted survival less than 80 percent relative to the negative control were identified as toxic.

Table 18
Comparison of Incidence of Toxicity in 10-day and 28-day Bioassay Tests Evaluated by McGee et al. (2004)

Duration:	10-day	28-day	28-day	28-day	28-day
Endpoint:	Survival	Survival	Growth and Reproduction	Survival	Growth and Reproduction
	Not fed	Feeding Regime 1		Feeding Regime 2	
Incidence of toxicity	73%	64%	0%	36%	18%
	(8 of 11)	(7 of 11)	(0 of 11)	(4 of 11)	(2 of 11)

Table 19
Sensitivity Comparison of Sublethal and Lethal Bioassay Test Endpoints
Performed by Greenstein et al. (2008)

Type	**Acute Survival**		**Sublethal/Chronic**				
Species	***Eohaustorius***	***Lepthocheirus***	***Mytilus* (mussel)**	***Mercinaria* (bivalve)**	***Crassostrea* (oyster)**	***Neanthes* (polychaete)**	***Amphiascus* (copepod)**
Incidence of toxicity	27%	60%	7%	13%	13%	53%	90%*
	(4 of 15)	(9 of 15)	(1 of 15)	(2 of 15)	(2 of 15)	(8 of 15)	(9 of 10)*

Note:
*Not all samples tested with this organism

Table 20
Sensitivity Comparison of Acute and Chronic Bioassay Tests
Performed by Steevens et al. (2008)

Sediment	10-Day Acute Tests*		28-Day *Leptocheirus*	
	Ampelisca	***Leptocheirus***	**Mean Survival**	**Neonates/Survivor**
Control	none	none	none	none
Reference	Significant	none	Significant and NSD >20%	Significant and NSD >20%
Arthur	none	Significant and NSD >20%	Significant and NSD >20%	none
Buttermilk	Significant and NSD >20%	Significant and NSD >20%	none	none
Chester	Significant and NSD >20%	Significant and NSD >20%	Significant and NSD >20%	Significant and NSD >20%
Flushing	Significant and NSD >20%	Significant and NSD >20% percent	none	Significant and NSD >20%
Hudson	Significant and NSD >20%	Significant and NSD >20%	Significant and NSD >20%	none
Jamaica	none	none	none	none
Newark	Significant and NSD >20%	Significant and NSD >20%	Significant and NSD >20%	Significant and NSD >20%
Perth	Significant and NSD >20%	none	none	none
Red Hook	none	Significant and NSD >20%	none	none

Notes:
* No significant differences from control were observed for *A. bahia* (data not shown).
"Significant" - There was a significant reduction compared to the control.
NSD > 20% - There was an ecologically significant endpoint response where there was a greater than 20% reduction relative to the control.

Table 21
Initial Reliability Analysis Results for Mean ERM-Q, Mean PEC-Q, Mean PEL-Q, PAH ESBTU, NOC ESBTU, and Metals ESBTU

Effect Threshold = 1.0	
ERM-Q	
False Negatives	6%
False Positives	64%
Reliability	60%
PEC-Q	
False Negatives	28%
False Positives	16%
Reliability	79%
PEL-Q	
False Negatives	0%
False Positives	80%
Reliability	53%
PAH ESBTU	
False Negatives	17%
False Positives	68%
Reliability	53%
NOC ESBTU	
False Negatives	100%
False Positives	0%
Reliability	52%
Metals ESBTU	
False Negatives	16%
False Positives	100%
Reliability	49%

Notes:
Shaded cells meet initial acceptability criteria
ERM-Q - Effect Range Median quotient
PEC-Q - probable effects concentration quotient
PEL-Q - probable effect limit quotient
PAH ESBTU - polynuclear aromatic hydrocarbon equilibrium screening benchmark toxic unit
NOC ESBTU - non-ionic COPC equilibrium screening benchmark toxic unit

Table 22
Results of Hypothesis Testing to Identify COPCs with a Significant Relationship Between Toxic and Non-Toxic Sample Groups

COPC	Test	Result
Lead	WMW	Reject H0
Silver	WMW	Reject H0
Total PAH 16 standard	WMW	Reject H0
Aroclor 1248	WMW	Reject H0
bis(2-Ethylhexyl)phthalate	WMW	Reject H0
Arsenic	WMW	Accept H0
Cadmium	WMW	Accept H0
Chromium	WMW	Accept H0
Copper	WMW	Accept H0
Mercury	WMW	Accept H0
Nickel	WMW	Accept H0
Zinc	WMW	Accept H0
Total Chlordane (a & g)	WMW	Accept H0
Total DDT	WMW	Accept H0

Notes:
Shaded COPCs showed significant differences between toxic and non-toxic samples at a 95% significance level (alpha=0.05)
WMW - Wilcoxon-Mann-Whitney

Table 23
Reliability Analysis Results for Initial and Optimized Mean PEL-Q and PEC-Q

SQG	mean PEC-Q		mean PEL-Q	
Model	Initial	Optimized	Initial	Optimized
COPC	All	PAH, PCB, Lead	All	PAH, PCB, BEHP, Lead
Threshold	1.00	1.21	2.44	1.56
False Negatives	28%	22%	22%	17%
False Positives	16%	4%	20%	20%
Reliability	79%	88%	79%	81%

Notes:
PEC-Q - probable effects concentation quotient
PEL-Q - probable effect level quotient

Table 24
Comparison of NOC ESBTU and Metals ESBTU Values to Predicted Toxicity using the Optimized Mean PEL-Q Model

Source	Station	Sample ID	SEM/AVS	MEAN PEL-Q [BEHP, PCB, PAH, Lead]	NOC ESBTU	[SEM]/[AVS] > 1.0	Optimized Mean PEL-Q > 1.56	NOC ESBTU > 1.0
TMDL	2.5	2.5-4/23/2001	0.739	1.68	0.363	FALSE	TRUE	FALSE
TMDL	2.5	2.5-9/5/2000	0.252	1.06	0.390	FALSE	FALSE	FALSE
TMDL	3	3-4/24/2001	0.0353	13.4	0.823	FALSE	TRUE	FALSE
TMDL	3	3-8/12/2003	0.175	2.27	0.0540	FALSE	TRUE	FALSE
TMDL	3	3-9/6/2000	0.0575	2.35	0.0670	FALSE	TRUE	FALSE
TMDL	5	5-4/24/2001	0.0537	4.70	0.0960	FALSE	TRUE	FALSE
TMDL	5	5-9/5/2000	0.148	1.45	0.00	FALSE	FALSE	FALSE
TMDL	7	7-4/26/2001	966	0.836	0.000	TRUE	FALSE	FALSE
TMDL	7	7-8/12/2003	0.307	2.80	0.00	FALSE	TRUE	FALSE
TMDL	7	7-9/6/2000	0.0768	1.65	0.00400	FALSE	TRUE	FALSE
TMDL	4A	4A-4/24/2001	0.182	1.29	0.0320	FALSE	FALSE	FALSE
TMDL	4A	4A-8/12/2003	0.0882	46.2	0.0	FALSE	TRUE	FALSE
TMDL	4A	4A-9/5/2000	0.0648	2.70	0.0100	FALSE	TRUE	FALSE
TMDL	6A	6A-4/25/2001	0.0335	3.15	0.0120	FALSE	TRUE	FALSE
TMDL	6A	6A-8/12/2003	0.126	14.9	0.0150	FALSE	TRUE	FALSE
TMDL	6A	6A-9/5/2000	0.0632	13.5	0.0360	FALSE	TRUE	FALSE
TMDL	E	E-4/23/2001	0.202	3.11	0.170	FALSE	TRUE	FALSE
TMDL	E	E-9/6/2000	0.998	0.857	0.487	FALSE	FALSE	FALSE
TMDL	G	G-4/24/2001	0.987	0.570	0.0100	FALSE	FALSE	FALSE
TMDL	G	G-9/6/2000	0.137	0.905	0.00100	FALSE	FALSE	FALSE
TMDL	Q	Q-4/25/2001	0.0483	3.22	0.0190	FALSE	TRUE	FALSE
TMDL	Q	Q-9/5/2000	0.0407	5.71	0.00	FALSE	TRUE	FALSE
TMDL	R	R-4/26/2001	0.135	0.695	0.00100	FALSE	FALSE	FALSE
TMDL	R	R-8/12/2003	0.551	0.634	0.000	FALSE	FALSE	FALSE
TMDL	R	R-9/5/2000	0.0835	1.07	0.00	FALSE	FALSE	FALSE
TMDL	S	S-4/24/2001	0.0463	6.14	0.858	FALSE	TRUE	FALSE
TMDL	S	S-9/5/2000	0.258	0.376	0.104	FALSE	FALSE	FALSE
TMDL	T	T-4/25/2001	0.0644	1.61	0.00700	FALSE	TRUE	FALSE
TMDL	T	T-9/5/2000	0.0534	1.44	0.00	FALSE	FALSE	FALSE
TMDL	U	U-4/24/2001	16.7	0.0814	0.0550	TRUE	FALSE	FALSE

Table 24
Comparison of NOC ESBTU and Metals ESBTU Values to Predicted Toxicity using the Optimized Mean PEL-Q Model

Source	Station	Sample ID	SEM/AVS	MEAN PEL-Q [BEHP, PCB, PAH, Lead]	NOC ESBTU	[SEM]/[AVS] > 1.0	Optimized Mean PEL-Q > 1.56	NOC ESBTU > 1.0
TMDL	U	U-9/6/2000	1.33	0.195	0.0180	TRUE	FALSE	FALSE
TMDL	V	V-4/23/2001	0.220	1.27	0.293	FALSE	FALSE	FALSE
TMDL	V	V-9/5/2000	0.0312	1.23	0.249	FALSE	FALSE	FALSE
TMDL	Y	Y-4/26/2001	6.54	0.358	0.00200	TRUE	FALSE	FALSE
TMDL	Y	Y-9/6/2000	0.119	6.91	0.00100	FALSE	TRUE	FALSE
RI/FS	EF001	EF001-1SC011-N	0.417	0.807	0.000	FALSE	FALSE	FALSE
RI/FS	PB003	PB003-1SC011-N	0.384	2.51	0.0570	FALSE	TRUE	FALSE
RI/FS	PB009	PB009-1SC011-N	1.72	3.33	0.136	TRUE	TRUE	FALSE
RI/FS	PB016	PB016-1SC011-N	1.93	2.37	0.138	TRUE	TRUE	FALSE
RI/FS	PB018	PB018-1SC011-N	0.218	19.6	0.147	FALSE	TRUE	FALSE
RI/FS	PB022	PB022-1SC011-N	0.229	3.44	0.163	FALSE	TRUE	FALSE
RI/FS	PB030	PB030-1SC011-N	0.271	0.865	0.00100	FALSE	FALSE	FALSE
RI/FS	PB036	PB036-1SC011-N	0.113	8.83	0.0740	FALSE	TRUE	FALSE
RI/FS	PB042	PB042-1SC011-N	0.157	11.7	0.00300	FALSE	TRUE	FALSE
RI/FS	PB048	PB048-1SC011-N	0.168	3.95	0.00500	FALSE	TRUE	FALSE
RI/FS	PB057	PB057-1SC011-N	0.0908	34.0	0.197	FALSE	TRUE	FALSE
RI/FS	PB063	PB063-1SC011-N	0.144	0.903	0.000	FALSE	FALSE	FALSE
RI/FS	PB073	PB073-1SC011-N	0.191	8.07	0.00100	FALSE	TRUE	FALSE

Notes:

Stippled cells indicate sample locations within the gunnite lined channel portion of the Site

Shaded cells indentify where the [SEM]/[AVS] value exceeds the default effect threshold of 1.0 but the optimized mean PEL-Q does not predict toxicity

PEC-Q - probable effects concentration quotient

PEL-Q - probable effect limit quotient

NOC ESBTU - non-ionic COPC equilibrium screening benchmark toxic unit

SEM/AVS - scanning electron microscopy/acid volatile sulfide

Table 25
Comparison of PEL-Q Values for COPCs Not Included in the Predictive Model to Predicted Toxicity Using the Optimized Mean PEL-Q Model

Station	Sample	Arsenic PEL-Q	Cadmium PEL-Q	Chromium PEL-Q	Mercury PEL-Q	Total DDT PEL-Q	Total Chlordane PEL-Q	Optimized Mean PEL-Q
2.5	2.5-4/23/2001	0.232	0.0917	0.274	3.36	28.6	0.197	1.68
2.5	2.5-9/5/2000	0.0685	0.0867	0.297	**4.16**	**1.34**	0	1.06
3	3-4/24/2001	0.255	0.385	2.75	229	2.94	0.332	13.4
3	3-8/12/2003	0.0716	0.107	0.336	12.9			2.28
3	3-9/6/2000	0.0849	0.0903	0.694	23.9	1.77	0	2.35
4A	4A-4/24/2001	0.240	0.314	0.513	**8.94**	0.509	0	1.29
4A	4A-8/12/2003	0.102	0.183	0.573	28.4			46.2
4A	4A-9/5/2000	0.0798	0.171	0.769	9.46	1.80	0	2.70
5	5-4/24/2001	0.296	0.299	2.24	11.8	1.87	0.0812	4.70
5	5-9/5/2000	0.0743	0.167	0.856	**6.50**	**1.41**	0	1.45
6A	6A-4/25/2001	0.274	0.0857	0.350	0.427	0.000	0	3.15
6A	6A-8/12/2003	0.0750	0.276	0.485	3.61			14.9
6A	6A-9/5/2000	0.129	0.0684	0.398	0.657	3.12	0.455	13.5
7	7-4/26/2001	**2.33**	0.271	**1.68**	0.0486	**1.41**	0.0146	0.837
7	7-8/12/2003	0.365	0.168	0.0638	0.167			2.80
7	7-9/6/2000	0.712	0.130	0.263	0.147	18.6	0	1.65
E	E-4/23/2001	0.187	0.124	0.351	6.01	0.851	0	3.11
E	E-9/6/2000	0.0517	0.0556	0.344	**4.40**	**1.16**	0	0.857
G	G-4/24/2001	0.303	0.0907	0.340	**2.09**	0.0935	0.0518	0.569
G	G-9/6/2000	0.120	0.0435	0.289	**2.53**	**1.26**	0	0.905
Q	Q-4/25/2001	0.305	0.437	2.38	1.60	1.22	0.238	3.22
Q	Q-9/5/2000	0.126	0.0831	0.256	0.467	3.10	0.620	5.71
R	R-4/26/2001	0.716	0.0976	**2.86**	0.190	0.499	0	0.695
R	R-8/12/2003	0.267	0.142	0.112	0.233			0.634
R	R-9/5/2000	**3.94**	0.245	0.456	0.0786	**1.10**	0.712	1.07
S	S-4/24/2001	0.288	0.0637	1.14	34.1	1.74	0.0480	6.15
S	S-9/5/2000	0.106	0.104	0.462	**15.3**	**1.52**	0	0.376
T	T-4/25/2001	0.274	0.0893	0.254	1.57	0.0998	0.0820	1.61
T	T-9/5/2000	0.114	0.0986	0.528	**4.59**	**1.57**	0	1.44

Table 25
Comparison of PEL-Q Values for COPCs Not Included in the Predictive Model to Predicted Toxicity Using the Optimized Mean PEL-Q Model

Station	Sample	Arsenic PEL-Q	Cadmium PEL-Q	Chromium PEL-Q	Mercury PEL-Q	Total DDT PEL-Q	Total Chlordane PEL-Q	Optimized Mean PEL-Q
U	U-4/24/2001	0.248	0.0216	0.251	**1.06**	0.0453	0.0630	0.0814
U	U-9/6/2000	0.0748	0.0207	0.184	0.951	**1.39**	0	0.195
V	V-4/23/2001	0.288	0.169	0.461	**5.69**	**1.36**	0.0639	1.27
V	V-9/5/2000	0.104	0.152	0.581	**9.36**	**4.30**	0	1.23
Y	Y-4/26/2001	0.353	0.0401	0.263	0.317	0.401	0.0234	0.358
Y	Y-9/6/2000	0.764	0.361	0.399	1.18	0	0	6.91
EF001	EF001-1SC011-N	0.141	0.0691	0.180	**1.05**	0	0	0.81
PB003	PB003-1SC011-N	0.153	0.214	0.416	8.04	18.4	7.62	2.51
PB009	PB009-1SC011-N	0.0885	0.192	0.554	5.10	23.1	13.8	3.33
PB016	PB016-1SC011-N	0.0428	0.0743	0.186	2.56	12.2	10.4	2.37
PB018	PB018-1SC011-N	0.0894	0.123	0.611	20.6	44.0	35.9	19.60
PB022	PB022-1SC011-N	0.119	0.245	1.01	10.7	32.1	19.2	3.44
PB030	PB030-1SC011-N	0.0728	0.0430	0.188	0.471	**23.1**	0	0.87
PB036	PB036-1SC011-N	0.135	0.314	3.01	231	48.2	31.1	8.83
PB042	PB042-1SC011-N	0.0954	0.170	0.888	3.60	430	0	11.70
PB048	PB048-1SC011-N	0.134	0.347	1.58	10.6	271	0.0	3.95
PB057	PB057-1SC011-N	0.0990	0.125	0.337	1.90	0	169	34.00
PB063	PB063-1SC011-N	0.0798	0.0577	0.279	0.231	0	0	0.90
PB073	PB073-1SC011-N	0.238	0.0758	0.138	0.816	0	80.2	8.07

Notes:
Bold text indicates COPCs that exceed their respective PEL, but no toxicity based on the optimized mean PEL-Q is predicted.
Stippled cells indicate sample locations within the gunnite-lined channel portion of the Site.
Shaded cells indentify optimized mean PEL-Q values exceeding the predicted effects threshold of 1.56.
PEQ-Q - probable effect level quotient

Table 26

Comparison of COPCs Without SQGs to Predicted Toxicity Using the Optimized Mean PEL-Q Model

			Ammonia		Barium		Aldrin		Endrin		Methoxychlor		Hexachlorobutadiene	
		Site Wide Average-->	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x
Location	Sample ID	Optimized Mean PEL-Q	138000	Average	834000	Average	50.0	Average	14.0	Average	72.5	Average	6860	Average
2.5	2.5-4/23/2001	1.68			270000	FALSE							27200	FALSE
2.5	2.5-9/5/2000	1.06			280000	FALSE							18000	FALSE
3	3-4/24/2001	13.4			826000	FALSE							459	FALSE
3	3-8/12/2003	2.27			137000	FALSE							7260	FALSE
3	3-9/6/2000	2.35			326000	FALSE							5580	FALSE
4A	4A-4/24/2001	4.70			366000	FALSE							339	FALSE
4A	4A-8/12/2003	1.45	134000	FALSE	240000	FALSE							391.3	FALSE
4A	4A-9/5/2000	0.836			325000	FALSE							882	FALSE
5	5-4/24/2001	2.80			484000	FALSE							233	FALSE
5	5-9/5/2000	1.65			414000	FALSE							606	FALSE
6A	6A-4/25/2001	1.29			696000	FALSE							0	FALSE
6A	6A-8/12/2003	46.2	362000	FALSE	274000	FALSE							0	FALSE
6A	6A-9/5/2000	2.70			779000	FALSE							0	FALSE
7	7-4/26/2001	3.15			397000	FALSE							0	FALSE
7	7-8/12/2003	14.9	17500	FALSE	150000	FALSE							0	FALSE
7	7-9/6/2000	13.5			386000	FALSE							0	FALSE
E	E-4/23/2001	3.11			334000	FALSE							8910	FALSE
E	E-9/6/2000	0.857			241000	FALSE							17800	FALSE
G	**G-4/24/2001**	**0.570**			277000	FALSE							548	FALSE
G	G-9/6/2000	0.905			265000	FALSE							0	FALSE
Q	Q-4/25/2001	3.22			429000	FALSE							0	FALSE
Q	Q-9/5/2000	5.71			447000	FALSE							0	FALSE
R	R-4/26/2001	0.695			238000	FALSE							55.7	FALSE
R	R-8/12/2003	0.634	39700	FALSE	168000	FALSE							0	FALSE
R	R-9/5/2000	1.07			307000	FALSE							0	FALSE
S	S-4/24/2001	6.14			522000	FALSE							14800	FALSE
S	S-9/5/2000	0.376			329000	FALSE							5990	FALSE
T	T-4/25/2001	1.61			318000	FALSE							89.7	FALSE
T	T-9/5/2000	1.44			383000	FALSE							0	FALSE
U	U-4/24/2001	0.0814			334000	FALSE							57.8	FALSE
U	U-9/6/2000	0.195			257000	FALSE							773	FALSE
V	V-4/23/2001	1.27			365000	FALSE							23300	FALSE
V	V-9/5/2000	1.23			373000	FALSE							16100	FALSE
Y	Y-4/26/2001	0.358			445000	FALSE							0	FALSE
Y	Y-9/6/2000	6.91			23500000	**TRUE**							0	FALSE
EF001	EF001-1SC011-N	0.807			118000	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB003	PB003-1SC011-N	2.51			337000	FALSE	0	FALSE	0	FALSE	0	FALSE	6200	FALSE
PB009	PB009-1SC011-N	3.33			176000	FALSE	50	FALSE	0	FALSE	0	FALSE	15000	FALSE
PB016	PB016-1SC011-N	2.37			110000	FALSE	0	FALSE	14	FALSE	0	FALSE	7000	FALSE
PB018	PB018-1SC011-N	19.6			326000	FALSE	0	FALSE	0	FALSE	0	FALSE	17000	FALSE
PB022	PB022-1SC011-N	3.44			293000	FALSE	0	FALSE	0	FALSE	0	FALSE	7300	FALSE
PB030	PB030-1SC011-N	0.865			147000	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB036	PB036-1SC011-N	8.83			472000	FALSE	0	FALSE	0	FALSE	25	FALSE	3200	FALSE
PB042	PB042-1SC011-N	11.7			285000	FALSE	0	FALSE	0	FALSE	0	FALSE	370	FALSE
PB048	PB048-1SC011-N	3.95			270000	FALSE	0	FALSE	0	FALSE	0	FALSE	250	FALSE
PB057	PB057-1SC011-N	34.0			885000	FALSE	0	FALSE	0	FALSE	0	FALSE	110	FALSE
PB063	PB063-1SC011-N	0.903			77200	FALSE	0	FALSE	0	FALSE	120	FALSE	0	FALSE
PB073	PB073-1SC011-N	8.07			634000	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE

Note:

Bold text indicates results that exceed 10 times the Site-wide average.

Table 26

Comparison of COPCs Without SQGs to Predicted Toxicity Using the Optimized Mean PEL-Q Model

			Benzidine		bis(2-Chloroisopropyl)ether		Di-n-octylphthalate		Hexachlorobenzene		Total xylene		4-Isopropyltoluene	
		Site Wide Average-->	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x
Location	Sample ID	Optimized Mean PEL-Q	423	Average	449	Average	60.3	Average	8740	Average	738	Average	124	Average
2.5	2.5-4/23/2001	1.68	0	FALSE	0.257	FALSE	48.7	FALSE	31500	FALSE			0	FALSE
2.5	2.5-9/5/2000	1.06	0	FALSE	0	FALSE	0	FALSE	16100	FALSE			0	FALSE
3	3-4/24/2001	13.4	1040	FALSE	83.4	FALSE	37.3	FALSE	683	FALSE			255	FALSE
3	3-8/12/2003	2.27	0	FALSE	0	FALSE	0	FALSE	2104	FALSE				FALSE
3	3-9/6/2000	2.35	0	FALSE	65.5	FALSE	0	FALSE	2440	FALSE			0	FALSE
4A	4A-4/24/2001	4.70	0	FALSE	741	FALSE	51.2	FALSE	150	FALSE			0	FALSE
4A	4A-8/12/2003	1.45	0	FALSE	0	FALSE	0	FALSE	475.7	FALSE				FALSE
4A	4A-9/5/2000	0.836	0	FALSE	25.2	FALSE	44.5	FALSE	295	FALSE			0	FALSE
5	5-4/24/2001	2.80	870	FALSE	3320	FALSE	160	FALSE	2280	FALSE			0	FALSE
5	5-9/5/2000	1.65	0	FALSE	98.6	FALSE	62.1	FALSE	232	FALSE			0	FALSE
6A	6A-4/25/2001	1.29	0	FALSE	1970	FALSE	35.3	FALSE	0	FALSE			0	FALSE
6A	6A-8/12/2003	46.2	0	FALSE	0	FALSE	19.8	FALSE	41.9	FALSE				FALSE
6A	6A-9/5/2000	2.70	128	FALSE	420	FALSE	57.9	FALSE	0	FALSE			0	FALSE
7	7-4/26/2001	3.15	503	FALSE	410	FALSE	26.6	FALSE	0	FALSE			0	FALSE
7	7-8/12/2003	14.9	0	FALSE	0	FALSE	0	FALSE	0	FALSE				FALSE
7	7-9/6/2000	13.5	484	FALSE	0	FALSE	106	FALSE	0	FALSE			0	FALSE
E	E-4/23/2001	3.11	263	FALSE	12.4	FALSE	89.4	FALSE	4520	FALSE			20.3	FALSE
E	E-9/6/2000	0.857	0	FALSE	0	FALSE	32.5	FALSE	20400	FALSE			0	FALSE
G	**G-4/24/2001**	**0.570**	213	FALSE	32	FALSE	63.5	FALSE	129000	**TRUE**			0	FALSE
G	G-9/6/2000	0.905	0	FALSE	0	FALSE	53.5	FALSE	1480	FALSE			0	FALSE
Q	Q-4/25/2001	3.22	353	FALSE	452	FALSE	295	FALSE	47	FALSE			0	FALSE
Q	Q-9/5/2000	5.71	0	FALSE	193	FALSE	0	FALSE	0	FALSE			0	FALSE
R	R-4/26/2001	0.695	776	FALSE	417	FALSE	15.3	FALSE	39.9	FALSE			0	FALSE
R	R-8/12/2003	0.634	0	FALSE	0	FALSE	0	FALSE	0	FALSE				FALSE
R	R-9/5/2000	1.07	0	FALSE	0	FALSE	28.1	FALSE	0	FALSE			0	FALSE
S	S-4/24/2001	6.14	444	FALSE	762	FALSE	22.2	FALSE	6570	FALSE			0	FALSE
S	S-9/5/2000	0.376	0	FALSE	0	FALSE	19.9	FALSE	3400	FALSE			0	FALSE
T	T-4/25/2001	1.61	119	FALSE	310	FALSE	83.4	FALSE	75.8	FALSE			0	FALSE
T	T-9/5/2000	1.44	143	FALSE	49.2	FALSE	46.1	FALSE	0	FALSE			0	FALSE
U	U-4/24/2001	0.0814	0	FALSE	0	FALSE	0	FALSE	13.8	FALSE			0	FALSE
U	U-9/6/2000	0.195	0	FALSE	0	FALSE	21.9	FALSE	1030	FALSE			0	FALSE
V	V-4/23/2001	1.27	0	FALSE	12.8	FALSE	49.7	FALSE	8790	FALSE			0	FALSE
V	V-9/5/2000	1.23	161	FALSE	40.2	FALSE	78.5	FALSE	10400	FALSE			0	FALSE
Y	Y-4/26/2001	0.358	0	FALSE	9.16	FALSE	19	FALSE	151	FALSE			0	FALSE
Y	Y-9/6/2000	6.91	0	FALSE	0	FALSE	0	FALSE	0	FALSE			0	FALSE
EF001	EF001-1SC011-N	0.807	0	FALSE	0	FALSE			0	FALSE	0.49	FALSE	0	FALSE
PB003	PB003-1SC011-N	2.51	0	FALSE	0	FALSE			1600	FALSE	9.4	FALSE	2.8	FALSE
PB009	PB009-1SC011-N	3.33	0	FALSE	0	FALSE			3300	FALSE	2.2	FALSE	0	FALSE
PB016	PB016-1SC011-N	2.37	0	FALSE	0	FALSE			30000	FALSE	0	FALSE	0	FALSE
PB018	PB018-1SC011-N	19.6	0	FALSE	0	FALSE			18000	FALSE	0	FALSE	0	FALSE
PB022	PB022-1SC011-N	3.44	0	FALSE	0	FALSE			1300	FALSE	10.3	FALSE	0	FALSE
PB030	PB030-1SC011-N	0.865	0	FALSE	0	FALSE			0	FALSE	11.2	FALSE	0	FALSE
PB036	PB036-1SC011-N	8.83	0	FALSE	0	FALSE			320	FALSE	4700	FALSE	410	FALSE
PB042	PB042-1SC011-N	11.7	0	FALSE	0	FALSE			300	FALSE	4.69	FALSE	0	FALSE
PB048	PB048-1SC011-N	3.95	0	FALSE	0	FALSE			66	FALSE	28	FALSE	24	FALSE
PB057	PB057-1SC011-N	34.0	0	FALSE	0	FALSE			88	FALSE	2600	FALSE	150	FALSE
PB063	PB063-1SC011-N	0.903	0	FALSE	0	FALSE			0	FALSE	0	FALSE	0	FALSE
PB073	PB073-1SC011-N	8.07	0	FALSE	0	FALSE			0	FALSE	8.9	FALSE	4.8	FALSE

Note:

Bold text indicates results that exceed 10 times the Site-wide average.

Table 26

Comparison of COPCs Without SQGs to Predicted Toxicity Using the Optimized Mean PEL-Q Model

			Isopropylbenzene		n-Butylbenzene		n-Propylbenzene		sec-Butylbenzene		tert-Butylbenzene	
		Site Wide Average-->	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x	Result	Exceeds 10x
Location	Sample ID	Optimized Mean PEL-Q	7460	Average	516	Average	314	Average	164	Average	512	Average
2.5	2.5-4/23/2001	1.68	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
2.5	2.5-9/5/2000	1.06	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
3	3-4/24/2001	13.4	23100	FALSE	699	FALSE	470	FALSE	383	FALSE	1160	FALSE
3	3-8/12/2003	2.27										
3	3-9/6/2000	2.35	134	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
4A	4A-4/24/2001	4.70	1950	FALSE	0	FALSE	0	FALSE	0	FALSE	108	FALSE
4A	4A-8/12/2003	1.45										
4A	4A-9/5/2000	0.836	15	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
5	5-4/24/2001	2.80	2680	FALSE	0	FALSE	1400	FALSE	89.7	FALSE	0	FALSE
5	5-9/5/2000	1.65	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
6A	6A-4/25/2001	1.29	73.9	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
6A	6A-8/12/2003	46.2										
6A	6A-9/5/2000	2.70	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
7	7-4/26/2001	3.15	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
7	7-8/12/2003	14.9										
7	7-9/6/2000	13.5	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
E	E-4/23/2001	3.11	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
E	E-9/6/2000	0.857	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
G	**G-4/24/2001**	**0.570**	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
G	G-9/6/2000	0.905	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
Q	Q-4/25/2001	3.22	1290	FALSE	176	FALSE	180	FALSE	109	FALSE	0	FALSE
Q	Q-9/5/2000	5.71	22.9	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
R	R-4/26/2001	0.695	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
R	R-8/12/2003	0.634										
R	R-9/5/2000	1.07	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
S	S-4/24/2001	6.14	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
S	S-9/5/2000	0.376	17	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
T	T-4/25/2001	1.61	25.4	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
T	T-9/5/2000	1.44	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
U	U-4/24/2001	0.0814	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
U	U-9/6/2000	0.195	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
V	V-4/23/2001	1.27	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
V	V-9/5/2000	1.23	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
Y	Y-4/26/2001	0.358	0	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
Y	Y-9/6/2000	6.91	29000	FALSE	0	FALSE	66	FALSE	10	FALSE	40.9	FALSE
EF001	EF001-1SC011-N	0.807	2.3	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB003	PB003-1SC011-N	2.51	31	FALSE	0	FALSE	1.3	FALSE	1.2	FALSE	0.83	FALSE
PB009	PB009-1SC011-N	3.33	6.1	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB016	PB016-1SC011-N	2.37	0.88	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB018	PB018-1SC011-N	19.6	98	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB022	PB022-1SC011-N	3.44	250	FALSE	0	FALSE	6.9	FALSE	0	FALSE	19	FALSE
PB030	PB030-1SC011-N	0.865	450	FALSE	3.9	FALSE	7.8	FALSE	4.4	FALSE	25	FALSE
PB036	PB036-1SC011-N	8.83	85000	**TRUE**	1400	FALSE	1100	FALSE	690	FALSE	3000	FALSE
PB042	PB042-1SC011-N	11.7	290	FALSE	0	FALSE	15	FALSE	0	FALSE	21	FALSE
PB048	PB048-1SC011-N	3.95	2400	FALSE	0	FALSE	58	FALSE	34	FALSE	45	FALSE
PB057	PB057-1SC011-N	34.0	32000	FALSE	300	FALSE	460	FALSE	320	FALSE	1200	FALSE
PB063	PB063-1SC011-N	0.903	1.9	FALSE	0	FALSE	0	FALSE	0	FALSE	0	FALSE
PB073	PB073-1SC011-N	8.07	230	FALSE	0	FALSE	5.6	FALSE	3.6	FALSE	8.2	FALSE

Note:

Bold text indicates results that exceed 10 times the Site-wide average.

Table 27
Prey Group Classification for Wildlife Diets

Prey Class	General Size	Site Use	General Trophic Level	Example Species	Approximate Size Class (cm)
Fish					
1	Small	Sedentary	Low	Minnows, mollies, killifish	<15
2A	Small	Migratory	Low	Mullet, shad, anchovies, sunfish, menhaden, silverside	<15
2B	Small	Migratory	High	Spot, croaker	<15
Invertebrates					
1C	Small	Sedentary	Low	Polychaetes, aquatic insects	<2
1A	Small	Sedentary	Low	Clams, mussels, oysters	<7.5
1B	Small	Sedentary	Low	Fiddler crabs, hermit crabs, juvenile blue crabs	7.5
2A	Small	Migratory	Low	Shrimp	<12.5

Note:
Table adapted from Calcasieu BERA (CDM 2002).

Table 28
Exposure Variables for Wildlife Total Daily Intake Models

Parameter	Receptor Group: Receptor: Units	Piscivorous Birds Belted Kingfisher	Sediment-probing Birds Spotted Sandpiper	Carnivorous Birds Composite	Ominivorous Mammals Raccoon
BW	g	136 a	42.5 a	870 a	3,990 a
NFMR	kcal/day/kg BW	637 b	820 b	339 b	99.8 b
a	unitless	14.25 g	8.13 h	14.25 g	6.03 i
b	unitless	0.659 g	0.77 h	0.659 g	0.678 i
C_{fish}	mg/kg WW	chemical specific	NA	chemical specific	chemical specific
$C_{invertebrates}$	mg/kg WW	chemical specific	chemical specific	chemical specific	chemical specific
C_{plants}	mg/kg WW	NA	NA	NA	0
$C_{animals}$	mg/kg WW	NA	NA	NA	0
$C_{sediment}$	mg/kg DW	chemical specific	chemical specific	chemical specific	chemical specific
AE_{fish}	unitless	0.77 c	NA	0.77 c	0.91 c
$AE_{invertebrates}$	unitless	0.79 c	0.79 c	0.79 c	0.91 c
AE_{Plants}	unitless	NA	NA	NA	0.74 j
$AE_{Animals}$	unitless	NA	NA	0.78 r	0.84 k
GE_{fish}	kcal/kg	1200 c	NA	1200 c	1200 c
$GE_{invertebrates}$	kcal/kg	1070 c	1070 c	1070 c	1070 c
GE_{Plants}	kcal/kg	NA	NA	NA	1300 l
$GE_{Animals}$	kcal/kg	NA	NA	1700 m	1700 m
$ME_{Average}$	kcal/kg	915 n	845 n	1021 n	1103 n
P_{fish}	unitless	0.89 o	0 o	0.33 o	0.233 o
$P_{invertebrates}$	unitless	0.11 o	1 o	0.33 o	0.233 o
P_{plants}	unitless	0 o	0 o	0 o	0.3 o
$P_{animals}$	unitless	0 o	0 o	0.33 o	0.233 o
NIR_{Fish}	mg_{food}/kg_{BW}/day WW	0.620 p	0 p	0.109 p	0.021 p
$NIR_{Invertevrates}$	mg_{food}/kg_{BW}/day WW	0.077 p	0.970 p	0.109 p	0.021 p
NIR_{Plants}	mg_{food}/kg_{BW}/day WW	0 p	0 p	0 p	0.027 p
$NIR_{Animals}$	mg_{food}/kg_{BW}/day WW	0 p	0 p	0.109 p	0.021 p
NIR_{Total}	mg_{food}/kg_{BW}/day WW	0.696 q	0.970 q	0.331 q	0.090 q
FS	unitless	0 f	0.3 d	0.01 f	0.094 e
AUF	unitless	TBD s	TBD s	TBD s	TBD s

Notes:
a Average for adults, both sexes (see text for derivation)
b Derived using Equation 6-7 in text
c See AE and GE derivation worksheet
d USEPA 1993. Semi-palmated sandpiper value used as surrogate
e Based on empirical data (Beyer et al. 1994)
f Best professional judgment
g Power (b) and slope (a) terms for marine birds (Nagy 1999)
h Power (b) and slope (a) terms for Charadriiformes (Nagy 1999)
i Power (b) and slope (a) terms for omnivores (Nagy 1999)
j Average AE for mammals consuming plants (USEPA 1993)
TBD - To be determined
k Average for mammals consuming small birds & mammals (USEPA 1993)
l Average of terrestrial monocot grasses (USEPA 1993)
m Average of reported values for mice, voles, and rabbits (USEPA 1993)
n Derived using Equation 6-4 in text
o See text for derivation
p Derived using Equation 6-6 in text
q Derived using Equation 6-3 in text
r Average of birds of prey consuming birds and small mammals (USEPA 1993)
s See text for discussion
NA - not applicable

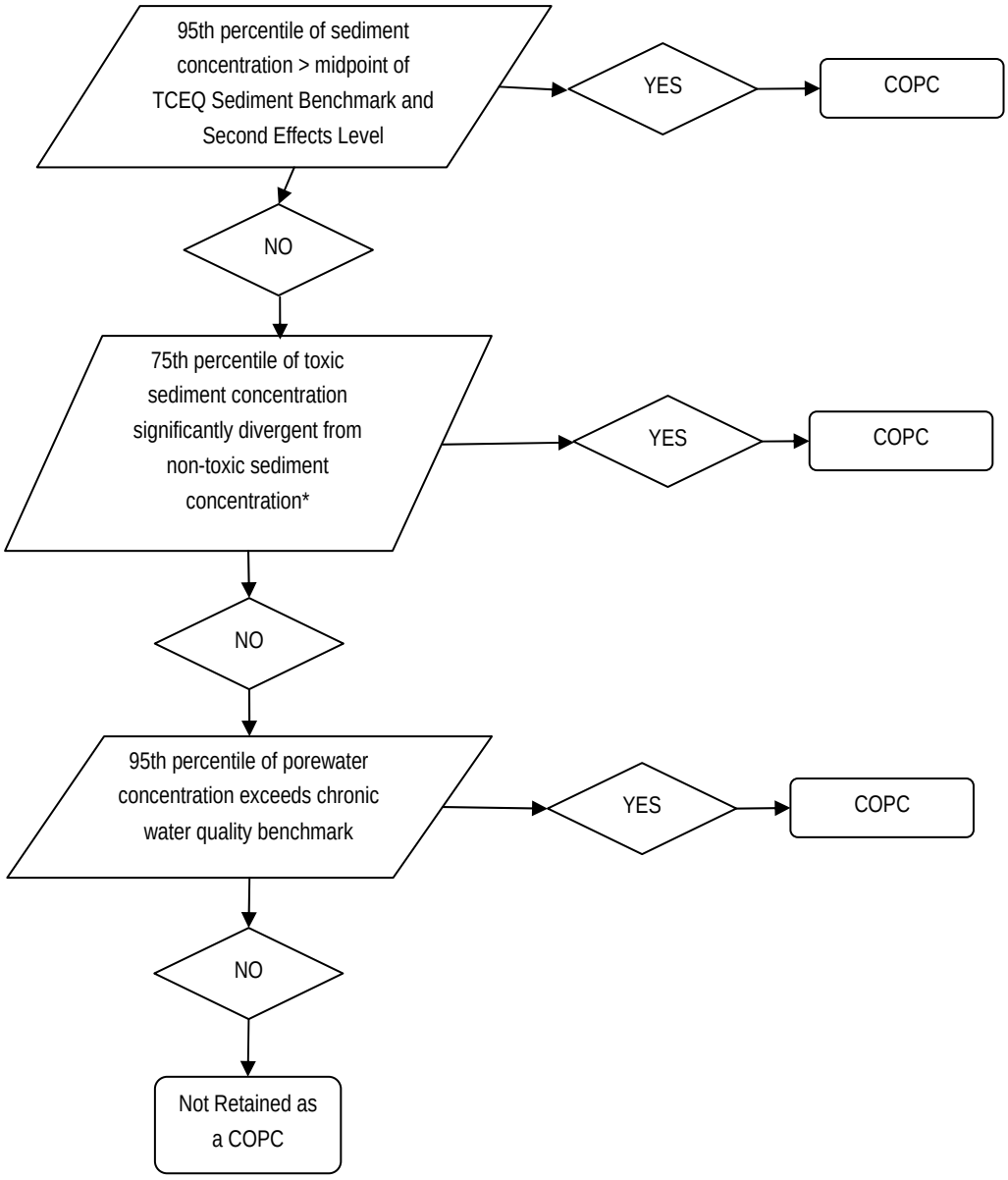
Table 29
Avian LOAEL TRVs

Chemical[a]	TRVs and Sources							
	Source	Test Species	LD50 to NOAEL	LOAEL to NOAEL	NOAEL (mg/kg-day)	LD50 to LOAEL	NOAEL to LOAEL	LOAEL (mg/kg-day)
Mercury	Sample et al (1996); methyl Hg	Mallard duck			0.0064			0.064
Total LPAH 16	Patton and Dieter (1980); Petroleum Hydrocarbon Mixtures	Mallard duck			8		5	40
PCB congeners	Sample et al (1996) as Aroclor 1242	Screech owl			0.41		5	2.05
Dioxin/furan congeners	Sample et al (1996); 2,3,7,8-TCDD	Ring-necked pheasant			0.000014			0.00014
Hexachlorobenzene	Vos et al (1971)	Japanese quail			0.67		5	3.35
Hexachlorobutadiene	ECOTOX (ref 35430) (USEPA 2007b)	Japanese quail			4		5	20
1,3-Dichlorobenzene	1,4-Dichlorobenzene used as surrogate	--	100		16.08	10		160.8
1,4-Dichlorobenzene	ECOTOX (ref 344) (USEPA 2007b)	Northern bobwhite	100		16.08	10		160.8

Table 30
Mammalian LOAEL TRVs

COPC	TRVs and Sources										
	Source	Test Species	Test Species Body Weight (BWt; kg)	Subchronic to Chronic	LOAEL to NOAEL	NOAEL (TRV; mg/kg-day)	Subchronic to Chronic	NOAEL to LOAEL	LOAEL (TRV; mg/kg-day)	Raccoon Body Weight (kg)	Raccoon LOAEL (mg/kgbw/day)
Mercury	Sample et al (1996); as methyl mercury	Mink	1	10		0.015	10		0.025	3.99	0.0177
PCB congeners	Sample et al (1996); as Aroclor 1248	Rhesus monkey	5		10	0.01			0.1	3.99	0.106
Dioxin/furan congeners	Sample et al (1996); 2,3,7,8-TCDD	Rat	0.35			0.000001			0.00001	3.99	0.00000544

FIGURES



* Significant divergence is defined as the 75th percentile concentration for the effects (toxic) distribution exceeding the 75th percentile concentration for the no effects distribution (non-toxic) by a factor of two.

ANCHOR QEA

Figure 1
Aquatic Receptor COPC Selection Process Flowchart
Draft Baseline Ecological Risk Assessment Work Plan
Patrick Bayou Superfund Site

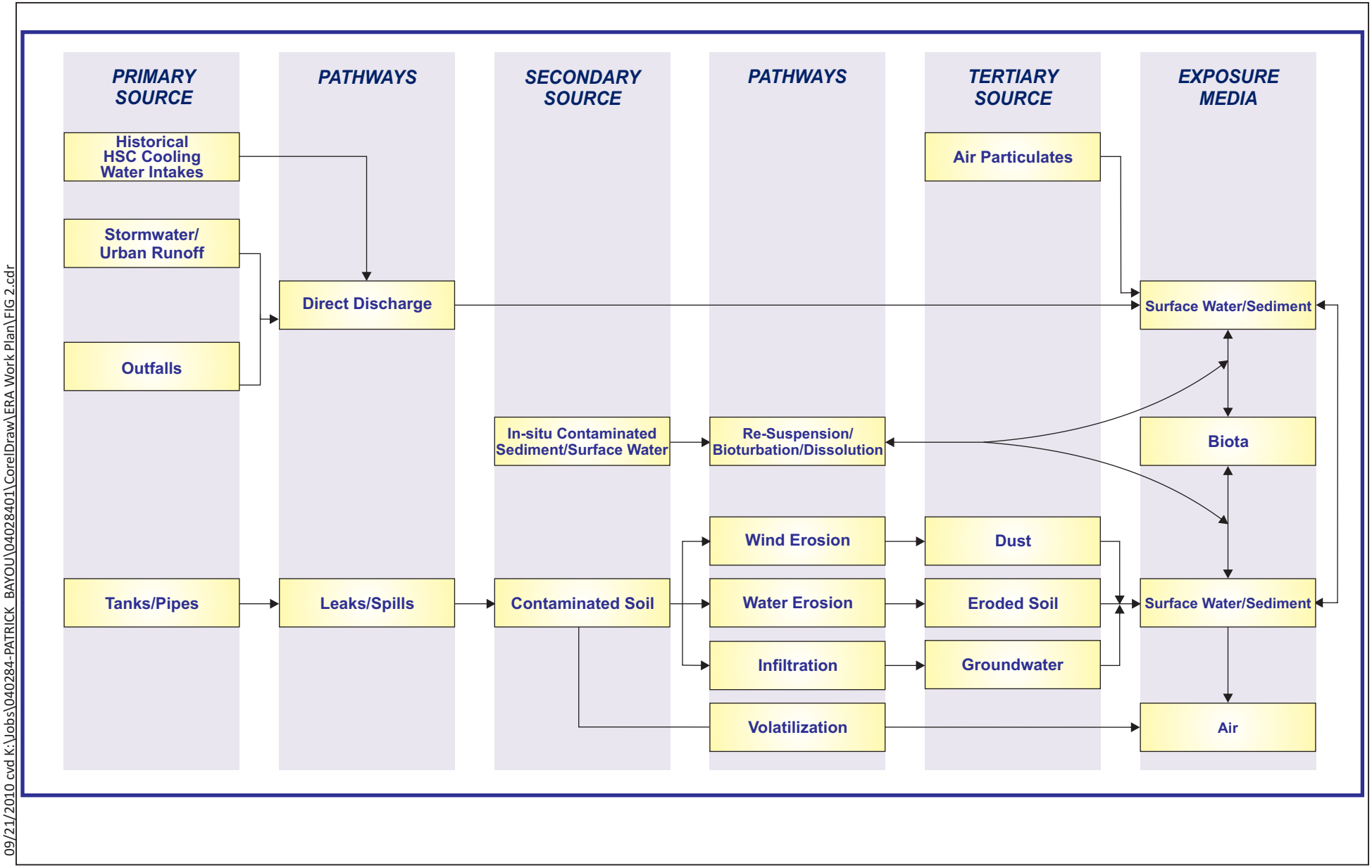


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Figure 2
Sources, Transport, and Media in Relation to Physical Features of the Site
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Exposure Media	Exposure Route	Plants	Aquatic Invertebrates	Fish	Amphibians & Reptiles	Birds				Mammals		Receptor Class
		Community				Piscivore	Carnivore	Omnivore	Sediment probing invertivore	Carnivore	Omnivore	Feeding Guild
						Belted Kingfisher	Composite	None[2]	Spotted Sandpiper	Mink and/or River Otter	Raccoon	Representative Species
Sediment & Pore water	Ingestion	na	●	●	□[1]	■	●	●	●	—	●	
	Direct Contact	□[1]	●	●	□[1]	□	□	□	□	—	□	
Surface Water	Ingestion	na	●	■	□[1]	■	■	■	■	—	■	
	Direct Contact	□[1]	●	●	□[1]	□	□	□	□	—	□	
Biota	Ingestion	na	●	●	□[1]	●	●	●	●	—	●	
Air	Inhalation	na	—	—	□[1]	■	■	■	■	—	■	

● Complete and major ■ Complete and minor □ Complete and uncertain — Incomplete na not applicable

1 Due to the lack of exposure and effects information for this receptor group, it will not be quantitatively assessed in the BERA
2 An omnivorous avian representative receptor was not selected; other avian feeding guilds are considered protective of this feeding guild

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Figure 3
Baseline Ecological Risk Assessment Conceptual Site Model
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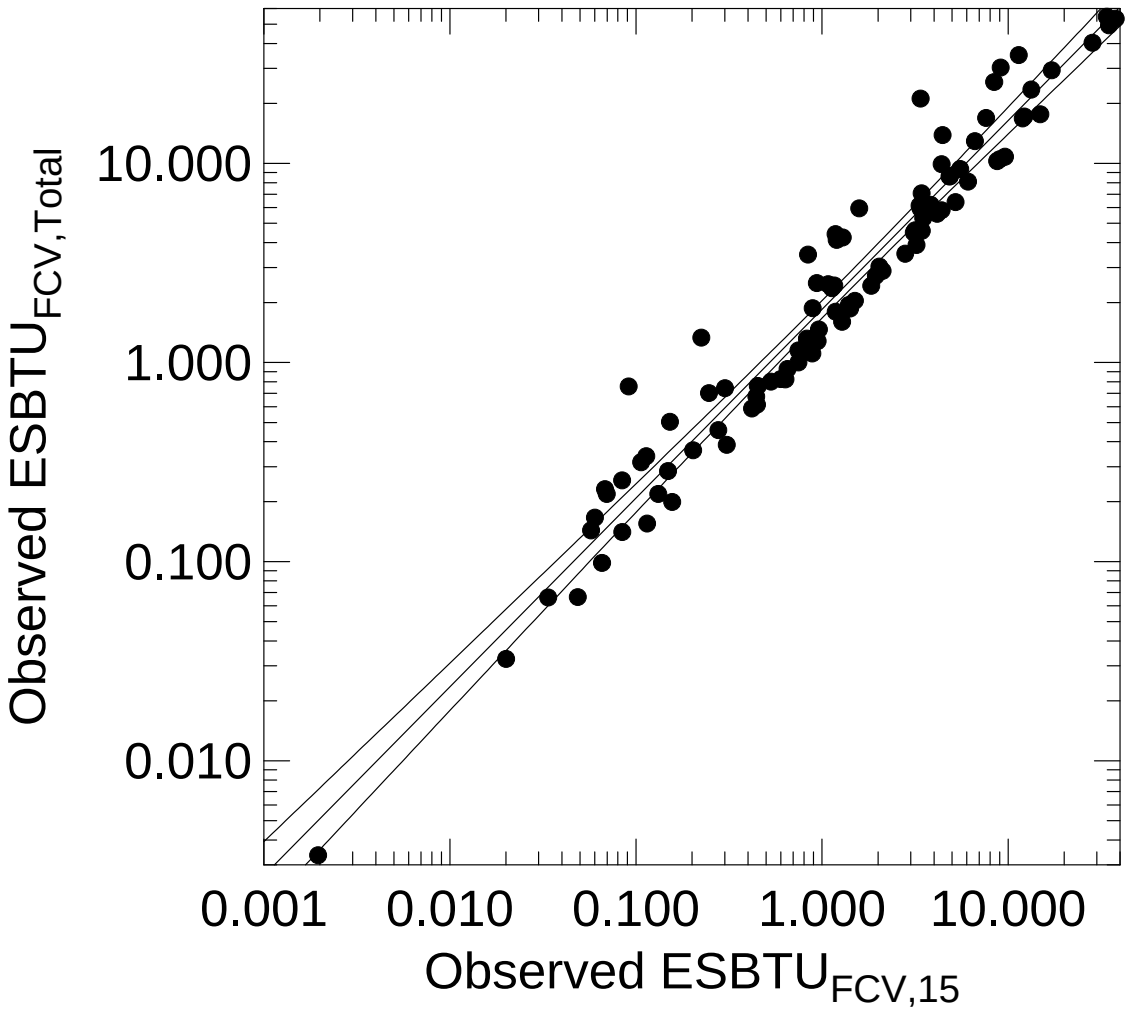

Figure 4
PAH ESBTU Site-Specific Scaling Factor for Samples with Less Than 34 PAH
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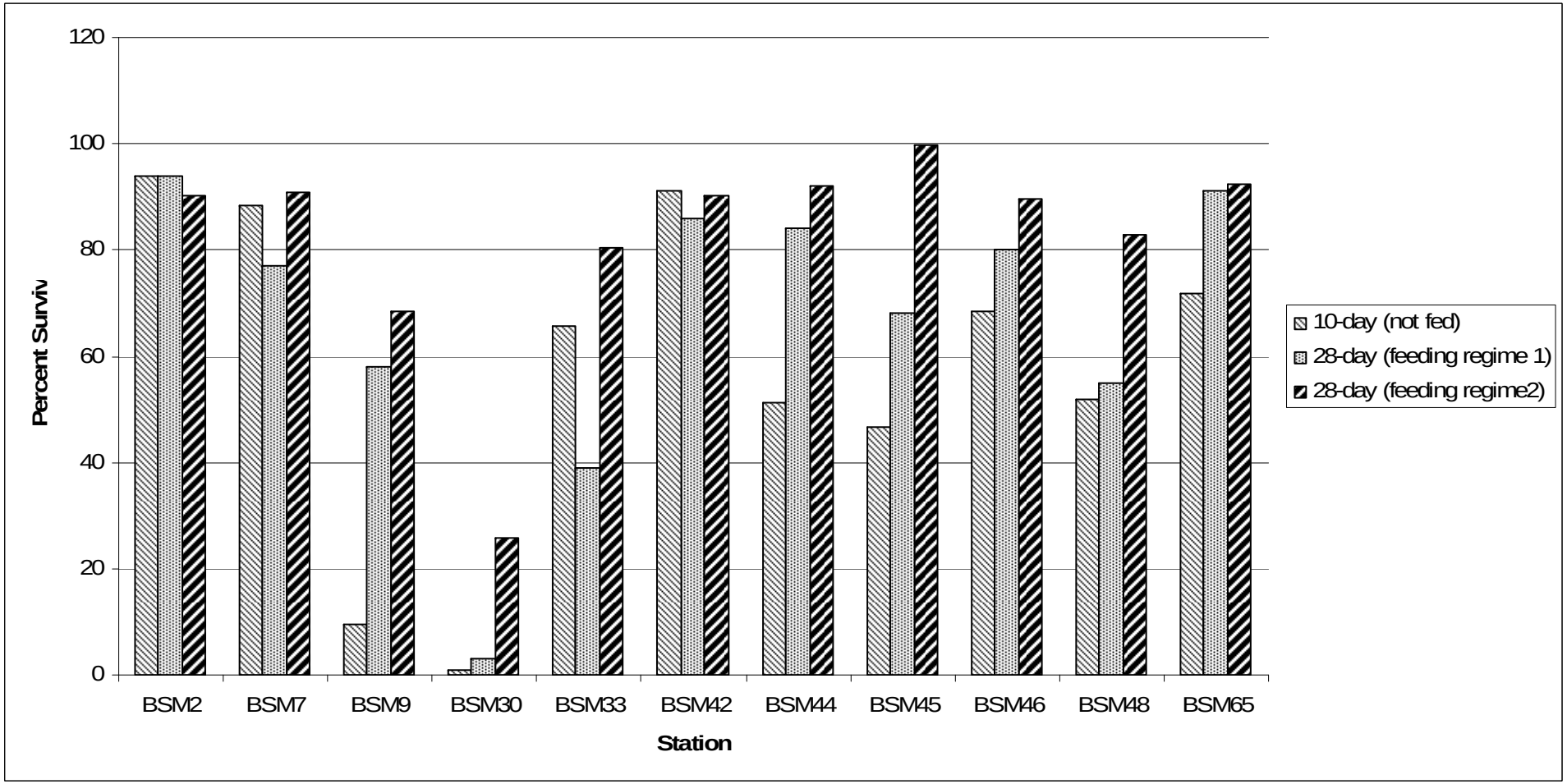

Figure 5
Comparison of Magnitude of Toxicity in 10-day and 28-day Bioassay Tests Evaluated by McGee et al. (2004)
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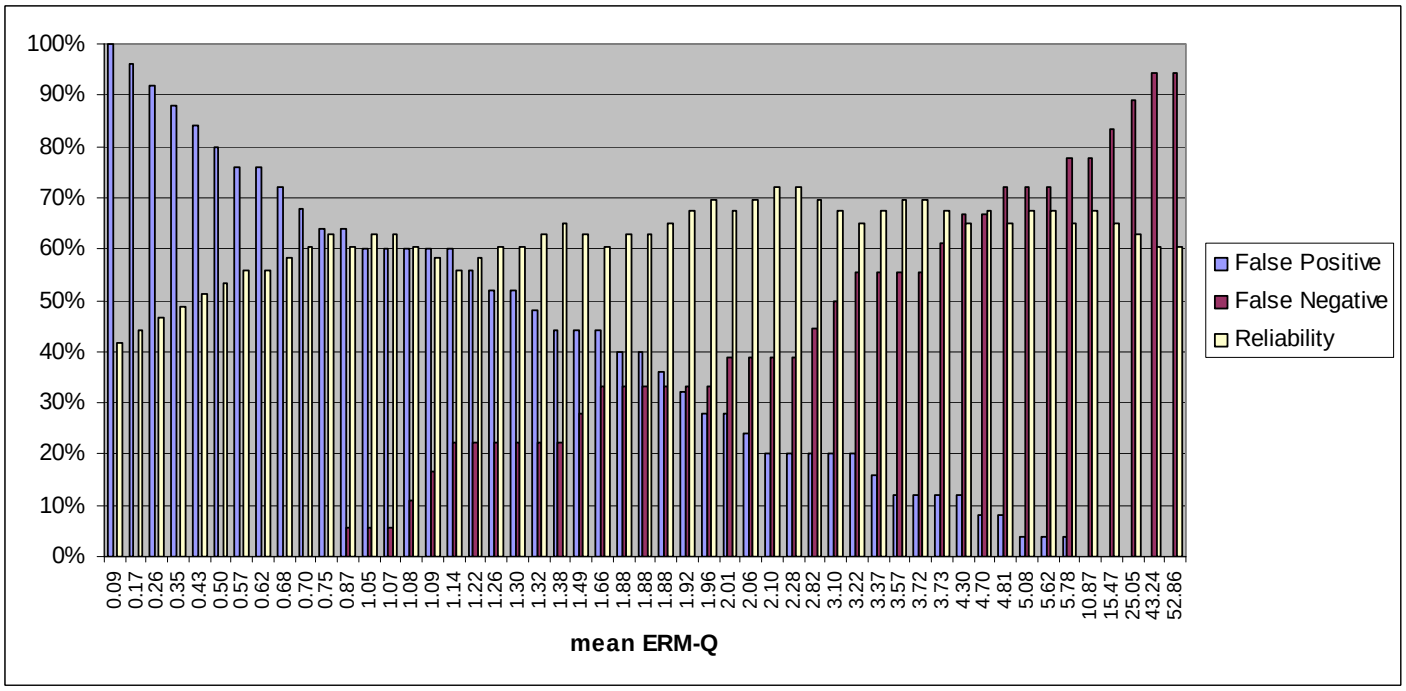

