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IDENTIFICATION OF TOXIC SITES IN HAMILTON HARBOUR

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NWRI Contribution No. 06-408

NATIONAL WATER RESEARCH INSTITUTE
INSTITUT NATIONAL DE RECHERCHE SUR LES EAUX

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ABSTRACT

In 2000, the National Water Research Institute sampled sites in Hamilton Harbour in order to provide an overall assessment of sediment degradation based on biological sediment guidelines according to the BEAST (Benthic Assessment of Sediment) methodology. Results indicated that for the benthic community structure component of this study, a large number of test sites were not well matched to Great Lakes reference sites based on natural habitat attributes. Additionally, there was the lack of correlation of sediment toxicity to any specific contaminant, making it difficult to set clean up criteria based on sediment contaminant concentrations alone. It was concluded that the hazardous sediments should be identified by laboratory sediment toxicity tests, specifically the mayfly (*Hexagenia* spp.), and amphipod (*Hyalella azteca*) tests, as these two organisms were found to be most strongly correlated to overall toxicity. In November 2002, 100 sites were sampled in the Harbour with emphasis placed on the Randle Reef area (80 sites) and Windermere Arm (20 sites). Toxic sites were identified using BEAST methodology, which involves the use of multivariate techniques using data on the physical and chemical attributes of the sediment and overlying water, and the functional responses of benthic invertebrates in laboratory toxicity tests. Data from test sites were compared to biological criteria developed for the Laurentian Great Lakes.

Total polycyclic aromatic hydrocarbon (PAH) and polychlorinated biphenyl (PCB) concentrations in surficial sediment range from 1 to 9048 μg/g and from below detection (20 sites) to 1.4 μg/g, respectively. The highest PAHs are noted in the Randle Reef area (along the Stelco wall) and the highest PCB concentration is in the Windermere Arm (Strathearne slip). Several metals are elevated above the Severe Effect Level in both areas of the Harbour, including manganese, zinc, iron, lead, copper, and chromium.

Thirty-one sites in the Randle Reef area and 12 sites in Windermere Arm are toxic or severely toxic. There is 'potential' toxicity at 19 sites in Randle Reef area and at 5 sites in Windermere Arm. Toxicity is associated with elevated levels of NO_3/NO_2 (overlying water), phosphorus (overlying water and sediment) and one or more sediment trace metals (Cu, Cd, Fe, Hg, Pb, Zn).

The BEAST methodology does not incorporate information on organic contaminants; therefore, relationships between organic (PAHs and PCBs) as well as metal contaminant concentrations in the sediment and toxic response were evaluated using regression analysis. Physico-chemical sediment and water variables were included as additional predictors. Toxicity of Randle Reef sediment is related to a group of sediment contaminants. Several metals and PAHs compounds (Fe, Pb, Cd, Cu, fluorene and acenaphthylene) and grain size account for up to 76% of the variability in toxicity among sampling sites.

ACKNOWLEDGEMENTS

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Advice on the study design and site selection was provided by Roger Santiago (GLSF), Hans Biberhofer (National Water Research Institute, NWRI), and Cheriene Vieira (Ontario Ministry of Environment). Technical support for the field sampling was provided by Craig Logan and Sherri Thompson (NWRI) and the technical operations division of NWRI. Laboratory toxicity tests were performed by Jennifer Dow and Jennifer Webber (NWRI) and site maps were provided by Marilyn Dunnett (NWRI).

Abstract

As part of the Great Lakes Basin 2020 Action Plan, the National Water Research Institute (NWRI) sampled 43 sites in the Hamilton Harbour in 2000. The primary objective was to provide an overall assessment of sediment degradation based on biological sediment guidelines according to the BEAST (Benthic Assessment of Sediment) methodology. Results indicated that for the benthic community structure component of this study, a large number of test sites were not well matched to Great Lakes reference sites based on natural habitat attributes. Additionally, there was the lack of correlation of sediment toxicity to any specific contaminant, making it difficult to set clean up criteria based on sediment contaminant concentrations alone. It was therefore concluded that future sediment assessment work related to remedial efforts focus on toxicity tests, specifically the *Hexagenia* spp. and *Hyalella azteca* tests, as these two organisms were found to be most strongly correlated to overall toxicity. In November 2002, the BEAST methodology (toxicity component only) was applied to selected areas of Hamilton Harbour to identify toxic sediment; emphasis was placed in the Randle Reef area (80 sites) and Windermere Arm (20 sites). Thirty-one Randle Reef sites are toxic or severely toxic and 12 Windermere Arm sites are toxic or severely toxic. Toxicity is associated with elevated levels of NO_3/NO_2 (overlying water) and one or more trace metals (Cu, Cd, Fe, Hg, Pb, Zn). Further evaluation of toxicity-contaminant relationships (incorporating organic contaminant data) reveals that toxicity of Randle Reef sediment is related to a group of sediment contaminants. Several metals and PAHs compounds (Fe, Pb, Cd, Cu, fluorene and acenaphthylene) and grain size account for up to 76% of the variability in toxicity among sampling sites.

Résumé

Dans le cadre du Plan d'action du bassin des Grands Lacs 2020, l'Institut national de recherche sur les eaux (INRE) a échantillonné 43 sites dans le port de Hamilton en 2000. L'objectif principal était de fournir une évaluation globale de la dégradation des sédiments en fonction des recommandations relatives aux paramètres biologiques dans les sédiments établies par la méthode BEAST (*BEnthic Assessment of SedimenT* ou évaluation benthique des sédiments). En ce qui concerne la composante de l'étude ayant trait à la structure de la communauté benthique, les résultats indiquent que pour un grand nombre de sites d'essais nous n'avons pu établir de bonnes correspondances avec les sites de référence des Grands Lacs, en fonction des caractéristiques de l'habitat naturel. En outre, nous n'avons pu établir de corrélation suffisante entre la toxicité des sédiments et un contaminant en particulier, ce qui contrarie l'établissement de critères de nettoyage en fonction uniquement des concentrations de contaminants dans les sédiments. Nous avons donc conclu qu'à l'avenir, le travail d'évaluation des sédiments au service de l'assainissement serait centré sur les tests de toxicité, surtout ceux portant sur les espèces *Hexagenia* spp. et *Hyalella azteca*, car c'est chez elles que l'on a trouvé la plus forte corrélation avec la toxicité globale. En novembre 2002, nous avons appliqué la méthode BEAST – la composante de toxicité seulement – à des zones choisies du port de Hamilton, afin d'y identifier les sédiments toxiques; nous avons mis l'accent sur les zones du récif Randle (80 sites) et du bras Windermere (20 sites). Il ressort que 31 sites du récif Randle et 12 du bras Windermere étaient toxiques ou gravement toxiques. La toxicité est associée à des niveaux élevés de NO_3/NO_2 (eau recouvrant les sédiments) et à un ou plusieurs métaux traces (Cu, Cd, Fe, Hg, Pb, Zn). D'autres évaluations des rapports entre la toxicité et les contaminants (en intégrant des données de contaminants organiques) ont révélé que la toxicité des sédiments du récif Randle est associée à un groupe de contaminants des sédiments. Plusieurs métaux et composés HAP (Fe, Pb, Cd, Cu, fluorène et acénaphtylène) et la granulométrie expliquaient 76 % de la variabilité de la toxicité au sein des sites d'échantillonnage.

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1 INTRODUCTION

1.1 Background

As part of the Great Lakes Basin 2020 Action Plan, the National Water Research Institute (NWRI) sampled 43 sites in the Hamilton Harbour Area of Concern at the western end of Lake Ontario in fall 2000. The primary objective was to provide an overall assessment of sediment degradation based on biological sediment guidelines according to the BEAST methodology of Reynoldson et al. (1995). The assessment process utilizes organisms present in the sediment (benthic invertebrates) as these animals are the most exposed and potentially most sensitive to contaminants associated with sediment. Decision on the spatial extent and severity of contamination is based on the type and number of species present in the harbour, and the response (survival, growth and reproduction) of these animals in standard laboratory tests. Study maps were generated that defined the areas where biological effects are observed and related any observed responses to specific contaminants.

Results from the 2000 survey (Milani and Grapentine 2003) indicated that sediment from 21 sites was *toxic* or *severely toxic*. Most of these toxic sites were located in the Randle Reef and Windermere Arm areas. Examination of the relationships between organic (PAHs and total PCBs) and metal contaminant concentrations and toxic responses (including survival and growth or reproduction) showed that toxicity of Hamilton Harbour sediment was not clearly related to one contaminant or group of contaminants. Several compounds of PCBs and PAHs (and perhaps Cu) appeared jointly related the pattern of toxicity among sampling sites. Of the ten toxicity endpoints, amphipod (*Hyalella azteca)* and mayfly (*Hexagenia* spp.) survival and growth showed the strongest responses to Hamilton Harbour sediments.

The lack of correlation of sediment toxicity to any specific contaminant makes it difficult to set clean up criteria based on sediment contaminant concentrations alone. Additionally, analyses of benthic community structure revealed that many Hamilton Harbour sites were not well matched to Great Lake reference sites based on natural habitat attributes, which possibly biased the assessment of in situ biological conditions. It was therefore recommended that hazardous sediments in Hamilton Harbour be identified primarily by toxicological responses of benthic invertebrates, specifically *Hexagenia* spp. and *Hyalella azteca*, in laboratory sediment toxicity tests.

In November 2002, selected areas of Hamilton Harbour were sampled to identify the areas of toxic sediment. Emphasis was placed in the Randle Reef area and Windermere Arm. This report presents the results of these investigations and provides a spatial description of the degree of contamination and toxicity of sediments in these sections of Hamilton Harbour.

1.2 Objectives for Study

The current study will supplement NWRI's 2000 study in identifying toxic sites in the Randle Reef area (highest priority) and in the Windermere Arm. The sampling coverage in the Randle Reef area (where highest sediment contamination was found) in the 2000 study was minimal; therefore, additional sampling locations were needed to adequately define specific areas of toxicity. Sites that are identified as most severe with respect to toxicity and contaminant levels will be considered for containment in or removal to an Engineered Containment Facility (ECF). The optimum sizing for the ECF will primarily consider the volume of toxic sediment from the Randle Reef area.

Toxic sites will be identified by the BEAST methodology using two toxicity tests: *H. azteca* 28-day survival and growth test and *Hexagenia* spp. 21-day survival and growth test. The severity of the toxicity response (non-toxic vs. potentially toxic vs. toxic vs. severely toxic) will provide the information to prioritize which sites within the areas should be considered for remediation. Chemical and physical characteristics of the sediments will be examined to aid site prioritization, which may be necessary if the volume of sediment identified for remediation by toxicity alone exceeds what the ECF can accommodate. Maps will be generated indicating priority sites within each area.

2 METHODS

2.1 Sample Collection and Handling

Sediment was collected from 100 sites in Hamilton Harbour 12-21 November 2002. Site co-ordinates were obtained using a differentially corrected global positioning (RTK20) receiver. Corrections were received from a reference station, located on top of the Canada Centre for Inland Waters building on the eastern shore of the harbour, that was previously calculated (to within centimetres) by the Canadian Hydrographic Service. This provided survey accuracy within 20 cm. Station co-ordinates and site depth are given in Tables 1a and 1b and site locations in Randle Reef and Windermere Arm are shown in Figures 1 and 2, respectively.

Prior to sediment collections, site depth was recorded using a depth sounder and temperature, conductivity, pH and dissolved oxygen were measured in the water column approximately 0.5 m above the bottom using Hydrolab apparatus. Water samples were then collected (for alkalinity and nutrients) from 0.5 m above the bottom using a van Dorn sampler. Total phosphorus samples (125 mL) were preserved with 1 mL of 30% sulphuric acid. Water samples were stored at 4°C for later analysis.

Sediment samples were collected for chemical and physical analysis of the sediment and for laboratory sediment toxicity tests. Details on sampling techniques and methods for the collection of all samples is described in Reynoldson et al. (1995, 1998a). Environmental variables measured at each site are listed in Table 2.

A mini-Ponar sampler was used to collect the top 10 cm of sediment (five grabs per site). At each site, a representative sample (200-300 mL) of each mini-Ponar was removed and set aside in a glass tray. The remaining sediment was placed in a plastic bag, sealed, and placed in a bucket. The sediment set aside in the glass tray was homogenized and distributed to containers for individual analyses. All samples were kept in coolers and stored at 4°C in the laboratory.

Ten sites were randomly selected as QA/QC stations. At these stations, duplicate samples of overlying water and sediment were taken and analyzed for the chemical and physical properties listed in Table 2.

2.2 Sediment Toxicity Tests

Two sediment toxicity tests were performed in pre-sieved (250-µm mesh) sediment: *Hyalella azteca* 28-d survival and growth, and *Hexagenia spp.* 21-d survival and growth. Sediment sieving and handling procedures and toxicity test methods are described elsewhere (Borgmann and Munawar 1989; Borgmann et al. 1989; Krantzberg 1990; Reynoldson et al. 1998b).

Water used for testing purposes was the City of Burlington tap water (Lake Ontario). Prior to use, the water was charcoal filtered and aerated for a minimum of three days. Water characteristics included: conductivity 273 – 347µS/cm; pH 7.5 - 8.5; hardness 120 - 140 mg/L; alkalinity 75 - 100 mg/L; and chloride ion 22 - 27 mg/L.

Water chemistry variables (pH, dissolved oxygen (mg/L), conductivity (µS/cm), temperature (°C), and total ammonia (mg/L)) were measured in each replicate test beaker on day 0 (start of test) and at completion of the test (day 21 or day 28). Tests were run under static conditions in environmental chambers at 23°C ±1 °C, under a photoperiod of 16L: 8D and an illumination of 500 - 1000 lux.

2.2.1 *Hyalella azteca* 28-day survival and growth test

The test was conducted for 28 days using 2 -10 day old organisms. On day 28, the contents of each beaker were rinsed through a 250-µm screen and the surviving amphipods counted. Amphipods were dried at 60 °C for 24 hours and dry weights recorded. (Initial weights were considered negligible.)

2.2.2 *Hexagenia* spp. 21-day survival and growth test

The test was conducted for 21 days using pre-weighed nymphs (between 5 - 8 mg wet weight/nymph). On day 21, the contents of each jar were wet sieved through a 500-µm screen and surviving mayfly nymphs counted. Nymphs were dried at 60 °C for 24 hours and weighed.

Initial mayfly wet weights were converted to dry weights using the following equation: Initial dry weight = (wet weight + 1.15)/ 7.35. (The relationship of mayfly wet weight to dry weight was previously determined by regression analysis.) Growth was determined by final dry weight minus initial dry weight.

2.3 Sediment and Water Physico-Chemical Analyses

Analyses of alkalinity, total phosphorus, nitrate+nitrite-N, ammonia-N and total Kjeldahl nitrogen in water samples were performed by NWRI's National Laboratory for Environmental Testing (NLET) (Burlington, ON) by procedures outlined in Cancilla (1994) and NLET (2000). Freeze dried sediment was analysed for trace elements (acid extracted), major oxides, loss on ignition (LOI), total organic carbon (TOC), total phosphorus (TP), and total nitrogen (TN) by Caduceon Laboratories (Ottawa, ON) using standard techniques outlined by the USEPA/CA (1981) or by in-house procedures. Particle size analysis was performed by the Sedimentology Laboratory at NWRI (Burlington, ON) following the procedure of Duncan and LaHaie (1979).

Total PAHs and total PCBs analysis were performed by PSC Analytical Services (Burlington, ON). Organic analyses procedures are provided in APHA (1995). Total PCBs methods are those of USEPA SW846 - 8082 modified, PAHs those of USEPA SW846 - 8270C modified, and OCPs those of USEPA SW846 – 8081A modified.

2.4 Data Analysis

2.4.1 BEAST

Test sites were assessed using BEAST methodology (Reynoldson and Day 1998; Reynoldson et al. 2000). Toxicity data were analysed using the ordination technique hybrid multidimensional scaling (HMDS) of Belbin (1993), with Euclidean distance site × site association matrices calculated from standardized data. Principal axis correlation (Belbin 1993) was used to identify relationships between habitat attributes and toxicity responses. Significant endpoints and environmental attributes were identified using Monte-Carlo permutation tests (Manly 1991). Test sites were assessed by comparison to confidence bands of appropriate reference sites.

Test data were analysed in subsets to maintain the ratio of test:reference sites ≤0.10. Thus, with 105 reference sites used in the analysis, no more than 10 test sites were analysed at one time. Probability ellipses (Figure 3) were produced using the software SYSTAT (Systat Software Inc. 2002). HMDS, principal axis correlation, and Monte-Carlo tests were performed using the software PATN (Belbin 1993).

Test site responses were also compared to numerical criteria previously established for each category (non-toxic, potentially toxic and toxic) and species from reference site data (Reynoldson and Day 1998).

2.4.2 Sediment toxicity and contaminant concentrations

As the BEAST assessment does not incorporate any information on organic contaminants in the sediment (organic contaminant concentrations were not measured in reference sediments), additional analyses of relationships between sediment toxicity (using all toxicity test endpoints) and contaminant concentrations for the Randle Reef sites were conducted. These should aid in identifying causes of toxicity (e.g., organic contaminants, inorganic compounds, sediment grain size).

Relationships between sediment toxicity and sediment contamination for the Randle Reef sites were assessed graphically and by regression analysis. Initially, to examine general and dominant patterns in the data, comparisons between the toxicity responses and contaminant conditions were made based on integrative, compound variables (from either summation or multivariate ordination of measurement variables). After this, to better detect less dominant (though significant) relationships between two or a few variables, analyses were conducted using the original measurement variables (i.e., the four toxicity endpoints and concentrations of individual compounds).

The sediment toxicity data for the Randle Reef sites were ordinated again by HMDS, as a single group and without the reference site data. To identify and relate the most important of the toxicity endpoints to the HMDS axes, principal axis correlation was conducted. Concentrations in sediment of 10 metals (Cd, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, and Zn) and 3 nutrients (total N, total organic C, and total P) were ordinated by principal components analysis (PCA). Data for all variables were ln(x)-transformed. The eigenanalysis was performed on the correlation matrix. The PCB and PAH data were integrated by summing the concentrations of the individual congeners. For PCBs, seven of the nine compounds measured were largely below detection limits; therefore, total PCBs was determined primarily by Arochlor-1254 and Arochlor-1260, which were detected at most sites.

Both the integrated descriptors of sediment toxicity (axes scores from the HMDS) and individual toxicity endpoints (survival and growth of *Hexagenia* and *Hyalella*) were plotted against the integrated contaminant descriptors (from PCA and summation of organic contaminants) as well as individual ln(x)-transformed sediment contaminant (10 metals, 2 PCBs and 16 PAHs), 3 nutrient variables, and mean grain size. To determine whether toxicity was better explained by joint consideration of the contaminant descriptors, multiple linear regression involving the contaminant descriptors as predictors was calculated with each toxicity descriptor as the response variable. The degree to which individual sediment variables account for toxicity was assessed by fitting regression models using "best subset" procedures (Draper and Smith 1998; Minitab 2000). Models were fitted for (a) all combinations of metals and nutrients (b) PCBs, PAHs and mean grain size, and then (c) all combinations of the best predictors from the two groups. (This procedure was used to avoid computational difficulties arising from working with 32 predictors simultaneously.) The best models were those having maximum explanatory power (based on $R^2_{adjusted}$), minimum number of nonsignificant predictors, and minimum amount of predictor multicollinearity.

2.5 Quality Assurance/Quality Control

2.5.1 Field duplicates

At 10 randomly selected test, duplicate overlying water and sediment samples were collected for determination of within-site and among-sample variability. Variability in a measured analyte was expressed as the coefficient of variation (CV = standard deviation / mean × 100).

2.5.2 PSC Analytical laboratory

PSC Analytical (Burlington, ON) analyzed sediment for PCBs and PAHs. Quality control procedures included matrix spikes, surrogate chemical spikes, sample duplicates, and the running of reference standards and method blanks. Sample duplicates, matrix spikes and surrogate spikes were analyzed for one in every 10 samples. Reference material was used in every analytical run.

2.5.3 Caduceon laboratory

Caduceon Environmental Laboratory (Ottawa, ON) analyzed sediment for trace metals, major oxides, total phosphorus, total nitrogen and total organic carbon. Quality control procedures included control charting of influences, standards, and blanks. Mercury reference material was used in each analytical run. Calibration standards were run before and after each run. Run blanks and reference standards were run 1 in 20 samples. Sample duplicates were analyzed once every 10 samples.

2.5.4 Organism health and test precision

Control sediment was included in each test set to ensure the health of the test organisms and consistency and precision of test results. This sediment was collected from Long Point Marsh, Lake Erie. The physico-chemical properties of this sediment have shown to produce high survival and growth results for both species. All tests passed an acceptability criteria based on percent control survival in culture sediment before being included in a data set, i.e. ≥ 80% for *H. azteca* (USEPA 1994; ASTM 1995); ≥80% for *Hexagenia* spp. (Reynoldson et al. 1998b). The measured endpoints for each species in the control sediment were also plotted in warning charts. If control data fell below two standard deviations of the mean response, the test was repeated.

Reference toxicant tests using Cu (as $CuCl_2 \cdot 2H_2O$) were performed periodically throughout the test period to monitor the health of the test organisms. Procedures are described elsewhere (Reynoldson et al. 1998b). Median lethal concentrations were calculated using the trimmed Spearman-Karber method (Hamilton et al. 1977), and plotted in warning charts for each species.

3 RESULTS AND DISCUSSION

3.1 Quality Assurance/Quality Control

Two replicate sediment and overlying water samples were collected at 4 Randle Reef (RR) sites and 6 Windermere Arm (WA) sites: RR11, RR14, RR27, RR51, WA02, WA05, WA08, WA12, WA14, and WA19. Variability among site duplicates in a measured analyte has three sources: natural within-site heterogeneity in the distribution of the analyte in sediment or water, differences in handling among samples, and laboratory measurement error. Among-duplicate variability indicates the overall "error" associated with quantifying conditions at a site based on a single sample.

3.1.1 Field duplicates

Coefficients of variation (CV) for total PAHs and PCBs, sediment particle size, trace metals, and sediment and overlying water nutrients for the field-replicated stations are shown in Appendix A; Table A1. The CVs are low overall, ranging from 0 to 86.7%, with a median of 2.6%. The highest CVs are noted for organic contaminant analyses, ranging from 3.1 to 86.7% (median 14.9%). Differences in variability are seen among sites and among the parameters from the same site, although in general, differences are low.

3.1.2 PSC Analytical laboratory

Duplicate analysis (PAHs only), matrix spikes and surrogate chemical spikes are shown in Appendix A; Table A2. There is good agreement between duplicate analyses (8 sites), with mean CVs ranging from 1.5 to 19.7% (median 9.3%). Matrix spikes were performed on total PCBs (sum of Aroclors 1016 and 1260) for nine sites and on total PAHs for four sites. Percent spike recoveries for total PCBs range from 60% to 170% (median 83%). Percent recoveries for two PCB surrogates (4,4'-Dibromooctaflourobiphenyl and Decachlorobiphenyl) range from 55 to 113% (median 80%). Percent spike recoveries for PAHs for a method blank range from 56 to 100% (median 82%). For test sites, percent spike recoveries for some PAHs are low in some cases, ranging from < detection to 150% (median 64%), and percent recovery for three PAH surrogates (Anthracene-2H10, Chrysene-2H12 and Benzo(a)pyrene-2H12) range from 68 to 125% (median 92%).

3.1.3 Caduceon laboratory

Duplicate sample analysis and percent recovery of matrix spikes and mercury reference standards are shown in Appendix A; Tables A3 and A4, respectively. There is good agreement between duplicate analyses (Table A3), with mean CVs ranging from 0.02 to 47.1% (median 2.5%). Spiked matrix recoveries are very good, ranging from 89 to 109% (median 100%), and percent recovery of the three mercury reference materials is also good, ranging from 93 to 109% (median 100%) (Table A4).

3.1.4 Organism health and test precision

Long Point and reference toxicant warning charts for each species are shown in Appendix A; Figures A1 to A4. Amphipod and mayfly survival in the Long Point control sediment fell within two standard deviations (SD) of the mean; therefore, all tests were included in the data set (Figures A1 and A2). Median lethal concentrations for the 96-hour reference toxicant tests reveals that the response of the test organisms to be within a normal range of variability (± 2 SD of the mean), indicating that the organisms were in good health (Figures A3 and A4).

3.2 Sediment and Water Physico-Chemical Properties

3.2.1 Organic contaminants

Total PAH and PCB concentrations in Hamilton Harbour sediments and the 'Severe Effect Level' (SEL, normalized to percent total organic carbon; Persaud et al. 1993) are shown in Appendix B; Tables B1 to B4. Individual PAH and PCB Aroclors are provided in Appendix B; Table B5. Levels of PAHs and PCBs are shown in Figures 4 and 5.

Total PAH concentrations in the Randle Reef sediments range from 1 to 9048 μg/g (median 87 μg/g, mean 320 μg/g), and in Windermere Arm range from 5.1 to 715 μg/g (median 24 μg/g, mean 67 μg/g). The highest PAHs in the Randle Reef area is at RR60, located along the Stelco wall, and in the Windermere Arm at WA20, located at the bottom of the Strathearne slip (Figures 4a,b). The SEL for total PAHs (normalized to TOC) is exceeded at 7 sites in the Randle Reef area: RR13, RR22, RR55, RR56, RR57, RR59, and RR60 (Appendix B; Table B1), all located along the Stelco wall (Figure 4a). The SEL is exceeded at 1 site in Windermere Arm: WA20

(Appendix B; Table B2), located at the base of the Strathearne slip (Figure 4b). The dominant PAH varies between sites; however, overall the predominant PAHs are fluoranthene, pyrene, naphthalene, and phenanthrene (Appendix B; Table B5).

Total PCB concentrations in Randle Reef sediment range from below detection (20 sites) to 1.4 µg/g (median/mean 0.3 µg/g), with highest concentrations noted at sites RR12 and RR30 (Figure 5a). Total PCBs are higher in the Windermere Arm, ranging from 0.1 to 2.3 µg/g (median 0.9 µg/g, mean 1.0 µg/g), with the highest concentration at WA19, located in the middle of the Strathearne slip (Figure 5b). The SEL for PCBs (normalized to TOC) is not exceeded at any site in the Harbour (Appendix B; Tables B3 and B4). The PCBs consist primarily of Aroclor-1254 and Aroclor-1260, detected at most sites, and to a lesser extent Aroclor 1248, which is detected at most sites in the Windermere Arm (Appendix B; Table B5).

3.2.2 Trace metals

Trace metals concentrations in Randle Reef and Windermere Arm sediments are shown in Appendix B; Tables B6 and B7, respectively. Maps showing levels of each trace metal in each area are also provided in Appendix B. Metals exceeding the SEL at Randle Reef (RR) and Windermere Arm sites (WA) include: Cr (3 RR, 11 WA), Cu (3 RR, 12 WA), Fe (21 RR, 13 WA), Pb (8 RR, 6 WA), Mn (63 RR, 10 WA), Ni (2 RR) and Zn (27 RR, 14 WA). For Randle Reef sites, Mn ranges from 742 to 11019 µg/g (median 1400 µg/g), Zn ranges from 67 to 2520 µg/g (median 586 µg/g), Fe ranges from 1.2 to 15.7% (median 3.1%), Pb ranges from 17 to 611 µg/g (median 103 µg/g), and Cu ranges from 17 to 708 µg/g (median 47 µg/g) (Table B6). For Windermere Arm sites, Mn ranges from 166 to 2190 µg/g (median 1094 µg/g), Zn ranges from 149 to 2945 µg/g (median 1006 µg/g), Fe ranges from 0.7 to 7.1% (median 4.2%), Pb ranges from 28 to 469 µg/g (median 161 µg/g), and Cu ranges from 24 to 293 µg/g (median 129 µg/g) (Table B7).

In the Randle Reef area, the highest levels of most trace metals occur in the same general location (Appendix B; Figures B1 to B10). For the Windermere Arm, levels of certain metals (Cu, Pb, Zn) are highest in the Strathearne slip (Appendix B; Figures B11 to B20).

Excluding Mn and Fe, 9 Randle Reef sites and 13 Windermere Arm sites have two or more trace metals elevated above the SEL. Concentrations of above mentioned metals are higher at test sites than at reference sites, with reference medians (where available) of Zn 97 µg/g, Cu 23 µg/g, and Pb 37 µg/g.

3.2.3 Sediment particle size

Particle size data for Randle Reef and Windermere Arm sediment are shown in Tables 3a and 3b, respectively. Overall, Randle Reef sediment consist mainly of silt (ranging from 18.9 to 69.5%, median 50.0%) and sand (ranging from 11.9 to 69.9%, median 34.2%), or silt and clay (ranging from 7.4 to 32.5%, median 16.0%) (Table 3a). Gravel is minimal overall (range 0 to 3.8%). Windermere Arm sediment consists mainly of silt (range 5.2 to 69.2%, median 55.5%) and clay (range 3.3 to 40.2% median 25.2%), or silt and sand (range 4.1 to 91.5%, median 14.5%) (Table 3b). Percent gravel ranges from 0 to 5.4%. In general, test sites are siltier and have less clay than reference sites (reference medians: silt 37.9%, clay 32.0%); percent sand is similar for test and reference sites (reference median 13.7%) for Windermere Arm sites, but Randle Reef sites are sandier than reference.

3.2.4 Sediment nutrients

Total phosphorus (TP), total nitrogen (TN), and total organic carbon (TOC) are shown in Appendix B; Tables B6 and B7. For Randle Reef sites, TN ranges from 577 to 3220 µg/g (median 1902 µg/g), TP ranges from 684 to 3610 µg/g (median 1265 µg/g), and TOC ranges from 1.4 to 11.7% (median 4.7%) (Table B6). Overall, nitrogen and phosphorus concentrations are higher in Windermere Arm; TN ranges from 607 to 7750 µg/g (median 3575 µg/g), and TP ranging from 722 to 7400 µg/g (median 3000 µg/g) (Table B7). The highest nutrient levels in Windermere Arm are at WA01, WA14 and WA17, located closest to the basin, followed by WA20, located at the base of the Strathearne slip. Total organic carbon at Windermere Arm sites range from 0.3 to 6.9% (median 4.0%), slightly lower than that found at Randle Reef sites. Overall, nutrient levels are higher at test sites than reference sites (reference medians for TN, TP, and TOC = 1836 µg/g, 538 µg/g, and 2.0%, respectively).

3.2.5 Overlying water

Conditions of overlying water 0.5 m above the sediment are shown in Appendix B; Tables B8 and B9. In general, test sites have slightly higher alkalinity, phosphorus (TP) and nitrogen (TKN), and lower dissolved oxygen and pH values compared to reference. Conductivity and nutrients are higher in Windermere Arm than Randle Reef but the ranges of variables do not vary much across sampling sites within an area. Median values for Randle Reef and Windermere Arm sites, respectively, are: alkalinity 97, 99 mg/L; conductivity 470, 809 µS/cm; NH_3 0.2, 0.9 mg/L; NO_3/NO_2 1.6, 3.2 mg/L; pH 7.2, 7.6; TKN 0.4, 1.6 mg/L; TP 0.03, 0.08 mg/L. Dissolved oxygen is ≥6.8 mg/L and temperature (bottom and surface) is ≥ 9.6°C at all test sites.

3.3 Sediment Toxicity Tests

Sediment toxicity was assessed by comparing observed conditions at test sites with expected conditions from reference sites. Probability ellipses were constructed around the reference sites, and the departure of test sites from the reference centroid indicated the degree of sediment toxicity. The ordination plot (see example Figure 3) consists of four bands, which represent the level of toxicity derived for reference sites in ordination space. Sites located inside Band 1 (within the smallest ellipse, which represents 90% probability) were considered equivalent to reference or non-toxic. Sites that fall in Band 2 between the smallest and next ellipse (99% probability ellipse) were potentially toxic. Sites that fall in Band 3 (between 99 and 99.9% probability ellipses) were toxic, and sites located in Band 4 (outside the third ellipse) were considered severely toxic.

Mean species survival and growth are provided in Tables 4a and 4b. Also included are the established numeric criteria for each category (non-toxic, potentially toxic and toxic) for each species. Both the mayfly *Hexagenia* and the amphipod *Hyalella* show reduced survival at a number of sites; however, the mayfly shows an acute and chronic response in Hamilton Harbour sediments at more sites than *Hyalella*. Low mayfly survival and/or negative growth are evident at 25 sites in the Randle Reef area and at 9 sites in Windermere Arm, whereas low amphipod survival and/or reduced growth are evident at 12 sites in Randle Reef and at no sites in

Windermere Arm. Six sites are acutely toxicity to both species (all located in the Randle Reef area): RR01, RR07, RR11, RR30, RR59 and 7039.

3.4 BEAST Analyses: Comparison to Reference Sites

The multivariate assessment (ordination) of sites was performed using the integrated survival and growth toxicity test endpoints on three axes. Stress values for the ordinations, which indicate how effectively among-site similarities are represented by three axes compared to four variables, ranged from 0.04 to 0.10 (which is good). Ordination results for integrated endpoints (in subsets of ≤ 10 test sites) are summarized in plots with two of the three axes in Appendix C. All four toxicity endpoints are significantly related to the ordination axes ($p \leq 0.01$). In general, endpoints are oriented opposite to test sites that are located outside of reference or the 90% ellipse, indicating low or poor survival or growth compared to reference associated with these sites. Site WA17, located in Band 3, is oriented in a similar direction to the *Hyalella* growth vector, indicating relatively high amphipod growth is associated with this site (Figure C6 [bottom]).

The relationships between the habitat variables and toxicity responses are also shown in each ordination plot in Appendix C. The number of habitat variables significantly ($p \leq 0.01$) correlated to the ordination axes scores range from 5 to 19. Overall, the most significant variables include the overlying water NO_3/NO_2 and sediment metals such as Pb and Zn. A habitat variable oriented in the same or similar direction to a test site indicates an increased level of the variable associated with the site. Most sites located outside of reference are associated with increased NO_3/NO_2 and one or more trace metals (i.e. Cu, Cd, Fe, Hg, Pb, and Zn) compared to reference. Some sites are also associated with increased phosphorus in the sediment and overlying water (Figures C1 [bottom], C4 [bottom], and C6) and increased nitrogen in the overlying water (Windermere Arm sites – Figure C6). The BEAST assessment does not incorporate any information on organic contaminants in the sediment; therefore contributions from organic contaminants are not known.

Site toxicity classifications from the BEAST assessment using integrated endpoints are shown in Tables 5a and 5b and mapped in Figures 1 and 2. In the Randle Reef area, 30 sites fall in Band 1 (non-toxic), 19 sites in Band 2 (potentially toxic), 8 sites in Band 3 (toxic) and 23 sites in Band 4 (severely toxic). In Windermere Arm, 3 sites fall in Band 1, 5 sites in Band 2, 5 sites in Band 3 and 7 sites in Band 4. The corresponding PAH and PCB concentrations for each site are also shown in Tables 5a and 5b. There are toxic or severely toxic sites that have low PAH concentrations, and conversely, there are non-toxic or potentially toxic sites that have high PAH concentrations. For example, severely toxic sites RR01, RR03, RR16, 7038 and 7039 have PAH concentrations in the range of 5 - 15 µg/g, whereas potentially toxic sites RR56 and RR60 have very high PAH concentrations (2474 and 9048 µg/g, respectively).

Mean survival and growth are displayed for sites in each of Bands 2, 3 and 4 in Figures 6 to 11. Each figure shows two horizontal lines (one for each species) that depicts the numeric criteria for the toxic category. Species survival and growth that fall below their respective lines indicate a toxic response. Figures 6 and 7 show survival and growth observed for the Band 2 (potentially toxic) sites. Survival is above the toxic line for both species at all 19 sites (Figure 6), and growth is below the toxic line for the mayfly at 3 of 19 sites (RR14, RR57 and RR60) (Figure 7). Figures 8 and 9 show survival and growth observed for the Band 3 (toxic) sites. Survival is below the toxic line for *Hexagenia* at 2 of 8 sites (RR13 and RR32) and for *Hyalella* at 1 site (RR15) (Figure 8), and growth is below the toxic line for the mayfly at 3 sites (RR06, RR13 and RR17) (Figure 9). Figures 10 and 11 show survival and growth observed for the Band 4 (severely toxic) sites. Survival is below the toxic line for *Hexagenia* at 19 of 23 sites and for *Hyalella* at 7 of 23 sites (Figure 10). Growth is below the toxic line for *Hexagenia* at 14 sites, and below the toxic line for *Hyalella* at 2 sites (Figure 11). Therefore, site movements from Band 1 to 4 results in a shift from a chronic response (*Hexagenia* only) to an acute and chronic response (mainly for *Hexagenia*, but also for *Hyalella*).