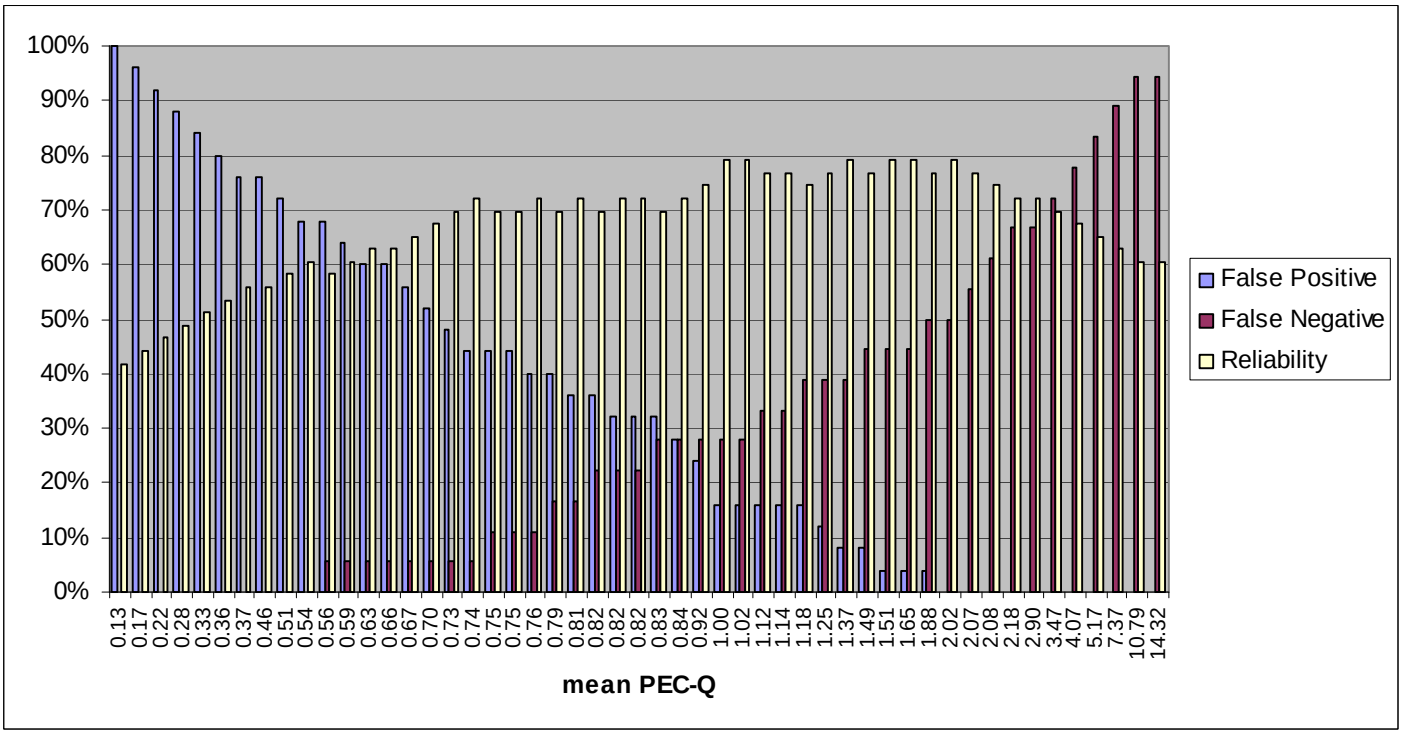

Figure 6a

Error Rates and Reliability of ERM-Q and PEC-Q Models Across a Range of Values

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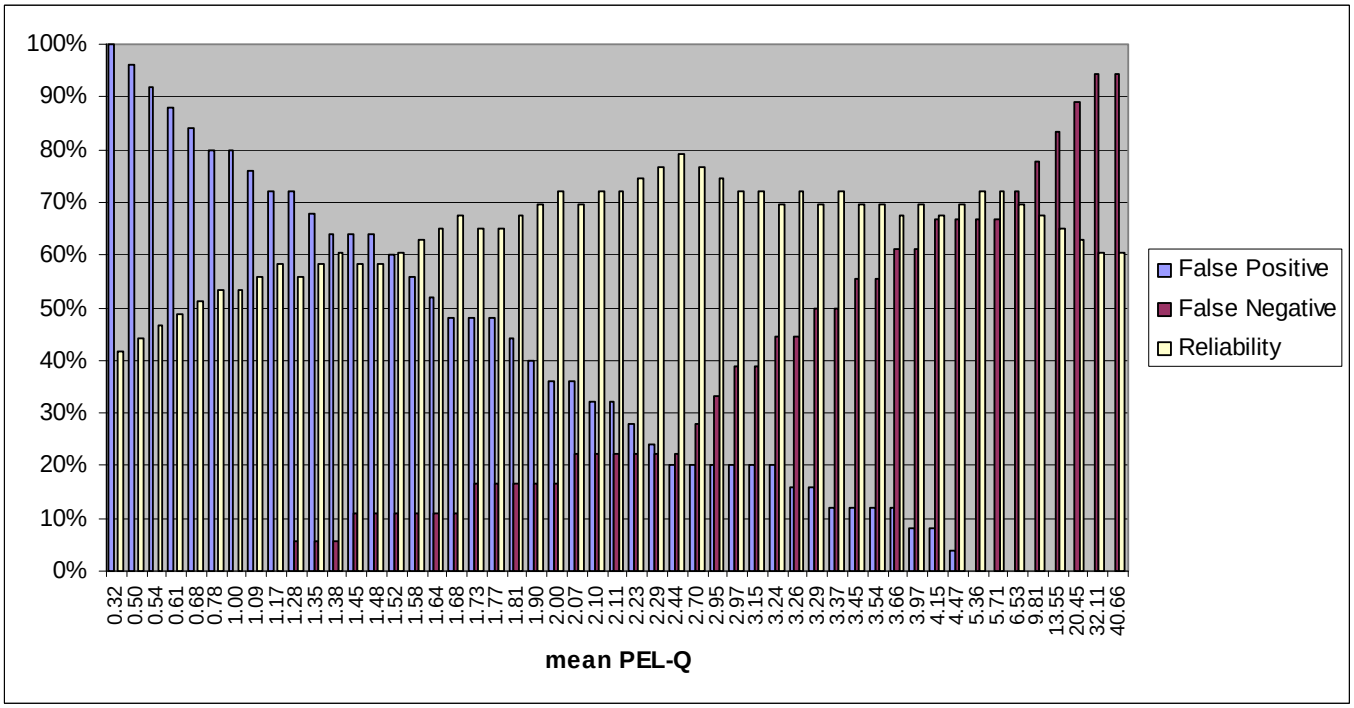


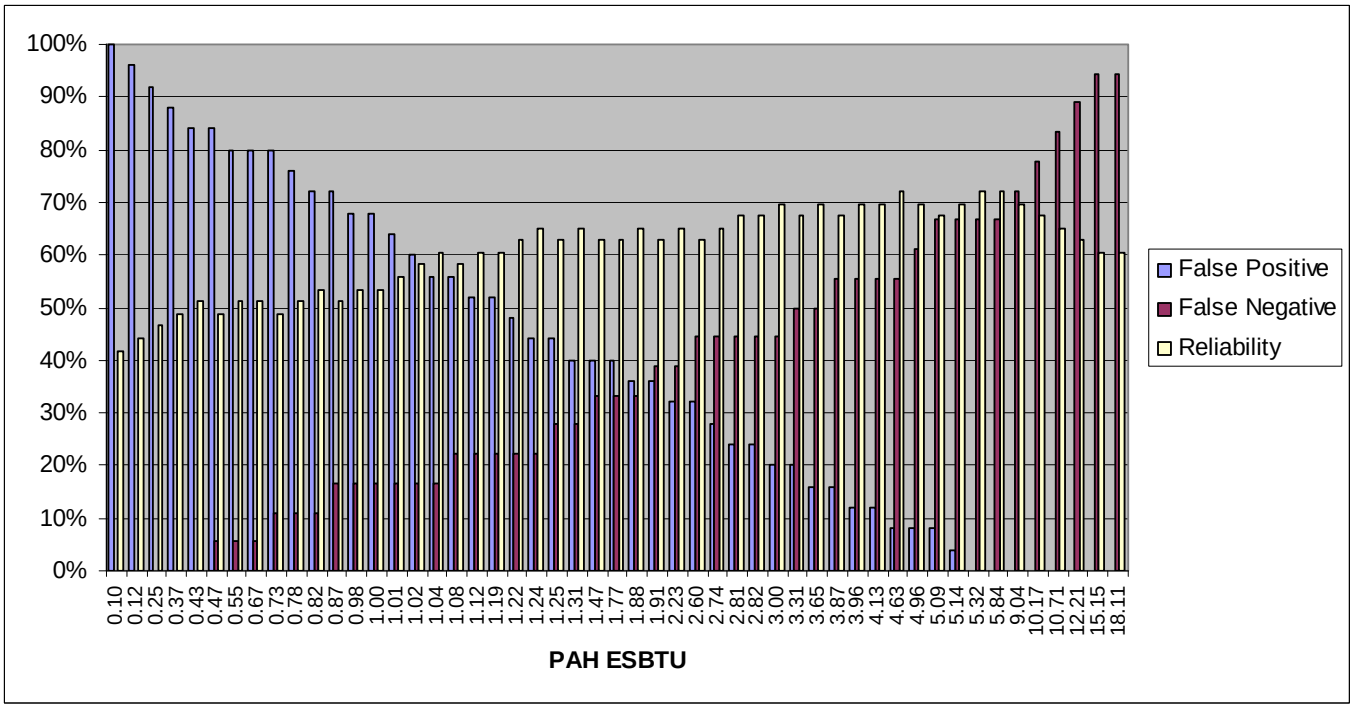
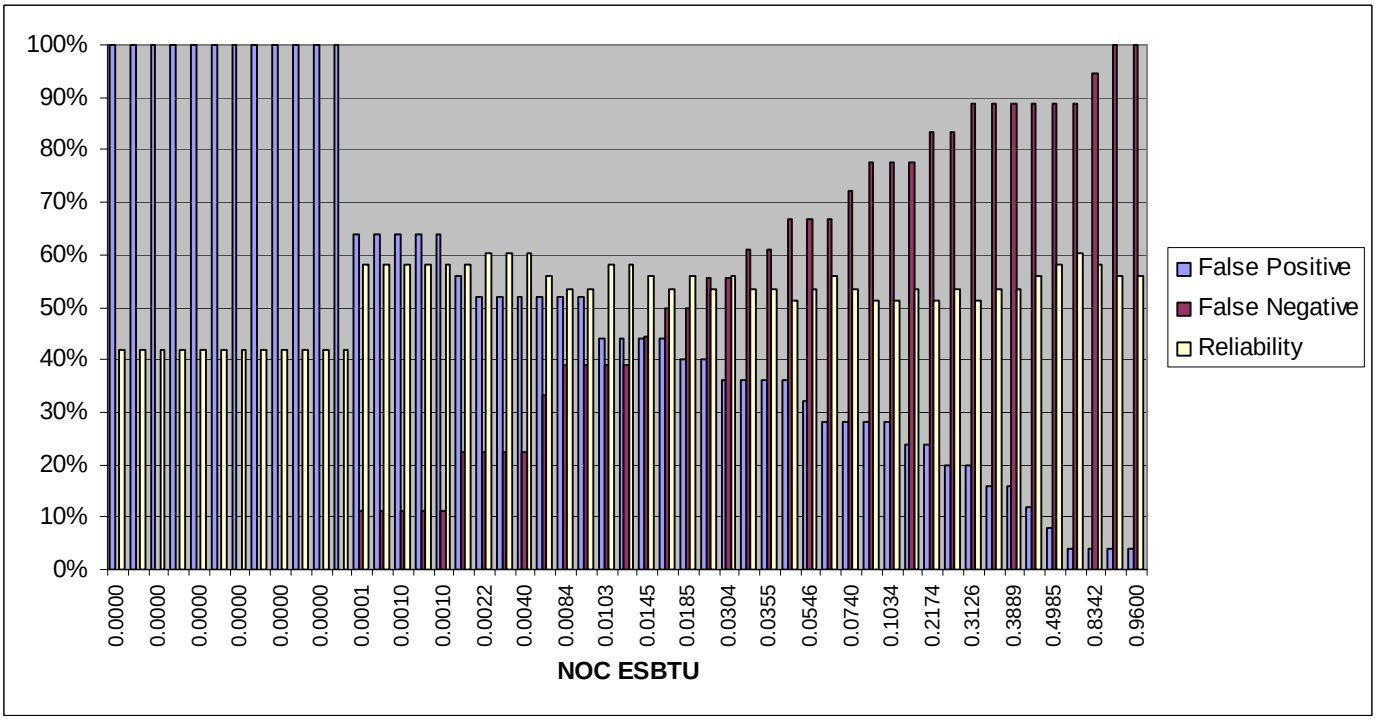


Figure 6b

Error Rates and Reliability of PEL-Q and PAH ESBTU Models Across a Range of Values



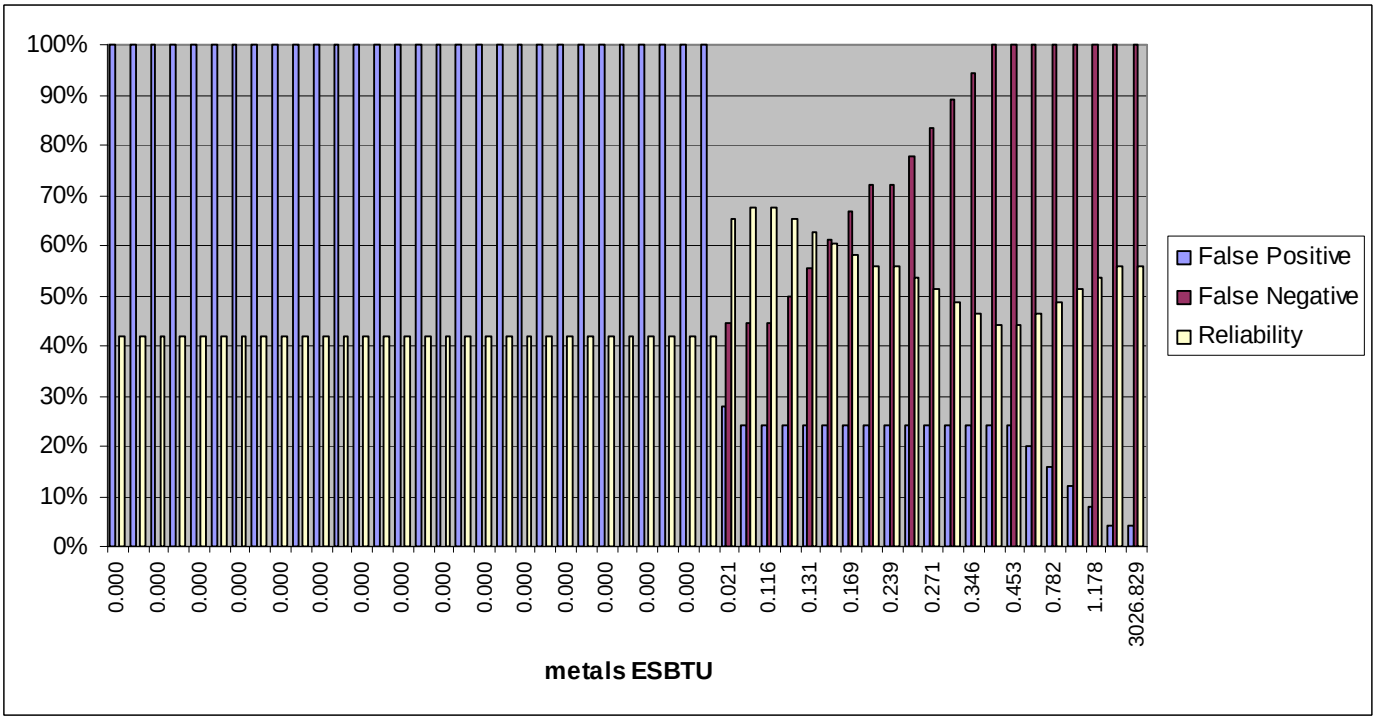


Figure 6c

Error Rates and Reliability of Two ESBTU Models Across a Range of Values

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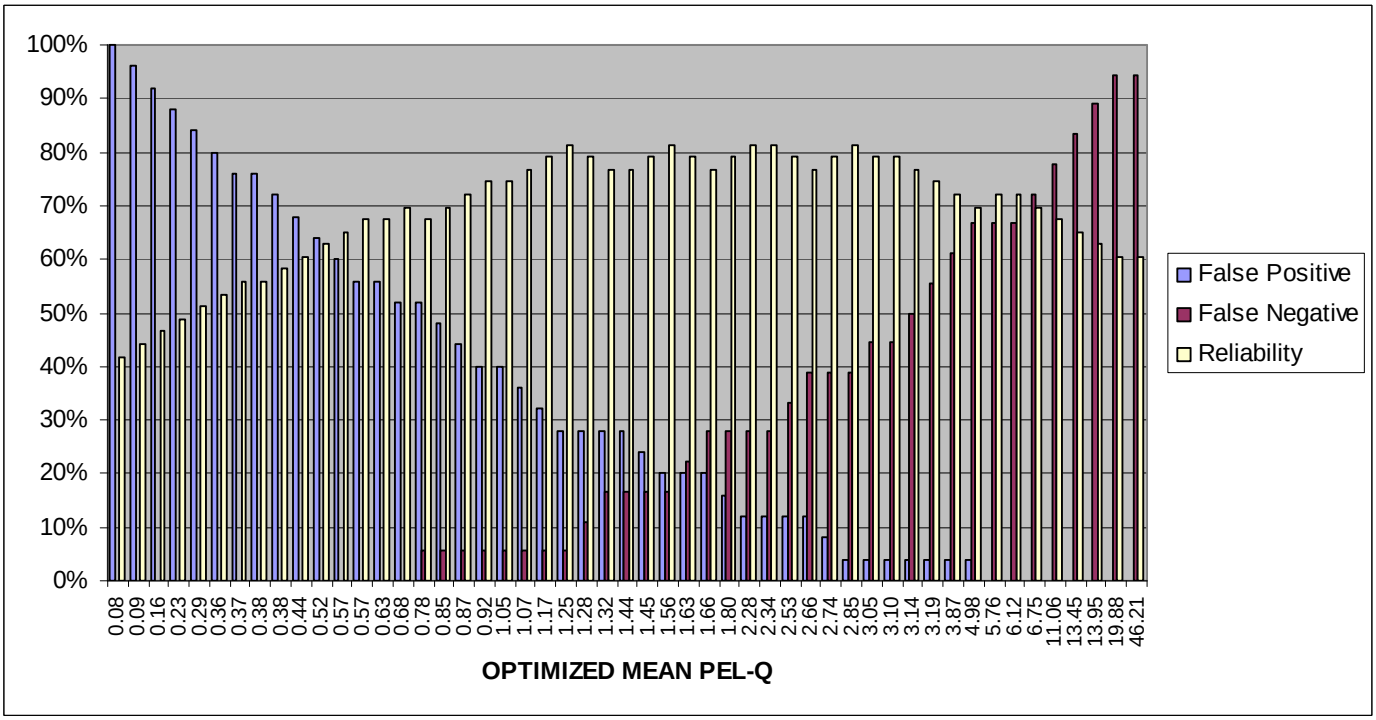

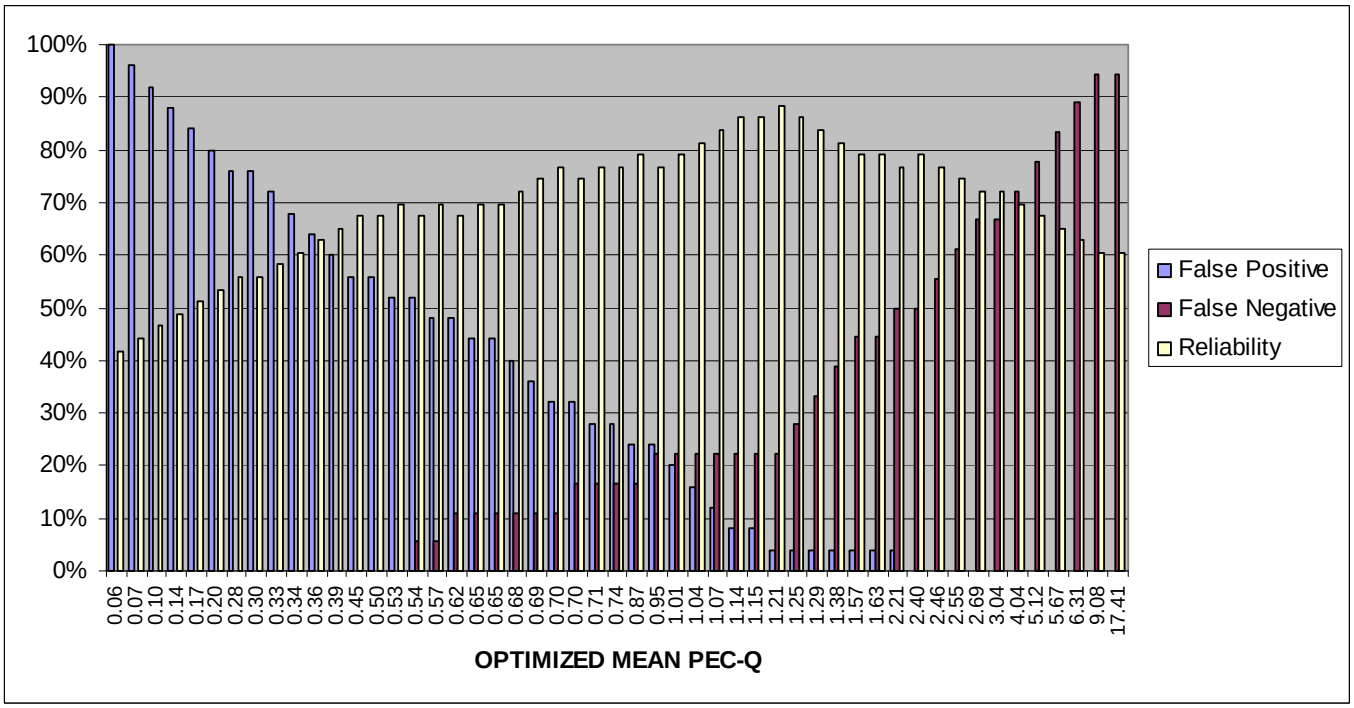

Figure 7

Error Rates and Reliability of the Optimized Mean PEL-Q and PEC-Q Models

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APPENDIX A
SUPPORTING INFORMATION FOR COPC REFINEMENT

SEMI-AQUATIC PISCIVOROUS MAMMAL HOME RANGE ANALYSIS

River Otter

Reported river otter home ranges were compiled from the literature (Table A-1). Data on reported home ranges for individuals were taken from two studies: Mel Quist and Honaker (1983) and Mack (1985). Box plots and normal probability plots were constructed to explore the distribution of reported home ranges (Figures A-1, A-2, and A-3). Differences in home range based on sex and location (i.e., study) were small relative to the range of reported individual home ranges. Although median values between males and females were similar (35 and 32 km, respectively; Table A-2), the variability was slightly higher for males, as described by the higher coefficient of variation (COV). Overall differences were not dramatic. Thus, data for males and females were pooled for purposes of identifying home ranges. Differences between studies were slightly greater than between sexes, but not dramatically so. Median home ranges between studies varied by less than 10 km. Again, data were pooled for determining home ranges.

Both graphical (box plots and probability plots) and statistical (Shapiro-Walk test, $p<0.05$) analyses indicate that home ranges for river otter follow a normal distribution. Thus, the range of home ranges for river otter that may use the Site is assumed to follow a normal distribution with a mean of 37 km and standard deviation of 18 km [i.e., N(37,18)]. Using this distribution, the potential upper and lower bound limits of the study area representing river otter home range can be determined. The 5th and 95th percentiles of the distribution were chosen as the lower and upper bound limits of the study area. The Excel function NORMINV (probability, mean, standard deviation) was used to estimate the 5th and 95th percentiles. Thus, the estimated home range for river otter is between 7.39 and 66.6 km.

Mink

Reported mink home ranges were compiled from the literature (Table A-3). Data on reported home ranges for individuals were taken from six different studies. Box plots and normal probability plots were constructed to explore the distribution of reported home ranges (Figures A-4, A-5, and BA6). Median values between males and females were different (4.9 and 2 km, respectively; Table A-4), the variability was the same for males and females, as described by the similar COV. Differences in home range based on sex were

significant (t-test, $p<0.05$). One study with a small sample size (Steevens et al. 1997; n=3) had relatively higher home ranges than reported in other studies; otherwise, home ranges were generally equivalent. Thus, data for males and females were not pooled for purposes of identifying home ranges. Data between studies were pooled by sex. The small study of Steevens et al. (1997) was included as it represented the closest study (geographically) to the study area and was considered relevant rather than an outlier.

Both graphical (box plots and probability plots) and statistical (Shapiro-Wilk test, $p<0.05$) analyses indicate that home ranges for female are best described by a lognormal distribution. Home ranges for male mink also followed a lognormal distribution. Thus, the range of home ranges for mink that may use the Site are assumed to follow a lognormal distribution with a mean of 2.2 km and standard deviation of 1.3 km for females and a mean and standard deviation of 4.5 and 2.3 km, respectively, for males. Using this distribution, the potential upper and lower bound limits of the study area representing mink home range can be determined. The 5th and 95th percentiles of the distributions were chosen as the lower- and upper bound limits of the study area. The Excel function LOGINV (probability, mean, standard deviation) was used to estimate the 5th and 95th percentiles. The upper bound estimate of home range for mink is 18.1 km and the lower bound is 1.11 km based on male mink. Although the lower-bound home range limit for females is greater than males, the range for female mink is smaller (1.39 to 3.51 km). Thus, the estimated home range for mink is between 1.11 and 18.1 km.

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Yamaguchi, N., and D. W. Macdonald, 2003. The burden of co-occupancy: intraspecific resource competition and spacing patterns in American mink, *Mustela vison*. Journal of Mammalogy 84:1341-1355

TABLES

Table A-1
River Otter Records Included in Home Range Estimates

Sex	Home Range (km)	River Otter Individual ID Reference	Study
Female	27	1	Melquist and Hornocker 1993
Female	26	35	Melquist and Hornocker 1993
Female	42	46	Melquist and Hornocker 1993
Female	42	35	Melquist and Hornocker 1993
Female	58	20	Melquist and Hornocker 1993
Female	44	38	Melquist and Hornocker 1993
Female	31	52	Melquist and Hornocker 1993
Female	38	10	Melquist and Hornocker 1993
Female	39	43	Melquist and Hornocker 1993
Female	35	50	Melquist and Hornocker 1993
Male	32	41	Melquist and Hornocker 1993
Male	10	32	Melquist and Hornocker 1993
Male	63	34	Melquist and Hornocker 1993
Male	81	37	Melquist and Hornocker 1993
Male	50	34	Melquist and Hornocker 1993
Male	33	32	Melquist and Hornocker 1993
Male	25	34	Melquist and Hornocker 1993
Male	21	M002	Mack 1985
Male	45	M019	Mack 1985
Female	71	F029	Mack 1985
Female	5	F035	Mack 1985
Female	29	F028	Mack 1985
Male	32	M311	Mack 1985
Male	49	M023	Mack 1985
Male	30	M031	Mack 1985
Male	57	M033	Mack 1985
Male	30	M038	Mack 1985
Male	11	M039	Mack 1985
Female	5	F006	Mack 1985
Female	35	F021	Mack 1985

Table A-2

Summary Statistics of River Otter Home Ranges Reported in the Literature

Statistic	Female	Male	Both Sexes
N of cases	15	15	30
Minimum	5	10	5
Maximum	71	81	81
Range	66	71	76
Median	35	32	34
Mean	35	38	37
Standard Deviation	17	20	18
Coefficient of Variation	0.48	0.52	0.49

Note:
Units in kilometers

Table A-3

Mink Records Included in Home Range Estimates

Sex	Home Range (km)	Mink Individual ID Reference	Study
Male	5.9	Male 1	Yamaguchi and Macdonald 2003
Male	8.6	Male 2	Yamaguchi and Macdonald 2003
Female	4.1	Female 1	Yamaguchi and Macdonald 2003
Female	4.3	Female 2	Yamaguchi and Macdonald 2003
Female	2	Female 4	Yamaguchi and Macdonald 2003
Female	0.8	Female 5	Yamaguchi and Macdonald 2003
Male	4.5	Male 3	Yamaguchi and Macdonald 2003
Male	5	Male 4	Yamaguchi and Macdonald 2003
Male	5.9	Male 5	Yamaguchi and Macdonald 2003
Female	4.3	Female 1	Yamaguchi and Macdonald 2003
Female	0.9	Female 3	Yamaguchi and Macdonald 2003
Female	2	Female 4	Yamaguchi and Macdonald 2003
Female	2	Female 6	Yamaguchi and Macdonald 2003
Female	3.8	Female 7	Yamaguchi and Macdonald 2003
Female	3.8	Female 8	Yamaguchi and Macdonald 2003
Male	5.857	M1	Stevens et al. 1997
Male	5.663	M3	Stevens et al. 1997
Male	11.038	M4	Stevens et al. 1997
Male	2.8	TM520	Linn and Birks 1997

Sex	Home Range (km)	Mink Individual ID Reference	Study
Male	5.94	TM525	Linn and Birks 1997
Male	4.8	TM536	Linn and Birks 1997
Female	2.85	TFRA	Linn and Birks 1997
Male	5.9	TM523	Linn and Birks 1997
Male	2.9	EM543	Linn and Birks 1997
Female	0.61	SF522	Linn and Birks 1997
Female	1.55	D	Dunstone and Birks
Female	1.8	E	Dunstone and Birks
Male	1.35	no IDs	Dunstone and Birks
Male	1.8	no IDs	Dunstone and Birks
Male	2.63	no IDs	Gerell 1970
Male	1.23	no IDs	Gerell 1970
Female	1.85	no IDs	Gerell 1970
Male	2.79	520	Birks and Linn 1982
Male	5.94	525	Birks and Linn 1982
Male	5.9	523	Birks and Linn 1982
Male	5.025	536	Birks and Linn 1982
Female	0.55	509	Birks and Linn 1982
Female	2.87	RA	Birks and Linn 1982
Female	1.46	522	Birks and Linn 1982
Male	1.9	505	Birks and Linn 1982
Male	2.9	543	Birks and Linn 1982
Male	2.9	543	Birks and Linn 1982
Female	0.5	547	Birks and Linn 1982

Table A-4

Summary Statistics of Mink Home Ranges Reported in the Literature

Statistic	Males	Females	Both sexes
N of cases	24	19	43
Minimum	1.23	0.5	0.5
Maximum	11.0	4.3	11.0
Range	9.8	3.8	10.5
Median	4.9	2	2.9
Mean	4.5	2.2	3.5
Standard Deviation	2.3	1.3	2.3
Coefficient of Variation	0.5	0.6	0.6

Note:
Units in kilometers

FIGURES

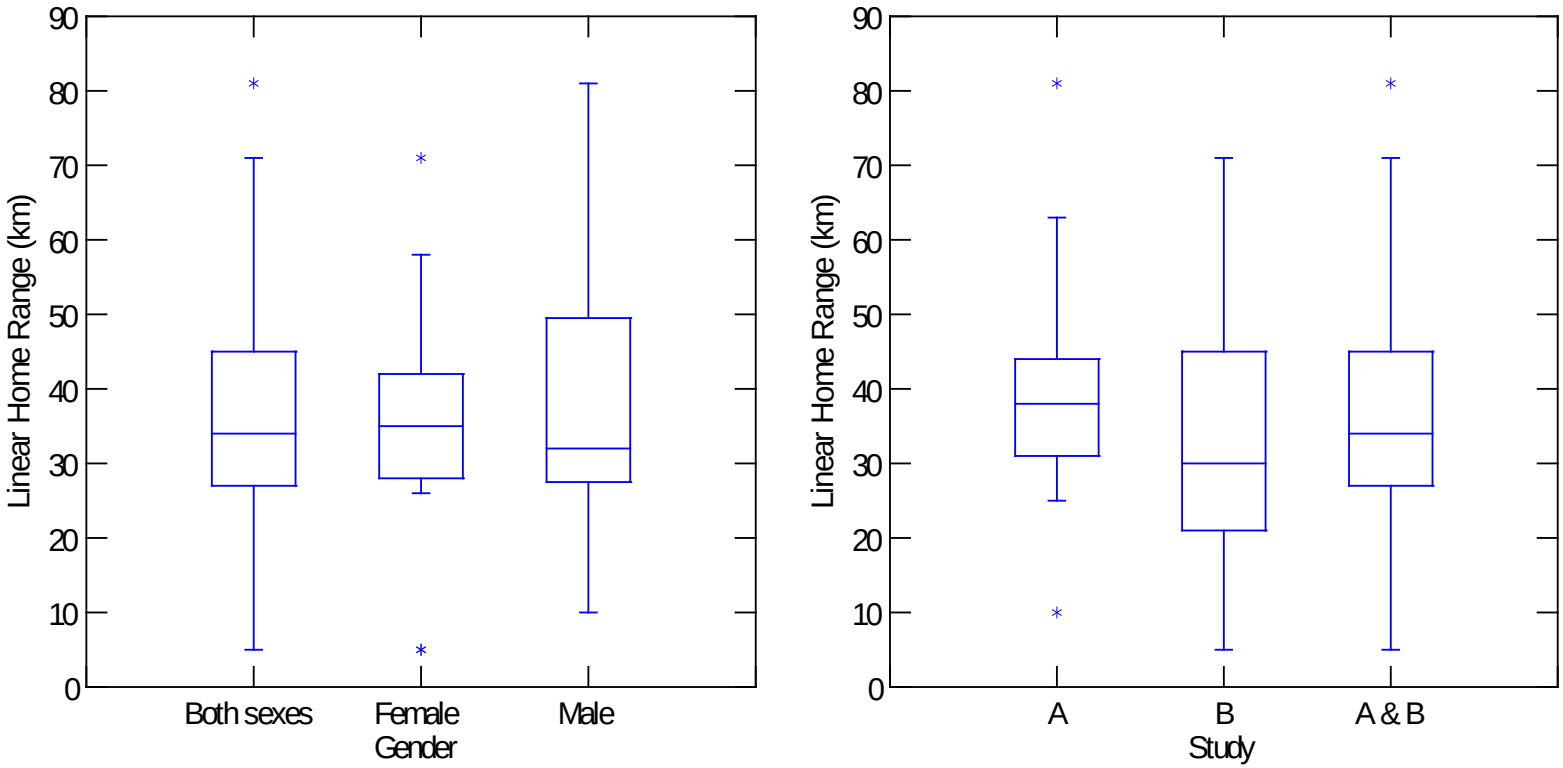

Figure A-1
Box Plots of Report Linear Home Range Data for River Otter by Gender and Location (i.e., Study)
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Patrick Bayou Superfund Site

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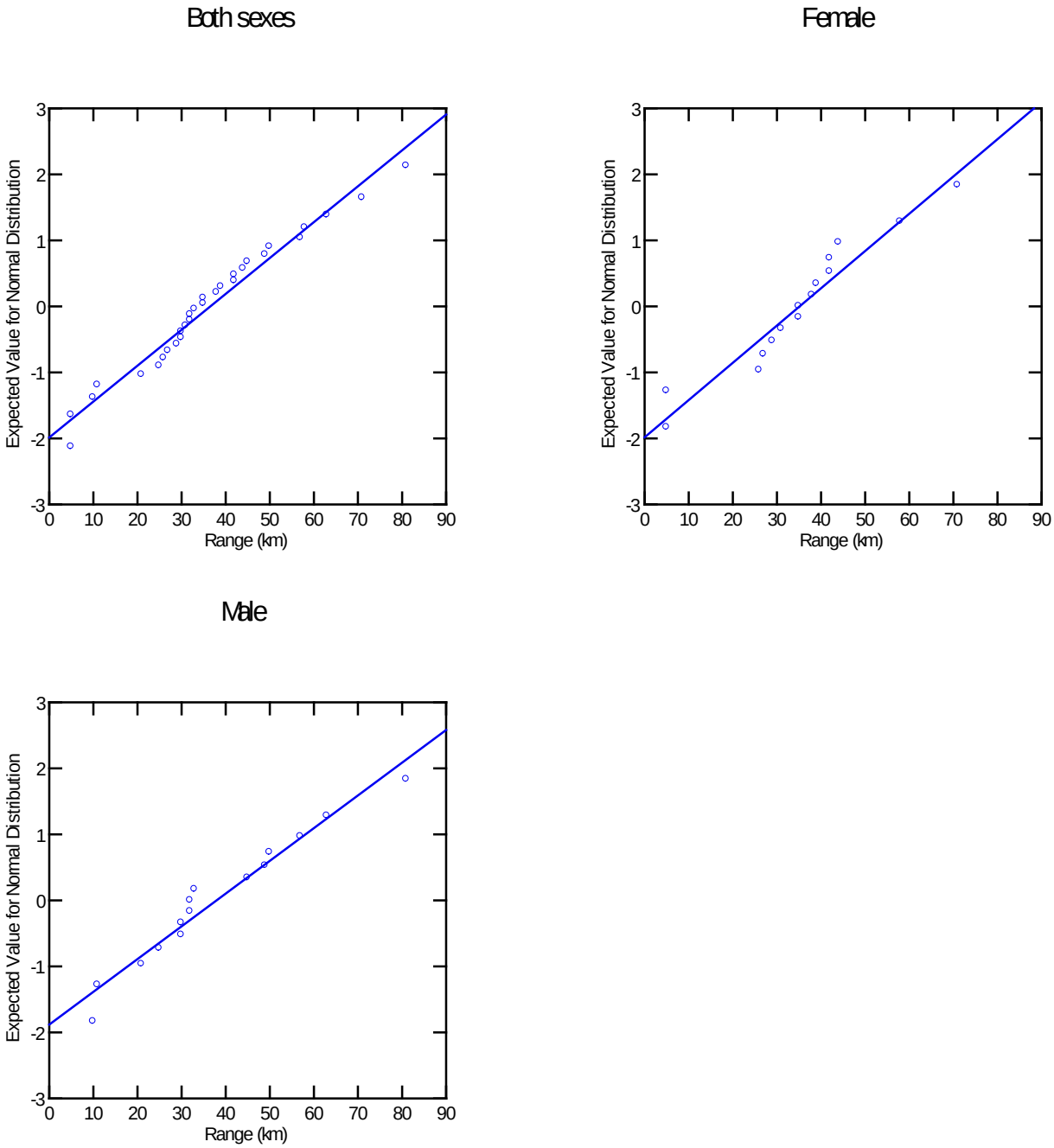

Figure A-2
Normal Probability Plots of River Otter Home Range by Gender
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Patrick Bayou Superfund Site

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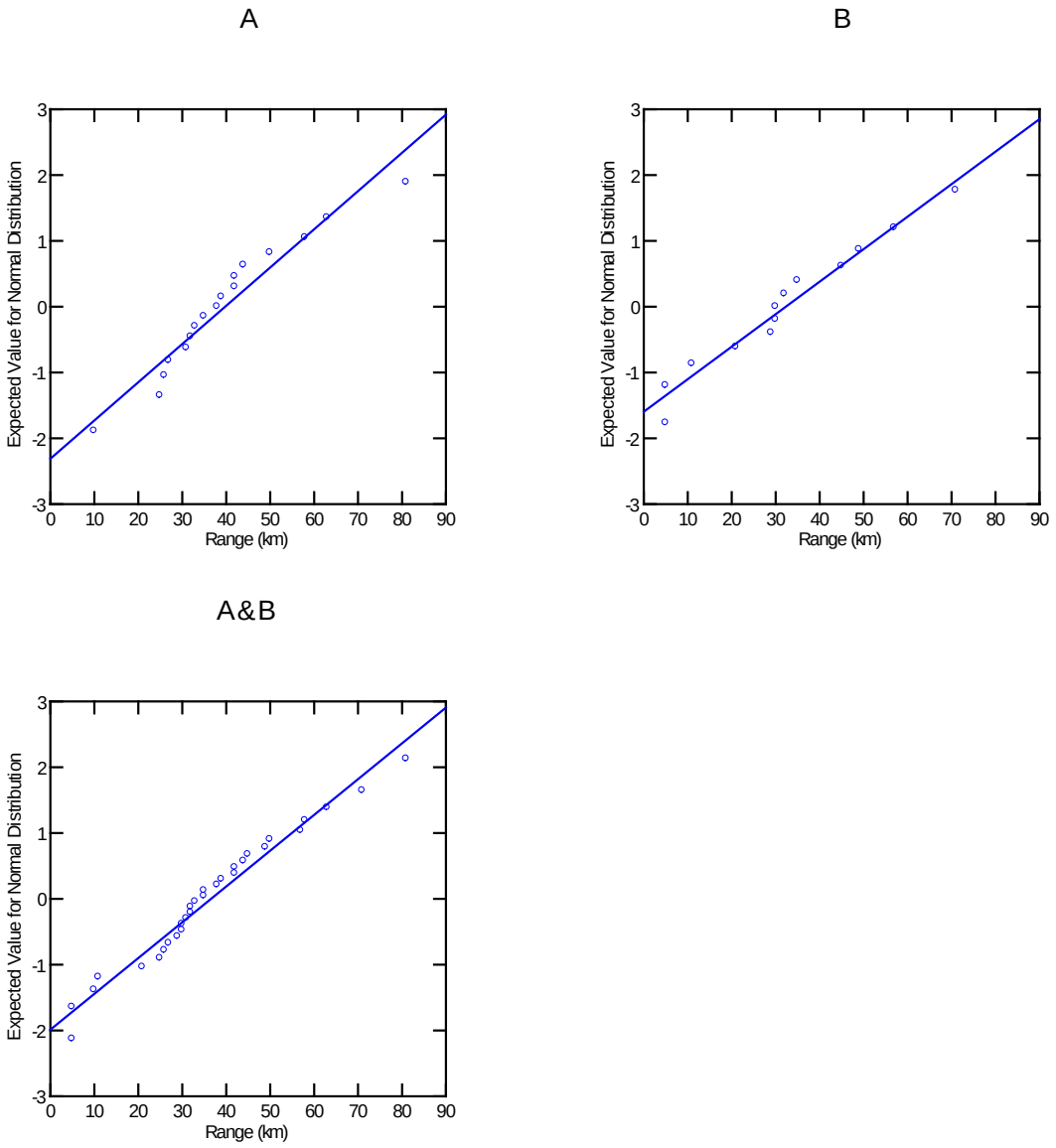
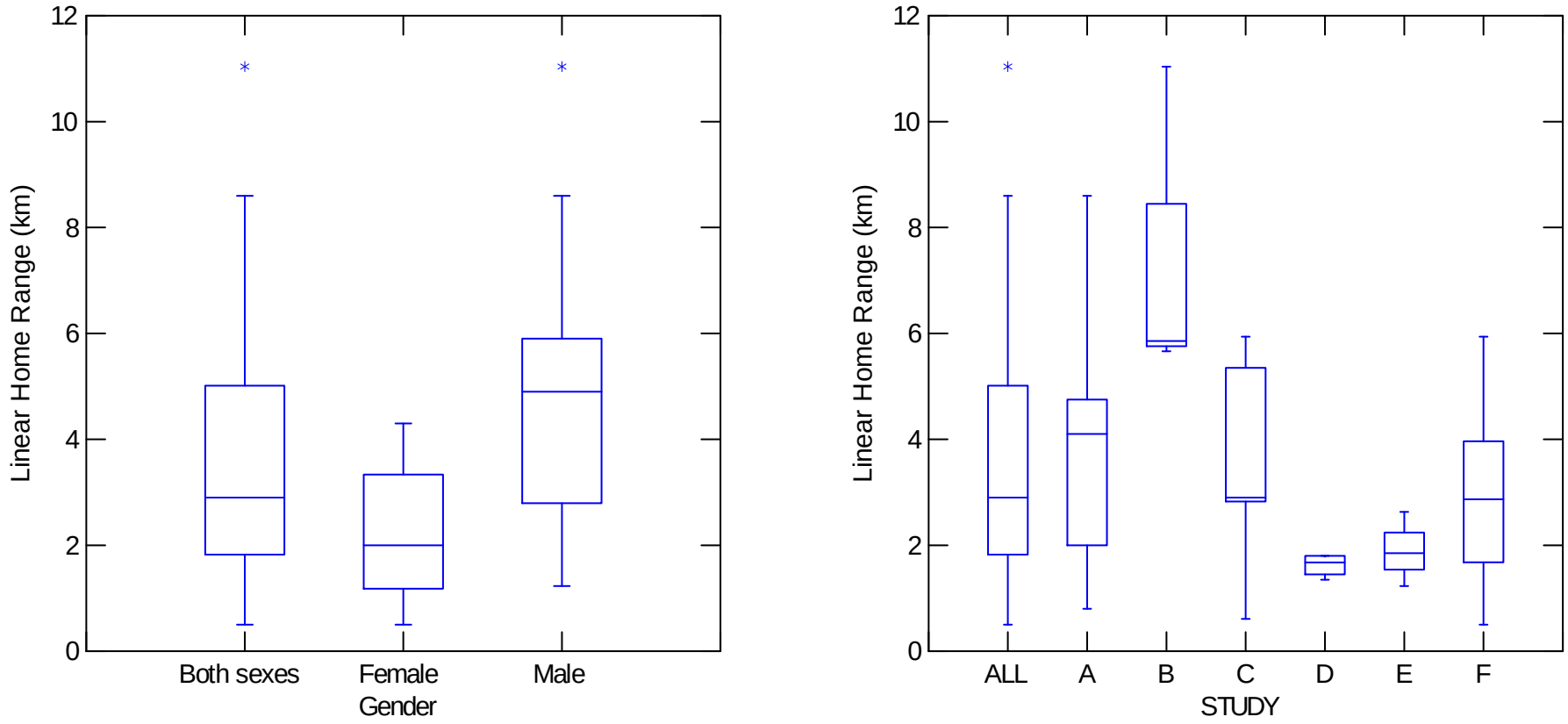


Figure A-3
Normal Probability Plots of River Otter Home Range by Location (i.e., Study)
Draft Baseline Ecological Risk Assessment Work Plan
Patrick Bayou Superfund Site



Notes:

A Yamaguchi and MacDonald 2003
B Steevens et al. 1997
C Linn and Birks 1981
D Dunstone and Birks 1983
E Gerell 1970
F Birks and Linn 1982

Figure A-4
Box Plots of Report Linear Home Range Data for Mink by Gender and Location (i.e., Study)
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Patrick Bayou Superfund Site

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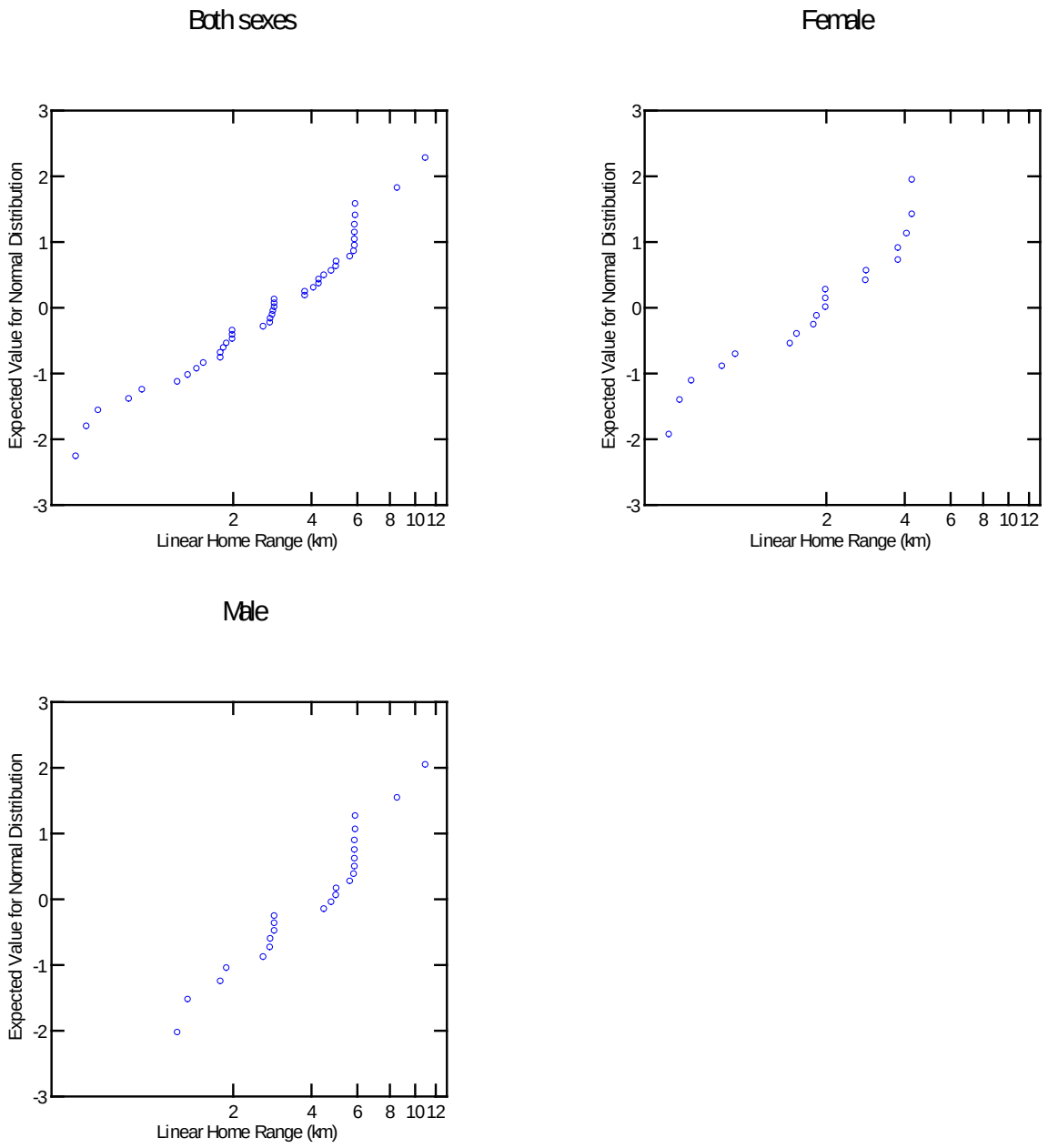

Figure A-5
Normal Probability Plots of Mink Home Range by Gender
Draft Baseline Ecological Risk Assessment Work Plan
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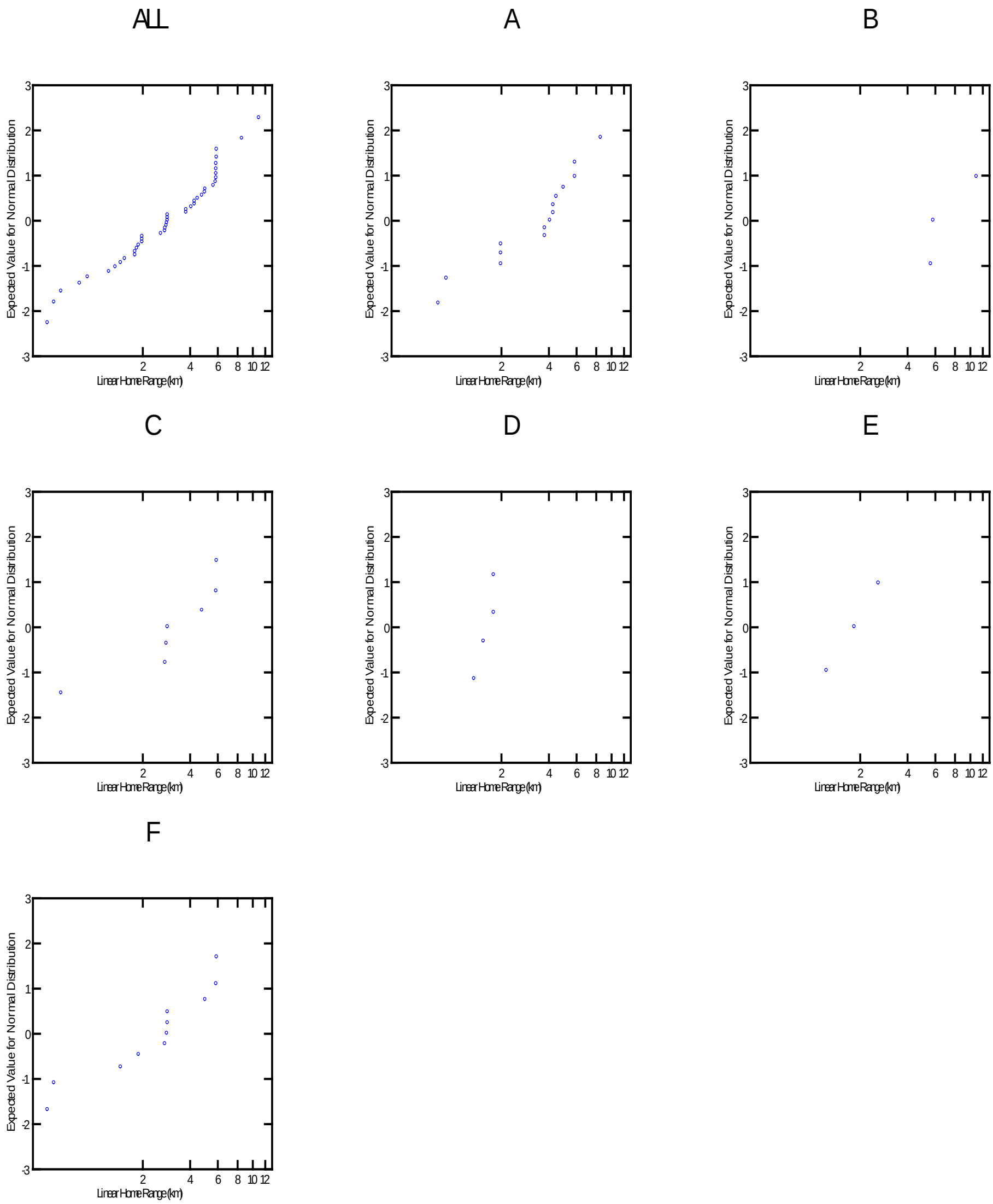

Figure A-6
Normal Probability Plot of Mink Range by Location (i.e., Study)
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COPC REFINEMENT TABLES

Derivation of Gross Energy and Assimilation Efficiency Parameters

Receptor		Average	Standard Deviation	5th Percentile	Distribution	Basis[a]
Gross Energy of Invertebrates (GE)						
Sediment probing bird	Aquatic invertebrates	1070	220	750	Lognormal	Gross energies of shrimp, isopods, and crabs, which are dietary food items consumed by sediment-probing birds, were available from the literature. The gross energies of these organisms were reported as follows: shrimp = 1,100 Kcal/kg (standard deviation = 240; Thayer et al. 1973), isopods/amphipods = 1,100 Kcal/kg (Jorgensen et al. 1991), and crabs = 1,000 Kcal/kg (standard deviation = 210; Thayer et al. 1973). For benthic invertebrates consumed by sediment-probing birds, the mean gross energy was set to 1,070 Kcal/kg (standard deviation = 220)
Carnivorous bird	Fish	1200	240	850	Lognormal	The gross energy of fish is equal to 1,200 Kcal/kg (standard deviation = 240; Thayer *et al* . 1973). The distribution for this variable was assumed to be lognormal.
Piscivorous bird	Fish	1200	240	850	Lognormal	The gross energy of fish is equal to 1,200 Kcal/kg (standard deviation = 240; Thayer *et al* . 1973). The distribution for this variable was assumed to be lognormal.
Omnivorous mammal	Fish	1200	240	850	Lognormal	Gross energies of fish and invertebrates, which are dietary food items consumed by omnivorous mammals, were available from the literature. The gross energies of these organisms were reported as follows: bony fish = 1200 kcal/kg (SD = 240; Thayer et al. 1973); bivalves = 800 Kcal/kg (estimated SD = 160; Cummins and Wuycheck 1971), crabs = 1000 Kcal/kg (SD = 210; Thayer et al. 1973), and shrimp (1100 Kcal/kg (SD = 240; Cummins and Wuycheck 1971). For aquatic invertebrates consumed by omnivorous mammals, the mean gross energy was set to 967 Kcal/kg (estimated standard deviation = 193) in the Monte Carlo analysis. The distribution for this variable was assumed to be lognormal.
	Aquatic invertebrates	967	193	685	Lognormal	
Assimilation Efficiency (AE)						
Sediment probing bird	Aquatic invertebrates	77%	8.40%	61%	Beta	Assimilation efficiencies of waterfowl consuming aquatic invertebrates studied by Karasov (1990). A beta distribution was assumed for this variable with the following paramterization: alpha=20, beta=6.5, and scale=1.0. This parameterization results in a distribution with a mean close to 77% and a 95% probability that the assimilation efficiency will be between 58 and 90%, which would be expected given a standard deviation of 8.4 and slightly left-skewed distribution. Assimilation efficiency is easily measured and several studies indicate that efficiencies vary little between different bird species consuming fish or aquatic invertebrates (USEPA 1993).
Carnivorous bird	Fish	77%	8.40%	61%	Beta	Assimilation efficiencies of waterfowl consuming aquatic invertebrates studied by Karasov (1990). A beta distribution was assumed for this variable with the following paramterization: alpha=20, beta=6.5, and scale=1.0. This parameterization results in a distribution with a mean close to 77% and a 95% probability that the assimilation efficiency will be between 58 and 90%, which would be expected given a standard deviation of 8.4 and slightly left-skewed distribution. Assimilation efficiency is easily measured and several studies indicate that efficiencies vary little between different bird species consuming fish or aquatic invertebrates (USEPA 1993).
Piscivorous bird	Fish	79%	4.50%	62%	Beta	A mean assimilation efficiency of 79% (SD=4.5%) was based on values reported by Karasov (1990), Stalmaster adn Gessaman (1982), Castro et al (1989), and Ricklefs (1974). A beta distribution was assumed for this variable with the following paramterization: alpha=15, beta=4, and scale=1.0. Assimilation efficiency is easily measured and several studies indicate that efficiencies vary little between different bird species consuming fish or aquatic invertebrates (USEPA 1993).
Omnivorous mammal	Fish	91%	9%	83%	Beta	The assimilation efficiency of omnivorous mammals depends upon the animal itself as well as the type of diet (USEPA 1993). Diets that include high percentages of indigestible material, such as ash, chitin or cellulose, tend to have lower assimilation efficiencies. Prey items with higher percent body weight fat will have higher assimilation efficiencies. The estimated assimilation efficiency for fish consumed by mammals is 91% (estimated SD = 9.0; USEPA 1993, estimated from Nagy 1987). The assimilation efficiency for the consumption of aquatic invertebrates (crabs and bivalves) by mammals was not found. However, small mammals consuming bivalves would shell the prey prior to consumption, so we can assume an efficiency similar to that of fish (mean = 91%; SD = 9.0). Beta distributions were assumed for this variable with parameters of: alpha = 60; beta = 7; scale = 1.0. This parameterization results in a distribution that has a mean close to 91%. With this distribution, there is approximately a 95% probability that assimilation efficiency will be between 81 and 96%.
	Aquatic invertebrates	91%	9%	83%	Beta	

Note:
a As discussed in the Calcasieu BERA (CDM 2002)

Summary of Whole Sediment 95% Upper Confidence Limits of the Mean

Chemical	95 UCL Basis	95UCL Cs (mg/kgdw)
Arsenic	Use 95% Approximate Gamma UCL	5.05
Cadmium	Use 95% Approximate Gamma UCL	0.708
Chromium	Use 95% H-UCL	80.46
Copper	Use 95% Student's-t UCL	49.52
Lead	Use 95% Chebyshev (Mean, Sd) UCL	102.8
Mercury	Use 99% Chebyshev (Mean, Sd) UCL	205.3
Selenium	Use 95% Student's-t UCL	1.064
Zinc	Use 95% Approximate Gamma UCL	439.3
2-Methylnaphthalene	Use 99% Chebyshev (Mean, Sd) UCL	44.033
Acenaphthene	Use 95% Chebyshev (Mean, Sd) UCL	6.024
Acenaphthylene	Use 95% H-UCL	4.637
Anthracene	Use 95% Chebyshev (Mean, Sd) UCL	7.698
Benzo(a)anthracene	Use 95% H-UCL	1.769
Benzo(a)pyrene	Use 95% H-UCL	2.115
Benzo(b)fluoranthene	95% KM (Chebyshev) UCL	2.33
Benzo(g,h,i)perylene	Use 95% H-UCL	2.471
Benzo(k)fluoranthene	Use 95% Chebyshev (Mean, Sd) UCL	1.724
Chrysene	Use 95% H-UCL	1.949
Dibenzo(a,h)anthracene	Use 95% H-UCL	0.2419
Fluoranthene	Use 95% H-UCL	7.066
Fluorene	Use 95% Chebyshev (Mean, Sd) UCL	14.226
Naphthalene	Use 97.5% Chebyshev (Mean, Sd) UCL	67.193
Phenanthrene	Use 95% Chebyshev (Mean, Sd) UCL	33.697
Total HPAH 16	Use 95% H-UCL	32.31
Total LPAH 16	Use 95% Chebyshev (Mean, Sd) UCL	123.315
Total PAH 16	Use 99% Chebyshev (Mean, Sd) UCL	301.812
Total PCB Congener	Use 99% Chebyshev (Mean, Sd) UCL	49.015318
PCB-077	95% KM (Chebyshev) UCL	0.109745
PCB-081	95% KM (Chebyshev) UCL	0.005515
PCB-105	Use 95% H-UCL	0.243203
PCB-114	Use 95% H-UCL	0.017849
PCB-118	Use 95% H-UCL	0.374256
PCB-123	95% KM (Chebyshev) UCL	0.015295
PCB-126	95% KM (Chebyshev) UCL	0.002598
PCB-156	Use 99% Chebyshev (Mean, Sd) UCL	0.049483
PCB-157	Use 99% Chebyshev (Mean, Sd) UCL	0.049483
PCB-167	Use 99% Chebyshev (Mean, Sd) UCL	0.014135
PCB-169	NA	0.0000915[a]
PCB-189	95% KM (Chebyshev) UCL	0.001417
1,2,3,4,6,7,8-HpCDD	Use 95% Chebyshev (Mean, Sd) UCL	0.0007067
1,2,3,4,6,7,8-HpCDF	Use 95% Approximate Gamma UCL	0.002158
1,2,3,4,7,8,9-HpCDF	Use 95% Approximate Gamma UCL	0.0002078

Summary of Whole Sediment 95% Upper Confidence Limits of the Mean

Chemical	95 UCL Basis	95UCL Cs (mg/kgdw)
1,2,3,4,7,8-HxCDD	95% KM (BCA) UCL	0.000005803
1,2,3,4,7,8-HxCDF	Use 95% Approximate Gamma UCL	0.0002381
1,2,3,6,7,8-HxCDD	95% KM (Chebyshev) UCL	0.00002847
1,2,3,6,7,8-HxCDF	Use 95% Approximate Gamma UCL	0.00008488
1,2,3,7,8,9-HxCDD	95% KM (t) UCL	0.00001171
1,2,3,7,8,9-HxCDF	Use 95% Approximate Gamma UCL	0.00005265
1,2,3,7,8-PeCDD	95% KM (Chebyshev) UCL	0.000004722
1,2,3,7,8-PeCDF	95% KM (Chebyshev) UCL	0.000138
2,3,4,6,7,8-HxCDF	Use 95% Approximate Gamma UCL	0.00004285
2,3,4,7,8-PeCDF	95% KM (Chebyshev) UCL	0.000118
2,3,7,8-TCDD	97.5% KM (Chebyshev) UCL	0.0001474
2,3,7,8-TCDF	Use 99% Chebyshev (Mean, Sd) UCL	0.0007833
OCDD	Use 95% Chebyshev (Mean, Sd) UCL	0.007098
OCDF	Use 97.5% Chebyshev (Mean, Sd) UCL	0.518328
4,4'-DDD	95% KM (% Bootstrap) UCL	0.02653
4,4'-DDE	97.5% KM (Chebyshev) UCL	0.009138
4,4'-DDT	97.5% KM (Chebyshev) UCL	0.03582
Endrin	95% KM (Percentile Bootstrap) UCL	0.02244
Heptachlor Epoxide	95% KM (Percentile Bootstrap) UCL	0.0383
Endosulfan II	95% KM (Percentile Bootstrap) UCL	0.09252
Total Chlordane (alpha & gamma)	95% KM (BCA) UCL	0.144
Total DDT	97.5% KM (Chebyshev) UCL	0.0648
Hexachlorobenzene	97.5% KM (Chebyshev) UCL	43.957
Hexachlorobutadiene	99% KM (Chebyshev) UCL	109.621
Hexachloroethane	95% KM (Chebyshev) UCL	2.959
1,3-Dichlorobenzene	99% KM (Chebyshev) UCL	2.324
1,4-Dichlorobenzene	99% KM (Chebyshev) UCL	1.876
bis(2-ethylhexyl)phthalate	Use 95% H-UCL	2.174

Note:

a Not detected in sediment, 1/2 of maximum detection limit used as sediment exposure point concentration

Fish HQ Refinement

Chemical Class	Chemical	95 UCL	Geomean BSAF[b] (ww fish/ dw sed)	TEF-fish - (WHO 1998)	Congener Tissue Conc (ww fish)[f]	Estimated Fish Tissue Conc (ww fish)	Midpoint TRV	HQ
Metals	Arsenic	5.05	0.097			0.4873	1.8755	0.26
	Cadmium	0.708	0.0064			0.0045	1.1477	0.00
	Chromium	80.46	0.00290			0.23333	3.2000	0.07
	Copper	49.52	0.0113			0.5596	6.5300	0.09
	Lead	102.8	0.00120			0.12336	2.7900	0.04
	Mercury	205.3	0.1067			21.906	2.4650	8.89
	Selenium	1.064	0.746			0.793	1.6200	0.49
	Zinc	439.3	0.0641			28.159	59.7000	0.47
PAH	2-Methylnaphthalene	44.033	0.0257			1.1316	1.9745	0.57
	Acenaphthene	6.024	0.0252			0.1518	10.5000	0.01
	Acenaphthylene	4.637	0.0265			0.1229	1.9745	0.06
	Anthracene	7.698	0.0260			0.2001	1.9745	0.10
	Benzo(a)anthracene	1.769	0.0260			0.0460	1.9745	0.02
	Benzo(a)pyrene	2.115	0.0263			0.0556	37.0000	0.00
	Benzo(b)fluoranthene	2.33	0.0254			0.0592	1.9745	0.03
	Benzo(g,h,i)perylene	2.471	0.0260			0.0642	1.9745	0.03
	Benzo(k)fluoranthene	1.724	0.0259			0.0447	1.9745	0.02
	Chrysene	1.949	0.0254			0.0495	--	--
	Dibenzo(a,h)anthracene	0.2419	0.0258			0.0062	1.9745	0.00
	Fluoranthene	7.066	0.0241			0.1703	1.9745	0.09
	Fluorene	14.226	0.0241			0.3428	1.9745	0.17
	Naphthalene[d]	67.193	0.0257			1.7269	9.3500	0.18
	Phenanthrene	33.697	0.0271			0.913	109.8000	0.01
	Total HPAH 16	32.31	0.0151			0.488	1.9745	0.25
	Total LPAH 16	123.315	0.0120			1.480	1.9745	0.75
	Total PAH 16	301.812	0.0054			1.630	1.9745	0.83
PCB	Total PCB Congeners[a]	49.015318	0.194			9.524	4.2295	2.25
	PCB-077[e]	0.109745	0.117	0.0001	1.28E-06	by TEQ	by TEQ	by TEQ

Fish HQ Refinement

Chemical Class	Chemical	95 UCL	Geomean BSAF[b] (ww fish/ dw sed)	TEF-fish - (WHO 1998)	Congener Tissue Conc (ww fish)[f]	Estimated Fish Tissue Conc (ww fish)	Midpoint TRV	HQ
	PCB-081[e]	0.005515	0.117	0.0005	3.21E-07	by TEQ	by TEQ	by TEQ
	PCB-105	0.243203	0.117	0.000005	1.42E-07	by TEQ	by TEQ	by TEQ
	PCB-114	0.017849	0.098	0.000005	8.72E-09	by TEQ	by TEQ	by TEQ
	PCB-118	0.374256	0.839	0.000005	1.57E-06	by TEQ	by TEQ	by TEQ
	PCB-123[f]	0.015295	0.0831	0.000005	6.36E-09	by TEQ	by TEQ	by TEQ
	PCB-126	0.002598	0.0831	0.005	1.08E-06	by TEQ	by TEQ	by TEQ
	PCB-156	0.049483	0.164	0.000005	4.07E-08	by TEQ	by TEQ	by TEQ
	PCB-157	0.049483	0.179	0.000005	4.42E-08	by TEQ	by TEQ	by TEQ
	PCB-167	0.014135	0.198	0.000005	1.40E-08	by TEQ	by TEQ	by TEQ
	PCB-169	0.0000915	0.0846	0.00005	3.87E-10	by TEQ	by TEQ	by TEQ
	PCB-189	0.001417	0.162	0.000005	1.14E-09	by TEQ	by TEQ	by TEQ
	PCB congeners TEQ[c]					4.51E-06	0.3849	0.00001
Dioxin/Furans	1,2,3,4,6,7,8-HpCDD	0.0007067	0.00240	0.001	1.70E-09	by TEQ	by TEQ	by TEQ
	1,2,3,4,6,7,8-HpCDF	0.002158	0.00430	0.01	9.28E-08	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8,9-HpCDF	0.0002078	0.000300	0.01	6.23E-10	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDD	0.000005803	0.0162	0.5	4.70E-08	by TEQ	by TEQ	by TEQ
	1,2,3,4,7,8-HxCDF	0.0002381	0.00130	0.1	3.10E-08	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDD	0.00002847	0.0248	0.01	7.06E-09	by TEQ	by TEQ	by TEQ
	1,2,3,6,7,8-HxCDF	0.00008488	0.0133	0.1	1.13E-07	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDD	0.00001171	0.0179	0.01	2.10E-09	by TEQ	by TEQ	by TEQ
	1,2,3,7,8,9-HxCDF	0.00005265	0.00160	0.1	8.42E-09	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDD	0.000004722	0.0201	1	9.49E-08	by TEQ	by TEQ	by TEQ
	1,2,3,7,8-PeCDF	0.000138	0.0294	0.05	2.03E-07	by TEQ	by TEQ	by TEQ
	2,3,4,6,7,8-HxCDF	0.00004285	0.00240	0.1	1.03E-08	by TEQ	by TEQ	by TEQ
	2,3,4,7,8-PeCDF	0.000118	0.00580	0.5	3.42E-07	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDD	0.0001474	0.0361	1	5.32E-06	by TEQ	by TEQ	by TEQ
	2,3,7,8-TCDF	0.0007833	0.0368	0.05	1.44E-06	by TEQ	by TEQ	by TEQ
	OCDD	0.007098	0.001100	0.0001	7.81E-10	by TEQ	by TEQ	by TEQ

Fish HQ Refinement

Chemical Class	Chemical	95 UCL	Geomean BSAF[b] (ww fish/ dw sed)	TEF-fish - (WHO 1998)	Congener Tissue Conc (ww fish)[f]	Estimated Fish Tissue Conc (ww fish)	Midpoint TRV	HQ
	OCDF	0.518328	0.0001000	0.0001	5.18E-09	by TEQ	by TEQ	by TEQ
	Dioxin/furan congeners TEQ[c]					7.72E-06	0.0005	0.02
Pesticides	4,4'-DDD	0.03	0.571			0.015	0.3300	0.05
	4,4'-DDE	0.01	1.217			0.011	0.4455	0.02
	4,4'-DDT	0.04	0.778			0.028	8.6200	0.00
	Endrin	0.02	0.511			0.011	0.3615	0.03
	Heptachlor Epoxide	0.04	0.686			0.026	4.2220	0.01
	Endosulfan II	0.09	0.681			0.063	0.5850	0.11
	Total Chlordane (alpha & gamma)	0.14	1.111			0.160	7.2405	0.02
	Total DDT	0.06	0.742			0.048	0.3300	0.15
SVOC	Hexachlorobenzene	43.957	0.0269			1.1824	--	--
	Hexachlorobutadiene	109.621	0.038			4.1656	14.1900	0.29
	Hexachloroethane	2.959	0.0272			0.0805	--	--
	1,3-Dichlorobenzene	2.324	15.7881			36.7	119.4000	0.31
	1,4-Dichlorobenzene	1.876	15.6984			29.5	68.3500	0.43

Notes:

Indicates HQ > 1.0

a Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

b See COPC Report and Addendum for derivation

c Dioxins and PCBs are evaluated using the Toxic Equivalency Quotient (TEQ) method in this COPC refinement step. Congener UCL were multiplied by BSAF and toxic equivalency factors (TEF) to derive a congener-based tissue concentration. To arrive at the TEQ concentration, the congener-based concentrations were summed.

d No BSAF values for Naphthalene available for Prey Group; Benzo(a)pyrene BSAF used as surrogate

e No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate

f No BSAF values for PCB-123 available for Prey Group; PCB-126 BSAF used as surrogate

Kingfisher HQ Refinement

Scenario: Hypothetical piscivorous bird receptor of concern - Belted Kingfisher

Exposure Assessment

Exposure Model

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota}$$

$$TDI_{biota} = \sum_{k=1}^{m} (C_k \times FR_k \times NIR_k)$$

$TDI_{sediment}$ = 0
TDI_{water} = 0

Variables

TDI_{all}	Total Daily Intake of COPCs from all sources (mg COPC/kgBW/day)
TDI_{water}	Total Daily Intake of COPCs from incidnetal and/or drinking water (mg/kg BW/day)
$TDI_{sediment}$	Total Daily Intake of COPCs from incidental sediment ingestion (mg/kg BW/day)
TDI_{biota}	Total Daily Intake of COPCs from ingestions of food items (mg/kg BW/day)
C_k	Concentration in k^{th} type of food (mg COPC/kg food)
FR_k	Fraction of kth type of food that is contaminated
NIR_k	Normalized ingestion rate of kth type of food on WW basis (mg food/kg BW/day)
m	Number of contaminated food types

Ingestion Rate

$$NIR_{total} = \frac{NFMR}{ME_{avg}}$$

NFMR	Free-living metabolic rate normalized to body weight (kcal/kg BW/day)
ME_{avg}	Average metabolizable energy of the total diet on a wet weight basis (kcal/kg food)

Metabolizable Energy

$$ME_k = GE_k \times AE_k$$

GE_k	Gross energy content of kth food type in WW (kcal/kg food)
AE_k	Assimilation efficiency for the kth species (unitless)

Concentration in Tissue

$$C_k = BSAF_k \times C_s$$

$BSAF_k$	Biota-sediment accumulation factor for the kth type of food (WW/dry weight [DW])
C_s	Concentration in sediment representing the range of exposure for the kth type of food

Free Metabolic Rate

$$NFMR = \frac{((a \times BW^b) \times CF_1)}{BW \times CF_2}$$

a	FMR-slope
b	FMR-power
CF_1	Conversion factor (1 kcal/4.186 kJ)
CF_2	Conversion factor (1 kg/1000 g)
BW	Body Weight (g)

NFMR	637	kcal/kg BW/day	a	14.25	unitless
NIRtotal	0.67	kg food/kg BW/day	b	0.659	unitless
AE_{fish}	0.79	unitless	ME	948	kcal/kg
GE_{fish}	1200	$kcal/kg_{fish}$	FR_k	1	unitless
BW	136	g			

Kingfisher HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Arsenic	5.05	0.0655	--	2.2E-01	3.37	0.07	No
Chromium	80.46	0.00589	--	3.2E-01	9.13	0.03	No
Lead	102.8	0.00450	--	3.1E-01	2.45	0.13	No
Mercury	205.3	0.133	--	1.8E+01	0.0352	521.64	Yes
Zinc	439.3	0.209	--	6.2E+01	119	0.52	No
2-Methylnaphthalene	44.033	0.0886	--	2.6E+00	3.33	0.79	No
Acenaphthene	6.024	0.0870	--	3.5E-01	3.03	0.12	No
Acenaphthylene	4.637	0.0939	--	2.9E-01	3.03	0.10	No
Anthracene	7.698	0.0924	--	4.8E-01	3.33	0.14	No
Fluorene	14.226	0.0873	--	8.4E-01	3.03	0.28	No
Phenanthrene	33.697	0.0983	--	2.2E+00	3.39	0.66	No
Total LPAH 16	123.315	0.0792	--	6.6E+00	24	0.27	No
Total PCB Congeners[a]	49.015318	0.148		4.9E+00	1.23	3.97	Yes
PCB-077[b]	0.109745	0.204	0.05	7.5E-04	by TEQ		
PCB-081[b]	0.005515	0.204	0.1	7.6E-05	by TEQ		
PCB-105	0.243203	0.204	0.0001	3.3E-06	by TEQ		
PCB-114	0.017849	0.0862	0.0001	1.0E-07	by TEQ		
PCB-118	0.374256	0.901	0.00001	2.3E-06	by TEQ		
PCB-123[c]	0.015295	0.0769	0.00001	7.9E-09	by TEQ		
PCB-126	0.002598	0.0769	0.1	1.3E-05	by TEQ		
PCB-156	0.049483	0.176	0.0001	5.9E-07	by TEQ		
PCB-157	0.049483	0.205	0.0001	6.8E-07	by TEQ		
PCB-167	0.014135	0.193	0.00001	1.8E-08	by TEQ		
PCB-169	0.0000915	0.0886	0.001	5.5E-09	by TEQ		
PCB-189	0.001417	0.103	0.00001	9.8E-10	by TEQ		
PCB congeners TEQ	--	--	--	8.5E-04	0.000077	11.02	Yes
1,2,3,4,6,7,8-HpCDD	0.0007067	0.00160	0.001	7.6E-10	by TEQ		
1,2,3,4,6,7,8-HpCDF	0.002158	0.00151	0.01	2.2E-08	by TEQ		
1,2,3,4,7,8,9-HpCDF	0.0002078	0.000765	0.01	1.1E-09	by TEQ		
1,2,3,4,7,8-HxCDD	0.000005803	0.00685	0.05	1.3E-09	by TEQ		
1,2,3,4,7,8-HxCDF	0.0002381	0.00330	0.1	5.3E-08	by TEQ		
1,2,3,6,7,8-HxCDD	0.00002847	0.00696	0.01	1.3E-09	by TEQ		
1,2,3,6,7,8-HxCDF	0.00008488	0.0204	0.1	1.2E-07	by TEQ		
1,2,3,7,8,9-HxCDD	0.00001171	0.00704	0.1	5.5E-09	by TEQ		
1,2,3,7,8,9-HxCDF	0.00005265	0.00411	0.1	1.5E-08	by TEQ		
1,2,3,7,8-PeCDD	0.000004722	0.0347	1	1.1E-07	by TEQ		
1,2,3,7,8-PeCDF	0.000138	0.0178	0.1	1.7E-07	by TEQ		
2,3,4,6,7,8-HxCDF	0.00004285	0.00339	0.1	9.8E-09	by TEQ		
2,3,4,7,8-PeCDF	0.000118	0.0431	1	3.4E-06	by TEQ		
2,3,7,8-TCDD	0.0001474	0.0574	1	5.7E-06	by TEQ		
2,3,7,8-TCDF	0.0007833	0.0615	1	3.2E-05	by TEQ		
OCDD	0.007098	0.00124	0.0001	5.9E-10	by TEQ		
OCDF	0.518328	0.000606	0.0001	2.1E-08	by TEQ		

Kingfisher HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Dioxin/furan congener TEQ	--	--	--	4.2E-05	0.000077	0.55	No
4,4'-DDD	0.02653	0.489	--	8.7E-03	1.25	0.01	No
4,4'-DDE	0.009138	0.618	--	3.8E-03	1.25	0.00	No
4,4'-DDT	0.03582	0.674	--	1.6E-02	1.25	0.01	No
Endrin	0.02244	0.527	--	8.0E-03	0.055	0.14	No
Total DDT	0.0648	0.479	--	2.1E-02	1.25	0.02	No
Hexachlorobenzene	43.957	0.0833	--	2.5E+00	2.01	1.23	Yes
Hexachlorobutadiene	109.621	0.0979	--	7.2E+00	12	0.60	No
Hexachloroethane	2.959	0.0982	--	2.0E-01	3	0.07	No
1,3-Dichlorobenzene	2.324	62.7	--	9.8E+01	88.44	1.11	Yes
1,4-Dichlorobenzene	1.876	61.2	--	7.7E+01	88.44	0.87	No

Notes:

Indicates HQ > 1.0

a Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

b No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate

c Not assessed due to lack of available effects data (i.e., TRV)

Scenario: Hypothetical sediment-probing bird receptor of concern - Spotted Sandpiper

Exposure Assessment

Exposure Model

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota}$$

$$TDI_{biota} = \sum_{k=1}^{m} (C_k \times FR_k \times NIR_k)$$

$$TDI_{sediment} = \left(\sum_{k=1}^{m} \left(C_k \times FS \times IR_{total} \times FR_k \right) \right) \Big/ BW$$

TDI_{water} = 0

Variables

TDI_{all}	Total Daily Intake of COPCs from all sources (mg COPC/kgBW/day)
TDI_{water}	Total Daily Intake of COPCs from incidnetal and/or drinking water (mg/kg BW/day)
$TDI_{sediment}$	Total Daily Intake of COPCs from incidental sediment ingestion (mg/kg BW/day)
TDI_{biota}	Total Daily Intake of COPCs from ingestions of food items (mg/kg BW/day)
C_k (biota)	Concentration in k^{th} type of food (mg COPC/kg food)
C_k (sediment)	Concentration in the kth foraging area sediment on a DW basis (mg/kg)
FR_k (biota)	Fraction of kth type of food that is contaminated
FR_k (sediment)	Fraction of total food intake from the kth foraging area (unitless)
NIR_k	Normalized ingestion rate of kth type of food on WW basis (mg food/kg BW/day)
m (biota)	Number of contaminated food types
m (sediment)	Number of foraging areas
FS	Fraction of sediment in diet (as percentage of diet on a DW basis; unitless)
IR_{total}	Food ingestion rate on a DW basis.
BW	Body weight (kg)

Ingestion Rate

$$NIR_{total} = \frac{NFMR}{ME_{avg}}$$

NFMR	Free-living metabolic rate normalized to body weight (kcal/kg BW/day)
ME_{avg}	Average metabolizable energy of the total diet on a wet weight basis (kcal/kg food)

Metabolizable Energy

$$ME_k = GE_k \times AE_k$$

GE_k	Gross energy content of kth food type in WW (kcal/kg food)
AE_k	Assimilation efficiency for the kth species (unitless)

Concentration in Tissue

$$C_k = BSAF_k \times C_s$$

$BSAF_k$	Biota-sediment accumulation factor for the kth type of food (WW/dry weight [DW])
C_s	Concentration in sediment representing the range of exposure for the kth type of food

Free Metabolic Rate

$$NFMR = \frac{\left(\left(a \times BW^{b} \right) \times CF_1 \right)}{BW \times CF_2}$$

a	FMR-slope
b	FMR-power
CF_1	Conversion factor (1 kcal/4.186 kJ)
CF_2	Conversion factor (1 kg/1000 g)

Ingestion Rate

$$IR_{Total} = \left(NIR_{Total} \times BW \right) \times \left(1 - P_{Moisture} \right)$$

NIR_{total}	Normalized total daily ingestion rate of food (mg food/kg BW/day)
$P_{moisture}$	Proportion of moisture in food (unitless)

NFMR	820	kcal/kg BW/day	a	8.13	unitless
$AE_{invertebrates}$	0.77	unitless	b	0.77	unitless
$GE_{invertebrates}$	1070	kcal/$kg_{invertebrate}$	FR_k	1	unitless
NIR_{total}	1.00	kg food/kg BW/day	ME	823.9	kcal/kg
IR total	0.009	kg food DW/day	$P_{moisture}$ (invert)	0.786	unitless
BW	42.5	g	FS	0.3	unitless

Sandpiper HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Arsenic	5.05	0.149	--	7.49E-01	3.37	0.22	No
Cadmium	0.708	0.331	--	2.33E-01	3.91	0.06	No
Chromium	80.46	0.00646	--	5.22E-01	9.13	0.06	No
Copper	49.52	0.0420	--	2.07E+00	8.08	0.26	No
Lead	102.8	0.00472	--	4.89E-01	2.45	0.20	No
Mercury	205.3	0.11	--	2.15E+01	0.04	611.94	Yes
Selenium	1.064	0.594	--	6.29E-01	5.40	0.12	No
Zinc	439.3	0.0506	--	2.21E+01	119.00	0.19	No
2-Methylnaphthalene	44.033	0.0359	--	1.58E+00	3.33	0.47	No
Acenaphthene	6.024	0.143	--	8.58E-01	3.03	0.28	No
Acenaphthylene	4.637	0.0202	--	9.35E-02	3.03	0.03	No
Anthracene	7.698	0.0154	--	1.18E-01	3.33	0.04	No
Fluorene	14.226	0.0269	--	3.82E-01	3.03	0.13	No
Phenanthrene	33.697	0.0622	--	2.09E+00	3.39	0.62	No
Total HPAH 16	32.31	0.581	--	1.87E+01	24.00	0.78	No
Total LPAH 16	123.315	1.07	--	1.31E+02	24.00	5.47	Yes
Total PAH 16	301.812	0.747	--	2.24E+02	24.00	9.35	Yes
Total PCB Congeners[a]	49.015318	0.500		2.44E+01	1.23	19.83	Yes
PCB-077[b]	0.109745	0.194	0.05	1.06E-03	by TEQ		
PCB-081[b]	0.005515	0.194	0.1	1.07E-04	by TEQ		
PCB-105	0.243203	0.194	0.0001	4.70E-06	by TEQ		
PCB-114	0.017849	0.0445	0.0001	7.92E-08	by TEQ		
PCB-118	0.374256	0.145	0.00001	5.40E-07	by TEQ		
PCB-123	0.015295	0.265	0.00001	4.03E-08	by TEQ		
PCB-126	0.002598	0.103	0.1	2.66E-05	by TEQ		
PCB-156	0.049483	0.132	0.0001	6.50E-07	by TEQ		
PCB-157	0.049483	0.261	0.0001	1.29E-06	by TEQ		
PCB-167	0.014135	0.103	0.00001	1.45E-08	by TEQ		
PCB-169	0.0000915	0.0106	0.001	9.71E-10	by TEQ		
PCB-189	0.001417	0.0202	0.00001	2.86E-10	by TEQ		
PCB congeners TEQ		--	--	1.20E-03	0.000077	15.59	Yes
1,2,3,4,6,7,8-HpCDD	0.0007067	0.101	0.001	7.11E-08	by TEQ		
1,2,3,4,6,7,8-HpCDF	0.002158	0.0668	0.01	1.44E-06	by TEQ		
1,2,3,4,7,8,9-HpCDF	0.0002078	0.0490	0.01	1.01E-07	by TEQ		
1,2,3,4,7,8-HxCDD	0.000005803	0.0828	0.05	2.39E-08	by TEQ		
1,2,3,4,7,8-HxCDF	0.0002381	0.0525	0.1	1.25E-06	by TEQ		
1,2,3,6,7,8-HxCDD	0.00002847	0.125	0.01	3.54E-08	by TEQ		
1,2,3,6,7,8-HxCDF	0.00008488	0.0797	0.1	6.74E-07	by TEQ		
1,2,3,7,8,9-HxCDD	0.00001171	0.0974	0.1	1.14E-07	by TEQ		
1,2,3,7,8,9-HxCDF	0.00005265	0.0418	0.1	2.19E-07	by TEQ		
1,2,3,7,8-PeCDD	0.000004722	0.129	1	6.06E-07	by TEQ		
1,2,3,7,8-PeCDF	0.000138	0.126	0.1	1.73E-06	by TEQ		
2,3,4,6,7,8-HxCDF	0.00004285	0.111	0.1	4.74E-07	by TEQ		
2,3,4,7,8-PeCDF	0.000118	0.107	1	1.26E-05	by TEQ		
2,3,7,8-TCDD	0.0001474	0.215	1	3.15E-05	by TEQ		
2,3,7,8-TCDF	0.0007833	0.268	1	2.09E-04	by TEQ		
OCDD	0.007098	0.0678	0.0001	4.79E-08	by TEQ		
OCDF	0.518328	0.0450	0.0001	2.32E-06	by TEQ		
Dioxin/furan congener TEQ		--	--	2.62E-04	0.000077	3.40	Yes
4,4'-DDD	0.02653	0.498	--	1.31E-02	1.25	0.01	No
4,4'-DDE	0.009138	0.602	--	5.47E-03	1.25	0.00	No
4,4'-DDT	0.03582	0.385	--	1.37E-02	1.25	0.01	No
Endrin	0.02244	0.289	--	6.46E-03	0.06	0.12	No
Heptachlor Epoxide	0.0383	0.444	--	1.69E-02	1.54	0.01	No
Total DDT	0.0648	0.395	--	2.55E-02	1.25	0.02	No

Sandpiper HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Hexachlorobenzene	43.957	0.501	--	2.19E+01	2.01	10.90	Yes
Hexachlorobutadiene	109.621	0.861	--	9.39E+01	12.00	7.83	Yes
Hexachloroethane	2.959	0.928	--	2.73E+00	3.00	0.91	No
1,3-Dichlorobenzene	2.324	45.4	--	1.05E+02	88.44	1.19	Yes
1,4-Dichlorobenzene	1.876	54.4	--	1.02E+02	88.44	1.15	Yes
bis(2-ethylhexyl)phthalate[c]	2.174	--	--	1.39E-04	3.30	0.00	No

Notes:

Indicates HQ > 1.0

a Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

b No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate

c Non-bioaccumulative; evaluated for direct ingestion only

Carnivorous Wader HQ Refinement

Scenario: Hypothetical carnivorous bird receptor of concern - Species composite

Exposure Assessment

Exposure Model

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota}$$

$$TDI_{biota} = \sum_{k=1}^{m} (C_k \times FR_k \times NIR_k)$$

$TDI_{sediment}$ = 0
TDI_{water} = 0

Variables

TDI_{all}	Total Daily Intake of COPCs from all sources (mg COPC/kgBW/day)
TDI_{water}	Total Daily Intake of COPCs from incidnetal and/or drinking water (mg/kg BW/day)
$TDI_{sediment}$	Total Daily Intake of COPCs from incidental sediment ingestion (mg/kg BW/day)
TDI_{biota}	Total Daily Intake of COPCs from ingestions of food items (mg/kg BW/day)
C_k	Concentration in k^{th} type of food (mg COPC/kg food)
FR_k	Fraction of kth type of food that is contaminated
NIR_k	Normalized ingestion rate of kth type of food on WW basis (mg food/kg BW/day)
m	Number of contaminated food types

Ingestion Rate

$$NIR_{total} = \frac{NFMR}{ME_{avg}}$$

NFMR	Free-living metabolic rate normalized to body weight (kcal/kg BW/day)
ME_{avg}	Average metabolizable energy of the total diet on a wet weight basis (kcal/kg food)

Metabolizable Energy

$$ME_k = GE_k \times AE_k$$

GE_k	Gross energy content of kth food type in WW (kcal/kg food)
AE_k	Assimilation efficiency for the kth species (unitless)

Concentration in Tissue

$$C_k = BSAF_k \times C_s$$

$BSAF_k$	Biota-sediment accumulation factor for the kth type of food (WW/dry weight [DW])
C_s	Concentration in sediment representing the range of exposure for the kth type of food

Normalized Free Metabolic Rate

$$NFMR = \frac{\left(\left(a \times BW^{b}\right) \times CF_1\right)}{BW \times CF_2}$$

a	FMR-slope
b	FMR-power
CF_1	Conversion factor (1 kcal/4.186 kJ)
CF_2	Conversion factor (1 kg/1000 g)
BW	Body Weight (g)

NFMR	339	kcal/kg BW/day	a	14.25	unitless
NIRtotal	0.37	kg food/kg BW/day	b	0.659	unitless
AE_{fish}	0.77	unitless	ME	924	kcal/kg
GE_{fish}	1200	$kcal/kg_{fish}$	FR_k	1	unitless
BW	870	g			

Carnivorous Wader HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Arsenic	5.05	0.0655	--	1.21E-01	3.37	0.035964198	No
Chromium	80.46	0.00589	--	1.74E-01	9.13	0.019019196	No
Lead	102.8	0.00450	--	1.70E-01	2.45	0.069184236	No
Mercury	205.3	0.133	--	1.00E+01	0.0352	284.2271307	Yes
Zinc	439.3	0.209	--	3.36E+01	119	0.282701512	No
2-Methylnaphthalene	44.033	0.0886	--	1.43E+00	3.33	0.429274773	No
Acenaphthene	6.024	0.0870	--	1.92E-01	3.03	0.063376637	No
Acenaphthylene	4.637	0.0939	--	1.60E-01	3.03	0.052653551	No
Anthracene	7.698	0.0924	--	2.61E-01	3.33	0.07826602	No
Phenanthrene	33.697	0.0983	--	1.21E+00	3.39	0.35802443	No
Total LPAH 16	123.315	0.0792	--	3.58E+00	24	0.1491068	No
Total PCB Congeners[a]	49.015318	0.148	--	2.66E+00	1.23	2.161006298	Yes
PCB-077[b]	0.109745	0.204	0.05	4.1E-04	see PCB congener TEQ		
PCB-081[b]	0.005515	0.204	0.1	4.1E-05	see PCB congener TEQ		
PCB-105	0.243203	0.204	0.0001	1.8E-06	see PCB congener TEQ		
PCB-114	0.017849	0.0862	0.0001	5.6E-08	see PCB congener TEQ		
PCB-118	0.374256	0.901	0.00001	1.2E-06	see PCB congener TEQ		
PCB-123[c]	0.015295	0.0769	0.00001	4.3E-09	see PCB congener TEQ		
PCB-126	0.002598	0.0769	0.1	7.3E-06	see PCB congener TEQ		
PCB-156	0.049483	0.176	0.0001	3.2E-07	see PCB congener TEQ		
PCB-157	0.049483	0.205	0.0001	3.7E-07	see PCB congener TEQ		
PCB-167	0.014135	0.193	0.00001	1.0E-08	see PCB congener TEQ		
PCB-169	0.0000915	0.0886	0.001	3.0E-09	see PCB congener TEQ		
PCB-189	0.001417	0.103	0.00001	5.3E-10	see PCB congener TEQ		
PCB congeners TEQ		--	--	4.6E-04	0.000077	6.006771405	Yes
1,2,3,4,6,7,8-HpCDD	0.0007067	0.00160	0.001	4.1E-10	see Dioxin/furan congener TEQ		
1,2,3,4,6,7,8-HpCDF	0.002158	0.00151	0.01	1.2E-08	see Dioxin/furan congener TEQ		
1,2,3,4,7,8,9-HpCDF	0.0002078	0.000765	0.01	5.8E-10	see Dioxin/furan congener TEQ		
1,2,3,4,7,8-HxCDD	0.000005803	0.00685	0.05	7.3E-10	see Dioxin/furan congener TEQ		
1,2,3,4,7,8-HxCDF	0.0002381	0.00330	0.1	2.9E-08	see Dioxin/furan congener TEQ		
1,2,3,6,7,8-HxCDD	0.00002847	0.00696	0.01	7.3E-10	see Dioxin/furan congener TEQ		
1,2,3,6,7,8-HxCDF	0.00008488	0.0204	0.1	6.3E-08	see Dioxin/furan congener TEQ		
1,2,3,7,8,9-HxCDD	0.00001171	0.00704	0.1	3.0E-09	see Dioxin/furan congener TEQ		
1,2,3,7,8,9-HxCDF	0.00005265	0.00411	0.1	7.9E-09	see Dioxin/furan congener TEQ		
1,2,3,7,8-PeCDD	0.000004722	0.0347	1	6.0E-08	see Dioxin/furan congener TEQ		
1,2,3,7,8-PeCDF	0.000138	0.0178	0.1	9.0E-08	see Dioxin/furan congener TEQ		
2,3,4,6,7,8-HxCDF	0.00004285	0.00339	0.1	5.3E-09	see Dioxin/furan congener TEQ		
2,3,4,7,8-PeCDF	0.000118	0.0431	1	1.9E-06	see Dioxin/furan congener TEQ		
2,3,7,8-TCDD	0.0001474	0.0574	1	3.1E-06	see Dioxin/furan congener TEQ		
2,3,7,8-TCDF	0.0007833	0.0615	1	1.8E-05	see Dioxin/furan congener TEQ		
OCDD	0.007098	0.00124	0.0001	3.2E-10	see Dioxin/furan congener TEQ		
OCDF	0.518328	0.000606	0.0001	1.2E-08	see Dioxin/furan congener TEQ		
Dioxin/furan congener TEQ		--	--	2.3E-05	0.000077	0.297395239	No

Carnivorous Wader HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
4,4'-DDD	0.02653	0.489	--	4.75E-03	1.25	0.003802802	No
4,4'-DDE	0.009138	0.618	--	2.07E-03	1.25	0.001655378	No
4,4'-DDT	0.03582	0.674	--	8.85E-03	1.25	0.0070769	No
Total DDT	0.0648	0.479	--	1.14E-02	1.25	0.009098465	No
Hexachlorobenzene	43.957	0.0833	--	1.34E+00	2.01	0.667489737	No
1,3-Dichlorobenzene	2.324	62.7	--	5.34E+01	88.55	0.602951949	No
1,4-Dichlorobenzene	1.876	61.2	--	4.21E+01	88.55	0.475076223	No

Notes:

Indicates HQ > 1.0

a Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

b No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate

c No BSAF values for PCB-123 available for Prey Group; PCB-126 BSAF used as surrogate

Scenario: Hypothetical omnivorous mammal receptor of concern - Raccoon

Exposure Assessment

Exposure Model

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota}$$

$$TDI_{biota} = \sum_{k=1}^{m} (C_k \times FR_k \times NIR_k)$$

$$TDI_{sediment} = \left(\sum_{k=1}^{m} \left(C_k \times FS \times IR_{total} \times FR_k \right) \right) \Big/ BW$$

Variables

TDI_{all}	Total Daily Intake of COPCs from all sources (mg COPC/kgBW/day)
TDI_{water}	Total Daily Intake of COPCs from incidnetal and/or drinking water (mg/kg BW/day)
$TDI_{sediment}$	Total Daily Intake of COPCs from incidental sediment ingestion (mg/kg BW/day)
TDI_{biota}	Total Daily Intake of COPCs from ingestions of food items (mg/kg BW/day)
C_k (biota)	Concentration in k^{th} type of food (mg COPC/kg food)
C_k (sediment)	Concentration in the kth foraging area sediment on a DW basis (mg/kg)
FR_k (biota)	Fraction of kth type of food that is contaminated
FR_k (sediment)	Fraction of total food intake from the kth foraging area (unitless)
NIR_k	Normalized ingestion rate of kth type of food on WW basis (mg food/kg BW/day)
m (biota)	Number of contaminated food types
m (sediment)	Number of foraging areas
FS	Fraction of sediment in diet (as percentage of diet on a DW basis; unitless)
IR_{total}	Food ingestion rate on a DW basis.
BW	Body weight (kg)

Ingestion Rate

$$NIR_{total} = \frac{NFMR}{ME_{avg}}$$

NFMR	Free-living metabolic rate normalized to body weight (kcal/kg BW/day)
ME_{avg}	Average metabolizable energy of the total diet on a wet weight basis (kcal/kg food)

Metabolizable Energy

$$ME_k = GE_k \times AE_k$$

GE_k	Gross energy content of kth food type in WW (kcal/kg food)
AE_k	Assimilation efficiency for the kth species (unitless)

Concentration in Tissue

$$C_k = BSAF_k \times C_s$$

$BSAF_k$	Biota-sediment accumulation factor for the kth type of food (WW/dry weight [DW])
C_s	Concentration in sediment representing the range of exposure for the kth type of food

Free Metabolic Rate

$$FMR = \frac{\left(\left(a \times BW^b\right) \times CF_1\right)}{BW \times CF_2}$$

a	FMR-slope
b	FMR-power
CF_1	Conversion factor (1 kcal/4.186 kJ)
CF_2	Conversion factor (1 kg/1000 g)

Food Ingestion Rate

$$IR_{Total} = \left(NIR_{Total} \times BW\right) \times \left(1 - P_{Moisture}\right)$$

NIR_{total}	Normalized total daily ingestion rate of food (mg food/kg BW/day)
$P_{moisture}$	Proportion of moisture in food (unitless)

NFMR	100	kcal/kg BW/day
AE_{fish}	0.91	unitless
GE_{fish}	1200	kcal/kg_{fish}
IR_{total}	0.104	kg food DW/day
BW	3990	g
a	6.03	unitless
b	0.678	unitless
$P_{moisture}$ (fish)	0.715	unitless
ME	1092	kcal/kg food
NIR	0.09	kg food/kg BW/day
FS	0.094	unitless
FR_k	1	unitless

Raccoon HQ Refinement

Chemical	95 UCL C_s (mg/kg_{dw})	Geomean BSAF	TEF	Geomean TDI ($mg/kg_{bw}/day$)	Arithmetic mean of LOAEL and NOAEL ($mg/kg_{bw}/day$)	HQ	COPC
Arsenic	5.05	0.0558	--	2.6E-02	1.5	0.017172161	No
Mercury	205.3	0.139	--	2.6E+00	0.01415	184.2948428	Yes
Selenium	1.064	0.624	--	6.1E-02	0.1445	0.4198162	No
Fluoranthene	7.066	0.0884	--	5.7E-02	1.617	0.035304466	No
Total HPAH 16	32.31	0.0485	--	1.4E-01	1.617	0.088591219	No
Total LPAH 16	123.315	0.0771	--	8.7E-01	11.04	0.078710789	No
Total PAH 16[d]	301.812	0.0375	--	1.0E+00			
Total PCB Congeners[a]	49.015318	0.153	--	6.9E-01	0.0583	11.75473697	Yes
PCB-077[b]	0.109745	0.137	0.0001	1.4E-07	see PCB congener TEQ		
PCB-081[b]	0.005515	0.137	0.0003	2.1E-08	see PCB congener TEQ		
PCB-105	0.243203	0.137	0.00003	9.1E-08	see PCB congener TEQ		
PCB-114	0.017849	0.0553	0.00003	2.7E-09	see PCB congener TEQ		
PCB-118	0.374256	0.722	0.00003	7.4E-07	see PCB congener TEQ		
PCB-123[c]	0.015295	0.0537	0.00003	2.3E-09	see PCB congener TEQ		
PCB-126	0.002598	0.0537	0.1	1.3E-06	see PCB congener TEQ		
PCB-156	0.049483	0.127	0.00003	1.7E-08	see PCB congener TEQ		
PCB-157	0.049483	0.154	0.00003	2.1E-08	see PCB congener TEQ		
PCB-167	0.014135	0.146	0.00003	5.7E-09	see PCB congener TEQ		
PCB-169	0.0000915	0.0730	0.03	1.8E-08	see PCB congener TEQ		
PCB-189	0.001417	0.0709	0.00003	2.8E-10	see PCB congener TEQ		
PCB congeners TEQ		--	--	2.3E-06	2.99211E-06	0.779633982	No
1,2,3,4,6,7,8-HpCDD	0.0007067	0.00106	0.01	7.0E-10	see Dioxin/furan congener TEQ		
1,2,3,4,6,7,8-HpCDF	0.002158	0.000682	0.01	1.4E-09	see Dioxin/furan congener TEQ		
1,2,3,4,7,8,9-HpCDF	0.0002078	0.000371	0.01	7.6E-11	see Dioxin/furan congener TEQ		
1,2,3,4,7,8-HxCDD	0.000005803	0.00628	0.1	3.3E-10	see Dioxin/furan congener TEQ		
1,2,3,4,7,8-HxCDF	0.0002381	0.00142	0.1	3.1E-09	see Dioxin/furan congener TEQ		
1,2,3,6,7,8-HxCDD	0.00002847	0.00487	0.1	1.3E-09	see Dioxin/furan congener TEQ		
1,2,3,6,7,8-HxCDF	0.00008488	0.0130	0.1	1.0E-08	see Dioxin/furan congener TEQ		
1,2,3,7,8,9-HxCDD	0.00001171	0.00554	0.1	6.0E-10	see Dioxin/furan congener TEQ		
1,2,3,7,8,9-HxCDF	0.00005265	0.00249	0.1	1.2E-09	see Dioxin/furan congener TEQ		
1,2,3,7,8-PeCDD	0.000004722	0.0209	1	9.0E-09	see Dioxin/furan congener TEQ		
1,2,3,7,8-PeCDF	0.000138	0.00774	0.03	2.9E-09	see Dioxin/furan congener TEQ		
2,3,4,6,7,8-HxCDF	0.00004285	0.00206	0.1	8.2E-10	see Dioxin/furan congener TEQ		
2,3,4,7,8-PeCDF	0.000118	0.0226	0.3	7.3E-08	see Dioxin/furan congener TEQ		
2,3,7,8-TCDD	0.0001474	0.0305	1	4.1E-07	see Dioxin/furan congener TEQ		
2,3,7,8-TCDF	0.0007833	0.0441	0.1	3.2E-07	see Dioxin/furan congener TEQ		
OCDD	0.007098	0.000722	0.0003	1.5E-10	see Dioxin/furan congener TEQ		
OCDF	0.518328	0.000256	0.0003	4.0E-09	see Dioxin/furan congener TEQ		
Dioxin/furan congeners		--	--	8.4E-07	2.99211E-06	0.279361796	No
Hexachlorobenzene	43.957	0.0849	--	3.4E-01	8.335	0.040921291	No

Notes:

Indicates HQ > 1.0

a Exposure concentrations for PCBs assessed on a congener basis for refinement of COPC. BSAF and TRV values for Total PCB Aroclors used as surrogate values for Total PCB Congeners

b No BSAF values for PCB-77 and PCB-81 available for Prey Group; PCB-105 BSAF used as surrogate

c No BSAF values for PCB-123 available for Prey Group; PCB-126 BSAF used as surrogate

d Not assessed due to lack of available effects data (i.e., TRV)

APPENDIX B
SUPPORTING INFORMATION FOR TOXICITY MODEL EVALUATIONS

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

Location	Sample ID	Sample Date	L. plumulosus survival (control adjusted; %)	Toxic (< 80% survival)	2-Methylnaphthalene			4,4'-DDD (p,p'-DDD)			4,4'-DDE (p,p'-DDE)			4,4'-DDT (p,p'-DDT)			Acenaphthene		
					Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	84.6	FALSE	23.8	TRUE	0.036	40.0	FALSE	1.00	0.240	TRUE	0.009	79.4	TRUE	11.3	157	TRUE	0.314
10	10-9/5/2000	09/05/2000	98.4	FALSE	289	TRUE	0.431	38.0	FALSE	0.950	3.07	TRUE	0.114	38.0	FALSE	2.71	483	TRUE	0.966
2	2-4/23/2001	04/23/2001	87.7	FALSE	108	TRUE	0.161	0.525	TRUE	0.026	2.47	TRUE	0.092	1.14	TRUE	0.163	43.6	TRUE	0.087
2	2-9/5/2000	09/05/2000	94.3	FALSE	602	TRUE	0.899	40.0	FALSE	1.00	3.00	FALSE	0.056	40.0	FALSE	2.86	758	TRUE	1.52
2.5	2.5-4/23/2001	04/23/2001	86.7	FALSE	464	TRUE	0.693	40.0	FALSE	1.00	136	TRUE	5.04	0.263	TRUE	0.038	1350	TRUE	2.70
2.5	2.5-9/5/2000	09/05/2000	90.2	FALSE	301	TRUE	0.449	41.0	FALSE	1.03	6.39	TRUE	0.237	41.0	FALSE	2.93	945	TRUE	1.89
3	3-4/24/2001	04/24/2001	0	TRUE	4770	TRUE	7.12	4.28	TRUE	0.214	40.0	FALSE	0.741	9.74	TRUE	1.39	25900	TRUE	51.8
3	3-8/12/2003	08/12/2003	95	FALSE	230	TRUE	0.343	--	--	--	--	--	--	--	--	--	528	TRUE	1.06
3	3-8/12/2003-EPA/TCEQ	08/12/2003	--	--	278	FALSE	0.207	29.6	FALSE	0.740	29.6	FALSE	0.548	34.8	TRUE	4.97	522	TRUE	1.04
3	3-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	61.6	FALSE	1.54	61.6	FALSE	1.14	123	FALSE	8.79	12500	TRUE	25.0
3	3-9/6/2000	09/06/2000	75.6	TRUE	1220	TRUE	1.82	40.0	FALSE	1.00	8.45	TRUE	0.313	40.0	FALSE	2.86	1680	TRUE	3.36
4A	4A-4/24/2001	04/24/2001	6.27	TRUE	96.9	TRUE	0.145	40.0	FALSE	1.00	2.43	TRUE	0.090	40.0	FALSE	2.86	268	TRUE	0.536
4A	4A-8/12/2003	08/12/2003	30	TRUE	223	TRUE	0.333	--	--	--	--	--	--	--	--	--	197	TRUE	0.393
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	436	FALSE	0.325	53.7	TRUE	2.69	43.5	FALSE	0.806	43.5	FALSE	3.11	436	FALSE	0.436
4A	4A-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	69.1	FALSE	1.73	69.1	FALSE	1.28	138	FALSE	9.86	4610	FALSE	4.61
4A	4A-9/5/2000	09/05/2000	89.1	FALSE	335	TRUE	0.500	38.0	FALSE	0.950	8.57	TRUE	0.317	38.0	FALSE	2.71	135	TRUE	0.270
5	5-4/24/2001	04/24/2001	0	TRUE	5000	TRUE	7.46	2.47	TRUE	0.124	4.76	TRUE	0.176	1.71	TRUE	0.244	2770	TRUE	5.54
5	5-9/5/2000	09/05/2000	103	FALSE	213	TRUE	0.318	35.0	FALSE	0.875	6.72	TRUE	0.249	35.0	FALSE	2.50	164	TRUE	0.328
6A	6A-4/25/2001	04/25/2001	0	TRUE	51.2	TRUE	0.076	40.0	FALSE	1.00	40.0	FALSE	0.741	40.0	FALSE	2.86	93.2	TRUE	0.186
6A	6A-8/12/2003	08/12/2003	31	TRUE	538	TRUE	0.802	--	--	--	--	--	--	--	--	--	858	TRUE	1.72
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	1220	TRUE	1.82	31.2	TRUE	1.56	26.4	FALSE	0.489	1990	TRUE	284	1670	TRUE	3.34
6A	6A-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	35.9	FALSE	0.898	35.9	FALSE	0.665	71.9	FALSE	5.14	2390	FALSE	2.39
6A	6A-9/5/2000	09/05/2000	24.9	TRUE	164	TRUE	0.245	39.0	FALSE	0.975	14.9	TRUE	0.552	39.0	FALSE	2.79	1160	TRUE	2.32
7	7-4/26/2001	04/26/2001	91.9	FALSE	152	TRUE	0.227	0.701	TRUE	0.035	6.02	TRUE	0.223	40.0	FALSE	2.86	127	TRUE	0.254
7	7-8/12/2003	08/12/2003	91	FALSE	11.0	FALSE	0.008	--	--	--	--	--	--	--	--	--	35.2	TRUE	0.070
7	7-8/12/2003-EPA/TCEQ	08/12/2003	--	--	229	FALSE	0.171	22.9	FALSE	0.573	22.9	FALSE	0.424	22.9	FALSE	1.64	229	FALSE	0.229
7	7-9/6/2000	09/06/2000	5.18	TRUE	377	FALSE	0.281	38.0	FALSE	0.950	9.45	TRUE	0.350	79.4	TRUE	11.3	123	TRUE	0.246
8	8-4/25/2001	04/25/2001	0	TRUE	121	TRUE	0.181	0.228	TRUE	0.011	40.0	FALSE	0.741	1.03	TRUE	0.147	565	TRUE	1.13
8	8-9/6/2000	09/06/2000	94.3	FALSE	42.2	TRUE	0.063	39.0	FALSE	0.975	9.51	TRUE	0.352	72.4	TRUE	10.3	80.5	TRUE	0.161
9	9-8/12/2003	08/12/2003	92	FALSE	23.0	FALSE	0.017	--	--	--	--	--	--	--	--	--	52.9	TRUE	0.106
9	9-8/12/2003-TCEQ	08/12/2003	--	--	245	FALSE	0.183	24.0	FALSE	0.600	24.0	FALSE	0.444	24.0	FALSE	1.71	245	FALSE	0.245
9	9-9/6/2000	09/06/2000	52.8	TRUE	90.9	TRUE	0.136	42.0	FALSE	1.05	8.11	TRUE	0.300	42.0	FALSE	3.00	806	TRUE	1.61
E	E-4/23/2001	04/23/2001	57.4	TRUE	570	TRUE	0.851	40.0	FALSE	1.00	4.06	TRUE	0.150	40.0	FALSE	2.86	1590	TRUE	3.18
E	E-9/6/2000	09/06/2000	104	FALSE	202	TRUE	0.301	40.0	FALSE	1.00	5.54	TRUE	0.205	40.0	FALSE	2.86	472	TRUE	0.944
G	G-4/24/2001	04/24/2001	93	FALSE	29.5	TRUE	0.044	0.140	TRUE	0.007	0.211	TRUE	0.008	0.0950	TRUE	0.014	42.7	TRUE	0.085
G	G-9/6/2000	09/06/2000	104	FALSE	408	FALSE	0.304	41.0	FALSE	1.03	5.99	TRUE	0.222	41.0	FALSE	2.93	160	TRUE	0.320
Q	Q-4/25/2001	04/25/2001	4.18	TRUE	212	TRUE	0.316	3.63	TRUE	0.182	1.01	TRUE	0.037	1.18	TRUE	0.169	99.5	TRUE	0.199
Q	Q-9/5/2000	09/05/2000	79.8	FALSE	250	TRUE	0.373	39.0	FALSE	0.975	14.8	TRUE	0.548	39.0	FALSE	2.79	580	TRUE	1.16
R	R-4/26/2001	04/26/2001	78.3	TRUE	73.2	TRUE	0.109	0.0730	TRUE	0.004	2.07	TRUE	0.077	0.238	TRUE	0.034	169	TRUE	0.338
R	R-8/12/2003	08/12/2003	98	FALSE	10.5	FALSE	0.008	--	--	--	--	--	--	--	--	--	90.3	TRUE	0.181
R	R-9/5/2000	09/05/2000	87	FALSE	108	TRUE	0.161	38.0	FALSE	0.950	5.23	TRUE	0.194	38.0	FALSE	2.71	134	TRUE	0.268
S	S-4/24/2001	04/24/2001	65.8	TRUE	2790	TRUE	4.16	2.63	TRUE	0.132	40.0	FALSE	0.741	5.65	TRUE	0.807	9830	TRUE	19.7
S	S-9/5/2000	09/05/2000	99.5	FALSE	75.3	TRUE	0.112	39.0	FALSE	0.975	7.24	TRUE	0.268	39.0	FALSE	2.79	230	TRUE	0.460
T	T-4/25/2001	04/25/2001	72.1	TRUE	82.9	TRUE	0.124	40.0	FALSE	1.00	40.0	FALSE	0.741	0.476	TRUE	0.068	180	TRUE	0.360
T	T-9/5/2000	09/05/2000	91.2	FALSE	133	TRUE	0.199	38.0	FALSE	0.950	7.49	TRUE	0.277	38.0	FALSE	2.71	96.4	TRUE	0.193
U	U-4/24/2001	04/24/2001	82.5	FALSE	29.1	TRUE	0.043	40.0	FALSE	1.00	0.178	TRUE	0.007	0.0380	TRUE	0.005	35.1	TRUE	0.070
U	U-9/6/2000	09/06/2000	98.4	FALSE	71.0	TRUE	0.106	40.0	FALSE	1.00	6.63	TRUE	0.246	40.0	FALSE	2.86	68.5	TRUE	0.137
V	V-4/23/2001	04/23/2001	79.4	TRUE	343	TRUE	0.512	0.979	TRUE	0.049	3.45	TRUE	0.128	2.04	TRUE	0.291	900	TRUE	1.80
V	V-9/5/2000	09/05/2000	102	FALSE	494	TRUE	0.737	40.0	FALSE	1.00	20.5	TRUE	0.759	40.0	FALSE	2.86	1550	TRUE	3.10
Y	Y-4/26/2001	04/26/2001	95	FALSE	30.1	TRUE	0.045	0.144	TRUE	0.007	1.77	TRUE	0.066	40.0	FALSE	2.86	2.47	TRUE	0.005
Y	Y-9/6/2000	09/06/2000	0	TRUE	22900	TRUE	34.2	40.0	FALSE	1.00	3.00	FALSE	0.056	40.0	FALSE	2.86	19200	TRUE	38.4

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

			Acenaphthylene			Anthracene			Arsenic			Benzo(a)anthracene			Benzo(a)pyrene			Cadmium		
Location	Sample ID	Sample Date	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	25.8	TRUE	0.040	44.3	TRUE	0.040	15.7	TRUE	0.224	491	FALSE	0.153	720	FALSE	0.225	0.165	TRUE	0.017
10	10-9/5/2000	09/05/2000	86.9	TRUE	0.136	795	TRUE	0.723	4.05	TRUE	0.058	1270	TRUE	0.794	1220	TRUE	0.763	0.187	TRUE	0.020
2	2-4/23/2001	04/23/2001	107	TRUE	0.167	57.4	TRUE	0.052	11.9	TRUE	0.170	86.7	TRUE	0.054	93.7	TRUE	0.059	0.162	TRUE	0.017
2	2-9/5/2000	09/05/2000	1810	TRUE	2.83	538	TRUE	0.489	2.91	TRUE	0.042	364	TRUE	0.228	539	TRUE	0.337	0.313	TRUE	0.033
2.5	2.5-4/23/2001	04/23/2001	2900	TRUE	4.53	1200	TRUE	1.09	9.64	TRUE	0.138	752	TRUE	0.470	1420	TRUE	0.888	0.386	TRUE	0.040
2.5	2.5-9/5/2000	09/05/2000	1730	TRUE	2.70	598	TRUE	0.544	2.85	TRUE	0.041	538	TRUE	0.336	1720	TRUE	1.08	0.365	TRUE	0.038
3	3-4/24/2001	04/24/2001	16100	TRUE	25.2	22500	TRUE	20.5	10.6	TRUE	0.151	6790	TRUE	4.24	5030	TRUE	3.14	1.62	TRUE	0.169
3	3-8/12/2003	08/12/2003	2100	TRUE	3.29	612	TRUE	0.556	2.98	TRUE	0.043	665	TRUE	0.416	725	TRUE	0.453	0.452	TRUE	0.047
3	3-8/12/2003-EPA/TCEQ	08/12/2003	1470	TRUE	2.30	629	TRUE	0.572	--	--	--	696	FALSE	0.218	801	TRUE	0.501	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	6270	TRUE	9.80	8830	TRUE	8.03	11.6	FALSE	0.083	4120	FALSE	1.29	4120	FALSE	1.29	1.59	FALSE	0.083
3	3-9/6/2000	09/06/2000	4360	TRUE	6.81	2670	TRUE	2.43	3.53	TRUE	0.050	1160	TRUE	0.725	1410	TRUE	0.881	0.380	TRUE	0.040
4A	4A-4/24/2001	04/24/2001	525	TRUE	0.820	465	TRUE	0.423	10.0	TRUE	0.143	959	TRUE	0.599	1360	TRUE	0.850	1.32	TRUE	0.138
4A	4A-8/12/2003	08/12/2003	775	TRUE	1.21	459	TRUE	0.417	4.23	TRUE	0.060	707	TRUE	0.442	805	TRUE	0.503	0.772	TRUE	0.080
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	586	TRUE	0.916	436	FALSE	0.198	--	--	--	1090	FALSE	0.341	1210	TRUE	0.756	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	3.60	4610	FALSE	2.10	11.5	FALSE	0.082	4610	FALSE	1.44	4610	FALSE	1.44	1.57	FALSE	0.082
4A	4A-9/5/2000	09/05/2000	493	TRUE	0.770	321	TRUE	0.292	3.32	TRUE	0.047	983	TRUE	0.614	385	FALSE	0.120	0.719	TRUE	0.075
5	5-4/24/2001	04/24/2001	6160	TRUE	9.63	5640	TRUE	5.13	12.3	TRUE	0.176	2730	TRUE	1.71	2990	TRUE	1.87	1.26	TRUE	0.131
5	5-9/5/2000	09/05/2000	963	TRUE	1.50	400	TRUE	0.364	3.09	TRUE	0.044	726	TRUE	0.454	351	FALSE	0.110	0.704	TRUE	0.073
6A	6A-4/25/2001	04/25/2001	694	TRUE	1.08	342	TRUE	0.311	11.4	TRUE	0.163	391	TRUE	0.244	720	FALSE	0.225	0.361	TRUE	0.038
6A	6A-8/12/2003	08/12/2003	1250	TRUE	1.95	774	TRUE	0.703	3.12	TRUE	0.045	481	TRUE	0.300	356	TRUE	0.222	1.16	TRUE	0.121
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	3180	TRUE	4.97	2330	TRUE	2.12	--	--	--	1130	TRUE	0.706	1000	TRUE	0.625	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	2390	FALSE	1.87	2390	FALSE	1.09	6.61	FALSE	0.047	2390	FALSE	0.747	2390	FALSE	0.747	0.901	FALSE	0.047
6A	6A-9/5/2000	09/05/2000	3290	TRUE	5.14	2510	TRUE	2.28	5.37	TRUE	0.077	4400	TRUE	2.75	3750	TRUE	2.34	0.288	TRUE	0.030
7	7-4/26/2001	04/26/2001	150	TRUE	0.234	322	TRUE	0.293	96.8	TRUE	1.38	1160	TRUE	0.725	1320	TRUE	0.825	1.14	TRUE	0.119
7	7-8/12/2003	08/12/2003	26.4	TRUE	0.041	13.0	FALSE	0.006	15.2	TRUE	0.217	112	TRUE	0.070	113	TRUE	0.071	0.708	TRUE	0.074
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.179	229	FALSE	0.104	--	--	--	572	FALSE	0.179	572	FALSE	0.179	--	--	--
7	7-9/6/2000	09/06/2000	272	TRUE	0.425	296	TRUE	0.269	29.6	TRUE	0.423	1080	TRUE	0.675	1320	TRUE	0.825	0.548	TRUE	0.057
8	8-4/25/2001	04/25/2001	237	TRUE	0.370	2140	TRUE	1.95	6.55	TRUE	0.094	13600	TRUE	8.50	14800	TRUE	9.25	0.278	TRUE	0.029
8	8-9/6/2000	09/06/2000	392	FALSE	0.306	342	TRUE	0.311	19.4	TRUE	0.277	1920	TRUE	1.20	2100	TRUE	1.31	0.484	TRUE	0.050
9	9-8/12/2003	08/12/2003	19.8	FALSE	0.016	92.4	TRUE	0.084	3.13	TRUE	0.045	733	TRUE	0.458	755	TRUE	0.472	0.335	TRUE	0.035
9	9-8/12/2003-TCEQ	08/12/2003	245	FALSE	0.191	245	FALSE	0.111	--	--	--	674	TRUE	0.421	1030	TRUE	0.644	--	--	--
9	9-9/6/2000	09/06/2000	266	TRUE	0.416	2650	TRUE	2.41	2.68	TRUE	0.038	12500	TRUE	7.81	13000	TRUE	8.13	0.235	TRUE	0.025
E	E-4/23/2001	04/23/2001	3050	TRUE	4.77	1680	TRUE	1.53	7.78	TRUE	0.111	1680	TRUE	1.05	2380	TRUE	1.49	0.524	TRUE	0.055
E	E-9/6/2000	09/06/2000	1510	TRUE	2.36	427	TRUE	0.388	2.15	TRUE	0.031	400	FALSE	0.125	660	FALSE	0.206	0.234	TRUE	0.024
G	G-4/24/2001	04/24/2001	88.0	TRUE	0.138	89.6	TRUE	0.082	12.6	TRUE	0.180	739	TRUE	0.462	793	TRUE	0.496	0.382	TRUE	0.040
G	G-9/6/2000	09/06/2000	408	FALSE	0.319	230	TRUE	0.209	4.98	TRUE	0.071	1070	TRUE	0.669	1170	TRUE	0.731	0.183	TRUE	0.019
Q	Q-4/25/2001	04/25/2001	1770	TRUE	2.77	1350	TRUE	1.23	12.7	TRUE	0.181	991	TRUE	0.619	1050	TRUE	0.656	1.84	TRUE	0.192
Q	Q-9/5/2000	09/05/2000	2030	TRUE	3.17	1490	TRUE	1.35	5.23	TRUE	0.075	1860	TRUE	1.16	1960	TRUE	1.23	0.350	TRUE	0.037
R	R-4/26/2001	04/26/2001	250	TRUE	0.391	403	TRUE	0.366	29.8	TRUE	0.426	2260	TRUE	1.41	2300	TRUE	1.44	0.411	TRUE	0.043
R	R-8/12/2003	08/12/2003	62.4	TRUE	0.098	317	TRUE	0.288	11.1	TRUE	0.159	1960	TRUE	1.23	1940	TRUE	1.21	0.596	TRUE	0.062
R	R-9/5/2000	09/05/2000	385	FALSE	0.301	335	TRUE	0.305	164	TRUE	2.34	1620	TRUE	1.01	1640	TRUE	1.03	1.03	TRUE	0.107
S	S-4/24/2001	04/24/2001	12500	TRUE	19.5	6520	TRUE	5.93	12.0	TRUE	0.171	2440	TRUE	1.53	3510	TRUE	2.19	0.268	TRUE	0.028
S	S-9/5/2000	09/05/2000	471	TRUE	0.736	184	TRUE	0.167	4.39	TRUE	0.063	392	FALSE	0.123	392	FALSE	0.123	0.436	TRUE	0.045
T	T-4/25/2001	04/25/2001	376	TRUE	0.588	326	TRUE	0.296	11.4	TRUE	0.163	1240	TRUE	0.775	1490	TRUE	0.931	0.376	TRUE	0.039
T	T-9/5/2000	09/05/2000	521	TRUE	0.814	264	TRUE	0.240	4.73	TRUE	0.068	716	TRUE	0.448	830	TRUE	0.519	0.415	TRUE	0.043
U	U-4/24/2001	04/24/2001	44.3	TRUE	0.069	23.2	TRUE	0.021	10.3	TRUE	0.147	660	FALSE	0.206	--	--	--	0.0910	TRUE	0.009
U	U-9/6/2000	09/06/2000	332	TRUE	0.519	119	TRUE	0.108	3.11	TRUE	0.044	400	FALSE	0.125	400	FALSE	0.125	0.0870	TRUE	0.009
V	V-4/23/2001	04/23/2001	1860	TRUE	2.91	774	TRUE	0.704	12.0	TRUE	0.171	807	TRUE	0.504	1300	TRUE	0.813	0.712	TRUE	0.074
V	V-9/5/2000	09/05/2000	2070	TRUE	3.23	803	TRUE	0.730	4.31	TRUE	0.062	550	TRUE	0.344	1160	TRUE	0.725	0.642	TRUE	0.067
Y	Y-4/26/2001	04/26/2001	59.0	TRUE	0.092	34.1	TRUE	0.031	14.7	TRUE	0.210	189	TRUE	0.118	222	TRUE	0.139	0.169	TRUE	0.018
Y	Y-9/6/2000	09/06/2000	31000	TRUE	48.4	14000	TRUE	12.7	31.8	TRUE	0.454	3260	TRUE	2.04	400	FALSE	0.125	1.52	TRUE	0.158