3.5 Sediment Toxicity and Contaminant Concentrations

3.5.1 Hybrid multi-dimensional scaling of toxicity endpoints

The ordination of the multiple measurements of sediment toxicity by HMDS for the Randle Reef sites alone produced two descriptors of sediment toxicity (Figure 12). These axes represent the original 4-dimensional among-site resemblances well (stress = 0.112). Principal axis correlation produces a vector for each toxicity endpoint along which the projections of sites in ordination space are maximally correlated. *Hyalella* survival and growth and *Hexagenia* survival endpoints are negatively correlated to Axis 1. Therefore the greater the toxicity, the higher its score for Axis 1 (Figure 12). *Hexagenia* survival and growth and *Hyalella* growth endpoints are positively correlated to Axis 2. Therefore the greater the toxicity, the lower its score on Axis 2. However, *Hyalella* survival is negatively correlated with Axis 2, indicating greater *Hyalella* toxicity with higher Axis 2 score. Thus, sites scoring high values on Axis 1 tend to show toxicity to both species (three of the four endpoints). Sites scoring either high or low values on Axis 2 tend to show toxicity dependent on the specific endpoint.

3.5.2 Principal components analysis of metal and nutrient concentrations

The first principal component (PC1) accounts for 58% of the total variation, whereas the remaining components each account for ≤11%. All measurement variables are negatively loaded for PC1. Loadings are also of a similar magnitude. Thus this component – denoted as "metPC1" – is considered a fair descriptor of general contamination and nutrient enrichment. Sites elevated in metals and nutrients score low for PC1.

3.5.3 Toxicity-contaminant relationships

The integrated descriptors of sediment toxicity (Axes 1 and 2 scores "toxAxis1" and "toxAxis2" from the HMDS) as well as each of the four individual toxicity endpoints were plotted against the contaminant descriptors metPC1, total PCBs and total PAHs (the latter two of which were ln-transformed to improve linearity) (Figures 13 and 14).

General contaminant descriptor relationships

Sediment toxicity is related to sediment contaminant levels (Figure 13). Both of the two HMDS axes for toxicity are graphically related to metal and nutrient conditions ("metPC1"), total PCBs ("lnTotPCBs") or total PAHs ("lnTotPAHs"). For the Axis 1 toxicity descriptor, the three contaminant descriptors account for 36% of the variability in the multiple linear regressions ($P < 0.001$ for the regression). "MetPC1" is the only significant predictor ($P = 0.006$). For the Axis 2 descriptor, the contaminant descriptors account for 60% of the variability ($P < 0.001$ for the regression). Both "lnTotPAHs" and "metPC1' are significant predictors ($P = 0.018$ and $P<0.001$, respectively).

Significant relationships are also found between the four individual toxicity endpoints and the integrated contaminant descriptors (Figure 14).

For *Hexagenia* survival, the regression is significant at $P < 0.001$, and accounts for 36.6% of the variability. "metPC1" is the only significant predictor ($P = 0.003$):

Hexagenia survival = *82.9 + 6.49 metPC1 – 2.16 lnTotPCBs – 0.20 lnTotPAHs*

For *Hexagenia* growth, the regression is significant at $P<0.001$, and accounts for 53.0% of the variability. "lnTotPAHs" is the only significant predictor ($P<0.001$):

Hexagenia growth = *2.68 + 0.106 metPC1 – 0.534 lnTotPCBs – 0.541 lnTotPAHs*

For *Hyalella* survival, the regression is significant at $P = 0.026$; however, the model accounts for only 11.1% of the variability, and no predictors are significant.

Hyalella survival = *67.3 + 2.63 metPC1 – 2.92 lnTotPCBs + 2.59 lnTotPAHs*

For *Hyalella* growth, the regression is significant at $P < 0.001$, and accounts for 43.3% of the variability. "metPC1" is the only significant predictor ($P< 0.001$):

Hyalella growth = *0.388 + 0.0351 metPC1 – 0.0273 lnTotPCB – 0.0055 lnTotPAH*

<u>Individual contaminant relationships</u>

Best subsets regression of the toxicity descriptor HMDS Axis 1 and the measured contaminant, nutrient, and grain size variables produces a significant relationship ($P<0.001$) with the following predictors explaining 63% of the variability:

- lnAs
- lnCr
- lnCu
- lnFe
- lnPb
- lnZn
- Aroclor-1254
- lnFluorene
- lnPhenanthrene
- lnPyrene
- lnBenzo(a)anthracene
- lnBenzo(k)fluoranthene
- lnBenzo(a)pyrene
- lnIndeno(1,2,3-cd)pyrene
- lnDibenzo(ah)anthracene
- lnmeanGrainSize

However, only lnIndeno(1,2,3-cd)pyrene is a significant predictor (P = 0.022). After dropping 7 terms with very high (>100) variance inflation factors (a measure of multicollinearity), and then dropping lnFe and lnZn (which had the next highest factors), the following model explains 58% of the variance in the Axis 1 toxicity descriptor:

$$Axis1 = -1.24 + 0.127\, lnAs - 0.631\, lnCr - 0.039\, lnCu + 1.02\, lnPb - 0.029\, lnAroclor1254 + 0.0201\, lnFluorene - 0.313\, lnmeanGrainSize$$

The regression is significant at P <0.001. Only lnCr (P=0.015) and lnPb (P=0.001) are significant as predictors, and based on the sign of the coefficient, lnCr does not show a toxicological relationship (i.e., high survival and growth are associated with high Cr concentration in sediment).

For the Axis 2 toxicity descriptor, 84% of the variability is explained by the following predictors:

- lnAs
- lnCr
- lnCu
- lnFe
- lnTN
- lnTP
- Aroclor-1260
- lnNaphthalene
- lnAcenaphthylene
- lnFluorene
- lnPhenanthrene
- lnAnthracene
- lnFluoranthene
- lnPyrene
- lnBenzo(a)pyrene
- lnIndeno(1,2,3-cd)pyrene
- lnBenzo(ghi)perylene
- lnmeanGrainSize

The regression is significant at P<0.001. However, most predictors are not significant. After dropping terms that were not significant (P>0.05) or had high (>10) variance inflation factors, the following model explains 76% of the variance in the Axis 2 toxicity descriptor:

$Axis\ 2 = -1.55 + 0.463\ lnCu - 1.10\ lnFe - 0.0883\ lnFluorene + 0.303\ lnmeanGrainSize$

All predictors are significant at $P \leq 0.002$, and the regression is significant at $P<0.001$. Predictors with positive regression coefficients (Cu, mean grain size) are potentially toxic to *Hyalella* survival, whereas those with negative coefficients (Fe, Fluorene) are possibly toxic to *Hexagenia* survival and growth.

Regression of the individual four toxicity endpoints and the individual measured contaminant, nutrient, and grain size variables also produce significant relationships (Figures 15-18). All individual endpoint regressions are significant at $P<0.001$. After dropping terms that were not significant ($P>0.05$) or had high (>10) variance inflation factors, the models below explained the most variance of each toxicity endpoint.

For *Hexagenia* survival, the following model explains 61% of the variation, with predictors significant at $P \leq 0.003$:
Hexagenia survival = $25.0 - 17.0\ lnCd + 23.6\ lnCu - 83.7\ lnFe + 18.2\ lnZn + 5.10\ lnBenzo(ghi)perylene$

For *Hexagenia* growth, the following model explains 68% of the variation, with predictors significant at $P \leq 0.005$:
Hexagenia growth = $-4.80 + 1.04\ lnCr - 1.53\ lnFe - 0.432\ lnAcenaphthylene + 0.988\ lnmeanGrainSize$

For *Hyalella* survival, only Pb is significant ($P \leq 0.001$), and only 14% of the variation is explained:
Hyalella survival = $123 - 9.04\ lnPb$

For *Hyalella* growth, the following model explains 36% of the variation, with predictors significant at $P \leq 0.023$:
Hyalella growth = $0.932 + 0.0989\ lnCu - 0.206\ lnPb + 0.0236\ lnBenz(a)anthracene$

Potential causes of toxicity

Although bulk and extractable concentrations of contaminants in sediment are imperfect indicators of bioavailability (Luoma and Carter 1991), better than 50%, and up to 76%, of the variability in toxicity of Hamilton Harbour sediments is explained by most regression models. Statistics for the best regressions between toxicity and sediment contaminants are summarized in Table 6. Overall, toxicity is best explained by the measured contaminant and grain size variables, except for *Hyalella* growth, where the integrated contaminant descriptors explain slightly more of the variability. The weakest relationship between toxicity and sediment contaminant concentration was for *Hyalella* survival (R^2=0.14). Regression of the toxicity descriptor Axis 2 and individual contaminants and grain size produces the strongest relationship.

Predictors with coefficients indicating decrease in toxicity with increase in contaminant concentration do not suggest causal relationships. These include negative contaminant coefficients for toxAxis1, and positive coefficients for the survival and growth variables. (Increase in values for toxAxis2 is associated with both increasing and decreasing toxicity, depending on the endpoint.) After excluding predictors not indicative of toxicity relationships, toxicity to *Hexagenia* is most strongly associated with metals (e.g., metPC1 for toxAxis1, toxAxis2, and *Hexagenia* survival). The responsible metals could be Cd (re *Hexagenia* survival), Fe (e.g., re toxAxis2, *Hexagenia* survival, and *Hexagenia* growth), and/or Pb (e.g., re toxAxis1). PAHs are also indicated as potentially toxic in the regressions for toxAxis2 (as TotPAHs and fluorene), *Hexagenia* survival (TotPAHs), and *Hexagenia* growth (acenaphthylene). Toxicity to *Hyalella* is most strongly associated with metals (e.g., metPC1 for toxAxis1, and *Hyalella* survival), possibly Pb (e.g., re toxAxis1, *Hyalella* survival, and *Hyalella* growth), and Cu (e.g., re toxAxis2). PCBs are not significant predictors of toxicity in any of the regressions. Grain size, which is known to affect sediment toxicity for both taxa, is significant for the toxAxis2 descriptor and *Hexagenia* growth.

Metals and PAHs were concluded to contribute to sediment toxicity in previous studies with *Hexagenia* and other invertebrates exposed to Hamilton Harbour sediment based on laboratory tests, contaminant bioaccumulation (in both toxicity test- and field-collected organisms), and in situ benthic community structure (Krantzberg and Boyd 1992; Krantzberg 1994). Significant spatial and temporal variability in sediment toxicity and contaminant bioaccumulation were observed. Not all highly contaminated sites were toxic, and sediments collected in autumn were generally more toxic than those from the spring. Seasonal hypolimnetic anoxia and sediment Fe and Mn oxide conditions were considered to be important factors affecting metal bioavailability. Borgmann and Norwood (1993) examined responses of *Hyalella* to sediment from most of the same sites as Krantzberg and Boyd (1992). Among 5 sites sampled 7 times in 1989-91, they also found high temporal variability in survival, but no correlation between toxicity to *Hyalella* and sediment concentrations of metals, PAHs or chlorinated organic compounds (for 1990 data).

4 CONCLUSIONS

4.1 BEAST Toxicity Assessment

Randle Reef sites fall into the following categories of similarity to reference conditions:

- 23 sites are severely toxic,
- 8 sites are toxic,
- 19 sites are potentially toxicity, and
- 30 sites are non-toxic.

Windermere Arm sites fall into the following categories of similarity to reference conditions:

- 7 sites are severely toxic,
- 5 sites are toxic,
- 5 sites are potentially toxic, and
- 3 sites are non-toxic.

Correspondence in the pattern of nutrients such as NO_3/NO_2 and phosphorus in the overlying water, and sediment phosphorus and one or more trace metals (Cu, Cd, Fe, Hg, Pb, Zn) and the biological conditions of test sites (indicated in the ordination plots as shifts by certain test sites away from the reference sites in the same direction as these vectors) suggests that these variables may be affecting toxicity.

4.2 Toxicity-Contaminant Relationships

Toxicity of Randle Reef sediment to the mayfly *Hexagenia* and the amphipod *Hyalella* is related to a group of contaminants. Metals, such as Fe, Pb, Cd, and Cu, PAHs (fluorene and acenaphthylene) and grain size jointly account for up to 76% of the variability of toxicity among sampling sites. For the individual toxicity endpoints, *Hexagenia* growth and survival were better explained by sediment conditions than *Hyalella* growth and survival.

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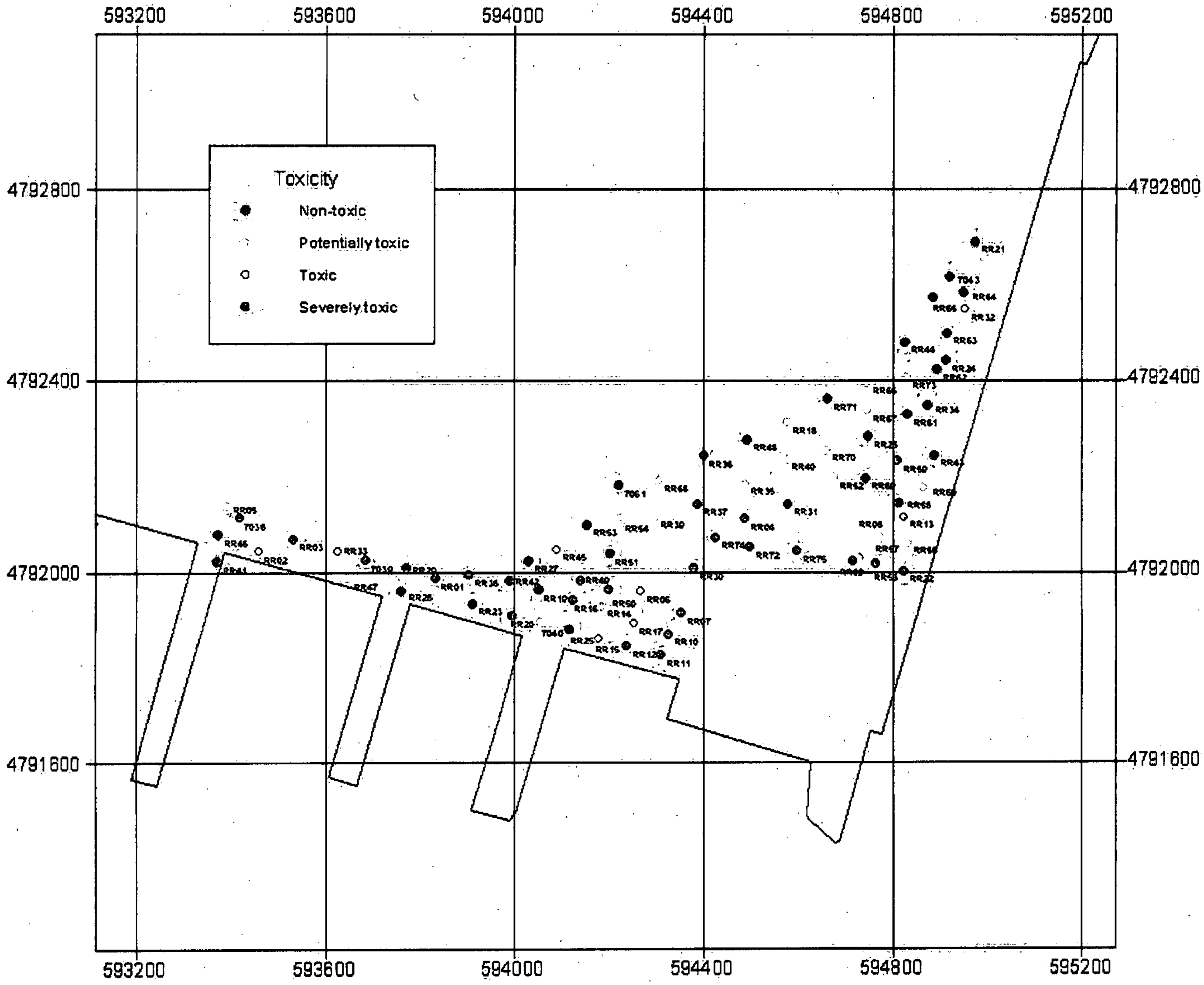


Figure 1. Sampling locations in the Randle Reef area. Toxicity response is colour-coded.

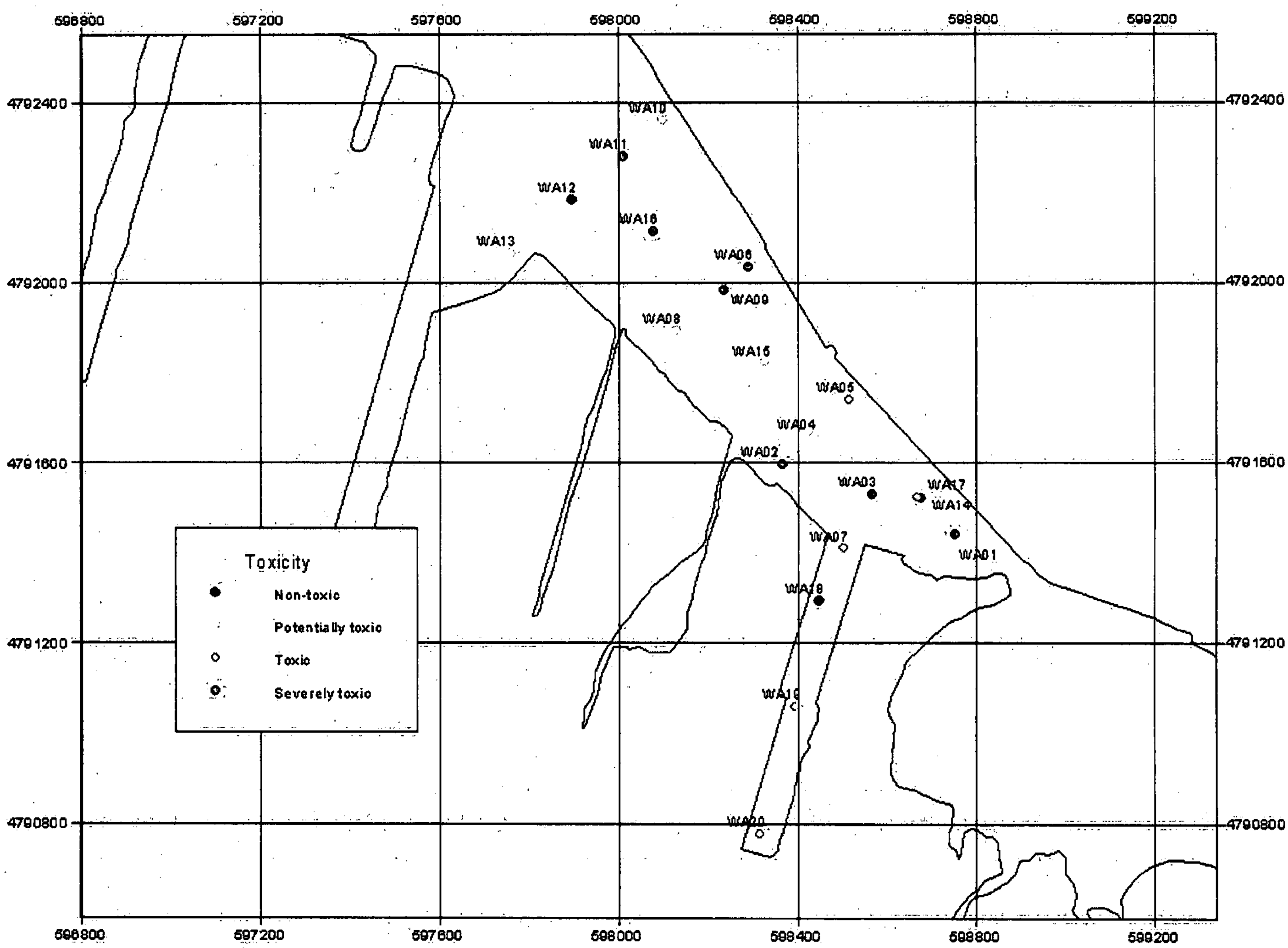


Figure 2. Sampling locations in Windermere Arm. Toxicity response is colour-coded.

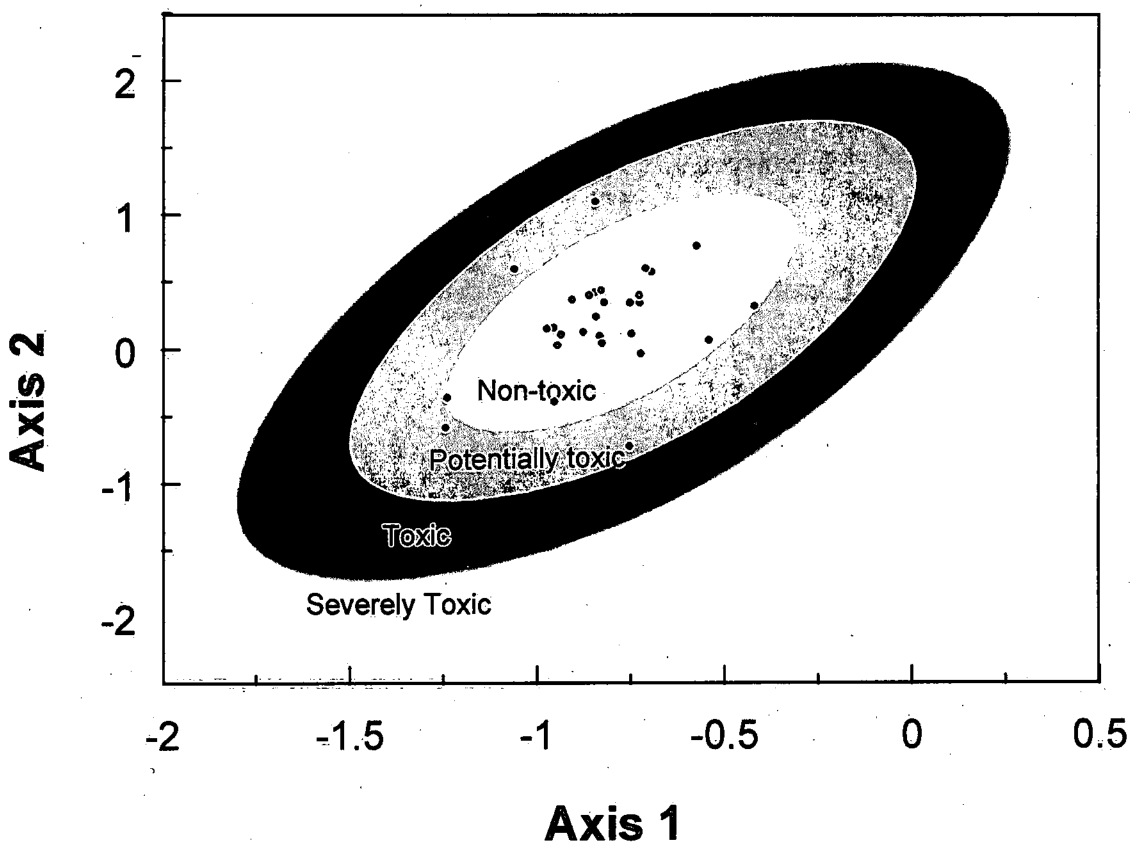


Figure 3. Use of 90, 99, and 99.9% probability bands in determining departure from reference condition.

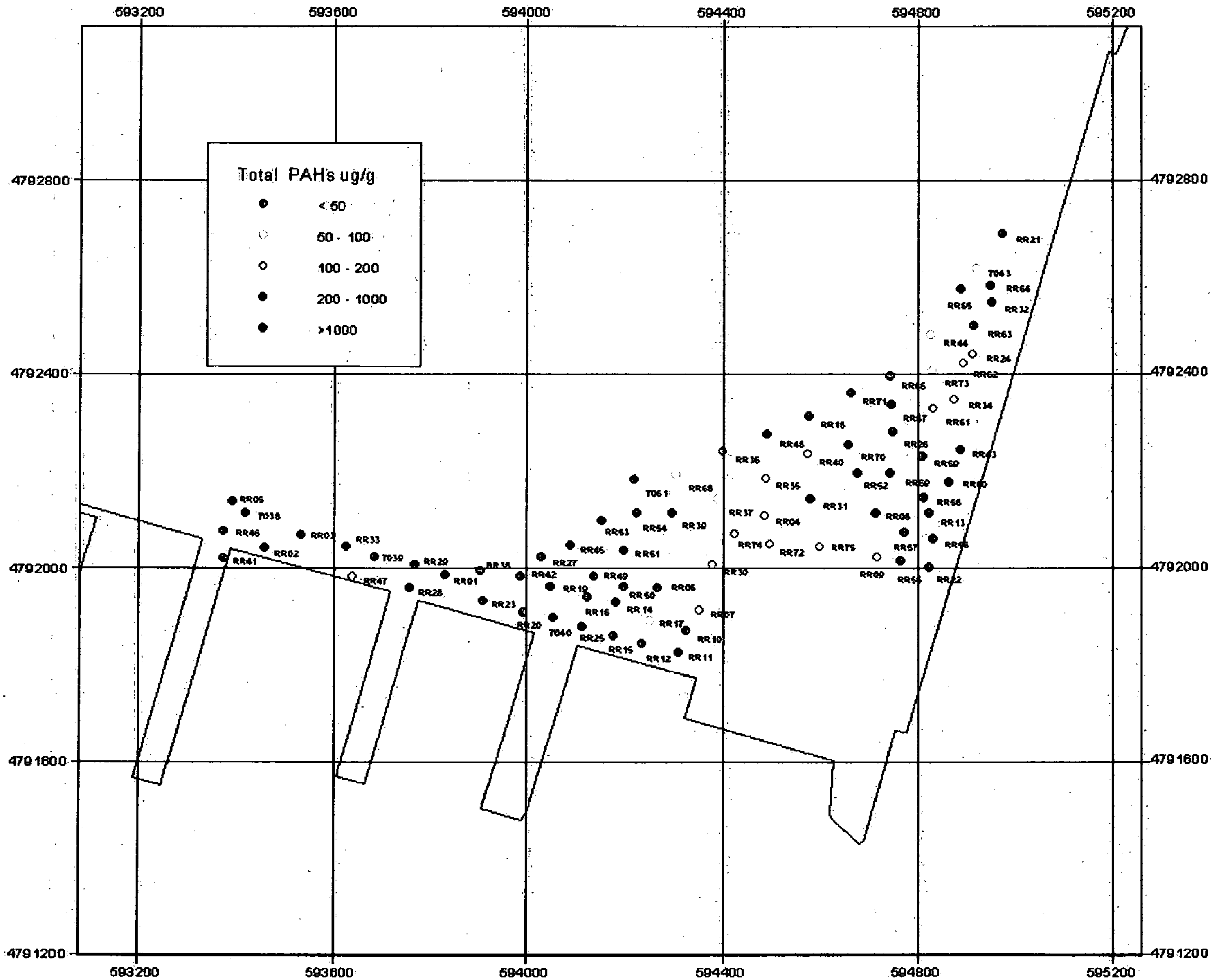


Figure 4a. Polycyclic aromatic hydrocarbon (PAH) levels in Randle Reef sediment.

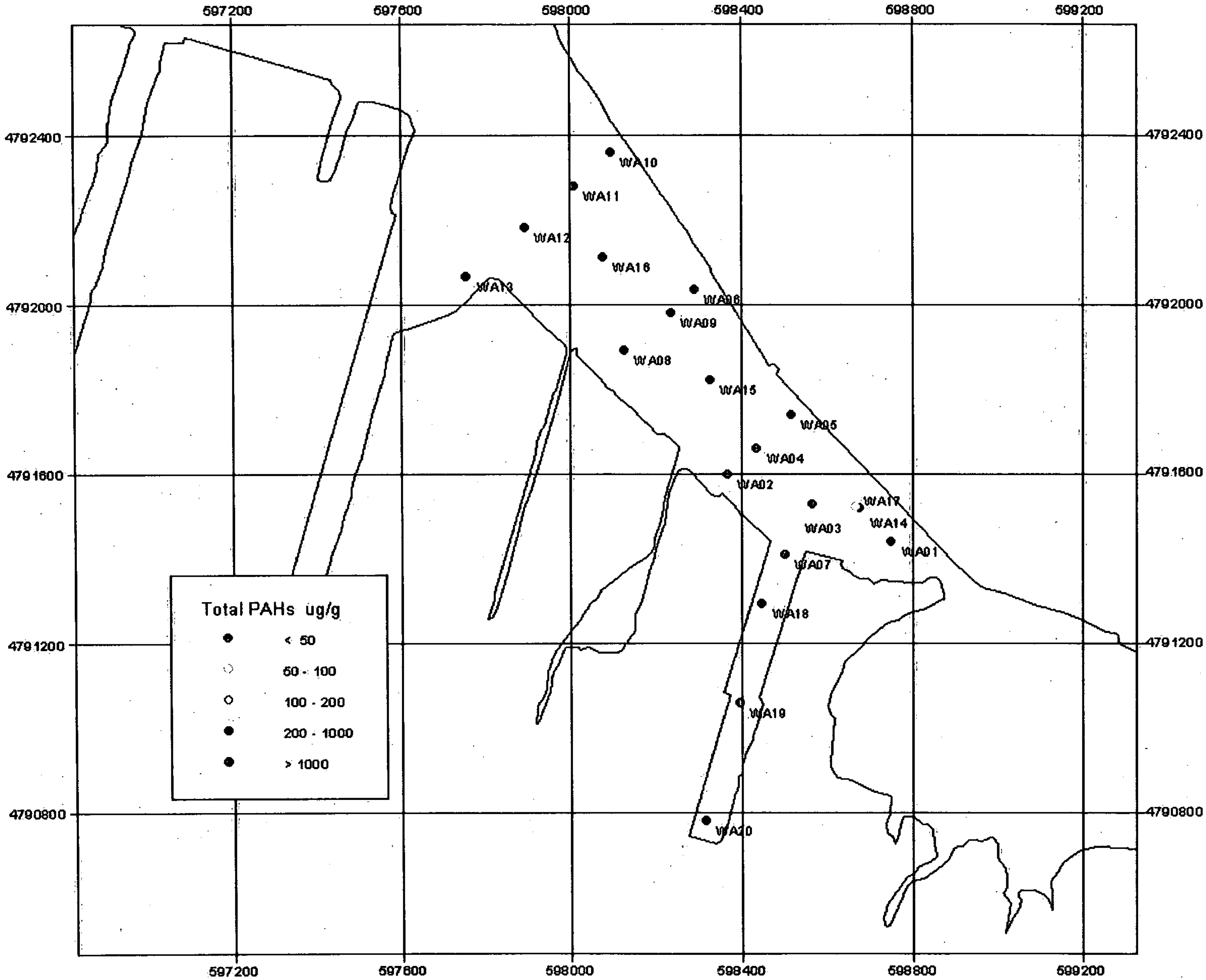


Figure 4b. Polycyclic aromatic hydrocarbon (PAH) levels in Windermere Arm sediment.

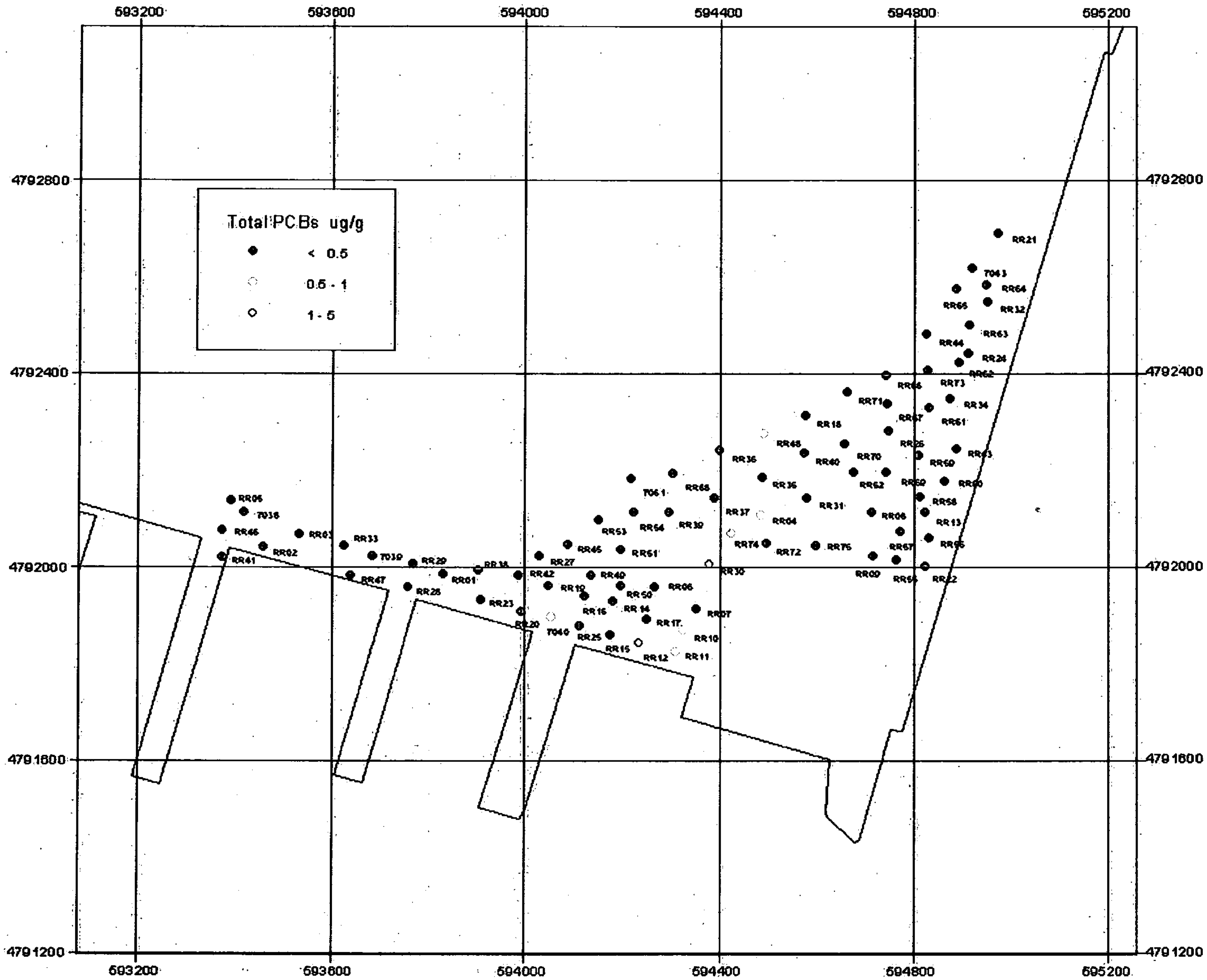


Figure 5a. Total polychlorinated biphenyl (PCB) levels in Randle Reef sediment.