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

			Chlordane (technical)			Chlordane			Chromium			Chrysene			Copper			Dibenzo(a,h)anthracene			Dieldrin		
Location	Sample ID	Sample Date	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	--	--	--	--	--	--	28.0	TRUE	0.076	356	TRUE	0.127	14.5	TRUE	0.054	400	FALSE	0.769	--	--	--
10	10-9/5/2000	09/05/2000	--	--	--	--	--	--	31.4	TRUE	0.085	1730	TRUE	0.618	21.3	TRUE	0.079	194	TRUE	0.746	--	--	--
2	2-4/23/2001	04/23/2001	--	--	--	--	--	--	32.4	TRUE	0.088	264	TRUE	0.094	27.7	TRUE	0.103	34.6	TRUE	0.133	--	--	--
2	2-9/5/2000	09/05/2000	--	--	--	--	--	--	58.5	TRUE	0.158	638	TRUE	0.228	40.1	TRUE	0.149	400	FALSE	0.769	--	--	--
2.5	2.5-4/23/2001	04/23/2001	--	--	--	--	--	--	43.8	TRUE	0.118	1320	TRUE	0.471	42.0	TRUE	0.156	234	TRUE	0.900	--	--	--
2.5	2.5-9/5/2000	09/05/2000	--	--	--	--	--	--	47.5	TRUE	0.128	1060	TRUE	0.379	40.9	TRUE	0.151	100	TRUE	0.385	--	--	--
3	3-4/24/2001	04/24/2001	--	--	--	--	--	--	440	TRUE	1.19	7960	TRUE	2.84	170	TRUE	0.630	723	TRUE	2.78	--	--	--
3	3-8/12/2003	08/12/2003	--	--	--	--	--	--	53.7	TRUE	0.145	795	TRUE	0.284	34.6	TRUE	0.128	359	TRUE	1.38	--	--	--
3	3-8/12/2003-EPA/TCEQ	08/12/2003	296	FALSE	24.7	--	--	--	--	--	--	893	TRUE	0.319	--	--	--	696	FALSE	1.34	29.6	FALSE	1.85
3	3-8/31/2006-TCEQ	08/31/2006	616	FALSE	51.3	616	FALSE	51.3	237	TRUE	0.641	2640	TRUE	0.943	133	TRUE	0.493	4120	FALSE	7.92	61.6	FALSE	3.85
3	3-9/6/2000	09/06/2000	--	--	--	--	--	--	111	TRUE	0.300	1640	TRUE	0.586	51.7	TRUE	0.191	141	TRUE	0.542	--	--	--
4A	4A-4/24/2001	04/24/2001	--	--	--	--	--	--	82.1	TRUE	0.222	1870	TRUE	0.668	57.5	TRUE	0.213	162	TRUE	0.623	--	--	--
4A	4A-8/12/2003	08/12/2003	--	--	--	--	--	--	91.6	TRUE	0.248	741	TRUE	0.265	48.2	TRUE	0.179	50.5	FALSE	0.097	--	--	--
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	435	FALSE	36.3	--	--	--	--	--	--	1190	TRUE	0.425	--	--	--	1090	FALSE	2.10	43.5	FALSE	2.72
4A	4A-8/31/2006-TCEQ	08/31/2006	691	FALSE	57.6	691	FALSE	57.6	148	TRUE	0.400	4610	FALSE	0.823	63.5	TRUE	0.235	4610	FALSE	8.87	69.1	FALSE	4.32
4A	4A-9/5/2000	09/05/2000	--	--	--	--	--	--	123	TRUE	0.332	1670	TRUE	0.596	65.0	TRUE	0.241	245	TRUE	0.942	--	--	--
5	5-4/24/2001	04/24/2001	--	--	--	--	--	--	359	TRUE	0.970	3980	TRUE	1.42	99.5	TRUE	0.369	713	TRUE	2.74	--	--	--
5	5-9/5/2000	09/05/2000	--	--	--	--	--	--	137	TRUE	0.370	1190	TRUE	0.425	66.6	TRUE	0.247	158	TRUE	0.608	--	--	--
6A	6A-4/25/2001	04/25/2001	--	--	--	--	--	--	56.0	TRUE	0.151	664	TRUE	0.237	34.8	TRUE	0.129	400	FALSE	0.769	--	--	--
6A	6A-8/12/2003	08/12/2003	--	--	--	--	--	--	77.6	TRUE	0.210	506	TRUE	0.181	71.0	TRUE	0.263	352	TRUE	1.35	--	--	--
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	264	FALSE	22.0	--	--	--	--	--	--	1350	TRUE	0.482	--	--	--	639	FALSE	1.23	26.4	FALSE	1.65
6A	6A-8/31/2006-TCEQ	08/31/2006	359	FALSE	29.9	359	FALSE	29.9	41.3	TRUE	0.112	685	TRUE	0.245	36.9	TRUE	0.137	2390	FALSE	4.60	35.9	FALSE	2.24
6A	6A-9/5/2000	09/05/2000	--	--	--	--	--	--	63.7	TRUE	0.172	5820	TRUE	2.08	24.3	TRUE	0.090	431	TRUE	1.66	--	--	--
7	7-4/26/2001	04/26/2001	--	--	--	--	--	--	268	TRUE	0.724	1960	TRUE	0.700	301	TRUE	1.11	252	TRUE	0.969	--	--	--
7	7-8/12/2003	08/12/2003	--	--	--	--	--	--	10.2	TRUE	0.028	140	TRUE	0.050	96.1	TRUE	0.356	27.9	FALSE	0.054	--	--	--
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	19.1	--	--	--	--	--	--	572	FALSE	0.102	--	--	--	572	FALSE	1.10	22.9	FALSE	1.43
7	7-9/6/2000	09/06/2000	--	--	--	--	--	--	42.1	TRUE	0.114	1990	TRUE	0.711	72.7	TRUE	0.269	169	TRUE	0.650	--	--	--
8	8-4/25/2001	04/25/2001	--	--	--	--	--	--	20.0	TRUE	0.054	20100	TRUE	7.18	19.3	TRUE	0.072	1190	TRUE	4.58	--	--	--
8	8-9/6/2000	09/06/2000	--	--	--	--	--	--	21.9	TRUE	0.059	3120	TRUE	1.11	15.8	TRUE	0.059	265	TRUE	1.02	--	--	--
9	9-8/12/2003	08/12/2003	--	--	--	--	--	--	6.04	TRUE	0.016	958	TRUE	0.342	8.38	TRUE	0.031	594	TRUE	2.28	--	--	--
9	9-8/12/2003-TCEQ	08/12/2003	240	FALSE	20.0	--	--	--	--	--	--	1430	TRUE	0.511	--	--	--	613	FALSE	1.18	24.0	FALSE	1.50
9	9-9/6/2000	09/06/2000	--	--	--	--	--	--	16.6	TRUE	0.045	17400	TRUE	6.21	11.5	TRUE	0.043	2040	TRUE	7.85	--	--	--
E	E-4/23/2001	04/23/2001	--	--	--	--	--	--	56.1	TRUE	0.152	3090	TRUE	1.10	55.0	TRUE	0.204	169	TRUE	0.650	--	--	--
E	E-9/6/2000	09/06/2000	--	--	--	--	--	--	55.0	TRUE	0.149	434	TRUE	0.155	29.9	TRUE	0.111	64.3	TRUE	0.247	--	--	--
G	G-4/24/2001	04/24/2001	--	--	--	--	--	--	54.4	TRUE	0.147	1290	TRUE	0.461	79.1	TRUE	0.293	80.9	TRUE	0.311	--	--	--
G	G-9/6/2000	09/06/2000	--	--	--	--	--	--	46.3	TRUE	0.125	1670	TRUE	0.596	65.3	TRUE	0.242	197	TRUE	0.758	--	--	--
Q	Q-4/25/2001	04/25/2001	--	--	--	--	--	--	380	TRUE	1.03	1770	TRUE	0.632	180	TRUE	0.667	95.3	TRUE	0.367	--	--	--
Q	Q-9/5/2000	09/05/2000	--	--	--	--	--	--	40.9	TRUE	0.111	3040	TRUE	1.09	25.6	TRUE	0.095	255	TRUE	0.981	--	--	--
R	R-4/26/2001	04/26/2001	--	--	--	--	--	--	457	TRUE	1.24	3540	TRUE	1.26	70.3	TRUE	0.260	487	TRUE	1.87	--	--	--
R	R-8/12/2003	08/12/2003	--	--	--	--	--	--	17.9	TRUE	0.048	2070	TRUE	0.738	221	TRUE	0.819	496	TRUE	1.91	--	--	--
R	R-9/5/2000	09/05/2000	--	--	--	--	--	--	73.0	TRUE	0.197	2400	TRUE	0.857	271	TRUE	1.00	275	TRUE	1.06	--	--	--
S	S-4/24/2001	04/24/2001	--	--	--	--	--	--	182	TRUE	0.492	3440	TRUE	1.23	80.2	TRUE	0.297	400	FALSE	0.769	--	--	--
S	S-9/5/2000	09/05/2000	--	--	--	--	--	--	73.9	TRUE	0.200	423	TRUE	0.151	104	TRUE	0.385	41.1	TRUE	0.158	--	--	--
T	T-4/25/2001	04/25/2001	--	--	--	--	--	--	40.7	TRUE	0.110	2300	TRUE	0.821	37.9	TRUE	0.140	138	TRUE	0.531	--	--	--
T	T-9/5/2000	09/05/2000	--	--	--	--	--	--	84.4	TRUE	0.228	1160	TRUE	0.414	52.3	TRUE	0.194	130	TRUE	0.500	--	--	--
U	U-4/24/2001	04/24/2001	--	--	--	--	--	--	40.1	TRUE	0.108	--	--	--	15.5	TRUE	0.057	400	FALSE	0.769	--	--	--
U	U-9/6/2000	09/06/2000	--	--	--	--	--	--	29.4	TRUE	0.080	254	TRUE	0.091	14.9	TRUE	0.055	400	FALSE	0.769	--	--	--
V	V-4/23/2001	04/23/2001	--	--	--	--	--	--	73.8	TRUE	0.199	1580	TRUE	0.564	62.3	TRUE	0.231	127	TRUE	0.488	--	--	--
V	V-9/5/2000	09/05/2000	--	--	--	--	--	--	92.9	TRUE	0.251	1040	TRUE	0.371	69.9	TRUE	0.259	109	TRUE	0.419	--	--	--
Y	Y-4/26/2001	04/26/2001	--	--	--	--	--	--	42.1	TRUE	0.114	397	TRUE	0.142	18.3	TRUE	0.068	400	FALSE	0.769	--	--	--
Y	Y-9/6/2000	09/06/2000	--	--	--	--	--	--	63.9	TRUE	0.173	6150	TRUE	2.20	47.1	TRUE	0.174	400	FALSE	0.769	--	--	--

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

			Fluoranthene			Fluorene			Lead			Mercury			Naphthalene			Nickel		
Location	Sample ID	Sample Date	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	145	TRUE	0.028	10.3	TRUE	0.019	20.1	TRUE	0.092	0.0640	TRUE	0.090	33.6	TRUE	0.016	16.5	TRUE	0.320
10	10-9/5/2000	09/05/2000	3950	TRUE	0.775	472	TRUE	0.874	9.55	TRUE	0.044	0.0820	TRUE	0.115	116	TRUE	0.055	13.6	TRUE	0.264
2	2-4/23/2001	04/23/2001	1000	TRUE	0.196	59.7	TRUE	0.111	22.2	TRUE	0.102	1.00	TRUE	1.41	255	TRUE	0.121	27.2	TRUE	0.527
2	2-9/5/2000	09/05/2000	2680	TRUE	0.525	901	TRUE	1.67	21.7	TRUE	0.100	1.94	TRUE	2.73	1150	TRUE	0.548	63.3	TRUE	1.23
2.5	2.5-4/23/2001	04/23/2001	7010	TRUE	1.37	2070	TRUE	3.83	34.8	TRUE	0.160	2.35	TRUE	3.31	924	TRUE	0.440	21.2	TRUE	0.411
2.5	2.5-9/5/2000	09/05/2000	4760	TRUE	0.933	729	TRUE	1.35	30.0	TRUE	0.138	2.91	TRUE	4.10	652	TRUE	0.310	21.8	TRUE	0.422
3	3-4/24/2001	04/24/2001	125	TRUE	0.025	32700	TRUE	60.6	308	TRUE	1.41	160	TRUE	225	23500	TRUE	11.2	103	TRUE	2.00
3	3-8/12/2003	08/12/2003	2590	TRUE	0.507	695	TRUE	1.29	43.4	TRUE	0.199	9.02	TRUE	12.7	328	TRUE	0.156	15.6	TRUE	0.302
3	3-8/12/2003-EPA/TCEQ	08/12/2003	2920	TRUE	0.573	586	TRUE	1.09	--	--	--	--	--	--	--	--	--	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	8090	TRUE	1.59	11200	TRUE	20.7	498	TRUE	2.28	159	TRUE	224	10300	TRUE	4.90	115	TRUE	2.23
3	3-9/6/2000	09/06/2000	4720	TRUE	0.925	2100	TRUE	3.89	67.7	TRUE	0.311	16.7	TRUE	23.5	1810	TRUE	0.862	31.0	TRUE	0.601
4A	4A-4/24/2001	04/24/2001	2680	TRUE	0.525	298	TRUE	0.552	39.7	TRUE	0.182	6.26	TRUE	8.82	84.2	TRUE	0.040	31.5	TRUE	0.610
4A	4A-8/12/2003	08/12/2003	2340	TRUE	0.459	163	TRUE	0.301	55.9	TRUE	0.256	19.9	TRUE	28.0	79.6	TRUE	0.038	26.5	TRUE	0.514
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	2690	TRUE	0.527	436	FALSE	0.404	--	--	--	--	--	--	--	--	--	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	5230	TRUE	1.03	4610	FALSE	4.27	58.8	TRUE	0.270	91.9	TRUE	129	4610	FALSE	1.10	44.4	TRUE	0.860
4A	4A-9/5/2000	09/05/2000	2260	TRUE	0.443	214	TRUE	0.396	36.0	TRUE	0.165	6.62	TRUE	9.32	1050	TRUE	0.500	30.3	TRUE	0.587
5	5-4/24/2001	04/24/2001	5290	TRUE	1.04	7630	TRUE	14.1	125	TRUE	0.573	8.24	TRUE	11.6	2510	TRUE	1.20	60.8	TRUE	1.18
5	5-9/5/2000	09/05/2000	1670	TRUE	0.327	311	TRUE	0.576	39.5	TRUE	0.181	4.55	TRUE	6.41	254	TRUE	0.121	28.9	TRUE	0.560
6A	6A-4/25/2001	04/25/2001	1100	TRUE	0.216	61.0	TRUE	0.113	50.6	TRUE	0.232	0.299	TRUE	0.421	167	TRUE	0.080	20.2	TRUE	0.391
6A	6A-8/12/2003	08/12/2003	983	TRUE	0.193	577	TRUE	1.07	76.6	TRUE	0.351	2.53	TRUE	3.56	2000	TRUE	0.954	15.7	TRUE	0.304
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	2490	TRUE	0.488	1700	TRUE	3.15	--	--	--	--	--	--	--	--	--	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	1300	TRUE	0.255	2390	FALSE	2.21	23.3	TRUE	0.107	0.538	TRUE	0.758	2390	FALSE	0.569	15.5	TRUE	0.300
6A	6A-9/5/2000	09/05/2000	11400	TRUE	2.24	559	TRUE	1.04	34.6	TRUE	0.159	0.460	TRUE	0.648	284	TRUE	0.135	21.1	TRUE	0.409
7	7-4/26/2001	04/26/2001	3540	TRUE	0.694	168	TRUE	0.311	144	TRUE	0.661	0.0340	TRUE	0.048	104	TRUE	0.050	19.7	TRUE	0.382
7	7-8/12/2003	08/12/2003	294	TRUE	0.058	12.8	FALSE	0.012	58.9	TRUE	0.270	0.117	TRUE	0.165	21.6	FALSE	0.005	9.60	TRUE	0.186
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.023	229	FALSE	0.212	--	--	--	--	--	--	--	--	--	--	--	--
7	7-9/6/2000	09/06/2000	2930	TRUE	0.575	246	TRUE	0.456	523	TRUE	2.40	0.103	TRUE	0.145	108	TRUE	0.051	26.8	TRUE	0.519
8	8-4/25/2001	04/25/2001	36700	TRUE	7.20	766	TRUE	1.42	26.4	TRUE	0.121	0.0370	TRUE	0.052	112	TRUE	0.053	12.1	TRUE	0.234
8	8-9/6/2000	09/06/2000	5370	TRUE	1.05	114	TRUE	0.211	52.7	TRUE	0.242	0.0290	TRUE	0.041	53.6	TRUE	0.026	17.8	TRUE	0.345
9	9-8/12/2003	08/12/2003	2020	TRUE	0.396	61.7	TRUE	0.114	54.3	TRUE	0.249	0.0300	TRUE	0.042	45.2	FALSE	0.011	3.66	TRUE	0.071
9	9-8/12/2003-TCEQ	08/12/2003	2490	TRUE	0.488	245	FALSE	0.227	--	--	--	--	--	--	--	--	--	--	--	--
9	9-9/6/2000	09/06/2000	34800	TRUE	6.82	995	TRUE	1.84	36.2	TRUE	0.166	0.0310	TRUE	0.044	83.5	TRUE	0.040	8.36	TRUE	0.162
E	E-4/23/2001	04/23/2001	7620	TRUE	1.49	1520	TRUE	2.81	47.5	TRUE	0.218	4.21	TRUE	5.93	819	TRUE	0.390	30.1	TRUE	0.583
E	E-9/6/2000	09/06/2000	2130	TRUE	0.418	560	TRUE	1.04	25.0	TRUE	0.115	3.08	TRUE	4.34	364	TRUE	0.173	15.8	TRUE	0.306
G	G-4/24/2001	04/24/2001	2060	TRUE	0.404	28.1	TRUE	0.052	52.0	TRUE	0.239	1.46	TRUE	2.06	49.1	TRUE	0.023	61.7	TRUE	1.20
G	G-9/6/2000	09/06/2000	2720	TRUE	0.533	97.9	TRUE	0.181	39.8	TRUE	0.183	1.77	TRUE	2.49	408	FALSE	0.097	56.8	TRUE	1.10
Q	Q-4/25/2001	04/25/2001	84.9	TRUE	0.017	131	TRUE	0.243	193	TRUE	0.885	1.12	TRUE	1.58	244	TRUE	0.116	156	TRUE	3.02
Q	Q-9/5/2000	09/05/2000	5040	TRUE	0.988	460	TRUE	0.852	27.3	TRUE	0.125	0.327	TRUE	0.461	473	TRUE	0.225	17.5	TRUE	0.339
R	R-4/26/2001	04/26/2001	6460	TRUE	1.27	236	TRUE	0.437	47.2	TRUE	0.217	0.133	TRUE	0.187	64.1	TRUE	0.031	54.5	TRUE	1.06
R	R-8/12/2003	08/12/2003	5450	TRUE	1.07	117	TRUE	0.216	46.3	TRUE	0.212	0.163	TRUE	0.230	69.5	TRUE	0.033	11.4	TRUE	0.221
R	R-9/5/2000	09/05/2000	4230	TRUE	0.829	173	TRUE	0.320	260	TRUE	1.19	0.0550	TRUE	0.078	67.1	TRUE	0.032	26.6	TRUE	0.516
S	S-4/24/2001	04/24/2001	269	TRUE	0.053	4970	TRUE	9.20	124	TRUE	0.569	23.9	TRUE	33.7	3690	TRUE	1.76	48.1	TRUE	0.932
S	S-9/5/2000	09/05/2000	1070	TRUE	0.210	260	TRUE	0.481	47.8	TRUE	0.219	10.7	TRUE	15.1	174	TRUE	0.083	24.0	TRUE	0.465
T	T-4/25/2001	04/25/2001	3490	TRUE	0.684	222	TRUE	0.411	127	TRUE	0.583	1.10	TRUE	1.55	121	FALSE	0.029	19.8	TRUE	0.384
T	T-9/5/2000	09/05/2000	1710	TRUE	0.335	153	TRUE	0.283	28.9	TRUE	0.133	3.21	TRUE	4.52	212	TRUE	0.101	25.0	TRUE	0.484
U	U-4/24/2001	04/24/2001	76.4	TRUE	0.015	18.1	TRUE	0.034	16.8	TRUE	0.077	0.744	TRUE	1.05	41.2	TRUE	0.020	21.4	TRUE	0.415
U	U-9/6/2000	09/06/2000	337	TRUE	0.066	125	TRUE	0.231	15.0	TRUE	0.069	0.666	TRUE	0.938	97.0	TRUE	0.046	12.9	TRUE	0.250
V	V-4/23/2001	04/23/2001	4010	TRUE	0.786	802	TRUE	1.49	50.9	TRUE	0.233	3.98	TRUE	5.61	585	TRUE	0.279	33.5	TRUE	0.649
V	V-9/5/2000	09/05/2000	3840	TRUE	0.753	824	TRUE	1.53	48.2	TRUE	0.221	6.55	TRUE	9.23	903	TRUE	0.430	33.5	TRUE	0.649
Y	Y-4/26/2001	04/26/2001	518	TRUE	0.102	18.1	TRUE	0.034	33.0	TRUE	0.151	0.222	TRUE	0.313	35.9	TRUE	0.017	31.9	TRUE	0.618
Y	Y-9/6/2000	09/06/2000	9810	TRUE	1.92	12000	TRUE	22.2	41.8	TRUE	0.192	0.823	TRUE	1.16	41500	TRUE	19.8	42.8	TRUE	0.829

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

			Phenanthrene			Pyrene			Silver			Sum 4,4 DDT, DDE, DDD (U=0)			Total 10 HPAH (U = 0)			Total 16 PAH (U = 0)		
Location	Sample ID	Sample Date	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	146	TRUE	0.097	126	TRUE	0.049	0.0780	TRUE	0.021	79.6	TRUE	11.4	899	TRUE	0.094	1320	TRUE	0.029
10	10-9/5/2000	09/05/2000	4280	TRUE	2.85	3020	TRUE	1.16	0.0740	TRUE	0.020	3.07	TRUE	0.439	14800	TRUE	1.54	21000	TRUE	0.468
2	2-4/23/2001	04/23/2001	338	TRUE	0.225	1910	TRUE	0.735	0.269	TRUE	0.073	4.14	TRUE	0.591	6270	TRUE	0.653	7130	TRUE	0.159
2	2-9/5/2000	09/05/2000	3140	TRUE	2.09	4350	TRUE	1.67	0.242	TRUE	0.065	40.0	FALSE	2.86	10100	TRUE	1.05	18400	TRUE	0.411
2.5	2.5-4/23/2001	04/23/2001	8650	TRUE	5.77	11400	TRUE	4.38	0.468	TRUE	0.126	136	TRUE	19.5	26100	TRUE	2.72	43200	TRUE	0.965
2.5	2.5-9/5/2000	09/05/2000	3250	TRUE	2.17	8880	TRUE	3.42	0.452	TRUE	0.122	6.39	TRUE	0.913	23000	TRUE	2.39	30900	TRUE	0.689
3	3-4/24/2001	04/24/2001	71500	TRUE	47.7	265	TRUE	0.102	0.627	TRUE	0.169	14.0	TRUE	2.00	38500	TRUE	4.01	231000	TRUE	5.15
3	3-8/12/2003	08/12/2003	2040	TRUE	1.36	5180	TRUE	1.99	0.148	TRUE	0.040	--	--	--	11900	TRUE	1.24	18200	TRUE	0.407
3	3-8/12/2003-EPA/TCEQ	08/12/2003	2910	TRUE	1.94	6910	TRUE	2.66	--	--	--	34.8	TRUE	4.97	12400	TRUE	1.29	18500	TRUE	0.413
3	3-8/31/2006-TCEQ	08/31/2006	34300	TRUE	22.9	17400	TRUE	6.69	1.43	TRUE	0.386	123	FALSE	8.79	28100	TRUE	2.93	112000	TRUE	2.49
3	3-9/6/2000	09/06/2000	8240	TRUE	5.49	8440	TRUE	3.25	0.410	TRUE	0.111	8.45	TRUE	1.21	21200	TRUE	2.21	42100	TRUE	0.940
4A	4A-4/24/2001	04/24/2001	686	TRUE	0.457	2810	TRUE	1.08	1.17	TRUE	0.316	2.43	TRUE	0.347	13800	TRUE	1.44	16100	TRUE	0.360
4A	4A-8/12/2003	08/12/2003	446	TRUE	0.297	5070	TRUE	1.95	0.574	TRUE	0.155	--	--	--	12100	TRUE	1.26	14200	TRUE	0.317
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	616	TRUE	0.411	7100	TRUE	2.73	--	--	--	53.7	TRUE	7.67	15000	TRUE	1.56	16200	TRUE	0.361
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	1.54	13200	TRUE	5.08	1.36	TRUE	0.368	138	FALSE	9.86	18400	TRUE	1.92	18400	TRUE	0.411
4A	4A-9/5/2000	09/05/2000	914	TRUE	0.609	2490	TRUE	0.958	1.57	TRUE	0.424	8.57	TRUE	1.22	11500	TRUE	1.20	14700	TRUE	0.327
5	5-4/24/2001	04/24/2001	15300	TRUE	10.2	14700	TRUE	5.65	1.05	TRUE	0.284	8.94	TRUE	1.28	38300	TRUE	3.98	78300	TRUE	1.75
5	5-9/5/2000	09/05/2000	1010	TRUE	0.673	1870	TRUE	0.719	1.10	TRUE	0.297	6.72	TRUE	0.960	8240	TRUE	0.858	11300	TRUE	0.253
6A	6A-4/25/2001	04/25/2001	365	TRUE	0.243	1220	TRUE	0.469	0.373	TRUE	0.101	40.0	FALSE	2.86	4160	TRUE	0.434	5890	TRUE	0.131
6A	6A-8/12/2003	08/12/2003	1270	TRUE	0.849	1630	TRUE	0.627	1.53	TRUE	0.414	--	--	--	5240	TRUE	0.546	12000	TRUE	0.267
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	5520	TRUE	3.68	5520	TRUE	2.12	--	--	--	2020	TRUE	289	13100	TRUE	1.37	27500	TRUE	0.615
6A	6A-8/31/2006-TCEQ	08/31/2006	407	TRUE	0.271	1250	TRUE	0.481	0.695	TRUE	0.188	71.9	FALSE	5.14	3240	TRUE	0.337	3640	TRUE	0.081
6A	6A-9/5/2000	09/05/2000	7410	TRUE	4.94	10000	TRUE	3.85	0.173	TRUE	0.047	14.9	TRUE	2.13	44900	TRUE	4.67	60100	TRUE	1.34
7	7-4/26/2001	04/26/2001	2120	TRUE	1.41	3560	TRUE	1.37	0.783	TRUE	0.212	6.72	TRUE	0.960	15800	TRUE	1.65	18800	TRUE	0.420
7	7-8/12/2003	08/12/2003	89.5	TRUE	0.060	231	TRUE	0.089	0.0750	FALSE	0.010	--	--	--	1310	TRUE	0.137	1460	TRUE	0.033
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.076	229	FALSE	0.044	--	--	--	22.9	FALSE	1.64	572	FALSE	0.030	572	FALSE	0.006
7	7-9/6/2000	09/06/2000	1790	TRUE	1.19	2390	TRUE	0.919	0.632	TRUE	0.171	88.9	TRUE	12.7	13700	TRUE	1.42	16500	TRUE	0.368
8	8-4/25/2001	04/25/2001	16600	TRUE	11.1	29100	TRUE	11.2	0.527	TRUE	0.142	1.26	TRUE	0.180	155000	TRUE	16.2	175000	TRUE	3.92
8	8-9/6/2000	09/06/2000	2920	TRUE	1.95	3980	TRUE	1.53	0.205	TRUE	0.055	81.9	TRUE	11.7	23000	TRUE	2.40	26500	TRUE	0.592
9	9-8/12/2003	08/12/2003	970	TRUE	0.647	1550	TRUE	0.598	0.0700	FALSE	0.009	--	--	--	8730	TRUE	0.910	9910	TRUE	0.221
9	9-8/12/2003-TCEQ	08/12/2003	1010	TRUE	0.673	2310	TRUE	0.888	--	--	--	24.0	FALSE	1.71	11400	TRUE	1.19	12400	TRUE	0.277
9	9-9/6/2000	09/06/2000	18500	TRUE	12.3	26600	TRUE	10.2	0.176	TRUE	0.048	8.11	TRUE	1.16	141000	TRUE	14.7	165000	TRUE	3.68
E	E-4/23/2001	04/23/2001	4310	TRUE	2.87	11300	TRUE	4.35	0.652	TRUE	0.176	4.06	TRUE	0.580	32100	TRUE	3.35	45100	TRUE	1.01
E	E-9/6/2000	09/06/2000	2170	TRUE	1.45	4080	TRUE	1.57	0.290	TRUE	0.078	5.54	TRUE	0.791	7970	TRUE	0.830	13500	TRUE	0.301
G	G-4/24/2001	04/24/2001	553	TRUE	0.369	1580	TRUE	0.608	0.247	TRUE	0.067	0.446	TRUE	0.064	8890	TRUE	0.926	9740	TRUE	0.217
G	G-9/6/2000	09/06/2000	1240	TRUE	0.827	2100	TRUE	0.808	0.240	TRUE	0.065	5.99	TRUE	0.856	12500	TRUE	1.30	14200	TRUE	0.318
Q	Q-4/25/2001	04/25/2001	914	TRUE	0.609	4440	TRUE	1.71	0.577	TRUE	0.156	5.82	TRUE	0.831	11800	TRUE	1.23	16300	TRUE	0.365
Q	Q-9/5/2000	09/05/2000	3400	TRUE	2.27	4900	TRUE	1.88	0.507	TRUE	0.137	14.8	TRUE	2.11	22500	TRUE	2.34	30900	TRUE	0.690
R	R-4/26/2001	04/26/2001	3910	TRUE	2.61	5500	TRUE	2.12	0.246	TRUE	0.067	2.38	TRUE	0.340	27000	TRUE	2.81	32000	TRUE	0.715
R	R-8/12/2003	08/12/2003	2380	TRUE	1.58	4100	TRUE	1.58	0.173	TRUE	0.047	--	--	--	20900	TRUE	2.18	24000	TRUE	0.535
R	R-9/5/2000	09/05/2000	2570	TRUE	1.71	3230	TRUE	1.24	0.384	TRUE	0.104	5.23	TRUE	0.747	18100	TRUE	1.89	21400	TRUE	0.478
S	S-4/24/2001	04/24/2001	14700	TRUE	9.80	41600	TRUE	16.0	0.580	TRUE	0.157	8.28	TRUE	1.18	64200	TRUE	6.69	116000	TRUE	2.60
S	S-9/5/2000	09/05/2000	1020	TRUE	0.680	1900	TRUE	0.731	0.424	TRUE	0.115	7.24	TRUE	1.03	4470	TRUE	0.466	6810	TRUE	0.152
T	T-4/25/2001	04/25/2001	1110	TRUE	0.740	2740	TRUE	1.05	0.611	TRUE	0.165	0.476	TRUE	0.068	15200	TRUE	1.58	17400	TRUE	0.388
T	T-9/5/2000	09/05/2000	745	TRUE	0.497	1550	TRUE	0.596	0.411	TRUE	0.111	7.49	TRUE	1.07	8720	TRUE	0.908	10700	TRUE	0.239
U	U-4/24/2001	04/24/2001	56.4	TRUE	0.038	149	TRUE	0.057	0.162	TRUE	0.044	0.216	TRUE	0.031	225	TRUE	0.024	444	TRUE	0.010
U	U-9/6/2000	09/06/2000	346	TRUE	0.231	507	TRUE	0.195	0.131	TRUE	0.035	6.63	TRUE	0.947	1510	TRUE	0.158	2600	TRUE	0.058
V	V-4/23/2001	04/23/2001	2380	TRUE	1.59	5650	TRUE	2.17	0.757	TRUE	0.205	6.47	TRUE	0.924	16700	TRUE	1.74	24000	TRUE	0.536
V	V-9/5/2000	09/05/2000	3520	TRUE	2.35	7450	TRUE	2.87	0.763	TRUE	0.206	20.5	TRUE	2.93	17300	TRUE	1.80	27000	TRUE	0.603
Y	Y-4/26/2001	04/26/2001	264	TRUE	0.176	429	TRUE	0.165	0.129	TRUE	0.035	1.91	TRUE	0.273	2400	TRUE	0.250	2810	TRUE	0.063
Y	Y-9/6/2000	09/06/2000	46800	TRUE	31.2	15700	TRUE	6.04	0.347	TRUE	0.094	40.0	FALSE	2.86	34900	TRUE	3.64	199000	TRUE	4.45

Table B-1
Toxicity Data and Effects Range Median Quotients (ERM-Q) Used in Toxicity Model Evaluations

			Total 6 LPAH (U = 0)			Total Chlordane (alpha and gamma) (U = 0)			Total PCB (U = 0)			Zinc		
Location	Sample ID	Sample Date	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q	Concentration	Detect	ERM-Q
10	10-4/25/2001	04/25/2001	417	TRUE	0.132	40.0	FALSE	3.33	1.98	TRUE	0.0110	91.7	TRUE	0.224
10	10-9/5/2000	09/05/2000	6230	TRUE	1.97	38.0	FALSE	3.17	50.0	FALSE	0.139	84.5	TRUE	0.206
2	2-4/23/2001	04/23/2001	861	TRUE	0.272	2.68	TRUE	0.447	41.1	TRUE	0.228	82.1	TRUE	0.200
2	2-9/5/2000	09/05/2000	8300	TRUE	2.63	40.0	FALSE	3.33	50.0	FALSE	0.139	133	TRUE	0.324
2.5	2.5-4/23/2001	04/23/2001	17100	TRUE	5.41	0.945	TRUE	0.158	525	TRUE	2.92	159	TRUE	0.388
2.5	2.5-9/5/2000	09/05/2000	7900	TRUE	2.50	41.0	FALSE	3.42	328	TRUE	1.82	161	TRUE	0.393
3	3-4/24/2001	04/24/2001	192000	TRUE	60.8	1.59	TRUE	0.265	6720	TRUE	37.3	471	TRUE	1.15
3	3-8/12/2003	08/12/2003	6300	TRUE	1.99	--	--	--	1360	TRUE	7.56	150	TRUE	0.366
3	3-8/12/2003-EPA/TCEQ	08/12/2003	6120	TRUE	1.94	296	FALSE	24.7	1360	TRUE	7.56	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	83400	TRUE	26.4	616	FALSE	51.3	17000	TRUE	94.4	364	TRUE	0.888
3	3-9/6/2000	09/06/2000	20900	TRUE	6.60	40.0	FALSE	3.33	1080	TRUE	6.00	239	TRUE	0.583
4A	4A-4/24/2001	04/24/2001	2330	TRUE	0.736	40.0	FALSE	3.33	398	TRUE	2.21	303	TRUE	0.739
4A	4A-8/12/2003	08/12/2003	2120	TRUE	0.670	--	--	--	34600	TRUE	192	305	TRUE	0.744
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	1200	TRUE	0.380	435	FALSE	36.3	34600	TRUE	192	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	0.729	691	FALSE	57.6	150000	TRUE	833	429	TRUE	1.05
4A	4A-9/5/2000	09/05/2000	3130	TRUE	0.990	38.0	FALSE	3.17	1690	TRUE	9.39	311	TRUE	0.759
5	5-4/24/2001	04/24/2001	40000	TRUE	12.7	0.389	TRUE	0.065	1910	TRUE	10.6	710	TRUE	1.73
5	5-9/5/2000	09/05/2000	3100	TRUE	0.982	35.0	FALSE	2.92	780	TRUE	4.33	365	TRUE	0.890
6A	6A-4/25/2001	04/25/2001	1720	TRUE	0.545	40.0	FALSE	3.33	2060	TRUE	11.4	294	TRUE	0.717
6A	6A-8/12/2003	08/12/2003	6730	TRUE	2.13	--	--	--	10900	TRUE	60.6	353	TRUE	0.861
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	14400	TRUE	4.56	264	FALSE	22.0	10900	TRUE	60.6	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	407	TRUE	0.129	359	FALSE	29.9	7700	TRUE	42.8	191	TRUE	0.466
6A	6A-9/5/2000	09/05/2000	15200	TRUE	4.81	2.18	TRUE	0.363	9370	TRUE	52.1	249	TRUE	0.607
7	7-4/26/2001	04/26/2001	2990	TRUE	0.947	0.0700	TRUE	0.012	62.1	TRUE	0.345	1850	TRUE	4.51
7	7-8/12/2003	08/12/2003	151	TRUE	0.048	--	--	--	1980	TRUE	11.0	481	TRUE	1.17
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.036	229	FALSE	19.1	1980	TRUE	11.0	--	--	--
7	7-9/6/2000	09/06/2000	2840	TRUE	0.897	38.0	FALSE	3.17	62.8	TRUE	0.349	503	TRUE	1.23
8	8-4/25/2001	04/25/2001	20400	TRUE	6.46	0.681	TRUE	0.114	15.4	TRUE	0.086	154	TRUE	0.376
8	8-9/6/2000	09/06/2000	3510	TRUE	1.11	39.0	FALSE	3.25	51.0	FALSE	0.142	146	TRUE	0.356
9	9-8/12/2003	08/12/2003	1180	TRUE	0.373	--	--	--	48.0	FALSE	0.133	132	TRUE	0.322
9	9-8/12/2003-TCEQ	08/12/2003	1010	TRUE	0.320	240	FALSE	20.0	48.0	FALSE	0.133	--	--	--
9	9-9/6/2000	09/06/2000	23300	TRUE	7.37	42.0	FALSE	3.50	49.0	FALSE	0.136	102	TRUE	0.249
E	E-4/23/2001	04/23/2001	13000	TRUE	4.10	40.0	FALSE	3.33	1580	TRUE	8.78	257	TRUE	0.627
E	E-9/6/2000	09/06/2000	5500	TRUE	1.74	40.0	FALSE	3.33	370	TRUE	2.06	120	TRUE	0.293
G	G-4/24/2001	04/24/2001	851	TRUE	0.269	0.248	TRUE	0.041	197	TRUE	1.09	400	TRUE	0.976
G	G-9/6/2000	09/06/2000	1730	TRUE	0.547	41.0	FALSE	3.42	399	TRUE	2.22	277	TRUE	0.676
Q	Q-4/25/2001	04/25/2001	4510	TRUE	1.43	1.14	TRUE	0.190	1070	TRUE	5.94	1100	TRUE	2.68
Q	Q-9/5/2000	09/05/2000	8430	TRUE	2.67	2.97	TRUE	0.495	3780	TRUE	21.0	304	TRUE	0.741
R	R-4/26/2001	04/26/2001	5030	TRUE	1.59	40.0	FALSE	3.33	37.7	TRUE	0.209	479	TRUE	1.17
R	R-8/12/2003	08/12/2003	3030	TRUE	0.959	--	--	--	--	--	--	256	TRUE	0.624
R	R-9/5/2000	09/05/2000	3280	TRUE	1.04	3.41	TRUE	0.568	103	TRUE	0.572	1750	TRUE	4.27
S	S-4/24/2001	04/24/2001	52200	TRUE	16.5	0.230	TRUE	0.038	2090	TRUE	11.6	355	TRUE	0.866
S	S-9/5/2000	09/05/2000	2340	TRUE	0.740	39.0	FALSE	3.25	113	TRUE	0.628	189	TRUE	0.461
T	T-4/25/2001	04/25/2001	2210	TRUE	0.701	0.393	TRUE	0.066	626	TRUE	3.48	252	TRUE	0.615
T	T-9/5/2000	09/05/2000	1990	TRUE	0.630	38.0	FALSE	3.17	837	TRUE	4.65	281	TRUE	0.685
U	U-4/24/2001	04/24/2001	218	TRUE	0.069	0.302	TRUE	0.050	12.8	TRUE	0.071	50.9	TRUE	0.124
U	U-9/6/2000	09/06/2000	1090	TRUE	0.344	40.0	FALSE	3.33	78.8	TRUE	0.438	54.3	TRUE	0.132
V	V-4/23/2001	04/23/2001	7300	TRUE	2.31	0.306	TRUE	0.051	442	TRUE	2.46	295	TRUE	0.720
V	V-9/5/2000	09/05/2000	9670	TRUE	3.06	40.0	FALSE	3.33	447	TRUE	2.48	310	TRUE	0.756
Y	Y-4/26/2001	04/26/2001	414	TRUE	0.131	0.112	TRUE	0.019	58.1	TRUE	0.323	73.9	TRUE	0.180
Y	Y-9/6/2000	09/06/2000	165000	TRUE	52.1	40.0	FALSE	3.33	2570	TRUE	14.3	1540	TRUE	3.76

Table B-2
Toxicity Data and Probable Effects Concentration Quotients (PEC-Q) Used in Toxicity Model Evaluations

					4,4'-DDD (p,p'-DDD)			4,4'-DDE (p,p'-DDE)			4,4'-DDT (p,p'-DDT)			Anthracene			Arsenic			Benzo(a)anthracene		
Location	Sample ID	Sample Date	L. plumulosus survival (control adjusted; %)	Toxic (< 80% survival)	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q
10	10-4/25/2001	04/25/2001	84.6	FALSE	40	FALSE	0.714	0.24	TRUE	0.008	79.4	TRUE	1.26	44.3	TRUE	0.052	15.7	TRUE	0.476	491	FALSE	0.234
10	10-9/5/2000	09/05/2000	98.4	FALSE	38	FALSE	0.679	3.07	TRUE	0.098	38	FALSE	0.302	795	TRUE	0.941	4.05	TRUE	0.123	1270	TRUE	1.21
2	2-4/23/2001	04/23/2001	87.7	FALSE	0.525	TRUE	0.019	2.47	TRUE	0.079	1.14	TRUE	0.018	57.4	TRUE	0.068	11.9	TRUE	0.361	86.7	TRUE	0.083
2	2-9/5/2000	09/05/2000	94.3	FALSE	40	FALSE	0.714	3	FALSE	0.048	40	FALSE	0.318	538	TRUE	0.637	2.91	TRUE	0.088	364	TRUE	0.347
2.5	2.5-4/23/2001	04/23/2001	86.7	FALSE	40	FALSE	0.714	136	TRUE	4.35	0.263	TRUE	0.004	1200	TRUE	1.42	9.64	TRUE	0.292	752	TRUE	0.716
2.5	2.5-9/5/2000	09/05/2000	90.2	FALSE	41	FALSE	0.732	6.39	TRUE	0.204	41	FALSE	0.326	598	TRUE	0.708	2.85	TRUE	0.086	538	TRUE	0.512
3	3-4/24/2001	04/24/2001	0	TRUE	4.28	TRUE	0.153	40	FALSE	0.639	9.74	TRUE	0.155	22500	TRUE	26.6	10.6	TRUE	0.321	6790	TRUE	6.47
3	3-8/12/2003	08/12/2003	95	FALSE	--	--	--	--	--	--	--	--	--	611.9	TRUE	0.724	2.98	TRUE	0.090	665.1	TRUE	0.633
3	3-8/12/2003-EPA/TCEQ	08/12/2003	--	--	29.6	FALSE	0.529	29.6	FALSE	0.473	34.8	TRUE	0.553	629	TRUE	0.744	--	--	--	696	FALSE	0.331
3	3-8/31/2006-TCEQ	08/31/2006	--	--	61.6	FALSE	1.1	61.6	FALSE	0.984	123	FALSE	0.978	8830	TRUE	10.4	11.6	FALSE	0.176	4120	FALSE	1.96
3	3-9/6/2000	09/06/2000	75.6	TRUE	40	FALSE	0.714	8.45	TRUE	0.270	40	FALSE	0.318	2670	TRUE	3.16	3.53	TRUE	0.107	1160	TRUE	1.10
4A	4A-4/24/2001	04/24/2001	6.27	TRUE	40	FALSE	0.714	2.43	TRUE	0.078	40	FALSE	0.318	465	TRUE	0.550	10	TRUE	0.303	959	TRUE	0.913
4A	4A-8/12/2003	08/12/2003	30	TRUE	--	--	--	--	--	--	--	--	--	459.2	TRUE	0.543	4.23	TRUE	0.128	707.2	TRUE	0.674
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	53.7	TRUE	1.918	43.5	FALSE	0.695	43.5	FALSE	0.346	436	FALSE	0.258	--	--	--	1090	FALSE	0.519
4A	4A-8/31/2006-TCEQ	08/31/2006	--	--	69.1	FALSE	1.234	69.1	FALSE	1.10	138	FALSE	1.10	4610	FALSE	2.73	11.5	FALSE	0.174	4610	FALSE	2.20
4A	4A-9/5/2000	09/05/2000	89.1	FALSE	38	FALSE	0.679	8.57	TRUE	0.274	38	FALSE	0.302	321	TRUE	0.380	3.32	TRUE	0.101	983	TRUE	0.936
5	5-4/24/2001	04/24/2001	0	TRUE	2.47	TRUE	0.088	4.76	TRUE	0.152	1.71	TRUE	0.027	5640	TRUE	6.67	12.3	TRUE	0.373	2730	TRUE	2.6
5	5-9/5/2000	09/05/2000	103	FALSE	35	FALSE	0.625	6.72	TRUE	0.215	35	FALSE	0.278	400	TRUE	0.473	3.09	TRUE	0.094	726	TRUE	0.691
6A	6A-4/25/2001	04/25/2001	0	TRUE	40	FALSE	0.714	40	FALSE	0.639	40	FALSE	0.318	342	TRUE	0.405	11.4	TRUE	0.345	391	TRUE	0.372
6A	6A-8/12/2003	08/12/2003	31	TRUE	--	--	--	--	--	--	--	--	--	773.5	TRUE	0.915	3.12	TRUE	0.095	480.7	TRUE	0.458
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	31.2	TRUE	1.11	26.4	FALSE	0.422	1990	TRUE	31.6	2330	TRUE	2.76	--	--	--	1130	TRUE	1.08
6A	6A-8/31/2006-TCEQ	08/31/2006	--	--	35.9	FALSE	0.641	35.9	FALSE	0.573	71.9	FALSE	0.572	2390	FALSE	1.41	6.61	FALSE	0.100	2390	FALSE	1.14
6A	6A-9/5/2000	09/05/2000	24.9	TRUE	39	FALSE	0.696	14.9	TRUE	0.476	39	FALSE	0.310	2510	TRUE	2.97	5.37	TRUE	0.163	4400	TRUE	4.19
7	7-4/26/2001	04/26/2001	91.9	FALSE	0.701	TRUE	0.025	6.02	TRUE	0.192	40	FALSE	0.318	322	TRUE	0.381	96.8	TRUE	2.93	1160	TRUE	1.10
7	7-8/12/2003	08/12/2003	91	FALSE	--	--	--	--	--	--	--	--	--	13	FALSE	0.008	15.2	TRUE	0.461	111.9	TRUE	0.107
7	7-8/12/2003-EPA/TCEQ	08/12/2003	--	--	22.9	FALSE	0.409	22.9	FALSE	0.366	22.9	FALSE	0.182	229	FALSE	0.136	--	--	--	572	FALSE	0.272
7	7-9/6/2000	09/06/2000	5.18	TRUE	38	FALSE	0.679	9.45	TRUE	0.302	79.4	TRUE	1.26	296	TRUE	0.350	29.6	TRUE	0.897	1080	TRUE	1.03
8	8-4/25/2001	04/25/2001	0	TRUE	0.228	TRUE	0.008	40	FALSE	0.639	1.03	TRUE	0.016	2140	TRUE	2.53	6.55	TRUE	0.198	13600	TRUE	13.0
8	8-9/6/2000	09/06/2000	94.3	FALSE	39	FALSE	0.696	9.51	TRUE	0.304	72.4	TRUE	1.15	342	TRUE	0.405	19.4	TRUE	0.588	1920	TRUE	1.83
9	9-8/12/2003	08/12/2003	92	FALSE	--	--	--	--	--	--	--	--	--	92.4	TRUE	0.109	3.13	TRUE	0.095	733.2	TRUE	0.698
9	9-8/12/2003-TCEQ	08/12/2003	--	--	24	FALSE	0.429	24	FALSE	0.383	24	FALSE	0.191	245	FALSE	0.145	--	--	--	674	TRUE	0.642
9	9-9/6/2000	09/06/2000	52.8	TRUE	42	FALSE	0.750	8.11	TRUE	0.259	42	FALSE	0.334	2650	TRUE	3.14	2.68	TRUE	0.081	12500	TRUE	11.9
E	E-4/23/2001	04/23/2001	57.4	TRUE	40	FALSE	0.714	4.06	TRUE	0.130	40	FALSE	0.318	1680	TRUE	1.99	7.78	TRUE	0.236	1680	TRUE	1.6
E	E-9/6/2000	09/06/2000	104	FALSE	40	FALSE	0.714	5.54	TRUE	0.177	40	FALSE	0.318	427	TRUE	0.505	2.15	TRUE	0.065	400	FALSE	0.190
G	G-4/24/2001	04/24/2001	93	FALSE	0.14	TRUE	0.005	0.211	TRUE	0.007	0.095	TRUE	0.002	89.6	TRUE	0.106	12.6	TRUE	0.382	739	TRUE	0.704
G	G-9/6/2000	09/06/2000	104	FALSE	41	FALSE	0.732	5.99	TRUE	0.191	41	FALSE	0.326	230	TRUE	0.272	4.98	TRUE	0.151	1070	TRUE	1.02
Q	Q-4/25/2001	04/25/2001	4.18	TRUE	3.63	TRUE	0.130	1.01	TRUE	0.032	1.18	TRUE	0.019	1350	TRUE	1.60	12.7	TRUE	0.385	991	TRUE	0.944
Q	Q-9/5/2000	09/05/2000	79.8	FALSE	39	FALSE	0.696	14.8	TRUE	0.473	39	FALSE	0.310	1490	TRUE	1.76	5.23	TRUE	0.158	1860	TRUE	1.77
R	R-4/26/2001	04/26/2001	78.3	TRUE	0.073	TRUE	0.003	2.07	TRUE	0.066	0.238	TRUE	0.004	403	TRUE	0.477	29.8	TRUE	0.903	2260	TRUE	2.15
R	R-8/12/2003	08/12/2003	98	FALSE	--	--	--	--	--	--	--	--	--	316.7	TRUE	0.375	11.1	TRUE	0.336	1963	TRUE	1.87
R	R-9/5/2000	09/05/2000	87	FALSE	38	FALSE	0.679	5.23	TRUE	0.167	38	FALSE	0.302	335	TRUE	0.396	164	TRUE	4.97	1620	TRUE	1.54
S	S-4/24/2001	04/24/2001	65.8	TRUE	2.63	TRUE	0.094	40	FALSE	0.639	5.65	TRUE	0.090	6520	TRUE	7.72	12	TRUE	0.364	2440	TRUE	2.32
S	S-9/5/2000	09/05/2000	99.5	FALSE	39	FALSE	0.696	7.24	TRUE	0.231	39	FALSE	0.310	184	TRUE	0.218	4.39	TRUE	0.133	392	FALSE	0.187
T	T-4/25/2001	04/25/2001	72.1	TRUE	40	FALSE	0.714	40	FALSE	0.639	0.476	TRUE	0.008	326	TRUE	0.386	11.4	TRUE	0.345	1240	TRUE	1.18
T	T-9/5/2000	09/05/2000	91.2	FALSE	38	FALSE	0.679	7.49	TRUE	0.239	38	FALSE	0.302	264	TRUE	0.312	4.73	TRUE	0.143	716	TRUE	0.682
U	U-4/24/2001	04/24/2001	82.5	FALSE	40	FALSE	0.714	0.178	TRUE	0.006	0.038	TRUE	0.001	23.2	TRUE	0.027	10.3	TRUE	0.312	660	FALSE	0.314
U	U-9/6/2000	09/06/2000	98.4	FALSE	40	FALSE	0.714	6.63	TRUE	0.212	40	FALSE	0.318	119	TRUE	0.141	3.11	TRUE	0.094	400	FALSE	0.190
V	V-4/23/2001	04/23/2001	79.4	TRUE	0.979	TRUE	0.035	3.45	TRUE	0.110	2.04	TRUE	0.032	774	TRUE	0.916	12	TRUE	0.364	807	TRUE	0.769
V	V-9/5/2000	09/05/2000	102	FALSE	40	FALSE	0.714	20.5	TRUE	0.655	40	FALSE	0.318	803	TRUE	0.950	4.31	TRUE	0.131	550	TRUE	0.524
Y	Y-4/26/2001	04/26/2001	95	FALSE	0.144	TRUE	0.005	1.77	TRUE	0.057	40	FALSE	0.318	34.1	TRUE	0.040	14.7	TRUE	0.445	189	TRUE	0.180
Y	Y-9/6/2000	09/06/2000	0	TRUE	40	FALSE	0.714	3	FALSE	0.048	40	FALSE	0.318	14000	TRUE	16.6	31.8	TRUE	0.964	3260	TRUE	3.10

Table B-2
Toxicity Data and Probable Effects Concentration Quotients (PEC-Q) Used in Toxicity Model Evaluations

			Benzo(a)pyrene			Cadmium			Chlordane (technical)			Chlordane			Chromium			Chrysene			Copper		
Location	Sample ID	Sample Date	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q
10	10-4/25/2001	04/25/2001	720	FALSE	0.248	0.165	TRUE	0.033	--	--	--	--	--	--	28	TRUE	0.252	356	TRUE	0.276	14.5	TRUE	0.097
10	10-9/5/2000	09/05/2000	1220	TRUE	0.841	0.187	TRUE	0.038	--	--	--	--	--	--	31.4	TRUE	0.283	1730	TRUE	1.34	21.3	TRUE	0.143
2	2-4/23/2001	04/23/2001	93.7	TRUE	0.065	0.162	TRUE	0.033	--	--	--	--	--	--	32.4	TRUE	0.292	264	TRUE	0.205	27.7	TRUE	0.186
2	2-9/5/2000	09/05/2000	539	TRUE	0.372	0.313	TRUE	0.063	--	--	--	--	--	--	58.5	TRUE	0.527	638	TRUE	0.495	40.1	TRUE	0.269
2.5	2.5-4/23/2001	04/23/2001	1420	TRUE	0.979	0.386	TRUE	0.078	--	--	--	--	--	--	43.8	TRUE	0.395	1320	TRUE	1.02	42	TRUE	0.282
2.5	2.5-9/5/2000	09/05/2000	1720	TRUE	1.19	0.365	TRUE	0.073	--	--	--	--	--	--	47.5	TRUE	0.428	1060	TRUE	0.822	40.9	TRUE	0.274
3	3-4/24/2001	04/24/2001	5030	TRUE	3.47	1.62	TRUE	0.325	--	--	--	--	--	--	440	TRUE	3.96	7960	TRUE	6.17	170	TRUE	1.14
3	3-8/12/2003	08/12/2003	725.2	TRUE	0.500	0.452	TRUE	0.091	--	--	--	--	--	--	53.7	TRUE	0.484	794.8	TRUE	0.616	34.6	TRUE	0.232
3	3-8/12/2003-EPA/TCEQ	08/12/2003	801	TRUE	0.552	--	--	--	296	FALSE	8.41	--	--	--	--	--	--	893	TRUE	0.692	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	4120	FALSE	1.42	1.59	FALSE	0.160	616	FALSE	17.5	616	FALSE	17.5	237	TRUE	2.14	2640	TRUE	2.05	133	TRUE	0.893
3	3-9/6/2000	09/06/2000	1410	TRUE	0.972	0.38	TRUE	0.076	--	--	--	--	--	--	111	TRUE	1.00	1640	TRUE	1.27	51.7	TRUE	0.347
4A	4A-4/24/2001	04/24/2001	1360	TRUE	0.938	1.32	TRUE	0.265	--	--	--	--	--	--	82.1	TRUE	0.740	1870	TRUE	1.45	57.5	TRUE	0.386
4A	4A-8/12/2003	08/12/2003	804.6	TRUE	0.555	0.772	TRUE	0.155	--	--	--	--	--	--	91.6	TRUE	0.825	740.7	TRUE	0.574	48.2	TRUE	0.323
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	1210	TRUE	0.834	--	--	--	435	FALSE	12.4	--	--	--	--	--	--	1190	TRUE	0.922	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	1.59	1.57	FALSE	0.158	691	FALSE	19.6	691	FALSE	19.6	148	TRUE	1.33	4610	FALSE	1.79	63.5	TRUE	0.426
4A	4A-9/5/2000	09/05/2000	385	FALSE	0.133	0.719	TRUE	0.144	--	--	--	--	--	--	123	TRUE	1.11	1670	TRUE	1.29	65	TRUE	0.436
5	5-4/24/2001	04/24/2001	2990	TRUE	2.06	1.26	TRUE	0.253	--	--	--	--	--	--	359	TRUE	3.23	3980	TRUE	3.09	99.5	TRUE	0.668
5	5-9/5/2000	09/05/2000	351	FALSE	0.121	0.704	TRUE	0.141	--	--	--	--	--	--	137	TRUE	1.23	1190	TRUE	0.922	66.6	TRUE	0.447
6A	6A-4/25/2001	04/25/2001	720	FALSE	0.248	0.361	TRUE	0.072	--	--	--	--	--	--	56	TRUE	0.505	664	TRUE	0.515	34.8	TRUE	0.234
6A	6A-8/12/2003	08/12/2003	355.8	TRUE	0.245	1.16	TRUE	0.233	--	--	--	--	--	--	77.6	TRUE	0.699	506	TRUE	0.392	71	TRUE	0.477
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	1000	TRUE	0.690	--	--	--	264	FALSE	7.50	--	--	--	--	--	--	1350	TRUE	1.05	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	2390	FALSE	0.824	0.901	FALSE	0.090	359	FALSE	10.2	359	FALSE	10.2	41.3	TRUE	0.372	685	TRUE	0.531	36.9	TRUE	0.248
6A	6A-9/5/2000	09/05/2000	3750	TRUE	2.59	0.288	TRUE	0.058	--	--	--	--	--	--	63.7	TRUE	0.574	5820	TRUE	4.51	24.3	TRUE	0.163
7	7-4/26/2001	04/26/2001	1320	TRUE	0.910	1.14	TRUE	0.229	--	--	--	--	--	--	268	TRUE	2.41	1960	TRUE	1.52	301	TRUE	2.02
7	7-8/12/2003	08/12/2003	112.8	TRUE	0.078	0.708	TRUE	0.142	--	--	--	--	--	--	10.2	TRUE	0.092	140.3	TRUE	0.109	96.1	TRUE	0.645
7	7-8/12/2003-EPA/TCEQ	08/12/2003	572	FALSE	0.197	--	--	--	229	FALSE	6.51	--	--	--	--	--	--	572	FALSE	0.222	--	--	--
7	7-9/6/2000	09/06/2000	1320	TRUE	0.910	0.548	TRUE	0.110	--	--	--	--	--	--	42.1	TRUE	0.379	1990	TRUE	1.54	72.7	TRUE	0.488
8	8-4/25/2001	04/25/2001	14800	TRUE	10.2	0.278	TRUE	0.056	--	--	--	--	--	--	20	TRUE	0.180	20100	TRUE	15.6	19.3	TRUE	0.130
8	8-9/6/2000	09/06/2000	2100	TRUE	1.45	0.484	TRUE	0.097	--	--	--	--	--	--	21.9	TRUE	0.197	3120	TRUE	2.42	15.8	TRUE	0.106
9	9-8/12/2003	08/12/2003	755.4	TRUE	0.521	0.335	TRUE	0.067	--	--	--	--	--	--	6.04	TRUE	0.054	958.1	TRUE	0.743	8.38	TRUE	0.056
9	9-8/12/2003-TCEQ	08/12/2003	1030	TRUE	0.710	--	--	--	240	FALSE	6.82	--	--	--	--	--	--	1430	TRUE	1.11	--	--	--
9	9-9/6/2000	09/06/2000	13000	TRUE	8.97	0.235	TRUE	0.047	--	--	--	--	--	--	16.6	TRUE	0.150	17400	TRUE	13.5	11.5	TRUE	0.077
E	E-4/23/2001	04/23/2001	2380	TRUE	1.64	0.524	TRUE	0.105	--	--	--	--	--	--	56.1	TRUE	0.505	3090	TRUE	2.40	55	TRUE	0.369
E	E-9/6/2000	09/06/2000	660	FALSE	0.228	0.234	TRUE	0.047	--	--	--	--	--	--	55	TRUE	0.495	434	TRUE	0.336	29.9	TRUE	0.201
G	G-4/24/2001	04/24/2001	793	TRUE	0.547	0.382	TRUE	0.077	--	--	--	--	--	--	54.4	TRUE	0.490	1290	TRUE	1.00	79.1	TRUE	0.531
G	G-9/6/2000	09/06/2000	1170	TRUE	0.807	0.183	TRUE	0.037	--	--	--	--	--	--	46.3	TRUE	0.417	1670	TRUE	1.29	65.3	TRUE	0.438
Q	Q-4/25/2001	04/25/2001	1050	TRUE	0.724	1.84	TRUE	0.369	--	--	--	--	--	--	380	TRUE	3.42	1770	TRUE	1.37	180	TRUE	1.21
Q	Q-9/5/2000	09/05/2000	1960	TRUE	1.35	0.35	TRUE	0.070	--	--	--	--	--	--	40.9	TRUE	0.368	3040	TRUE	2.36	25.6	TRUE	0.172
R	R-4/26/2001	04/26/2001	2300	TRUE	1.59	0.411	TRUE	0.083	--	--	--	--	--	--	457	TRUE	4.12	3540	TRUE	2.74	70.3	TRUE	0.472
R	R-8/12/2003	08/12/2003	1937	TRUE	1.34	0.596	TRUE	0.120	--	--	--	--	--	--	17.9	TRUE	0.161	2067	TRUE	1.60	221	TRUE	1.48
R	R-9/5/2000	09/05/2000	1640	TRUE	1.13	1.03	TRUE	0.207	--	--	--	--	--	--	73	TRUE	0.658	2400	TRUE	1.86	271	TRUE	1.82
S	S-4/24/2001	04/24/2001	3510	TRUE	2.42	0.268	TRUE	0.054	--	--	--	--	--	--	182	TRUE	1.64	3440	TRUE	2.67	80.2	TRUE	0.538
S	S-9/5/2000	09/05/2000	392	FALSE	0.135	0.436	TRUE	0.088	--	--	--	--	--	--	73.9	TRUE	0.666	423	TRUE	0.328	104	TRUE	0.698
T	T-4/25/2001	04/25/2001	1490	TRUE	1.03	0.376	TRUE	0.076	--	--	--	--	--	--	40.7	TRUE	0.367	2300	TRUE	1.78	37.9	TRUE	0.254
T	T-9/5/2000	09/05/2000	830	TRUE	0.572	0.415	TRUE	0.083	--	--	--	--	--	--	84.4	TRUE	0.760	1160	TRUE	0.899	52.3	TRUE	0.351
U	U-4/24/2001	04/24/2001	--	--	--	0.091	TRUE	0.018	--	--	--	--	--	--	40.1	TRUE	0.361	--	--	--	15.5	TRUE	0.104
U	U-9/6/2000	09/06/2000	400	FALSE	0.138	0.087	TRUE	0.017	--	--	--	--	--	--	29.4	TRUE	0.265	254	TRUE	0.197	14.9	TRUE	0.100
V	V-4/23/2001	04/23/2001	1300	TRUE	0.897	0.712	TRUE	0.143	--	--	--	--	--	--	73.8	TRUE	0.665	1580	TRUE	1.22	62.3	TRUE	0.418
V	V-9/5/2000	09/05/2000	1160	TRUE	0.800	0.642	TRUE	0.129	--	--	--	--	--	--	92.9	TRUE	0.837	1040	TRUE	0.806	69.9	TRUE	0.469
Y	Y-4/26/2001	04/26/2001	222	TRUE	0.153	0.169	TRUE	0.034	--	--	--	--	--	--	42.1	TRUE	0.379	397	TRUE	0.308	18.3	TRUE	0.123
Y	Y-9/6/2000	09/06/2000	400	FALSE	0.138	1.52	TRUE	0.305	--	--	--	--	--	--	63.9	TRUE	0.576	6150	TRUE	4.77	47.1	TRUE	0.316

Table B-2
Toxicity Data and Probable Effects Concentration Quotients (PEC-Q) Used in Toxicity Model Evaluations

			Dieldrin			Endrin			Fluoranthene			Fluorene			gamma-BHC (Lindane)			Heptachlor epoxide			Lead		
Location	Sample ID	Sample Date	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q
10	10-4/25/2001	04/25/2001	--	--	--	--	--	--	145	TRUE	0.065	10.3	TRUE	0.019	--	--	--	40	FALSE	1.25	20.1	TRUE	0.157
10	10-9/5/2000	09/05/2000	--	--	--	--	--	--	3950	TRUE	1.77	472	TRUE	0.881	--	--	--	38	FALSE	1.19	9.55	TRUE	0.075
2	2-4/23/2001	04/23/2001	--	--	--	--	--	--	1000	TRUE	0.448	59.7	TRUE	0.111	--	--	--	7.94	TRUE	0.496	22.2	TRUE	0.173
2	2-9/5/2000	09/05/2000	--	--	--	--	--	--	2680	TRUE	1.20	901	TRUE	1.68	--	--	--	40	FALSE	1.25	21.7	TRUE	0.170
2.5	2.5-4/23/2001	04/23/2001	--	--	--	--	--	--	7010	TRUE	3.14	2070	TRUE	3.86	--	--	--	0.41	TRUE	0.026	34.8	TRUE	0.272
2.5	2.5-9/5/2000	09/05/2000	--	--	--	--	--	--	4760	TRUE	2.13	729	TRUE	1.36	--	--	--	41	FALSE	1.28	30	TRUE	0.234
3	3-4/24/2001	04/24/2001	--	--	--	--	--	--	125	TRUE	0.056	32700	TRUE	61.0	--	--	--	0.338	TRUE	0.021	308	TRUE	2.41
3	3-8/12/2003	08/12/2003	--	--	--	--	--	--	2587	TRUE	1.16	695	TRUE	1.30	--	--	--	--	--	--	43.4	TRUE	0.339
3	3-8/12/2003-EPA/TCEQ	08/12/2003	29.6	FALSE	0.239	29.6	FALSE	0.071	2920	TRUE	1.31	586	TRUE	1.09	14.8	FALSE	1.48	14.8	FALSE	0.463	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	61.6	FALSE	0.498	61.6	FALSE	0.149	8090	TRUE	3.63	11200	TRUE	20.9	61.6	FALSE	6.17	61.6	FALSE	1.93	498	TRUE	3.89
3	3-9/6/2000	09/06/2000	--	--	--	--	--	--	4720	TRUE	2.12	2100	TRUE	3.92	--	--	--	40	FALSE	1.25	67.7	TRUE	0.529
4A	4A-4/24/2001	04/24/2001	--	--	--	--	--	--	2680	TRUE	1.20	298	TRUE	0.556	--	--	--	40	FALSE	1.25	39.7	TRUE	0.310
4A	4A-8/12/2003	08/12/2003	--	--	--	--	--	--	2341	TRUE	1.05	162.5	TRUE	0.303	--	--	--	--	--	--	55.9	TRUE	0.437
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	43.5	FALSE	0.352	43.5	FALSE	0.105	2690	TRUE	1.21	436	FALSE	0.407	21.8	FALSE	2.18	21.8	FALSE	0.681	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	69.1	FALSE	0.559	69.1	FALSE	0.167	5230	TRUE	2.35	4610	FALSE	4.30	69.1	FALSE	6.92	69.1	FALSE	2.16	58.8	TRUE	0.459
4A	4A-9/5/2000	09/05/2000	--	--	--	--	--	--	2260	TRUE	1.01	214	TRUE	0.399	--	--	--	38	FALSE	1.19	36	TRUE	0.281
5	5-4/24/2001	04/24/2001	--	--	--	--	--	--	5290	TRUE	2.37	7630	TRUE	14.2	--	--	--	0.307	TRUE	0.019	125	TRUE	0.977
5	5-9/5/2000	09/05/2000	--	--	--	--	--	--	1670	TRUE	0.749	311	TRUE	0.580	--	--	--	35	FALSE	1.09	39.5	TRUE	0.309
6A	6A-4/25/2001	04/25/2001	--	--	--	--	--	--	1100	TRUE	0.493	61	TRUE	0.114	--	--	--	40	FALSE	1.25	50.6	TRUE	0.395
6A	6A-8/12/2003	08/12/2003	--	--	--	--	--	--	982.7	TRUE	0.441	576.8	TRUE	1.08	--	--	--	--	--	--	76.6	TRUE	0.598
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	26.4	FALSE	0.214	26.4	FALSE	0.064	2490	TRUE	1.12	1700	TRUE	3.17	13.2	FALSE	1.32	13.2	FALSE	0.413	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	35.9	FALSE	0.290	35.9	FALSE	0.087	1300	TRUE	0.583	2390	FALSE	2.23	35.9	FALSE	3.60	35.9	FALSE	1.12	23.3	TRUE	0.182
6A	6A-9/5/2000	09/05/2000	--	--	--	--	--	--	11400	TRUE	5.11	559	TRUE	1.04	--	--	--	39	FALSE	1.22	34.6	TRUE	0.270
7	7-4/26/2001	04/26/2001	--	--	--	--	--	--	3540	TRUE	1.59	168	TRUE	0.313	--	--	--	40	FALSE	1.25	144	TRUE	1.125
7	7-8/12/2003	08/12/2003	--	--	--	--	--	--	294.3	TRUE	0.132	12.8	FALSE	0.012	--	--	--	--	--	--	58.9	TRUE	0.460
7	7-8/12/2003-EPA/TCEQ	08/12/2003	22.9	FALSE	0.185	22.9	FALSE	0.055	229	FALSE	0.051	229	FALSE	0.214	11.4	FALSE	1.14	11.4	FALSE	0.356	--	--	--
7	7-9/6/2000	09/06/2000	--	--	--	--	--	--	2930	TRUE	1.31	246	TRUE	0.459	--	--	--	38	FALSE	1.19	523	TRUE	4.09
8	8-4/25/2001	04/25/2001	--	--	--	--	--	--	36700	TRUE	16.5	766	TRUE	1.43	--	--	--	40	FALSE	1.25	26.4	TRUE	0.206
8	8-9/6/2000	09/06/2000	--	--	--	--	--	--	5370	TRUE	2.41	114	TRUE	0.213	--	--	--	39	FALSE	1.22	52.7	TRUE	0.412
9	9-8/12/2003	08/12/2003	--	--	--	--	--	--	2020	TRUE	0.906	61.7	TRUE	0.115	--	--	--	--	--	--	54.3	TRUE	0.424
9	9-8/12/2003-TCEQ	08/12/2003	24	FALSE	0.194	24	FALSE	0.058	2490	TRUE	1.12	245	FALSE	0.229	12	FALSE	1.20	12	FALSE	0.375	--	--	--
9	9-9/6/2000	09/06/2000	--	--	--	--	--	--	34800	TRUE	15.6	995	TRUE	1.86	--	--	--	42	FALSE	1.31	36.2	TRUE	0.283
E	E-4/23/2001	04/23/2001	--	--	--	--	--	--	7620	TRUE	3.42	1520	TRUE	2.84	--	--	--	40	FALSE	1.25	47.5	TRUE	0.371
E	E-9/6/2000	09/06/2000	--	--	--	--	--	--	2130	TRUE	0.955	560	TRUE	1.04	--	--	--	40	FALSE	1.25	25	TRUE	0.195
G	G-4/24/2001	04/24/2001	--	--	--	--	--	--	2060	TRUE	0.924	28.1	TRUE	0.052	--	--	--	0.576	TRUE	0.036	52	TRUE	0.406
G	G-9/6/2000	09/06/2000	--	--	--	--	--	--	2720	TRUE	1.22	97.9	TRUE	0.183	--	--	--	41	FALSE	1.28	39.8	TRUE	0.311
Q	Q-4/25/2001	04/25/2001	--	--	--	--	--	--	84.9	TRUE	0.038	131	TRUE	0.244	--	--	--	40	FALSE	1.25	193	TRUE	1.51
Q	Q-9/5/2000	09/05/2000	--	--	--	--	--	--	5040	TRUE	2.26	460	TRUE	0.858	--	--	--	39	FALSE	1.22	27.3	TRUE	0.213
R	R-4/26/2001	04/26/2001	--	--	--	--	--	--	6460	TRUE	2.90	236	TRUE	0.440	--	--	--	40	FALSE	1.25	47.2	TRUE	0.369
R	R-8/12/2003	08/12/2003	--	--	--	--	--	--	5446	TRUE	2.44	116.7	TRUE	0.218	--	--	--	--	--	--	46.3	TRUE	0.362
R	R-9/5/2000	09/05/2000	--	--	--	--	--	--	4230	TRUE	1.90	173	TRUE	0.323	--	--	--	38	FALSE	1.19	260	TRUE	2.03125
S	S-4/24/2001	04/24/2001	--	--	--	--	--	--	269	TRUE	0.121	4970	TRUE	9.27	--	--	--	1.26	TRUE	0.079	124	TRUE	0.969
S	S-9/5/2000	09/05/2000	--	--	--	--	--	--	1070	TRUE	0.480	260	TRUE	0.485	--	--	--	39	FALSE	1.22	47.8	TRUE	0.373
T	T-4/25/2001	04/25/2001	--	--	--	--	--	--	3490	TRUE	1.57	222	TRUE	0.414	--	--	--	0.319	TRUE	0.020	127	TRUE	0.992
T	T-9/5/2000	09/05/2000	--	--	--	--	--	--	1710	TRUE	0.767	153	TRUE	0.285	--	--	--	38	FALSE	1.19	28.9	TRUE	0.226
U	U-4/24/2001	04/24/2001	--	--	--	--	--	--	76.4	TRUE	0.034	18.1	TRUE	0.034	--	--	--	40	FALSE	1.25	16.8	TRUE	0.131
U	U-9/6/2000	09/06/2000	--	--	--	--	--	--	337	TRUE	0.151	125	TRUE	0.233	--	--	--	40	FALSE	1.25	15	TRUE	0.117
V	V-4/23/2001	04/23/2001	--	--	--	--	--	--	4010	TRUE	1.80	802	TRUE	1.50	--	--	--	40	FALSE	1.25	50.9	TRUE	0.398
V	V-9/5/2000	09/05/2000	--	--	--	--	--	--	3840	TRUE	1.72	824	TRUE	1.54	--	--	--	40	FALSE	1.25	48.2	TRUE	0.377
Y	Y-4/26/2001	04/26/2001	--	--	--	--	--	--	518	TRUE	0.232	18.1	TRUE	0.034	--	--	--	0.278	TRUE	0.017	33	TRUE	0.258
Y	Y-9/6/2000	09/06/2000	--	--	--	--	--	--	9810	TRUE	4.40	12000	TRUE	22.4	--	--	--	40	FALSE	1.25	41.8	TRUE	0.327

Table B-2
Toxicity Data and Probable Effects Concentration Quotients (PEC-Q) Used in Toxicity Model Evaluations

			Mercury			Naphthalene			Nickel			Phenanthrene			Pyrene			Sum 4,4 DDT, DDE, DDD (U=0)			Total 16 PAH (U = 0)		
Location	Sample ID	Sample Date	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q
10	10-4/25/2001	04/25/2001	0.064	TRUE	0.060	33.6	TRUE	0.060	16.5	TRUE	0.340	146	TRUE	0.125	126	TRUE	0.083	79.64	TRUE	1.27	1316.1	TRUE	0.058
10	10-9/5/2000	09/05/2000	0.082	TRUE	0.077	116	TRUE	0.207	13.6	TRUE	0.280	4280	TRUE	3.66	3020	TRUE	1.99	3.07	TRUE	0.049	20982.9	TRUE	0.920
2	2-4/23/2001	04/23/2001	1	TRUE	0.943	255	TRUE	0.455	27.2	TRUE	0.560	338	TRUE	0.289	1910	TRUE	1.26	4.135	TRUE	0.066	7125.7	TRUE	0.313
2	2-9/5/2000	09/05/2000	1.94	TRUE	1.83	1150	TRUE	2.05	63.3	TRUE	1.30	3140	TRUE	2.68	4350	TRUE	2.86	40	FALSE	0.318	18409	TRUE	0.807
2.5	2.5-4/23/2001	04/23/2001	2.35	TRUE	2.22	924	TRUE	1.65	21.2	TRUE	0.436	8650	TRUE	7.39	11400	TRUE	7.5	136.263	TRUE	2.17	43235	TRUE	1.90
2.5	2.5-9/5/2000	09/05/2000	2.91	TRUE	2.75	652	TRUE	1.16	21.8	TRUE	0.449	3250	TRUE	2.78	8880	TRUE	5.84	6.39	TRUE	0.102	30858	TRUE	1.35
3	3-4/24/2001	04/24/2001	160	TRUE	150.9433962	23500	TRUE	41.9	103	TRUE	2.12	71500	TRUE	61.1	265	TRUE	0.174	14.02	TRUE	0.223	230683	TRUE	10.1
3	3-8/12/2003	08/12/2003	9.02	TRUE	8.51	328.1	TRUE	0.585	15.6	TRUE	0.321	2035	TRUE	1.74	5178	TRUE	3.41	--	--	--	18235.5	TRUE	0.800
3	3-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	--	--	--	--	--	--	2910	TRUE	2.49	6910	TRUE	4.55	34.8	TRUE	0.553	18505	TRUE	0.812
3	3-8/31/2006-TCEQ	08/31/2006	159	TRUE	150	10300	TRUE	18.4	115	TRUE	2.37	34300	TRUE	29.3	17400	TRUE	11.4	123	FALSE	0.978	111530	TRUE	4.89
3	3-9/6/2000	09/06/2000	16.7	TRUE	15.8	1810	TRUE	3.23	31	TRUE	0.638	8240	TRUE	7.04	8440	TRUE	5.55	8.45	TRUE	0.134	42091	TRUE	1.85
4A	4A-4/24/2001	04/24/2001	6.26	TRUE	5.91	84.2	TRUE	0.150	31.5	TRUE	0.648	686	TRUE	0.586	2810	TRUE	1.85	2.43	TRUE	0.039	16133.2	TRUE	0.708
4A	4A-8/12/2003	08/12/2003	19.9	TRUE	18.8	79.6	TRUE	0.142	26.5	TRUE	0.545	446.1	TRUE	0.381	5066	TRUE	3.33	--	--	--	14201.2	TRUE	0.623
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	--	--	--	--	--	--	616	TRUE	0.526	7100	TRUE	4.67	53.7	TRUE	0.854	16192	TRUE	0.710
4A	4A-8/31/2006-TCEQ	08/31/2006	91.9	TRUE	86.7	4610	FALSE	4.11	44.4	TRUE	0.914	4610	FALSE	1.97	13200	TRUE	8.68	138	FALSE	1.10	18430	TRUE	0.808
4A	4A-9/5/2000	09/05/2000	6.62	TRUE	6.25	1050	TRUE	1.87	30.3	TRUE	0.623	914	TRUE	0.781	2490	TRUE	1.64	8.57	TRUE	0.14	14655	TRUE	0.643
5	5-4/24/2001	04/24/2001	8.24	TRUE	7.77	2510	TRUE	4.47	60.8	TRUE	1.25	15300	TRUE	13.1	14700	TRUE	9.67	8.94	TRUE	0.142	78263	TRUE	3.43
5	5-9/5/2000	09/05/2000	4.55	TRUE	4.29	254	TRUE	0.453	28.9	TRUE	0.595	1010	TRUE	0.863	1870	TRUE	1.23	6.72	TRUE	0.107	11337	TRUE	0.497
6A	6A-4/25/2001	04/25/2001	0.299	TRUE	0.282	167	TRUE	0.298	20.2	TRUE	0.416	365	TRUE	0.312	1220	TRUE	0.803	40	FALSE	0.318	5886.2	TRUE	0.258
6A	6A-8/12/2003	08/12/2003	2.53	TRUE	2.39	2004	TRUE	3.57	15.7	TRUE	0.323	1274	TRUE	1.09	1631	TRUE	1.07	--	--	--	11974.4	TRUE	0.525
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	--	--	--	--	--	--	5520	TRUE	4.72	5520	TRUE	3.63	2021.2	TRUE	32.1	27538	TRUE	1.21
6A	6A-8/31/2006-TCEQ	08/31/2006	0.538	TRUE	0.508	2390	FALSE	2.13	15.5	TRUE	0.319	407	TRUE	0.348	1250	TRUE	0.822	71.9	FALSE	0.572	3642	TRUE	0.160
6A	6A-9/5/2000	09/05/2000	0.46	TRUE	0.434	284	TRUE	0.506	21.1	TRUE	0.434	7410	TRUE	6.33	10000	TRUE	6.58	14.9	TRUE	0.237	60074	TRUE	2.63
7	7-4/26/2001	04/26/2001	0.034	TRUE	0.032	104	TRUE	0.185	19.7	TRUE	0.405	2120	TRUE	1.81	3560	TRUE	2.34	6.721	TRUE	0.107	18823	TRUE	0.826
7	7-8/12/2003	08/12/2003	0.117	TRUE	0.110	21.6	FALSE	0.019	9.6	TRUE	0.198	89.5	TRUE	0.076	231.2	TRUE	0.152	--	--	--	1462.45	TRUE	0.064
7	7-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	--	--	--	--	--	--	229	FALSE	0.098	229	FALSE	0.075	22.9	FALSE	0.182	572	FALSE	0.013
7	7-9/6/2000	09/06/2000	0.103	TRUE	0.097	108	TRUE	0.193	26.8	TRUE	0.551	1790	TRUE	1.53	2390	TRUE	1.57	88.85	TRUE	1.41	16489	TRUE	0.723
8	8-4/25/2001	04/25/2001	0.037	TRUE	0.035	112	TRUE	0.200	12.1	TRUE	0.249	16600	TRUE	14.2	29100	TRUE	19.1	1.258	TRUE	0.020	175460	TRUE	7.70
8	8-9/6/2000	09/06/2000	0.029	TRUE	0.027	53.6	TRUE	0.096	17.8	TRUE	0.366	2920	TRUE	2.50	3980	TRUE	2.62	81.91	TRUE	1.30	26505.1	TRUE	1.16
9	9-8/12/2003	08/12/2003	0.03	TRUE	0.028	45.2	FALSE	0.040	3.66	TRUE	0.075	970.4	TRUE	0.829	1554	TRUE	1.02	--	--	--	9909.1	TRUE	0.435
9	9-8/12/2003-TCEQ	08/12/2003	--	--	--	--	--	--	--	--	--	1010	TRUE	0.863	2310	TRUE	1.52	24	FALSE	0.191	12389	TRUE	0.543
9	9-9/6/2000	09/06/2000	0.031	TRUE	0.029	83.5	TRUE	0.149	8.36	TRUE	0.172	18500	TRUE	15.8	26600	TRUE	17.5	8.11	TRUE	0.129	164790.5	TRUE	7.23
E	E-4/23/2001	04/23/2001	4.21	TRUE	3.97	819	TRUE	1.46	30.1	TRUE	0.619	4310	TRUE	3.68	11300	TRUE	7.43	4.06	TRUE	0.065	45108	TRUE	1.98
E	E-9/6/2000	09/06/2000	3.08	TRUE	2.91	364	TRUE	0.649	15.8	TRUE	0.325	2170	TRUE	1.85	4080	TRUE	2.68	5.54	TRUE	0.088	13475.3	TRUE	0.591
G	G-4/24/2001	04/24/2001	1.46	TRUE	1.38	49.1	TRUE	0.088	61.7	TRUE	1.27	553	TRUE	0.473	1580	TRUE	1.04	0.446	TRUE	0.007	9737.4	TRUE	0.427
G	G-9/6/2000	09/06/2000	1.77	TRUE	1.67	408	FALSE	0.364	56.8	TRUE	1.17	1240	TRUE	1.06	2100	TRUE	1.38	5.99	TRUE	0.095	14234.9	TRUE	0.624
Q	Q-4/25/2001	04/25/2001	1.12	TRUE	1.06	244	TRUE	0.435	156	TRUE	3.21	914	TRUE	0.781	4440	TRUE	2.92	5.82	TRUE	0.093	16349.7	TRUE	0.717
Q	Q-9/5/2000	09/05/2000	0.327	TRUE	0.308	473	TRUE	0.843	17.5	TRUE	0.360	3400	TRUE	2.91	4900	TRUE	3.22	14.8	TRUE	0.235	30926	TRUE	1.36
R	R-4/26/2001	04/26/2001	0.133	TRUE	0.125	64.1	TRUE	0.114	54.5	TRUE	1.12	3910	TRUE	3.34	5500	TRUE	3.62	2.381	TRUE	0.038	32039.1	TRUE	1.41
R	R-8/12/2003	08/12/2003	0.163	TRUE	0.154	69.5	TRUE	0.124	11.4	TRUE	0.235	2375	TRUE	2.03	4104	TRUE	2.70	--	--	--	23977.47	TRUE	1.05
R	R-9/5/2000	09/05/2000	0.055	TRUE	0.052	67.1	TRUE	0.120	26.6	TRUE	0.547	2570	TRUE	2.20	3230	TRUE	2.13	5.23	TRUE	0.083	21404.1	TRUE	0.939
S	S-4/24/2001	04/24/2001	23.9	TRUE	22.5	3690	TRUE	6.58	48.1	TRUE	0.990	14700	TRUE	12.6	41600	TRUE	27.4	8.28	TRUE	0.132	116399	TRUE	5.11
S	S-9/5/2000	09/05/2000	10.7	TRUE	10.1	174	TRUE	0.310	24	TRUE	0.494	1020	TRUE	0.872	1900	TRUE	1.25	7.24	TRUE	0.115	6812.1	TRUE	0.299
T	T-4/25/2001	04/25/2001	1.1	TRUE	1.04	121	FALSE	0.108	19.8	TRUE	0.407	1110	TRUE	0.949	2740	TRUE	1.80	0.476	TRUE	0.008	17373	TRUE	0.762
T	T-9/5/2000	09/05/2000	3.21	TRUE	3.03	212	TRUE	0.378	25	TRUE	0.514	745	TRUE	0.637	1550	TRUE	1.02	7.49	TRUE	0.119	10712.4	TRUE	0.470
U	U-4/24/2001	04/24/2001	0.744	TRUE	0.702	41.2	TRUE	0.073	21.4	TRUE	0.440	56.4	TRUE	0.048	149	TRUE	0.098	0.216	TRUE	0.003	443.7	TRUE	0.019
U	U-9/6/2000	09/06/2000	0.666	TRUE	0.628	97	TRUE	0.173	12.9	TRUE	0.265	346	TRUE	0.296	507	TRUE	0.334	6.63	TRUE	0.105	2601.5	TRUE	0.114
V	V-4/23/2001	04/23/2001	3.98	TRUE	3.75	585	TRUE	1.04	33.5	TRUE	0.689	2380	TRUE	2.03	5650	TRUE	3.72	6.469	TRUE	0.103	24025	TRUE	1.05
V	V-9/5/2000	09/05/2000	6.55	TRUE	6.18	903	TRUE	1.61	33.5	TRUE	0.689	3520	TRUE	3.01	7450	TRUE	4.90	20.5	TRUE	0.326	26994	TRUE	1.18
Y	Y-4/26/2001	04/26/2001	0.222	TRUE	0.209	35.9	TRUE	0.064	31.9	TRUE	0.656	264	TRUE	0.226	429	TRUE	0.282	1.914	TRUE	0.030	2813.57	TRUE	0.123
Y	Y-9/6/2000	09/06/2000	0.823	TRUE	0.776	41500	TRUE	74.0	42.8	TRUE	0.881	46800	TRUE	40	15700	TRUE	10.3	40	FALSE	0.318	199420	TRUE	8.75

Table B-2
Toxicity Data and Probable Effects Concentration Quotients (PEC-Q) Used in Toxicity Model Evaluations

			Total Chlordane (alpha and gamma) (U = 0)			Total PCB (U = 0)			Zinc		
Location	Sample ID	Sample Date	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q	Concentration	Detect	PEC-Q
10	10-4/25/2001	04/25/2001	40	FALSE	1.14	1.98	TRUE	0.003	91.7	TRUE	0.200
10	10-9/5/2000	09/05/2000	38	FALSE	1.08	50	FALSE	0.037	84.5	TRUE	0.184
2	2-4/23/2001	04/23/2001	2.68	TRUE	0.152	41.1	TRUE	0.061	82.1	TRUE	0.179
2	2-9/5/2000	09/05/2000	40	FALSE	1.14	50	FALSE	0.037	133	TRUE	0.290
2.5	2.5-4/23/2001	04/23/2001	0.945	TRUE	0.054	525	TRUE	0.777	159	TRUE	0.346
2.5	2.5-9/5/2000	09/05/2000	41	FALSE	1.16	328	TRUE	0.485	161	TRUE	0.351
3	3-4/24/2001	04/24/2001	1.59	TRUE	0.090	6720	TRUE	9.94	471	TRUE	1.03
3	3-8/12/2003	08/12/2003	--	--	--	1360	TRUE	2.01	150	TRUE	0.327
3	3-8/12/2003-EPA/TCEQ	08/12/2003	296	FALSE	8.41	1360	TRUE	2.01	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	616	FALSE	17.5	17000	TRUE	25.1	364	TRUE	0.793
3	3-9/6/2000	09/06/2000	40	FALSE	1.14	1080	TRUE	1.60	239	TRUE	0.521
4A	4A-4/24/2001	04/24/2001	40	FALSE	1.14	398	TRUE	0.589	303	TRUE	0.660
4A	4A-8/12/2003	08/12/2003	--	--	--	34600	TRUE	51.2	305	TRUE	0.664
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	435	FALSE	12.4	34600	TRUE	51.2	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	691	FALSE	19.6	150000	TRUE	222	429	TRUE	0.935
4A	4A-9/5/2000	09/05/2000	38	FALSE	1.08	1690	TRUE	2.5	311	TRUE	0.678
5	5-4/24/2001	04/24/2001	0.389	TRUE	0.022	1910	TRUE	2.83	710	TRUE	1.55
5	5-9/5/2000	09/05/2000	35	FALSE	0.994	780	TRUE	1.15	365	TRUE	0.795
6A	6A-4/25/2001	04/25/2001	40	FALSE	1.14	2060	TRUE	3.05	294	TRUE	0.641
6A	6A-8/12/2003	08/12/2003	--	--	--	10900	TRUE	16.1	353	TRUE	0.769
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	264	FALSE	7.5	10900	TRUE	16.1	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	359	FALSE	10.2	7700	TRUE	11.4	191	TRUE	0.416
6A	6A-9/5/2000	09/05/2000	2.18	TRUE	0.124	9370	TRUE	13.9	249	TRUE	0.542
7	7-4/26/2001	04/26/2001	0.07	TRUE	0.004	62.1	TRUE	0.092	1850	TRUE	4.03
7	7-8/12/2003	08/12/2003	--	--	--	1980	TRUE	2.93	481	TRUE	1.05
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	6.51	1980	TRUE	2.93	--	--	--
7	7-9/6/2000	09/06/2000	38	FALSE	1.08	62.8	TRUE	0.093	503	TRUE	1.10
8	8-4/25/2001	04/25/2001	0.681	TRUE	0.039	15.4	TRUE	0.023	154	TRUE	0.336
8	8-9/6/2000	09/06/2000	39	FALSE	1.11	51	FALSE	0.038	146	TRUE	0.318
9	9-8/12/2003	08/12/2003	--	--	--	48	FALSE	0.036	132	TRUE	0.288
9	9-8/12/2003-TCEQ	08/12/2003	240	FALSE	6.82	48	FALSE	0.036	--	--	--
9	9-9/6/2000	09/06/2000	42	FALSE	1.19	49	FALSE	0.036	102	TRUE	0.222
E	E-4/23/2001	04/23/2001	40	FALSE	1.14	1580	TRUE	2.34	257	TRUE	0.560
E	E-9/6/2000	09/06/2000	40	FALSE	1.14	370	TRUE	0.547	120	TRUE	0.261
G	G-4/24/2001	04/24/2001	0.248	TRUE	0.014	197	TRUE	0.291	400	TRUE	0.871
G	G-9/6/2000	09/06/2000	41	FALSE	1.16	399	TRUE	0.590	277	TRUE	0.603
Q	Q-4/25/2001	04/25/2001	1.14	TRUE	0.065	1070	TRUE	1.58	1100	TRUE	2.40
Q	Q-9/5/2000	09/05/2000	2.97	TRUE	0.169	3780	TRUE	5.59	304	TRUE	0.662
R	R-4/26/2001	04/26/2001	40	FALSE	1.14	37.7	TRUE	0.056	479	TRUE	1.04
R	R-8/12/2003	08/12/2003	--	--	--	--	--	--	256	TRUE	0.558
R	R-9/5/2000	09/05/2000	3.41	TRUE	0.194	103	TRUE	0.152	1750	TRUE	3.81
S	S-4/24/2001	04/24/2001	0.23	TRUE	0.013	2090	TRUE	3.09	355	TRUE	0.773
S	S-9/5/2000	09/05/2000	39	FALSE	1.11	113	TRUE	0.167	189	TRUE	0.412
T	T-4/25/2001	04/25/2001	0.393	TRUE	0.022	626	TRUE	0.926	252	TRUE	0.549
T	T-9/5/2000	09/05/2000	38	FALSE	1.08	837	TRUE	1.24	281	TRUE	0.612
U	U-4/24/2001	04/24/2001	0.302	TRUE	0.017	12.8	TRUE	0.019	50.9	TRUE	0.111
U	U-9/6/2000	09/06/2000	40	FALSE	1.14	78.8	TRUE	0.117	54.3	TRUE	0.118
V	V-4/23/2001	04/23/2001	0.306	TRUE	0.017	442	TRUE	0.654	295	TRUE	0.643
V	V-9/5/2000	09/05/2000	40	FALSE	1.14	447	TRUE	0.661	310	TRUE	0.675
Y	Y-4/26/2001	04/26/2001	0.112	TRUE	0.006	58.1	TRUE	0.086	73.9	TRUE	0.161
Y	Y-9/6/2000	09/06/2000	40	FALSE	1.14	2570	TRUE	3.80	1540	TRUE	3.36

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

Location	Sample ID	Sample Date	L. plumulosus survival (control adjusted; %)	Toxic (< 80% survival)	2-Methylnaphthalene			4,4'-DDD (p,p'-DDD)			4,4'-DDE (p,p'-DDE)			4,4'-DDT (p,p'-DDT)			Acenaphthene		
					Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	84.6	FALSE	23.8	TRUE	0.118	40	FALSE	2.56	0.24	TRUE	0.001	79.4	TRUE	16.6	157	TRUE	1.77
10	10-9/5/2000	09/05/2000	98.4	FALSE	289	TRUE	1.44	38	FALSE	2.43	3.07	TRUE	0.008	38	FALSE	3.98	483	TRUE	5.43
2	2-4/23/2001	04/23/2001	87.7	FALSE	108	TRUE	0.537	0.525	TRUE	0.067	2.47	TRUE	0.007	1.14	TRUE	0.239	43.6	TRUE	0.490
2	2-9/5/2000	09/05/2000	94.3	FALSE	602	TRUE	3.00	40	FALSE	2.56	3	FALSE	0.004	40	FALSE	4.19	758	TRUE	8.53
2.5	2.5-4/23/2001	04/23/2001	86.7	FALSE	464	TRUE	2.31	40	FALSE	2.56	136	TRUE	0.364	0.263	TRUE	0.055	1350	TRUE	15.2
2.5	2.5-9/5/2000	09/05/2000	90.2	FALSE	301	TRUE	1.50	41	FALSE	2.62	6.39	TRUE	0.017	41	FALSE	4.30	945	TRUE	10.6
3	3-4/24/2001	04/24/2001	0	TRUE	4770	TRUE	23.7	4.28	TRUE	0.548	40	FALSE	0.053	9.74	TRUE	2.04	25900	TRUE	291
3	3-8/12/2003	08/12/2003	95	FALSE	229.8	TRUE	1.14	--	--	--	--	--	--	--	--	--	527.6	TRUE	5.93
3	3-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	61.6	FALSE	3.94	61.6	FALSE	0.082	123	FALSE	12.9	12500	TRUE	141
3	3-9/6/2000	09/06/2000	75.6	TRUE	1220	TRUE	6.07	40	FALSE	2.56	8.45	TRUE	0.023	40	FALSE	4.19	1680	TRUE	18.9
4A	4A-4/24/2001	04/24/2001	6.27	TRUE	96.9	TRUE	0.482	40	FALSE	2.56	2.43	TRUE	0.006	40	FALSE	4.19	268	TRUE	3.01
4A	4A-8/12/2003	08/12/2003	30	TRUE	223.2	TRUE	1.11	--	--	--	--	--	--	--	--	--	196.5	TRUE	2.21
4A	4A-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	69.1	FALSE	4.42	69.1	FALSE	0.092	138	FALSE	14.5	4610	FALSE	25.9
4A	4A-9/5/2000	09/05/2000	89.1	FALSE	335	TRUE	1.67	38	FALSE	2.43	8.57	TRUE	0.023	38	FALSE	3.98	135	TRUE	1.52
5	5-4/24/2001	04/24/2001	0	TRUE	5000	TRUE	24.9	2.47	TRUE	0.316	4.76	TRUE	0.013	1.71	TRUE	0.358	2770	TRUE	31.2
5	5-9/5/2000	09/05/2000	103	FALSE	213	TRUE	1.06	35	FALSE	2.24	6.72	TRUE	0.018	35	FALSE	3.67	164	TRUE	1.84
6A	6A-4/25/2001	04/25/2001	0	TRUE	51.2	TRUE	0.255	40	FALSE	2.56	40	FALSE	0.053	40	FALSE	4.19	93.2	TRUE	1.05
6A	6A-8/12/2003	08/12/2003	31	TRUE	537.6	TRUE	2.67	--	--	--	--	--	--	--	--	--	857.7	TRUE	9.65
6A	6A-8/31/2006-TCEQ	08/31/2006	--	--	--	--	--	35.9	FALSE	2.30	35.9	FALSE	0.048	71.9	FALSE	7.54	2390	FALSE	13.4
6A	6A-9/5/2000	09/05/2000	24.9	TRUE	164	TRUE	0.816	39	FALSE	2.50	14.9	TRUE	0.040	39	FALSE	4.09	1160	TRUE	13.0
7	7-4/26/2001	04/26/2001	91.9	FALSE	152	TRUE	0.756	0.701	TRUE	0.090	6.02	TRUE	0.016	40	FALSE	4.19	127	TRUE	1.43
7	7-8/12/2003	08/12/2003	91	FALSE	11	FALSE	0.027	--	--	--	--	--	--	--	--	--	35.2	TRUE	0.396
7	7-9/6/2000	09/06/2000	5.18	TRUE	377	FALSE	0.938	38	FALSE	2.43	9.45	TRUE	0.025	79.4	TRUE	16.6	123	TRUE	1.38
8	8-4/25/2001	04/25/2001	0	TRUE	121	TRUE	0.602	0.228	TRUE	0.029	40	FALSE	0.053	1.03	TRUE	0.216	565	TRUE	6.36
8	8-9/6/2000	09/06/2000	94.3	FALSE	42.2	TRUE	0.210	39	FALSE	2.50	9.51	TRUE	0.025	72.4	TRUE	15.2	80.5	TRUE	0.906
9	9-8/12/2003	08/12/2003	92	FALSE	23	FALSE	0.057	--	--	--	--	--	--	--	--	--	52.9	TRUE	0.595
9	9-9/6/2000	09/06/2000	52.8	TRUE	90.9	TRUE	0.452	42	FALSE	2.69	8.11	TRUE	0.022	42	FALSE	4.40	806	TRUE	9.07
E	E-4/23/2001	04/23/2001	57.4	TRUE	570	TRUE	2.84	40	FALSE	2.56	4.06	TRUE	0.011	40	FALSE	4.19	1590	TRUE	17.9
E	E-9/6/2000	09/06/2000	104	FALSE	202	TRUE	1.00	40	FALSE	2.56	5.54	TRUE	0.015	40	FALSE	4.19	472	TRUE	5.31
G	G-4/24/2001	04/24/2001	93	FALSE	29.5	TRUE	0.147	0.14	TRUE	0.018	0.211	TRUE	0.001	0.095	TRUE	0.020	42.7	TRUE	0.480
G	G-9/6/2000	09/06/2000	104	FALSE	408	FALSE	1.01	41	FALSE	2.62	5.99	TRUE	0.016	41	FALSE	4.30	160	TRUE	1.80
Q	Q-4/25/2001	04/25/2001	4.18	TRUE	212	TRUE	1.05	3.63	TRUE	0.465	1.01	TRUE	0.003	1.18	TRUE	0.247	99.5	TRUE	1.12
Q	Q-9/5/2000	09/05/2000	79.8	FALSE	250	TRUE	1.24	39	FALSE	2.50	14.8	TRUE	0.040	39	FALSE	4.09	580	TRUE	6.52
R	R-4/26/2001	04/26/2001	78.3	TRUE	73.2	TRUE	0.364	0.073	TRUE	0.009	2.07	TRUE	0.006	0.238	TRUE	0.050	169	TRUE	1.90
R	R-8/12/2003	08/12/2003	98	FALSE	10.5	FALSE	0.026	--	--	--	--	--	--	--	--	--	90.3	TRUE	1.02
R	R-9/5/2000	09/05/2000	87	FALSE	108	TRUE	0.537	38	FALSE	2.43	5.23	TRUE	0.014	38	FALSE	3.98	134	TRUE	1.51
S	S-4/24/2001	04/24/2001	65.8	TRUE	2790	TRUE	13.9	2.63	TRUE	0.337	40	FALSE	0.053	5.65	TRUE	1.18	9830	TRUE	111
S	S-9/5/2000	09/05/2000	99.5	FALSE	75.3	TRUE	0.375	39	FALSE	2.50	7.24	TRUE	0.019	39	FALSE	4.09	230	TRUE	2.59
T	T-4/25/2001	04/25/2001	72.1	TRUE	82.9	TRUE	0.412	40	FALSE	2.56	40	FALSE	0.053	0.476	TRUE	0.100	180	TRUE	2.02
T	T-9/5/2000	09/05/2000	91.2	FALSE	133	TRUE	0.662	38	FALSE	2.43	7.49	TRUE	0.020	38	FALSE	3.98	96.4	TRUE	1.08
U	U-4/24/2001	04/24/2001	82.5	FALSE	29.1	TRUE	0.145	40	FALSE	2.56	0.178	TRUE	0.000	0.038	TRUE	0.008	35.1	TRUE	0.395
U	U-9/6/2000	09/06/2000	98.4	FALSE	71	TRUE	0.353	40	FALSE	2.56	6.63	TRUE	0.018	40	FALSE	4.19	68.5	TRUE	0.771
V	V-4/23/2001	04/23/2001	79.4	TRUE	343	TRUE	1.71	0.979	TRUE	0.125	3.45	TRUE	0.009	2.04	TRUE	0.428	900	TRUE	10.1
V	V-9/5/2000	09/05/2000	102	FALSE	494	TRUE	2.46	40	FALSE	2.56	20.5	TRUE	0.055	40	FALSE	4.19	1550	TRUE	17.4
Y	Y-4/26/2001	04/26/2001	95	FALSE	30.1	TRUE	0.150	0.144	TRUE	0.018	1.77	TRUE	0.005	40	FALSE	4.19	2.47	TRUE	0.028
Y	Y-9/6/2000	09/06/2000	0	TRUE	22900	TRUE	114	40	FALSE	2.56	3	FALSE	0.004	40	FALSE	4.19	19200	TRUE	216
3	3-8/12/2003-EPA/TCEQ	08/12/2003	--	--	278	FALSE	0.692	29.6	FALSE	1.90	29.6	FALSE	0.040	34.8	TRUE	7.30	522	TRUE	5.87
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	436	FALSE	1.08	53.7	TRUE	6.88	43.5	FALSE	0.058	43.5	FALSE	4.56	436	FALSE	2.45
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	1220	TRUE	6.07	31.2	TRUE	3.99	26.4	FALSE	0.035	1990	TRUE	417	1670	TRUE	18.8
7	7-8/12/2003-EPA/TCEQ	08/12/2003	--	--	229	FALSE	0.570	22.9	FALSE	1.47	22.9	FALSE	0.031	22.9	FALSE	2.40	229	FALSE	1.29
9	9-8/12/2003-TCEQ	08/12/2003	--	--	245	FALSE	0.609	24	FALSE	1.54	24	FALSE	0.032	24	FALSE	2.52	245	FALSE	1.38

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Acenaphthylene			Anthracene			Aroclor 1254			Arsenic			Benzo(a)anthracene			Benzo(a)pyrene		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	25.8	TRUE	0.202	44.3	TRUE	0.181	--	--	--	15.7	TRUE	0.377	491	FALSE	0.354	720	FALSE	0.472
10	10-9/5/2000	09/05/2000	86.9	TRUE	0.679	795	TRUE	3.24	--	--	--	4.05	TRUE	0.097	1270	TRUE	1.83	1220	TRUE	1.60
2	2-4/23/2001	04/23/2001	107	TRUE	0.836	57.4	TRUE	0.234	--	--	--	11.9	TRUE	0.286	86.7	TRUE	0.125	93.7	TRUE	0.123
2	2-9/5/2000	09/05/2000	1810	TRUE	14.1	538	TRUE	2.20	--	--	--	2.91	TRUE	0.070	364	TRUE	0.525	539	TRUE	0.706
2.5	2.5-4/23/2001	04/23/2001	2900	TRUE	22.7	1200	TRUE	4.90	--	--	--	9.64	TRUE	0.232	752	TRUE	1.09	1420	TRUE	1.86
2.5	2.5-9/5/2000	09/05/2000	1730	TRUE	13.5	598	TRUE	2.44	--	--	--	2.85	TRUE	0.069	538	TRUE	0.776	1720	TRUE	2.25
3	3-4/24/2001	04/24/2001	16100	TRUE	126	22500	TRUE	91.8	--	--	--	10.6	TRUE	0.255	6790	TRUE	9.80	5030	TRUE	6.59
3	3-8/12/2003	08/12/2003	2103	TRUE	16.4	611.9	TRUE	2.50	--	--	--	2.98	TRUE	0.072	665.1	TRUE	0.960	725.2	TRUE	0.950
3	3-8/31/2006-TCEQ	08/31/2006	6270	TRUE	49.0	8830	TRUE	36.0	620	FALSE	0.437	11.6	FALSE	0.139	4120	FALSE	2.97	4120	FALSE	2.70
3	3-9/6/2000	09/06/2000	4360	TRUE	34.1	2670	TRUE	10.9	--	--	--	3.53	TRUE	0.085	1160	TRUE	1.67	1410	TRUE	1.85
4A	4A-4/24/2001	04/24/2001	525	TRUE	4.10	465	TRUE	1.90	--	--	--	10	TRUE	0.240	959	TRUE	1.38	1360	TRUE	1.78
4A	4A-8/12/2003	08/12/2003	774.7	TRUE	6.05	459.2	TRUE	1.87	--	--	--	4.23	TRUE	0.102	707.2	TRUE	1.02	804.6	TRUE	1.05
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	18.0	4610	FALSE	9.41	1400	FALSE	0.987	11.5	FALSE	0.138	4610	FALSE	3.33	4610	FALSE	3.02
4A	4A-9/5/2000	09/05/2000	493	TRUE	3.85	321	TRUE	1.31	--	--	--	3.32	TRUE	0.080	983	TRUE	1.42	385	FALSE	0.252
5	5-4/24/2001	04/24/2001	6160	TRUE	48.1	5640	TRUE	23.0	--	--	--	12.3	TRUE	0.296	2730	TRUE	3.94	2990	TRUE	3.92
5	5-9/5/2000	09/05/2000	963	TRUE	7.52	400	TRUE	1.63	--	--	--	3.09	TRUE	0.074	726	TRUE	1.05	351	FALSE	0.230
6A	6A-4/25/2001	04/25/2001	694	TRUE	5.42	342	TRUE	1.40	--	--	--	11.4	TRUE	0.274	391	TRUE	0.564	720	FALSE	0.472
6A	6A-8/12/2003	08/12/2003	1246	TRUE	9.73	773.5	TRUE	3.16	--	--	--	3.12	TRUE	0.075	480.7	TRUE	0.694	355.8	TRUE	0.466
6A	6A-8/31/2006-TCEQ	08/31/2006	2390	FALSE	9.34	2390	FALSE	4.88	360	FALSE	0.254	6.61	FALSE	0.079	2390	FALSE	1.72	2390	FALSE	1.57
6A	6A-9/5/2000	09/05/2000	3290	TRUE	25.7	2510	TRUE	10.2	--	--	--	5.37	TRUE	0.129	4400	TRUE	6.35	3750	TRUE	4.91
7	7-4/26/2001	04/26/2001	150	TRUE	1.17	322	TRUE	1.31	--	--	--	96.8	TRUE	2.33	1160	TRUE	1.67	1320	TRUE	1.73
7	7-8/12/2003	08/12/2003	26.35	TRUE	0.206	13	FALSE	0.027	--	--	--	15.2	TRUE	0.365	111.9	TRUE	0.161	112.8	TRUE	0.148
7	7-9/6/2000	09/06/2000	272	TRUE	2.125	296	TRUE	1.21	--	--	--	29.6	TRUE	0.712	1080	TRUE	1.56	1320	TRUE	1.73
8	8-4/25/2001	04/25/2001	237	TRUE	1.85	2140	TRUE	8.73	--	--	--	6.55	TRUE	0.157	13600	TRUE	19.6	14800	TRUE	19.4
8	8-9/6/2000	09/06/2000	392	FALSE	1.53	342	TRUE	1.40	--	--	--	19.4	TRUE	0.466	1920	TRUE	2.77	2100	TRUE	2.75
9	9-8/12/2003	08/12/2003	19.8	FALSE	0.077	92.4	TRUE	0.377	--	--	--	3.13	TRUE	0.075	733.2	TRUE	1.06	755.4	TRUE	0.990
9	9-9/6/2000	09/06/2000	266	TRUE	2.08	2650	TRUE	10.8	--	--	--	2.68	TRUE	0.064	12500	TRUE	18.0	13000	TRUE	17.0
E	E-4/23/2001	04/23/2001	3050	TRUE	23.8	1680	TRUE	6.86	--	--	--	7.78	TRUE	0.187	1680	TRUE	2.42	2380	TRUE	3.12
E	E-9/6/2000	09/06/2000	1510	TRUE	11.8	427	TRUE	1.74	--	--	--	2.15	TRUE	0.052	400	FALSE	0.289	660	FALSE	0.433
G	G-4/24/2001	04/24/2001	88	TRUE	0.688	89.6	TRUE	0.366	--	--	--	12.6	TRUE	0.303	739	TRUE	1.07	793	TRUE	1.04
G	G-9/6/2000	09/06/2000	408	FALSE	1.59	230	TRUE	0.939	--	--	--	4.98	TRUE	0.120	1070	TRUE	1.54	1170	TRUE	1.53
Q	Q-4/25/2001	04/25/2001	1770	TRUE	13.8	1350	TRUE	5.51	--	--	--	12.7	TRUE	0.305	991	TRUE	1.43	1050	TRUE	1.38
Q	Q-9/5/2000	09/05/2000	2030	TRUE	15.9	1490	TRUE	6.08	--	--	--	5.23	TRUE	0.126	1860	TRUE	2.68	1960	TRUE	2.57
R	R-4/26/2001	04/26/2001	250	TRUE	1.95	403	TRUE	1.64	--	--	--	29.8	TRUE	0.716	2260	TRUE	3.26	2300	TRUE	3.01
R	R-8/12/2003	08/12/2003	62.37	TRUE	0.487	316.7	TRUE	1.29	--	--	--	11.1	TRUE	0.267	1963	TRUE	2.83	1937	TRUE	2.54
R	R-9/5/2000	09/05/2000	385	FALSE	1.50	335	TRUE	1.37	--	--	--	164	TRUE	3.94	1620	TRUE	2.34	1640	TRUE	2.15
S	S-4/24/2001	04/24/2001	12500	TRUE	97.7	6520	TRUE	26.6	--	--	--	12	TRUE	0.288	2440	TRUE	3.52	3510	TRUE	4.60
S	S-9/5/2000	09/05/2000	471	TRUE	3.68	184	TRUE	0.751	--	--	--	4.39	TRUE	0.106	392	FALSE	0.283	392	FALSE	0.257
T	T-4/25/2001	04/25/2001	376	TRUE	2.94	326	TRUE	1.33	--	--	--	11.4	TRUE	0.274	1240	TRUE	1.79	1490	TRUE	1.95
T	T-9/5/2000	09/05/2000	521	TRUE	4.07	264	TRUE	1.08	--	--	--	4.73	TRUE	0.114	716	TRUE	1.03	830	TRUE	1.09
U	U-4/24/2001	04/24/2001	44.3	TRUE	0.346	23.2	TRUE	0.095	--	--	--	10.3	TRUE	0.248	660	FALSE	0.476	--	--	--
U	U-9/6/2000	09/06/2000	332	TRUE	2.59	119	TRUE	0.486	--	--	--	3.11	TRUE	0.075	400	FALSE	0.289	400	FALSE	0.262
V	V-4/23/2001	04/23/2001	1860	TRUE	14.5	774	TRUE	3.16	--	--	--	12	TRUE	0.288	807	TRUE	1.16	1300	TRUE	1.70
V	V-9/5/2000	09/05/2000	2070	TRUE	16.2	803	TRUE	3.28	--	--	--	4.31	TRUE	0.104	550	TRUE	0.794	1160	TRUE	1.52
Y	Y-4/26/2001	04/26/2001	59	TRUE	0.461	34.1	TRUE	0.139	--	--	--	14.7	TRUE	0.353	189	TRUE	0.273	222	TRUE	0.291
Y	Y-9/6/2000	09/06/2000	31000	TRUE	242	14000	TRUE	57.1	--	--	--	31.8	TRUE	0.764	3260	TRUE	4.70	400	FALSE	0.262
3	3-8/12/2003-EPA/TCEQ	08/12/2003	1470	TRUE	11.5	629	TRUE	2.57	296	FALSE	0.209	--	--	--	696	FALSE	0.502	801	TRUE	1.05
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	586	TRUE	4.58	436	FALSE	0.890	3270	FALSE	2.31	--	--	--	1090	FALSE	0.786	1210	TRUE	1.59
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	3180	TRUE	24.8	2330	TRUE	9.51	1590	FALSE	1.12	--	--	--	1130	TRUE	1.63	1000	TRUE	1.31
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.895	229	FALSE	0.467	457	FALSE	0.322	--	--	--	572	FALSE	0.413	572	FALSE	0.375
9	9-8/12/2003-TCEQ	08/12/2003	245	FALSE	0.957	245	FALSE	0.500	24	FALSE	0.017	--	--	--	674	TRUE	0.973	1030	TRUE	1.35

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Bis(2-ethylhexyl) phthalate			Cadmium			Chlordane (technical)			Chlordane			Chromium			Chrysene		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	237	TRUE	0.090	0.165	TRUE	0.039	--	--	--	--	--	--	28	TRUE	0.175	356	TRUE	0.421
10	10-9/5/2000	09/05/2000	385	FALSE	0.073	0.187	TRUE	0.044	--	--	--	--	--	--	31.4	TRUE	0.196	1730	TRUE	2.04
2	2-4/23/2001	04/23/2001	497	TRUE	0.188	0.162	TRUE	0.038	--	--	--	--	--	--	32.4	TRUE	0.203	264	TRUE	0.312
2	2-9/5/2000	09/05/2000	1370	TRUE	0.518	0.313	TRUE	0.074	--	--	--	--	--	--	58.5	TRUE	0.366	638	TRUE	0.754
2.5	2.5-4/23/2001	04/23/2001	2800	TRUE	1.06	0.386	TRUE	0.092	--	--	--	--	--	--	43.8	TRUE	0.274	1320	TRUE	1.56
2.5	2.5-9/5/2000	09/05/2000	1060	TRUE	0.400	0.365	TRUE	0.087	--	--	--	--	--	--	47.5	TRUE	0.297	1060	TRUE	1.25
3	3-4/24/2001	04/24/2001	3940	TRUE	1.49	1.62	TRUE	0.385	--	--	--	--	--	--	440	TRUE	2.75	7960	TRUE	9.41
3	3-8/12/2003	08/12/2003	1120	TRUE	0.423	0.452	TRUE	0.107	--	--	--	--	--	--	53.7	TRUE	0.336	794.8	TRUE	0.939
3	3-8/31/2006-TCEQ	08/31/2006	4120	FALSE	0.778	1.59	FALSE	0.189	616	FALSE	64.3	616	FALSE	64.3	237	TRUE	1.48	2640	TRUE	3.12
3	3-9/6/2000	09/06/2000	1540	TRUE	0.582	0.38	TRUE	0.090	--	--	--	--	--	--	111	TRUE	0.694	1640	TRUE	1.94
4A	4A-4/24/2001	04/24/2001	4630	TRUE	1.75	1.32	TRUE	0.314	--	--	--	--	--	--	82.1	TRUE	0.513	1870	TRUE	2.21
4A	4A-8/12/2003	08/12/2003	1135	TRUE	0.429	0.772	TRUE	0.183	--	--	--	--	--	--	91.6	TRUE	0.573	740.7	TRUE	0.876
4A	4A-8/31/2006-TCEQ	08/31/2006	4610	FALSE	0.871	1.57	FALSE	0.186	691	FALSE	72.1	691	FALSE	72.1	148	TRUE	0.925	4610	FALSE	2.72
4A	4A-9/5/2000	09/05/2000	1780	TRUE	0.672	0.719	TRUE	0.171	--	--	--	--	--	--	123	TRUE	0.769	1670	TRUE	1.97
5	5-4/24/2001	04/24/2001	7670	TRUE	2.90	1.26	TRUE	0.299	--	--	--	--	--	--	359	TRUE	2.244	3980	TRUE	4.70
5	5-9/5/2000	09/05/2000	1700	TRUE	0.642	0.704	TRUE	0.167	--	--	--	--	--	--	137	TRUE	0.856	1190	TRUE	1.41
6A	6A-4/25/2001	04/25/2001	2330	TRUE	0.880	0.361	TRUE	0.086	--	--	--	--	--	--	56	TRUE	0.350	664	TRUE	0.785
6A	6A-8/12/2003	08/12/2003	1068	TRUE	0.403	1.16	TRUE	0.276	--	--	--	--	--	--	77.6	TRUE	0.485	506	TRUE	0.598
6A	6A-8/31/2006-TCEQ	08/31/2006	2390	FALSE	0.451	0.901	FALSE	0.107	359	FALSE	37.5	359	FALSE	37.5	41.3	TRUE	0.258	685	TRUE	0.810
6A	6A-9/5/2000	09/05/2000	1610	TRUE	0.608	0.288	TRUE	0.068	--	--	--	--	--	--	63.7	TRUE	0.398	5820	TRUE	6.88
7	7-4/26/2001	04/26/2001	1610	TRUE	0.608	1.14	TRUE	0.271	--	--	--	--	--	--	268	TRUE	1.675	1960	TRUE	2.32
7	7-8/12/2003	08/12/2003	241.4	TRUE	0.091	0.708	TRUE	0.168	--	--	--	--	--	--	10.2	TRUE	0.064	140.3	TRUE	0.166
7	7-9/6/2000	09/06/2000	1580	TRUE	0.597	0.548	TRUE	0.130	--	--	--	--	--	--	42.1	TRUE	0.263	1990	TRUE	2.35
8	8-4/25/2001	04/25/2001	3650	TRUE	1.38	0.278	TRUE	0.066	--	--	--	--	--	--	20	TRUE	0.125	20100	TRUE	23.8
8	8-9/6/2000	09/06/2000	392	FALSE	0.074	0.484	TRUE	0.115	--	--	--	--	--	--	21.9	TRUE	0.137	3120	TRUE	3.69
9	9-8/12/2003	08/12/2003	377.8	TRUE	0.143	0.335	TRUE	0.080	--	--	--	--	--	--	6.04	TRUE	0.038	958.1	TRUE	1.13
9	9-9/6/2000	09/06/2000	695	FALSE	0.131	0.235	TRUE	0.056	--	--	--	--	--	--	16.6	TRUE	0.104	17400	TRUE	20.6
E	E-4/23/2001	04/23/2001	2550	TRUE	0.963	0.524	TRUE	0.124	--	--	--	--	--	--	56.1	TRUE	0.351	3090	TRUE	3.65
E	E-9/6/2000	09/06/2000	1170	TRUE	0.442	0.234	TRUE	0.056	--	--	--	--	--	--	55	TRUE	0.344	434	TRUE	0.513
G	G-4/24/2001	04/24/2001	507	TRUE	0.192	0.382	TRUE	0.091	--	--	--	--	--	--	54.4	TRUE	0.340	1290	TRUE	1.52
G	G-9/6/2000	09/06/2000	809	TRUE	0.306	0.183	TRUE	0.043	--	--	--	--	--	--	46.3	TRUE	0.289	1670	TRUE	1.97
Q	Q-4/25/2001	04/25/2001	12000	TRUE	4.53	1.84	TRUE	0.437	--	--	--	--	--	--	380	TRUE	2.375	1770	TRUE	2.09
Q	Q-9/5/2000	09/05/2000	1960	TRUE	0.740	0.35	TRUE	0.083	--	--	--	--	--	--	40.9	TRUE	0.256	3040	TRUE	3.59
R	R-4/26/2001	04/26/2001	656	TRUE	0.248	0.411	TRUE	0.098	--	--	--	--	--	--	457	TRUE	2.86	3540	TRUE	4.18
R	R-8/12/2003	08/12/2003	157.8	TRUE	0.060	0.596	TRUE	0.142	--	--	--	--	--	--	17.9	TRUE	0.112	2067	TRUE	2.44
R	R-9/5/2000	09/05/2000	695	FALSE	0.131	1.03	TRUE	0.245	--	--	--	--	--	--	73	TRUE	0.456	2400	TRUE	2.84
S	S-4/24/2001	04/24/2001	14400	TRUE	5.44	0.268	TRUE	0.064	--	--	--	--	--	--	182	TRUE	1.14	3440	TRUE	4.07
S	S-9/5/2000	09/05/2000	392	FALSE	0.074	0.436	TRUE	0.104	--	--	--	--	--	--	73.9	TRUE	0.462	423	TRUE	0.500
T	T-4/25/2001	04/25/2001	2550	TRUE	0.963	0.376	TRUE	0.089	--	--	--	--	--	--	40.7	TRUE	0.254	2300	TRUE	2.72
T	T-9/5/2000	09/05/2000	1180	TRUE	0.446	0.415	TRUE	0.099	--	--	--	--	--	--	84.4	TRUE	0.528	1160	TRUE	1.37
U	U-4/24/2001	04/24/2001	--	--	--	0.091	TRUE	0.022	--	--	--	--	--	--	40.1	TRUE	0.251	--	--	--
U	U-9/6/2000	09/06/2000	400	FALSE	0.076	0.087	TRUE	0.021	--	--	--	--	--	--	29.4	TRUE	0.184	254	TRUE	0.300
V	V-4/23/2001	04/23/2001	2250	TRUE	0.850	0.712	TRUE	0.169	--	--	--	--	--	--	73.8	TRUE	0.461	1580	TRUE	1.87
V	V-9/5/2000	09/05/2000	1390	TRUE	0.525	0.642	TRUE	0.152	--	--	--	--	--	--	92.9	TRUE	0.581	1040	TRUE	1.23
Y	Y-4/26/2001	04/26/2001	1750	TRUE	0.661	0.169	TRUE	0.040	--	--	--	--	--	--	42.1	TRUE	0.263	397	TRUE	0.469
Y	Y-9/6/2000	09/06/2000	4690	TRUE	1.77	1.52	TRUE	0.361	--	--	--	--	--	--	63.9	TRUE	0.399	6150	TRUE	7.27
3	3-8/12/2003-EPA/TCEQ	08/12/2003	1340	TRUE	0.506	--	--	--	296	FALSE	30.9	--	--	--	--	--	--	893	TRUE	1.06
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	1500	TRUE	0.567	--	--	--	435	FALSE	45.4	--	--	--	--	--	--	1190	TRUE	1.41
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	1860	TRUE	0.703	--	--	--	264	FALSE	27.6	--	--	--	--	--	--	1350	TRUE	1.60
7	7-8/12/2003-EPA/TCEQ	08/12/2003	13400	TRUE	5.06	--	--	--	229	FALSE	23.9	--	--	--	--	--	--	572	FALSE	0.338
9	9-8/12/2003-TCEQ	08/12/2003	645	TRUE	0.244	--	--	--	240	FALSE	25.1	--	--	--	--	--	--	1430	TRUE	1.69