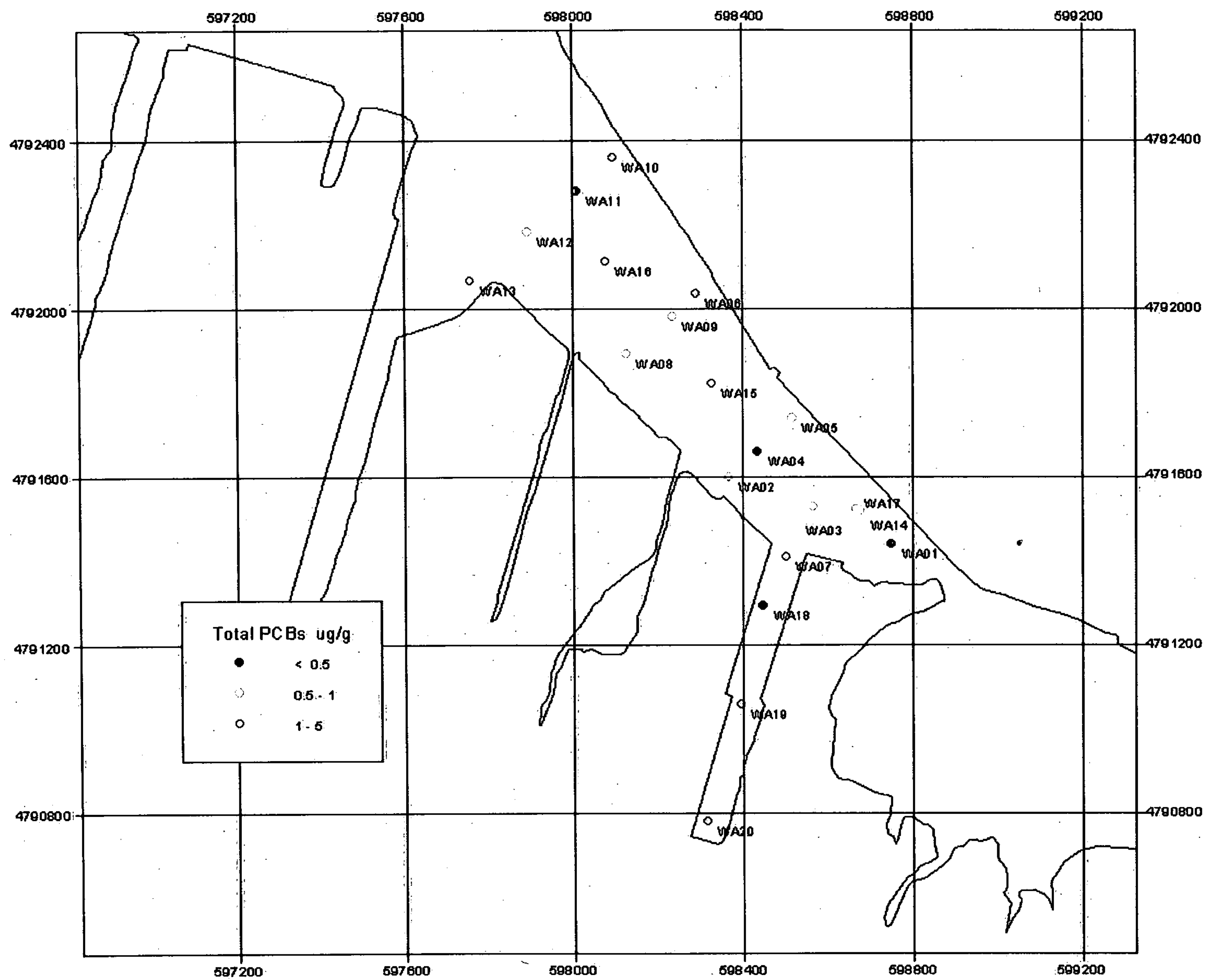


Figure 5b. Total polychlorinated biphenyl (PCB) levels in Windermere Arm sediment.

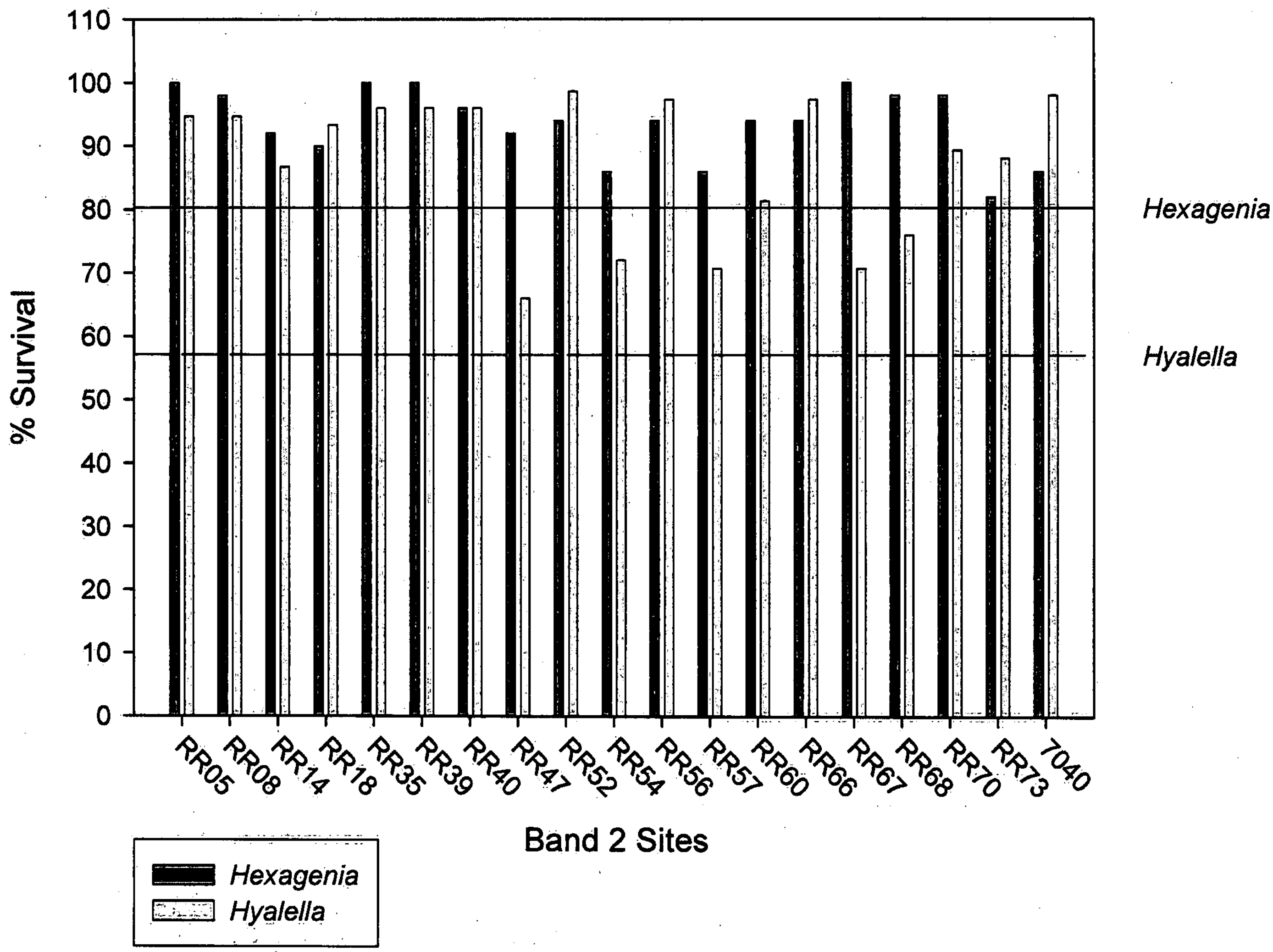


Figure 6. Mean percent survival for Randle Reef Band 2 (potentially toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = <80.3%; *Hyalella* = <57.1%).

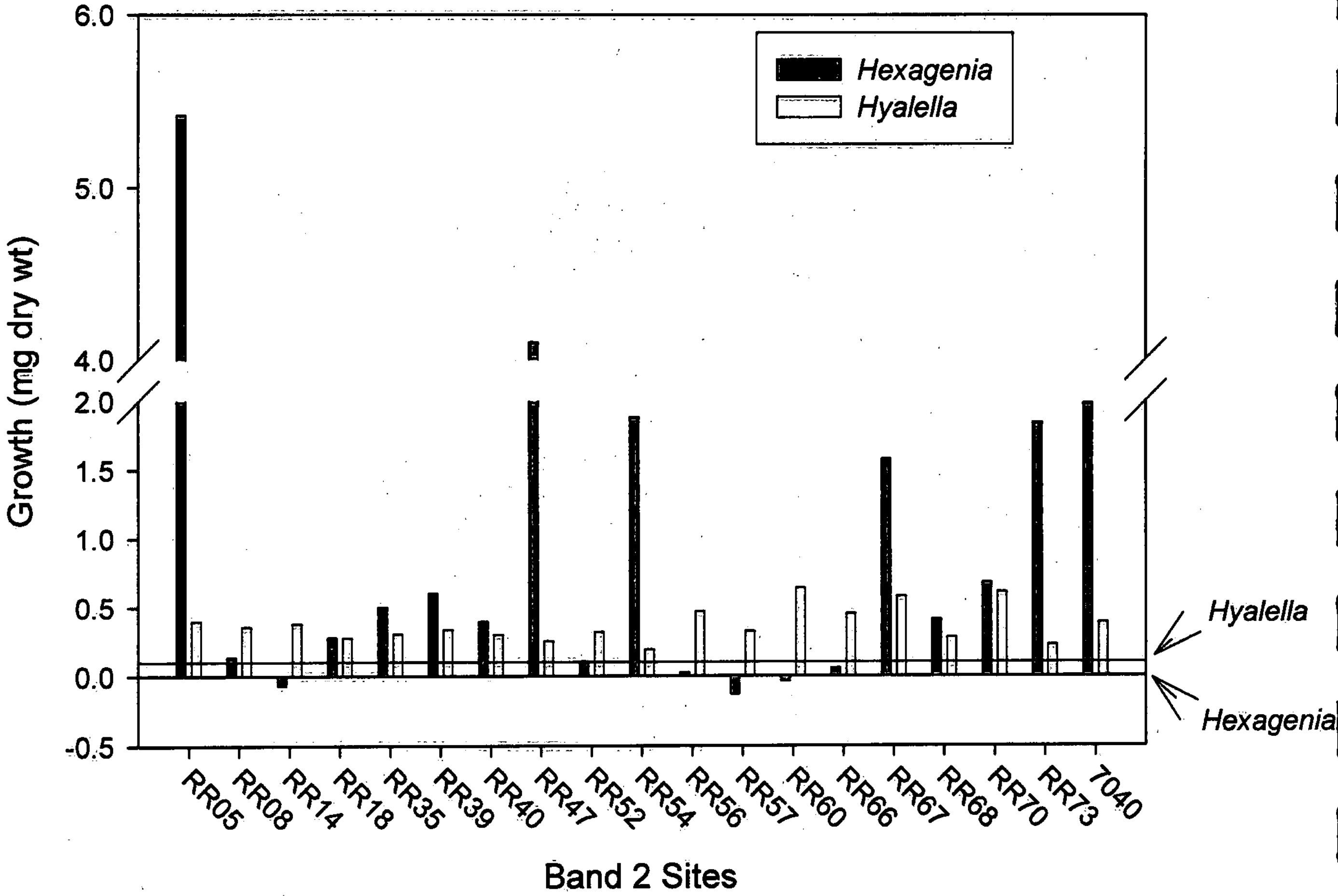


Figure 7. Mean growth (mg dry wt) for Randle Reef Band 2 (potentially toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = negative growth; *Hyalella* = <0.10 mg).

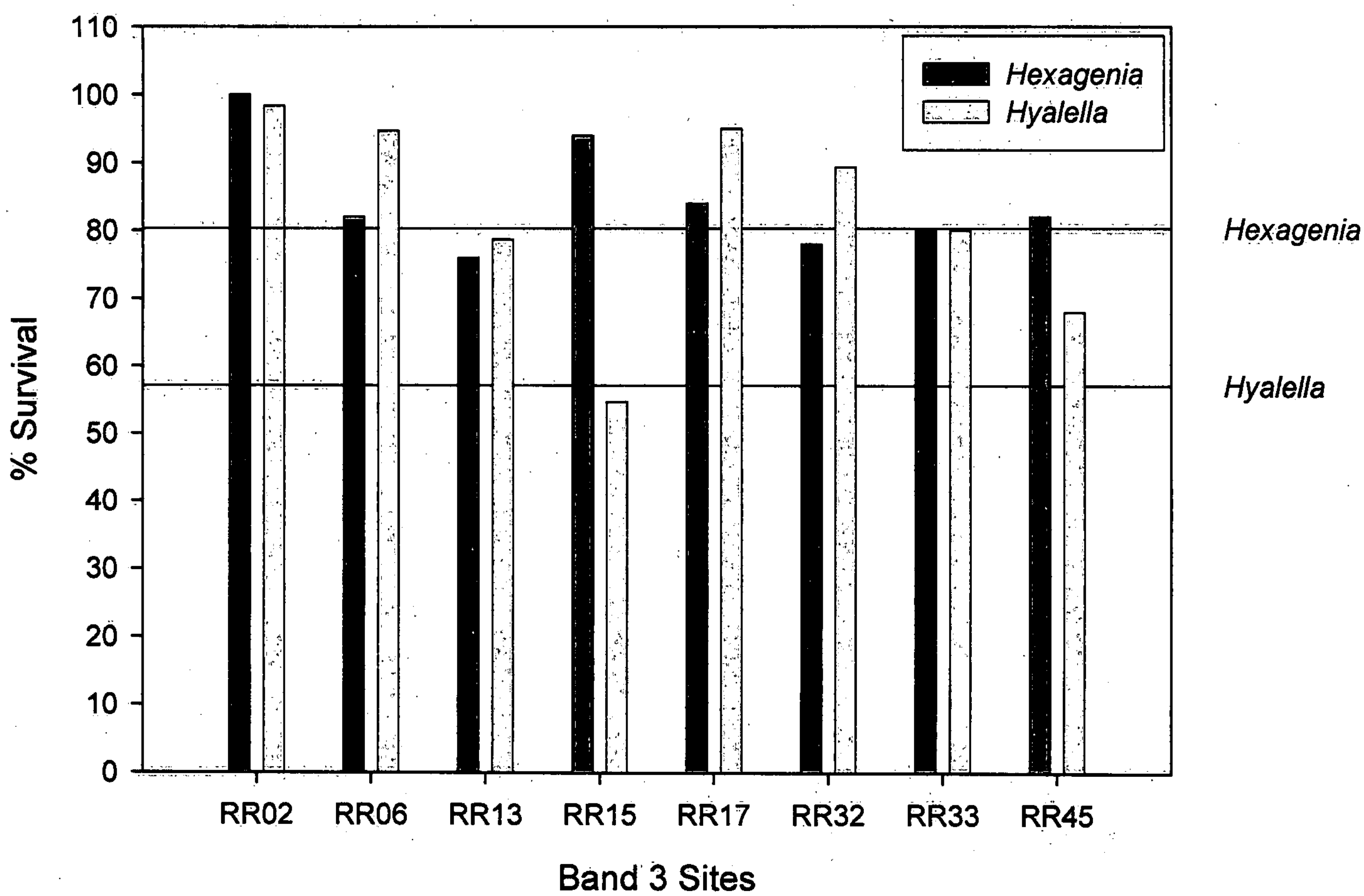


Figure 8. Mean percent survival for Randle Reef Band 3 (toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = <80.3%; *Hyalella* = <57.1%).

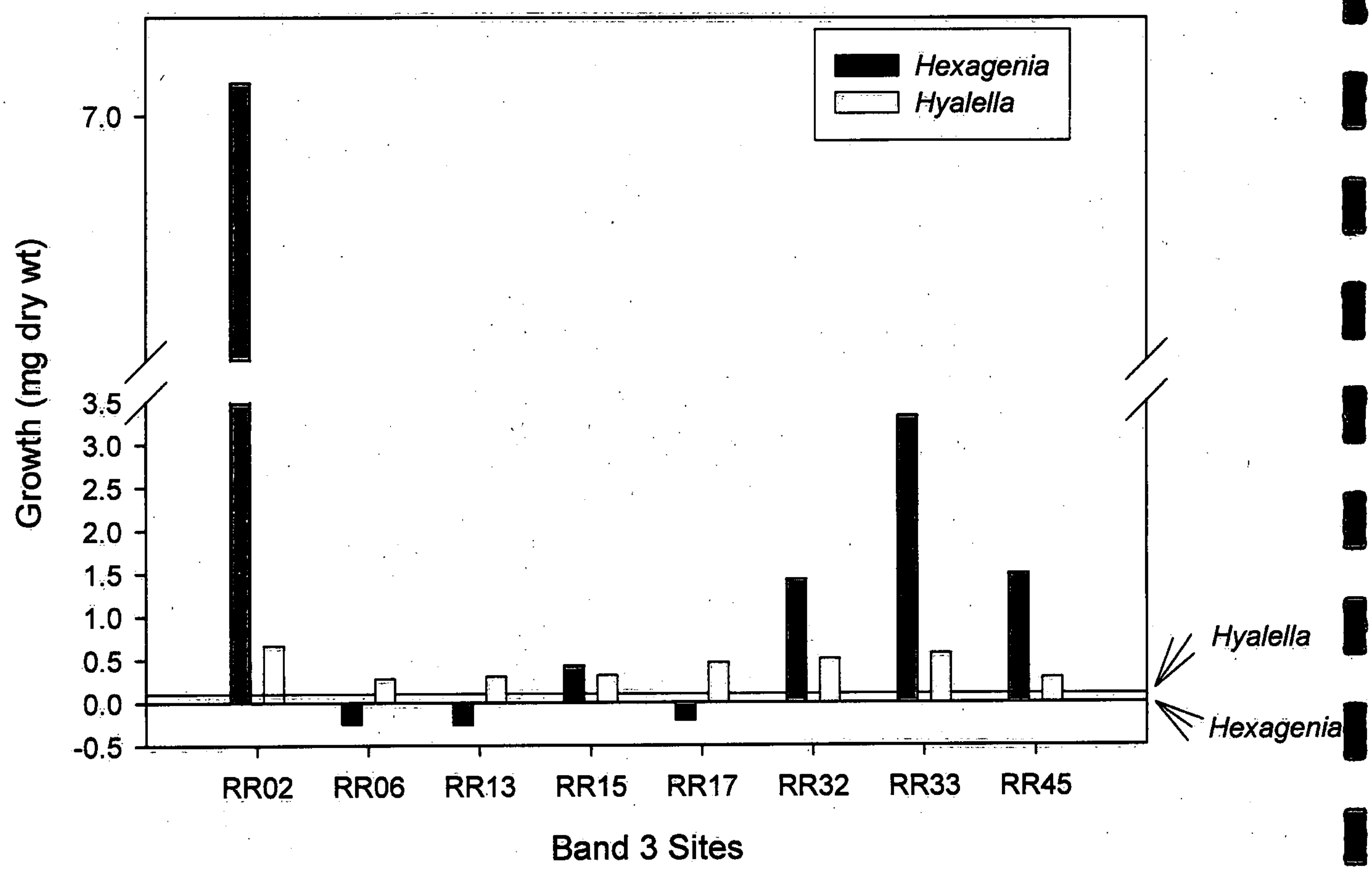


Figure 9. Mean growth (mg dry wt) for Randle Reef Band 3 (toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = negative growth; *Hyalella* = <0.10 mg).

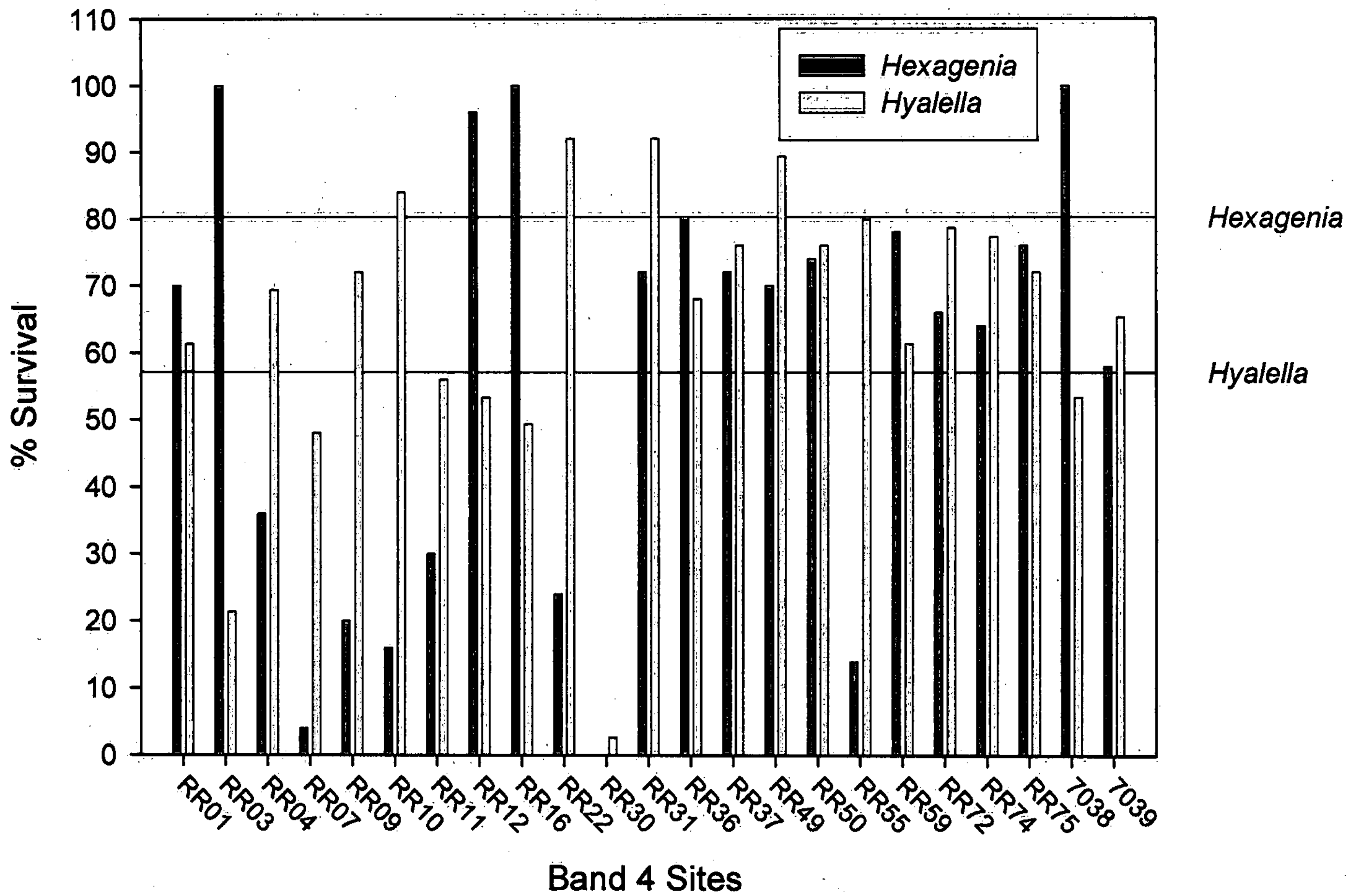


Figure 10. Mean percent survival for Randle Reef Band 4 (severely toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = <80.3%; *Hyalella* = <57.1%).

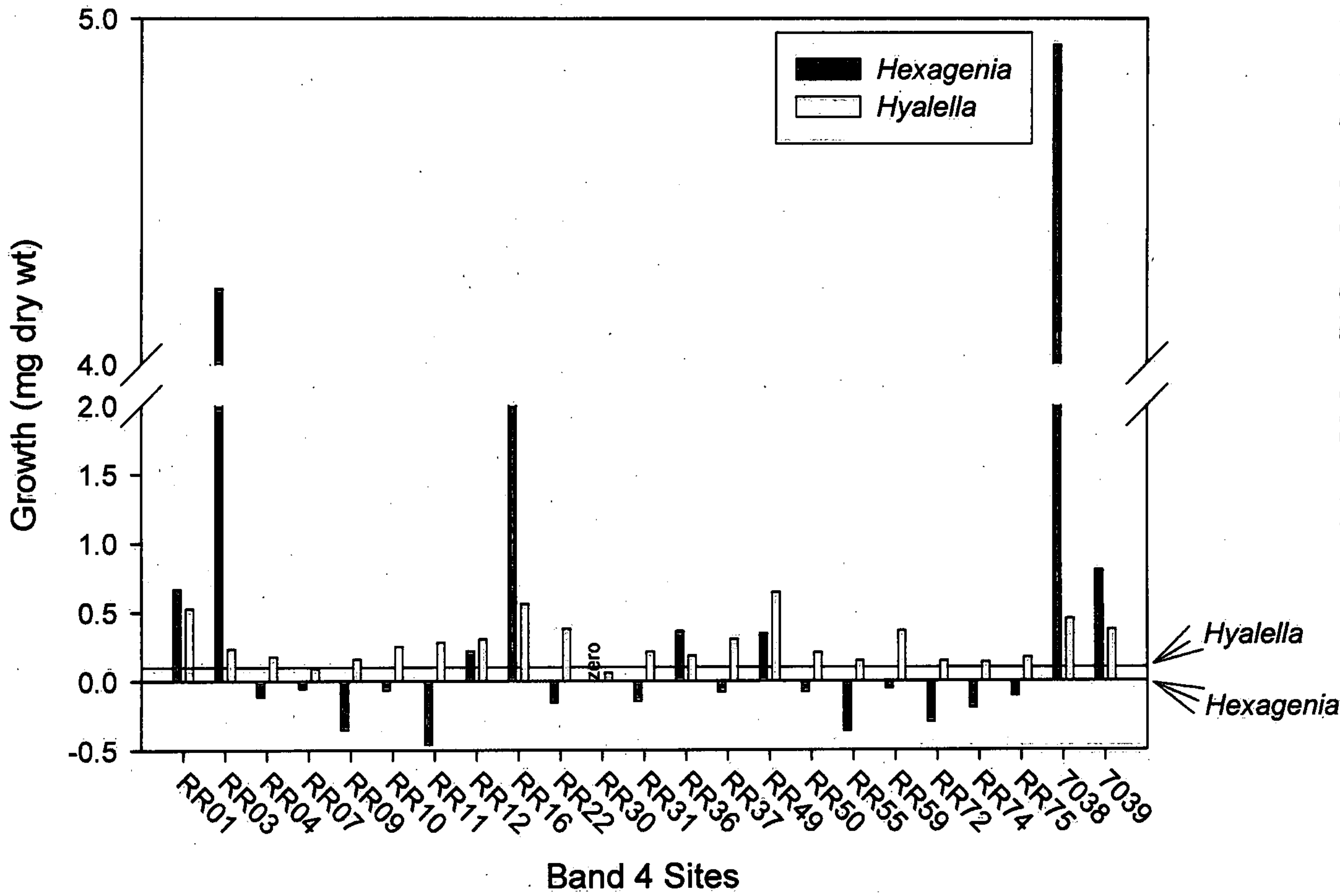


Figure 11. Mean growth (mg dry wt) for Randle Reef Band 4 (severely toxic) sites. The horizontal lines depict the numeric criteria for the toxic category (*Hexagenia* = negative growth; *Hyalella* = <0.10 mg).

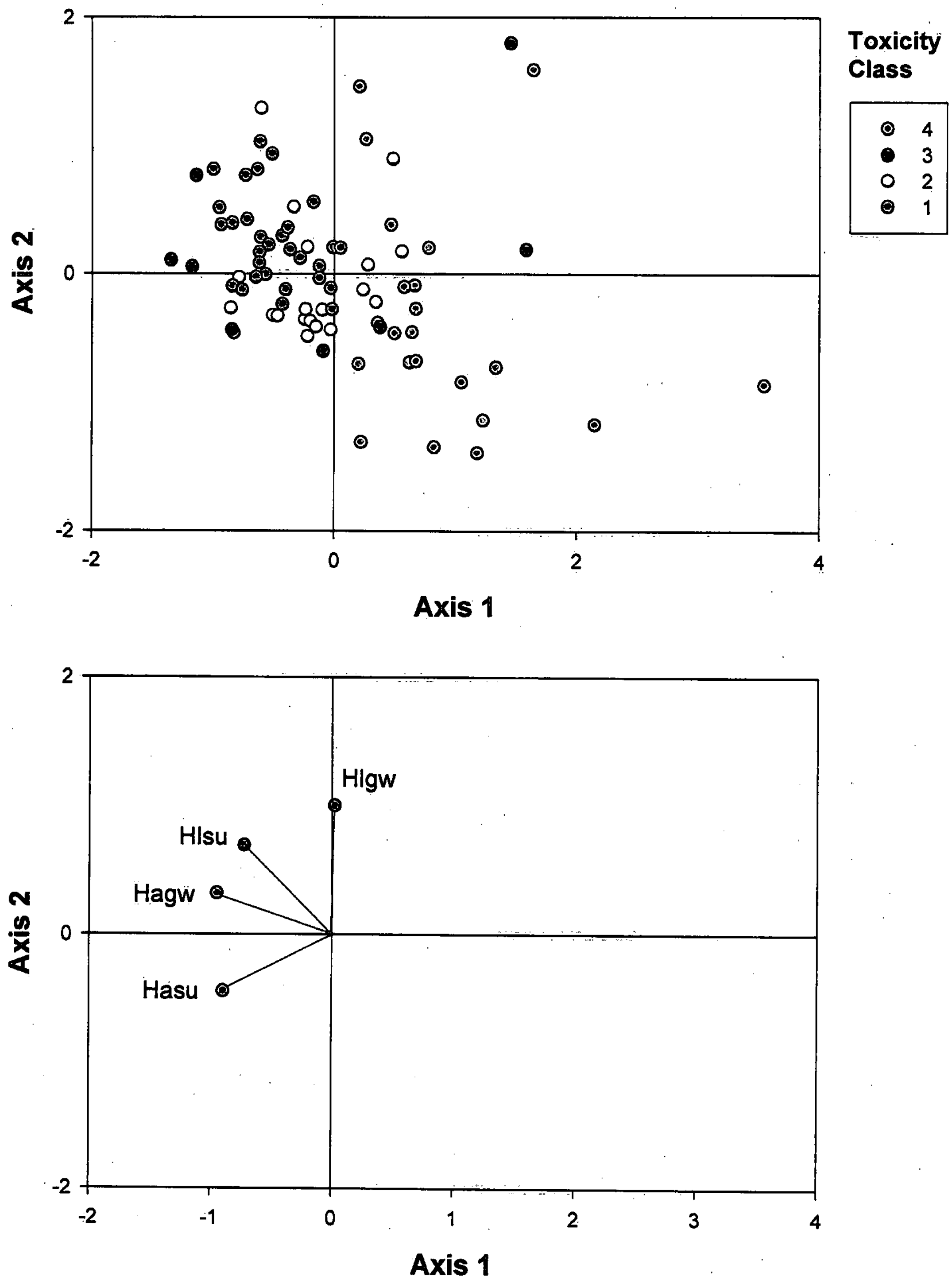


Figure 12. Toxicity of sediment from Randle Reef sites represented by 2-dimensional hybrid multidimensional scaling (HMDS). The upper figure shows co-ordinates of sites, colour coded by toxicity class as determined by the BEAST assessment with reference sites. The lower figure shows directions of maximum correlations of toxicity endpoints with sites in HMDS dimensions.

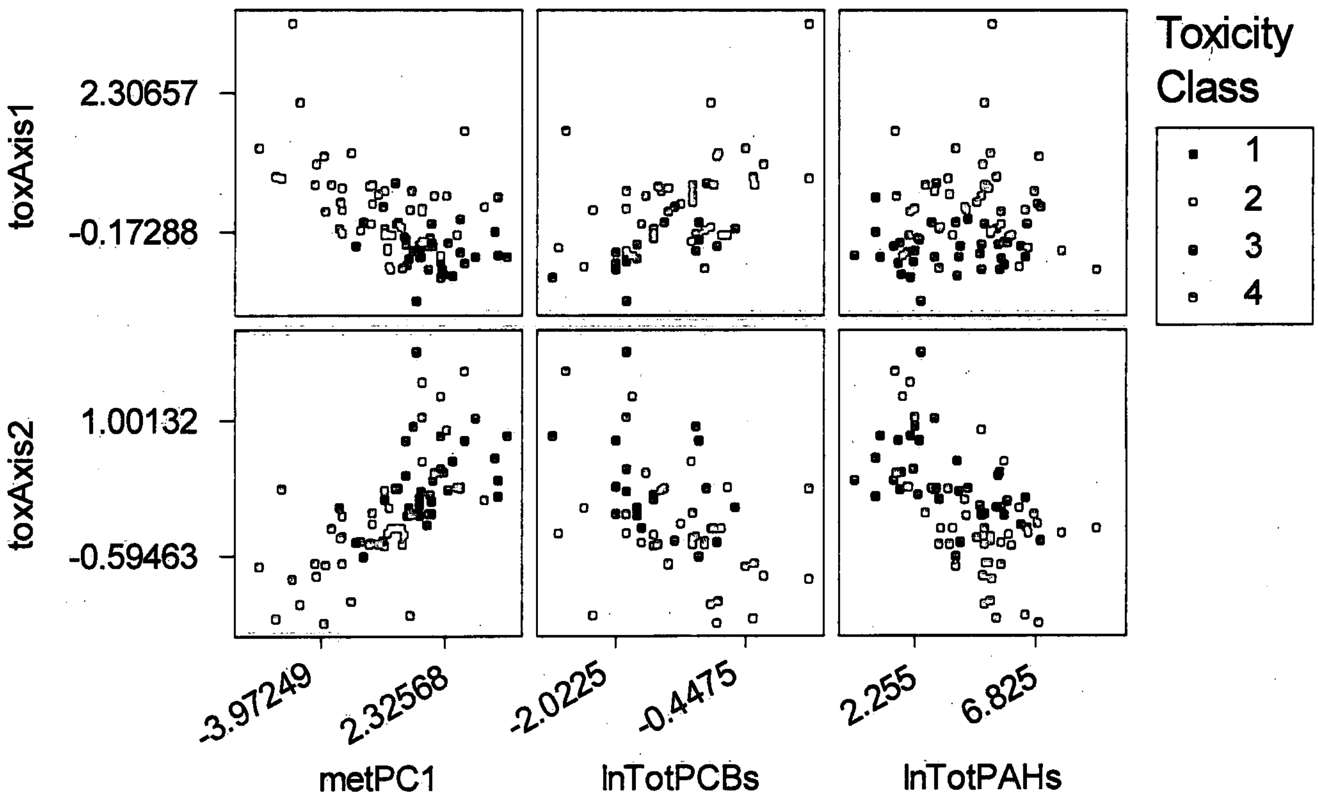


Figure 13. Randle Reef sediment toxicity relationships to contaminant concentrations based on integrated descriptors. High values for toxAxis 1 correspond to sites with high relative toxicity for *Hyalella* survival and growth and *Hexagenia* survival. Low values for toxAxis 2 correspond to high relative toxicity for *Hexagenia* growth and survival and *Hyalella* growth and high values for Axis 2 correspond to high relative toxicity to *Hyalella* survival. (See text for derivation of variables.) Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

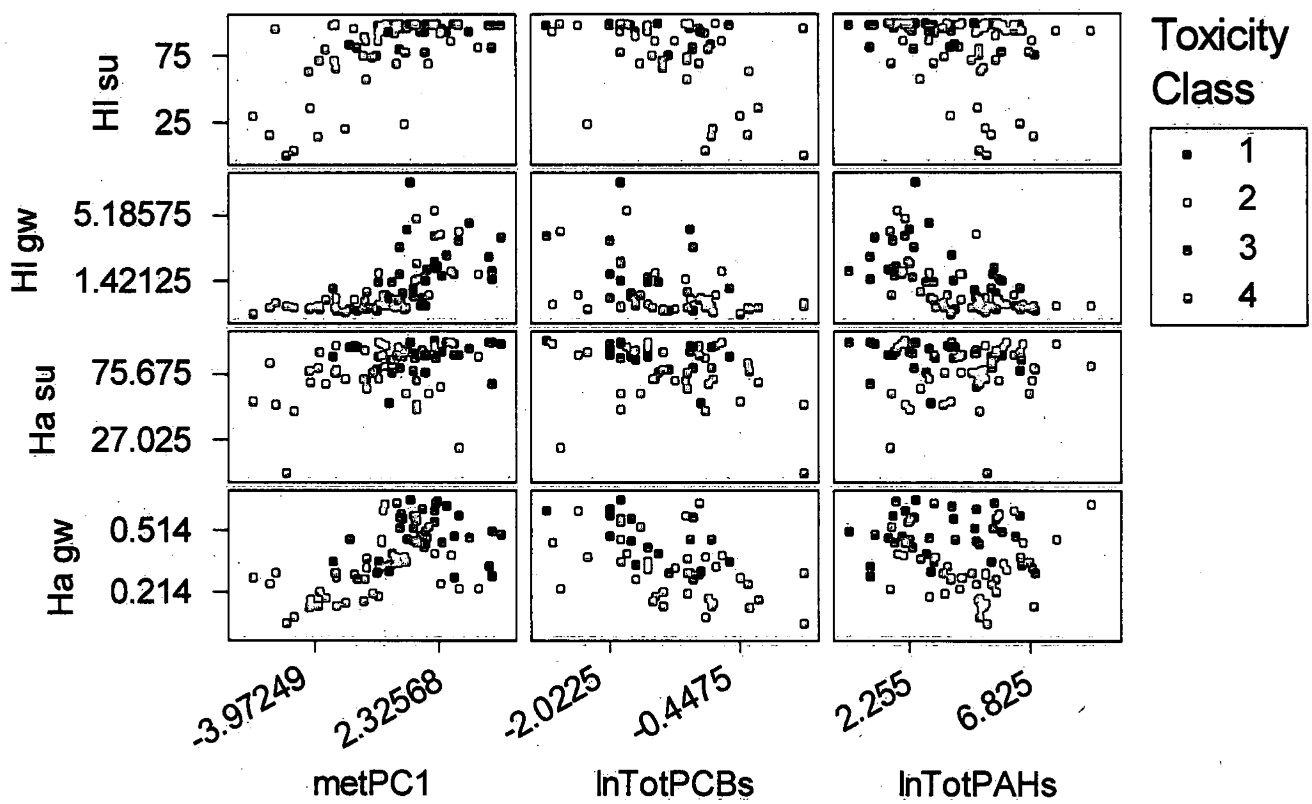


Figure 14. Randle Reef sediment toxicity relationships to contaminant concentrations based on individual toxicity endpoint and integrated descriptors of metal, nutrient, PAH and PCB concentrations. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