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Copper			Dibenzo(a,h)anthracene			Dieldrin			Fluoranthene			Fluorene			gamma-BHC (Lindane)		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	14.5	TRUE	0.134	400	FALSE	1.48	--	--	--	145	TRUE	0.097	10.3	TRUE	0.072	--	--	--
10	10-9/5/2000	09/05/2000	21.3	TRUE	0.197	194	TRUE	1.44	--	--	--	3950	TRUE	2.64	472	TRUE	3.28	--	--	--
2	2-4/23/2001	04/23/2001	27.7	TRUE	0.256	34.6	TRUE	0.256	--	--	--	1000	TRUE	0.669	59.7	TRUE	0.415	--	--	--
2	2-9/5/2000	09/05/2000	40.1	TRUE	0.371	400	FALSE	1.48	--	--	--	2680	TRUE	1.79	901	TRUE	6.26	--	--	--
2.5	2.5-4/23/2001	04/23/2001	42	TRUE	0.389	234	TRUE	1.73	--	--	--	7010	TRUE	4.69	2070	TRUE	14.4	--	--	--
2.5	2.5-9/5/2000	09/05/2000	40.9	TRUE	0.379	100	TRUE	0.741	--	--	--	4760	TRUE	3.19	729	TRUE	5.06	--	--	--
3	3-4/24/2001	04/24/2001	170	TRUE	1.57	723	TRUE	5.36	--	--	--	125	TRUE	0.084	32700	TRUE	227	--	--	--
3	3-8/12/2003	08/12/2003	34.6	TRUE	0.320	359.4	TRUE	2.66	--	--	--	2587	TRUE	1.73	695	TRUE	4.83	--	--	--
3	3-8/31/2006-TCEQ	08/31/2006	133	TRUE	1.23	4120	FALSE	15.3	61.6	FALSE	7.16	8090	TRUE	5.41	11200	TRUE	77.8	61.6	FALSE	31.1
3	3-9/6/2000	09/06/2000	51.7	TRUE	0.479	141	TRUE	1.04	--	--	--	4720	TRUE	3.16	2100	TRUE	14.6	--	--	--
4A	4A-4/24/2001	04/24/2001	57.5	TRUE	0.532	162	TRUE	1.2	--	--	--	2680	TRUE	1.79	298	TRUE	2.07	--	--	--
4A	4A-8/12/2003	08/12/2003	48.2	TRUE	0.446	50.5	FALSE	0.187	--	--	--	2341	TRUE	1.57	162.5	TRUE	1.13	--	--	--
4A	4A-8/31/2006-TCEQ	08/31/2006	63.5	TRUE	0.588	4610	FALSE	17.1	69.1	FALSE	8.03	5230	TRUE	3.50	4610	FALSE	16.0	69.1	FALSE	34.9
4A	4A-9/5/2000	09/05/2000	65	TRUE	0.602	245	TRUE	1.81	--	--	--	2260	TRUE	1.51	214	TRUE	1.49	--	--	--
5	5-4/24/2001	04/24/2001	99.5	TRUE	0.921	713	TRUE	5.28	--	--	--	5290	TRUE	3.54	7630	TRUE	53.0	--	--	--
5	5-9/5/2000	09/05/2000	66.6	TRUE	0.617	158	TRUE	1.17	--	--	--	1670	TRUE	1.12	311	TRUE	2.16	--	--	--
6A	6A-4/25/2001	04/25/2001	34.8	TRUE	0.322	400	FALSE	1.48	--	--	--	1100	TRUE	0.736	61	TRUE	0.424	--	--	--
6A	6A-8/12/2003	08/12/2003	71	TRUE	0.657	352.2	TRUE	2.61	--	--	--	982.7	TRUE	0.658	576.8	TRUE	4.01	--	--	--
6A	6A-8/31/2006-TCEQ	08/31/2006	36.9	TRUE	0.342	2390	FALSE	8.85	35.9	FALSE	4.17	1300	TRUE	0.870	2390	FALSE	8.30	35.9	FALSE	18.1
6A	6A-9/5/2000	09/05/2000	24.3	TRUE	0.225	431	TRUE	3.19	--	--	--	11400	TRUE	7.63	559	TRUE	3.88	--	--	--
7	7-4/26/2001	04/26/2001	301	TRUE	2.79	252	TRUE	1.87	--	--	--	3540	TRUE	2.37	168	TRUE	1.17	--	--	--
7	7-8/12/2003	08/12/2003	96.1	TRUE	0.890	27.9	FALSE	0.103	--	--	--	294.3	TRUE	0.197	12.8	FALSE	0.044	--	--	--
7	7-9/6/2000	09/06/2000	72.7	TRUE	0.673	169	TRUE	1.25	--	--	--	2930	TRUE	1.96	246	TRUE	1.71	--	--	--
8	8-4/25/2001	04/25/2001	19.3	TRUE	0.179	1190	TRUE	8.81	--	--	--	36700	TRUE	24.6	766	TRUE	5.32	--	--	--
8	8-9/6/2000	09/06/2000	15.8	TRUE	0.146	265	TRUE	1.96	--	--	--	5370	TRUE	3.59	114	TRUE	0.792	--	--	--
9	9-8/12/2003	08/12/2003	8.38	TRUE	0.078	593.6	TRUE	4.40	--	--	--	2020	TRUE	1.35	61.7	TRUE	0.428	--	--	--
9	9-9/6/2000	09/06/2000	11.5	TRUE	0.106	2040	TRUE	15.1	--	--	--	34800	TRUE	23.3	995	TRUE	6.91	--	--	--
E	E-4/23/2001	04/23/2001	55	TRUE	0.509	169	TRUE	1.25	--	--	--	7620	TRUE	5.10	1520	TRUE	10.56	--	--	--
E	E-9/6/2000	09/06/2000	29.9	TRUE	0.277	64.3	TRUE	0.476	--	--	--	2130	TRUE	1.43	560	TRUE	3.89	--	--	--
G	G-4/24/2001	04/24/2001	79.1	TRUE	0.732	80.9	TRUE	0.599	--	--	--	2060	TRUE	1.38	28.1	TRUE	0.195	--	--	--
G	G-9/6/2000	09/06/2000	65.3	TRUE	0.605	197	TRUE	1.46	--	--	--	2720	TRUE	1.82	97.9	TRUE	0.680	--	--	--
Q	Q-4/25/2001	04/25/2001	180	TRUE	1.67	95.3	TRUE	0.706	--	--	--	84.9	TRUE	0.057	131	TRUE	0.910	--	--	--
Q	Q-9/5/2000	09/05/2000	25.6	TRUE	0.237	255	TRUE	1.89	--	--	--	5040	TRUE	3.37	460	TRUE	3.19	--	--	--
R	R-4/26/2001	04/26/2001	70.3	TRUE	0.651	487	TRUE	3.61	--	--	--	6460	TRUE	4.32	236	TRUE	1.64	--	--	--
R	R-8/12/2003	08/12/2003	221	TRUE	2.05	495.9	TRUE	3.67	--	--	--	5446	TRUE	3.65	116.7	TRUE	0.810	--	--	--
R	R-9/5/2000	09/05/2000	271	TRUE	2.51	275	TRUE	2.04	--	--	--	4230	TRUE	2.83	173	TRUE	1.20	--	--	--
S	S-4/24/2001	04/24/2001	80.2	TRUE	0.743	400	FALSE	1.48	--	--	--	269	TRUE	0.180	4970	TRUE	34.5	--	--	--
S	S-9/5/2000	09/05/2000	104	TRUE	0.963	41.1	TRUE	0.304	--	--	--	1070	TRUE	0.716	260	TRUE	1.81	--	--	--
T	T-4/25/2001	04/25/2001	37.9	TRUE	0.351	138	TRUE	1.02	--	--	--	3490	TRUE	2.34	222	TRUE	1.54	--	--	--
T	T-9/5/2000	09/05/2000	52.3	TRUE	0.484	130	TRUE	0.963	--	--	--	1710	TRUE	1.14	153	TRUE	1.0625	--	--	--
U	U-4/24/2001	04/24/2001	15.5	TRUE	0.144	400	FALSE	1.48	--	--	--	76.4	TRUE	0.051	18.1	TRUE	0.126	--	--	--
U	U-9/6/2000	09/06/2000	14.9	TRUE	0.138	400	FALSE	1.48	--	--	--	337	TRUE	0.226	125	TRUE	0.868	--	--	--
V	V-4/23/2001	04/23/2001	62.3	TRUE	0.577	127	TRUE	0.941	--	--	--	4010	TRUE	2.68	802	TRUE	5.57	--	--	--
V	V-9/5/2000	09/05/2000	69.9	TRUE	0.647	109	TRUE	0.807	--	--	--	3840	TRUE	2.57	824	TRUE	5.72	--	--	--
Y	Y-4/26/2001	04/26/2001	18.3	TRUE	0.169	400	FALSE	1.48	--	--	--	518	TRUE	0.347	18.1	TRUE	0.126	--	--	--
Y	Y-9/6/2000	09/06/2000	47.1	TRUE	0.436	400	FALSE	1.48	--	--	--	9810	TRUE	6.57	12000	TRUE	83.3	--	--	--
3	3-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	696	FALSE	2.58	29.6	FALSE	3.44	2920	TRUE	1.95	586	TRUE	4.07	14.8	FALSE	7.47
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	1090	FALSE	4.04	43.5	FALSE	5.06	2690	TRUE	1.80	436	FALSE	1.51	21.8	FALSE	11.0
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	639	FALSE	2.37	26.4	FALSE	3.07	2490	TRUE	1.67	1700	TRUE	11.8	13.2	FALSE	6.67
7	7-8/12/2003-EPA/TCEQ	08/12/2003	--	--	--	572	FALSE	2.12	22.9	FALSE	2.66	229	FALSE	0.077	229	FALSE	0.795	11.4	FALSE	5.76
9	9-8/12/2003-TCEQ	08/12/2003	--	--	--	613	FALSE	2.27	24	FALSE	2.79	2490	TRUE	1.67	245	FALSE	0.851	12	FALSE	6.06

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Heptachlor epoxide			Lead			Mercury			Naphthalene			Nickel			Phenanthrene		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	40	FALSE	7.30	20.1	TRUE	0.179	0.064	TRUE	0.091	33.6	TRUE	0.086	16.5	TRUE	0.386	146	TRUE	0.268
10	10-9/5/2000	09/05/2000	38	FALSE	6.93	9.55	TRUE	0.085	0.082	TRUE	0.117	116	TRUE	0.297	13.6	TRUE	0.318	4280	TRUE	7.87
2	2-4/23/2001	04/23/2001	7.94	TRUE	2.90	22.2	TRUE	0.198	1	TRUE	1.43	255	TRUE	0.652	27.2	TRUE	0.636	338	TRUE	0.621
2	2-9/5/2000	09/05/2000	40	FALSE	7.30	21.7	TRUE	0.194	1.94	TRUE	2.77	1150	TRUE	2.94	63.3	TRUE	1.48	3140	TRUE	5.77
2.5	2.5-4/23/2001	04/23/2001	0.41	TRUE	0.150	34.8	TRUE	0.311	2.35	TRUE	3.36	924	TRUE	2.36	21.2	TRUE	0.495	8650	TRUE	15.9
2.5	2.5-9/5/2000	09/05/2000	41	FALSE	7.48	30	TRUE	0.268	2.91	TRUE	4.16	652	TRUE	1.67	21.8	TRUE	0.509	3250	TRUE	5.97
3	3-4/24/2001	04/24/2001	0.338	TRUE	0.123	308	TRUE	2.75	160	TRUE	229	23500	TRUE	60.1	103	TRUE	2.41	71500	TRUE	131
3	3-8/12/2003	08/12/2003	--	--	--	43.4	TRUE	0.388	9.02	TRUE	12.9	328.1	TRUE	0.839	15.6	TRUE	0.364	2035	TRUE	3.74
3	3-8/31/2006-TCEQ	08/31/2006	61.6	FALSE	11.2	498	TRUE	4.45	159	TRUE	227	10300	TRUE	26.3	115	TRUE	2.69	34300	TRUE	63.1
3	3-9/6/2000	09/06/2000	40	FALSE	7.30	67.7	TRUE	0.604	16.7	TRUE	23.9	1810	TRUE	4.63	31	TRUE	0.72	8240	TRUE	15.1
4A	4A-4/24/2001	04/24/2001	40	FALSE	7.30	39.7	TRUE	0.354	6.26	TRUE	8.94	84.2	TRUE	0.215	31.5	TRUE	0.736	686	TRUE	1.26
4A	4A-8/12/2003	08/12/2003	--	--	--	55.9	TRUE	0.499	19.9	TRUE	28.4	79.6	TRUE	0.204	26.5	TRUE	0.619	446.1	TRUE	0.820
4A	4A-8/31/2006-TCEQ	08/31/2006	69.1	FALSE	12.6	58.8	TRUE	0.525	91.9	TRUE	131	4610	FALSE	5.90	44.4	TRUE	1.04	4610	FALSE	4.24
4A	4A-9/5/2000	09/05/2000	38	FALSE	6.93	36	TRUE	0.321	6.62	TRUE	9.46	1050	TRUE	2.69	30.3	TRUE	0.708	914	TRUE	1.68
5	5-4/24/2001	04/24/2001	0.307	TRUE	0.112	125	TRUE	1.12	8.24	TRUE	11.8	2510	TRUE	6.42	60.8	TRUE	1.42	15300	TRUE	28.1
5	5-9/5/2000	09/05/2000	35	FALSE	6.39	39.5	TRUE	0.353	4.55	TRUE	6.5	254	TRUE	0.650	28.9	TRUE	0.675	1010	TRUE	1.86
6A	6A-4/25/2001	04/25/2001	40	FALSE	7.30	50.6	TRUE	0.452	0.299	TRUE	0.427	167	TRUE	0.427	20.2	TRUE	0.472	365	TRUE	0.671
6A	6A-8/12/2003	08/12/2003	--	--	--	76.6	TRUE	0.684	2.53	TRUE	3.61	2004	TRUE	5.13	15.7	TRUE	0.367	1274	TRUE	2.34
6A	6A-8/31/2006-TCEQ	08/31/2006	35.9	FALSE	6.55	23.3	TRUE	0.208	0.538	TRUE	0.769	2390	FALSE	3.06	15.5	TRUE	0.362	407	TRUE	0.748
6A	6A-9/5/2000	09/05/2000	39	FALSE	7.12	34.6	TRUE	0.309	0.46	TRUE	0.657	284	TRUE	0.726	21.1	TRUE	0.493	7410	TRUE	13.6
7	7-4/26/2001	04/26/2001	40	FALSE	7.30	144	TRUE	1.29	0.034	TRUE	0.049	104	TRUE	0.266	19.7	TRUE	0.460	2120	TRUE	3.90
7	7-8/12/2003	08/12/2003	--	--	--	58.9	TRUE	0.526	0.117	TRUE	0.167	21.6	FALSE	0.028	9.6	TRUE	0.224	89.5	TRUE	0.165
7	7-9/6/2000	09/06/2000	38	FALSE	6.93	523	TRUE	4.67	0.103	TRUE	0.147	108	TRUE	0.276	26.8	TRUE	0.626	1790	TRUE	3.29
8	8-4/25/2001	04/25/2001	40	FALSE	7.30	26.4	TRUE	0.236	0.037	TRUE	0.053	112	TRUE	0.286	12.1	TRUE	0.283	16600	TRUE	30.5
8	8-9/6/2000	09/06/2000	39	FALSE	7.12	52.7	TRUE	0.471	0.029	TRUE	0.041	53.6	TRUE	0.137	17.8	TRUE	0.416	2920	TRUE	5.37
9	9-8/12/2003	08/12/2003	--	--	--	54.3	TRUE	0.485	0.03	TRUE	0.043	45.2	FALSE	0.058	3.66	TRUE	0.086	970.4	TRUE	1.78
9	9-9/6/2000	09/06/2000	42	FALSE	7.66	36.2	TRUE	0.323	0.031	TRUE	0.044	83.5	TRUE	0.214	8.36	TRUE	0.195	18500	TRUE	34.0
E	E-4/23/2001	04/23/2001	40	FALSE	7.30	47.5	TRUE	0.424	4.21	TRUE	6.01	819	TRUE	2.09	30.1	TRUE	0.703	4310	TRUE	7.9
E	E-9/6/2000	09/06/2000	40	FALSE	7.30	25	TRUE	0.223	3.08	TRUE	4.4	364	TRUE	0.931	15.8	TRUE	0.369	2170	TRUE	3.99
G	G-4/24/2001	04/24/2001	0.576	TRUE	0.210	52	TRUE	0.464	1.46	TRUE	2.09	49.1	TRUE	0.126	61.7	TRUE	1.44	553	TRUE	1.02
G	G-9/6/2000	09/06/2000	41	FALSE	7.48	39.8	TRUE	0.355	1.77	TRUE	2.53	408	FALSE	0.522	56.8	TRUE	1.33	1240	TRUE	2.28
Q	Q-4/25/2001	04/25/2001	40	FALSE	7.30	193	TRUE	1.72	1.12	TRUE	1.6	244	TRUE	0.624	156	TRUE	3.64	914	TRUE	1.68
Q	Q-9/5/2000	09/05/2000	39	FALSE	7.12	27.3	TRUE	0.244	0.327	TRUE	0.467	473	TRUE	1.21	17.5	TRUE	0.409	3400	TRUE	6.25
R	R-4/26/2001	04/26/2001	40	FALSE	7.30	47.2	TRUE	0.421	0.133	TRUE	0.19	64.1	TRUE	0.164	54.5	TRUE	1.27	3910	TRUE	7.19
R	R-8/12/2003	08/12/2003	--	--	--	46.3	TRUE	0.413	0.163	TRUE	0.233	69.5	TRUE	0.178	11.4	TRUE	0.266	2375	TRUE	4.37
R	R-9/5/2000	09/05/2000	38	FALSE	6.93	260	TRUE	2.32	0.055	TRUE	0.079	67.1	TRUE	0.172	26.6	TRUE	0.621	2570	TRUE	4.72
S	S-4/24/2001	04/24/2001	1.26	TRUE	0.460	124	TRUE	1.11	23.9	TRUE	34.1	3690	TRUE	9.44	48.1	TRUE	1.12	14700	TRUE	27.0
S	S-9/5/2000	09/05/2000	39	FALSE	7.12	47.8	TRUE	0.427	10.7	TRUE	15.3	174	TRUE	0.445	24	TRUE	0.561	1020	TRUE	1.88
T	T-4/25/2001	04/25/2001	0.319	TRUE	0.116	127	TRUE	1.13	1.1	TRUE	1.57	121	FALSE	0.155	19.8	TRUE	0.463	1110	TRUE	2.04
T	T-9/5/2000	09/05/2000	38	FALSE	6.93	28.9	TRUE	0.258	3.21	TRUE	4.59	212	TRUE	0.542	25	TRUE	0.584	745	TRUE	1.37
U	U-4/24/2001	04/24/2001	40	FALSE	7.30	16.8	TRUE	0.150	0.744	TRUE	1.06	41.2	TRUE	0.105	21.4	TRUE	0.500	56.4	TRUE	0.104
U	U-9/6/2000	09/06/2000	40	FALSE	7.30	15	TRUE	0.134	0.666	TRUE	0.951	97	TRUE	0.248	12.9	TRUE	0.301	346	TRUE	0.636
V	V-4/23/2001	04/23/2001	40	FALSE	7.30	50.9	TRUE	0.454	3.98	TRUE	5.69	585	TRUE	1.50	33.5	TRUE	0.783	2380	TRUE	4.375
V	V-9/5/2000	09/05/2000	40	FALSE	7.30	48.2	TRUE	0.430	6.55	TRUE	9.36	903	TRUE	2.31	33.5	TRUE	0.783	3520	TRUE	6.47
Y	Y-4/26/2001	04/26/2001	0.278	TRUE	0.101	33	TRUE	0.295	0.222	TRUE	0.317	35.9	TRUE	0.092	31.9	TRUE	0.745	264	TRUE	0.485
Y	Y-9/6/2000	09/06/2000	40	FALSE	7.30	41.8	TRUE	0.373	0.823	TRUE	1.18	41500	TRUE	106	42.8	TRUE	1	46800	TRUE	86.0
3	3-8/12/2003-EPA/TCEQ	08/12/2003	14.8	FALSE	2.70	--	--	--	--	--	--	--	--	--	--	--	--	2910	TRUE	5.35
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	21.8	FALSE	3.98	--	--	--	--	--	--	--	--	--	--	--	--	616	TRUE	1.13
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	13.2	FALSE	2.41	--	--	--	--	--	--	--	--	--	--	--	--	5520	TRUE	10.1
7	7-8/12/2003-EPA/TCEQ	08/12/2003	11.4	FALSE	2.08	--	--	--	--	--	--	--	--	--	--	--	--	229	FALSE	0.210
9	9-8/12/2003-TCEQ	08/12/2003	12	FALSE	2.19	--	--	--	--	--	--	--	--	--	--	--	--	1010	TRUE	1.86

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Pyrene			Silver			Sum 4,4 DDT, DDE, DDD (U=0)			Total 10 HPAH (U = 0)			Total 16 PAH (U = 0)			Total 6 LPAH (U = 0)		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	126	TRUE	0.090	0.078	TRUE	0.044	79.64	TRUE	16.7	899.1	TRUE	0.135	1316.1	TRUE	0.078	417	TRUE	0.289
10	10-9/5/2000	09/05/2000	3020	TRUE	2.16	0.074	TRUE	0.042	3.07	TRUE	0.644	14750	TRUE	2.21	20982.9	TRUE	1.25	6232.9	TRUE	4.32
2	2-4/23/2001	04/23/2001	1910	TRUE	1.37	0.269	TRUE	0.152	4.135	TRUE	0.867	6265	TRUE	0.938	7125.7	TRUE	0.425	860.7	TRUE	0.597
2	2-9/5/2000	09/05/2000	4350	TRUE	3.11	0.242	TRUE	0.137	40	FALSE	4.19	10112	TRUE	1.51	18409	TRUE	1.10	8297	TRUE	5.75
2.5	2.5-4/23/2001	04/23/2001	11400	TRUE	8.15	0.468	TRUE	0.264	136.263	TRUE	28.6	26141	TRUE	3.92	43235	TRUE	2.58	17094	TRUE	11.9
2.5	2.5-9/5/2000	09/05/2000	8880	TRUE	6.35	0.452	TRUE	0.255	6.39	TRUE	1.34	22954	TRUE	3.44	30858	TRUE	1.84	7904	TRUE	5.48
3	3-4/24/2001	04/24/2001	265	TRUE	0.190	0.627	TRUE	0.354	14.02	TRUE	2.94	38483	TRUE	5.76	230683	TRUE	13.8	192200	TRUE	133
3	3-8/12/2003	08/12/2003	5178	TRUE	3.70	0.148	TRUE	0.084	--	--	--	11934.9	TRUE	1.79	18235.5	TRUE	1.09	6300.6	TRUE	4.37
3	3-8/31/2006-TCEQ	08/31/2006	17400	TRUE	12.4	1.43	TRUE	0.808	123	FALSE	12.9	28130	TRUE	4.21	111530	TRUE	6.65	83400	TRUE	57.8
3	3-9/6/2000	09/06/2000	8440	TRUE	6.04	0.41	TRUE	0.232	8.45	TRUE	1.77	21231	TRUE	3.18	42091	TRUE	2.51	20860	TRUE	14.5
4A	4A-4/24/2001	04/24/2001	2810	TRUE	2.01	1.17	TRUE	0.661	2.43	TRUE	0.509	13807	TRUE	2.07	16133.2	TRUE	0.962	2326.2	TRUE	1.61
4A	4A-8/12/2003	08/12/2003	5066	TRUE	3.62	0.574	TRUE	0.324	--	--	--	12082.6	TRUE	1.81	14201.2	TRUE	0.847	2118.6	TRUE	1.47
4A	4A-8/31/2006-TCEQ	08/31/2006	13200	TRUE	9.44	1.36	TRUE	0.768	138	FALSE	14.5	18430	TRUE	2.76	18430	TRUE	1.10	4610	FALSE	1.60
4A	4A-9/5/2000	09/05/2000	2490	TRUE	1.78	1.57	TRUE	0.887	8.57	TRUE	1.80	11528	TRUE	1.73	14655	TRUE	0.874	3127	TRUE	2.17
5	5-4/24/2001	04/24/2001	14700	TRUE	10.5	1.05	TRUE	0.593	8.94	TRUE	1.87	38253	TRUE	5.73	78263	TRUE	4.67	40010	TRUE	27.7
5	5-9/5/2000	09/05/2000	1870	TRUE	1.34	1.1	TRUE	0.621	6.72	TRUE	1.41	8235	TRUE	1.23	11337	TRUE	0.676	3102	TRUE	2.15
6A	6A-4/25/2001	04/25/2001	1220	TRUE	0.873	0.373	TRUE	0.211	40	FALSE	4.19	4164	TRUE	0.624	5886.2	TRUE	0.351	1722.2	TRUE	1.19
6A	6A-8/12/2003	08/12/2003	1631	TRUE	1.17	1.53	TRUE	0.864	--	--	--	5242.4	TRUE	0.785	11974.4	TRUE	0.714	6732	TRUE	4.67
6A	6A-8/31/2006-TCEQ	08/31/2006	1250	TRUE	0.894	0.695	TRUE	0.393	71.9	FALSE	7.54	3235	TRUE	0.485	3642	TRUE	0.217	407	TRUE	0.282
6A	6A-9/5/2000	09/05/2000	10000	TRUE	7.15	0.173	TRUE	0.098	14.9	TRUE	3.12	44861	TRUE	6.72	60074	TRUE	3.58	15213	TRUE	10.5
7	7-4/26/2001	04/26/2001	3560	TRUE	2.55	0.783	TRUE	0.442	6.721	TRUE	1.41	15832	TRUE	2.37	18823	TRUE	1.12	2991	TRUE	2.07
7	7-8/12/2003	08/12/2003	231.2	TRUE	0.165	0.075	FALSE	0.021	--	--	--	1311.4	TRUE	0.196	1462.45	TRUE	0.087	151.05	TRUE	0.105
7	7-9/6/2000	09/06/2000	2390	TRUE	1.71	0.632	TRUE	0.357	88.85	TRUE	18.6	13654	TRUE	2.05	16489	TRUE	0.983	2835	TRUE	1.97
8	8-4/25/2001	04/25/2001	29100	TRUE	20.8	0.527	TRUE	0.298	1.258	TRUE	0.264	155040	TRUE	23.2	175460	TRUE	10.5	20420	TRUE	14.2
8	8-9/6/2000	09/06/2000	3980	TRUE	2.85	0.205	TRUE	0.116	81.91	TRUE	17.2	22995	TRUE	3.44	26505.1	TRUE	1.58	3510.1	TRUE	2.43
9	9-8/12/2003	08/12/2003	1554	TRUE	1.11	0.07	FALSE	0.020	--	--	--	8731.7	TRUE	1.31	9909.1	TRUE	0.591	1177.4	TRUE	0.817
9	9-9/6/2000	09/06/2000	26600	TRUE	19.0	0.176	TRUE	0.099	8.11	TRUE	1.70	141490	TRUE	21.2	164790.5	TRUE	9.83	23300.5	TRUE	16.2
E	E-4/23/2001	04/23/2001	11300	TRUE	8.08	0.652	TRUE	0.368	4.06	TRUE	0.851	32139	TRUE	4.81	45108	TRUE	2.69	12969	TRUE	8.99
E	E-9/6/2000	09/06/2000	4080	TRUE	2.92	0.29	TRUE	0.164	5.54	TRUE	1.16	7972.3	TRUE	1.19	13475.3	TRUE	0.804	5503	TRUE	3.82
G	G-4/24/2001	04/24/2001	1580	TRUE	1.13	0.247	TRUE	0.140	0.446	TRUE	0.094	8886.9	TRUE	1.33	9737.4	TRUE	0.581	850.5	TRUE	0.590
G	G-9/6/2000	09/06/2000	2100	TRUE	1.50	0.24	TRUE	0.136	5.99	TRUE	1.26	12507	TRUE	1.87	14234.9	TRUE	0.849	1727.9	TRUE	1.20
Q	Q-4/25/2001	04/25/2001	4440	TRUE	3.18	0.577	TRUE	0.326	5.82	TRUE	1.22	11841.2	TRUE	1.77	16349.7	TRUE	0.975	4508.5	TRUE	3.13
Q	Q-9/5/2000	09/05/2000	4900	TRUE	3.51	0.507	TRUE	0.286	14.8	TRUE	3.10	22493	TRUE	3.37	30926	TRUE	1.84	8433	TRUE	5.85
R	R-4/26/2001	04/26/2001	5500	TRUE	3.93	0.246	TRUE	0.139	2.381	TRUE	0.499	27007	TRUE	4.05	32039.1	TRUE	1.91	5032.1	TRUE	3.49
R	R-8/12/2003	08/12/2003	4104	TRUE	2.94	0.173	TRUE	0.098	--	--	--	20946.9	TRUE	3.14	23977.47	TRUE	1.43	3030.57	TRUE	2.10
R	R-9/5/2000	09/05/2000	3230	TRUE	2.31	0.384	TRUE	0.217	5.23	TRUE	1.10	18125	TRUE	2.71	21404.1	TRUE	1.28	3279.1	TRUE	2.27
S	S-4/24/2001	04/24/2001	41600	TRUE	29.8	0.58	TRUE	0.328	8.28	TRUE	1.74	64189	TRUE	9.61	116399	TRUE	6.94	52210	TRUE	36.2
S	S-9/5/2000	09/05/2000	1900	TRUE	1.36	0.424	TRUE	0.240	7.24	TRUE	1.52	4473.1	TRUE	0.670	6812.1	TRUE	0.406	2339	TRUE	1.62
T	T-4/25/2001	04/25/2001	2740	TRUE	1.96	0.611	TRUE	0.345	0.476	TRUE	0.100	15159	TRUE	2.27	17373	TRUE	1.04	2214	TRUE	1.54
T	T-9/5/2000	09/05/2000	1550	TRUE	1.11	0.411	TRUE	0.232	7.49	TRUE	1.57	8721	TRUE	1.31	10712.4	TRUE	0.639	1991.4	TRUE	1.38
U	U-4/24/2001	04/24/2001	149	TRUE	0.107	0.162	TRUE	0.092	0.216	TRUE	0.045	225.4	TRUE	0.034	443.7	TRUE	0.026	218.3	TRUE	0.151
U	U-9/6/2000	09/06/2000	507	TRUE	0.363	0.131	TRUE	0.074	6.63	TRUE	1.39	1514	TRUE	0.227	2601.5	TRUE	0.155	1087.5	TRUE	0.754
V	V-4/23/2001	04/23/2001	5650	TRUE	4.04	0.757	TRUE	0.428	6.469	TRUE	1.36	16724	TRUE	2.51	24025	TRUE	1.43	7301	TRUE	5.06
V	V-9/5/2000	09/05/2000	7450	TRUE	5.33	0.763	TRUE	0.431	20.5	TRUE	4.30	17324	TRUE	2.59	26994	TRUE	1.61	9670	TRUE	6.71
Y	Y-4/26/2001	04/26/2001	429	TRUE	0.307	0.129	TRUE	0.073	1.914	TRUE	0.401	2400	TRUE	0.359	2813.57	TRUE	0.168	413.57	TRUE	0.287
Y	Y-9/6/2000	09/06/2000	15700	TRUE	11.2	0.347	TRUE	0.196	40	FALSE	4.19	34920	TRUE	5.23	199420	TRUE	11.9	164500	TRUE	114
3	3-8/12/2003-EPA/TCEQ	08/12/2003	6910	TRUE	4.94	--	--	--	34.8	TRUE	7.30	12388	TRUE	1.86	18505	TRUE	1.10	6117	TRUE	4.24
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	7100	TRUE	5.08	--	--	--	53.7	TRUE	11.3	14990	TRUE	2.25	16192	TRUE	0.966	1202	TRUE	0.834
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	5520	TRUE	3.95	--	--	--	2021.2	TRUE	424	13138	TRUE	1.97	27538	TRUE	1.64	14400	TRUE	9.99
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	0.082	--	--	--	22.9	FALSE	2.40	572	FALSE	0.043	572	FALSE	0.017	229	FALSE	0.079
9	9-8/12/2003-TCEQ	08/12/2003	2310	TRUE	1.65	--	--	--	24	FALSE	2.52	11379	TRUE	1.70	12389	TRUE	0.739	1010	TRUE	0.700

Table B-3
Toxicity Data and Probable Effects Limit Quotients (PEL-Q) Used in Toxicity Model Evaluations

			Total Chlordane (alpha and gamma) (U = 0)			Total PCB (U = 0)			Zinc		
Location	Sample ID	Sample Date	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q	Concentration	Detect	PEL-Q
10	10-4/25/2001	04/25/2001	40	FALSE	4.18	1.98	TRUE	0.010	91.7	TRUE	0.338
10	10-9/5/2000	09/05/2000	38	FALSE	3.97	50	FALSE	0.132	84.5	TRUE	0.312
2	2-4/23/2001	04/23/2001	2.68	TRUE	0.559	41.1	TRUE	0.217	82.1	TRUE	0.303
2	2-9/5/2000	09/05/2000	40	FALSE	4.18	50	FALSE	0.132	133	TRUE	0.491
2.5	2.5-4/23/2001	04/23/2001	0.945	TRUE	0.197	525	TRUE	2.78	159	TRUE	0.587
2.5	2.5-9/5/2000	09/05/2000	41	FALSE	4.28	328	TRUE	1.74	161	TRUE	0.594
3	3-4/24/2001	04/24/2001	1.59	TRUE	0.332	6720	TRUE	35.6	471	TRUE	1.74
3	3-8/12/2003	08/12/2003	--	--	--	1360	TRUE	7.20	150	TRUE	0.554
3	3-8/31/2006-TCEQ	08/31/2006	616	FALSE	64.3	17000	TRUE	89.9	364	TRUE	1.34
3	3-9/6/2000	09/06/2000	40	FALSE	4.18	1080	TRUE	5.71	239	TRUE	0.882
4A	4A-4/24/2001	04/24/2001	40	FALSE	4.18	398	TRUE	2.11	303	TRUE	1.12
4A	4A-8/12/2003	08/12/2003	--	--	--	34600	TRUE	183	305	TRUE	1.13
4A	4A-8/31/2006-TCEQ	08/31/2006	691	FALSE	72.1	150000	TRUE	794	429	TRUE	1.58
4A	4A-9/5/2000	09/05/2000	38	FALSE	3.97	1690	TRUE	8.94	311	TRUE	1.15
5	5-4/24/2001	04/24/2001	0.389	TRUE	0.081	1910	TRUE	10.1	710	TRUE	2.62
5	5-9/5/2000	09/05/2000	35	FALSE	3.65	780	TRUE	4.13	365	TRUE	1.35
6A	6A-4/25/2001	04/25/2001	40	FALSE	4.18	2060	TRUE	10.9	294	TRUE	1.08
6A	6A-8/12/2003	08/12/2003	--	--	--	10900	TRUE	57.7	353	TRUE	1.30
6A	6A-8/31/2006-TCEQ	08/31/2006	359	FALSE	37.5	7700	TRUE	40.7	191	TRUE	0.705
6A	6A-9/5/2000	09/05/2000	2.18	TRUE	0.455	9370	TRUE	49.6	249	TRUE	0.919
7	7-4/26/2001	04/26/2001	0.07	TRUE	0.015	62.1	TRUE	0.329	1850	TRUE	6.83
7	7-8/12/2003	08/12/2003	--	--	--	1980	TRUE	10.5	481	TRUE	1.77
7	7-9/6/2000	09/06/2000	38	FALSE	3.97	62.8	TRUE	0.332	503	TRUE	1.86
8	8-4/25/2001	04/25/2001	0.681	TRUE	0.142	15.4	TRUE	0.081	154	TRUE	0.568
8	8-9/6/2000	09/06/2000	39	FALSE	4.07	51	FALSE	0.135	146	TRUE	0.539
9	9-8/12/2003	08/12/2003	--	--	--	48	TRUE	0.254	132	TRUE	0.487
9	9-9/6/2000	09/06/2000	42	FALSE	4.38	49	FALSE	0.130	102	TRUE	0.376
E	E-4/23/2001	04/23/2001	40	FALSE	4.18	1580	TRUE	8.36	257	TRUE	0.948
E	E-9/6/2000	09/06/2000	40	FALSE	4.18	370	TRUE	1.96	120	TRUE	0.443
G	G-4/24/2001	04/24/2001	0.248	TRUE	0.052	197	TRUE	1.04	400	TRUE	1.48
G	G-9/6/2000	09/06/2000	41	FALSE	4.28	399	TRUE	2.11	277	TRUE	1.02
Q	Q-4/25/2001	04/25/2001	1.14	TRUE	0.238	1070	TRUE	5.66	1100	TRUE	4.06
Q	Q-9/5/2000	09/05/2000	2.97	TRUE	0.620	3780	TRUE	20	304	TRUE	1.12
R	R-4/26/2001	04/26/2001	40	FALSE	4.18	37.7	TRUE	0.199	479	TRUE	1.77
R	R-8/12/2003	08/12/2003	--	--	--	--	--	--	256	TRUE	0.945
R	R-9/5/2000	09/05/2000	3.41	TRUE	0.712	103	TRUE	0.545	1750	TRUE	6.46
S	S-4/24/2001	04/24/2001	0.23	TRUE	0.048	2090	TRUE	11.1	355	TRUE	1.31
S	S-9/5/2000	09/05/2000	39	FALSE	4.07	113	TRUE	0.598	189	TRUE	0.697
T	T-4/25/2001	04/25/2001	0.393	TRUE	0.082	626	TRUE	3.31	252	TRUE	0.930
T	T-9/5/2000	09/05/2000	38	FALSE	3.97	837	TRUE	4.43	281	TRUE	1.04
U	U-4/24/2001	04/24/2001	0.302	TRUE	0.063	12.8	TRUE	0.068	50.9	TRUE	0.188
U	U-9/6/2000	09/06/2000	40	FALSE	4.18	78.8	TRUE	0.417	54.3	TRUE	0.200
V	V-4/23/2001	04/23/2001	0.306	TRUE	0.064	442	TRUE	2.34	295	TRUE	1.09
V	V-9/5/2000	09/05/2000	40	FALSE	4.18	447	TRUE	2.37	310	TRUE	1.14
Y	Y-4/26/2001	04/26/2001	0.112	TRUE	0.023	58.1	TRUE	0.307	73.9	TRUE	0.273
Y	Y-9/6/2000	09/06/2000	40	FALSE	4.18	2570	TRUE	13.6	1540	TRUE	5.68
3	3-8/12/2003-EPA/TCEQ	08/12/2003	296	FALSE	30.9	1360	TRUE	7.2	--	--	--
4A	4A-8/12/2003-EPA/TCEQ	08/12/2003	435	FALSE	45.4	34600	TRUE	183	--	--	--
6A	6A-8/12/2003-EPA/TCEQ	08/12/2003	264	FALSE	27.6	10900	TRUE	57.7	--	--	--
7	7-8/12/2003-EPA/TCEQ	08/12/2003	229	FALSE	23.9	1980	TRUE	10.5	--	--	--
9	9-8/12/2003-TCEQ	08/12/2003	240	FALSE	25.1	48	FALSE	0.127	--	--	--

Table B-4
Toxicity Data and Eqilibrium Screening Benchmarks Used in Toxicity Model Evaluations

Location	Sample ID	Sample Date	L. plumulosus survival (control adjusted; %)	Toxic (< 80% survival)	Total NOC ESB TU	Total PAH ESB TU
2	2-4/23/2001	04/23/2001	87.7	FALSE	0.960	0.746
2	2-9/5/2000	09/05/2000	94.3	FALSE	0.505	1.77
2.5	2.5-4/23/2001	04/23/2001	86.7	FALSE	0.363	5.25
2.5	2.5-9/5/2000	09/05/2000	90.2	FALSE	0.390	5.10
3	3-4/24/2001	04/24/2001	0	TRUE	0.823	18.1
3	3-8/12/2003	08/12/2003	95	FALSE	0.0540	1.01
3	3-8/31/2006-TCEQ	08/31/2006	--	--	0.157	3.61
3	3-9/6/2000	09/06/2000	75.6	TRUE	0.0670	4.79
5	5-4/24/2001	04/24/2001	0	TRUE	0.0960	5.86
5	5-9/5/2000	09/05/2000	103	FALSE	0.00	0.806
7	7-4/26/2001	04/26/2001	91.9	FALSE	0.000	0.973
7	7-8/12/2003	08/12/2003	91	FALSE	0.000	0.128
7	7-9/6/2000	09/06/2000	5.18	TRUE	0.00400	0.832
8	8-4/25/2001	04/25/2001	0	TRUE	0.00400	11.1
8	8-9/6/2000	09/06/2000	94.3	FALSE	0.0	2.73
9	9-8/12/2003	08/12/2003	92	FALSE	0.00	1.01
9	9-9/6/2000	09/06/2000	52.8	TRUE	0.00	14.6
10	10-4/25/2001	04/25/2001	84.6	FALSE	0.00100	0.314
10	10-9/5/2000	09/05/2000	98.4	FALSE	0.0300	4.15
4A	4A-4/24/2001	04/24/2001	6.27	TRUE	0.0320	1.42
4A	4A-8/12/2003	08/12/2003	30	TRUE	0.00	0.448
4A	4A-8/31/2006-TCEQ	08/31/2006	--	--	0.000	0.710
4A	4A-9/5/2000	09/05/2000	89.1	FALSE	0.0100	1.23
6A	6A-4/25/2001	04/25/2001	0	TRUE	0.0120	1.24
6A	6A-8/12/2003	08/12/2003	31	TRUE	0.0150	0.685
6A	6A-8/31/2006-TCEQ	08/31/2006	--	--	0.000	0.331
6A	6A-9/5/2000	09/05/2000	24.9	TRUE	0.0360	10.4
E	E-4/23/2001	04/23/2001	57.4	TRUE	0.170	5.08
E	E-9/6/2000	09/06/2000	104	FALSE	0.487	2.81
G	G-4/24/2001	04/24/2001	93	FALSE	0.0100	1.02
G	G-9/6/2000	09/06/2000	104	FALSE	0.00100	1.19
Q	Q-4/25/2001	04/25/2001	4.18	TRUE	0.0190	1.06
Q	Q-9/5/2000	09/05/2000	79.8	FALSE	0.00	3.51
R	R-4/26/2001	04/26/2001	78.3	TRUE	0.00100	3.06
R	R-8/12/2003	08/12/2003	98	FALSE	0.00	1.91
R	R-9/5/2000	09/05/2000	87	FALSE	0.00	3.94
S	S-4/24/2001	04/24/2001	65.8	TRUE	0.858	9.83
S	S-9/5/2000	09/05/2000	99.5	FALSE	0.104	1.12
T	T-4/25/2001	04/25/2001	72.1	TRUE	0.00700	1.90
T	T-9/5/2000	09/05/2000	91.2	FALSE	0.00	1.26
U	U-4/24/2001	04/24/2001	82.5	FALSE	0.0550	0.0950
U	U-9/6/2000	09/06/2000	98.4	FALSE	0.0180	0.417
V	V-4/23/2001	04/23/2001	79.4	TRUE	0.293	2.53
V	V-9/5/2000	09/05/2000	102	FALSE	0.249	2.83
Y	Y-4/26/2001	04/26/2001	95	FALSE	0.00200	0.540
Y	Y-9/6/2000	09/06/2000	0	TRUE	0.00100	3.85

Table B-5
Proxy Chemistry Data Used in Toxicity Model Evaluations

Station	Original Sample ID	Proxy Data Sample ID	Analyte
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Aldrin
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Aldrin
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Aldrin
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Aldrin
9	9-8/12/2003	9-8/12/2003-TCEQ	Aldrin
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Aroclor 1248
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Aroclor 1248
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Aroclor 1248
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Aroclor 1248
9	9-8/12/2003	9-8/12/2003-TCEQ	Aroclor 1248
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Endosulfan-alpha (I)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Endosulfan-alpha (I)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Endosulfan-alpha (I)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Endosulfan-alpha (I)
9	9-8/12/2003	9-8/12/2003-TCEQ	Endosulfan-alpha (I)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Endosulfan-beta (II)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Endosulfan-beta (II)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Endosulfan-beta (II)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Endosulfan-beta (II)
9	9-8/12/2003	9-8/12/2003-TCEQ	Endosulfan-beta (II)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Endrin
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Endrin
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Endrin
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Endrin
9	9-8/12/2003	9-8/12/2003-TCEQ	Endrin
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	gamma-BHC (Lindane)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	gamma-BHC (Lindane)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	gamma-BHC (Lindane)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	gamma-BHC (Lindane)
9	9-8/12/2003	9-8/12/2003-TCEQ	gamma-BHC (Lindane)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Methoxychlor
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Methoxychlor
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Methoxychlor
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Methoxychlor
9	9-8/12/2003	9-8/12/2003-TCEQ	Methoxychlor
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Sum DDD (U = 0)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Sum DDD (U = 0)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Sum DDD (U = 0)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Sum DDD (U = 0)
9	9-8/12/2003	9-8/12/2003-TCEQ	Sum DDD (U = 0)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Sum DDE (U = 0)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Sum DDE (U = 0)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Sum DDE (U = 0)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Sum DDE (U = 0)
9	9-8/12/2003	9-8/12/2003-TCEQ	Sum DDE (U = 0)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Sum DDT (U = 0)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Sum DDT (U = 0)

Table B-5
Proxy Chemistry Data Used in Toxicity Model Evaluations

Station	Original Sample ID	Proxy Data Sample ID	Analyte
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Sum DDT (U = 0)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Sum DDT (U = 0)
9	9-8/12/2003	9-8/12/2003-TCEQ	Sum DDT (U = 0)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Toluene
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Toluene
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Toluene
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Toluene
9	9-8/12/2003	9-8/12/2003-TCEQ	Toluene
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Total Chlordane (alpha and gamma) (U = 0)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Total Chlordane (alpha and gamma) (U = 0)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Total Chlordane (alpha and gamma) (U = 0)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Total Chlordane (alpha and gamma) (U = 0)
9	9-8/12/2003	9-8/12/2003-TCEQ	Total Chlordane (alpha and gamma) (U = 0)
3	3-8/12/2003	3-8/12/2003-EPA/TCEQ	Total DDT (U = 0)
4A	4A-8/12/2003	4A-8/12/2003-EPA/TCEQ	Total DDT (U = 0)
6A	6A-8/12/2003	6A-8/12/2003-EPA/TCEQ	Total DDT (U = 0)
7	7-8/12/2003	7-8/12/2003-EPA/TCEQ	Total DDT (U = 0)
9	9-8/12/2003	9-8/12/2003-TCEQ	Total DDT (U = 0)
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Arsenic
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Arsenic
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Arsenic
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Arsenic
9	9-8/12/2003-TCEQ	9-8/12/2003	Arsenic
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Barium
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Barium
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Barium
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Barium
9	9-8/12/2003-TCEQ	9-8/12/2003	Barium
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Benzidine
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Benzidine
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Benzidine
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Benzidine
9	9-8/12/2003-TCEQ	9-8/12/2003	Benzidine
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Cadmium
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Cadmium
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Cadmium
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Cadmium
9	9-8/12/2003-TCEQ	9-8/12/2003	Cadmium
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Chromium
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Chromium
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Chromium
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Chromium
9	9-8/12/2003-TCEQ	9-8/12/2003	Chromium
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Copper
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Copper
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Copper
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Copper

Table B-5
Proxy Chemistry Data Used in Toxicity Model Evaluations

Station	Original Sample ID	Proxy Data Sample ID	Analyte
9	9-8/12/2003-TCEQ	9-8/12/2003	Copper
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Lead
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Lead
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Lead
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Lead
9	9-8/12/2003-TCEQ	9-8/12/2003	Lead
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Mercury
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Mercury
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Mercury
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Mercury
9	9-8/12/2003-TCEQ	9-8/12/2003	Mercury
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Nickel
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Nickel
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Nickel
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Nickel
9	9-8/12/2003-TCEQ	9-8/12/2003	Nickel
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Silver
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Silver
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Silver
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Silver
9	9-8/12/2003-TCEQ	9-8/12/2003	Silver
3	3-8/12/2003-EPA/TCEQ	3-8/12/2003	Zinc
4A	4A-8/12/2003-EPA/TCEQ	4A-8/12/2003	Zinc
6A	6A-8/12/2003-EPA/TCEQ	6A-8/12/2003	Zinc
7	7-8/12/2003-EPA/TCEQ	7-8/12/2003	Zinc
9	9-8/12/2003-TCEQ	9-8/12/2003	Zinc

APPENDIX C
ECOLOGICAL REPRESENTATIVE RECEPTOR SPECIES PROFILES

APPENDIX C-1
SPOTTED SANDPIPER SPECIES PROFILE

INTRODUCTION

Spotted sandpiper (*Actitis macularius*)

The spotted sandpiper has a breeding range that extends from east to west across North America and from north to south from the southern edge of the Arctic to the southern states of the United States, which is the most widespread breeding range of any sandpiper. Spotted sandpipers have been able to colonize this wide variety in habitat because of their generalist behavior, including feeding on a variety of animal matter and occupying almost all habitats near water. These include areas from shorelines of rivers and lakes to urban and agricultural ponds and pools. Unlike many shorebirds that migrate in large groups, spotted sandpipers migrate alone or in small groups to their wintering grounds, which extend from the southern United States to southern South America (Oring et al. 1997).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

For the spring migrations, spotted sandpipers begin to head north in March and continue through early June. Migrants arrive in central Texas generally from late March through late May, with extreme ranges of February 20 to June 14. Fall migration generally begins in early July. In central Texas, spotted sandpipers depart from mid-July to mid-October, with extreme ranges of June 27 through November 22 (Oring et al. 1997).

HABITAT

Breeding

The spotted sandpiper breeds over much of North America (USEPA 1993; Oring et al. 1997). Their breeding range extends from northern Alaska south to California, south Nevada, north Arizona, south Colorado, and all the way to the eastern coast of the United States. Spotted sandpipers become extremely localized and scarce near the southern edge of their breeding

range in eastern North America. They will occasionally breed as far south as the northern Gulf States, Arkansas, western Oklahoma, and northern Texas (Oring et al. 1997).

Dense vegetation is required for breeding to occur (USEPA 1993). Spotted sandpipers will nest in a variety of semi-open habitats including sagebrush, grassland, forests, and shoreline, but must be near water. The greatest breeding densities are reached in areas that have restricted numbers of terrestrial predators, for example, islands surrounded by deep water or broad areas of semi-open cover (Oring et al. 1997). Nests are always located with 300 meters of the water's edge, but most are within 100 meters. Areas in the shade provided by herbaceous vegetation are preferred (USEPA 1993; Oring et al. 1997). The suitability of nesting habitat varies from year to year in some locations, controlled by precipitation and predators (USEPA 1993).

Non-Breeding/Winter

The spotted sandpiper spends the winter season in coastal or near coastal portions of Washington, Oregon, and California, in the southern portion of the United States, and south throughout Middle America, Bermuda, and the West Indies. They will reside either in the interior or on the coast, as long as water is present. The only locations they may occupy year-round include the coastal areas of California north to southwest British Columbia (Oring et al. 1997).

FOOD HABITS

Diet

Spotted sandpipers consume mainly invertebrates, including freshwater, marine, and terrestrial. They will occasionally consume small fish (Oring et al. 1997).

Major Food Items

Spotted sandpipers will consume almost all animals that are small enough to be eaten, including carrion, with the exception of tadpoles. The most common food items include terrestrial and aquatic invertebrates such as midges and mayflies. They have also been known to consume house flies, grasshoppers, crickets, mole crickets, beetles, caterpillars, worms, mollusks, crustaceans, fish, and spiders (Oring et al. 1997).

Quantitative Analysis

Studies investigating prey selection and prey availability have not been completed for this bird and quantitative information is very limited. One study in Puerto Rico reported that 11 percent of the total spotted sandpiper diet was made up of mole crickets. Another study in Yellowstone National Park found that adults fed primarily on fly larvae (Oring et al. 1997).

Selection and Capture Methods

Spotted sandpipers rely primarily on visual cues for capturing their prey. They are considered to be generalist consumers on animal matter, and consumption of plant material is strictly accidental. Individual feeding strategies are extremely plastic and will alternate between high and low specificity depending on the abundance of food. Their feeding movements are described as stitching, probing, or jabbing. These birds generally probe soil, in search of soil-dwelling invertebrates. They will occasionally hop into the air to catch flying insects (Oring et al. 1997).

The foraging rate of these birds is dependent on the current egg-laying stage. During pre-incubation males forage at a rate of 6.8 pecks per 15 seconds (± 0.5 SE), during incubation when both sexes were participating their forage rate increased to 10.5 pecks per 15 seconds (± 0.6 SE), and increased yet again to 15.4 pecks per 15 seconds (± 0.6) when only males were incubating. Females spend a significantly greater amount of time foraging for food than males during pre-laying, laying, and incubation because of the increased energy demands of producing eggs (Oring et al. 1997).

Foraging Microhabitat

Spotted sandpipers forage mostly in areas such as beaches, where there is a significant amount of open habitat. They will forage anywhere from the shoreline to dense forest, but typically will not move beyond 200 meters from the shoreline. Spotted sandpipers prefer to forage in sandy or firm substrate, but will also pick insects off of aquatic vegetation, plants, and debris. They often forage in temporary sand-spit pools formed by wave action, where there is an abundance of aquatic invertebrates. When inland, they forage on borders of sandy ponds, creeks, streams, and rivers. They will also forage in low vegetation of meadows, fields, and gardens when in agricultural areas (Oring et al. 1997).

NUTRITION, ENERGETICS, AND METABOLISM

The basal metabolic rate (BMR) of female spotted sandpipers is calculated as 7.824 kcal/day, which is slightly higher than the BMR of males, 6.672 kcal/d. Then energy requirements of spotted sandpipers vary by sex and stage of the breeding cycle. Females require more energy than males during all stages of the breeding cycle. The energy demands for both sexes decreases from pre-laying to incubation (Oring et al. 1997).

BEHAVIOR

Female spotted sandpipers will defend a variety of territories, which include shoreline for foraging, drinking, bathing, and displaying; semi-open habitat for nesting; and areas of dense vegetation for brood cover. They establish their territory by occupying vacant space or by evicting an occupant. Females will normally defend the same territory until they leave their final mate of the breeding season. A wide variety of female territory sizes has been reported for spotted sandpipers. In north-central Minnesota, female territory size was small, only 812.8 meters^2 ± 148.6 SD. At another location where there were higher levels of predation, territory size was much larger, varying from 12,700 to 14,500 meters^2. On Great Gull Island in New York, a marine island with very low predations, territory sizes varied from 3,000 to 20,000 meters^2. These birds will sometimes nest with 5 meters of one another; however, in areas where predation is intense or food abundance is low, territory size is greatly increased (Oring et al. 1997). In a study done on Little Pelican Island, Minnesota, population densities were found to range from four to 13 females per hectare and 7 to 20 males per hectare over a 10-year period, depending on weather and other conditions (USEPA 1993). Overall, spotted sandpipers are relatively sedentary birds with a mean territory size of 0.55 acres (0.22 hectares; Miller and Miller 1948; Hays 1972; Heldeman and Oring 1976; Maxson and Oring 1980; Oring et al. 1983), including upland and surface water based foraging habitat and nesting habitat.

Spotted sandpipers are not highly gregarious. Individuals may, at times, roost together in the winter. Small flocks of less than ten loosely associated individuals may form in late summer and fall (USEPA 1993; Oring et al. 1997).

MEASUREMENT

Mass

Females are up to 20 to 25 percent larger than males. During breeding season, the mean body mass of females is significantly higher than that of males (female: mean 47.76 g ± 7.63 SD; male: mean 39.44 g ± 3.76 SD; Oring et al. 1997).

Size

Adult male spotted sandpipers have an average bill length of 22.8 mm (range of 19.0 to 26.0 mm). Females have an average bill length of 24.2 mm (range of 19.5 to 29.0 mm). The tarsus of adult males is, on average, 24.6 mm (range of 21.0 to 28.0 mm). Once again, the females are larger, having a mean tarsus length of 25.6 mm (range 21.5 to 30.0 mm; Oring et al. 1997).

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Factor	Value	References
Body Weight (g)	F 47.76 ± 7.63 SD M 39.44 ± 3.76 SD	Oring et al. 1997
Bill length (mm)	F 24.2 (range 19.5 – 29.0) M 22.8 (range 19.0 – 26.0)	Oring et al. 1997
Tarsus length (mm)	F 25.6 (range 21.5 – 30.0) M 24.6 (range 21.0 – 28.0)	Oring et al. 1997
Foraging Distance from Colony (m)	100 – 300	Oring et al. 1997
Territory Size (m^2)	3,000 – 20,000 m^2 0.22 ha	Miller and Miller 1948, Hays 1972, Heldeman and Oring 1976, Maxson and Oring 1980, Oring et al. 1983, USEPA 1993
Population Density (#/ha)	M 13.9 (range 7.5 – 20) F 10 (range 3.8 – 12.5)	USEPA 1993
Nearest Neighbor Distance (m)	5	Oring et al. 1997
Metabolic Rate	F 7.824 kcal/day M 6.672 kcal/day Free living 460 kcal/kg-day (range 213 – 994)	USEPA 1993
Food Ingestion Rate	No information available	
Surface Area (cm^2)	F 131 M 113	USEPA 1993
Dietary Composition	Midges Mayflies Mollusks Crustaceans Fish Other terrestrial invertebrates	Oring et al. 1997

APPENDIX C-2
BELTED KINGFISHER SPECIES PROFILE

INTRODUCTION

The belted kingfisher is one of the most widely distributed land birds in North America and inhabits a diverse range of aquatic habitats. The availability of suitable nesting sites is critical for the distribution and local abundance of belted kingfishers. They prefer earthen banks where they can excavate dirt to create nesting borrows. In some regions, human activities such as digging sand and gravel pits have created nesting sites, which have increased population growth and distribution. Despite their heavy reliance on fish as a food source, environmental contaminants do not seem to have affected their productivity as with other fish-eating birds. Kingfishers have been studied as bio-indicators of environmental toxins, especially mercury contamination (Kelly et al. 2009).

Belted Kingfisher (*Ceryle alcyon)*

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

Although the belted kingfisher breeds at northern latitudes, most individuals migrate south for the winter, some even as far as South America. In the fall, migratory populations generally shift southward and towards coastal areas. Migration occurs from mid-September through November. Many birds migrate towards coastal Texas (Kelly et al. 2009).

HABITAT

Breeding

Belted kingfishers have an extremely broad breeding range. They will breed in suitable habitats throughout all of North America, from western and central Alaska, central Yukon, British Columbia, western and south-central Mackenzie, northern Saskatchewan, central and probably northern Manitoba, northern Ontario, central Quebec, east-central Labrador, and Newfoundland south to southern California, southern Arizona, southern New Mexico, southern Texas, the Gulf coast and central Florida (Prose 1985; USEPA 1993). Breeding has not been confirmed in coastal Texas (Kelly et al. 2009).

The most important requirements for breeding seem to be waters that support aquatic animal populations and nearly vertical exposures of earth that can be excavated to form nesting burrows. Belted kingfishers prefer streams, rivers, ponds, lakes, and estuaries or calm marine waters that provide easy visibility of their prey. Clear water is a necessity, and the birds will avoid turbid water. They prefer waters that are not obscured by vegetation, and will avoid waters that contain masses of emergent vegetation, regardless of the abundance of prey that may be in the water (USEPA 1993; Kelly et al. 2009). In Minnesota, two out of nine nests were directly over water, three were within 152.4 meters of water, and four were within 0.5 to 1.6 km (Prose 1985). Local abundance is also greatly affected by the availability of suitable nesting sites (Kelly et al. 2009).

Non-Breeding/Winter

During the winter months, belted kingfishers generally withdraw from most of Canada, but will remain year round throughout most of the United States (USEPA 1993; Kelly et al. 2009). They are relatively common inland in places that have a frost-free period of greater than 180 days per year. They are a very common winter resident of coastal Texas. Belted kingfishers also spend much of their non-breeding season in Central America and the Caribbean. When in these areas, belted kingfishers will live in coastal swamps, brackish lagoons, oxbows, and bayous. They will also live along the shores of reservoirs but, once again, avoid turbid waters or habitats that lack perches.

FOOD HABITS

Diet

Belted kingfishers are primarily piscivorous, but may also consume a variety of aquatic invertebrates including mollusks, crustaceans, and insects.

Major Food Items

Belted kingfishers rely heavily on fish as their major food source, but do not prefer any particular fish. Kingfishers take fishes that are the most abundant and present in shallow water (Prose 1985; Kelly et al. 2009). Diet varies greatly with location and season (USEPA 1993). Fishes that are abundant in their diet often include sticklebacks, mummichogs, trout, and stonerollers. Crayfish may also make up a significant portion of their diet, especially during periods of high water and high turbidity (Kelly et al. 2009).

Quantitative Analysis

In Michigan trout streams, diets of belted kingfishers were comprised of 39 percent forage fish and 24 percent crayfish. Trout did not make up a significant portion of their diet because forage fish were caught more easily than trout and were more abundant in open, sunlit streams where kingfishers frequently fed. In non-trout streams, forage fish were also the most abundant diet item, making up a total of 53 percent of the diet. Crayfish made up 12 percent of the diet. In Ohio streams, the diet of Belted Kingfishers were 37.6 percent stonerollers, 13.3 percent crayfish, 10.2 percent non-minnows, and 38.8 percent miscellaneous cyprinids (Prose 1985).

Selection and Capture Methods

Belted kingfishers often forage by perching on branches, telephone wires, or pilings of piers. They may sometimes forage by hovering over the water surface. The bird dives and grabs the prey with its bill. Kingfishers generally do not submerge themselves in the water because they look for prey near the water surface (Kelly et al. 2009). The fish they catch are usually less than 10.2 cm in length, as larger fish are thought to be difficult to swallow (Prose 1985; Kelly et al. 2009).

Foraging Microhabitat

For belted kingfishers, the most essential habitat requirements to ensure successful foraging are clear waters and an unobstructed view of the prey. They will even abandon a fishing area if the water becomes too turbid after a heavy rainfall. The majority of fish are caught less than 60 cm below the surface (USEPA 1993; Kelly et al. 2009). Docks, pilings, or overhead branches are often used as perches to spot fish that swim by (Kelly et al. 2009). Belted kingfishers prefer stream riffles for foraging sites even when pools are more plentiful because of the higher concentration of fish at riffle edges (USEPA 1993; Kelly et al. 2009). Belted kingfishers do not require that the foraging site be close to the nest. They will nest near suitable fishing areas when possible, but will nest away from bodies of water and even feed in bodies of water other than the ones closest to their nest (Kelly et al. 2009). Fishing sites are usually within 1.6 km of nest sites, although a daily flight of 3.2 km is not uncommon (Prose 1985).

NUTRITION, ENERGETICS, AND METABOLISM

The average daily consumption of adult belted kingfishers weighing approximately 130 g is 55 to 61 kcal (Kelly et al. 2009). Belted kingfishers have a basal metabolic rate of 132 kcal/day and a free living metabolic rate of 327 kcal/day. Their food ingestion rate is 0.5 g/g-day (USEPA 1993).

BEHAVIOR

Belted kingfishers are solitary except during the breeding season (USEPA 1993; Kelly et al. 2009). During breeding season, males will establish and defend a breeding territory and then attract a female. After the birds have paired, both males and females will aggressively defend both their nest site and foraging area from conspecifics (Kelly et al. 2009). Breeding territories average more than twice as long as non-breeding territories (1,030 ± 219 SD m versus 389.29 ± 92.63 SD m) along stream habitat in Ohio (Prose 1985). Non-breeding territory size is inversely related to food abundance, but breeding territory size is not. However, breeding territory size appears to be related to the distribution of food sources; i.e., the smallest territories contained the richest food sources near the nests. Breeding habitat quality may therefore be better represented by food density near the nest than by total food quantity (Prose 1985). The shape of the territories will often mirror the shape of an associated water body. In Itasca State Park in Minnesota, Belted kingfisher territories extended up to 8 km from the nest site, and overall density was one breeding pair per 4.7 km^2 (Kelly et al. 2009). In Michigan, territory sizes on lakes were much smaller than those on rivers. Lakeside territories averaged approximately 0.8 km of shoreline, with a maximum of 2.4 km. Territory size along rivers usually was 2.4 to 4.8 km or more. Another territory that included two small ponds was approximately 14.2 ha in size (Prose 1985).

MEASUREMENT

Mass

Variation between sexes for both mass and size are very slight, although females tend to be slightly larger. Males weigh an average of 143.6 g (range 138-150), and females weigh an average of 151.6 g (range 138-169; Kelly et al. 2009).

Size

Male belted kingfishers have an average bill length of 57.2 mm (range 53.5-60.1) and average tarsus length of 11.8 (range 11.3 to 12.4). Females have an average bill length of 57.0 (range 55.6 to 59.6) and an average tarsus length of 11.8 (range 11.2 to 12.5; Kelly et al. 2009).

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Factor	Value	Reference
Body Weight (g)	M 143.6 (range 138 – 150) F 151.6 (range 138 – 169)	Kelly et al. 2009
Bill length (mm)	M 57.2 (range 53.5 – 60.1) F 57.0 (range 55.6 – 59.6)	Kelly et al. 2009
Tarsus length (mm)	M 11.8 (range 11.3 – 12.4) F 11.8 (range 11.2 – 12.5)	Kelly et al. 2009
Foraging Distance from Colony	Generally within 1.6 km, but can be up to 3.2 km	Prose, 1985
Territory Size	Extends up to 8 km from nesting site Breeding: 1,030m ± 219 SD Non-breeding: 389.29m ± 92.63 SD	Kelly et al. 2009 Prose, 1985
Population Density (km^2)	1 pair per 4.7 km^2 - MN 1/320 m – New Brunswick 1 pair/2 km of stream - OH	Kelly et al. 2009
Nearest Neighbor Distance (m)	No information available	
Metabolic Rate (kcal/day)	Basal: 132 Free Living: 327 (range 154 – 693)	USEPA 1993
Daily consumption (kcal/day)	55 – 61	Kelly et al. 2009
Food Ingestion Rate (g/g-day)	0.5	USEPA 1993
Surface Area (cm^2)	280	USEPA 1993
Dietary Composition	Sticklebacks Mummichogs Trout Stonerollers Crayfish	Kelly et al. 2009

APPENDIX C-3
RACCOON SPECIES PROFILE

INTRODUCTION

Raccoons are the most abundant and wide-spread omnivore in North America. Their range covers most of the continent, in addition to Mexico and Central America. They are medium-sized animals and feed on insects, small mammals, birds, lizards, and fruits. They are also highly abundant in urban areas, where they frequently raid garbage cans and dumps (USEPA 1993).

Raccoon (*Procyon lotor*)

DISTRIBUTION IN TEXAS

Raccoons are native to the state of Texas are very common throughout the entire state (Texas Tech University 1997). They are present in Texas for the entire year and do not migrate for breeding or wintering (USEPA 1993). In Texas, they live primarily in broadleaf woodlands, however are also common in the mixed-pine forests in southeastern Texas. They are also one of the most abundant omnivores in the semi-desert areas of West Texas but seldom occur far from water. Water seems to have more of an influence on their distribution than does the type of vegetation present (Texas Tech University 1997).

HABITAT

Foraging

A permanent water source is necessary for raccoons to drink and eat (Zeiner et al. 1988 – 1990). Raccoons are found near virtually every aquatic habitat, particularly in hardwood swamps, mangroves, floodplain forests, and freshwater and saltwater marshes (USEPA 1993; Cadmus Group 2002). They are able to live in a diversity of habitats as long as certain requirements are present nearby, including food, water, and a protected area for denning (Cadmus Group 2002; USEPA 1993). Raccoons are also able to inhabit suburban residential areas, cultivated farms, and abandoned farmlands. They are also likely to forage in farmlands (USEPA 1993). Raccoons forage along all saline and freshwater riparian habitats, in shallow water, in vegetation, and on the ground (Zeiner et al. 1988 – 1990). Most of their foraging is

done in, or near bodies of water, except during seasons when fruits, nuts, and corn are maturing (Texas Tech University 1997).

Breeding/Denning

Raccoons use cavities in trees, snags, logs, and rocky areas for dens and cover. They may also use abandoned buildings or dense vegetation for their dens (Zeiner et al. 1998 – 1990). Dens serve as a nesting site for sleeping during the daylight hours (Texas Tech University 1997). While breeding, raccoons prefer to nest in secure dens in hollow trees or logs. Their nests are generally located 6.1 to 12.2 meters above the ground (Zeiner et al. 1988 – 1990).

FOOD HABITS

Diet

Raccoons will consume virtually any animal and vegetable matter (USEPA 1993). In eastern Texas, acorns and crayfish account for greater than half of the yearly diet of raccoons. Both acorns and crayfish are consumed in large quantities in all seasons. Grapes and persimmons are eaten when they are available, and other fruits may be consumed in smaller quantities. Insects and other invertebrates are also important contributors to raccoon diets. On occasion, fish, birds, and snakes may also be eaten (Texas Tech University 1997). Raccoons will also feed on garbage and carrion (USEPA 1993).

The proportion of different foods in their diet depends greatly on location and season, although generally vegetable matter is a more important component of their diet (USEPA 1993). Animal matter is consumed more frequently in the spring and early summer; however, raccoons rely more on grains, nuts, acorns, and fruits in late and summer and fall (Zeiner et al. 1988 – 1990; Cadmus Group 2002). Acorns tend to be the most important diet item in the winter; however, raccoons will eat any corn or fruits that may still be available (USEPA 1993).

Feeding Strategies

Raccoons are omnivorous and opportunistic feeders. They are primarily nocturnal; however, they will change their activity period to accommodate the availability of food and water (USEPA 1993).

NUTRITION, ENERGETICS, AND METABOLISM

Information regarding the nutrition, energetic, and metabolism of raccoons is extremely limited. One study completed on raccoons in a zoo during winter determined that they had a metabolic rate of 9.36 ± 1.68 SD IO_2/kg-day. Another study on juvenile raccoons found that they had a metabolic rate of 304 kcal/kg-day (USEPA 1993).

BEHAVIOR

Territoriality and Home Range

The size of a raccoon's home range is dependent upon its sex, age, habitat, food sources, and season. Home ranges have been reported to vary between a few hectares to more than several thousand hectares, but the average home range size is around a few hundred hectares (USEPA 1993). Zeiner et al. (1988 – 1990) reported average home range sizes of 225 hectares. Home ranges of 0.2 to 8 km^2 have been reported in riparian areas of Michigan (Cadmus Group 2002). Male raccoons generally have larger home ranges than females. In Michigan, home ranges of males averaged 204 hectares (range 18.2 to 814 ha), whereas females have an average home range of only 108 hectares (range 5.3 to 376 ha) (Zeiner et al. 1988 – 1990). In addition, females with young have a very restricted home range. Home ranges in the winter are also generally smaller for both sexes (USEPA 1993).

Male raccoons do not exhibit territoriality towards females. Male and female home ranges will often overlap freely, as each male will mate with several females during the breeding period. However, male raccoons are territorial towards other males. Females are not territorial (USEPA 1993; Zeiner et al. 1988 - 1990).

Individual Distance/Density

The density of a raccoon population is dependent upon the quality and quantity of food resources and den sites that are available. Population densities between 0.005 and 1.5 raccoons per hectare have been reported; however, the most common population densities range between 0.1 to 0.2 raccoons per hectare. In residential areas, values greater than 1 raccoon per hectare have been reported (USEPA 1993).

Sociality

Adult raccoons are solitary animals. They will only come together briefly during the mating season, which in Texas occurs between March and June. If raccoons are in a group, it generally consists of a mother and her young of that year (USEPA 1993).

MEASUREMENT

Mass

Body weights of raccoons vary by location, age and sex (USEPA 1993). Adult female raccoons range in weight from 3 to 7.5 kg. Males can weigh up to 9 kg (Cadmus Group 2002).

Size

Adult raccoons measure from 46 to 71 cm long with a tail 20 to 30 cm long (USEPA 1993, Cadmus Group 2002).

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Factor	Value	Reference
Body Weight (kg)	M 7.6 (range 7.0-8.3) IL F 6.4 (range 5.6-7.1) IL M 6.76 MO F 5.74 MO M up to 8.8 AL F up to 5.9 AL	USEPA 1993
Body size (cm)	46 – 71 (not including tail)	Cadmus Group 2002
Surface Area (cm^2)	M 3,796 F 3,414	USEPA 1993
Home Range Size (ha)	M (May-Dec) 204 (range 18.2-108) MI F (May-Dec) 108 (range 5.3-376) MI M 65 ± 18 SE GA F 39 ± SE GA	USEPA 1993
	225 (range 85 – 380)	Zeiner et al. 1988 - 1990
Population Density (N/ha)	1.46 OH (residential) 0.17 (spring) OH (marsh) 0.022 (spring) WI	USEPA 1993
Metabolic Rate (IO_2/kg-day)	9.36 ± 1.68 SD	USEPA 1993
Ingestion Rate (g/g-day)	No information available	
Dietary Composition	Fleshy fruits Nuts Acorns Corn Grains Insects Frogs Crayfish Eggs Animal/vegetable matter	USEPA 1993

APPENDIX C-4
GREAT BLUE HERON SPECIES PROFILE

INTRODUCTION

The great blue heron is one of the most widespread and adaptable wading birds in North America (Butler 1992). It is widely distributed in both saltwater and freshwater environments, including freshwater lakes and rivers, brackish marshes, lagoons, mangroves, and coastal wetlands. Great blue herons are often found on tidal flats and sandbars, but will occasionally forage in wet meadows and other terrestrial habitats (USEPA 1993). They nest mostly in colonies of several hundred pairs. The colonies are often located on islands or in wooded swamps in isolated areas where predation is limited (Butler 1992).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

Habitat

Great blue herons are extremely widespread and adaptable in terms of their habitat requirements. They feed mostly in slow moving or calm freshwater and also along coastlines. They will occasionally feed in the surf and in fields (Butler 1992).

Breeding

The breeding range of great blue herons is widespread, covering most of North and Central America. Along the coasts of southeast Alaska and northern British Columbia they nest as single pairs and in small colonies. They breed mostly in colonies on the south coast and mountain valleys of British Columbia, in central Canadian Prairies, southern Ontario, southern Quebec, and the Canadian Maritime provinces south to Florida, Texas, Baja California, and Central America at least to Belize and Guatemala (Butler 1992). The herons migrate to the northern breeding ranges between February and early May (NatureServe 2009).

Nests are often located in trees, bushes, on the ground, and in artificial structures and are often found near fresh- or saltwater. These birds prefer vegetation on islands or in swamps, presumably to avoid ground predators. Where trees are not available they will nest on the ground, but generally only on predator free islands or on other low lying shrubs (Butler 1992).

Non-Breeding/Winter

Great blue herons living in the northern portions of their range will migrate southward from mid-September to late October. The general movement is away from the northern edge of their breeding range. The winter range of great blue herons extends from the northern Pacific coast south through Central America, and mostly south of Canada and the midwestern United States (Butler 1992). In the United States in winter, the highest densities occur along the lower Colorado River, around the Great Salt Lake, and the Texas Coast (NatureServe 2009). Most great blue herons probably winter along ice-free coastlines and watercourses. Populations living on the Pacific coast do not seem to migrate, but some post-breeding dispersal does occur (Butler 1992).

FOOD HABITS

Diet

Great blue herons exhibit opportunistic feeding strategies depending on the availability of food. They rely most heavily on fish, but crustaceans, amphibians, insects, birds, and mammals also make up a small part of their diet (USEPA 1993).

Major Food Items

The herons feed on a wide array of animals including fish, insects, mammals, amphibians, and crustaceans (Butler 1992).

Quantitative Analysis

Fish is the most predominant diet item of great blue herons. The fish generally range in size from 5 to 30 cm; however; some fish are occasionally longer (Butler 1992). Approximately 75 percent of the diet is made up of fish, mostly species that are not sought after by humans. The rest of the diet comprises small rodents, amphibians, snakes, lizards, insects, crustaceans, and small birds (Zeiner et al. 1988-1990).

Selection and Capture Methods

Great blue herons have very flexible behaviors when foraging for food. They hunt most often by slowly wading or standing in wait of prey in shallow water. They will forage both at day and night, locating prey visually. Herons tend to forage for food either singly or with conspecifics, ciconiiforms, or double-crested cormorants (Butler 1992).

Foraging Microhabitat

Herons will forage in a variety of habitats. In estuarine habitats they prefer herbaceous wetlands, lagoons, tidal rivers, scrub-shrub wetlands, and tidal flats. In riverine and lacustrine habitats they prefer low gradients and shallow water (NatureServe 2009). Herons will choose to forage in open water rather than among emergent vegetation (Zeiner et al. 1988-1990).

NUTRITION, ENERGETICS, AND METABOLISM

Great blue herons have an ingestion rate of 0.18 g/g-day (USEPA 1993). Estimated average intake of metabolized energy per day by individual herons feeding on small fish during four breeding stages is reported as: 1) egg-laying 1,163 kJ (± 555); 2) incubation 1,197 kJ (± 194); 3) small chicks 4,264 kJ (± 764); and 4) large chicks 1,598 kJ (± 151) (Butler 1992).

BEHAVIOR

Great blue herons tend to nest in dense colonies in areas that are generally close to their foraging grounds. Many great blue heron colonies are found in areas that are close to inlets containing large concentrations of fish. This distance has been reported to be, on average, from approximately 3.1 km to 7 to 8 km, and does not exceed 20 km. Because they nest colonially, local population density varies with the amount of suitable nesting habitat and food availability (USEPA 1993). According to the USEPA Wildlife Exposure Factors Handbook (1993), the population density of Great Blue Herons is 2.3 birds/km along streams and 3.6 birds/km along rivers. Their breeding territory is limited to their nest and immediate surroundings (Zeiner et al. 1988-1990).

Whereas herons will nest in dense colonies, they often forage alone or in loose flocks throughout the year. They will also roost alone or in loose flocks. Herons from neighboring colonies will overlap their foraging grounds. The distance between individuals on foraging grounds is maintained by aggressive interactions. Adults will also defend their territories along rivers, creeks, and mudflats through displays, threats, and chases. Adult males defend year-round feeding territories; however, adult females and juveniles feed non-territorially on beaches, marshes, and fields (Butler 1992). Average foraging territory size defended by males has been reported to be between 0.6 ha in the fall and 8.4 ha in the winter (USEPA 1993). The feeding territories are generally larger in winter (NatureServe 2009).

MEASUREMENT

Mass

Adult males tend to be slightly larger than adult females. Males have an average body mass of 2.48 kg, whereas average females weigh 2.11 kg (Butler 1992).

Size

Adult males are reported to have an average bill length of 137 mm, and female bills are, on average, 123.9 mm. The average tarsus length is 165.9 mm and 152.0 mm for males and females, respectively (Butler 1992).

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Factor	Mean	Reference
Body Weight (kg)	M 2.48 ± 0.29 F 2.11 ± 0.34	Butler 1992
Bill Length (mm)	M 137.0 ± 4.4 F 123.9 ± 4.7	Butler 1992
Tarsus Length (mm)	M 165.9 ± 6.7 F 152.0 ± 7.0	Butler 1992
Food Ingestion Rate (g/g-day)	0.18	USEPA 1993
Dietary Composition (%)	Fish - 75% Remaining 25%: Crustaceans Reptiles Amphibians Mammals Insects	Zeiner et al. 1988-1990
Size Feeding Territory (ha)	Fall: 0.6 ± 0.1 SD Winter: 8.4 ± 5.4 SD	USEPA 1993
Breeding Territory	Immediate area surrounding nest	Zeiner et al. 1988-1990
Foraging Distance from Colony	3.1 km 7 to 8 km	USEPA 1993
Population Density (birds/km)	Stream: 2.3 River: 3.6	USEPA 1993
Population Density (nests/ha)	Maine: 149 ± 53 SD Oregon: 461	USEPA 1993

APPENDIX C-5
GREAT EGRET SPECIES PROFILE

INTRODUCTION

The great egret (*Casmerodius albus*), also known as the great white egret (*Ardea alba*), is a common wading bird found in coastal environments of the eastern half of the United States. This species ranges from the Atlantic coasts of Canada and Maine, down through Florida, and along the Gulf State coasts over to Texas. Great egrets can also be found on the coasts of the Great Lakes region. These birds are known for their showy displays of territoriality and courtship, and their populations have lately been adversely affected by a loss of habitat and water and air pollution (Jones 2002).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

Habitat

Great egrets are found in freshwater or marine environments where there is a primary water source such as a pond, lake, river, stream, wetland, or estuary. Most commonly, they are found in marine, wooded and vegetative wetlands and marshes, but they are also common to mudflats in freshwater environments (Jones 2002). They migrate along the Gulf coast from Mexico during the winter months and then along the Texas coast and onto the coasts of Louisiana to Florida for the spring and summer (Eubanks et al. 2006).

Breeding

Breeding tends to occur in large rookeries along the Gulf coast states of Louisiana, Mississippi, and Alabama (Eubanks et al. 2006). Nests are made of sticks and placed either in the tall grasses or trees (The Nature Conservancy 2009).

Non-Breeding/Winter

Winters are mostly spent in Mexico, and in the inland regions of southern Texas (Mccrimmon et al. 2001).

FOOD HABITS

Diet

Great egrets typically feed on marine invertebrates, but will feed on small reptiles and occasionally small mammals in the drier habitats and seasons. They take advantage of freshly flooded rice fields and other coastal salt and mudflats for an easy hunt (Eubanks et al. 2006).

Major Food Items

Prey are normally marine invertebrates living in the sediment and around vegetation such as crawfish, amphipods, and mollusks. Their diet also includes fish, small mammals, plants (The Nature Conservancy 2009), frogs, crickets, grasshoppers, and aquatic insects (Jones 2002).

Quantitative Analysis

Often mistaken for the white, juvenile versions of the great blue heron, the great egret can be distinguished by solid black legs and feet. Non-breeding adults, as well as juveniles, have yellow bills. As breeding season approaches, mature great egrets will grow large plumes, and their bills will turn an auburn to orange color (The Nature Conservancy 2009).

Selection and Capture Methods

As a wading bird, food is obtained by standing still and waiting in the shallow water and then is snatched up with the long bill. On more patient days, great egrets will hunt or slowly stalk potential food (The Nature Conservancy 2009).

Foraging Microhabitat

Flooded rice fields are prime hunting grounds (Eubanks et al. 2006), and great egrets typically hunt alone, out of sight of potential competitors (The Nature Conservancy 2009). Most of the foraging varys with the tidal placement and whether or not it is a wet or dry season. At low tide, low elevations with inundation and dense vegetation are sought out; at high tide, the higher elevations are the foraging grounds.

The distances traveled by great egrets to foraging habitats can vary greatly, generally representative of the geographical habitats. Average foraging distance for great egrets in the upper Mississippi region is 8.4 km (Mccrimmon et al., 2001).

NUTRITION, ENERGETICS, AND METABOLISM

There is no information available at this time on nutrition and energetics. Further field studies are necessary.

To thermoregulate, both young and adult great egrets will either seek shade or sunlight, and/or use gular fluttering, or fluff the feathers (Mccrimmon et al. 2001).

BEHAVIOR

Territoriality is common when it comes to food, nesting, and courtship. Territory is claimed by the male during courtship, and the female joins him as his monogamous mate for the season. Food is often stolen from other great egret nests, as well as from other species' nests, in order to feed hatchlings. Competition for food can be fatal for hatchlings and competitive adults, and birds can be aggressive even when food is not a factor.

Both courtship and the defining of territory are active and showy displays. Courting involve ritualistic vocalizations and elaborate dances. Defending one's territory is more harsh with loud squawking and lots of leaping and jabbing movements (Jones 2002).

Great egrets are social birds that have been observed migrating and hunting in flocks and are known for the nesting rookeries that they form. They are known for their varying demonstrations of territoriality and courtship (Mccrimmon et al. 2001).

MEASUREMENT

Mass

The average mass for adult Great Egrets is 1,026 grams (Jones, 2002).

Size

In terms of sexual dimorphism, males are larger than females, but both look identical to one another. Both sexes are full grown when standing at approximately 1 meter high. Wingspans are measured at about 1.5 meters, and great egrets range from 912 to 1,140 grams in mass (Jones 2002). Female bills and tarsus lengths average around 106 mm and 137 mm, respectively. Males, on average, have a bill length of 112 mm and a tarsus length of 167 mm (Mccrimmon et al. 2001).

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Factor	Mean	Reference
Body Weight (g)	912 – 1140	Jones 2002
Bill length (mm)	M 112 (range 105-116) F 106 (range 104-108)	Mccrimmon et al. 2001
Tarsus length (mm)	M 167 (range 161-173) F 137 (range 121-158)	Mccrimmon et al. 2001
Foraging Distance from Colony	Varies; Breeding and Non-breeding distances are similar; approximately 3-10 km	Mccrimmon et al. 2001
Territory Size	Average about 4 m^2 between males	Mccrimmon et al. 2001
Nest Density	Varies by nesting substrate	Mccrimmon et al. 2001
Nearest Neighbor Distance (cm) (nest rim to nest rim)	Approximately 1.85 m ± 1.30 SD	Mccrimmon et al. 2001

APPENDIX C-6
GREEN HERON SPECIES PROFILE

INTRODUCTION

The green heron is a common species of wetland thickets throughout much of North America. It is widely distributed among both marine and freshwater coastal habitats. It feeds in swamps, riparian zones along creeks and streams, marshes, ditches, canals, ponds, lake edges, oxbow ponds, salt marshes, mangrove swamps, pastures, and harbors. The green heron prefers thick vegetation throughout its home range; however, it will feed in the open when food is available. In salt marshes, it tends to hug creek banks and avoid the open flats that are frequented by longer-legged herons, such as the great blue heron (Davis and Kushlan 1994).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

Habitat

Green herons are extremely flexible in their habitat requirements, generally requiring only a water source. They are able to use all available marine and freshwater habitats. They nest in forests, swamp patches, dry woods, and orchards (Davis and Kushlan 1994).

Breeding

The breeding range of the green heron extends from southeastern Canada and eastern North America south to Florida, west to eastern North Dakota through the Great Plains, through southern Texas, Arizona, and New Mexico. They also breed along the Pacific Coast from British Columbia through Baja California and south throughout Central America. Their range is limited by high latitudes, aridity, and altitude. They also avoid the drier areas of the western United States. Within this broad breeding range, their local distribution is limited by suitable wetlands, either freshwater or marine, for breeding (Davis and Kushlan 1994). Green herons will nest in various habitats that provide secluded nesting sets and wetland feeding habitats. They will often nest on islands or tree islands in marshes. Nests are generally located over water, but may be up to 0.8 km from standing water (Davis and Kushlan 1994).

Non-Breeding/Winter

Post-breeding birds often migrate to areas where breeding does not occur. Most of the populations in North America are migratory. Those from the eastern United State often migrate south to winter along the Gulf of Mexico, from Florida to northern South America,

to more favorable foraging areas. Populations that nest in Florida and other southern states appear not to migrate and remain residents; however, more data are needed to confirm this (Davis and Kushlan 1994).

FOOD HABITS

Diet

Green herons exhibit opportunistic feeding strategies depending on the availability of food (USEPA 1993). Their prey selection is very broad and includes a variety of fish and invertebrates (Davis and Kushlan, 1994).

Major Food Items

The green heron relies heavily on fish as a food source. These include topminnows, minnows, sunfish, catfish, pickerel, carp, perch, gobies, shad, silverside, and eels (Davis and Kushlan 1994). In addition to fish, the green heron will also feed on both aquatic and terrestrial insects, spiders, crabs, crayfish, earthworms, prawns, snails, snakes, lizards, and amphibians (Niethammer and Kaiser 1983; Davis and Kushlan 1994).

Quantitative Analysis

Because green herons are opportunistic feeders, their reported diets vary widely among studies that have examined their diet. However, in all cases, fish tended to make up the greatest percentage of the biomass in their stomach. After fish, crustaceans and insects also make up a significant portion of their diet (Davis and Kushlan 1994).

Selection and Capture Methods

The most common feeding technique used by green herons is to stand in a crouched position and look into the water for prey. They have the greatest capture success in water that is less than 10 cm deep and poorest success in water deeper than 20 cm. Green herons will often employ the use of various objects such as twigs, leaves, or berries to bait for fish.

Foraging Microhabitat

Green herons usually feed by wading at the water's edge or in shallow water, less than 10 cm deep. They can also access deeper waters by perching on branches or rocks and plunging into the water after prey. They prefer to feed under the cover of thick vegetation; however,

they will feed in the open on exposed mudflats, tidal channels, open marshes, and pond edges (Davis and Kushlan 1994).

NUTRITION, ENERGETICS, AND METABOLISM

The Green heron has a food ingestion rate of 0.16 g/g-day (Davis and Kushlan 1994).

BEHAVIOR

Green herons often nest alone, but in some circumstances may nest with conspecifics or other colonial birds (Davis and Kushlan 1994). Birds may nest alone if they can defend a feeding territory, such as one along a stream, but nest in loose aggregations in wetlands where territorial defense is more difficult (Kaiser and Reid 1987). Green herons nest in various habitats, but require seclusion and proximity to wetland feeding habitat. They often nest in protected sites within trees or bushes. They place the nest from ground level to 10 meters above ground, and occasionally up to 20 meters. Green herons prefer trees that have branches large enough to support a nest. It is essential that the trees have overhanging branches, which act to conceal the nest. Territoriality is limited to the area around the nest (Davis and Kushlan 1994). Jurek (1974) reported the density of green heron nests to be 6 nests/km. Because most green herons are solitary nesters and are dispersed widely through marine and freshwater habitats, estimating the population density is difficult. Therefore, few data on population or colony sites exist (Davis and Kushlan 1994). Home range data, foraging distance, and feeding territory size of green herons are also not available forthe same reasons.

MEASUREMENT

Mass

Adult green herons have an average mass of 241 g ± 28.5 g (Neithammer and Kaiser 1983).

Size

Bill lengths for adult green herons average 6.3 cm long. Females average larger in some parts of their range and smaller in others. Average tarsus length for males is 5.3 cm; for females the average is 5.1 cm (Davis and Kushlan 1994).

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Factor	Mean	Reference
Body Weight (g)	241 ± 28.5 SD	Neithammer and Kaiser 1983
Metabolic Rate (kcal/kg-day)	No information Available	
Food Ingestion Rate (g/g-day)	0.16	Davis and Kushlan 1994
Bill Length (cm)	6.3	Davis and Kushlan 1994
Tarsus Length (cm)	M 5.3 F 5.1	Davis and Kushlan 1994
Dietary Composition (% wet weight; stomach contents)	Fish 45 Crustaceans 21 Insects 24 Other 10	Davis and Kushlan 1994
	Fish 93 Crustaceans 1 Insects 6 Arachnids 1	Neithammer and Kaiser 1983
Territory Size	Only nesting site or roosting site	Davis and Kushlan 1994
Size Feeding Territory (ha)	No information available	
Foraging Distance from Colony	No information available	
Population Density (birds/km)	No information available	
Population Density (nests/km)	6 (Northeastern LA)	Jurek 1974

APPENDIX C-7
ROSEATE SPOONBILL SPECIES PROFILE

INTRODUCTION

Roseate spoonbills (*platalea ajaja*) are wading birds commonly found all along the Gulf of Mexico coast, down through Central America and into South America, and as far east as the West Indies. They are a recovering species along the Texas coast and are easily identified by their pink body color and spoon-shaped bills (Texas Parks and Wildlife Department 2009).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

During the warmer months, March through October, roseate spoonbills are typically found in the marshes and wetland habitats on the Texas coast. In the winter, they either migrate to inland environments, or to Central and/or South America (Texas Parks and Wildlife Department 2009). Overall, roseate spoonbills are non-migratory or locally migratory and do not make long flights between continents and/or hemispheres (NatureServe Explorer 2009)

HABITAT

Breeding

Breeding takes place in the early spring and through the summer for Texas and Louisiana populations (Dumas 2000). Roseate spoonbills are colonial nesters and form small heron colonies, or rookeries, which have approximately 15 active nests in a 2 to 3 year span (NatureServe Explorer 2009). Nests are formed on the ground and are typically built on both constructed and naturally made islands and over standing water to minimize terrestrial predation (Dumas 2000).

Non-Breeding/Winter

These birds live an overall solitary lifestyle, but are known to travel in small flocks while maintaining individual spacing for hunting purposes. They remain along the coasts throughout the year and will migrate slightly inland or to Mexico should less favorable conditions occur (Dumas 2000).

FOOD HABITS

Diet

Roseate spoonbills obtain food by moving their bills back and forth through the water; by this movement, small crustaceans and other invertebrates are trapped. When necessary, they

will stir up the mud on the bottom to "extract" any prey hiding below. They typically feed from dusk into the night, in the shallow waters (NatureServe Explorer 2009).

Major Food Items

Food eaten by the roseate spoonbill includes small fish, crustaceans, mollusks, and aquatic insects (NatureServe Explorer 2009).

Selection and Capture Methods

Hunting tends to occur in water depths of 12 cm or less, dependent upon leg length of the bird. Any submerging form of foraging method has not been reported. Roseate spoonbills use visual and tactile cues when searching for prey. When they move their slightly-opened spatulate-shaped bills back and forth through the water, food enters and the bill closes for capture. That back and forth motion is known as head sweeping and is an innate behavior. They wade through the water waiting for visual confirmation of prey, and may even charge after a potential meal.

When larger prey, or shelled prey, are captured, roseate spoonbills have to break up the meal and get rid of any shell pieces before swallowing and digestion. This problem is solved by using the bill's strength to break prey into smaller pieces or throwing crustaceans and shelled invertebrates against rocks to be broken (Dumas 2000).

Foraging Microhabitat

Often solitary hunters (Texas Parks and Wildlife Department 2009), they feed in freshwater habitats, as well as marine and brackish water (Louisiana Department of Wildlife and Fisheries). Habitats range from inland and coastal ponds, to wetlands, to salt marshes, to estuaries. Typically, seasonal and hunting movements are dependent on water levels (NatureServe Explorer 2009).

In Texas, the common habitats are brackish and coastal bays (NatureServe Explorer 2009).

NUTRITION, ENERGETICS, AND METABOLISM

There is no known information available at this time regarding the nutrition, energetics, and metabolism of the roseate spoonbill.

BEHAVIOR

Roseate spoonbills will walk while wading and hunting, but also climb and hop for other forms of terrestrial locomotion. They also fly and are able to swim, but only when necessary. They tend to function most effectively in very shallow bodies of water. They preen their feathers, as all other birds do, and they sleep standing up and often on one foot. This action is also performed by flamingos, the also-pink relatives of roseate spoonbills. They will sleep sitting down when incubating.

Little information has been found regarding social interactions of the roseate spoonbill. Territorial disputes occur mainly during the breeding season as a competition for mates and nest space. The "fighting" has been observed as either chasing, or the in-flight rapid beating of the wings towards the opponent.

While courting, the male will present the female with nest-building material. Males are usually the only birds that display any aggression, although females have been observed in "threatening posture" when defending nests (Dumas 2000).

MEASUREMENT

Mass

The average mass of an adult roseate spoonbill is 1,496 grams (NatureServe Explorer 2009).

Size

Roseate spoonbill adults are around 81 cm in height (NatureServe Explorer 2009). Males are generally larger than females in overall size. Tarsus lengths for males and females are 11.4 cm and 10.4 cm, respectively. Males also have bills that are slightly longer and wider at the "spoon" portion (Dumas 2000).

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Factor	Mean	Reference
Body Weight (g)	Average = 1496	NatureServe Explorer 2009
Bill width (cm)	M 5.4 (4.9 – 5.9) F 4.9 (4.5 – 5.3)	Dumas 2000
Tarsus length (cm)	M 11.4 (10.7 – 12.3) F 10.4 (9.7 – 10.7)	Dumas 2000
Foraging Distance from Colony	Breeding season: Non-breeding season:	
Territory Size	Only nesting site or roosting site	Dumas 2000
Nest Density	No Data	
Nearest Neighbor Distance (cm) (nest rim to nest rim)	No Data	
Dietary Composition	Crustaceans 55% Insects 31% Fish 14%	Dumas 2000

APPENDIX C-8
WHITE IBIS SPECIES PROFILE

INTRODUCTION

The white ibis is a striking white wading bird that inhabits much of the coastal eastern United States and Central America. They inhabit freshwater and estuarine wetlands (Heath et al. 2009). They are one of the most important predators in the food chains in terms of energy flow in these habitats (Hingtgen et al. 1985). Historically, the white ibis is one of the most abundant wading birds in North America. They nest, feed and fly in large conspecific flocks. They are known for shifting their colony and roost sites, long migrations, and variable breeding times. The young cannot develop normally on brackish water crustaceans and, therefore, require a freshwater food source for breeding success. Their dependence on wetlands and large population sizes has made the white ibis a symbol for wetland conservation and restoration (Heath et al. 2009).

DISTRIBUTION AND MIGRATION IN COASTAL TEXAS

Habitat

White ibises are residents from central Baja California, southeastern and eastern Texas, southern Louisiana, Florida, southeastern Georgia, and coastal North Carolina south along the coasts of Central America (NatureServe Explorer 2009). White ibises live in freshwater and estuarine wetlands, typically cypress swamps, bottomland hardwood and mangrove swamps, and freshwater and saltwater marshes. Even though they may nest in coastal areas dominated by saltwater, there must be freshwater feeding sites nearby so they can forage for their nestlings (Heath et al. 2009). White ibises tend to be locally migrant, however, generally do not migrate over long distances (NatureServe Explorer 2009).

Breeding

The breeding range of the white ibis is generally from coastal Virginia through Louisiana and Texas, with centers of abundance in the Carolinas, Florida, Louisiana, and Texas. They may also breed inland from the coast in South Carolina through Florida. They nest on barrier, marsh, and spoil islands on the coast, in addition to islands in inland lakes. White ibises will also nest in forests and stands of trees within marshes and mangrove swamps. Their nest sites are located in interior and coastal wetlands (Heath et al. 2009). Breeding colonies may occur in freshwater wetlands as far as 160 miles inland (Hingtgen et al. 1985). Specific requirements for colony site selection include close distance to suitable feeding areas, sufficient space for territories, near an adequate supply of nesting materials, and free from

excessive predation and disturbances. An area with suitable nest sites, isolated by water, and lacking in mammalian predators, specifically raccoons, provides excellent nesting habitat for white ibises as long as food resources are available. Changes in nesting locations from year to year are thought to be influenced by food availability (Hingtgen et al. 1985).

Non-Breeding/Winter

Outside the nesting season, ibises are primarily coastal, most using mangrove swamps, *Spartina* marshes, and coastal lagoons. They are generally distributed from the coastal Carolinas south over the rest of the breeding range. Their non-breeding range is wider than their breeding range. This is likely due to post-breeding dispersal, which is often northward in late summer and fall. They have been known to appear regularly as far north as Delaware and southeast New York (Heath et al. 2009). Birds in Louisiana and Texas often move to local feeding and roosting areas during the non-breeding season (Hingtgen et al. 1985). The highest densities during the non-breeding season occur in Florida and around the mouth of the Mississippi River (NatureServe Explorer 2009).

FOOD HABITS

Diet

The white ibis depends primarily on small aquatic and semiaquatic organisms such as crustaceans and invertebrates to fulfill their diet. They will also feed on fish when present in high quantities. Their complete diet is very broad, as they are able to eat whatever they can pick up with their bill. Because of salt stress, nestlings do not develop normally on brackish-water prey such as fiddler crabs. Even at estuarine colony sites, the bulk of the nestling diet consists of freshwater prey, especially crayfish (Heath et al. 2009).

Major Food Items

Diet of the white ibis includes aquatic and terrestrial arthropods, polychaetes, snails, frogs, lizards, young snakes, crayfish, and small fish. When living in mangrove swamps or *Spartina* marshes, they rely heavily on fiddler crabs. Other common prey include cockroaches, worms, and other lawn insects, especially in the wet seasons when the wetlands are too deep to allow foraging. Commonly consumed fish include mosquitofish, flagfish, and occasionally sunfish (Heath et al. 2009).

Quantitative Analysis

White ibises exhibit very generalist feeding habits, based upon what is available. In coastal environments, crabs, including mud crabs and fiddler crabs, and crayfish account for nearly all of prey they consume. In freshwater environments, insects account for a larger percentage of white ibis diet than in brackish environments (Heath et al. 2009). Ibises generally feed on small prey averaging 2 cm long, presumably to reduce handling time and piracy (Hingtgen et al. 1985).

Selection and capture methods

Food selection is exhibited through tactile and visual foraging. They wade in shallow water and probe for prey items beneath the surface of the water. While wading in the water, most foraging is tactile. Ibises also forage for food in *Spartina* marshes. Here they alternate between tactile and visual foraging, both digging for fiddler crabs and chasing those that are spotted on the surface. While nesting, white ibises will selectivity consume crayfish, crabs, insects, and frogs in higher proportion to what is available at the feeding sites. When feeding on fiddler crabs, a major dietary component, they will select females over males, likely to avoid the large claw on the males. They do not select high energy prey, but when raising nestlings they will select low-salt prey captured from freshwater areas (Heath et al. 2009).

Piracy is also common among ibises at colony sites. Generally, adult males will take prey from adult females while regurgitating food to the nestlings. The males will also steal directly from the nestlings (Heath et al. 2009).

Foraging Microhabitat

The generalized microhabitat requirements of the white ibis are broad, as the birds can feed in nearly any shallow water or on land in soft substrate or ground vegetation. They prefer to forage in ponds or marshes with high prey availability and low to medium water depths. The maximum depth in which they will forage is 24 cm, but generally prefer water that is 10 to 14 cm deep. These birds generally prefer open, sparse emergent vegetation; their density has been positively correlated with the percent of open prairies. When foraging in *Spartina* marshes, they prefer areas that have less emergent vegetation and structural complexity. They preferred the high marsh areas dominated by the short form of saltmarsh cord grass

more than areas along creek banks that were dominated by the tall form of cord grass. Most nesting birds forage in freshwater wetlands because of the nestlings' need to maintain salt balance. Inland feeding habitat is mainly shallow seasonal sedge marshes and cypress swamps, in addition to lawns, pastures, and shallow ponds. Coastal birds prefer salt marshes in the north and mangrove swamps in the south (Heath et al. 2009).

NUTRITION, ENERGETICS, AND METABOLISM

The basal metabolic rate of an adult white ibis is 81 to 88 kcal/day (Heath et al. 2009). Their daily expenditure is 164.4 kcal/day or 21 percent of their body mass. An additional 9,940 kcal/breeding season is necessary to produce a fledgling (Kushlan 1977). Newly fledged birds require approximately 148 kcal/day (Hingtgen et al. 1985) and approximately 8,620 calories of food during the entire nestling period. The daily energy use of young ibises peaks at 600 grams, then decreases as they become fledglings (Heath et al. 2009).

BEHAVIOR

White ibises are highly gregarious at all times. They are a colonial nester, living in large and densely populated colonies. They feed in large aggregations and fly in cohesive flocks among feeding and roosting sites. Aggregations can reach up to 5,000 individuals in suitable habitat (Heath et al. 2009), but probably average between 6.5 and 28.5 birds (Hingtgen et al. 1985). Almost 100 percent of ibises that leave their colony will land near or with conspecifics in foraging flocks. Juveniles often flock separately or feed on the periphery of the adult flocks (Heath et al. 2009). Foraging distance tends to vary, based on whether the colonies are located in coastal areas or inland. Coastal colonies tend to forage within 2.4 miles of the nesting colony, but distances up to 4 miles have been reported. Foraging distance for inland colonies tends to greater, on average 6.2 miles from the colony site. No more than two different feeding sites are used in a day (Hingtgen et al. 1985).

Ibises often breed in mixed-species colonies with anhingas, herons, egrets, and other ibises. Their breeding colonies vary in size from less than 100 pairs to over 10,000 pairs, but an average colony has 1,060 ± 240 pairs. These colony sites are generally used for many years (Hingtgen et al. 1985).

White ibises will defend their territories, position, and mates from others. The propensity to fight and fighting ability varies widely among males. Eggs that are left unattended in a colony site are sometimes destroyed by adults that are looking for nest sites. The display territory of males is in the immediate area of the nest. Once the male has attracted a female, both will defend the nest. Nest territory usually extends only as far as the incubating parent is able to reach. The distance between nests averages between 0.54 and 1.04 meters (Hingtgen et al. 1985; Heath et al. 2009). Nests are found from ground level to approximately 9 meters above ground level, based upon the habitat that is available (Hingtgen et al. 1985).

MEASUREMENT

Mass

Male white ibises are significantly larger than their female counterparts in all measurements. Males tend to be approximately 35 percent larger than females (Hingtgen et al. 1985). Males weigh, on average, 1,036 g ± 30.3 g, whereas females only weigh an average of 764 g ± 1.1 g (Heath et al. 2009).

Size

Males also have much larger bill and tarsus measurements than females. The average bill lengths of males and females are 142 mm ± 1 mm and 111 mm ± 1 mm, respectively. Males have an average tarsus length of 102 mm ± 2 mm, and female length is 87 mm ± 1 mm (Heath et al. 2009).

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Factor	Mean	Reference
Body Weight (g)	M 1,036 ± 30.3 F 64 ± 1.1	Heath et al. 2009
Basal Metabolic Rate (kcal/day)	81 to 88	Heath et al. 2009
Bill length (mm)	M 142 ± 1 F 111 ± 1	Heath et al. 2009
Tarsus length (mm)	M 102 ± 2 F 87 ± 1	Heath et al. 2009
Foraging Distance from Colony	Coastal areas: 2 mi. Inland areas: 6.2 mi	Heath et al. 2009
Territory Size	Only nesting site or roosting site	Heath et al. 2009
Nest Density (number pairs/colony)	1060 ± 240 pairs	Hingtgen et al. 1985
Nearest Neighbor Distance (m) (nest rim to nest rim)	0.54 to 1.04	Hingtgen et al. 1985
Dietary Composition	Fiddler crabs Crayfish Insects Fish	Heath et al. 2009

ATTACHMENT 1
TISSUE SAMPLING AND ANALYSIS PLAN

DRAFT
FISH AND INVERTEBRATE TISSUE SAMPLING AND ANALYSIS PLAN
PATRICK BAYOU SUPERFUND SITE

Prepared for

Patrick Bayou Joint Defense Group

Prepared by

Anchor QEA, LLC
614 Magnolia Avenue
Ocean Springs, Mississippi 39564

June 2010

TABLE OF CONTENTS

1 INTRODUCTION AND PURPOSE 1

2 PROJECT MANAGEMENT 2

2.1 Task Organization 2

3 SAMPLING DESIGN AND RATIONALE 5

3.1 Problem Statement 5

3.2 Tissue Sampling Objectives 6

3.2.1 Support Exposure Assessment in the BERA 6

3.2.2 Develop Site Specific BSAFs for Modeling Future Conditions and Remedial Scenarios 6

3.2.3 Establish Baseline Tissue Concentrations 7

3.3 Relationship to Other Activities 7

3.4 Background Information 7

3.4.1 Site Description 7

3.4.2 Conceptual Site Model Summary 8

3.4.3 Contaminants of Potential Concern 8

3.5 Task Description 9

3.5.1 Overview of Sampling Activities 9

3.5.2 Special Equipment and Personnel Requirements 9

3.6 Experimental Design 9

3.6.1 Target Organisms 9

3.6.1.1 Typical Body Size 10

3.6.1.2 Foraging/Trophic Level 10

3.6.1.3 Migratory Habits and Home Range 10

3.6.2 Prey Groups 11

3.6.3 Sample Locations 13

3.6.4 Number of Samples 14

3.7 Sampling Schedule 16

3.8 Documentation and Records 17

4 LABORATORY ANALYTICAL METHODS, QUALITY CONTROL, AND MEASUREMENT QUALITY OBJECTIVES 18

4.1 Sample Processing and Homogenization 18
4.2 Analytical Parameters, Methods, Reporting Limits, and Quality Control 19
4.3 Instrument Testing, Inspection, and Maintenance 20

5 DATA GENERATION AND ACQUISITION 27
5.1 Sampling and Preparation Methods 27
5.1.1 Location Control 27
5.1.2 Collection Methods 27
5.1.3 Equipment Decontamination 29
5.1.4 Organism Inspection and Processing 30
5.1.4.1 Depuration 31
5.1.4.2 Shelling Group 1A Invertebrates 31
5.1.5 Compositing 31
5.1.6 Sample Archiving 32
5.2 Sample Identification 32
5.3 Sample Handling and Custody Requirements 33
5.3.1 Sample Handling, Preservation, Transportation, and Storage 33
5.3.1.1 Sample Packaging 33
5.3.1.2 Shipping 33
5.3.2 Chain-of-Custody 34
5.4 Field Instrument Calibration 34

6 DATA ACQUISITION 35
6.1 Field Documentation 35
6.1.1 Field Logbooks 35
6.1.2 Field Forms 35
6.1.3 Photographs 35
6.2 Laboratory Documentation 35
6.3 Data Reporting 35

7 ASSESSMENT AND OVERSIGHT 37
7.1 Audits and Corrective Actions 37
7.2 Field Contingency Plan 37
7.3 Assessment of Sample Size Adequacy 38

8 DATA VALIDATION AND USABILITY 39

9 REFERENCES 40

List of Tables

Table 2-1 Project Personnel Quality Assurance Responsibilities 2
Table 3-1 Bioaccumulative COPCs for Receptor Groups 8
Table 3-2 Description of Prey Groups 13
Table 3-3 Number of Samples for Each Prey Group 16
Table 3-4 Analyte Classes for Each Prey Group based on Receptor Diets 16
Table 4-1 Sample Size, Preservation, and Holding Times for Tissue Samples 21
Table 4-2 Analytical Methods and Reporting Limits 22
Table 4-3 Laboratory Quality Control Sample Summary 25
Table 4-4 Laboratory Measurement Objectives for Porewater, Sediment, and Sediment Trap Samples 26
Table 5-1 Definition of Fishing Effort for Various Gears 28
Table 5-2 Sample Distance Limits 29

List of Figures

Figure 3-1 Sampling Reaches and Locations for Tissue Collection

List of Appendices

Appendix A List of Target Species for Prey Groups
Appendix B Randomly Selected and Ranked Sample Locations
Appendix C Field Data Sheets
Appendix D Species Code List

LIST OF ACRONYMS AND ABBREVIATIONS

BERA	Baseline Ecological Risk Assessment
BSAF	biota-sediment accumulation factors
CLP	Contract Laboratory Program
COPC	contaminants of potential concern
CSM	conceptual site model
DGPS	differential global positioning system
DQO	data quality objective
EDD	electronic data deliverable
ERDC	Engineering Research and Development Center
HHRA	human health risk assessment
HSC	Houston Ship Channel
JDG	Patrick Bayou Joint Defense Group
MDD	minimum detectable difference
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
PTFE	polytetrafluoroethylene
QA	Quality Assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limits
ROD	Record of Decision
SAP	Sampling and Analysis Plan
Site	Patrick Bayou Superfund Site
SOP	Standard Operating Procedure
SVOC	semivolatile organic compounds
TCEQ	Texas Commission on Environmental Quality
TL	trophic level
TPWD	Texas Parks and Wildlife Department
TRV	toxicity reference value
UCL	Upper Confidence Level

USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1 INTRODUCTION AND PURPOSE

This Fish and Invertebrate Tissue Sampling and Analysis Plan (SAP) has been prepared for the Patrick Bayou Joint Defense Group (JDG) to assist in the preparation of the Remedial Investigation/Feasibility Study (RI/FS) at Patrick Bayou Superfund Site (Site) in Deer Park, Texas. The primary focus of this SAP is to support completion of the Baseline Ecological Risk Assessment (BERA). This SAP presents the approach and methods for collecting and analyzing fish and invertebrate tissue at the Site, which was identified as a data gap in the fish and wildlife exposure assessment in the Draft Baseline Ecological Risk Assessment Work Plan (BERA Work Plan; Anchor QEA 2010a). This information will be used to refine the baseline exposure assessment for aquatic and wildlife receptors in the BERA. Ancillary objectives include the development of sediment/fish contaminant relationships to support evaluation of potential remedial effectiveness, as well as establishment of a baseline data set for evaluation of post-Record of Decision (ROD) monitoring.

2 PROJECT MANAGEMENT

2.1 Task Organization

A comprehensive description of the project organization, schedule, and contacts was provided in the Quality Assurance Project Plan (QAPP) (submitted as part of the RI Work Plan; Anchor 2007a). For this study, Anchor QEA, LLC (Anchor QEA) will conduct the field work. Alpha Analytical (Alpha) has been selected to provide analytical services for collected samples. Table 2-1 provides an updated list of names and Quality Assurance (QA) responsibilities of the key project personnel who will be involved in sampling and analysis activities described in this SAP.

Table 2-1
Project Personnel Quality Assurance Responsibilities

Title	Responsibility	Name/Affiliation	Contact Information
Anchor QEA Project Director	Responsible for the overall delivery of project objectives in alignment with the operating parameters set forth in this SAP.	Tom Schadt	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 tschadt@anchorqea.com
Anchor QEA Project Manager	Responsible for the coordination and execution of all work items associated with project planning and implementation. Liaison between program-level managers and project-level team members. Identifies team members and project assignments. Manages and tracks schedule and budget. Ensures that all tasks are completed by assigned team members within schedule and budget constraints.	David Keith	Anchor QEA, LLC 614 Magnolia Avenue Ocean Springs, MS 39564 (228) 818-9626 dkeith@anchorqea.com
Anchor QEA Project Health and Safety Manager	Responsible for overseeing health and safety program for field tasks associated with RI/FS. Reviews Site Health and Safety Plan, Site job safety analyses and training requirements.	Chris Torell	Anchor QEA, LLC 290 Elwood Davis Road Suite 340 Liverpool, NY 13088 (315) 453-9009 ctorell@anchorqea.com

Title	Responsibility	Name/Affiliation	Contact Information
Anchor QEA Project QA Manager	Responsible for Data Quality Objective (DQO) planning, QAPP development, ensuring the project objectives are met. Liaison between project manager and project team. Task lead for data interpretation and final report preparation.	Delaney Peterson	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 dpeterson@anchorqea.com
Anchor QEA Data Manager (DM)	Point of contact for all issues concerning laboratory data, database maintenance, data loading, verifying data, and communicating with the laboratory and project team regarding database and data content issues.	Lisa Allen	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 lallen@anchorqea.com
Anchor QEA Project Chemist (PC)	The PC is responsible for validating the data and providing data validation flags and their meanings to the DM. The PC is responsible for validating the data according to the requirements of the Quality Assurance Project Plan and identifying and resolving any issues affecting completeness, accuracy, or usability.	Joy Dunay	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 jdunay@anchorqea.com
Field Supervisor	Responsible for sample collection, sample handling, maintaining and documenting the sample chain-of-custody, delivering the samples to the laboratory, and delivering the field notes, field measurements, and chains-of-custody to the DM. In addition, the Field Supervisor will implement the Health and Safety Plan in the field.	Jason Kase	Anchor QEA, LLC 4208 Cherry Laurel Drive Pensacola, FL 32504 (850) 912-8400 jkase@ anchorqea.com
Project Emergency Coordinator	Responsible for managing potential emergency situations during field work for the RI/FS. Includes notifying appropriate Points of Contact at each facility and the Project Manager in case of fire, spills, personal injury, or any other emergency situation that may arise.	Jason Kase	Anchor QEA, LLC 4208 Cherry Laurel Drive Pensacola, FL 32504 (850) 912-8400 jkase@ anchorqea.com

Title	Responsibility	Name/Affiliation	Contact Information
Fisheries Biologist	Responsible for the accurate identification of collected specimens, collection permits and reporting, and overall oversight of collection efforts.	Ali Wick	Anchor QEA, LLC 1423 Third Avenue Suite 300 Seattle, WA 98101 (206) 287-9130 awick@anchorqea.com
Vessel Operator	Responsible for the safe operation of boats or other sampling platforms utilized during sampling and maintenance activities. Will assure that proper safety equipment is on the vessel and operating correctly and that all personnel on the boat are familiar with safety procedures, features, and equipment.	To Be Determined	Not available
Subcontractor Lab Project Manager(s)	Point of contact for the laboratory. The PC communicates the sampling schedule, analytical methods, turnaround time, laboratory QA/QC, and reporting requirements.	Elizabeth Porta	Alpha Analytical Mansfield, MA 508-844-4114 eporta@alphalab.com

3 SAMPLING DESIGN AND RATIONALE

3.1 Problem Statement

This SAP is designed to address three issues associated with the RI/FS: ecological risk assessment, evaluation of the relative benefits of alternative remediation plans, and monitoring.

The primary focus of the work described here is to support the BERA. Existing Site data and data collected during previous RI/FS tasks for the Site (Anchor 2007c, 2007d) were used to perform preliminary and refined assessments of ecological contaminants of potential concern (COPCs; Anchor 2007b, 2008a, and 2008b). These assessments identified several COPCs for fish and aquatic-dependant wildlife receptors (e.g., birds and mammals).

In the Draft Selection of Chemicals of Potential Concern for Ecological Risk Assessment (COPC Report; Anchor 2008a) and the Draft Selection of Chemicals of Potential Concern for Ecological Risk Assessment Addendum (COPC Report Addendum; Anchor 2008b), estimates exposure for fish and wildlife receptors at the Site were based on modeled tissue concentrations using Site sediment chemical concentrations and biota-sediment accumulation factors (BSAFs) developed using reported values from other sources (i.e., U.S. Army Corps of Engineers (USACE), Engineering Research and Development Center (ERDC), BSAF database, and Calcasieu Estuary RI/FS project database). Results of these exposure estimates were compared to dietary toxicity reference values (TRVs) to select potentially bioaccumulative COPCs for aquatic and wildlife receptors (Anchor 2008a and 2008b). For the upcoming phase of the ecological risk assessment process (i.e., the baseline risk assessment), more site-specific exposure data are desired to reduce the uncertainty in the risk estimates.

In particular, site-specific exposure data are required to evaluate potential risk to fish and wildlife receptors in the BERA. This includes biota that represents 1) fish species targeted as measurement endpoints in the BERA, and 2) typical dietary components of aquatic-dependent wildlife receptors that may be present at the Site. These data will be used to refine the baseline exposure assessment for fish and wildlife receptors that consume aquatic-based prey items from the Site.

In addition, assessing the benefits of alternative remediation plans will require an understanding of the relationship between contaminant concentrations in the potentially remediated medium (the sediments of Patrick Bayou) and contaminant concentrations in the target species (fish bodies and wildlife diet). Organisms accumulate contaminants from both water and sediment. To the extent that local sediments are the primary source, local sediment remediation will have a direct impact on contaminant concentrations in the organisms. For organisms tied primarily to local sediments, the relationship between sediment and organism, the BSAF, can be used to estimate how changes in Site sediment concentrations, due to various remedial actions (e.g., capping and natural recovery) would affect changes in tissue concentrations (and subsequently exposure and risk) to ecological receptors.

Finally, an important component of any sediment remediation plan is monitoring to assess the consequences of remedial decisions, which may include monitored natural recovery and/or active remediation; a robust pre-decision data set is required.

3.2 Tissue Sampling Objectives

Specific objectives of this SAP include:

3.2.1 Support Exposure Assessment in the BERA

The primary objective of this SAP is to collect sufficient tissue chemistry data for fish and wildlife bioaccumulative COPCs to support exposure assessment for these receptors in the BERA. The objective is to collect sufficient tissue data to estimate deterministic (e.g., exposure estimates of bioaccumulative COPCs in for these receptors. Exposure will be estimated using a body burden approach for fish and dietary intake approach for wildlife receptors.

3.2.2 Develop Site Specific BSAFs for Modeling Future Conditions and Remedial Scenarios

Tissue conditions measured from this study will be used to develop site-specific BSAFs. Briefly, BSAFs will be calculated as the ratio of COPC concentration in tissue to the concentration in sediment. This ratio expresses the steady-state ratio between the

concentration of a bioaccumulating chemical in sediment and the concentration measured in the tissue of an organism for which the sediment represents the primary source of contamination. Development of site-specific BSAF values can be used to estimate the risk-based effectiveness of different remedial options for the Site.

3.2.3 Establish Baseline Tissue Concentrations

Baseline COPC concentrations in biota at the Site will also be characterized to provide a point of comparison for long-term (post-remediation) monitoring data, if required as part of the remedy selection. The baseline data and long-term monitoring data may be necessary to evaluate the performance of implemented remedial actions in meeting risk reduction goals.

3.3 Relationship to Other Activities

The human health risk assessment work plan (HHRA Work Plan) is currently under development. If the need to collect additional Site tissue data for fish or invertebrates should arise from the data gaps identified in the HHRA Work Plan, it is anticipated that an addendum to this SAP would be prepared to address sampling needs for the HHRA. This sampling would occur concurrent with activities described in this SAP in order to streamline efforts (e.g., mobilization costs, lab costs, etc.) associated with such sampling.

3.4 Background Information

3.4.1 Site Description

Patrick Bayou is a tributary of the Houston Ship Channel (HSC) in Harris County, Texas. The Site originates south of State Highway 225 in the City of Deer Park, Texas, and flows approximately 2.5 miles in a northerly direction, discharging into the south side of the HSC approximately 2.3 miles upstream of its confluence with the San Jacinto River. The Site and its salient features are described in more detail in BERA Work Plan.

The Site is best described a bayou system with several on- and off-site modifications that have affected its surface hydrology over time. It is typically a low-flow, tidally influenced system. Sediments have generally high silt content and are susceptible to disturbance under scouring (flood tide, wind, or heavy rainfall) conditions. Sediment stability varies; shallow

depositional zones tend to be less stable than relatively deeper channels, which serve as conduits for flow.

3.4.2 Conceptual Site Model Summary

The current conceptual site model (CSM) is fully described in the BERA Work Plan (Anchor QEA 2010a). The current CSM divides potential ecological receptors into two categories: 1) aquatic receptors including invertebrates, and fish; and 2) aquatic-dependent wildlife receptors including birds and mammals. For fish, exposure to sediment, biota, and surface water are complete and significant exposure pathways for bioaccumulative COPCs; tissue concentrations (body burden) will reflect these exposures. For aquatic-dependent wildlife, ingestion of biota (i.e., tissue) and incidental ingestion of sediment[1] are complete and significant exposure pathways.

3.4.3 Contaminants of Potential Concern

Bioaccumulative COPC were identified for fish, birds, and mammals on a receptor specific basis (Anchor QEA 2010a). Table 3-1 includes the list of COPC for each receptor. This list includes metals.

Table 3-1
Bioaccumulative COPCs for Receptor Groups

COPC	Receptor Group				
	Kingfisher	Spotted Sandpiper	Carnivorous Wading Bird	Fish	Raccoon
Mercury	X	X	X	X	X
PAHs		X			
Total PCB Congeners	X	X	X	X	X
PCB congeners TEQ	X	X	X		X
Dioxin/furan congener TEQ		X			
Hexachlorobenzene	X	X			
Hexachlorobutadiene		X			
1,3-Dichlorobenzene	X	X			
1,4-Dichlorobenzene		X			

1 For a subset of wildlife receptors

3.5 Task Description

3.5.1 Overview of Sampling Activities

Fish and invertebrates will be collected from the waters of the Site using passive and active sampling methods. Organisms will include fish and invertebrates present in the upper, middle, and lower reaches of Patrick Bayou. These organisms will be organized by "Prey Groups" representing typical prey items for wildlife receptors for the area. Prey Groups that have relatively high Site fidelity will be targeted. Samples will be collected and sent to the laboratory for processing and chemical analysis.