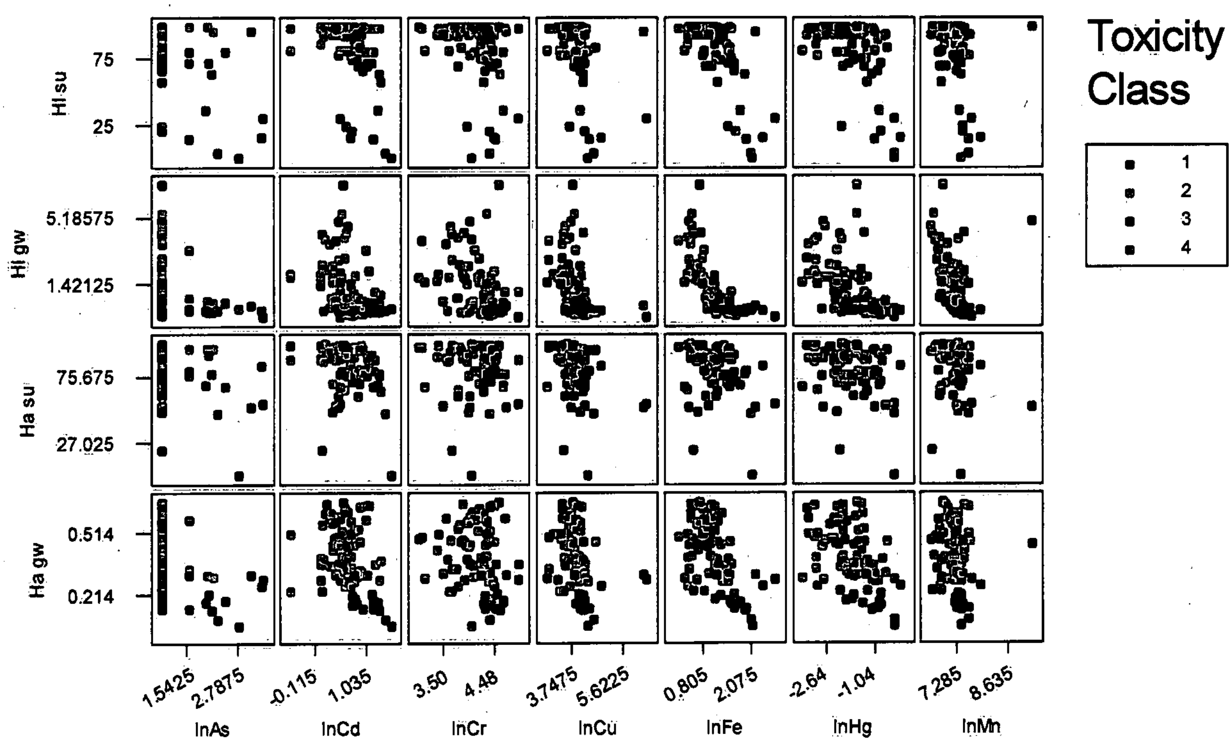


Figure 15. Randle Reef sediment toxicity relationships to individual ln(x)-transformed metal concentrations I. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

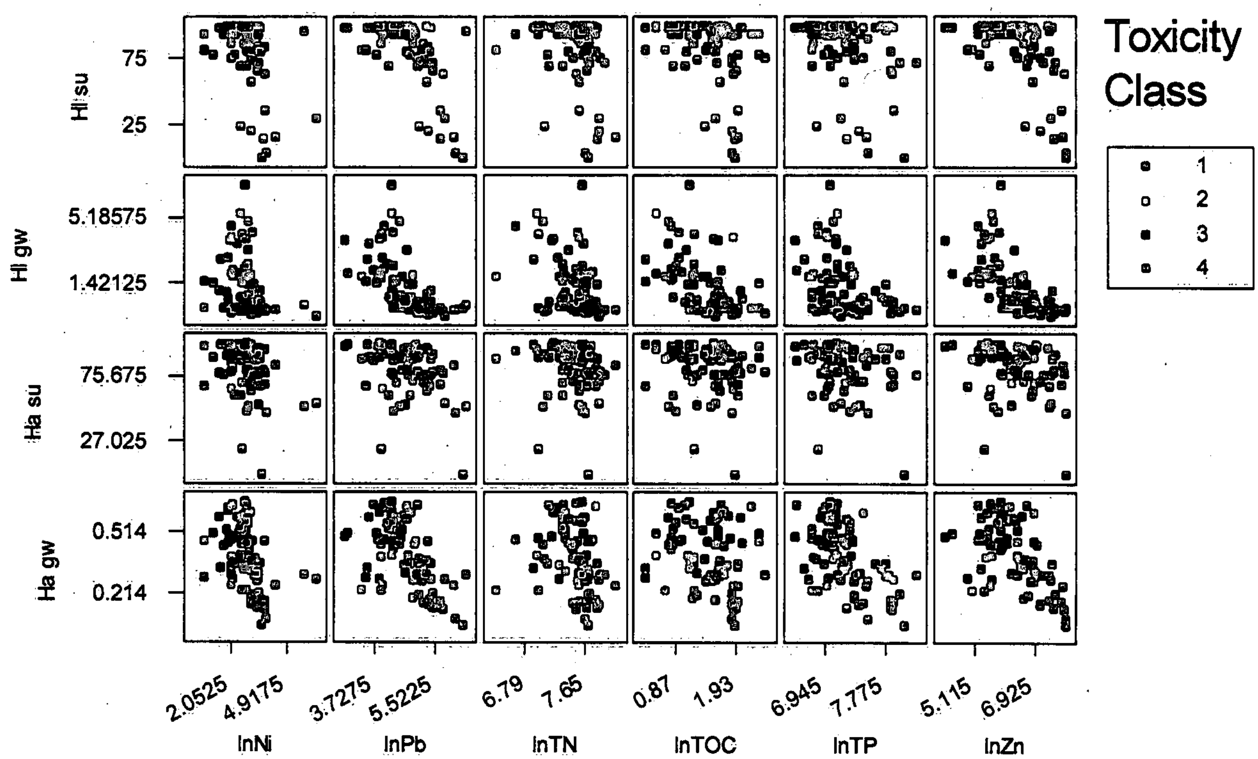


Figure 16. Randle Reef sediment toxicity relationships to individual ln(x)-transformed metal and nutrient concentrations II. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

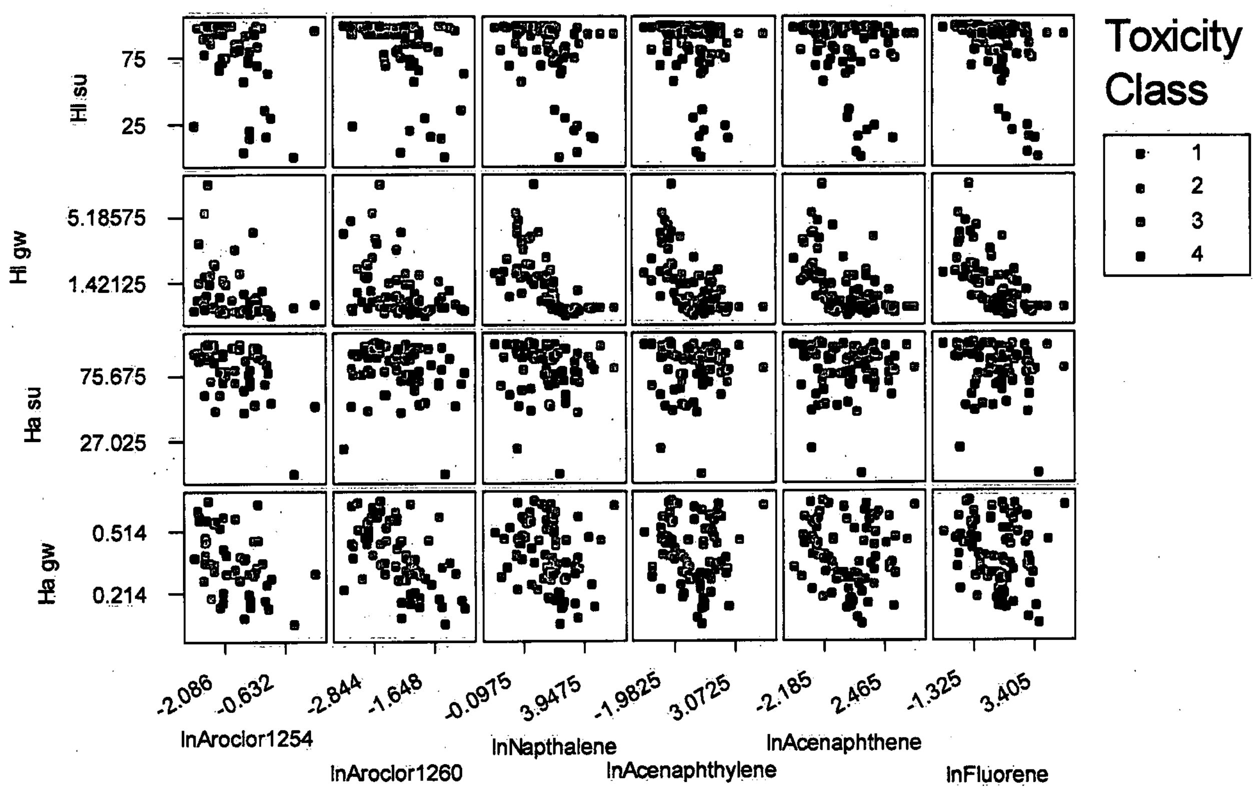


Figure 17. Randle Reef sediment toxicity relationships to individual ln(x)-transformed PCB and PAH concentrations. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

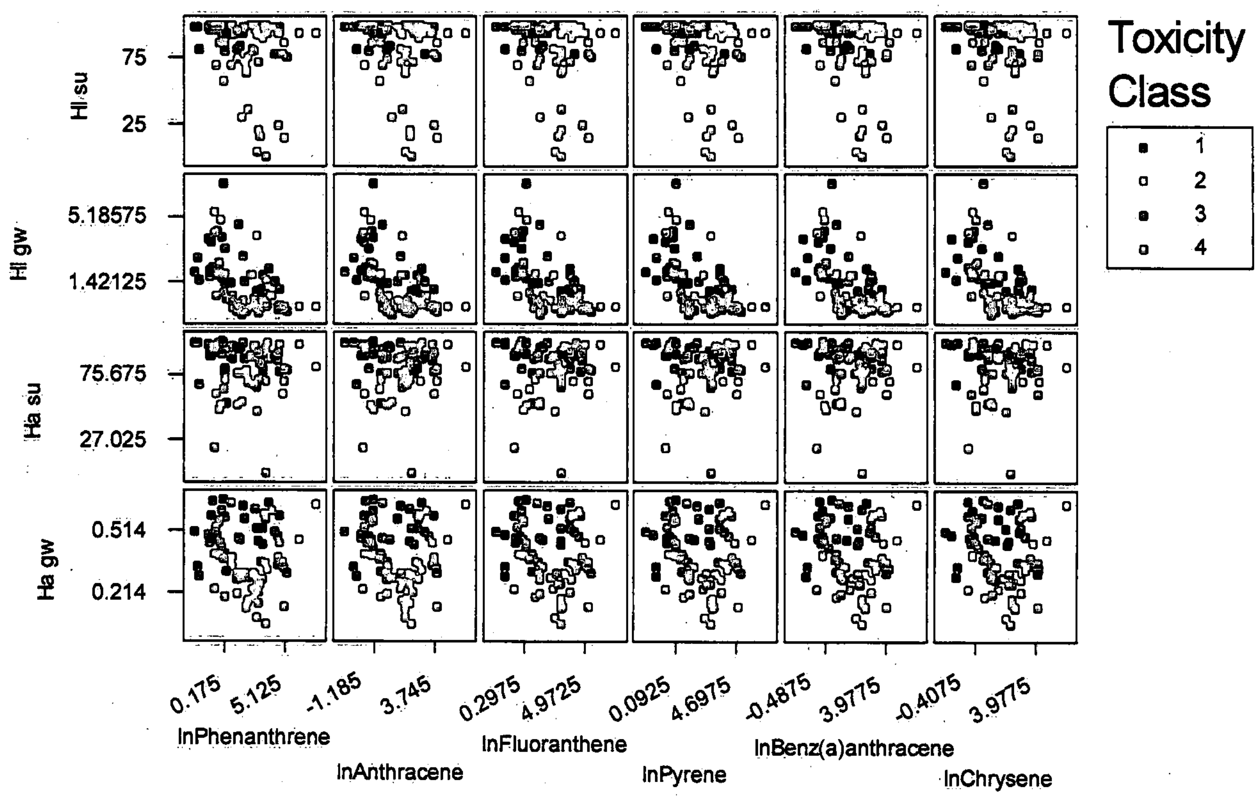


Figure 18a. Randle Reef sediment toxicity relationships to individual ln(x)-transformed PAH concentrations I. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

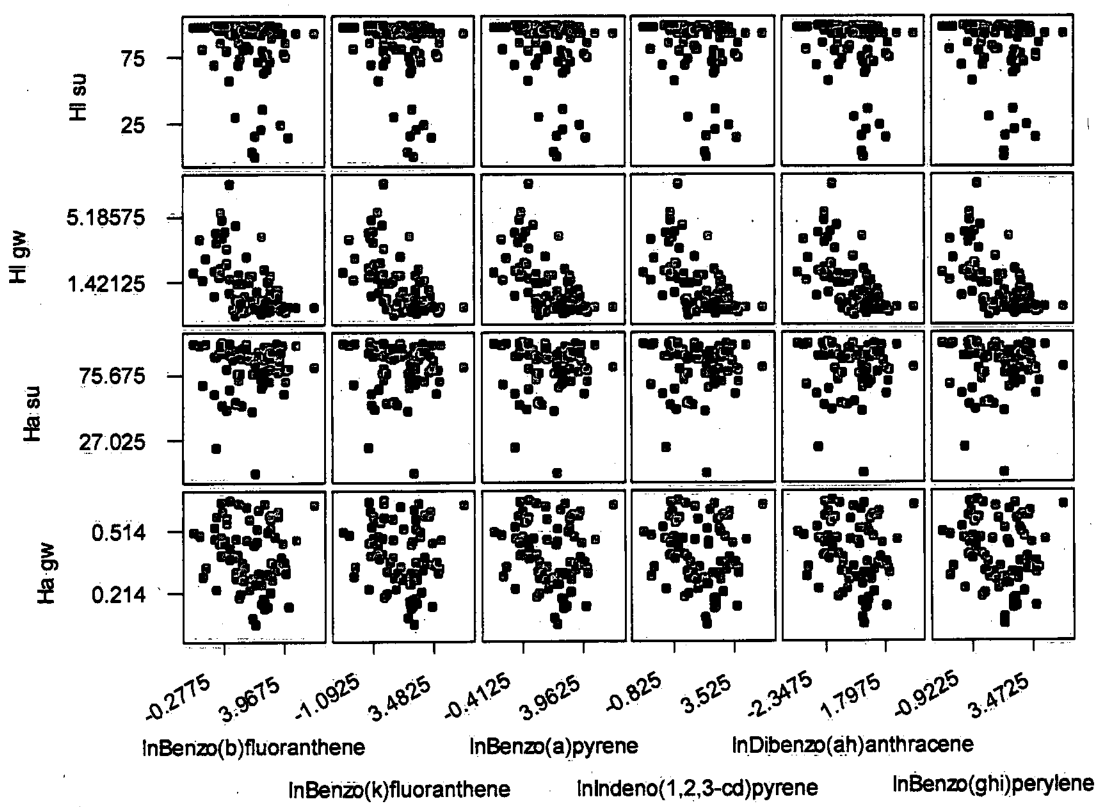


Figure 18b. Randle Reef sediment toxicity relationships to individual ln(x)-transformed PAH concentrations II. "Hl su", "Ha su" and "Hl gw", "Ha gw" = survival and growth of *Hexagenia* and *Hyalella*, respectively. Sites are colour-coded by toxicity class as determined by the BEAST assessment with reference sites.

Table 1a. Randle Reef station co-ordinates (UTM Nad 83) and site depth (m).

Site	Easting	Northing	Depth	Site	Easting	Northing	Depth
RR01	593831	4791985	9.2	RR41	593370	4792019	9.3
RR02	593457	4792041	9.5	RR42	593987	4791981	8.8
RR03	593532	4792067	8.9	RR43	594887	4792242	9.2
RR04	594486	4792108	5.4	RR44	594826	4792479	8.7
RR05	593389	4792136	10.2	RR45	594088	4792045	9.5
RR06	594266	4791957	7.3	RR46	593372	4792076	9.0
RR07	594351	4791912	7.3	RR47	593639	4791982	9.1
RR08	594714	4792114	4.7	RR48	594492	4792274	7.4
RR09	594716	4792021	7.8	RR49	594138	4791981	9.1
RR10	594326	4791868	9.0	RR50	594198	4791961	8.7
RR11[a]	594309	4791823	9.0	RR51[a]	594200	4792036	8.5
RR12	594237	4791843	8.8	RR52	594676	4792194	5.4
RR13	594823	4792113	8.5	RR53	594152	4792096	9.3
RR14[a]	594183	4791927	8.8	RR54	594226	4792112	9.0
RR15	594177	4791859	8.5	RR55	594764	4792015	8.5
RR16	594123	4791940	9.0	RR56	594831	4792059	8.5
RR17	594251	4791891	8.3	RR57	594772	4792072	8.3
RR18	594576	4792311	8.0	RR58	594811	4792142	8.4
RR19	594049	4791961	9.3	RR59	594810	4792229	7.1
RR20	593993	4791908	9.0	RR60	594863	4792174	8.9
RR21	594974	4792688	10.3	RR61	594832	4792327	7.2
RR22	594823	4792000	9.0	RR62	594892	4792420	9.6
RR23	593910	4791932	8.5	RR63	594915	4792498	9.7
RR24	594911	4792440	10.2	RR64	594950	4792582	9.6
RR25	594114	4791878	9.0	RR65	594886	4792573	9.1
RR26	594748	4792280	6.3	RR66	594744	4792393	7.3
RR27[a]	594029	4792021	9.4	RR67	594745	4792335	6.7
RR28	593760	4791957	9.5	RR68	594304	4792190	8.8
RR29	593771	4792007	9.9	RR69	594742	4792193	5.6
RR30	594379	4792006	3.6	RR70	594658	4792253	6.2
RR31	594578	4792139	5.2	RR71	594662	4792359	7.6
RR32	594951	4792547	9.6	RR72	594497	4792049	4.4
RR33	593625	4792042	9.2	RR73	594829	4792405	8.5
RR34	594875	4792346	8.9	RR74	594424	4792070	5.1
RR35	594487	4792182	6.7	RR75	594598	4792042	4.5
RR36	594399	4792240	8.6	7038	593417	4792112	9.8
RR37	594388	4792140	6.8	7039	593685	4792023	9.0
RR38	593903	4791992	9.2	7040	594054	4791895	10.0
RR39	594296	4792113	7.0	7043	594919	4792616	9.5
RR40	594574	4792234	6.9	7061	594219	4792179	9.6

[a]QA/QC station

Table 1b. Windermere Arm station co-ordinates (UTM Nad 83) and site depth (m).

Site	Easting	Northing	Depth
WA01	598750	4791441	6.3
WA02[a]	598365	4791597	7.5
WA03	598565	4791530	9.0
WA04	598435	4791657	9.4
WA05[a]	598515	4791738	8.8
WA06	598236	4791980	8.9
WA07	598501	4791409	8.8
WA08[a]	598127	4791890	7.5
WA09	598235	4791980	9.3
WA10	598097	4792358	8.8
WA11	598011	4792280	10.1
WA12[a]	597894	4792182	8.3
WA13	597758	4792064	6.7
WA14[a]	598675	4791519	7.8
WA15	598326	4791819	9.1
WA16	598077	4792111	9.1
WA17	598665	4791524	8.2
WA18	598447	4791293	8.3
WA19[a]	598393	4791058	8.8
WA20	598314	4790777	8.0

[a]QA/QC station

Table 2. List of environmental variables measured at each site.

Field	Water	Sediment
Northing	Alkalinity	Trace metals
Easting	Conductivity (on site)	Major Oxides
Site Depth	Dissolved Oxygen (on site)	Percents Clay, Silt, Sand, & Gravel
	pH (on site)	Total Phosphorus
	Temperature (on site)	Total Nitrogen
	Total Kjeldahl Nitrogen	Total Organic Carbon, LOI
	NO_3/NO_2	Total PCBs, PAHs
	Total Phosphorus	
	Ammonia	

Table 3a. Physical characteristics of Randle Reef sediment (top 10 cm).

Site	% Sand	% Silt	% Clay	% Gravel		Site	% Sand	% Silt	% Clay	% Gravel
Reference Median	13.68	37.89	32.02	0.00		Reference Median	13.68	37.89	32.02	0.00
RR01	16.48	51.04	32.48	0.00		RR41	35.62	47.86	16.53	0.00
RR02	58.51	29.18	12.30	0.00		RR42	49.48	37.07	13.45	0.00
RR03	49.98	29.38	20.64	0.00		RR43	35.39	49.40	13.73	1.48
RR04	24.06	57.73	17.91	0.30		RR44	27.04	53.16	19.80	0.00
RR05	59.54	26.87	10.91	2.68		RR45	31.08	51.15	17.77	0.00
RR06	26.51	56.97	16.52	0.00		RR46	64.63	20.41	14.96	0.00
RR07	18.57	60.89	20.55	0.00		RR47	56.66	30.64	12.40	0.29
RR08	36.38	50.37	13.25	0.00		RR48	20.08	61.15	18.77	0.00
RR09	15.62	65.61	18.77	0.00		RR49	34.28	50.47	15.25	0.00
RR10	11.86	67.24	20.90	0.00		RR50	34.05	49.91	16.04	0.00
RR11[a]	33.19	50.87	15.94	0.00		RR51[a]	32.63	48.70	18.68	0.00
RR12	40.34	45.15	14.52	0.00		RR52	20.26	60.84	18.90	0.00
RR13	35.50	50.03	14.07	0.40		RR53	47.27	35.90	16.73	0.10
RR14[a]	35.93	47.05	17.03	0.00		RR54	31.93	50.04	18.03	0.00
RR15	37.83	46.92	15.25	0.00		RR55	18.46	63.29	18.25	0.00
RR16	42.10	42.01	15.89	0.00		RR56	52.47	34.42	10.61	2.51
RR17	24.76	56.09	19.15	0.00		RR57	22.94	59.89	16.83	0.34
RR18	24.86	56.13	19.01	0.00		RR58	32.74	52.44	14.82	0.00
RR19	40.16	44.70	15.14	0.00		RR59	46.20	41.32	12.48	0.00
RR20	44.95	40.93	14.12	0.00		RR60	50.94	38.37	8.90	1.79
RR21	13.25	69.46	15.84	1.45		RR61	37.11	49.30	13.59	0.00
RR22	23.41	56.45	20.15	0.00		RR62	35.30	50.63	14.06	0.00
RR23	59.73	28.63	11.64	0.00		RR63	51.24	36.45	12.19	0.13
RR24	31.32	51.55	17.13	0.00		RR64	44.14	41.21	11.95	2.69
RR25	36.70	46.12	17.18	0.00		RR65	36.73	46.95	15.97	0.35
RR26	24.55	57.29	18.16	0.00		RR66	34.20	50.22	15.58	0.00
RR27[a]	30.52	50.85	18.64	0.00		RR67	36.19	48.74	15.07	0.00
RR28	36.73	47.02	15.47	0.79		RR68	18.21	60.14	21.65	0.00
RR29	20.12	46.61	32.54	0.73		RR69	37.14	49.06	13.80	0.00
RR30	24.15	53.62	22.23	0.00		RR70	31.70	52.37	15.93	0.00
RR31	23.54	60.87	15.59	0.00		RR71	38.91	43.66	16.75	0.68
RR32	69.85	18.93	7.44	3.79		RR72	35.33	49.07	15.51	0.09
RR33	38.53	45.45	15.71	0.31		RR73	43.91	35.17	20.92	0.00
RR34	37.88	49.49	12.63	0.00		RR74	25.17	58.72	16.11	0.00
RR35	14.17	64.77	21.06	0.00		RR75	33.21	50.82	15.08	0.89
RR36	22.46	57.56	19.98	0.00		7038	65.91	23.43	9.29	1.38
RR37	14.18	65.48	20.34	0.00		7039	17.04	57.05	25.00	0.90
RR38	51.88	35.40	11.95	0.77		7040	23.30	57.03	19.67	0.00
RR39	28.73	54.19	17.07	0.00		7043	50.92	35.85	13.23	0.00
RR40	17.14	63.00	19.86	0.00		7061	34.09	48.20	17.71	0.00

[a]QA/QC site (value represents the mean of three replicates)

Table 3b. Physical characteristics of Windermere arm sediment (top 10 cm).

Site	% Sand	% Silt	% Clay	% Gravel		Site	% Sand	% Silt	% Clay	% Gravel
Reference Median	13.68	37.89	32.02	0.00		Reference Median	13.68	37.89	32.02	0.00
WA01	7.20	64.43	28.37	0.00		WA11	66.98	18.73	8.94	5.35
WA02[a]	34.05	48.60	17.35	0.00		WA12[a]	31.02	49.24	19.75	0.00
WA03	16.09	41.31	40.15	2.45		WA13	8.63	66.31	25.05	0.00
WA04	13.60	53.81	32.59	0.00		WA14[a]	13.99	60.62	25.40	0.00
WA05[a]	34.37	48.45	17.18	0.00		WA15	11.85	63.72	24.43	0.00
WA06	14.97	57.07	27.47	0.49		WA16	12.19	61.67	26.14	0.00
WA07	51.61	33.39	15.01	0.00		WA17	7.57	62.73	29.71	0.00
WA08[a]	4.10	69.20	26.71	0.00		WA18	91.50	5.24	3.26	0.00
WA09	12.73	62.55	24.73	0.00		WA19[a]	20.15	50.04	29.82	0.00
WA10	26.23	53.93	19.84	0.00		WA20	5.23	63.53	31.24	0.00

[a]QA/QC site (value represents the mean of three replicates)

Table 4a. Mean percent survival and growth (mg dry wt) in sediment toxicity tests for Randle Reef sites. The established numeric criteria for each endpoint are included. Toxicity is highlighted yellow; potential toxicity is bolded/italicized.

Site	*Hexagenia* Survival	*Hexagenia* Growth	*H. azteca* survival	*H. azteca* Growth	**Site**	*Hexagenia* survival	*Hexagenia* growth	*H. azteca* survival	*H. azteca* Growth
Ref. Mean	96	3.03	85.6	0.50	*Ref. Mean*	96	3.03	85.6	0.50
RR01	**70**	***0.67***	***61.3***	0.53	RR41	98	3.73	89.3	0.58
RR02	100	7.07	98.3	0.66	RR42	100	1.78	97.3	0.48
RR03	100	4.22	**21.3**	0.23	RR43	94	***0.04***	89.3	0.49
RR04	**36**	**-0.12**	69.3	***0.18***	RR44	98	1.42	86.7	0.57
RR05	100	5.42	94.7	0.40	RR45	***82***	1.50	68.0	0.29
RR06	***82***	**-0.25**	94.7	0.28	RR46	94	4.74	94.0	0.48
RR07	**40**	**-0.06**	**48.0**	**0.09**	RR47	92	4.10	***66.0***	0.26
RR08	98	***0.14***	94.7	0.36	RR48	98	1.05	88.0	0.36
RR09	**20**	**-0.35**	72.0	***0.16***	RR49	**70**	***0.35***	89.3	0.65
RR10	**16**	**-0.07**	84.0	0.25	RR50	**74**	**-0.08**	76.0	***0.21***
RR11	**30**	**-0.46**	**56.0**	0.28	RR51	100	1.39	76.0	0.40
RR12	96	***0.22***	**53.3**	0.31	RR52	94	***0.11***	98.7	0.32
RR13	**76**	**-0.26**	78.7	0.30	RR53	98	2.81	98.7	0.34
RR14	92	**-0.07**	86.7	0.38	RR54	86	1.88	72.0	***0.19***
RR15	94	***0.43***	**54.7**	0.32	RR55	**14**	***0.00***	80.0	***0.15***
RR16	100	2.42	**49.3**	0.57	RR56	94	***0.03***	97.3	0.47
RR17	***84***	**-0.21**	95.0	0.47	RR57	86	**-0.13**	70.7	0.33
RR18	90	***0.28***	93.3	0.28	RR58	94	***0.02***	85.3	0.35
RR19	100	2.22	92.0	0.66	RR59	**78**	**-0.05**	***61.3***	0.37
RR20	94	1.59	90.0	0.43	RR60	94	**-0.03**	81.3	0.64
RR21	98	3.92	97.3	0.49	RR61	98	***0.47***	93.3	0.62
RR22	**24**	**-0.16**	92.0	0.38	RR62	98	***0.51***	90.7	0.47
RR23	98	4.02	100.0	0.61	RR63	98	0.97	77.3	0.58
RR24	100	0.87	90.7	0.53	RR64	98	2.22	86.7	0.65
RR25	96	4.36	92.0	0.47	RR65	94	2.86	98.7	0.63
RR26	98	***0.73***	88.0	0.57	RR66	94	***0.06***	97.3	0.45
RR27	96	1.75	91.7	0.45	RR67	100	1.58	70.7	0.58
RR28	98	2.01	98.0	0.51	RR68	98	***0.41***	76.0	0.28
RR29	100	2.05	89.3	0.48	RR69	96	***0.41***	93.3	0.59
RR30	**0**	-	**2.7**	**0.06**	RR70	98	***0.68***	89.3	0.61
RR31	**72**	**-0.14**	92.0	***0.21***	RR71	100	1.83	80.0	0.53
RR32	**78**	1.43	89.3	0.51	RR72	**66**	**-0.30**	78.7	***0.15***
RR33	**80**	3.33	80.0	0.57	RR73	***82***	1.84	88.0	0.23
RR34	94	***0.02***	76.0	0.45	RR74	**64**	**-0.19**	77.3	***0.14***
RR35	100	***0.50***	96.0	0.31	RR75	**76**	**-0.11**	72.0	***0.17***
RR36	**80**	***0.36***	68.0	***0.19***	7038	100	4.92	**53.3**	0.45
RR37	**72**	**-0.08**	76.0	0.31	7039	**58**	0.81	***65.3***	0.38
RR38	98	2.51	97.3	0.56	7040	86	1.98	98.0	0.39
RR39	100	***0.60***	96.0	0.34	7043	100	1.80	89.3	0.28
RR40	96	***0.40***	96.0	0.30	7061	98	1.40	88.0	0.36
Non toxic	85.5	5.0 – 0.9	67.0	0.75 – 0.23	Non toxic	85.5	5.0 – 0.9	67.0	0.75 – 0.23
Pot. toxic	85.4 – 80.3	0.8 – 0	66.9–57.1	0.22 – 0.10	Pot. toxic	85.4 – 80.3	0.8 – 0	66.9–57.1	0.22 – 0.10
Toxic	**< 80.3**	**negative**	**< 57.1**	**< 0.10**	Toxic	**< 80.3**	**negative**	**< 57.1**	**< 0.10**

Table 4b. Mean percent survival and growth (mg dry wt) in sediment toxicity tests for Windermere Arm sites. The established numeric criteria for each endpoint are included. Toxicity is highlighted yellow; potential toxicity is bolded/italicized.

Site	*Hexagenia* survival	*Hexagenia* growth	*H. azteca* survival	*H. azteca* growth
Ref. Mean	96	3.03	85.6	0.50
WA01	86	**-0.04**	94.7	0.86
WA02	**36**	***0.15***	97.3	0.46
WA03	**42**	**-0.03**	94.7	0.45
WA04	92	***0.72***	70.7	0.31
WA05	***74***	***0.48***	94.7	0.37
WA06	**46**	***0.13***	90.7	***0.21***
WA07	***82***	0.82	94.7	0.25
WA08	98	***0.70***	90.7	0.29
WA09	**70**	***0.51***	94.7	0.30
WA10	90	0.88	96.0	0.26
WA11	**68**	***0.69***	80.0	***0.21***
WA12	96	***0.79***	74.7	0.34
WA13	***84***	1.24	69.3	0.31
WA14	94	***0.42***	96.0	0.47
WA15	86	1.15	85.3	0.42
WA16	**58**	***0.14***	92.0	***0.19***
WA17	100	***0.27***	92.0	0.82
WA18	96	0.84	84.0	0.41
WA19	86	***0.07***	97.3	0.44
WA20	88	**-0.02**	96.0	0.60
Non toxic	85.5	5.00 – 0.90	67.0	0.75 – 0.23
Pot. toxic	85.4 – 80.3	0.80 – 0	66.9–57.1	0.22 – 0.10
Toxic	**< 80.3**	**negative**	**< 57.1**	**< 0.10**

Table 5a. BEAST summary results for Randle Reef sites (n = 80 sites) and corresponding total PAH concentration (mg/kg).

Band 1 n = 30	PAHs	Band 2 n = 19	PAHs	Band 3 n = 8	PAHs	Band 4 n = 23	PAHs
RR19	5.8	RR05	6.2	RR02	12.5	RR01	5.0
RR20	10.8	RR08	332.2	RR06	46.4	RR03	4.7
RR21	2.6	RR14[a]	27.9	RR13	1104.7	RR04	128.6
RR23	8.2	RR18	254.8	RR15	22.0	RR07	135.8
RR24	111.8	RR35	166.8	RR17	53.4	RR09	170.3
RR25	9.8	RR39	40.6	RR32	324.1	RR10	208.8
RR26	247.8	RR40	171.6	RR33	11.3	RR11[a]	75.7
RR27[a]	6.1	RR47	120.3	RR45	2.2	RR12	34.4
RR28	1.0	RR52	372.5			RR16	9.9
RR29	4.4	RR54	20.9			RR22	626.4
RR34	134.6	RR56	2474.0			RR30	182.7
RR38	9.2	RR57	1010.7			RR31	249.5
RR41	5.1	RR60	9048.0			RR36	133.6
RR42	7.5	RR66	704.0			RR37	98.0
RR43	541.6	RR67	289.6			RR49	24.1
RR44	50.4	RR68	67.7			RR50	36.6
RR46	20.8	RR70	487.9			RR55	1047.1
RR48	213.8	RR73	63.5			RR59	888.5
RR51[a]	21.4	7040	7.5			RR72	157.5
RR53	2.1					RR74	138.8
RR58	648.9					RR75	132.3
RR61	122.5					7038	8.0
RR62	120.0					7039	14.5
RR63	612.2						
RR64	237.7						
RR65	48.4						
RR69	281.2						
RR71	230.8						
7043	73.9						
7061	24.6						

[a]QA/QC site. Value represents the mean of three replicates.

Table 5b. BEAST result for Windermere Arm sites (n = 20 sites) and corresponding total PAH and PCB concentration (mg/kg).

Band 1 n = 3	**Total PAHs/PCBs**	**Band 2 n = 5**	**Total PAHs/PCBs**	**Band 3 n = 5**	**Total PAHs/PCBs**	**Band 4 n = 7**	**Total PAHs/PCBs**
WA12[a]	11.2/0.6	WA04	11.5/0.5	WA05[a]	25.3/0.7	WA01	26.0/0.5
WA14[a]	33.3/0.9	WA08[a]	29.6/0.9	WA07	19.7/1.1	WA02[a]	21.9/0.6
WA18	5.1/0.1	WA10	17.8/1.1	WA17	53.2/0.9	WA03	17.6/0.8
		WA13	24.9/1.2	WA19[a]	190.9/2.3	WA06	24.0/1.5
		WA15	20.5/1.2	WA20	715.4/1.7	WA09	22.9/0.9
						WA11	8.5/0.3
						WA16	32.0/1.8

[a]QA/QC site. Value represents the mean of three replicates.

Table 6. Statistics for regressions of sediment toxicity against sediment contaminant concentrations and grain size for two invertebrate taxa from laboratory tests. Predictor and response variables were examined as (a) ordinated or summed "integrated descriptor" variables, and (b) unintegrated measured variables (usually log(x)-transformed). Groups of measured variable predictors are from best subsets multiple linear models that maximized response variance explained and predictor significance, and minimized predictor multicollinearity. Nonsignificant P-values (>0.05) for predictors are not shown.

Response	Predictor Type	Predictors	Coefficient	P (predictor)	R^2_{adj}	P (regression)
toxAxis1	integrated descriptors	lnmetPC1	-0.180	0.006	0.36	<0.001
		lnTotPCBs	0.182			
		lnTotPAHs	-0.039*			
	measured variables	lnAs	0.127		0.58	<0.001
		lnCr	-0.631*	0.015		
		lnCu	-0.040*			
		lnPb	1.018	0.001		
		lnAroclor1254	-0.029*			
		lnFluorene	0.020			
		lnmeanGrainSize	-0.313			
toxAxis2	integrated descriptors	metPC1	0.097	<0.001	0.60	<0.001
		lnTotPCBs	-0.145			
		lnTotPAHs	-0.198	0.018		
	measured variables	lnCu	0.463	<0.001	0.76	<0.001
		lnFe	-1.100	<0.001		
		lnFluorene	-0.088	0.002		
		lnmeanGrainSize	0.303	0.002		
***Hexagenia* survival**	integrated descriptors	metPC1	6.49	0.003	0.37	<0.001
		lnTotPCBs	-2.16			
		lnTotPAHs	-0.20			
	measured variables	lnCd	-17.0	0.002	0.61	<0.001
		lnCu	23.6*	<0.001		
		lnFe	-83.7	<0.001		
		lnZn	18.2*	0.003		
		lnBenzo(ghi)perylene	5.1*	<0.001		
***Hexagenia* growth**	integrated descriptors	metPC1	0.106		0.53	<0.001
		lnTotPCBs	-0.534			
		lnTotPAHs	-0.510	<0.001		
	measured variables	lnCr	1.04*	0.005	0.68	<0.001
		lnFe	-1.53	<0.001		
		lnAcenaphthylene	-0.43	<0.001		
		lnmeanGrainSize	0.99	<0.001		
***Hyalella* survival**	integrated descriptors	metPC1	2.63		0.11	0.026
		lnTotPCBs	-2.92			
		lnTotPAHs	2.59*			
	measured variables	lnPb	-9.04	<0.001	0.14	<0.001
***Hyalella* growth**	integrated descriptors	metPC1	0.0351	<0.001	0.433	<0.001
		lnTotPCBs	-0.0273			
		lnTotPAHs	0.0055*			
	measured variables	lnCu	0.0989*	0.023	0.36	<0.001
		lnPb	-0.2060	<0.001		
		lnBenz(a)anthracene	0.0236*	0.014		

* sign not indicative of toxicity relationship

APPENDIX A Quality Assurance/Quality Control

Table A1. Analytical variability in sediment and overlying water samples expressed as the coefficient of variation.

	Coefficient of Variation									
Variable	RR11	RR14	RR27	RR51	WA02	WA05	WA08	WA12	WA14	WA19
Total PAHs	56.1	14.0	-	17.2	4.9	7.6	7.4	12.4	7.6	15.7
Total PCBs	25.1	44.2	-	24.2	25.3	19.1	9.0	86.7	13.1	3.1
% clay	1.7	0.6	7.6	3.3	6.5	2.3	0.1	1.4	0.5	5.9
% sand	0.6	2.4	14.0	2.8	7.4	8.9	0.0	1.9	7.1	2.8
% silt	0.1	1.6	5.6	3.2	2.8	5.5	0.0	0.7	1.8	2.4
Cd	7.6	2.6	20.4	3.7	4.4	12.0	47.1	84.9	6.3	0.0
Co	5.3	0.7	1.4	6.7	0.4	3.4	0.9	6.2	1.2	4.3
Cr	1.4	43.6	29.7	9.6	6.3	5.2	3.6	0.2	0.1	13.1
Cu	0.5	2.0	1.9	3.9	1.8	2.3	2.5	2.6	2.2	1.7
Fe	3.2	1.4	7.0	0.5	0.9	2.7	2.4	1.4	0.7	5.8
Hg	27.2	29.8	4.7	5.9	7.6	15.4	11.9	25.2	2.5	6.8
Mn	1.6	4.6	1.3	1.5	0.1	3.2	2.1	0.3	2.1	6.8
Ni	4.4	0.9	19.6	0.1	0.9	0.5	0.0	4.7	1.9	0.8
Pb	1.8	0.4	5.2	4.1	0.4	3.5	0.5	0.4	0.4	2.1
Zn	0.5	2.7	10.3	1.6	2.2	2.3	1.6	1.4	0.2	1.1
Total N	15.4	7.3	7.1	13.1	2.2	12.6	15.6	6.5	6.3	17.1
TOC	3.0	6.5	6.4	0.0	2.5	1.8	1.4	9.4	4.6	0.0
Total P	21.8	17.0	8.6	13.0	3.6	10.3	16.5	7.1	9.3	3.2
Alkalinity	0.4	0.6	0.0	1.1	0.5	0.7	1.6	0.1	0.7	1.7
NO_3/NO_2	2.1	1.2	0.0	0.5	2.5	0.2	1.7	0.3	0.2	0.6
TKN (water)	0.0	14.4	1.2	11.8	0.5	6.3	1.6	2.1	0.8	0.9
Total P (water)	1.3	3.3	0.6	0.2	0.6	2.9	2.5	0.9	7.7	16.0

Table A2. Method Blanks, duplicate samples and matrix spike recoveries (Phillips).

	Client ID:		Method Blank	Method Blank	Method Blank	70RR1401	70RR1401	70RR1401	70RR1401	70RR1401	70RR1401	70RR28	70RR28	70RR28	70RR28	70RR28	70RR28
	Lab No.:		078288 02	078288 02	078288 02	078302 02	078302 02	078302 02	078302 02	078302 02	078302 02	078316 02	078316 02	078316 02	078316 02	078316 02	078316 02
	Date Sampled:		13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002
Component	**MDL**	**Units**		M. Spike	MS % Rec.		Duplicate	M. Spike	MS % Rec.	MS Dup	MSD % Rec.		Duplicate	M. Spike	MS % Rec.	MS Dup	MSD % Rec.
Aroclor-1016	0.038	ug/gm	<	0.34	84	<	NA	0.260	73.000	0.330	89.000	<0.041	NA	0.230	52.000	0.250	58.000
Aroclor-1221	0.015	"	<	<	<	<	NA	<	<	<	<	<0.016	NA	<	<	<	<
Aroclor-1232	0.038	"	<	<	<	<	NA	<	<	<	<	<0.041	NA	<	<	<	<
Aroclor-1242	0.038	"	<	<	<	<	NA	<	<	<	<	<0.041	NA	<	<	<	<
Aroclor-1248	0.021	"	<	<	<	0.100	NA	<	<	<	<	<0.023	NA	<	<	<	<
Aroclor-1254	0.059	"	<	<	<	0.210	NA	<	<	<	<	<0.064	NA	<	<	<	<
Aroclor-1260	0.031	"	<	0.32	80	0.110	NA	0.340	94.000	0.390	110.000	<0.034	NA	0.310	71.000	0.390	88.000
Aroclor-1262	0.031	"	<	<	<	<	NA	<	<	<	<	<0.034	NA	<	<	<	<
Aroclor-1268	0.031	"	<	<	<	<	NA	<	<	<	<	<0.034	NA	<	<	<	<
Total PCB	0.059	"	<	0.66	82	0.420	NA	0.600	84.000	0.720	98.000	<0.064	NA	0.540	61.000	0.640	73.000
Surrogate Recoveries		%															
4,4'-Dibromooctaflourobiphenyl			69	79	79	60	NA	74	74	85	85	90	NA	75	75	89	89
Decachlorobiphenyl			87	87	87	77	NA	83	83	99	99	105	NA	88	88	107	107
Naphthalene	0.010	mg/kg	<	0.22	56	6.10	6.10	-	-	-	-	0.12	0.11	0.15	54.00	-	-
Acenaphthylene	0.010	"	<	0.29	71	0.31	0.34	-	-	-	-	0.01	0.01	0.07	90.00	-	-
Acenaphthene	0.010	"	<	0.29	72	0.17	0.19	-	-	-	-	<	<	0.05	76.00	-	-
Fluorene	0.010	"	<	0.31	77	1.30	1.30	-	-	-	-	0.03	0.02	0.08	83.00	-	-
Phenanthrene	0.010	"	<	0.33	81	2.20	2.30	-	-	-	-	0.10	0.08	0.13	59.00	-	-
Anthracene	0.010	"	<	0.31	79	0.56	0.66	-	-	-	-	0.03	0.02	0.08	86.00	-	-
Fluoranthene	0.010	"	<	0.34	84	2.70	2.60	-	-	-	-	0.13	0.11	0.17	87.00	-	-
Pyrene	0.010	"	<	0.33	83	2.00	2.00	-	-	-	-	0.11	0.10	0.16	86.00	-	-
Benz(a)anthracene	0.010	"	<	0.37	92	1.30	1.40	-	-	-	-	0.07	0.05	0.11	84.00	-	-
Chrysene	0.010	"	<	0.38	96	1.50	1.50	-	-	-	-	0.07	0.06	0.11	68.00	-	-
Benzo(b)fluoranthene	0.010	"	<	0.35	87	1.40	1.60	-	-	-	-	0.09	0.08	0.14	93.00	-	-
Benzo(k)fluoranthene	0.010	"	<	0.40	100	1.40	1.30	-	-	-	-	0.03	0.03	0.09	93.00	-	-
Benzo(a)pyrene	0.010	"	<	0.37	92	1.70	1.80	-	-	-	-	0.07	0.07	0.14	100.00	-	-
Indeno(1,2,3-cd)pyrene	0.010	"	<	0.32	79	1.20	1.30	-	-	-	-	0.05	0.05	0.11	96.00	-	-
Dibenzo(ah)anthracene	0.010	"	<	0.31	78	0.30	0.30	-	-	-	-	0.01	0.01	0.08	100.00	-	-
Benzo(ghi)perylene	0.010	"	<	0.34	85	1.00	1.00	-	-	-	-	0.04	0.04	0.10	84.00	-	-
TOTAL PAHS						**25.14**	**25.69**					**0.97**	**0.84**	**1.76**			
Surrogate Recoveries		%															
Anthracene-2H10			85	81	81	83	87	-	-	-	-	86	99	98	98	-	-
Chrysene-2H12			88	89	89	106	105	-	-	-	-	78	79	80	80	-	-
Benzo(a)pyrene-2H12			90	93	93	90	88	-	-	-	-	93	102	112	112	-	-

Table A2. Continued.

	Client ID:		70RR35	70RR35	70RR35	70RR35	70RR35	70RR35	70RR42	70RR42	70RR5101	70RR5101	70RR5101	70RR5101	70RR5101	70RR5101	70RR56
	Lab No.:		078323 02	078323 02	078323 02	078323 02	078323 02	078323 02	078330 02	078330 02	078339 02	078339 02	078339 02	078339 02	078339 02	078339 02	078344 02
	Date Sampled:		14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	13-Nov-2002	13-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002
Component	MDL	Units		Duplicate	M. Spike	MS % Rec.	MS Dup	MSD % Rec.		Duplicate		Duplicate	M. Spike	MS % Rec.	MS Dup	MSD % Rec.	
Aroclor-1016	0.038	ug/gm	<0.044	NA	0.360	73.000	0.320	60.000	<	-	<0.046	NA	0.460	81.000	0.550	91.000	<0.041
Aroclor-1221	0.015	"	<0.017	NA	<	<	<	<	<	-	<0.018	NA	<	<	<	<	<0.016
Aroclor-1232	0.038	"	<0.044	NA	<	<	<	<	<	-	<0.046	NA	<	<	<	<	<0.041
Aroclor-1242	0.038	"	0.068	NA	<	<	<	<	<	-	<0.046	NA	<	<	<	<	<0.041
Aroclor-1248	0.021	"	<0.024	NA	<	<	<	<	<	-	<0.025	NA	<	<	<	<	<0.023
Aroclor-1254	0.059	"	0.150	NA	<	<	<	<	0.077	-	0.130	NA	<	<	<	<	0.079
Aroclor-1260	0.031	"	0.130	NA	0.410	84.000	0.430	81.000	0.048	-	0.110	NA	0.570	99.000	0.570	95.000	0.073
Aroclor-1262	0.031	"	<0.036	NA	<	<	<	<	<	-	<0.037	NA	<	<	<	<	<0.034
Aroclor-1268	0.031	"	<0.036	NA	<	<	<	<	<	-	<0.037	NA	<	<	<	<	<0.034
Total PCB	0.059	"	0.350	NA	0.770	79.000	0.750	70.000	0.130	-	0.240	NA	1.000	90.000	1.100	93.000	0.150
Surrogate Recoveries		%															
4,4'-Dibromooctaflourobiphenyl			69	NA	77	77	68	68	63	-	92	NA	92	92	97	97	78
Decachlorobiphenyl			73	NA	80	80	73	73	73	-	98	NA	95	95	89	89	102
Naphthalene	0.010	mg/kg	6.70	-	-	-	-	-	0.99	1.10	3.60	-	-	-	-	-	150.00
Acenaphthylene	0.010	"	2.10	-	-	-	-	-	0.07	0.09	0.25	-	-	-	-	-	34.00
Acenaphthene	0.010	"	1.20	-	-	-	-	-	0.05	0.05	0.11	-	-	-	-	-	68.00
Fluorene	0.010	"	1.70	-	-	-	-	-	0.21	0.20	0.38	-	-	-	-	-	90.00
Phenanthrene	0.010	"	13.00	-	-	-	-	-	0.66	0.70	1.20	-	-	-	-	-	500.00
Anthracene	0.010	"	4.70	-	-	-	-	-	0.17	0.17	0.48	-	-	-	-	-	110.00
Fluoranthene	0.010	"	28.00	-	-	-	-	-	0.93	1.00	2.20	-	-	-	-	-	450.00
Pyrene	0.010	"	23.00	-	-	-	-	-	0.75	0.85	1.90	-	-	-	-	-	350.00
Benz(a)anthracene	0.010	"	11.00	-	-	-	-	-	0.52	0.58	1.30	-	-	-	-	-	120.00
Chrysene	0.010	"	12.00	-	-	-	-	-	0.58	0.66	1.30	-	-	-	-	-	120.00
Benzo(b)fluoranthene	0.010	"	16.00	-	-	-	-	-	0.58	0.76	1.90	-	-	-	-	-	130.00
Benzo(k)fluoranthene	0.010	"	7.30	-	-	-	-	-	0.46	0.45	0.67	-	-	-	-	-	54.00
Benzo(a)pyrene	0.010	"	15.00	-	-	-	-	-	0.60	0.70	1.60	-	-	-	-	-	120.00
Indeno(1,2,3-cd)pyrene	0.010	"	12.00	-	-	-	-	-	0.44	0.51	0.96	-	-	-	-	-	82.00
Dibenzo(ah)anthracene	0.010	"	2.10	-	-	-	-	-	0.10	0.15	0.22	-	-	-	-	-	15.00
Benzo(ghi)perylene	0.010	"	11.00	-	-	-	-	-	0.37	0.45	0.75	-	-	-	-	-	81.00
TOTAL PAHS			**166.80**						**7.48**	**8.42**	**18.82**						**2474.00**
Surrogate Recoveries		%															
Anthracene-2H10			85	-	-	-	-	-	85	87	110	-	-	-	-	-	90
Chrysene-2H12			112	-	-	-	-	-	90	89	88	-	-	-	-	-	115
Benzo(a)pyrene-2H12			88	-	-	-	-	-	91	85	99	-	-	-	-	-	106

Table A2. Continued.

Client ID:			70RR56	70RR56	70RR56	70RR65	70RR65	70RR65	70RR65	70RR65	70RR66	70RR66	70RR66	70RR66	70RR66	70RR70	70RR70
Lab No.:			078344 02	078344 02	078344 02	078353 02	078353 02	078353 02	078353 02	078353 02	078354 02	078354 02	078354 02	078354 02	078354 02	078358 02	078358 02
Date Sampled:			14-Nov-2002	14-Nov-2002	14-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002
Component	**MDL**	**Units**	Duplicate	M. Spike	MS % Rec.		M. Spike	MS % Rec.	MS Dup	MSD % Rec.		M. Spike	MS % Rec.	MS Dup	MSD % Rec.		Duplicate
Aroclor-1016	0.038	ug/gm	-	-	-	<0.049	0.380	61.000	0.280	45.000	<0.048	0.340	54.000	0.300	53.000	<0.045	-
Aroclor-1221	0.015	"	-	-	-	<0.019	<	<	<	<	<0.019	<	<	<	<	<0.018	-
Aroclor-1232	0.038	"	-	-	-	<0.049	<	<	<	<	<0.048	<	<	<	<	<0.045	-
Aroclor-1242	0.038	"	-	-	-	<0.049	<	<	<	<	<0.048	<	<	<	<	<0.045	-
Aroclor-1248	0.021	"	-	-	-	<0.027	<	<	<	<	<0.027	<	<	<	<	<0.025	-
Aroclor-1254	0.059	"	-	-	-	<0.077	<	<	<	<	<0.075	<	<	<	<	<0.070	-
Aroclor-1260	0.031	"	-	-	-	0.056	0.500	80.000	0.460	75.000	0.065	0.520	83.000	0.470	84.000	0.089	-
Aroclor-1262	0.031	"	-	-	-	<0.040	<	<	<	<	<0.040	<	<	<	<	<0.037	-
Aroclor-1268	0.031	"	-	-	-	<0.040	<	<	<	<	<0.040	<	<	<	<	<0.037	-
Total PCB	0.059	"	-	-	-	<	0.880	70.000	0.740	60.000	0.065	0.850	68.000	0.780	68.000	0.089	-
Surrogate Recoveries		%															
4,4'-Dibromooctaflourobiphenyl			-	-	-	75	77	77	75	75	65	79	79	74	74	72	-
Decachlorobiphenyl			-	-	-	91	88	88	89	89	71	90	90	90	90	91	-
Naphthalene	0.010	mg/kg	62.00	68.00	31.00	3.80	-	-	-	-	7.40	-	-	-	-	7.20	6.00
Acenaphthylene	0.010	"	27.00	53.00	3.00	0.76	-	-	-	-	5.30	-	-	-	-	4.70	3.90
Acenaphthene	0.010	"	45.00	72.00	8.00	0.53	-	-	-	-	13.00	-	-	-	-	7.60	5.70
Fluorene	0.010	"	51.00	94.00	14.00	1.10	-	-	-	-	15.00	-	-	-	-	8.10	6.40
Phenanthrene	0.010	"	350.00	600.00	53.00	5.60	-	-	-	-	110.00	-	-	-	-	58.00	46.00
Anthracene	0.010	"	100.00	180.00	4.00	2.30	-	-	-	-	34.00	-	-	-	-	19.00	16.00
Fluoranthene	0.010	"	360.00	590.00	32.00	7.50	-	-	-	-	140.00	-	-	-	-	87.00	73.00
Pyrene	0.010	"	280.00	460.00	23.00	5.40	-	-	-	-	100.00	-	-	-	-	69.00	57.00
Benz(a)anthracene	0.010	"	95.00	150.00	9.00	3.50	-	-	-	-	45.00	-	-	-	-	35.00	28.00
Chrysene	0.010	"	96.00	160.00	7.00	3.60	-	-	-	-	45.00	-	-	-	-	36.00	29.00
Benzo(b)fluoranthene	0.010	"	110.00	170.00	7.00	3.60	-	-	-	-	46.00	-	-	-	-	36.00	30.00
Benzo(k)fluoranthene	0.010	"	43.00	82.00	4.00	2.60	-	-	-	-	30.00	-	-	-	-	26.00	22.00
Benzo(a)pyrene	0.010	"	100.00	170.00	8.00	3.30	-	-	-	-	47.00	-	-	-	-	39.00	32.00
Indeno(1,2,3-cd)pyrene	0.010	"	68.00	110.00	5.00	2.20	-	-	-	-	31.00	-	-	-	-	26.00	21.00
Dibenzo(ah)anthracene	0.010	"	11.00	16.00	<	0.65	-	-	-	-	5.30	-	-	-	-	4.30	3.60
Benzo(ghi)perylene	0.010	"	70.00	110.00	4.00	2.00	-	-	-	-	30.00	-	-	-	-	25.00	21.00
TOTAL PAHS			**1868.00**	**3085.00**		**48.44**					**704.00**					**487.90**	**400.60**
Surrogate Recoveries		%															
Anthracene-2H10			116	125	125	86	-	-	-	-	71	-	-	-	-	86	84
Chrysene-2H12			125	99	99	79	-	-	-	-	87	-	-	-	-	94	93
Benzo(a)pyrene-2H12			107	97	97	73	-	-	-	-	82	-	-	-	-	68	72

Table A2. Continued.

Client ID:			70WA04	70WA04	70WA04	70WA04	70WA09	70WA09	70WA09	70WA09	70WA09	70WA18	70WA1
Lab No.:			078372 02	078372 02	078372 02	078372 02	078377 02	078377 02	078377 02	078377 02	078377 02	078386 02	078386
Date Sampled:			21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002
Component	MDL	Units		Duplicate	M. Spike	MS % Rec.		M. Spike	MS % Rec.	MS Dup	MSD % Rec.		Duplicate
Aroclor-1016	0.038	ug/gm	<0.039	-	-	-	<0.048	0.450	68.000	0.360	59.000	<	NA
Aroclor-1221	0.015	"	<	-	-	-	<0.019	<	<	<	<	<	NA
Aroclor-1232	0.038	"	<0.039	-	-	-	<0.048	<	<	<	<	<	NA
Aroclor-1242	0.038	"	<0.039	-	-	-	<0.048	<	<	<	<	<	NA
Aroclor-1248	0.021	"	0.078	-	-	-	0.130	<	<	<	<	<	NA
Aroclor-1254	0.059	"	0.120	-	-	-	0.260	<	<	<	<	<	NA
Aroclor-1260	0.031	"	0.270	-	-	-	0.510	0.860	130.000	0.850	140.000	0.082	NA
Aroclor-1262	0.031	"	<0.032	-	-	-	<0.039	<	<	<	<	<	NA
Aroclor-1268	0.031	"	<0.032	-	-	-	<0.039	<	<	<	<	<	NA
Total PCB	0.059	"	0.470	-	-	-	0.900	1.300	99.000	1.200	98.000	0.130	NA
Surrogate Recoveries		%											
4,4'-Dibromooctaflourobiphenyl			57	-	-	-	55	65	65	59	59	93	NA
Decachlorobiphenyl			69	-	-	-	63	66	66	63	63	98	NA
Naphthalene	0.010	mg/kg	0.49	0.67	0.72	<	1.90	-	-	-	-	0.14	0.13
Acenaphthylene	0.010	"	0.19	0.25	0.34	<	0.37	-	-	-	-	0.05	0.06
Acenaphthene	0.010	"	0.16	0.18	0.25	130.00	0.27	-	-	-	-	0.05	0.05
Fluorene	0.010	"	0.14	0.17	0.23	120.00	0.25	-	-	-	-	0.05	0.05
Phenanthrene	0.010	"	0.60	0.72	0.78	<	1.00	-	-	-	-	0.24	0.26
Anthracene	0.010	"	0.23	0.27	0.35	150.00	0.39	-	-	-	-	0.07	0.09
Fluoranthene	0.010	"	1.50	2.20	2.30	13.00	3.00	-	-	-	-	0.85	0.85
Pyrene	0.010	"	1.80	2.00	2.10	6.00	2.50	-	-	-	-	0.74	0.73
Benz(a)anthracene	0.010	"	1.00	1.50	1.60	<	1.90	-	-	-	-	0.52	0.52
Chrysene	0.010	"	1.10	1.50	1.60	<	2.10	-	-	-	-	0.52	0.53
Benzo(b)fluoranthene	0.010	"	1.40	1.80	2.00	11.00	2.30	-	-	-	-	0.56	0.58
Benzo(k)fluoranthene	0.010	"	0.57	0.78	0.87	<	2.00	-	-	-	-	0.34	0.40
Benzo(a)pyrene	0.010	"	1.10	1.50	1.50	<	2.20	-	-	-	-	0.48	0.50
Indeno(1,2,3-cd)pyrene	0.010	"	0.58	0.77	0.82	<	1.30	-	-	-	-	0.26	0.26
Dibenzo(ah)anthracene	0.010	"	0.13	0.18	0.22	100.00	0.28	-	-	-	-	0.06	0.06
Benzo(ghi)perylene	0.010	"	0.50	0.64	0.66	140.00	1.10	-	-	-	-	0.20	0.22
TOTAL PAHS			11.49	15.13	16.34		22.86					5.12	5.28
Surrogate Recoveries		%											
Anthracene-2H10			107	106	115	115	87	-	-	-	-	90	92
Chrysene-2H12			102	98	100	100	114	-	-	-	-	102	105
Benzo(a)pyrene-2H12			98	93	95	95	91	-	-	-	-	91	92

Client ID:			70WA18	70WA18	70WA18	70WA18	70WA1902	70WA1902	70WA1902	70WA1902	70WA1902	70WA1902
Lab No.:			078386 02	078386 02	078386 02	078386 02	078398 02	078398 02	078398 02	078398 02	078398 02	078398 02
Date Sampled:			21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002
Component	MDL	Units	M. Spike	MS % Rec.	MS Dup	MSD % Rec.		Duplicate	M. Spike	MS % Rec.	MS Dup	MSD % Rec.
Aroclor-1016	0.038	ug/gm	0.260	73.000	0.250	71.000	<0.044	NA	0.570	90.000	0.760	130.000
Aroclor-1221	0.015	"	<	<	<	<	<0.017	NA	<	<	<	<
Aroclor-1232	0.038	"	<	<	<	<	<0.044	NA	<	<	<	<
Aroclor-1242	0.038	"	<	<	<	<	<0.044	NA	<	<	<	<
Aroclor-1248	0.021	"	<	<	<	<	0.750	NA	<	<	<	<
Aroclor-1254	0.059	"	<	<	<	<	0.680	NA	<	<	<	<
Aroclor-1260	0.031	"	0.370	110.000	0.330	92.000	0.910	NA	0.940	150.000	1.300	210.000
Aroclor-1262	0.031	"	<	<	<	<	<0.036	NA	<	<	<	<
Aroclor-1268	0.031	"	<	<	<	<	<0.036	NA	<	<	<	<
Total PCB	0.059	"	0.630	89.000	0.580	82.000	2.300	NA	1.500	120.000	2.000	170.000
Surrogate Recoveries		%										
4,4'-Dibromooctaflourobiphenyl			101	101	91	91	81	NA	71	71	73	73
Decachlorobiphenyl			113	113	96	96	88	NA	80	80	78	78
Naphthalene	0.010	mg/kg	-	-	-	-	3.10	2.80	2.80	<	-	-
Acenaphthylene	0.010	"	-	-	-	-	0.58	0.72	0.56	<	-	-
Acenaphthene	0.010	"	-	-	-	-	5.90	4.90	5.00	<	-	-
Fluorene	0.010	"	-	-	-	-	4.50	4.10	3.90	<	-	-
Phenanthrene	0.010	"	-	-	-	-	20.00	18.00	17.00	<	-	-
Anthracene	0.010	"	-	-	-	-	5.40	5.50	4.50	<	-	-
Fluoranthene	0.010	"	-	-	-	-	38.00	33.00	32.00	<	-	-
Pyrene	0.010	"	-	-	-	-	31.00	26.00	26.00	<	-	-
Benz(a)anthracene	0.010	"	-	-	-	-	12.00	11.00	11.00	<	-	-
Chrysene	0.010	"	-	-	-	-	11.00	10.00	9.70	<	-	-
Benzo(b)fluoranthene	0.010	"	-	-	-	-	13.00	12.00	11.00	<	-	-
Benzo(k)fluoranthene	0.010	"	-	-	-	-	5.00	4.70	4.80	<	-	-
Benzo(a)pyrene	0.010	"	-	-	-	-	9.70	9.00	8.50	<	-	-
Indeno(1,2,3-cd)pyrene	0.010	"	-	-	-	-	5.10	4.70	4.40	<	-	-
Dibenzo(ah)anthracene	0.010	"	-	-	-	-	0.87	0.92	1.00	130.00	-	-
Benzo(ghi)perylene	0.010	"	-	-	-	-	4.50	4.30	4.00	<	-	-
TOTAL PAHS							169.65	151.64	146.16			
Surrogate Recoveries		%										
Anthracene-2H10			-	-	-	-	78	97	80	80	-	-
Chrysene-2H12			-	-	-	-	92	91	106	106	-	-
Benzo(a)pyrene-2H12			-	-	-	-	85	78	91	91	-	-

Table A3. Laboratory and field-duplicates (Caduceon).

Sample ID	Cd	Co	Cr	Cu	Fe	Mercury	Mg	Mn	Ni	Pb	Zn	Phosphorus	TOC	Nitrogen
Units	µg/g	µg/g	µg/g	µg/g	pct	µg/g	pct	µg/g	µg/g	µg/g	µg/g	µg/g	pct	µg/g
Detection Limit	1	1	1	1	0.01	0.005	0.01	1	1	1	1	0.3	0.1	0.05
70RR01	2	9	43	47	2.41	0.246	0.09	926	12	62	255	866	2.3	1500
70RR01 Dup	2	10	45	48	2.50	0.239	0.10	957	13	65	267			
70RR09	2	10	81	69	5.26	0.431	0.17	1713	21	200	1158	1650	6.4	2530
70RR09 Dup														
70RR10	2	20	90	131	10.7	0.788	0.27	2740	72	438	2350	1830	7.1	3220
70RR10 Dup	1	21	90	139	11.1		0.28	2840	80	448	2400			
70RR1101	2	200	141	703	15.0	0.658	0.22	2200	572	327	1580	1290	4.8	2540
70RR1102	1	216	144	708	15.7	0.446	0.23	2250	609	336	1590	1760	4.6	3160
70RR1401	1	11	35	62	3.17	0.437	0.18	1774	25	112	609	1170	3.1	1740
70RR1401 Dup												1590		2130
70RR1402	1	11	67	64	3.11	0.285	0.17	1662	26	111	586	1490	3.4	1930
70RR16	1	9	53	58	1.98	0.1	0.15	1519	16	70	330	1470	2.4	1970
70RR16 Dup						0.094								
70RR23	1	7	57	35	1.63	0.117	0.15	1548	17	47	235	1200	4.7	1330
70RR23 Dup												1040		1260
70RR24	2	8	82	59	2.53	0.121	0.14	1378	6	70	364	850	5.1	1570
70RR24 Dup	2	8	86	42	2.67		0.14	1438	5	71	375			
70RR2701	1	7	51	32	1.82	0.102	0.12	1171	13	49	266	992	2.3	1790
70RR2702	1	7	33	31	1.65	0.109	0.11	1149	10	46	229	1120	2.1	1980
70RR32	2	6	77	29	2.22	0.053	0.20	2041	3	42	186	1160	10.5	2050
70RR32 Dup						0.043								
70RR39	2	8	43	48	3.15	0.132	0.13	1309	21	103	699	2220	3.1	2050
70RR39 Dup	1	8	41	57	2.90		0.13	1279	21	104	680			
70RR48	4	11	143	70	4.78	0.248	0.16	1616	33	218	1710	2072	5.2	2047
70RR48 Dup														
70RR49	3	9	86	50	2.89	0.12	0.11	1070	16	146	766	1110	2.8	1250
70RR49 Dup						0.128								
70RR5101	2	8	74	56	2.68	0.124	0.13	1341	18	109	593	1490	3	2120
70RR5102	2	9	64	59	2.70	0.114	0.13	1312	18	115	607	1240	3	1760
70RR54	2	10	83	62	3.07	0.165	0.14	1375	21	126	712	1560	3.2	2201
70RR54 Dup	2	9	81	59	2.98		0.14	1351	20	124	695			
70RR56	2	7	88	45	3.33	0.195	0.21	2084	2	138	586	1330	10.3	2280
70RR56 Dup														
70RR59	2	7	56	33	3.19	0.176	0.14	1356	9	113	872	1012	7.1	1210
70RR59 Dup												1090		1330
70RR65	2	7	66	31	2.20	0.036	0.11	1122	6	51	297	1055	2.5	1420
70RR65 Dup						0.041								
70RR70	1	8	72	41	3.68	0.235	0.12	1234	20	122	987	1750	5.5	1570
70RR70 Dup	2	8	74	40	3.78		0.13	1273	20	124	986			
70RR74	4	10	99	67	6.61	0.311	0.16	1615	42	314	2430	2630	6.7	1830
70RR74 Dup														
70WA0201	2	8	126	89	3.36	0.293	0.09	854	24	146	814	2510	2.8	2550
70WA0201 Dup						0.281								
70WA0202	2	9	115	87	3.32	0.263	0.09	855	24	145	790	2640	2.9	2630
70WA0501	2	11	94	127	3.87	0.258	0.10	1031	26	152	922	2880	3.8	3210
70WA0501 Dup	2	10	92	133	3.82		0.10	1011	25	152	918			
70WA0502	1	10	101	131	3.72	0.321	0.10	986	25	145	892	3330	3.9	3840
70WA06	4	14	266	233	5.12	0.487	0.14	1392	42	296	1903	3300	4.4	3470
70WA06 Dup														
70WA0801	2	10	184	144	6.63	0.439	0.18	1750	49	260	1830	3030	5	3760
70WA0802	1	10	175	139	6.41	0.371	0.17	1700	49	258	1790	3830	4.9	4690
70WA0802 Dup												3660		3810
70WA1201	<1	10	117	74	4.19	0.288	0.15	1530	16	169	1039	1890	4	2940
70WA1202	2	9	117	77	4.27	0.201	0.15	1523	17	168	1060	1710	3.5	2680
70WA1401	2	11	102	153	4.02	0.323	0.10	971	30	160	962	4721	4.5	4632
70WA1402	2	10	102	158	3.98	0.312	0.09	943	31	160	964	5389	4.8	5060
70WA1402 Dup						0.304								
70WA17	2	11	109	185	4.26	0.216	0.09	936	31	162	1012	7400	5.3	6900
70WA17 Dup	3	11	109	183	4.24		0.09	948	32	164	1023	7080		6290
70WA1901	2	11	159	198	4.11	0.274	0.11	1098	35	308	1744	4690	4	4600
70WA1902	2	11	132	203	4.46	0.249	0.12	1210	35	299	1718	4480	4	3610

Table A4. Percent recovery in matrix spikes and mercury reference standards (Caduceon).