3.5.2 Special Equipment and Personnel Requirements

Equipment used for sampling is described below and in Section 5.1.2, and will include small motorized boats and various fishing equipment. Personnel will include an experienced fisheries biologist in the sampling crew to oversee sampling operations. Differential global positioning system (DGPS) equipment will be used to record location.

The collection of resident fish species in the study area will require prior approval via a permit from the Texas Parks and Wildlife Department (TPWD) for collection of fish species for research purposes. Permit applications include providing a standard form to TPWD, as well as a brief study plan with permittee qualifications.

3.6 Experimental Design

The experimental design for this study includes sampling fish and invertebrate species from the Site as representatives of various trophic levels, distributions, and foraging ranges for prey items present at the Site. The following sections identify the fish and invertebrate species to be sampled and the basis for their selection, proposed sample locations, and the number of samples required for each species and location.

3.6.1 Target Organisms

In order to collect prey organisms that can be linked to Site receptors, target species were categorized into Prey Groups that share similar size ranges, habitats, and trophic levels. This section describes each Prey Group that will be targeted for collection during the tissue

sampling program. The proportion of each Prey Group in the diet of wildlife receptors is discussed in the BERA Work Plan (Anchor QEA 2010a). The characteristics discussed in Sections 3.6.1.1 to 3.6.1.3 below were considered during the development of Prey Groups for this study.

3.6.1.1 Typical Body Size

The body size of fish and invertebrate species found in the southern United States vary widely. Body size can range from that of tiny gobies (*Gobiidae*) less than a centimeter in length to that of alligator gars and drums up to 2 to 3 meters in length. Prey size is often an important selection factor for predators. Most wildlife species target specific size classes of prey. In Patrick Bayou, prey items in the diet of fish and wildlife receptors are not expected to exceed 15 cm in length for fish and 5 cm for invertebrates (Anchor QEA 2010a). Thus, organisms larger than these limits will not be targeted.

3.6.1.2 Foraging/Trophic Level

The trophic level of an organism is its feeding position in the food chain. Because of bioaccumulation, contaminant concentrations tend to increase with each trophic level, so prey species at different trophic levels are likely to have different levels of bioaccumulative chemicals in their tissues. Zooplankton represent trophic level 1 (TL1), planktivorous fish represent TL2, and predatory fish represent TL3 and TL4. Most fish species in Patrick Bayou are omnivores and thus feed on more than one trophic level. Trophic levels range from 2.1 for mullets (*Mugilidae)* to 3.4 for silversides (*Atherinidae*) and pupfishes (*Cyprinodontidae*). Prey Groups were classified as low (phytoplanktivores, omnivores, etc.) or high (carnivores) to reflect differences in potential bioaccumulation.

3.6.1.3 Migratory Habits and Home Range

Movement patterns, which include day-to-day foraging ranges, as well as seasonal migration, may have a significant influence on the body burden of prey species that may be consumed by predators. Movement in and out of Patrick Bayou is also likely to affect remedial effectiveness; that is, remediation within Patrick Bayou will only affect the portion of exposure that occurs within the Site. Some fish, such as killifishes, tend to be non-migratory and have home ranges smaller than the size of the Site. Other species, such as shrimp and

mullet, may utilize the Site to different degrees during their life cycle. Finally, other species such as anchovies and gulf menhaden tend to forage over large areas. To account for differences in migratory or home range factors, Prey Groups were labeled as migratory or sedentary to represent the general status of species within that group.

3.6.2 Prey Groups

Four Prey Groups (two invertebrate and two fish) were established based on body size. Predators are assumed not to prefer one species over another within a prey group. To reflect variation in movement patterns and trophic level, these numeric Prey Groups were subdivided into alphabetical (A and B) groups. Species within an alphabetical designation are expected to have similar tissue COPC levels, provided they are collected in the same area. Prey groups are described below and life history and size information is given in Table 3-2; representative species for each group are in Appendix A.

Group 1 Invertebrates. This group includes small, sedentary epibenthic invertebrates with a localized distribution. This group is further subdivided into two groups (A and B), reflecting their feeding strategies, life cycles, and other attributes[2]. Group 1A includes bivalves such as oysters and clams. Group 1B includes small crustaceans such as fiddler crabs and juvenile blue crabs. Tissue residue levels are expected to vary substantially between individuals depending on proximity to sources and should reflect localized exposure.

Group 2 Invertebrates. This group includes medium-sized invertebrates with a broader distribution and migratory patterns. This group is further subdivided into two groups reflecting trophic level. Group 2A includes lower trophic level organisms such as brown and white shrimp. Group 2B includes higher trophic level invertebrates such as blue crab. Tissue residue levels are expected to vary less between individuals than Group 1 depending on proximity to sources and residence time at the Site.

Group 1 Fish. This group includes small bentho-pelagic fish that inhabit shallow water and have a localized distribution. The trophic level ranges from 2 to 2.5. Total length is less than

2 Soft-bodied benthic infauna (e.g. polychaetes) were not included as a target group due to the relatively low abundance (Parsons Engineering 2002, 2004) and small size. It is considered improbable that sufficient tissue volume could be collected for chemical analysis of multiple samples.

15 cm. Tissue residue levels are expected to vary substantially among individuals depending on proximity to sources.

Group 2 Fish. This group includes small pelagic fish that inhabit any water depth and have a broad foraging range. This group is further subdivided into two groups (A and B) based on their trophic level. Group 2A fish include lower trophic level (less than 2.5) species such as mullet and shad. Group 2B includes higher trophic level (greater than 2.5) species such as spot, croaker, and pinfish. Total length of an individual fish in Group 2 is less than 15 cm. Tissue residue levels among individuals are not expected to vary widely throughout the Site and may be a function of both on- and off-site exposure.

Fish and wildlife receptors are expected to primarily feed upon Fish Groups 1-2 and Invertebrate Groups 1 A/B and 2A. Receptors are unlikely to feed on prey species larger than Group 2 fish or Group 2A invertebrates. Additionally, due to their size and life history, these larger organisms are likely to average their exposure over a much larger area than represented by the Site. Thus, fish larger than 15 cm and invertebrates larger than 5 cm will not be sampled. Individuals in these groups that are caught incidentally during the field investigation will be recorded on logsheets, but will not be submitted for analysis. Finally, soft-bodied benthic infauna (e.g. polychaetes) were not included as a target group due to the relatively low abundance (Parsons Engineering 2002, 2004) and small size. It is considered improbable that sufficient tissue volume could be collected for chemical analysis of multiple samples for this group.

Table 3-2
Description of Prey Groups

Prey Class	General Size	Site Use	Trophic Level	Example Species	Approximate Size Class (cm)
Fish					
1A	Small	Sedentary	Low	minnows, mollies, killifish	<15
2A	Small	Migratory	Low	mullet, shad, anchovies, sunfish, menhaden, silverside	<15
2B	Small	Migratory	High	spot, croaker	<15
Invertebrates					
1A	Small	Sedentary	Low	Clams, mussels, oysters	2 – 7.5 cm
1B	Small	Sedentary	Low	fiddler crabs, hermit crabs, juvenile blue crabs	<7.5
2A	Small	Migratory	Low	Shrimp	<12.5

Note:

* Based on best professional judgment

3.6.3 Sample Locations

The Site will be divided into four reaches (Figure 3-1):

- Reach 1 - lower Patrick Bayou (Lower Reach): This reach is subject to frequent influences of the Houston Ship Channel due to tidal flow reversals.
- Reach 2 - middle Patrick Bayou (Middle Reach): This reach may reflect conditions in the HSC or upstream areas depending on rainfall, water level, and tidal conditions.
- Reach 3 – upper Patrick Bayou (Upper Reach): This reach includes the confluence with the East Fork Tributary and is influenced significantly by upstream flow and runoff; particularly during precipitation events.
- Reach 4 - open culvert (Gunite-Lined Reach): This reach is completely lined with gunite and primarily serves as a conveyance for runoff from upstream areas. Habitat is minimal in this reach.

For each Prey Group, an attempt will be made to collect tissue samples from each reach and as evenly across reaches as possible. The primary exception to this would be Reach 4. This

reach is much smaller, is harder to access, and has less natural habitat than the other three reaches. Attempts to collect samples in Reach 4 will be made, but will not receive the same level of effort as the other reaches, if initial sampling activities in this reach prove unsuccessful.

Two methodologies will be utilized to collect samples. For Prey Group 1A Fish and Group 1(A/B) Invertebrates, sample locations will be selected randomly from among the sediment sample locations previously sampled as part of the sediment and surface water COPC delineation effort(Anchor QEA 2010b; Figure 3-1). Five randomly selected stations will be sampled for Group 1A Fish and Group 1 Invertebrates in each of Reaches 1, 2, and 3. Reach 4 will only have three sampling sites due to its restricted size. Samples will be collected within a 15-meter radius of the designated coordinates. Alternate sampling stations will also be identified in case the primary sampling stations do not yield sufficient samples (see Section 5.1.2 for discussion of alternate station selection).

For Group 2 Fish and Group 2A Invertebrates, samples locations will not necessarily be co-located with sediment samples. Rather, collection efforts will be performed on a reach-wide basis (i.e., sampling locations will be selected opportunistically based on Site conditions such as substrate, water depth, etc.). In-field observations will be used to target sample collection within each reach.

3.6.4 Number of Samples

Based on the sampling objectives in Section 3.2, a sufficient number of samples should be collected to estimate the mean and the variability of Site tissue concentrations for each of the Prey Groups targeted for collection.

The variability in Site tissue concentrations in target Prey Groups is not known; there is no site-specific tissue data to perform any preliminary estimation of variability. Generally, as variability in a population increases, the number of samples required to meet sampling objectives (e.g., estimating the mean) increases. Thus, variability can be a controlling aspect in identifying the number of samples. Since there is no existing tissue data for the Site, a more general approach is necessary to determine the number of samples that should be

collected. This approach included a review of variability and the number of samples collected at similar sites (e.g., Calcasieu Estuary BERA) and general statistical principles.

In the Calcasieu Estuary BERA, 20 samples per Prey Group were recommended for collection (MESL et al. 2002). This number was based on an analysis of variability for preliminary tissue data collected in the Calcasieu Estuary. Power analysis was performed on this data and it was determined that 20 samples would provide 80 percent power to reveal a minimum detectable difference (MDD) of a factor of 3. Twenty samples would need to be collected to detect a difference in tissue concentrations varying by a factor of 3 or greater with a power of 80 percent.

Based on general statistical principles for performing exposure point concentration estimates (e.g., Upper Confidence Level [UCL] 95), distribution goodness-of-fit testing, and bootstrapping, USEPA (2007) recommends at least 10 to 15 total observations and a minimum of 8 to 10 detected observations. Finally, Crystal Ball (Oracle 2007) requires a minimum of 15 observations to perform goodness-of-fit and distribution fitting.

Thus, the minimum number of samples to be targeted for collection within a Prey Group is set at 15. Prey Group 1A Fish and Group 1 Invertebrates (small, lower trophic level species with small home ranges found mostly in shallow areas) are likely to have the highest levels of variability in the concentrations of tissue-associated contaminants. Due to the relatively higher levels of expected variability, a minimum of 20 samples will be targeted for Prey Group 1A Fish and Group 1 Invertebrates. A maximum sample target number for each Prey Group was set at 25. Beyond 25 samples, the benefit of additional analytical data tends to be offset by increased analytical cost. Table 3-3 lists the numbers of samples that will be targeted for each Prey Group. Table 3-4 identifies the analyte classes that will be analyzed for in each Prey Group. This table reflects the specific COPC/receptor group combinations and their assumed dietary components identified in Section 6.2 and Table 13 in the BERA Work Plan (Anchor QEA 2010a).

Table 3-3
Number of Samples for Each Prey Group

Prey Class	Minimum Sample Number Target	Maximum Sample Number Target
Fish		
1A	20	25
2 (A,B)	15	25
Invertebrates		
1 (A,B)	20	25
2A	15	25

Table 3-4
Analyte Classes for Each Prey Group based on Receptor Diets

Chemical	Invertebrate			Fish		
	Group 1A	Group 1B	Group 2A	Group 1A	Group 2A	Group 2B
Mercury	X	X	X	X	X	X
PCB Congeners	X	X	X	X	X	X
Hexachlorobenzene	X	X	X	X	X	X
1,3-Dichlorobenzene	X	X	X	X	X	X
PAHs	X	X				
Dioxin/Furan Congeners	X	X				
Hexachlorobutadiene	X	X				
1,4-Dichlorobenzene	X	X				

3.7 Sampling Schedule

Sampling is currently expected to occur between May 1 and November 31, 2010. Sampling between the months of December and April will not be performed because 1) water levels are typically low and access to areas of the Site is problematic, and 2) lipid content (which is an important reservoir for some organic contaminants) of fish and invertebrates may generally be low. Sampling will occur over approximately two weeks and collection may include night efforts, depending on catch. This schedule is subject to change based on agency approval of this sampling plan, weather delays, and other factors that may occur.

3.8 Documentation and Records

Complete and accurate records of sample collection, sample analysis, quality assurance, data corrections, and data analysis will be maintained. Integrity of this information will be maintained throughout all data transfers and manipulations. Procedures used to generate, transform, and validate data are critical for effective data management. A summary of the data management procedures is described in the Data Management Plan (included as part of the RI Work Plan; Anchor 2007a) and is incorporated into this SAP by reference.

4 LABORATORY ANALYTICAL METHODS, QUALITY CONTROL, AND MEASUREMENT QUALITY OBJECTIVES

4.1 Sample Processing and Homogenization

The following steps and methods will be used to prepare composite tissue homogenates from whole fish and invertebrate tissue samples:

- Quartz, ceramic, borosilicate glass, polytetrafluoroethylene (PTFE), and high-quality stainless steel are recommended materials for sample processing equipment.
- Prior to preparing each composite sample, utensils and containers will be cleaned thoroughly with a detergent solution, rinsed with tap water, and rinsed thoroughly with organics- and metal-free water.
- Samples may be partially thawed prior to homogenization. Partially thawed tissue is often easier to homogenate.
- Individual samples may be combined into a single composite sample to meet the tissue mass requirements. Prior to processing any samples in the laboratory, the laboratory project manager will coordinate directly with the Anchor QEA project manager to identify the compositing scheme that will be used. Samples that will be assembled to create a composite sample should be assembled and processed at the same time.
- Whole body fish samples should be ground and homogenized using an automatic grinder, high-speed blender, or similar equipment. Large, whole body samples may be cut into smaller pieces with high-quality stainless steel knives or a food service grade band saw. Samples will be ground until it appears homogenous. The grinding process should be repeated as needed to create a homogenate. If, after several (more than 3 to 5) attempts to process the homogenate, large pieces of tissue remain (i.e., skin), they should be removed from the sample prior to analysis to avoid biasing the extraction and digestion process.
- After homogenization, samples should be analyzed immediately or placed in sample containers (Table 4-1) and stored at temperatures no higher than -20 °C.
- Equipment rinsate blanks will be collected and analyzed for each type of sampling equipment and analyzed for the same list of analytes as tissue samples, per the RI Work Plan QAPP (Anchor 2007a).
- At least one duplicate homogenization sample will be prepared for every 20 samples

processed in the laboratory. The duplicate homogenization sample consists of collecting a sufficient amount of additional fish tissue in the field, such that the laboratory has sufficient fish tissue volume to prepare a blind split sample for every 20 samples processed. Identification of samples for duplicate homogenization will be made in the field by the field supervisor and will be dependent on the number and frequency of samples collected with sufficient mass to prepare duplicates. Prior to processing any samples in the laboratory, the laboratory project manager will coordinate directly with the Anchor project manager to identify samples for homogenization duplicates. This duplicate homogenate will be given a unique sample identifier and will be tracked by the analytical laboratory as a separate sample for analysis.

4.2 Analytical Parameters, Methods, Reporting Limits, and Quality Control

All data generated will be reported in full data validatable reports (Contract Laboratory Program [CLP] level IV) with electronic deliverables in the Anchor QEA custom EQuIS 5 format. The laboratory QAPP and Standard Operating Procedures (SOPs) provide data quality procedures according to the protocols for the analytical method. Sample containers, holding times, and preservation requirements are listed in Table 4-1.

Risk-based target practical quantitation limits (PQLs) were determined using the NOAEL-based equivalent food and tissue residue effect values (Anchor 2008a; Table C-1). The lowest effect value of the bird, mammal, and fish receptor groups was selected as the target PQL for each analyte.

Analyses will follow methodology found in Table 4-2 and may employ modifications as the laboratories deem necessary to achieve the project-specified reporting limits (RL). These modifications, if outside the laboratory SOP, will be narrated in the final report.

Laboratory quality control sample frequency and quality control limits are summarized in Table 4-3 and 4-4. Requirements are consistent with the Patrick Bayou QAPP (Anchor 2007a) and have been modified to meet project requirements (e.g., addition of lipids).

4.3 Instrument Testing, Inspection, and Maintenance

Instrument testing, inspection, and maintenance will occur per the Patrick Bayou QAPP (Anchor 2007a).

Table 4-1

Sample Size, Preservation, and Holding Times for Tissue Samples

Parameter	Sample Size	Sample Container	Preservative	Holding Time
Lipids	5 g	Plastic, borosilicate glass, quartz, PTFE	Freeze -20°C	1 year
Mercury	5 g	Plastic, borosilicate glass, quartz, PTFE	Freeze -20°C	1 year
Semivolatile organic compounds (SVOC)	10 g	Plastic, borosilicate glass, quartz, PTFE	Freeze -20°C	1 year until extraction
			Cool/4° C	40 days after extraction
Polychlorinated biphenyls (PCB) Congeners	50 g	Plastic, borosilicate glass, quartz, PTFE	Freeze -20°C	1 year until extraction
			Cool/4° C	40 days after extraction
			Cool/4° C	40 days after extraction
Dioxins/Furans	50 g	Plastic, borosilicate glass, quartz, PTFE	Freeze -20°C	1 year to extraction
			Cool/4° C	40 days after extraction

Table 4-2
Analytical Methods and Reporting Limits

Target Analytes	Analytical Method	Units (wet weight)	Risk-based Tissue Target PQL	Project Reporting Limit
Conventionals				
Lipid	Bligh and Byer	%	--	0.2
Metals				
Mercury, total	7471A	mg/kg	0.01	0.02
Semivolatiles				
LPAH				
Naphthalene	8270C SIM	µg/kg	1590	1.0
Acenaphthylene	8270C SIM	µg/kg	659	1.0
Acenaphthene	8270C SIM	µg/kg	1450	1.0
Fluorene	8270C SIM	µg/kg	659	1.0
Phenanthrene	8270C SIM	µg/kg	1620	1.0
Anthracene	8270C SIM	µg/kg	659	1.0
2-Methylnaphthalene	8270C SIM	µg/kg	659	1.0
HPAH				
Benz(a)anthracene	8270C SIM	µg/kg	659	1.0
Benzo(a)pyrene	8270C SIM	µg/kg	1320	1.0
Benzo(b)fluoranthene	8270C SIM	µg/kg	659	1.0
Benzo(g,h,i)perylene	8270C SIM	µg/kg	659	1.0
Benzo(k)fluoranthene	8270C SIM	µg/kg	659	1.0
Chrysene	8270C SIM	µg/kg	1320	1.0
Dibenz(a,h)anthracene	8270C SIM	µg/kg	659	1.0

Target Analytes	Analytical Method	Units (wet weight)	Risk-based Tissue Target PQL	Project Reporting Limit
Fluoranthene	8270C SIM	µg/kg	659	1.0
Indeno(1,2,3-cd) pyrene	8270C SIM	µg/kg	659	1.0
Pyrene	8270C SIM	µg/kg	659	1.0
Miscelleneous				
Hexachlorobenzene	8270C SIM	µg/kg	962	100
Hexachlorobutadiene	8270C SIM	µg/kg	2580	100
1,3-Dichlorobenzene	8270C SIM	µg/kg	2309	100
1,4-Dichlorobenzene	8270C SIM	µg/kg	2309	100
PCBs				
PCB Congeners (1-209)	1668	ng/kg	2.43	Variesa
Dioxins and Furans				
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	0.50
1,2,3,7,8-Pentachlordibenzo-p-dioxin	1613B	ng/kg	2.43	2.50
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	2.50
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	2.50
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	2.50
Dioxins and Furans (cont.)				
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	2.50
Octachlorodibenzo-p-dioxin	1613B	ng/kg	2.43	5.00
2,3,7,8-Tetrachlorodibenzofuran	1613B	ng/kg	2.43	0.50
1,2,3,7,8-Pentachlorodibenzofuran	1613B	ng/kg	2.43	2.50
2,3,4,7,8-Pentachlorodibenzofuran	1613B	ng/kg	2.43	2.50
1,2,3,4,7,8-Hexachlorodibenzofuran	1613B	ng/kg	2.43	2.50
1,2,3,6,7,8-Hexachlorodibenzofuran	1613B	ng/kg	2.43	2.50

Target Analytes	Analytical Method	Units (wet weight)	Risk-based Tissue Target PQL	Project Reporting Limit
1,2,3,7,8,9-Hexachlorodibenzofuran	1613B	ng/kg	2.43	2.50
2,3,4,6,7,8-Hexachlorodibenzofuran	1613B	ng/kg	2.43	2.50
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1613B	ng/kg	2.43	2.50
1,2,3,4,7,8,9-Hepachlorodibenzofuran	1613B	ng/kg	2.43	2.50
Octachlorodibenzofuran	1613B	ng/kg	2.43	5.00

Notes:
NA - not available
a Varies between 1.0 and 6.0 depending on congener

Table 4-3
Laboratory Quality Control Sample Summary

Analysis Type	Initial Calibration[b]	Ongoing Calibration	Standard Reference Material or LCS	Replicates	Matrix Spikes[e]	Matrix Spike Duplicates[e]	Method Blanks	Surrogate Spikes
Lipids	Daily[a]	NA	NA	1 per 20 samples	NA	NA	NA	NA
Mercury	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Dioxins and furans	As needed[c]	Every 12 hours	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	NA[d]
PCB congeners	As needed[c]	Every 12 hours	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	NA[d]
SVOC	As needed[c]	Every 12 hours	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample

Notes:
a Calibration and certification of drying ovens and weighing scales are conducted bi-annually. Scale should be calibrated with class 5 weights daily; weights must bracket the weight of sample and weighing vessel.
b Initial calibration verification and calibration blank must be analyzed after initial calibrations are performed and before samples are analyzed.
c Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
d Standard reference material is not applicable for this analysis. There is also no surrogate spike to be used for the analysis.
e If sufficient material is available.
NA Not applicable.
LCS Laboratory control sample/laboratory control sample duplicate.

Table 4-4

Laboratory Measurement Objectives for Porewater, Sediment, and Sediment Trap Samples

Parameter	Precision	Accuracy	Completeness
Lipid	+/- 30% RPD	50-140% R	95%
Mercury	+/- 20% RPD	65-130% R	95%
Dioxins and furans	+/- 50% RPD	50-140% R	95%
PCB congeners	+/- 50% RPD	50-140% R	95%
SVOC	+/- 50% RPD	50-140% R	95%

Notes:
RPD Relative percent difference
R Recovery

5 DATA GENERATION AND ACQUISITION

General methods for data generation and acquisition for the study will be consistent with those described in the RI Work Plan QAPP (Anchor 2007a), and specific requirements of the fish tissue collection are discussed below.

5.1 Sampling and Preparation Methods

5.1.1 Location Control

Location of stationary sampling gear will be recorded using DGPS. For active sampling gear (i.e., trawls) the sampling track will be recorded using DGPS.

5.1.2 Collection Methods

Either active or passive collection methods may be used as long as the methods selected result in collection of a representative sample of the type consumed by representative ecological receptors. Organisms are anticipated to be collected using a combination of stationary or semi-stationary gear, which may include crab traps, minnow traps, gillnets, trawls, cast nets, and/or hook-and-line sampling. The number and types of gear to deploy at each station will be determined in the field based on targeted Prey Group, habitat type, and initial sampling efficiency observations. Electro shocking may be used for tissue collection in Patrick Bayou depending on water salinity; brackish water may inhibit predictable electrical currents. Trawling and seining may be problematic due to difficult maneuverability in soft mud substrates. Gear will be deployed from shore or by boat, depending on water depths. Sampling may occur at night to target species that may be more active during evening hours. Table 5-1 defines the list of sampling gear expected to be used and what defines a single 'effort' that will be used to record how much effort is expended to catch target Prey Groups.

Sampling will be conducted over a period of two weeks. At the outset of the sampling effort, baited minnow traps (three per station) will be set at a maximum of five randomly selected primary stations within Reach 1, 2, and 3. Only three stations will be set in Reach 4, due to the size of this reach and access restrictions. See Appendix B for a list of stations and their coordinates.

Baited minnow traps (targeting primarily Group 1A Fish) will be checked at regular intervals (i.e., daily) for three days. If sufficient Group 1A Fish are collected at a station to create at least two composite samples during that time, then traps will be moved to the next randomly selected station within a sample reach. If, after three days, insufficient numbers of Group 1A Fish are collected at a station for two composite samples, then traps will be moved to the next randomly selected station within the sample reach. A similar approach will be used to for crab traps or other gear targeting either Group 1A Fish or Group 1(A/B) Invertebrates. This cycling of traps will be continued while the field sampling event is in progress. If all stations within a reach have been sampled, then the initial set of stations will be reset.

For active sampling and other passive gear aside from minnow or crab traps (e.g., gill nets), four days of sampling will be performed in Reaches 1, 2, and 3, while two days of sampling will be performed in Reach 4. The sampling crew will complete the circuit of the four reaches in this manner. If some stations still lack the full complement of samples for a Prey Group, then a field contingency strategy will be implemented, as described in Section 7.2.

Table 5-1
Definition of Fishing Effort for Various Gears

Gear Type	Prey Groups Targeted	Definition of One Unit of Fishing Effort at Each Sampling Location
Benthic trawl	Invertebrates Fish Groups 1 & 2	10 minutes
Otter trawl	Invertebrates Fish Group 1 &2	10 minutes
Gillnet (various sizes may be used)	All Fish Groups	One gillnet (5 hour set)
Crab trap	Invertebrates	One trap (24 hour set)
Clam rake	Invertebrates	30 minutes
Minnow trap	Fish Groups 1 and 2	One trap (24 hour set)
Cast net	Fish Group 1 and 2	Three casts
Beach seine	Fish Group 1 & 2	Two beach seine sets
Hook and line	Fish Groups 1 &2	30 minutes
Dip nets	Invertebrates	30 minutes
Electroshocking	All Fish Groups	20 minutes

Because the results of this study will ultimately be used to relate tissue and sediment concentrations, location and timing information for sampling is important. Foraging ranges for various Prey Groups are expected to differ; therefore, in order to ensure that discrete locations are being sampled, a sampling area will be specified for each Prey Group in order for sampling efforts targeting those Prey Groups to be considered the same "location" (Table 5-2) for the purposes of compositing samples if necessary to meet analytical tissue volume requirements. For Group 1A Fish and Group 1(A/B) Invertebrates, samples should be collected within 30 meters of each other. For Group 2(A/B) Fish and Group 2A Invertebrates, samples should be collected within 300 meters of each other. Organisms within a Prey Group collected outside of these limits will not be combined across samples.

Table 5-2
Sample Distance Limits

Prey Class	Maximum Sample Distance for a Location (m)
Fish	
1A	30
2 (A,B)	300
3 (A,B)	300
Invertebrates	
1 (A,B,C)	30
2A	300

5.1.3 Equipment Decontamination

To prevent sample cross-contamination, the field collection team will keep sampling gear clean. Utensils used for handling or processing organisms will be composed of inert materials such as high-quality stainless steel or polycarbonate. Parts of these utensils and other handling and processing equipment (e.g., measuring boards, scale plates), which will touch tissue will be decontaminated prior to and between sample collection activities at each new location using the following steps:

- Rinse with Site water and wash with a scrub brush
- Wash with phosphate-free detergent and tap water

- Rinse with Site water
- Rinse with distilled water
- Wrap in clean aluminum foil, if practical

5.1.4 Organism Inspection and Processing

Collected organisms will be kept in live wells on a boat or in clean buckets supplied with Site water prior to processing. For safety reasons, live blue crabs may be inactivated before processing by wrapping in aluminum foil and placing temporarily on ice. Once inactive, the crabs will then be measured and processed. Organisms collected will be identified at least to the lowest practicable taxonomic level necessary to classify them to a Prey Group.

The following steps as recommended by the U.S. Environmental Protection Agency (USEPA 2000) will be taken to process the organisms (with the exception of Group 1A Invertebrates; see below for explanation) for shipping to the lab:

1. Whole organisms will be euthanized by packing in ice, and then will be rinsed with distilled water in order to remove any debris.
2. Each organism will be inspected for acceptability. Any specimens that show any severe skin, shell, or carapace lacerations or fin deterioration due to sampling gear will not be used for chemical analysis.
3. Each organism within a target species will be measured to determine total body length to the nearest millimeter and weighed to the nearest 0.1 gram. Total body length is measured from the anterior-most part of the fish or invertebrate (i.e., front of jaw for fish) to the tip of the longest caudal fin ray for fish (USEPA 2000) or tip of the posterior-most part of the invertebrate. For crabs, carapace width will be measured. For small species such as killifish that require many individuals per sample, a subset of 10 individuals from the sample will be weighed and measured, and that information will be applied to the remainder of the organisms from that effort. This information will be recorded on the field data sheet (Appendix C).
4. Organisms will be composited according to the criteria in the following section, Section 5.1.5, wrapped in aluminum foil, and placed in zip-sealed plastic bags with an identification label, which will contain all relevant sample information. Bags will

be stored in coolers supplied with dry ice while sampling and subsequently frozen (- 4° C) when back at shore.

5.1.4.1 Depuration

Consistent with USEPA/USACE guidance (1998), digestive tracts of benthic invertebrates and bivalves will be emptied prior to homogenization and analysis. Sediment in the digestive tracts of these organisms can be high relative to body size (i.e., more than 10 percent of total mass) and may include contaminants in forms which are not biologically available, but which may incorrectly identified as such during chemical analysis.

These organisms will be allowed to void the material in their digestive tracts by holding them for 24 hours in filtered (0.45 um) Site surface water. No sediment will be included in the containers and temperature conditions will be maintained at field collection conditions. During the holding period, voided material will be periodically removed (i.e., siphoned) from the holding containers.

5.1.4.2 Shelling Group 1A Invertebrates

Bivalves with shells widths exceeding 2 cm will generally be dissected prior to analysis. Shells will be removed and only the soft tissues will be analyzed. Shells are not included in the analysis as their weight and low levels of contaminants would give artificially low indication of exposure and bioaccumulation. Removal of shells for bivalves less than 2 cm is not considered practical and will not be performed. These organisms will be analyzed on a whole body basis.

5.1.5 Compositing

Composite samples are homogeneous mixtures of samples from two or more individual organisms of the same species collected at a particular location and analyzed as a single sample. The objectives of the sample design include characterizing the range of tissue concentrations at the Site. Thus, compositing will be limited to the minimum number of organisms to obtain sufficient sample volume to meet the analytical reporting limits presented in Section 3.6.4.

Organisms used in a composite sample will follow the following criteria:

- Must all be of the same species for fish and genus for invertebrates.
- Must be from the same location. Depending on the Prey Group, samples may be considered from the same location if they meet the proximity requirements listed in Table 5-2. These proximity requirements are based on best professional judgment considering the size and foraging behavior of species within each Prey Group.
- Should be within the same Prey Group size range limits presented in Table 3-1.
- Should be collected at the same time (i.e., collected as close to the same time as possible but no more than 2 weeks apart). (Note: This assumes that a sampling crew was unable to collect all fish needed to prepare a composite sample of sufficient sample mass on the same day. If organisms used in the same composite are collected on different days, they will be frozen until all the organisms to be included in the composite are delivered to the laboratory. At that time, the composite homogenate sample may be prepared.)
- Should include sufficient numbers of individuals to meet the sample tissue volume requirements for analysis of recommended target analytes. For fish, effort will be made to use the same number of individuals in all composites.
- No compositing will occur across stations[3] Invertebrates, sample Reaches[4], or species unless specifically discussed with and approved by the USEPA Project Manager.

5.1.6 Sample Archiving

Any samples to be archived will be frozen (less than -20 °C) either in the field or in the lab until analysis is required. Analytical sample holding times are summarized in Table 4-1.

5.2 Sample Identification

Each tissue sample will be assigned a unique alphanumeric identifier using the format described below.

- Each location will be identified by "PB," to depict the project location (Patrick Bayou), and a number 01 through 04, identifying the reach (e.g., PB01 for upper

3 Applies to Group 1 Fish and Group 1 Invertebrates
4 Applies to Group 2 Fish and Invertebrates

bayou).

- Individual organisms to comprise each sample will be identified by the same alphanumeric identifier used to identify the location followed by a three digit species identifier (e.g., "GKF" for gulf killifish). Appendix D provides species identification codes for various species to be collected.
- Individual organisms that comprise one sample may be frozen together in one package or frozen individually. Identifiers for each package will be numbered identified using the following approach:

PB##-X##[A/B]-XXX-###X-YYMMDD

Where:

PB##	=	Patrick Bayou Sample Reach (## = 01, 02, 03, 04)
X	=	I or F (Invertebrate or Fish, respectively)
##	=	Prey Group (01, 02)
[A/B]	=	Trophic level/size class code
XXX	=	Species code (Appendix D)
###	=	Sequential sample number (001, 002, 003,…,999)
YYMMDD	=	Year, month, day sample is collected

5.3 Sample Handling and Custody Requirements

5.3.1 Sample Handling, Preservation, Transportation, and Storage

5.3.1.1 Sample Packaging

As described above, labeled samples will be packaged in aluminum foil and plastic zip-sealed bags. Samples will be kept frozen on dry ice before shipping to the laboratory.

5.3.1.2 Shipping

Samples will be delivered frozen in ice-filled coolers to the laboratories via next day priority shipping.

5.3.2 Chain-of-Custody

Chain-of-custody procedures provided in the Patrick Bayou RI Work Plan QAPP (Anchor 2007a) will be followed for all samples throughout the field and laboratory process.

5.4 Field Instrument Calibration

Field instruments will be calibrated as discussed in the Patrick Bayou RI Work Plan QAPP (Anchor 2007a). In addition, the field crew will confirm proper operation of the boat and GPS navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. The only other field equipment that requires testing or calibration includes the scales used to weigh each individual organism. Scales used for weighing organisms will be calibrated according to the manufacturer's directions at the beginning of each sampling day. The scales will also be tested prior to weighing samples. The scale testing will consist of measuring an object of known weight that is within the range of expected organism weights for each sampling station. If the scale measures high or low by 5 percent or greater, the scale will be re-calibrated prior to weighing.

6 DATA ACQUISITION

Data from tissue collection will be managed in the field and in the laboratory, as described below.

6.1 Field Documentation

6.1.1 Field Logbooks

As described in the Patrick Bayou RI Work Plan QAPP (Anchor 2007a), a field logbook will be kept in order to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. All on-site activities will be documented in the Site log book, and any deviations from this SAP will be noted.

6.1.2 Field Forms

In addition to maintaining a field log book, fish tissue specimen forms will be completed for each sample. In addition to standard entries (i.e., station coordinates, date and time of collection, etc.), the collection form includes information regarding identification, total fish length in millimeters (mm), total weight (grams), and any morphological anomalies.

6.1.3 Photographs

Photographs will be taken as necessary during sampling in order to document activities.

6.2 Laboratory Documentation

Laboratory documentation will follow the procedures described in the Patrick Bayou RI Work Plan QAPP (Anchor 2007a), and will include logbooks, project files, and electronic data. Laboratory deliverables may include these elements and others used to track tissue analyses.

6.3 Data Reporting

All data reporting packages will be consistent with the requirements and procedures used for data validation and data assessment as described in the Patrick Bayou RI Work Plan QAPP

(Anchor 2007a), and all data report formats will be consistent with the content and format of the USEPA CLP Program.

As discussed in Anchor (2007a), laboratory data reporting packages will be described in detail in a set of project instructions to the laboratory. The laboratory project instructions will be tailored to provide the specific information the laboratory requires to analyze the samples successfully and report the data back to the project, including instructions for electronic data deliverable (EDD) format and submittal instructions.

7 ASSESSMENT AND OVERSIGHT

7.1 Audits and Corrective Actions

As described in the Patrick Bayou RI Work Plan QAPP (Anchor 2007a), field and laboratory audits, reports to management, and corrective actions may take place if necessary.

7.2 Field Contingency Plan

Sample collection methodology is described in Section 5.1.2. It is possible that a sufficient number of samples from each target Prey Group will not be obtainable during the designated two weeks of field sampling. If some stations still lack the full complement of samples for a Prey Group, then a field contingency strategy will be implemented, as described below, to guide follow-up sampling efforts.

1. **Resample Incomplete Reaches and Stations**. Once the circuit of four reaches has been completed, the sampling crew will resample any stations or reaches where additional Prey Group samples are still needed. The remaining number of available sampling days will be allocated among the remaining incomplete stations and reaches, and the sampling crew will continue to collect samples at each station until the requisite numbers Prey Group samples are collected or the allotted number of sampling days has been exhausted. It is estimated that an additional one or two days will be allocated to the incomplete stations and reaches.
2. **Reduce Sample Sizes**. If the desired numbers of samples for a Prey Group cannot be achieved with additional sampling effort within a specific reach, then fewer numbers of samples will be provided to the laboratory from that reach or Prey Group. Sampling will be considered complete if 20 or more samples are obtained for Group 1A Fish, Group 1(A/B) and 2A Invertebrates and 15 or more Group 2 Fish, regardless of their location at the Site. If sufficient numbers of requisite samples for a Prey Group cannot be obtained, then fewer samples will be submitted to the laboratory. Sampling will be considered complete for a Prey Group if at least 10 samples of sufficient mass can be obtained.
3. **Combine Prey Groups or Species**. If there are still insufficient numbers of samples for a Prey Group, consideration will be given to combining species within a Prey Group to obtain the necessary tissue mass to create a composite sample.

Alternatively, combining Prey Groups (i.e., Group 1 and 2 Fish) to obtain the necessary tissue mass to may be considered. These combinations will not be made in the field. Rather, choosing such a composite scheme will be decided after the sampling event in coordination with the USEPA project manager, Anchor QEA project manager, and laboratory project manager.

7.3 Assessment of Sample Size Adequacy

The variability in the COPC concentration in the tissue data will be evaluated and compared to statistical assumptions that were originally used to estimate sample sizes and compared to risk-based decision error limits that may be developed for the BERA Work Plan. If the power of the data is low relative to these limits and assumptions (i.e., coefficient of variation is significantly higher than expected), additional samples may be necessary to increase the ability to assess exposure, characterize risk, and detect or predict changes in concentration. If these objectives cannot be met, the need for additional sampling would be discussed between the JDG, USEPA, Texas Commission on Environmental Quality (TCEQ), and trustees.

8 DATA VALIDATION AND USABILITY

Data validation will follow the USEPA Laboratory Data Validation Functional Guidelines (USEPA 1999 and 2004). The data validation process and data management are described in the Patrick Bayou QAPP and project Data Management Plan (Anchor 2007a).

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FIGURES

\\orcas\gis\Jobs\040284-Patrick_Bayou\Maps\2010_04\Tissue Sample Locations.mxd ckiblinger 06/03/2010 5:42 PM

ANCHOR QEA

Target locations are co-located with previous sediment sampling locations performed as part of the sediment COPC delineation sampling in Fall of 2009.

Feet
0 550 1,100

Figure 3-1
Sampling Reaches and Tissue Collection Locations
Fish and Invertebrate Tissue Sampling and Analysis Plan
Patrick Bayou Superfund Site

APPENDIX A
LIST OF TARGET SPECIES FOR PREY GROUPS

List of Target Species for Prey Groups

FISH			INVERTEBRATES		
Group 1A	**Group 2A**	**Group 2B**	**Group 1A**	**Group 1B**	**Group 2A**
Fundulidae	**Clupeidae**	**Sciaenidae**	**Mactridae**	**Ocypodidae**	**Penaeidae**
Gulf killifish (*Fundulus grandis)* ***piscivorous***	Gulf Menhaden (*Brevortia patronus)*	Atlantic croaker (*Micropogonias Undulates)*	*Rangia cuneata*	Fiddler crab (*Uca* sp.)	Brown shrimp (*Penaeus aztecus)*
Plains killifish (*Fundulus zebrinus*)	Threadfin shad (*Dorosoma petenese)*	**Clupeidae**		**Portunidae**	White shrimp (*Penaeus setiferus)*
Longnose killifish (*Fundulus similis)*	Gizzard shad (*Dorosoma cepedianum)*	Skipjack herring (*Alosa chrysochloris)*		Juvenile blue crab (*Calinectes Sapidus)*	Seabob (*Xiphopenaeus kroyeri)*
Pygmy killifish (*Leptolucania ommata*)	**Engraulidae**	**Paralichthyidae**		**Palaemonidae**	**Sergestidae**
Bayou killifish (*Fundulus pulverous*)	Bay Anchovy (*Anchoa mitchilli)*	Smallmouth flounder (*Etropus microstomus*)		Grass shrimp (*Palaemonetes pugio)*	Sergestid shrimp (*Acetes americanus)*
Diamond killifish (*Adinia xenica*)	**Atherinopsidae**			**Xanthidae**	
Mummichog (*Fundulus heteroclitus*)	Inland silverside (*Menidia beryllina)*			Mud crabs	
Cyprinodontidae	Brook silverside (*Labidesthes sicculus)*				

FISH			INVERTEBRATES		
Group 1A	**Group 2A**	**Group 2B**	**Group 1A**	**Group 1B**	**Group 2A**
Sheepshead minnow (*Cyprinodon variegates)*	Rough silverside *(Membras martinica*)				
Poecillidae	**Sciaenidae**				
Least killifish (*Heterandria formosa)*	Spot (*Leiostomus xanthurus)*				
Sailfin molly (*Poecilia latipinna)*	**Fundulidae**				
Blenneiidae	Rainwater killifish (*Lucania parva*)				
Freckled blenny (*Hypsoblennius ionthas*)	**Cynoglossidae**				
Crested blenny (*Hypleurochilus geminates)*	Longtail tonguefish (*Symphurus pelicanus*)				
Seaweed blenny (*Parablennius marmoreus*)					
Florida blenny (*Chasmodes saburrae)*					
Feather blenny					

FISH			INVERTEBRATES		
Group 1A	**Group 2A**	**Group 2B**	**Group 1A**	**Group 1B**	**Group 2A**
(*Hypsoblennius hentz)*					
<u>Gobiidae</u>					
Marked goby (*Ctenogobius stigmaticus)*					
Spottail goby *(Ctenogobius stigmaturus)*					
Ragged goby (*Bollmannia communis)*					
Code goby (*Gobiosoma robustum)*					
Naked goby (*Gobiosoma bosc*)					
Clown goby (*Micorgobius gulosus*)					
Darter goby (*Ctenogobius boleosoma*)					
Green goby (*Microgobius thalassinus)*					
American freshwater goby					

FISH			INVERTEBRATES		
Group 1A	**Group 2A**	**Group 2B**	**Group 1A**	**Group 1B**	**Group 2A**
(*Ctenogobius shufeldti*)					
Centrarchidae					
Spotted sunfish (*Lepomis punctatus*) (20 cm)					
Orangespotted sunfish (*Lepomis humilis*)					
Dollar sunfish (*Lepomis marginatus)*					
Elassomatidae					
Banded pygmy sunfish (*Elassoma zonatum*)					

Notes:
This table is not exhaustive; other species may be collected depending on occurrence and abundance during sampling
a - Although most of these species in this group are migratory, these species particular species are sedentary and likely reflect localized exposure to COPCs
Sources: MESL (2002); Sieler et al. 1991

APPENDIX B
RANDOMLY SELECTED AND RANKED SAMPLE LOCATIONS

Randomly Selected and Ranked Sample Locations

Reach	Sample Locations	Random Number Assignment	Northing (X)	Easting (Y)
1	PB025.3	22	3201089.67156000000	13835122.83770000000
1	PB-023.2	35	3201076.83210000000	13835412.53560000000
1	PB-021.2	25	3201022.95139000000	13835531.41900000000
1	PB-017	28	3201093.90982000000	13835983.80970000000
1	PB-016.1	9	3201099.60226000000	13836147.99610000000
1	PB-027	30	3201283.96767000000	13834979.22790000000
1	PB-025.5	27	3201194.35269000000	13835191.29950000000
1	PB-023.1	6	3201219.10999000000	13835439.25240000000
1	PB-016.1	21	3201190.23389000000	13835669.71200000000
1	PB-018	12	3201216.22251000000	13835829.88090000000
1	PB016.2	16	3201295.93030000000	13835954.89330000000
1	PB-015	33	3201282.41736000000	13836115.20750000000
1	PB-028	1	3201367.18169000000	13835084.70180000000
1	PB-025.1	2	3201360.02491000000	13835256.19970000000
1	PB-024	4	3201336.01525000000	13835388.60530000000
1	PB-021.1	24	3201302.00092000000	13835596.71070000000
1	PB-019	26	3201302.64655000000	13835726.73010000000
1	PB-014.1	7	3201434.84925000000	13836039.28150000000
1	PB-014.2	8	3201386.61224000000	13836280.21080000000
1	PB-009.1	23	3201688.97876000000	13836010.61120000000
1	PB-013	36	3201515.72880000000	13836205.48320000000
1	PB-009.2	29	3201785.24719000000	13836097.04770000000
1	PB-009.3	32	3201856.67156000000	13836239.29550000000
1	PB-008	15	3201963.92926000000	13836032.95820000000
1	PB-007.1	17	3202066.79777000000	13836192.21770000000
1	1PB-006	13	3202080.59233000000	13836345.45490000000
1	PB-007.2	34	3202195.02243000000	13836039.00970000000
1	PB-005	31	3202294.77950000000	13836181.49020000000
1	PB-004.1	20	3202289.59328000000	13836368.38680000000
1	PB-003.1	18	3202282.83085000000	13836505.92190000000
1	PB-004.2	5	3202423.87828000000	13836240.53140000000
1	PB-003.2	3	3202406.05823000000	13836443.48480000000

Reach	Sample Locations	Random Number Assignment	Northing (X)	Easting (Y)
1	PB-001	10	3202498.45973000000	13836611.77720000000
1	PB-003.3	11	3202574.58509000000	13836378.99750000000
1	PB-002	14	3202671.28559000000	13836535.37700000000
1	PB-001.2	19	3202762.35817000000	13836549.54070000000
2	PB-017	4	3201494.06624000000	13832225.42630000000
2	PB-054	7	3201438.70644000000	13832391.87700000000
2	PB-049	14	3201328.04870000000	13832682.57700000000
2	PB-075	8	3201489.69740000000	13832739.44510000000
2	PB-048.1	12	3201386.87236000000	13832913.25330000000
2	PB-045	2	3201430.12920000000	13833197.49800000000
2	PB-047.2	15	3201362.94026000000	13833364.47610000000
2	PB-040	18	3201387.22393000000	13833694.50730000000
2	PB-038	21	3201365.13558000000	13833884.78970000000
2	PB-036	5	3201441.49434000000	13834072.74580000000
2	PB-034	19	3201407.77905000000	13834290.37860000000
2	PB-033	9	3201350.63531000000	13834410.74820000000
2	PB-031	1	3201379.64853000000	13834588.15090000000
2	PB-029	6	3201373.82040000000	13834840.96500000000
2	PB-052	16	3201517.13524000000	13832541.54780000000
2	PB-048.2	10	3201545.94558000000	13832866.20000000000
2	PB-047	13	3201515.28784000000	13833024.60120000000
2	PB-049	17	3201657.58103000000	13833259.27220000000
2	PB047.1	20	3201541.70052000000	13833394.87760000000
2	PB-045	3	3201500.91052000000	13833517.97310000000
2	PB-046	11	3201731.21137000000	13833076.37710000000
3	PB-070	7	3201181.28922000000	13830891.13790000000
3	PB-067	6	3201280.72332000000	13831091.31440000000
3	PB-066	10	3201379.65654000000	13831237.25190000000
3	PB-065	5	3201487.69774000000	13831320.43680000000
3	PB-062.2	3	3201465.43687000000	13831655.04370000000
3	PB-058	11	3201473.92151000000	13831891.30600000000
3	PB-064	4	3201651.44411000000	13831298.09080000000
3	PB-063	12	3201518.87456000000	13831474.73240000000

Reach	Sample Locations	Random Number Assignment	Northing (X)	Easting (Y)
3	PB-062.1	2	3201632.10539000000	13831681.57070000000
3	PB-059	1	3201594.06320000000	13831845.45560000000
3	PB-057	9	3201581.69597000000	13832089.22230000000
3	PB-075	8	3200873.05642000000	13830523.92380000000
4	PB-081	3	3200769.31404000000	13829967.48730000000
4	PB-87	4	3200830.54244000000	13829493.61020000000
4	PB-093	1	3200957.93656000000	13828967.78800000000
4	PB-098	5	3201193.71471000000	13828383.05820000000
4	PB-089	2	3200962.47301000000	13829289.22920000000

Note:
Coordinate System is NAD 1983 State Plane Texas South Central, U.S. feet.

APPENDIX C
FIELD DATA SHEETS

2010 Patrick Bayou Fish-Invertebrate Tissue Collection

Run Sheet

Station: _____ Consecutive Fishing Run No.: _____ Date: _____

Gear Type(s): _____ Bank (as looking upstream): R L

Location description: _____

Weather: _____ Collector(s):_____

GPS Location: Start_____°_____._____ End_____°_____._____
_____°_____._____ _____°_____._____

Time (24hr): Start _____ End _____
Date_____ Date_____

Appx Water Depth

Minimum: _____ Maximum: _____ Mean: _____

Substrate
(silt, sand, gravel, rip rap, organic detritus, etc.)

_____

Habitat Description and Nearby Landmarks
(vegetation, over-water structures, channel features, hydrology, etc.)

_____

_____

Total Catch (including throwbacks)

_____

_____

_____

Notes:_____

_____

Signature _____

Printed Name _____

LGP-01 FISH TALLY

FISH GROUP 1

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

FISH GROUP 2

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

FISH GROUP 3

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

FISH GROUP 4

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

INVERT GROUP 1

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

INVERT GROUP 2

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

INVERT GROUP 3

SPECIES	REACH	TALLY

LGP-01 FISH TALLY

INVERT GROUP 4

SPECIES	REACH	TALLY

2010 Patrick Bayou Fish-Invert Tissue Collection Weights/Measures Data Sheet

Station: _____ Fishing Run #: _____ Date: _____ Initials_____ Page ___ of ___

Species	Length (0.1 in)	Weight		Notes
		Value	Unit	

APPENDIX D
SPECIES CODE LIST

Species Code List

Species Code	Species Name	Scientific Name	Family
ABP	Atlantic bumper	*Chloroscombrus chrysurus*	Carangidae
ACF	Atlantic cutlassfish	*Trichiurus lepturus*	Trichiuridae
AEL	American eel	*Anguilla rostrata*	Anguillidae
AFG	American freshwater goby	*Ctenogobius shufeldti*	Gobiidae
ALG	Alligator gar	*Lepisosteus spatula*	Lepisosteidae
AMS	Atlantic midshipman	*Porichthys porosissimus*	Batrachoididae
ANC	Anchovy	*Anchoa spp.*	Engraulidae
AND	Atlantic needlefish	*Strongylura marina*	Belonidae
ASP	Atlantic spadefish	*Chaetodipterus faber*	Ephippidae
BAN	Bay anchovy	*Anchoa mitchilli*	Engraulidae
BCP	Black crappie	*Pomoxis nigromaculatus*	Centrarchidae
BCR	Blue crab	*Callinectes sapidus*	Portunidae
BCT	Blue catfish	*Ictalurus furcatus*	Ictaluridae
BDR	Black drum	*Pogonias cromis*	Sciaenidae
BEN	Benthic invertebrates (< 2 cm)	NA	NA
BFN	Bowfin	*Amia calva*	Amiidae
BHM	Bullhead minnow	*Pimephales vigilax*	Cyprinidae
BKB	Black bullhead	*Ameiurus melas*	Ictaluridae
BKF	Bayou killifish	*Fundulus pulvereus*	Cyprinodontidae
BKS	Brook silverside	*Labidesthes sicculus*	Atherinopsidae
BLF	Bluefish	*Pomatomus saltatrix*	Pomatomidae
BLG	Blue gill	*Lepomis macrochirus*	Lepomis
BLY	Blenny	*NA*	Blennidae
BNB	Brown bullhead	*Ameiurus nebulosus*	Ictaluridae
BPS	Banded pygmy sunfish	*Elassoma zonatum*	Elassomatidae
BRS	Brown shrimp	*Penaeus aztecus*	Penaeidae
BST	Blackstripe topminnow	*Fundulus notatus*	Fundulidae
BWF	Bay whiff	*Citarichthys spilopterus*	Paralichthyidae
CCT	Channel catfish	*Ictalurus punctatus*	Ictaluridae
CDG	Code goby	*Gobiosoma robustum*	Gobiidae
CNG	Clown goby	*Microgobius gulosus*	Gobiidae
CRB	Crab (unknown)	NA	NA
CRK	Atlantic croaker	*Micropogon undulatus*	Sciaenidae

Species Code	Species Name	Scientific Name	Family
CRP	Carp	*Cyprinus carpio*	Cyprinidae
CSB	Crested blenny	*Hypleurochilus geminates*	Blennidae
CTL	Cuttlefish	NA	NA
CTN	Ctenophores	NA	NA
DKF	Diamond killifish	*Adinia xenica*	Fundulidae
DRS	Dollar sunfish	*Lepomis marginatus*	Centrarchidae
FCB	Freckled blenny	*Hypsoblennius ionthas*	Blennidae
FDC	Fiddler crab	*Uca sp.*	Ocypodidae
FDR	Freshwater drum	*Aplodinotus grunniens*	Sciaenidae
FLB	Florida blenny	*Chasmodes saburrae*	Blennidae
FLF	Flatfish	NA	Bothidae
FTB	Feather blenny	*Hypsoblennius hentz*	Blennidae
GAR	Gar (unknown)	*Lepisosteus spp.*	Lepisosteidae
GBA	Sharptail goby	*Gobionellus hastatus*	Gobiidae
GBB	Naked goby	*Gobiosamna bosci*	Gobiidae
GBC	Darter goby	*Gobionellus boleosoma*	Gobiidae
GBY	Goby (unknown)	NA	Gobiidae
GCT	Gafftopsail catfish	*Bagre marinus*	Ariidae
GKF	Gulf killifish	*Fundulus grandis*	Cyprinodontidae
GM	Gulf menhaden	*Brevoortia patronus*	Clupeidae
GNG	Green goby	*Microgobius thalassinus*	Gobiidae
GNS	Green sunfish	*Lepomis cyanellus*	Centrarchidae
GRM	Ohio river shrimp	*Macrobrachium ohione*	Palaemonidae
GRP	Shore shrimp	*Palaemonetes pugio*	Palaemonidae
GRS	Grass shrimp (unknown)	NA	
GS	Gizzard shad	*Dorosoma cepedianum*	Clupeidae
GSH	Golden shiner	*Notemigonus crysoleucas*	Cyprinidae
GWF	Gray weakfish	*Cynoscion regalis*	Sciaenidae
HHC	Hardhead catfish	*Ariopsis felis*	Ariidae
HOG	Hog choker	*Trinectes maculatus*	Bothidae
ILS	Inland silverside	*Menidia beryllina*	Atherinopsidae
KLF	Killifish (unknown)	NA	Cyprinodontidae
LDY	Ladyfish	*Elops saurus*	Elopidae
LGP	Log perch	*Percina caprodes*	Percidae
LJK	Leatherjacket	*Oligoplites saurus*	Carangidae

Species Code	Species Name	Scientific Name	Family
LKD	Lookdown	*Selene vomer*	Carangidae
LKF	Least killifish	*Heterandria formosa*	Poecillidae
LMB	Largemouth bass	*Micropterus salmoides*	Centrarchidae
LNG	Longnose gar	*Lepisosteus osseus*	Lepisosteidae
LNK	Longnose killifish	*Fundulus similis*	Fundulidae
LNS	Lined sole	*Achirus lineatus*	Bothidae
LSF	Longear sunfish	*Lepomis megalotis*	Lepomis
LTT	Longtail tonguefish	*Symphurus pelicanus*	Cynoglossidae
LZF	Inshore lizardfish	*Synodus foetens*	Synodontidae
MCG	Mummichog	*Fundulus heteroclitus*	Fundulidae
MCR	Mud crab	*Rhitropaneopus harrisci*	Xanthidae
MDG	Marked goby	*Ctenogobius stigmaticus*	Gobiidae
MDS	Mud sunfish	*Acantharchus pomotis*	Centrarchidae
MLT	Mullet (unknown)	NA	Mugilidae
MMJ	Mottled mojarra	*Ulaema lefroyi*	Gerridae
MNS	Mantis shrimp	*Squilla empusa*	Squillidae
MNW	Minnow (unknown)	NA	Cyprinidae
MSF	Mosquito fish	*Gambosia affinis*	Poeciliidae
OSS	Orangespotted sunfish	*Lepomis humilis*	Centrarchidae
OTF	Oyster toadfish	*Opsanus tau*	Batrachoididae
OYS	Oyster	*Crassostrea virginica*	Ostreidae
PFR	Southern puffer	*Sphoeroides nephelus*	Tetraodontidae
PKF	Plains killifish	*Fundulus zebrinus*	Fundulidae
PNF	Pinfish	*Lagodon rhomboides*	Sparidae
PSD	Pumpkinseed	*Lepomis gibbosus*	Centrarchidae
PYK	Pygmy killifish	*Leptolucania ommata*	Fundulidae
RDG	Ragged goby	*Bollmannia communis*	Gobiidae
RDR	Red drum	*Sciaenops ocellatus*	Sciaenidae
RGS	Rough silverside	*Membras martinica*	Atherinopsidae
RNG	Rangia	*Rangia cuneata*	Mactridae
RSF	Redear sunfish	*Lepomis microlophus*	Lepomis
RWK	Rainwater killifish	*Lucania parva*	Fundulidae
SAN	Striped anchovy	*Anchoa hepsetus*	Engraulidae
SAS	Sand seatrout	*Cynoscion arenarius*	Sciaenidae
SBS	Seabob shrimp	*Xiphopenaeus kroyeri*	Penaeidae

Species Code	Species Name	Scientific Name	Family
SCS	Spiny cheek sleeper	*Eleotris pisonis*	Gobiidae
SCT	Sea catfish	*Arius felis*	Ariidae
SDM	Star drum	*Stellifer lanceolatus*	Sciaenidae
SDS	Spotted sunfish	*Lepomis punctatus*	Centrarchidae
SFL	Shoal flounder	*Syacium gunteri*	Paralichthyidae
SFM	Sailfin molly	*Poecilia latipinna*	Porciliidae
SH	Shad (unknown)	NA	Clupeidae
SHD	Sheepshead	*Archsargus probatocephalus*	Sparidae
SHM	Sheepshead minnow	*Cyprinodon variegatus*	Cyprinodontidae
SHR	Shrimp (unknown)	*Penaeus spp.*	Penaeidae
SKJ	Skipjack herring	*Alosa chrysochloris*	Clupeidae
SKR	Sucker (unknown)	NA	Catastomidae
SLG	Spottail goby	*Ctenogobius stigmaturus*	Gobiidae
SLM	Silvery minnow	*Hybognathus nuchalis*	Cyprinidae
SLP	Silver perch	*Bairdiella chrysoura*	Sciaenidae
SMF	Smallmouth flounder	*Etropus microstomus*	Paralichthyidae
SNA	Sunfish sp. A	*Lepomis spp.*	Centrarchidae
SNF	Sunfish sp. B	*Lepomis spp.*	Centrarchidae
SNS	Snapping shrimp	*Alpheus spp.*	Alpheidae
SPB	Spotted bass	*Micropterus punctulatus*	Centrarchidae
SPD	Spadefish	*Chaetodipterus faber*	Ephippidae
SPG	Spotted gar	*Lepisosteus oculatus*	Lepisosteidae
SPM	Spanish mackerel	*Scomberomorus maculatus*	Scomberidae
SPS	Spotted seatrout	*Cynoscion nebulosus*	Sciaenidae
SPT	Spot	*Leiostomus xanthurus*	Sciaenidae
SQD	Squid	NA	NA
SRB	Searobin	*Prionotus spp.*	Triglidae
SRF	Summer flounder	*Paralichthys dentatus*	Paralichthyidae
SRS	Silver seatrout	*Cynoscion nothos*	Sciaenidae
SSK	Spotted sucker	*Minytrema melanops*	Catastomidae
SST	Softshell turtle	*Trionyx spp.*	Trionychidae
STB	Striped bass	*Morone saxatilis*	Percichthyidae
STF	Southern flounder	*Paralichthys lethostigma*	Bothidae
STM	Striped mullet	*Mugil cephalus*	Mugilidae
STO	Stomatopoda	*Squilla empusa*	Squillidae

Species Code	Species Name	Scientific Name	Family
SWB	Seaweed blenny	*Parablennius marmoreus*	Blennidae
TFS	Threadfin shad	*Dorosoma petenense*	Clupeidae
TGF	Blackcheek tonguefish	*Symphurus plagiusa*	Cynoglossidae
THR	Atlantic thread herring	*Opisthonema oglinum*	Clupeidae
TRT	Trout	*Cynoscion spp.*	Sciaenidae
TSS	Tidewater silverside	*Menidia beryllina*	Atherinidae
TUN	Tunicate	NA	NA
UND	Unidentified	NA	NA
VTG	Violet goby	*Gobioides broussonnetii*	Gobiidae
WHC	White crappie	*Pomoxis annularis*	Centrarchidae
WHS	White shrimp	*Penaeus setiferus*	Penaeidae
WSK	White sucker	*Catastomus commersoni*	Catastomidae
WTM	White mullet	*Mugil curema*	Mugilidae
YBH	Yellow bullhead	*Ameirus natalis*	Ictaluridae
YLB	Yellow bass	*Morone mississippiensis*	Percichthyidae