LKSD-2/WH89-1	% Recovery
Ag	102
As	100
Cd	100
Co	94
Cr	95
Cu	100
Fe	89
Mn	98
Mo	106
Ni	109
Pb	100
V	91
Zn	101
Aluminum	98
Barium	100
Calcium	99
Chromium	100
Iron	100
Potassium	94
Magnesium	99
Manganese	100
Sodium	98
Phosphorus	106
Silicon	103
Titanium	96
Loss on Ignition	96
Whole Rock	101
Mean	**99**
Median	**100**

Reference Material	Expected Total Hg (µg/g)	Measured Total Hg (µg/g)	% Recovery
STSD-2	46	51	111
STSD-2	46	49	107
STSD-2	46	51	111
STSD-2	46	44	96
STSD-2	46	43	93
STSD-2	46	43	93
STSD-4	930	865	93
STSD-4	930	867	93
STSD-4	930	1010	109
STSD-4	930	876	94
STSD-1	110	115	105
STSD-1	110	104	95
STSD-1	110	117	106
STSD-1	110	117	106
		Mean	**101**
		Median	**100**

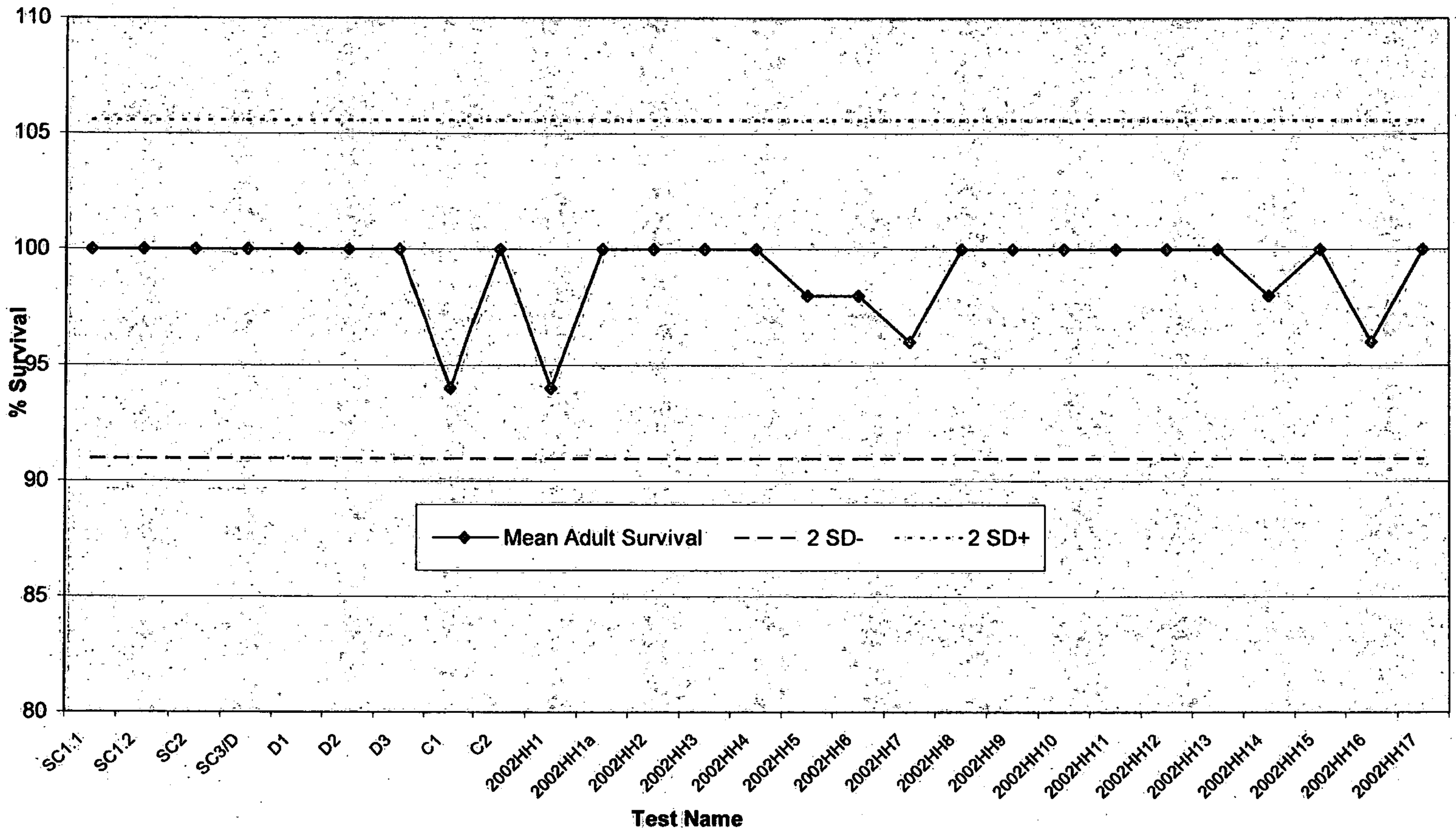


Figure A1. Mean Long Point control survival for *Hexagenia* 21-day test.

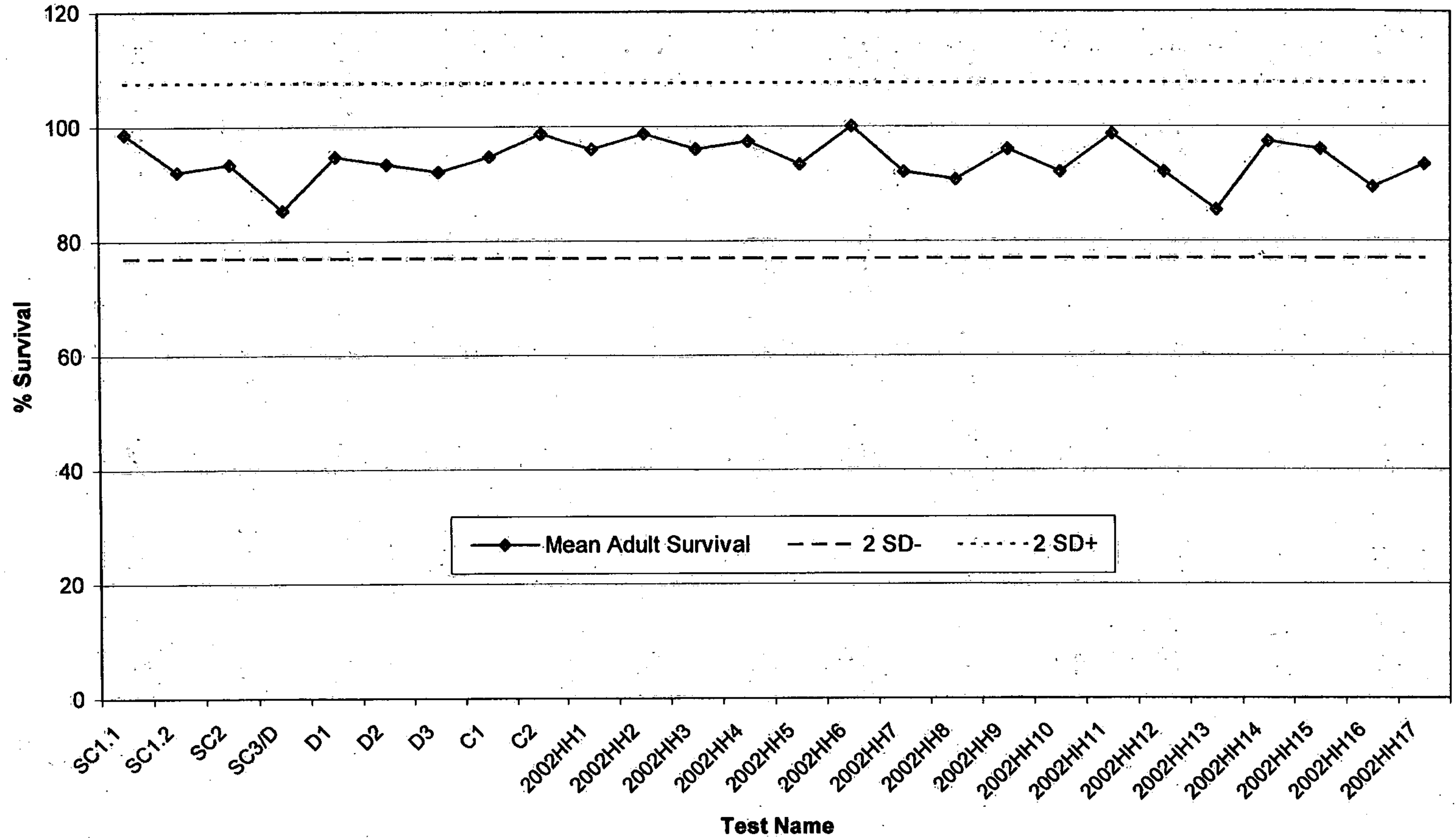


Figure A2. Mean Long Point control survival for *Hyalella* 28-day test.

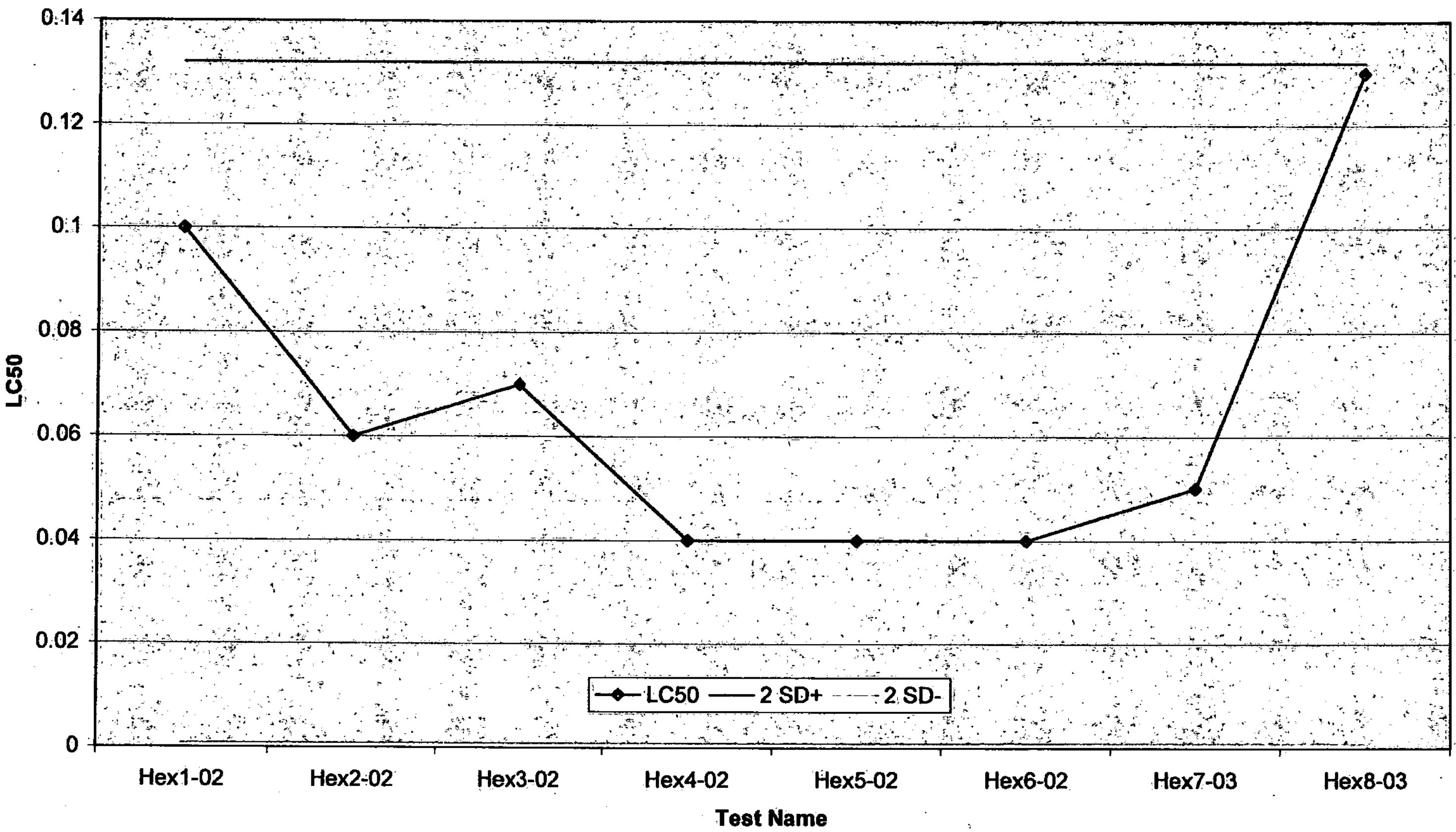


Figure A3. Reference toxicant (Cu) LC50s for Hexagenia.

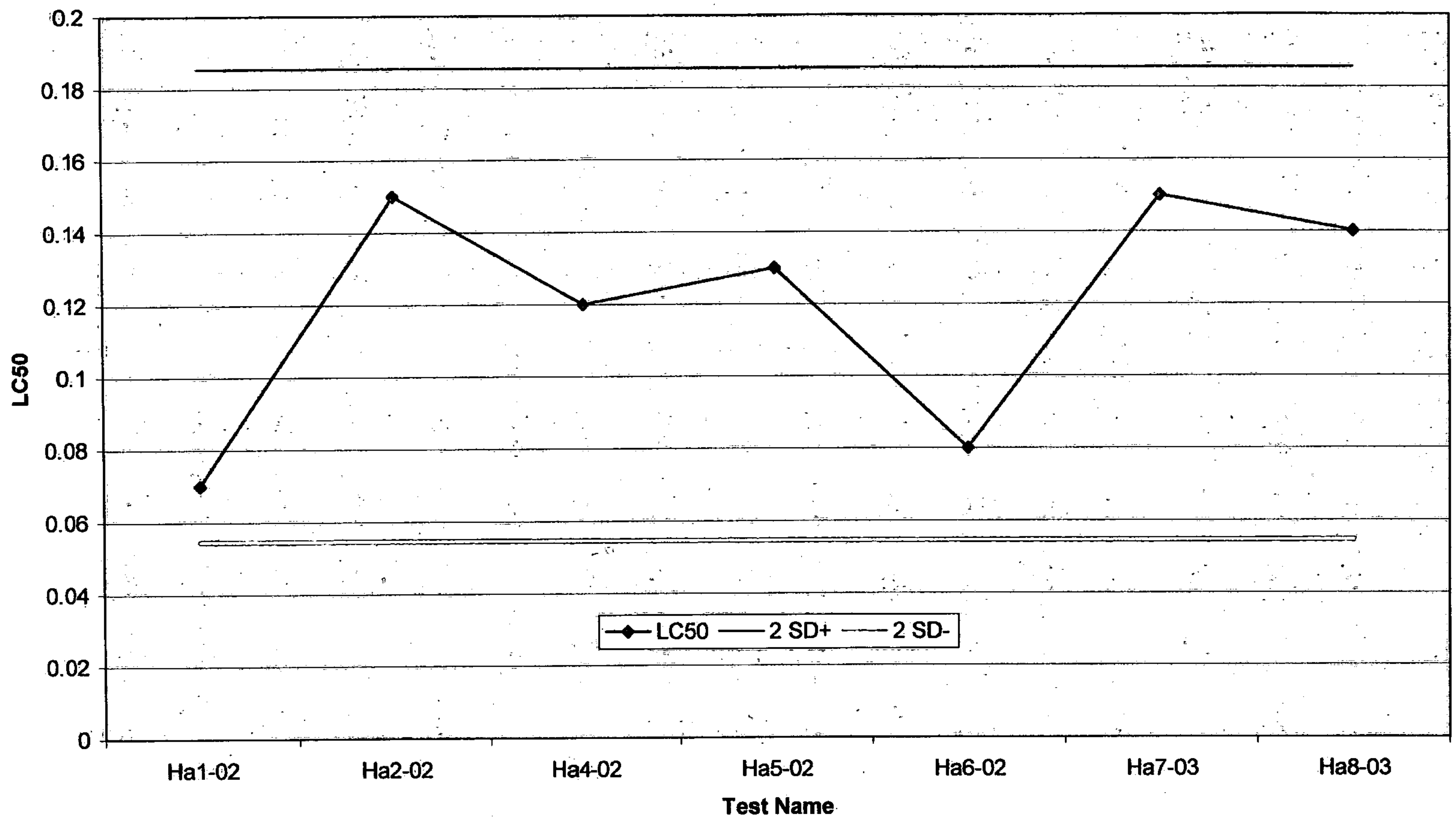


Figure A4. Reference toxicant (Cu) LC50s for Hexagenia.

APPENDIX B Chemistry Data

Table B1. Total PAHs in Randle Reef sediments. Concentrations higher than the severe effect level (normalized to percent total organic carbon) (Persaud *et al.* 1993) are highlighted.

Site	Total PAHs µg/g	TOC (%)	SEL (µg/g TOC)	Site	Total PAHs µg/g	TOC (%)	SEL (µg/g TOC)
70RR01	5.0	2.3	230	70RR40	171.6	5.2	520
70RR02	12.5	3.1	310	70RR41	5.1	2.1	210
70RR03	4.7	3.3	330	70RR42	7.5	2.2	220
70RR04	128.6	7.2	720	70RR43	541.6	6.3	630
70RR05	6.2	1.7	170	70RR44	50.4	4.5	450
70RR06	46.4	4.1	410	70RR45	2.2	1.4	140
70RR07	135.8	6.4	640	70RR46	20.8	2.2	220
70RR08	332.2	6.0	600	70RR47	120.3	6.7	670
70RR09	170.3	6.4	640	70RR48	213.8	5.2	520
70RR10	208.8	7.1	710	70RR49	24.1	2.8	280
70RR1101	45.7	4.8	480	70RR50	36.6	3.5	350
70RR1102	105.7	4.6	460	70RR5101	18.8	3.0	300
70RR12	34.4	4.4	440	70RR5102	24.0	3.0	300
70RR13	1104.7	11.7	1000	70RR52	372.5	5.4	540
70RR1401	25.1	3.1	310	70RR53	2.1	1.4	140
70RR1402	30.63	3.4	340	70RR54	20.9	3.2	320
70RR15	22.0	3.5	350	70RR55	1047.1	6.8	680
70RR16	9.9	2.4	240	70RR56	2474.0	10.3	1000
70RR17	53.4	4.2	420	70RR57	1010.7	5.1	510
70RR18	254.8	4.6	460	70RR58	648.9	7.1	710
70RR19	5.8	2.2	220	70RR59	888.5	7.1	710
70RR20	10.8	2.2	220	70RR60	9048.0	9.0	900
70RR21	2.6	5.1	510	70RR61	122.5	5.7	570
70RR22	626.4	4.0	400	70RR62	120.0	7.8	780
70RR23	8.2	4.7	470	70RR63	612.2	7.6	760
70RR24	111.8	5.1	510	70RR64	237.7	5.3	530
70RR25	9.8	2.5	250	70RR65	48.4	2.5	250
70RR26	247.8	4.8	480	70RR66	704.0	4.8	480
70RR2701	5.6	2.3	230	70RR67	289.6	5.1	510
70RR2702	6.66	2.1	210	70RR68	67.7	4.7	470
70RR28	1.0	1.7	170	70RR69	281.2	6.1	610
70RR29	4.4	2.7	270	70RR70	487.9	5.5	550
70RR30	182.7	6.8	680	70RR71	230.8	3.9	390
70RR31	249.5	6.5	650	70RR72	157.5	6.9	690
70RR32	324.1	10.5	1000	70RR73	63.5	2.0	200
70RR33	11.3	2.9	290	70RR74	138.8	6.7	670
70RR34	134.6	5.6	560	70RR75	132.3	6.4	640
70RR35	166.8	5.6	560	7038	8.0	2.1	210
70RR36	133.6	4.8	480	7039	14.5	5.2	520
70RR37	98.0	4.9	490	7040	7.5	3.3	330
70RR38	9.2	3.3	330	7043	73.9	4.2	420
70RR39	40.6	3.1	310	7061	24.6	3.3	330

Table B2. Total PAHs in Windermere Arm sediments. Concentration higher than the severe effect level (normalized to percent total organic carbon) (Persaud *et al.* 1993) is highlighted.

Site	Total PAHs µg/g	TOC (%)	SEL (µg/g TOC)
70WA01	26.0	6.9	690
70WA0201	21.1	2.8	280
70WA0202	22.6	2.9	290
70WA03	17.6	2.0	200
70WA04	11.5	2.1	210
70WA0501	23.9	3.8	380
70WA0502	26.6	3.9	390
70WA06	24.0	4.4	440
70WA07	19.7	1.1	110
70WA0801	28.0	5.0	500
70WA0802	31.1	4.9	490
70WA09	22.9	3.8	380
70WA10	17.8	4.1	410
70WA11	8.5	1.2	120
70WA1201	18.7	4.0	400
70WA1202	22.3	3.5	350
70WA13	24.9	4.9	490
70WA1401	31.5	4.5	450
70WA1402	35.1	4.8	480
70WA15	20.5	4.4	440
70WA16	32.0	4.9	490
70WA17	53.2	5.3	530
70WA18	5.1	0.3	30
70WA1901	212.0	4.0	400
70WA1902	169.7	4.0	400
70WA20	715.4	6.7	670

Table B3. Total PCBs (sum of nine Aroclors) in Randle Reef sediments.

Site	Total PCBs µg/g	TOC (%)	SEL (µg/g TOC)	Site	Total PCBs µg/g	TOC (%)	SEL (µg/g TOC)
70RR01	0.19	2.3	12.2	70RR40	0.39	5.2	27.6
70RR02	0.15	3.1	16.4	70RR41	0.13	2.1	11.1
70RR03	0.07	3.3	17.5	70RR42	0.13	2.2	11.7
70RR04	0.81	7.2	38.2	70RR43	<	6.3	
70RR05	0.16	1.7	9.0	70RR44	0.15	4.5	23.9
70RR06	0.36	4.1	21.7	70RR45	<0.060	1.4	7.4
70RR07	0.42	6.4	33.9	70RR46	<	2.2	
70RR08	0.21	6.0	31.8	70RR47	<	6.7	
70RR09	0.46	6.4	33.9	70RR48	0.57	5.2	27.6
70RR10	0.71	7.1	37.6	70RR49	0.39	2.8	14.8
70RR1101	0.65	4.8	25.4	70RR50	0.34	3.5	18.6
70RR1102	0.93	4.6	24.4	70RR5101	0.24	3.0	15.9
70RR12	1.40	4.4	23.3	70RR5102	0.17	3.0	15.9
70RR13	0.27	11.7	53.0	70RR52	0.21	5.4	28.6
70RR1401	0.42	3.1	16.4	70RR53	<	1.4	7.4
70RR1402	0.22	3.4	18.0	70RR54	0.23	3.2	17.0
70RR15	0.40	3.5	18.6	70RR55	0.45	6.8	36.0
70RR16	0.15	2.4	12.7	70RR56	0.15	10.3	53.0
70RR17	0.45	4.2	22.3	70RR57	0.29	5.1	27.0
70RR18	0.18	4.6	24.4	70RR58	0.18	7.1	37.6
70RR19	<	2.2		70RR59	0.15	7.1	37.6
70RR20	0.21	2.2	11.7	70RR60	<	9.0	47.7
70RR21	<0.065	5.1	27.0	70RR61	0.13	5.7	30.2
70RR22	0.10	4.0	21.2	70RR62	0.17	7.8	41.3
70RR23	0.06	4.7	24.9	70RR63	<	7.6	40.3
70RR24	<	5.1		70RR74	<	5.3	
70RR25	0.35	2.5	13.3	70RR65	<	2.5	
70RR26	0.17	4.8	25.4	70RR66	0.07	4.8	25.4
70RR2701	<	2.3		70RR67	0.33	5.1	27.0
70RR2702	<	2.1		70RR68	<	4.7	
70RR28	<0.064	1.7	9.0	70RR69	<	6.1	
70RR29	<	2.7		70RR70	0.09	5.5	29.2
70RR30	1.40	6.8	36.0	70RR71	<	3.9	
70RR31	0.25	6.5	34.5	70RR72	0.25	6.9	36.6
70RR32	<	10.5		70RR73	<	2.0	10.6
70RR30	0.36	2.9	15.4	70RR74	0.72	6.7	35.5
70RR34	<	5.6		70RR75	0.22	6.4	33.9
70RR35	0.35	5.6	29.7	7038	<	2.1	
70RR36	0.44	4.8	25.4	7039	0.34	5.2	27.6
70RR37	0.34	4.9	26.0	7040	0.51	3.3	17.5
70RR38	0.15	3.3	17.5	7043	<0.061	4.2	22.3
70RR39	0.48	3.1	16.4	7061	0.21	3.3	17.5

Table B4. Total PCBs (sum of 9 Aroclors) in Windermere Arm sediments.

Site	Total PCBs μg/g	TOC (%)	SEL (μg/g TOC)
70WA01	0.47	6.9	36.6
70WA0201	0.66	2.8	14.8
70WA0202	0.46	2.9	15.4
70WA03	0.80	2.0	10.6
70WA04	0.47	2.1	11.1
70WA0501	0.61	3.8	20.1
70WA0502	0.80	3.9	20.7
70WA06	1.50	4.4	23.3
70WA07	1.10	1.1	5.8
70WA0801	1.00	5.0	26.5
70WA0802	0.88	4.9	26.0
70WA09	0.90	3.8	20.1
70WA10	1.10	4.1	21.7
70WA11	0.32	1.2	6.4
70WA1201	1.00	4.0	21.2
70WA1202	0.24	3.5	18.6
70WA13	1.20	4.9	26.0
70WA1401	1.00	4.5	23.9
70WA1402	0.83	4.8	25.4
70WA15	1.20	4.4	23.3
70WA16	1.80	4.9	26.0
70WA17	0.94	5.3	28.1
70WA18	0.13	0.3	1.6
70WA1901	2.20	4.0	21.2
70WA1902	2.30	4.0	21.2
70WA20	1.70	6.7	35.5

Table B5. PAHs and PCBs in Hamilton Harbour sediment.

Site ID:			70RR01	70RR02	70RR03	70RR04	70RR05	70RR06	70RR07	70RR08	70RR09	70RR10	70RR11	70RR12	70RR13
Date Sampled:			13-Nov-2002	12-Nov-2002	13-Nov-2002	14-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	14-Nov-2002	14-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002	15-Nov-2002
Component	**MDL**	**Units**													
Aroclor-1016	0.038	ug/gm	<0.048	<	<	<0.040	<	<	<	<	<0.039	<0.043	<0.039	<	<
Aroclor-1221	0.015	"	<0.019	<	<	<0.016	<	<	<	<	<	<0.017	<	<	<
Aroclor-1232	0.038	"	<0.048	<	<	<0.040	<	<	<	<	<0.039	<0.043	<0.039	<	<
Aroclor-1242	0.038	"	<0.048	<	<	<0.040	<	<	<	<	<0.039	<0.043	<0.039	<	<
Aroclor-1248	0.021	"	<0.027	<	<	0.150	0.029	0.085	0.120	0.046	0.110	0.180	0.100	<	0.067
Aroclor-1254	0.059	"	0.110	0.083	<	0.330	0.078	0.180	0.200	0.096	0.230	0.340	0.390	1.100	0.130
Aroclor-1260	0.031	"	0.074	0.066	0.032	0.330	0.056	0.094	0.100	0.066	0.120	0.180	0.160	0.290	0.072
Aroclor-1262	0.031	"	<0.039	<	<	<0.033	<	<	<	<	<	<0.035	<0.032	<	<
Aroclor-1268	0.031	"	<0.039	<	<	<0.033	<	<	<	<	<	<0.035	<0.032	<	<
Total PCBs	**0.059**	"	**0.190**	**0.150**	**0.071**	**0.810**	**0.160**	**0.360**	**0.420**	**0.210**	**0.460**	**0.710**	**0.650**	**1.400**	**0.270**
Naphthalene	0.010	mg/kg	0.34	1.80	0.60	7.20	0.50	13.00	32.00	7.80	26.00	83.00	15.00	5.40	28.00
Acenaphthylene	0.010	"	0.05	0.11	0.04	1.50	0.05	0.54	1.00	4.00	1.80	1.20	0.75	0.39	11.00
Acenaphthene	0.010	"	0.07	0.10	0.04	0.85	0.04	0.29	1.50	4.20	3.50	1.70	0.77	0.34	26.00
Fluorene	0.010	"	0.23	0.18	0.09	1.90	0.08	1.90	19.00	4.40	5.80	22.00	3.60	1.20	26.00
Phenanthrene	0.010	"	0.56	1.10	0.50	8.10	0.52	3.40	16.00	32.00	19.00	21.00	4.60	3.30	200.00
Anthracene	0.010	"	0.12	0.25	0.11	2.90	0.12	0.84	3.60	11.00	5.30	5.30	1.10	0.78	45.00
Fluoranthene	0.010	"	0.68	1.40	0.59	21.00	0.81	4.30	14.00	57.00	22.00	17.00	4.00	4.10	220.00
Pyrene	0.010	"	0.58	1.20	0.50	17.00	0.67	3.20	10.00	45.00	17.00	12.00	2.90	3.20	160.00
Benz(a)anthracene	0.010	"	0.42	0.94	0.30	8.90	0.48	2.40	5.90	22.00	8.90	7.10	1.90	2.00	58.00
Chrysene	0.010	"	0.49	1.10	0.36	9.60	0.55	2.70	5.90	24.00	9.40	7.20	2.00	2.30	58.00
Benzo(b)fluoranthene	0.010	"	0.39	1.20	0.43	12.00	0.63	3.00	6.00	26.00	11.00	7.30	1.80	2.70	61.00
Benzo(k)fluoranthene	0.010	"	0.30	0.74	0.24	6.30	0.46	2.80	4.70	18.00	9.20	5.60	1.70	2.00	45.00
Benzo(a)pyrene	0.010	"	0.36	1.00	0.36	12.00	0.54	3.10	6.60	29.00	12.00	7.60	2.10	2.50	68.00
Indeno(1,2,3-cd)pyrene	0.010	"	0.21	0.64	0.25	9.30	0.36	2.30	4.50	23.00	9.20	5.20	1.40	1.90	48.00
Dibenzo(ah)anthracene	0.010	"	0.05	0.15	0.06	1.90	0.08	0.49	1.20	3.80	1.80	1.30	0.76	0.45	8.70
Benzo(ghi)perylene	0.010	"	0.18	0.54	0.23	8.10	0.32	2.10	3.90	21.00	8.40	4.30	1.30	1.80	42.00
TOTAL PAHs			**5.02**	**12.45**	**4.70**	**128.55**	**6.22**	**46.36**	**135.80**	**332.20**	**170.30**	**208.80**	**45.68**	**34.36**	**1104.70**

Site ID:			70RR14	70RR15	70RR16	70RR17	70RR18	70RR19	70RR20	70RR21	70RR22	70RR23	70RR24	70RR25	70RR26
Date Sampled:			13-Nov-2002	12-Nov-2002	12-Nov-2002	12-Nov-2002	15-Nov-2002	13-Nov-2002	12-Nov-2002	15-Nov-2002	14-Nov-2002	12-Nov-2002	15-Nov-2002	12-Nov-2002	15-Nov-2002
Component	**MDL**	**Units**													
Aroclor-1016	0.038	ug/gm	<	<0.051	<0.041	<0.052	<0.049	<0.040	<0.043	<0.042	<0.040	<0.051	<	<0.046	<0.053
Aroclor-1221	0.015	"	<	<0.020	<0.016	<0.020	<0.019	<0.016	<0.017	<0.017	<0.016	<0.020	<	<0.018	<0.021
Aroclor-1232	0.038	"	<	<0.051	<0.041	<0.052	<0.049	<0.040	<0.043	<0.042	<0.040	<0.051	<	<0.046	<0.053
Aroclor-1242	0.038	"	<	<0.051	<0.041	<0.052	<0.049	<0.040	<0.043	<0.042	<0.040	<0.051	<	<0.046	<0.053
Aroclor-1248	0.021	"	0.100	<0.028	<0.022	<0.029	<0.027	<0.022	<0.024	<0.023	<0.022	<0.028	<	<0.025	<0.030
Aroclor-1254	0.059	"	0.210	0.260	0.100	0.280	0.074	<0.063	0.120	<0.065	0.060	<0.080	<	0.250	0.081
Aroclor-1260	0.031	"	0.110	0.140	0.051	0.170	0.110	0.041	0.090	<0.034	0.038	0.060	0.041	0.100	0.090
Aroclor-1262	0.031	"	<	<0.041	<0.033	<0.042	<0.040	<0.033	<0.035	<0.034	<0.032	<0.042	<	<0.037	<0.044
Aroclor-1268	0.031	"	<	<0.041	<0.033	<0.042	<0.040	<0.033	<0.035	<0.034	<0.032	<0.042	<	<0.037	<0.044
Total PCBs	**0.059**	"	**0.420**	**0.400**	**0.150**	**0.450**	**0.180**	**<**	**0.210**	**<0.065**	**0.099**	**0.060**	**<**	**0.350**	**0.170**
Naphthalene	0.010	mg/kg	6.10	5.00	1.50	15.00	5.20	0.58	1.40	0.79	34.00	1.30	6.80	2.30	6.70
Acenaphthylene	0.010	"	0.31	0.28	0.12	0.44	3.20	0.08	0.14	0.06	11.00	0.10	1.90	0.11	3.90
Acenaphthene	0.010	"	0.17	0.13	0.05	0.22	2.70	0.04	0.06	0.02	5.70	0.08	1.20	0.05	3.80
Fluorene	0.010	"	1.30	0.55	0.28	3.90	3.70	0.15	0.22	0.09	19.00	0.26	2.60	0.21	5.70
Phenanthrene	0.010	"	2.20	1.40	0.75	4.00	28.00	0.45	0.88	0.32	98.00	0.89	16.00	0.64	35.00
Anthracene	0.010	"	0.56	0.48	0.26	1.00	11.00	0.15	0.27	0.09	36.00	0.25	5.70	0.22	11.00
Fluoranthene	0.010	"	2.70	2.30	1.20	5.40	47.00	0.79	1.40	0.27	110.00	1.00	20.00	1.10	44.00
Pyrene	0.010	"	2.00	1.90	1.10	4.50	37.00	0.71	1.20	0.21	84.00	0.87	15.00	0.95	34.00
Benz(a)anthracene	0.010	"	1.30	1.40	0.65	3.10	19.00	0.41	0.75	0.11	39.00	0.50	6.90	0.56	18.00
Chrysene	0.010	"	1.50	1.50	0.67	2.90	18.00	0.40	0.78	0.11	35.00	0.51	6.20	0.61	16.00
Benzo(b)fluoranthene	0.010	"	1.40	1.80	0.97	3.90	23.00	0.58	1.10	0.14	43.00	0.68	8.20	0.85	20.00
Benzo(k)fluoranthene	0.010	"	1.40	0.90	0.37	1.40	8.70	0.23	0.44	0.05	17.00	0.27	3.30	0.34	7.90
Benzo(a)pyrene	0.010	"	1.70	1.90	0.85	3.50	22.00	0.53	0.94	0.13	42.00	0.60	8.10	0.76	19.00
Indeno(1,2,3-cd)pyrene	0.010	"	1.20	1.20	0.56	2.00	13.00	0.35	0.60	0.09	26.00	0.41	4.80	0.52	11.00
Dibenzo(ah)anthracene	0.010	"	0.30	0.27	0.14	0.50	2.30	0.09	0.15	0.02	4.70	0.10	1.00	0.13	2.10
Benzo(ghi)perylene	0.010	"	1.00	0.97	0.47	1.60	11.00	0.30	0.49	0.08	22.00	0.34	4.10	0.44	9.70
TOTAL PAHs			**25.14**	**21.98**	**9.94**	**53.36**	**254.80**	**5.84**	**10.82**	**2.58**	**626.40**	**8.16**	**111.80**	**9.79**	**247.80**

Table B5. Continued.

Component	MDL	Units	70RR27	70RR28	70RR29	70RR30	70RR31	70RR32	70RR33	70RR34	70RR35	70RR36	70RR37	70RR38	70RR39
Date Sampled:			13-Nov-2002	12-Nov-2002	13-Nov-2002	13-Nov-2002	14-Nov-2002	15-Nov-2002	13-Nov-2002	15-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	13-Nov-2002	14-Nov-2002
Aroclor-1016	0.038	ug/gm	<0.045	<0.041	<	<0.041	<0.039	<	<	<0.040	<0.044	<0.053	<0.044	<	<
Aroclor-1221	0.015	"	<0.018	<0.016	<	<0.016	<	<	<	<0.016	<0.017	<0.021	<0.017	<	<
Aroclor-1232	0.038	"	<0.045	<0.041	<	<0.041	<0.039	<	<	<0.040	<0.044	<0.053	<0.044	<	<
Aroclor-1242	0.038	"	<0.045	<0.041	<	0.490	<0.039	<	0.100	<0.040	0.068	<0.053	<0.044	<	<
Aroclor-1248	0.021	"	<0.025	<0.023	<	<0.022	<0.022	<	<	<0.022	<0.024	<0.029	<0.024	<	<
Aroclor-1254	0.059	"	<0.070	<0.064	<	0.670	0.120	<	0.160	<0.063	0.150	0.230	0.220	0.097	0.270
Aroclor-1260	0.031	"	0.049	<0.034	<	0.240	0.130	<	0.090	0.038	0.130	0.210	0.130	0.049	0.220
Aroclor-1262	0.031	"	<0.037	<0.034	<	<0.033	<0.032	<	<	<0.033	<0.036	<0.044	<0.036	<	<
Aroclor-1268	0.031	"	<0.037	<0.034	<	<0.033	<0.032	<	<	<0.033	<0.036	<0.044	<0.036	<	<
Total PCBs	**0.059**	"	**<**	**<0.064**	**<**	**1.400**	**0.250**	**<**	**0.360**	**<**	**0.350**	**0.440**	**0.340**	**0.150**	**0.480**
Naphthalene	0.010	mg/kg	0.70	0.12	0.24	9.80	8.70	6.30	0.85	7.50	6.70	5.10	6.60	1.10	4.10
Acenaphthylene	0.010	"	0.07	0.01	0.05	1.40	2.90	3.50	0.09	1.50	2.10	1.50	1.30	0.11	0.52
Acenaphthene	0.010	"	0.03	<	0.03	2.10	2.00	6.20	0.07	5.60	1.20	0.98	0.49	0.05	0.24
Fluorene	0.010	"	0.11	0.03	0.06	43.00	2.40	8.20	1.00	4.60	1.70	1.50	0.83	0.20	0.41
Phenanthrene	0.010	"	0.36	0.10	0.36	33.00	19.00	68.00	1.20	25.00	13.00	12.00	5.80	0.72	2.30
Anthracene	0.010	"	0.16	0.03	0.10	5.50	6.60	17.00	0.18	7.40	4.70	4.20	2.50	0.21	0.89
Fluoranthene	0.010	"	0.65	0.13	0.63	21.00	45.00	63.00	1.00	22.00	28.00	22.00	15.00	1.10	5.50
Pyrene	0.010	"	0.57	0.11	0.55	16.00	37.00	46.00	0.96	17.00	23.00	18.00	12.00	0.91	4.50
Benz(a)anthracene	0.010	"	0.46	0.07	0.37	9.60	17.00	16.00	0.88	6.50	11.00	8.90	6.70	0.65	2.70
Chrysene	0.010	"	0.48	0.07	0.44	8.70	18.00	16.00	1.00	6.30	12.00	9.20	7.20	0.76	3.00
Benzo(b)fluoranthene	0.010	"	0.57	0.09	0.39	7.00	20.00	16.00	0.95	6.70	16.00	12.00	8.40	0.95	3.40
Benzo(k)fluoranthene	0.010	"	0.22	0.03	0.32	6.90	13.00	12.00	0.73	5.70	7.30	7.80	6.00	0.59	2.60
Benzo(a)pyrene	0.010	"	0.50	0.07	0.37	8.20	22.00	17.00	0.93	6.80	15.00	11.00	9.10	0.74	3.70
Indeno(1,2,3-cd)pyrene	0.010	"	0.36	0.05	0.24	5.10	17.00	14.00	0.71	5.60	12.00	8.90	7.60	0.52	3.00
Dibenzo(ah)anthracene	0.010	"	0.09	0.01	0.05	1.40	2.90	1.90	0.18	0.98	2.10	1.90	1.40	0.13	0.69
Benzo(ghi)perylene	0.010	"	0.31	0.04	0.21	4.00	16.00	13.00	0.61	5.40	11.00	8.60	7.10	0.46	3.00
TOTAL PAHs			**5.64**	**0.97**	**4.41**	**182.70**	**249.50**	**324.10**	**11.34**	**134.58**	**166.80**	**133.58**	**98.02**	**9.20**	**40.55**

Component	MDL	Units	70RR40	70RR41	70RR42	70RR43	70RR44	70RR45	70RR46	70RR47	70RR48	70RR49	70RR50	70RR51	70RR52
Date Sampled:			14-Nov-2002	13-Nov-2002	13-Nov-2002	15-Nov-2002	15-Nov-2002	13-Nov-2002	12-Nov-2002	12-Nov-2002	15-Nov-2002	13-Nov-2002	13-Nov-2002	14-Nov-2002	14-Nov-2002
Aroclor-1016	0.038	ug/gm	<0.055	<0.041	<	<	<0.044	<0.039	<	<	<0.051	<0.040	<0.045	<0.046	<0.042
Aroclor-1221	0.015	"	<0.022	<0.016	<	<	<0.017	<	<	<	<0.020	<0.016	<0.018	<0.018	<0.016
Aroclor-1232	0.038	"	<0.055	<0.041	<	<	<0.044	<0.039	<	<	<0.051	<0.040	<0.045	<0.046	<0.042
Aroclor-1242	0.038	"	<0.055	<0.041	<	<	<0.044	<0.039	<	<	<0.051	<0.040	<0.045	<0.046	<0.042
Aroclor-1248	0.021	"	<0.030	<0.023	<	<	<0.024	<	<	<	<0.028	<0.022	<0.025	<0.025	<0.023
Aroclor-1254	0.059	"	0.250	0.067	0.077	<	0.067	<0.060	<	<	0.310	0.280	0.220	0.130	0.095
Aroclor-1260	0.031	"	0.140	0.062	0.048	0.052	0.078	<0.032	<	<	0.260	0.120	0.120	0.110	0.110
Aroclor-1262	0.031	"	<0.045	<0.033	<	<	<0.036	<0.032	<	<	<0.042	<0.032	<0.037	<0.037	<0.034
Aroclor-1268	0.031	"	<0.045	<0.033	<	<	<0.036	<0.032	<	<	<0.042	<0.032	<0.037	<0.037	<0.034
Total PCBs	**0.059**	"	**0.390**	**0.130**	**0.130**	**<**	**0.150**	**<0.060**	**<**	**<**	**0.570**	**0.390**	**0.340**	**0.240**	**0.210**
Naphthalene	0.010	mg/kg	4.20	0.80	0.99	66.00	3.80	0.18	0.58	1.50	6.00	2.90	10.00	3.60	7.30
Acenaphthylene	0.010	"	2.20	0.05	0.07	4.00	0.76	0.02	0.08	0.25	2.80	0.18	0.31	0.25	4.20
Acenaphthene	0.010	"	1.50	0.03	0.05	29.00	0.65	0.02	0.24	5.50	1.70	0.16	0.21	0.11	5.10
Fluorene	0.010	"	2.10	0.08	0.21	19.00	0.99	0.31	0.32	2.60	2.90	2.50	2.70	0.38	5.90
Phenanthrene	0.010	"	15.00	0.37	0.66	93.00	5.80	0.15	3.60	16.00	22.00	1.90	3.30	1.20	39.00
Anthracene	0.010	"	6.30	0.12	0.17	25.00	1.80	0.07	0.52	2.90	8.10	0.57	0.77	0.48	13.00
Fluoranthene	0.010	"	30.00	0.58	0.93	86.00	8.10	0.29	4.00	21.00	37.00	3.20	3.90	2.20	70.00
Pyrene	0.010	"	25.00	0.49	0.75	66.00	6.30	0.25	3.20	16.00	30.00	2.70	3.10	1.90	56.00
Benz(a)anthracene	0.010	"	12.00	0.34	0.52	24.00	3.30	0.14	1.30	8.30	15.00	1.70	1.90	1.30	25.00
Chrysene	0.010	"	12.00	0.39	0.58	25.00	3.60	0.15	1.50	9.00	15.00	1.50	2.20	1.30	26.00
Benzo(b)fluoranthene	0.010	"	13.00	0.44	0.58	29.00	4.40	0.17	1.70	11.00	20.00	2.20	2.50	1.90	33.00
Benzo(k)fluoranthene	0.010	"	9.30	0.32	0.48	12.00	1.50	0.07	0.64	5.10	8.50	0.74	0.95	0.87	14.00
Benzo(a)pyrene	0.010	"	14.00	0.44	0.60	26.00	3.80	0.15	1.40	8.60	18.00	1.70	2.10	1.60	30.00
Indeno(1,2,3-cd)pyrene	0.010	"	12.00	0.34	0.44	18.00	2.60	0.09	0.88	5.80	13.00	1.10	1.30	0.96	21.00
Dibenzo(ah)anthracene	0.010	"	2.00	0.08	0.10	2.60	0.54	0.02	0.19	1.20	1.80	0.25	0.32	0.22	3.00
Benzo(ghi)perylene	0.010	"	11.00	0.29	0.37	17.00	2.50	0.07	0.68	5.50	12.00	0.82	1.00	0.75	20.00
TOTAL PAHs			**171.60**	**5.16**	**7.48**	**541.60**	**50.44**	**2.16**	**20.83**	**120.25**	**213.80**	**24.12**	**36.56**	**18.82**	**372.50**

Table B5. Continued.

	Site ID:		70RR53	70RR54	70RR55	70RR56	70RR57	70RR58	70RR59	70RR60	70RR61	70RR62	70RR63	70RR64	70RR65	70RR66
	Date Sampled:		14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	14-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002	15-Nov-2002
Component	**MDL**	**Units**														
Aroclor-1016	0.038	ug/gm	<	<0.043	<0.051	<0.041	<0.049	<0.043	<	<0.043	<0.039	<0.044	<	<	<0.049	<0.048
Aroclor-1221	0.015	"	<	<0.017	<0.020	<0.016	<0.019	<0.017	<	<0.017	<	<0.017	<	<	<0.019	<0.019
Aroclor-1232	0.038	"	<	<0.043	<0.051	<0.041	<0.049	<0.043	<	<0.043	<0.039	<0.044	<	<	<0.049	<0.048
Aroclor-1242	0.038	"	<	<0.043	<0.051	<0.041	<0.049	<0.043	<	<0.043	<0.039	<0.044	<	<	<0.049	<0.048
Aroclor-1248	0.021	"	<	<0.024	<0.028	<0.023	<0.027	<0.024	<	<0.024	<0.022	<0.024	<	<	<0.027	<0.027
Aroclor-1254	0.059	"	<	0.089	0.230	0.079	0.160	0.095	0.077	<0.067	0.065	0.078	<	<	<0.077	<0.075
Aroclor-1260	0.031	"	<	0.140	0.220	0.073	0.130	0.089	0.072	0.037	0.065	0.095	0.055	<	0.056	0.065
Aroclor-1262	0.031	"	<	<0.035	<0.042	<0.034	<0.040	<0.035	<	<0.035	<0.032	<0.036	<	<	<0.040	<0.040
Aroclor-1268	0.031	"	<	<0.035	<0.042	<0.034	<0.040	<0.035	<	<0.035	<0.032	<0.036	<	<	<0.040	<0.040
Total PCBs	**0.059**	"	<	0.230	0.450	0.150	0.290	0.180	0.150	<	0.130	0.170	<	<	<	0.065
Naphthalene	0.010	mg/kg	0.28	4.40	100.00	150.00	36.00	27.00	15.00	390.00	5.20	7.60	33.00	5.60	3.80	7.40
Acenaphthylene	0.010	"	0.02	0.26	14.00	34.00	12.00	7.10	7.60	270.00	1.40	1.50	7.40	5.50	0.76	5.30
Acenaphthene	0.010	"	0.01	0.10	24.00	68.00	17.00	17.00	22.00	120.00	2.50	2.40	17.00	2.90	0.53	13.00
Fluorene	0.010	"	0.07	0.34	33.00	90.00	22.00	16.00	21.00	320.00	2.80	3.10	17.00	6.80	1.10	15.00
Phenanthrene	0.010	"	0.12	1.20	150.00	500.00	150.00	98.00	130.00	2000.00	15.00	18.00	100.00	43.00	5.60	110.00
Anthracene	0.010	"	0.05	0.49	50.00	110.00	50.00	33.00	38.00	500.00	4.80	5.40	35.00	14.00	2.30	34.00
Fluoranthene	0.010	"	0.28	2.80	170.00	450.00	170.00	110.00	180.00	1500.00	20.00	20.00	100.00	44.00	7.50	140.00
Pyrene	0.010	"	0.24	2.00	130.00	350.00	130.00	81.00	120.00	1100.00	15.00	14.00	79.00	34.00	5.40	100.00
Benz(a)anthracene	0.010	"	0.17	1.30	58.00	120.00	68.00	41.00	58.00	500.00	8.70	7.30	38.00	13.00	3.50	45.00
Chrysene	0.010	"	0.18	1.30	57.00	120.00	68.00	40.00	57.00	480.00	8.70	7.60	38.00	14.00	3.60	45.00
Benzo(b)fluoranthene	0.010	"	0.21	2.20	73.00	130.00	62.00	38.00	53.00	440.00	9.00	7.60	36.00	13.00	3.60	46.00
Benzo(k)fluoranthene	0.010	"	0.08	0.75	29.00	54.00	50.00	31.00	42.00	320.00	6.90	6.40	24.00	9.80	2.60	30.00
Benzo(a)pyrene	0.010	"	0.19	1.70	65.00	120.00	70.00	44.00	59.00	470.00	9.30	7.80	38.00	13.00	3.30	47.00
Indeno(1,2,3-cd)pyrene	0.010	"	0.11	1.00	46.00	82.00	50.00	31.00	40.00	300.00	6.30	5.30	23.00	9.00	2.20	31.00
Dibenzo(ah)anthracene	0.010	"	0.03	0.23	7.10	15.00	7.70	5.80	6.90	48.00	1.10	0.94	3.80	1.40	0.65	5.30
Benzo(ghi)perylene	0.010	"	0.09	0.80	41.00	81.00	48.00	29.00	39.00	290.00	5.80	5.10	23.00	8.70	2.00	30.00
TOTAL PAHs			**2.13**	**20.87**	**1047.10**	**2474.00**	**1010.70**	**648.90**	**888.50**	**9048.00**	**122.50**	**120.04**	**612.20**	**237.70**	**48.44**	**704.00**

	Site ID:		70RR67	70RR68	70RR69	70RR70	70RR71	70RR72	70RR73	70RR74	70RR75	7038	7039	7040	7043	7061
	Date Sampled:		15-Nov-2002	14-Nov-2002	14-Nov-2002	15-Nov-2002	15-Nov-2002	13-Nov-2002	15-Nov-2002	14-Nov-2002	13-Nov-2002	13-Nov-2002	13-Nov-2002	12-Nov-2002	15-Nov-2002	14-Nov-2002
Component	**MDL**	**Units**														
Aroclor-1016	0.038	ug/gm	<0.047	<	<	<0.045	<0.044	<	<	<0.041	<	<	<	<	<0.039	<0.040
Aroclor-1221	0.015	"	<0.019	<	<	<0.018	<0.017	<	<	<0.016	<	<	<	<	<	<0.016
Aroclor-1232	0.038	"	<0.047	<	<	<0.045	<0.044	<	<	<0.041	<	<	<	<	<0.039	<0.040
Aroclor-1242	0.038	"	<0.047	<	<	<0.045	<0.044	<	<	<0.041	<	<	<	<	<0.039	<0.040
Aroclor-1248	0.021	"	<0.026	<	<	<0.025	<0.024	<	<	<0.023	<	<	<	0.220	<0.022	<0.022
Aroclor-1254	0.059	"	0.120	<	<	<0.070	<0.068	0.110	<	0.360	0.120	<	0.200	0.180	<0.061	0.087
Aroclor-1260	0.031	"	0.210	0.046	0.056	0.089	0.052	0.140	<	0.350	0.100	0.037	0.130	0.110	<0.032	0.120
Aroclor-1262	0.031	"	<0.038	<	<	<0.037	<0.036	<	<	<0.034	<	<	<	<	<0.032	<0.033
Aroclor-1268	0.031	"	<0.038	<	<	<0.037	<0.036	<	<	<0.034	<	<	<	<	<0.032	<0.033
Total PCBs	**0.059**	"	0.330	<	<	0.089	<	0.250	<	0.720	0.220	<	0.340	0.510	<0.061	0.210
Naphthalene	0.010	mg/kg	6.30	4.20	6.20	7.20	3.90	12.00	2.20	11.00	13.00	0.64	0.75	0.51	3.30	1.80
Acenaphthylene	0.010	"	2.80	0.91	2.90	4.70	3.10	1.90	1.20	1.40	1.60	0.07	0.14	0.09	1.10	0.40
Acenaphthene	0.010	"	6.20	0.41	4.70	7.60	2.90	0.93	0.78	0.68	1.10	0.07	0.11	0.07	1.20	0.21
Fluorene	0.010	"	5.80	0.73	4.70	8.10	4.00	1.80	1.80	3.00	2.40	0.14	2.40	0.59	1.90	0.42
Phenanthrene	0.010	"	35.00	5.00	29.00	58.00	26.00	7.00	11.00	7.20	7.80	0.84	1.10	0.70	9.60	1.90
Anthracene	0.010	"	12.00	1.80	10.00	19.00	10.00	3.50	2.50	3.50	3.50	0.20	0.41	0.23	3.50	0.80
Fluoranthene	0.010	"	52.00	9.70	50.00	87.00	41.00	25.00	12.00	22.00	20.00	1.40	1.90	1.20	12.00	3.60
Pyrene	0.010	"	39.00	7.70	40.00	69.00	32.00	21.00	8.80	18.00	16.00	1.20	1.60	1.00	9.50	3.00
Benz(a)anthracene	0.010	"	21.00	5.30	20.00	35.00	17.00	12.00	3.80	11.00	8.90	0.53	1.20	0.52	4.80	1.70
Chrysene	0.010	"	21.00	5.80	20.00	36.00	17.00	12.00	3.50	11.00	9.60	0.63	1.20	0.53	5.00	1.90
Benzo(b)fluoranthene	0.010	"	19.00	5.90	21.00	36.00	21.00	17.00	4.50	14.00	13.00	0.71	1.20	0.62	6.00	2.60
Benzo(k)fluoranthene	0.010	"	16.00	4.70	16.00	26.00	8.10	6.70	1.80	6.00	5.40	0.30	0.53	0.27	2.50	1.20
Benzo(a)pyrene	0.010	"	22.00	6.20	23.00	39.00	19.00	15.00	3.90	12.00	12.00	0.53	0.92	0.52	5.40	2.10
Indeno(1,2,3-cd)pyrene	0.010	"	15.00	4.30	16.00	26.00	12.00	10.00	2.70	8.40	8.70	0.36	0.48	0.32	3.80	1.50
Dibenzo(ah)anthracene	0.010	"	2.50	1.10	2.70	4.30	1.80	1.70	0.43	1.50	1.30	0.08	0.12	0.07	0.88	0.30
Benzo(ghi)perylene	0.010	"	14.00	3.90	15.00	25.00	12.00	10.00	2.60	8.10	8.00	0.31	0.39	0.28	3.60	1.20
TOTAL PAHs			**289.60**	**67.65**	**281.20**	**487.90**	**230.80**	**157.53**	**63.51**	**138.78**	**132.30**	**8.01**	**14.45**	**7.53**	**73.88**	**24.63**

Table B5. Continued.

Component	MDL	Units	70WA01	70WA02	70WA03	70WA04	70WA05	70WA06	70WA07	70WA08	70WA09	70WA10
Date Sampled:			21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002
Aroclor-1016	0.038	ug/gm	<0.065	<0.039	<	<0.039	<0.044	<0.051	<0.040	<0.050	<0.048	<0.054
Aroclor-1221	0.015	"	<0.026	<	<	<	<0.017	<0.020	<0.016	<0.020	<0.019	<0.021
Aroclor-1232	0.038	"	<0.065	<0.039	<	<0.039	<0.044	<0.051	<0.040	<0.050	<0.048	<0.054
Aroclor-1242	0.038	"	<0.065	<0.039	<	<0.039	<0.044	<0.051	<0.040	<0.050	<0.048	<0.054
Aroclor-1248	0.021	"	0.093	0.100	0.190	0.078	0.110	0.300	0.210	0.110	0.130	0.150
Aroclor-1254	0.059	"	0.130	0.210	0.210	0.120	0.170	0.370	0.310	0.270	0.260	0.320
Aroclor-1260	0.031	"	0.250	0.360	0.400	0.270	0.330	0.800	0.560	0.630	0.510	0.600
Aroclor-1262	0.031	"	<0.053	<	<	<0.032	<0.036	<0.041	<0.032	<0.041	<0.039	<0.044
Aroclor-1268	0.031	"	<0.053	<	<	<0.032	<0.036	<0.041	<0.032	<0.041	<0.039	<0.044
Total PCBs	**0.059**	"	0.470	0.660	0.800	0.470	0.610	1.500	1.100	1.000	0.900	1.100
Naphthalene	0.010	mg/kg	0.30	1.00	0.59	0.49	0.96	1.20	0.64	3.40	1.90	2.00
Acenaphthylene	0.010	"	0.26	0.29	0.24	0.19	0.28	0.44	0.18	0.47	0.37	0.33
Acenaphthene	0.010	"	0.11	0.24	0.21	0.16	0.16	1.00	0.20	0.31	0.27	0.26
Fluorene	0.010	"	0.12	0.21	0.21	0.14	0.22	0.27	0.20	0.32	0.25	0.21
Phenanthrene	0.010	"	0.72	1.10	0.90	0.60	1.20	1.10	0.88	1.40	1.00	0.87
Anthracene	0.010	"	0.25	0.40	0.32	0.23	0.65	0.32	0.28	0.39	0.39	0.31
Fluoranthene	0.010	"	3.90	3.40	3.20	1.50	3.50	3.60	3.20	2.40	3.00	1.90
Pyrene	0.010	"	3.60	3.20	2.80	1.80	3.10	3.20	2.80	3.10	2.50	1.70
Benz(a)anthracene	0.010	"	2.40	1.90	1.50	1.00	2.00	1.80	1.80	2.30	1.90	1.80
Chrysene	0.010	"	2.60	2.00	1.60	1.10	2.30	2.00	1.90	2.50	2.10	2.00
Benzo(b)fluoranthene	0.010	"	3.80	2.50	2.00	1.40	2.50	2.20	2.20	3.10	2.30	1.70
Benzo(k)fluoranthene	0.010	"	1.60	0.95	0.90	0.57	1.80	1.70	1.40	2.10	2.00	1.40
Benzo(a)pyrene	0.010	"	3.00	1.80	1.50	1.10	2.40	2.20	2.00	2.80	2.20	1.60
Indeno(1,2,3-cd)pyrene	0.010	"	1.70	0.99	0.77	0.58	1.30	1.40	0.98	1.60	1.30	0.83
Dibenzo(ah)anthracene	0.010	"	0.35	0.24	0.19	0.13	0.29	0.32	0.24	0.41	0.28	0.20
Benzo(ghi)perylene	0.010	"	1.30	0.85	0.64	0.50	1.20	1.20	0.82	1.40	1.10	0.72
TOTAL PAHs			**26.01**	**21.07**	**17.57**	**11.49**	**23.86**	**23.95**	**19.72**	**28.00**	**22.86**	**17.83**

Component	MDL	Units	70WA11	70WA12	70WA13	70WA14	70WA15	70WA16	70WA17	70WA18	70WA19	70WA20
Date Sampled:			21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002	21-Nov-2002
Aroclor-1016	0.038	ug/gm	<	<0.052	<0.050	<0.050	<0.050	<0.041	<0.062	<	<0.042	<0.055
Aroclor-1221	0.015	"	<	<0.021	<0.020	<0.020	<0.020	<0.016	<0.025	<	<0.017	<0.022
Aroclor-1232	0.038	"	<	<0.052	<0.050	<0.050	<0.050	<0.041	<0.062	<	<0.042	<0.055
Aroclor-1242	0.038	"	<	<0.052	<0.050	<0.050	<0.050	<0.041	<0.062	<	<0.042	<0.055
Aroclor-1248	0.021	"	0.043	0.110	0.077	0.180	0.190	<0.023	0.160	<	<0.023	<0.030
Aroclor-1254	0.059	"	0.100	0.300	0.280	0.270	0.290	0.490	0.210	<	0.960	0.900
Aroclor-1260	0.031	"	0.170	0.610	0.840	0.540	0.730	1.300	0.570	0.082	1.300	0.840
Aroclor-1262	0.031	"	<	<0.043	<0.041	<0.041	<0.041	<0.034	<0.051	<	<0.034	<0.045
Aroclor-1268	0.031	"	<	<0.043	<0.041	<0.041	<0.041	<0.034	<0.051	<	<0.034	<0.045
Total PCBs	**0.059**	"	0.320	1.000	1.200	1.000	1.200	1.800	0.940	0.130	2.200	1.700
Naphthalene	0.010	mg/kg	0.81	3.50	6.00	0.88	1.30	2.80	0.87	0.14	2.50	46.00
Acenaphthylene	0.010	"	0.21	0.36	0.43	0.38	0.37	1.20	0.58	0.05	0.98	3.20
Acenaphthene	0.010	"	0.20	0.24	0.28	0.22	0.18	2.50	0.21	0.05	4.90	30.00
Fluorene	0.010	"	0.10	0.27	0.42	0.24	0.21	0.37	0.27	0.05	4.70	27.00
Phenanthrene	0.010	"	0.44	1.10	1.70	1.20	0.95	1.60	1.40	0.24	27.00	130.00
Anthracene	0.010	"	0.15	0.34	0.49	0.37	0.33	0.48	0.41	0.07	9.10	32.00
Fluoranthene	0.010	"	1.20	1.80	2.10	4.40	2.80	3.90	7.30	0.85	48.00	150.00
Pyrene	0.010	"	1.00	1.80	1.80	3.80	2.40	3.20	6.40	0.74	37.00	120.00
Benz(a)anthracene	0.010	"	0.75	1.80	1.50	3.00	1.70	2.60	4.60	0.52	16.00	42.00
Chrysene	0.010	"	0.80	1.30	1.70	3.20	1.90	2.80	5.10	0.52	15.00	36.00
Benzo(b)fluoranthene	0.010	"	0.82	1.60	2.00	3.70	2.30	2.70	6.70	0.56	16.00	35.00
Benzo(k)fluoranthene	0.010	"	0.53	1.20	1.80	2.60	1.50	1.80	4.60	0.34	6.40	14.00
Benzo(a)pyrene	0.010	"	0.68	1.60	2.10	3.50	2.00	2.50	6.40	0.48	12.00	26.00
Indeno(1,2,3-cd)pyrene	0.010	"	0.38	0.80	1.20	2.00	1.30	1.70	4.10	0.26	6.10	12.00
Dibenzo(ah)anthracene	0.010	"	0.09	0.22	0.30	0.46	0.29	0.44	0.88	0.06	1.10	2.40
Benzo(ghi)perylene	0.010	"	0.31	0.73	1.10	1.50	1.00	1.40	3.60	0.20	5.20	9.80
TOTAL PAHs			**8.47**	**18.66**	**24.92**	**31.45**	**20.53**	**31.99**	**53.22**	**5.12**	**211.98**	**715.40**

Table B6. Metal and nutrient concentrations in Randle Reef sediment (top10 cm). Values in µg/g dry weight unless otherwise noted. Exceedences of SELs are highlighted.

Site	Al_2O_3 (%)	As	Cd	Co	Cr	Cu	Fe (%)	Hg	K_2O (%)	LOI (%)	Mg (%)	Mn
Reference Median	10.24	2.50	0.80	11.00	39.00	23.00	-	0.04	2.44	12.10	-	-
70RR01	8.67	2.50	2.40	9.27	43.16	47.40	2.41	0.25	2.15	16.50	0.09	926
70RR02	8.52	2.50	1.70	8.03	97.97	44.29	2.10	0.19	2.01	13.60	0.10	1022
70RR03	8.74	2.50	1.07	7.65	38.91	31.24	1.76	0.11	2.03	13.60	0.08	772
70RR04	7.88	7.52	3.67	8.29	104.37	59.76	6.01	0.40	1.74	16.40	0.16	1590
70RR05	8.55	2.50	1.63	7.16	76.77	47.36	1.73	0.19	1.94	11.60	0.08	789
70RR06	8.23	2.50	1.88	11.69	87.60	76.09	4.44	0.34	1.83	15.50	0.17	1667
70RR07	8.16	9.95	4.45	12.07	82.45	98.89	7.86	0.66	1.75	16.70	0.20	2040
70RR08	7.46	2.50	1.22	7.53	58.88	33.75	3.38	0.33	1.69	17.50	0.12	1210
70RR09	7.55	2.50	2.08	10.17	80.79	68.57	5.26	0.43	1.67	19.90	0.17	1713
70RR10	7.42	30.00	2.00	19.87	90.00	131.06	10.70	0.79	1.46	19.00	0.27	2740
70RR1101	7.38	30.33	1.58	200.03	141.00	703.00	15.00	0.66	1.33	14.30	0.22	2200
70RR1102	7.55	31.66	1.42	215.61	143.85	708.14	15.70	0.45	1.35	14.00	0.23	2250
70RR12	8.11	22.95	1.40	128.14	111.47	608.49	8.85	0.34	1.69	14.00	0.17	1710
70RR13	5.98	2.50	2.19	8.13	67.04	46.60	3.16	0.26	1.27	29.30	0.15	1548
70RR1401	8.26	2.50	1.08	10.64	35.35	61.76	3.17	0.44	2.02	14.60	0.18	1774
70RR1402	8.35	2.50	1.04	10.75	66.89	63.55	3.11	0.29	1.93	14.50	0.17	1662
70RR15	8.31	2.50	1.43	13.05	32.84	70.34	2.67	0.49	1.91	14.90	0.15	1483
70RR16	8.20	2.50	1.32	9.29	53.37	58.47	1.98	0.10	1.89	15.50	0.15	1519
70RR17	8.36	2.50	2.45	16.35	46.60	101.09	4.57	0.52	1.92	16.00	0.17	1740
70RR18	8.67	2.50	2.11	8.32	78.03	55.78	3.68	0.38	2.02	15.50	0.14	1404
70RR19	8.61	2.50	1.15	6.91	48.03	30.54	1.67	0.22	2.02	13.40	0.10	992
70RR20	8.28	2.50	1.32	8.78	29.11	46.13	2.01	0.23	1.91	15.30	0.18	1757
70RR21	7.02	2.50	1.41	6.18	21.61	18.15	1.18	0.05	1.65	22.30	0.08	827
70RR22	7.99	2.50	1.85	9.24	53.24	38.99	4.37	0.12	1.77	18.00	0.17	1685
70RR23	7.74	2.50	1.11	7.21	56.65	35.44	1.63	0.12	1.78	14.30	0.15	1548
70RR24	6.85	2.50	2.12	7.55	82.32	58.63	2.53	0.12	1.53	22.80	0.14	1378
70RR25	7.97	2.50	1.84	12.36	48.87	64.87	2.19	0.24	1.85	16.60	0.18	1787
70RR26	7.90	2.50	1.42	8.85	76.42	43.77	3.25	0.13	1.89	17.50	0.12	1229
70RR2701	8.28	2.50	1.34	7.20	50.53	31.94	1.82	0.10	1.93	15.20	0.12	1171
70RR2702	8.52	2.50	1.00	7.35	33.00	31.08	1.65	0.11	1.99	15.60	0.11	1149
70RR28	8.51	2.50	0.51	7.29	30.40	21.47	1.53	0.04	2.03	14.10	0.10	993
70RR29	9.35	2.50	1.55	10.23	48.16	39.73	2.14	0.13	2.21	15.60	0.09	941
70RR30	8.23	17.00	5.00	8.49	57.83	75.67	8.18	0.66	1.74	16.00	0.16	1613
70RR31	7.98	7.91	3.24	8.79	94.28	55.05	5.08	0.42	1.83	16.70	0.15	1543
70RR32	5.18	2.50	2.03	5.69	77.22	28.67	2.22	0.05	1.01	28.60	0.20	2041
70RR30	9.10	5.00	2.86	6.70	61.38	48.92	2.29	0.10	1.85	12.60	0.09	885
70RR34	7.01	2.50	1.87	6.45	54.82	37.44	2.53	0.06	1.54	22.20	0.14	1361
70RR35	8.35	7.59	2.61	9.93	72.39	61.39	4.51	0.19	1.90	16.90	0.16	1615
70RR36	8.95	12.20	3.31	10.35	104.86	68.25	4.55	0.13	2.03	15.50	0.17	1660
70RR37	8.52	5.00	2.89	9.35	80.99	68.90	4.35	0.15	1.95	16.30	0.16	1631
70RR38	8.47	2.50	1.05	7.74	45.77	37.14	1.93	0.08	1.93	13.20	0.13	1257
70RR39	8.58	5.00	1.76	7.95	42.92	48.36	3.15	0.13	1.91	14.10	0.13	1309
70RR40	8.38	9.05	2.27	8.60	59.61	52.61	3.85	0.18	1.93	16.30	0.15	1455

Table B6. Continued.

Site	Al_2O_3 (%)	As	Cd	Co	Cr	Cu	Fe (%)	Hg	K_2O (%)	LOI (%)	Mg (%)	Mn
Reference Median	10.24	2.50	0.80	11.00	39.00	23.00	-	0.04	2.44	12.10	-	-
70RR41	8.42	2.50	1.25	6.86	35.11	29.26	1.63	0.04	1.92	14.80	0.11	1139
70RR42	8.71	2.50	1.37	7.00	20.26	28.47	1.70	0.08	1.91	12.40	0.14	1395
70RR43	7.07	2.50	1.54	6.93	80.18	36.66	2.70	0.09	1.56	21.10	0.14	1434
70RR44	7.95	2.50	2.02	7.85	52.85	38.15	2.62	0.09	1.51	18.40	0.12	1222
70RR45	8.32	2.50	1.57	6.42	23.16	16.64	1.41	0.03	1.77	15.90	0.10	960
70RR46	8.77	2.50	1.86	8.06	37.97	32.41	1.70	0.07	1.96	14.20	0.07	742
70RR47	7.44	2.50	1.76	7.24	43.27	38.87	1.52	0.05	1.59	20.10	0.09	944
70RR48	8.64	2.50	3.53	10.50	143.46	69.65	4.78	0.25	1.92	15.90	0.16	1616
70RR49	8.54	2.50	2.89	8.51	86.37	49.55	2.89	0.12	1.87	14.10	0.11	1070
70RR50	8.57	2.50	2.08	10.60	73.80	64.95	3.56	0.17	1.88	14.60	0.16	1642
70RR5101	8.61	2.50	2.01	8.49	73.56	55.76	2.68	0.12	1.94	14.50	0.13	1341
70RR5102	8.70	2.50	2.12	9.34	64.21	58.89	2.70	0.11	1.88	14.50	0.13	1312
70RR52	7.93	2.50	2.53	7.97	82.12	46.82	3.87	0.14	1.72	16.70	0.13	1325
70RR53	8.83	2.50	1.51	5.81	39.65	17.72	1.58	0.05	1.93	12.40	0.09	869
70RR54	8.95	2.50	2.21	9.62	82.71	61.90	3.07	0.17	1.96	14.90	0.14	1375
70RR55	7.40	5.00	3.35	9.95	92.30	80.01	6.86	0.35	1.55	21.20	0.20	2030
70RR56	5.75	2.50	2.49	7.15	87.82	44.64	3.33	0.20	1.15	28.00	0.21	2084
70RR57	7.39	2.50	2.43	9.29	67.29	58.99	4.26	0.26	1.58	20.70	0.16	1565
70RR58	6.96	2.50	2.03	8.11	72.81	48.66	3.42	0.11	1.46	22.70	0.15	1502
70RR59	7.27	2.50	1.54	6.73	56.38	33.21	3.19	0.18	1.59	19.80	0.14	1356
70RR60	5.22	2.50	2.46	7.10	82.19	62.32	3.08	0.10	1.05	29.30	0.20	2040
70RR61	7.40	2.50	1.89	7.38	59.56	35.40	2.48	0.12	1.61	20.20	0.12	1150
70RR62	6.90	2.50	1.63	7.68	77.29	38.08	2.78	0.10	1.50	23.20	0.14	1375
70RR63	6.42	2.50	1.56	6.51	109.82	34.29	2.62	0.09	1.34	24.10	0.15	1468
70RR74	4.85	2.50	3.00	5.75	88.00	29.12	1.92	0.05	0.99	28.80	0.18	1780
70RR65	8.08	2.50	1.77	7.13	65.83	30.66	2.20	0.04	1.76	16.90	0.11	1122
70RR66	8.32	2.50	2.14	8.88	73.64	43.60	3.65	0.17	1.81	16.40	0.13	1319
70RR67	8.15	2.50	1.32	7.51	65.27	35.76	2.84	0.10	1.77	16.10	0.11	1108
70RR68	8.68	2.50	3.91	9.45	84.71	71.32	4.25	0.31	1.84	15.80	0.16	1575
70RR69	7.85	2.50	1.48	7.54	55.70	38.49	3.25	0.19	1.73	17.50	0.12	1221
70RR70	8.05	2.50	1.27	7.51	72.23	41.18	3.68	0.24	1.77	15.90	0.12	1234
70RR71	8.56	2.50	1.65	8.07	63.64	37.59	3.06	0.20	1.83	14.50	0.14	1445
70RR72	7.92	2.50	2.67	9.29	73.87	57.99	5.14	0.39	1.71	16.40	0.15	1460
70RR73	10.90	2.50	0.50	8.34	37.31	26.06	2.32	0.27	2.38	8.09	0.10	971
70RR74	8.16	8.53	3.91	9.94	98.56	66.89	6.61	0.31	1.74	16.30	0.16	1615
70RR75	7.73	2.50	2.28	9.08	72.13	49.47	4.66	0.24	1.69	17.10	0.14	1412
7038	8.34	2.50	1.53	28.04	55.94	41.37	1.59	0.06	1.86	11.90	1.10	11019
7039	9.16	2.50	4.00	9.28	71.66	66.97	3.31	0.27	1.99	15.90	0.10	956
7040	7.77	2.50	1.00	7.04	68.59	31.49	1.52	0.05	1.57	17.30	0.11	1069
7043	7.08	2.50	1.00	6.11	48.77	25.23	1.87	0.06	1.96	20.30	0.11	1146
7061	8.99	2.50	1.00	9.06	90.69	56.25	3.08	0.14	2.17	13.90	0.13	1347

Table B6. Continued.

Site	Na_2O (%)	Ni	P_2O_5 (%)	Pb	SiO_2 (%)	TiO_2 (%)	Total N	TOC (%)	Total P	V	Zn
Reference Median	1.28	29.00	0.16	37.00	59.02	0.51	1700.00	1.86	644.00	34.00	97.00
70RR01	1.15	12.43	0.29	62.10	48.20	0.47	1500	2.30	866	11.52	255.07
70RR02	1.55	15.57	0.33	67.13	56.40	0.40	1990	3.10	1100	10.26	356.14
70RR03	1.63	13.25	0.30	49.07	56.50	0.40	1074	3.30	934	9.90	222.49
70RR04	1.32	42.00	0.64	284.55	49.20	0.38	1900	7.20	2680	7.19	2160.00
70RR05	1.71	12.22	0.33	68.04	59.40	0.41	1050	1.70	1230	9.78	266.55
70RR06	1.34	28.44	0.43	168.76	50.80	0.43	2080	4.10	1560	11.92	900.92
70RR07	1.09	44.00	0.56	446.86	46.73	0.41	2090	6.40	1840	10.04	2480.00
70RR08	1.36	13.12	0.35	97.72	48.50	0.34	1440	6.00	1410	6.31	697.93
70RR09	0.96	20.55	0.39	200.28	43.30	0.38	2530	6.40	1650	10.16	1157.81
70RR10	0.67	72.00	0.46	438.01	38.90	0.38	3220	7.10	1830	15.73	2350.00
70RR1101	0.68	572.00	0.42	327.29	37.40	0.41	2540	4.80	1290	39.95	1580.00
70RR1102	0.68	609.00	0.45	335.61	37.85	0.43	3160	4.60	1760	47.33	1590.00
70RR12	1.13	303.00	0.43	611.03	47.10	0.43	1980	4.40	1590	18.89	1560.00
70RR13	0.76	7.33	0.30	146.87	35.15	0.29	2560	11.70	1220	8.75	575.70
70RR1401	1.46	25.44	0.37	111.79	53.10	0.41	1740	3.10	1170	10.29	608.86
70RR1402	1.47	25.77	0.36	111.22	53.60	0.42	1930	3.40	1490	10.03	586.33
70RR15	1.44	29.86	0.37	101.15	53.10	0.41	1903	3.50	1670	10.00	494.43
70RR16	1.38	15.91	0.29	69.63	53.88	0.38	1970	2.40	1470	8.72	329.82
70RR17	1.19	42.24	0.40	200.11	49.70	0.43	2170	4.20	1530	10.47	978.05
70RR18	1.32	28.23	0.49	128.80	51.68	0.43	1870	4.60	1870	11.46	954.88
70RR19	1.53	15.09	0.27	52.74	55.50	0.42	1830	2.20	1220	9.85	260.55
70RR20	1.52	19.67	0.31	70.25	54.60	0.38	1760	2.20	1190	9.62	351.51
70RR21	1.12	7.00	0.18	16.96	44.20	0.35	1300	5.10	684	7.54	67.20
70RR22	1.05	11.73	0.30	149.65	44.84	0.40	1160	4.00	926	9.55	726.70
70RR23	1.45	16.77	0.27	46.85	58.10	0.35	1330	4.70	1200	8.38	234.71
70RR24	0.97	6.01	0.25	70.23	41.43	0.32	1570	5.10	850	9.07	363.94
70RR25	1.28	22.37	0.27	69.87	50.21	0.38	1870	2.50	1050	9.36	340.42
70RR26	1.20	17.86	0.33	88.77	47.80	0.39	1560	4.80	1120	9.12	568.15
70RR2701	1.41	13.00	0.29	49.11	53.00	0.40	1790	2.30	992	9.36	265.71
70RR2702	1.35	9.83	0.27	45.63	52.96	0.41	1980	2.10	1120	8.26	229.49
70RR28	1.47	11.31	0.22	18.28	54.20	0.42	2050	1.70	1050	8.10	83.16
70RR29	1.10	17.61	0.26	45.47	51.90	0.48	2310	2.70	1510	13.26	202.01
70RR30	0.98	36.00	0.56	566.10	45.41	0.37	2180	6.80	3030	5.06	2520.00
70RR31	1.10	29.59	0.47	223.17	47.43	0.39	2210	6.50	2850	7.94	1838.33
70RR32	0.69	3.00	0.18	42.04	34.60	0.28	2050	10.50	1160	10.90	185.95
70RR30	1.50	18.41	0.30	103.21	57.96	0.42	1660	2.90	1380	9.03	532.73
70RR34	0.98	5.03	0.26	70.89	42.32	0.33	1720	5.60	1080	8.25	378.60
70RR35	1.03	31.25	0.57	192.23	48.04	0.43	2240	5.60	2510	10.83	1498.51
70RR36	1.14	33.27	0.56	208.57	51.55	0.45	2440	4.80	2550	11.93	1514.92
70RR37	1.09	28.93	0.54	178.94	49.13	0.44	2750	4.90	3610	10.97	1261.90
70RR38	1.43	17.14	0.28	59.76	57.33	0.38	1530	3.30	1240	8.55	343.14
70RR39	1.33	21.06	0.42	103.22	54.71	0.44	2050	3.10	2220	9.40	698.53
70RR40	1.12	25.11	0.48	134.69	49.73	0.41	2170	5.20	2370	10.33	1014.92

Table B6. Continued.

Site	Na_2O (%)	Ni	P_2O_5 (%)	Pb	SiO_2 (%)	TiO_2 (%)	Total N	TOC (%)	Total P	V	Zn
Reference Median	1.28	29.00	0.16	37.00	59.02	0.51	1700.00	1.86	644.00	34.00	97.00
70RR41	1.39	10.33	0.23	34.74	54.63	0.40	2030	2.10	1210	8.15	197.95
70RR42	1.54	12.55	0.24	45.39	59.28	0.37	1570	2.20	1300	8.71	242.73
70RR43	1.01	9.30	0.22	86.37	44.00	0.31	1070	6.30	856	8.05	430.62
70RR44	1.14	13.21	0.27	70.33	47.80	0.37	1850	4.50	1090	9.48	424.52
70RR45	1.34	1.85	0.20	31.51	51.56	0.39	2130	1.40	1070	6.71	133.93
70RR46	1.39	7.63	0.27	53.11	55.70	0.39	784	2.20	931	10.40	181.90
70RR47	1.32	7.49	0.22	51.63	51.93	0.32	1910	6.70	1060	9.33	259.48
70RR48	1.13	32.83	0.53	217.60	49.25	0.43	2047	5.20	2072	12.35	1709.62
70RR49	1.43	16.40	0.33	146.02	53.88	0.40	1250	2.80	1110	10.06	766.03
70RR50	1.36	22.87	0.36	154.69	53.82	0.40	2170	3.50	1540	10.61	797.91
70RR5101	1.40	18.20	0.35	108.56	54.14	0.41	2120	3.00	1490	10.82	593.01
70RR5102	1.40	18.16	0.35	115.08	54.24	0.42	1760	3.00	1240	10.89	606.70
70RR52	1.25	20.52	0.36	135.76	48.65	0.38	1590	5.40	1310	8.35	1029.03
70RR53	1.61	4.53	0.23	32.74	57.45	0.38	1015	1.40	771	6.37	198.12
70RR54	1.31	20.65	0.36	125.94	53.09	0.43	2201	3.20	1560	12.27	711.60
70RR55	0.75	39.00	0.38	284.74	39.43	0.37	2490	6.80	1390	10.58	1790.00
70RR56	0.68	1.93	0.28	137.59	33.45	0.26	2280	10.30	1330	10.51	586.36
70RR57	0.92	13.88	0.33	172.98	42.57	0.35	2180	5.10	1370	10.10	979.79
70RR58	0.93	7.67	0.30	109.67	41.09	0.32	1990	7.10	1310	8.74	652.18
70RR59	1.23	9.03	0.27	113.01	46.50	0.31	1210	7.10	1012	6.86	872.07
70RR60	0.88	8.00	0.21	106.14	30.90	0.24	2440	9.00	1033	8.74	477.05
70RR61	1.18	6.71	0.25	68.88	46.07	0.33	1480	5.70	999	8.69	392.67
70RR62	1.00	6.27	0.26	75.36	41.71	0.33	1650	7.80	1021	9.88	432.57
70RR63	0.91	3.97	0.25	66.80	40.08	0.30	2070	7.60	986	10.12	358.37
70RR74	0.60	8.00	0.19	39.45	31.60	0.22	1540	5.30	706	9.13	182.00
70RR65	1.28	6.43	0.30	51.48	50.34	0.37	1420	2.50	1055	9.55	297.23
70RR66	1.29	16.94	0.30	132.85	50.70	0.38	1710	4.80	1380	9.46	1058.24
70RR67	1.34	13.31	0.28	76.19	51.20	0.35	1504	5.10	1110	7.96	494.08
70RR68	1.17	29.81	0.54	215.68	51.10	0.41	2180	4.70	2640	11.30	1602.36
70RR69	1.29	14.30	0.34	94.43	49.11	0.35	1540	6.10	1210	6.73	677.54
70RR70	1.30	20.12	0.35	122.20	50.03	0.37	1570	5.50	1750	8.29	986.74
70RR71	1.34	16.97	0.33	90.65	52.34	0.37	1530	3.90	1430	9.66	604.70
70RR72	1.27	29.18	0.51	227.10	48.85	0.37	2140	6.90	2550	7.28	1765.23
70RR73	1.74	16.85	0.25	27.04	64.20	0.44	577	2.00	858	14.51	153.18
70RR74	1.23	42.00	0.62	313.85	49.12	0.40	1830	6.70	2630	7.74	2430.00
70RR75	1.24	21.47	0.45	172.06	48.64	0.36	1740	6.40	1740	6.74	1163.54
7038	1.58	18.22	0.27	85.06	60.25	0.37	1140	2.10	1160	1.39	287.72
7039	1.23	21.14	0.34	190.80	52.65	0.49	1910	5.20	1330	11.39	948.39
7040	1.21	7.76	0.21	49.51	50.60	0.36	1930	3.30	885	9.97	230.81
7043	1.17	8.00	0.24	47.96	45.50	0.30	1450	4.20	818	8.66	277.29
7061	1.42	24.73	0.47	126.49	55.02	0.42	2480	3.30	2360	12.18	775.49

Table B7. Metals and nutrient concentrations in Windermere Arm sediment (top10 cm). Values in µg/g dry weight unless otherwise noted. Exceedences of SELs are highlighted.

Site	Al_2O_3 (%)	As	Cd	Co	Cr	Cu	Fe (%)	Hg	K_2O (%)	LOI (%)	Mg (%)	Mn
Reference Median	10.24	2.50	0.80	11.00	39.00	23.00	-	0.04	2.44	12.10	-	-
70WA01	9.66	14.15	1.78	10.87	120.83	213.81	4.55	0.35	1.80	22.10	0.09	942
70WA0201	7.55	2.50	1.52	8.48	126.20	88.96	3.36	0.29	1.69	12.80	0.09	854
70WA0202	7.39	2.50	1.62	8.53	115.49	86.76	3.32	0.26	1.73	12.30	0.09	855
70WA03	9.04	2.50	1.48	9.72	102.97	91.96	3.32	0.37	2.14	13.30	0.08	833
70WA04	9.55	2.50	1.54	9.76	77.69	75.06	3.16	0.21	2.17	14.90	0.09	867
70WA0501	8.90	2.50	1.71	10.75	93.90	126.68	3.87	0.26	1.90	15.60	0.10	1031
70WA0502	8.80	2.50	1.44	10.25	101.10	130.86	3.72	0.32	1.91	16.10	0.10	986
70WA06	9.15	8.93	4.00	14.14	265.94	232.61	5.12	0.49	1.95	19.70	0.14	1392
70WA07	6.61	2.50	1.68	6.79	86.94	112.09	2.60	0.25	1.97	9.42	0.07	661
70WA0801	8.83	12.18	2.00	10.20	184.00	144.03	6.63	0.44	1.97	20.10	0.18	1750
70WA0802	8.59	7.02	1.00	10.33	175.00	138.97	6.41	0.37	1.88	20.20	0.17	1700
70WA09	8.82	2.50	2.00	10.23	110.67	99.88	4.22	0.25	1.94	18.20	0.12	1212
70WA10	7.42	2.50	2.00	9.16	102.91	87.19	4.12	0.34	1.59	19.70	0.14	1408
70WA11	7.04	2.50	0.50	7.27	66.89	36.70	2.25	0.13	1.50	15.30	0.11	1089
70WA1201	7.36	2.50	0.50	9.53	116.89	74.08	4.19	0.29	1.56	19.40	0.15	1530
70WA1202	7.30	2.50	2.00	8.73	117.17	76.91	4.27	0.20	1.54	19.60	0.15	1523
70WA13	7.89	2.50	3.00	9.72	171.00	117.68	6.86	0.38	1.68	21.30	0.22	2190
70WA1401	9.46	8.36	2.32	10.56	102.50	153.01	4.02	0.32	2.07	17.10	0.10	971
70WA1402	9.39	4.71	2.12	10.39	102.32	157.91	3.98	0.31	2.05	16.90	0.09	943
70WA15	8.93	2.50	2.56	10.26	120.42	142.84	4.37	0.21	1.96	17.80	0.12	1231
70WA16	8.02	11.08	4.00	11.46	245.00	136.08	7.07	0.32	1.74	20.90	0.19	1930
70WA17	9.56	5.00	2.20	10.71	108.75	185.47	4.26	0.22	2.13	20.30	0.09	936
70WA18	3.81	2.50	0.50	1.80	40.44	23.54	0.68	0.05	1.67	2.25	0.02	166
70WA1901	9.11	2.50	2.00	11.19	159.25	197.88	4.11	0.27	2.06	16.60	0.11	1098
70WA1902	9.04	2.50	2.00	10.53	132.23	202.77	4.46	0.25	2.11	17.10	0.12	1210
70WA20	8.27	4.61	3.00	12.29	161.48	293.36	4.43	0.52	2.23	26.10	0.15	1470

Table B7. Continued.

Site	Na_2O (%)	Ni	P_2O_5 (%)	Pb	SiO_2 (%)	TiO_2 (%)	Total N	TOC (%)	Total P	V	Zn
Reference Median	1.28	29.00	0.16	37.00	59.02	0.51	1700.00	1.86	644.00	34.00	97.00
70WA01	0.69	34.65	1.55	160.26	44.12	0.54	7750	6.90	7110	14.31	977.81
70WA0201	0.85	23.83	0.61	145.92	60.50	0.42	2550	2.80	2510	9.83	814.46
70WA0202	0.83	24.15	0.57	145.10	62.07	0.39	2630	2.90	2640	9.59	790.04
70WA03	0.85	24.49	0.53	118.06	56.21	0.47	2830	2.00	2703	12.18	692.15
70WA04	1.11	20.65	0.49	103.59	51.84	0.52	2000	2.10	1910	13.99	602.98
70WA0501	1.06	25.65	0.79	151.88	52.59	0.48	3210	3.80	2880	11.17	921.69
70WA0502	0.90	25.47	0.79	144.55	52.23	0.50	3840	3.90	3330	12.09	892.00
70WA06	0.71	42.13	0.78	296.44	45.34	0.50	3470	4.40	3300	16.67	1902.50
70WA07	0.87	23.27	0.45	132.60	66.40	0.32	2590	1.10	2890	7.15	746.33
70WA0801	0.72	49.00	0.78	259.77	42.64	0.48	3760	5.00	3030	11.59	1830.00
70WA0802	0.72	49.00	0.75	258.13	41.70	0.46	4690	4.90	3830	11.60	1790.00
70WA09	0.93	24.93	0.62	173.79	47.28	0.47	3540	3.80	2970	13.47	1055.73
70WA10	0.86	18.34	0.53	158.99	47.42	0.62	3800	4.10	2880	8.83	1000.04
70WA11	1.12	8.04	0.27	64.98	54.42	0.33	1380	1.20	1200	6.38	392.04
70WA1201	0.85	16.19	0.42	169.14	45.52	0.37	2940	4.00	1890	9.35	1038.88
70WA1202	0.83	17.31	0.43	168.23	45.10	0.37	2680	3.50	1710	8.67	1060.02
70WA13	0.65	43.00	0.54	279.61	39.03	0.42	3481	4.90	2348	13.47	1960.00
70WA1401	0.82	29.92	1.07	160.32	51.67	0.52	4632	4.50	4721	11.83	961.84
70WA1402	0.78	30.71	1.09	159.54	50.57	0.51	5060	4.80	5389	11.48	964.21
70WA15	0.93	28.07	0.78	201.68	48.93	0.48	3825	4.40	3588	10.56	1218.38
70WA16	0.96	54.00	0.75	330.31	40.20	0.42	3945	4.90	4230	13.71	2360.00
70WA17	0.65	31.19	1.36	161.83	45.51	0.52	6900	5.30	7400	11.37	1012.24
70WA18	0.43	7.01	0.12	28.28	86.07	0.09	607	0.30	722	4.58	148.49
70WA1901	0.67	34.55	0.71	308.48	50.48	0.48	4600	4.00	4690	13.74	1744.48
70WA1902	0.67	34.92	0.76	299.37	49.59	0.46	3610	4.00	4480	11.89	1717.57
70WA20	0.44	40.44	0.89	468.47	35.90	0.45	5030	6.70	5140	20.25	2944.52

Table B8. Measured environmental variables in overlying water (Randle Reef). Values in mg/L dry weight unless otherwise noted.

Site	Alkalinity	Conduct. (µS/cm)	DO	NH_3	NO_3/NO_2	pH	Temp (Bottom) (°C)	Temp (Surface) (°C)	Total Kjeldahl N	Total P
Reference Median	88	-	8.76	-	0.24	8.07	13.60	-	0.15	0.01
70RR01	98	471	7.18	0.16	1.75	7.08	9.94	9.95	0.43	0.02
70RR02	97	470	7.87	0.16	1.73	7.34	10.05	10.18	0.53	0.03
70RR03	97	470	7.67	0.13	1.77	7.11	9.96	9.99	0.35	0.02
70RR04	97	467	7.26	0.14	1.80	7.13	9.92	9.92	0.43	0.02
70RR05	97	468	7.69	0.14	1.82	7.10	9.95	9.95	0.34	0.02
70RR06	97	470	7.11	0.20	1.81	7.11	10.00	10.00	0.54	0.04
70RR07	97	471	7.04	0.18	1.78	7.10	10.01	10.04	0.51	0.03
70RR08	97	468	7.01	0.16	1.85	7.10	9.87	9.89	0.37	0.03
70RR09	96	470	6.84	0.20	1.82	7.03	9.92	9.95	0.50	0.03
70RR10	96	469	7.01	0.21	1.63	7.03	9.99	10.05	0.53	0.03
70RR1101	96	469	6.99	0.18	1.67	7.01	10.01	10.10	0.47	0.03
70RR1102	97	469	6.99	0.17	1.72	7.01	10.01	10.10	0.47	0.03
70RR12	96	469	6.99	0.17	1.73	7.03	10.01	10.10	0.41	0.03
70RR13	97	470	7.14	0.17	1.60	7.25	9.81	9.85	0.47	0.02
70RR1401	98	471	7.08	0.16	1.69	7.04	9.96	9.98	0.35	0.03
70RR1402	97	471	7.08	0.17	1.72	7.04	9.96	9.98	0.43	0.03
70RR15	97	467	7.18	0.16	1.72	7.20	10.16	10.35	0.48	0.04
70RR16	97	470	7.18	0.15	1.71	7.04	9.94	9.96	0.41	0.03
70RR17	96	467	7.40	0.18	1.66	7.16	10.14	10.29	0.42	0.03
70RR18	97	469	7.19	0.13	1.68	7.22	9.80	9.80	0.41	0.02
70RR19	97	471	7.15	0.13	1.65	7.06	9.95	10.00	0.43	0.03
70RR20	96	471	7.18	0.16	1.69	7.26	10.14	10.25	0.33	0.05
70RR21	96	468	7.17	0.15	1.67	7.23	9.83	9.85	0.33	0.02
70RR22	96	471	7.45	0.16	1.60	7.08	10.01	10.02	0.53	0.04
70RR23	95	470	7.24	95.00	1.67	7.28	10.11	10.21	0.38	0.06
70RR24	97	471	7.10	0.18	1.56	7.27	9.84	9.85	0.35	0.02
70RR25	95	468	7.17	0.19	1.54	7.23	10.14	10.15	0.36	0.04
70RR26	97	469	7.19	0.14	1.56	7.20	9.80	9.80	0.37	0.02
70RR2701	97	470	7.66	0.15	1.56	7.15	9.98	9.98	0.47	0.03
70RR2702	97	470	7.66	0.14	1.56	7.15	9.98	9.98	0.46	0.03
70RR28	96	477	7.17	0.20	1.57	7.31	10.12	10.13	0.41	0.10
70RR29	96	470	7.17	0.15	1.57	7.07	9.94	10.00	0.41	0.10
70RR30	97	470	7.04	0.20	1.56	7.14	10.00	10.10	0.51	0.03
70RR31	96	468	7.27	0.13	1.55	7.14	9.90	9.90	0.41	0.02
70RR32	97	470	7.10	0.15	1.62	7.24	9.89	9.95	0.47	0.02
70RR30	97	470	7.10	0.17	1.61	7.22	9.97	9.99	0.47	0.02
70RR34	98	470	7.06	0.16	1.61	7.27	9.85	9.90	0.43	0.02
70RR35	97	468	7.22	0.15	1.60	7.18	9.92	9.90	0.35	0.03
70RR36	97	468	7.23	0.14	1.58	7.16	9.92	9.90	0.34	0.03
70RR37	97	469	7.07	0.14	1.58	7.16	9.92	9.90	0.34	0.03
70RR38	97	470	7.23	0.13	1.59	7.10	9.95	9.97	0.34	0.02
70RR39	97	469	7.80	0.15	1.56	7.16	9.91	9.90	0.39	0.03
70RR40	96	469	7.21	0.16	1.57	7.16	9.93	9.95	0.35	0.03

Table B8. Continued.

Site	Alkalinity	Conduct. (µS/cm)	DO	NH_3	NO_3/NO_2	pH	Temp (Bottom) (°C)	Temp (Surface) (°C)	Total Kjeldahl N	Total P
Reference Median	88	-	8.76	-	0.24	8.07	13.60	-	0.15	0.01
70RR41	97	470	7.75	0.09	1.69	7.13	9.97	9.97	0.45	0.03
70RR42	97	470	7.23	0.14	1.58	7.10	9.94	9.97	0.35	0.03
70RR43	97	470	7.16	0.15	1.56	7.20	9.77	9.80	0.44	0.03
70RR44	96	469	7.20	0.15	1.56	7.23	9.85	9.90	0.36	0.03
70RR45	97	470	7.78	0.14	1.55	7.19	9.98	9.98	0.47	0.03
70RR46	96	472	7.03	0.16	1.55	7.26	10.03	10.23	0.35	0.03
70RR47	93	470	7.53	0.15	1.63	7.32	10.12	10.22	0.34	0.03
70RR48	97	470	7.17	0.13	1.63	7.23	9.78	9.80	0.33	0.03
70RR49	97	469	7.28	0.15	1.58	7.13	9.97	9.97	0.44	0.03
70RR50	97	470	7.15	0.18	1.55	7.10	10.00	10.02	0.46	0.04
70RR5101	98	469	7.04	0.16	1.56	7.15	9.90	9.90	0.46	0.04
70RR5102	97	469	7.04	0.17	1.57	7.15	9.90	9.90	0.39	0.04
70RR52	97	468	7.25	0.13	1.58	7.18	9.95	9.90	0.36	0.04
70RR53	96	469	7.18	0.15	1.55	7.15	9.90	9.90	0.37	0.04
70RR54	97	469	7.20	0.14	1.58	7.17	9.91	9.91	0.34	0.03
70RR55	96	470	6.95	0.18	1.57	7.04	9.90	9.90	0.32	0.03
70RR56	96	470	6.93	0.19	1.57	7.11	9.92	9.95	0.33	0.03
70RR57	97	470	7.07	0.19	1.56	7.14	9.92	9.95	0.33	0.03
70RR58	97	468	7.30	0.18	1.56	7.20	9.95	10.00	0.33	0.03
70RR59	96	468	7.28	0.15	1.59	7.21	9.96	10.00	0.50	0.03
70RR60	99	469	7.28	0.17	1.54	7.21	9.96	10.00	0.37	0.03
70RR61	96	470	7.10	0.15	1.54	7.20	9.81	9.85	0.36	0.03
70RR62	96	470	7.09	0.09	1.72	7.22	9.77	9.80	0.40	0.03
70RR63	96	470	7.06	0.15	1.60	7.24	9.86	9.90	0.49	0.03
70RR74	96	469	7.20	0.10	1.69	7.24	9.89	9.90	0.39	0.03
70RR65	96	469	7.20	0.10	1.71	7.23	9.84	9.85	0.40	0.03
70RR66	97	469	7.13	0.14	1.67	7.22	9.78	9.80	0.49	0.03
70RR67	96	469	7.08	0.10	1.73	7.20	9.81	9.85	0.38	0.03
70RR68	96	469	7.17	0.07	1.75	7.15	9.91	9.90	0.37	0.03
70RR69	95	468	7.28	0.11	1.66	7.18	9.96	10.00	0.32	0.03
70RR70	97	468	7.22	0.08	1.74	7.21	9.80	9.80	0.39	0.03
70RR71	96	470	7.18	0.11	1.70	7.22	9.81	9.85	0.33	0.03
70RR72	96	471	7.03	0.15	1.65	7.10	10.00	10.10	0.46	0.03
70RR73	97	470	7.15	0.09	1.67	7.22	9.82	9.86	0.46	0.03
70RR74	95	468	7.20	0.08	1.70	7.13	9.90	9.90	0.34	0.03
70RR75	97	470	7.18	0.17	1.65	7.10	10.00	10.10	0.52	0.03
7038	97	469	7.70	0.13	1.58	7.15	9.95	9.95	0.41	0.02
7039	97	470	7.55	0.14	1.58	7.16	9.94	9.95	0.36	0.02
7040	96	469	7.23	0.18	1.60	7.24	10.15	10.21	0.47	0.06
7043	97	469	7.21	0.15	1.57	7.23	9.87	9.90	0.48	0.03
7061	96	468	7.20	0.12	1.58	7.18	9.90	9.90	0.37	0.04

Table B9. Measured environmental variables in overlying water (Windermere Arm). Values in mg/L dry weight unless otherwise noted.

Site	Alkalinity	Conduct. (µS/cm)	DO	NH_3	NO_3/NO_2	pH	Temp (Bottom) (°C)	Temp (Surface) (°C)	Total Kjeldahl N	Total P
Reference Median	88	-	8.76	-	0.24	8.07	13.60	-	0.15	0.01
70WA01	102	1050	6.81	0.89	4.00	7.35	11.44	11.50	2.07	0.72
70WA0201	99	857	7.47	0.84	3.13	7.66	10.37	10.40	1.59	0.13
70WA0202	100	857	7.47	0.84	3.02	7.66	10.37	10.40	1.58	0.13
70WA03	103	854	7.83	0.94	3.32	7.50	10.30	10.35	2.10	0.70
70WA04	99	802	8.07	0.83	3.02	7.57	10.10	10.10	1.54	0.12
70WA0501	102	873	7.80	0.94	3.40	7.60	10.51	10.55	1.73	0.13
70WA0502	101	873	7.80	0.95	3.41	7.60	10.51	10.55	1.89	0.12
70WA06	98	845	7.02	0.88	2.87	7.74	10.05	10.01	1.55	0.07
70WA07	101	880	7.88	0.88	3.38	7.52	10.38	10.40	1.63	0.25
70WA0801	99	769	7.71	0.77	2.51	7.73	9.82	9.90	1.34	0.05
70WA0802	97	769	7.71	0.78	2.57	7.73	9.82	9.90	1.37	0.05
70WA09	99	801	7.24	0.79	2.93	7.70	9.96	10.00	1.39	0.06
70WA10	97	660	8.86	0.62	2.37	7.81	9.96	10.00	1.16	0.06
70WA11	100	849	7.35	0.91	3.13	7.68	9.99	10.01	1.54	0.07
70WA1201	99	719	8.22	0.72	2.75	7.77	9.82	9.90	1.34	0.06
70WA1202	99	719	8.22	0.72	2.76	7.77	9.82	9.90	1.30	0.06
70WA13	98	639	8.60	0.56	2.26	7.93	9.59	9.60	1.00	0.04
70WA1401	103	809	7.59	1.01	3.98	7.45	10.54	10.60	1.89	0.16
70WA1402	104	809	7.59	0.99	3.99	7.45	10.54	10.60	1.87	0.17
70WA15	97	771	7.90	0.81	3.26	7.72	9.92	9.93	1.45	0.09
70WA16	99	792	7.55	0.85	3.16	7.69	9.91	9.95	1.47	0.08
70WA17	103	908	7.57	0.96	4.24	7.52	10.58	10.60	1.85	0.13
70WA18	100	818	8.07	0.84	3.57	7.45	10.00	10.00	1.68	0.40
70WA1901	97	792	7.57	0.88	3.32	7.40	9.68	9.70	1.51	0.07
70WA1902	99	792	7.57	0.86	3.35	7.40	9.68	9.70	1.49	0.06
70WA20	98	819	6.84	1.02	3.48	6.73	9.68	9.75	1.71	0.07

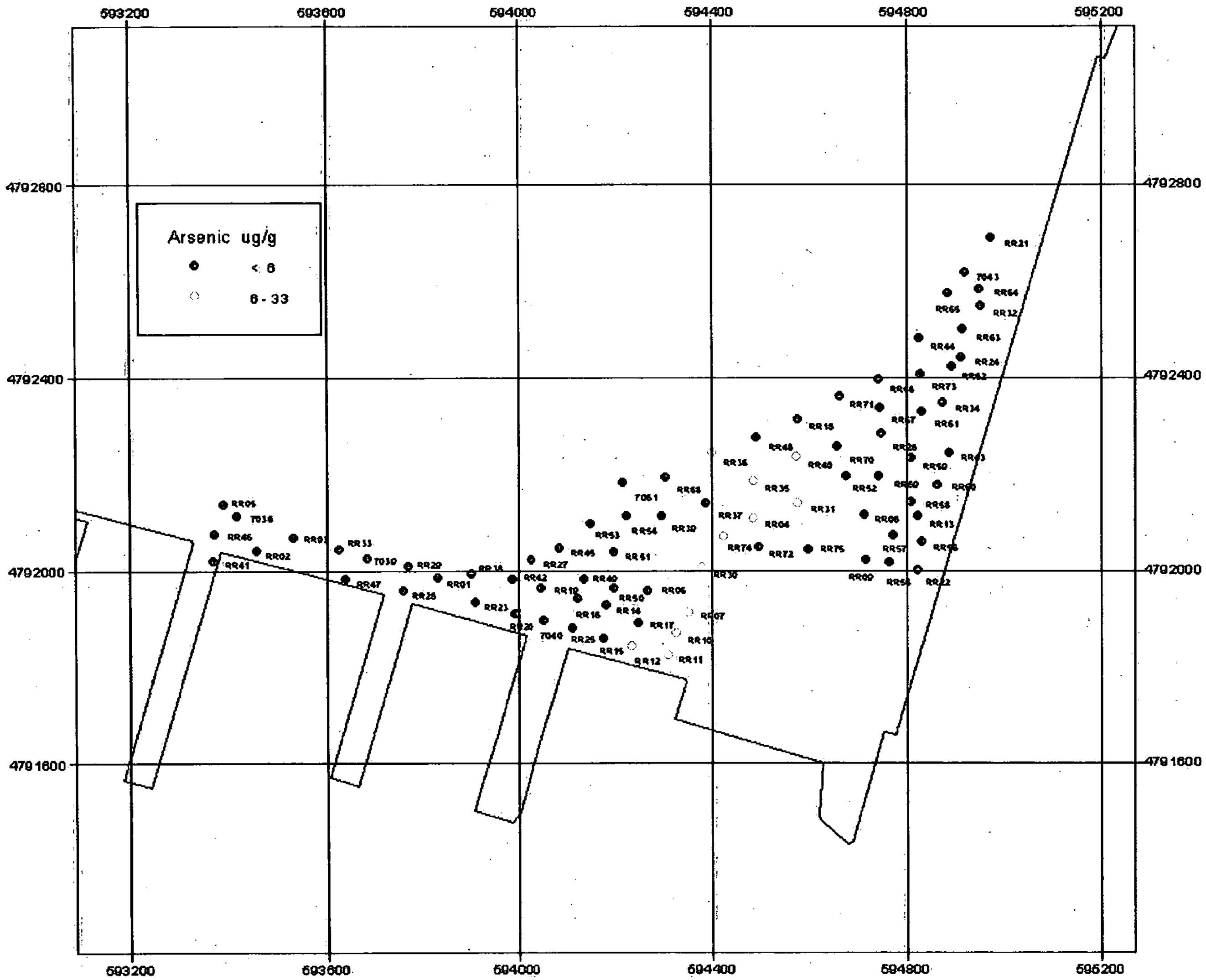


Figure B1. Exceedences of the LEL (6 µg/g) for arsenic in Randle Reef sediments.

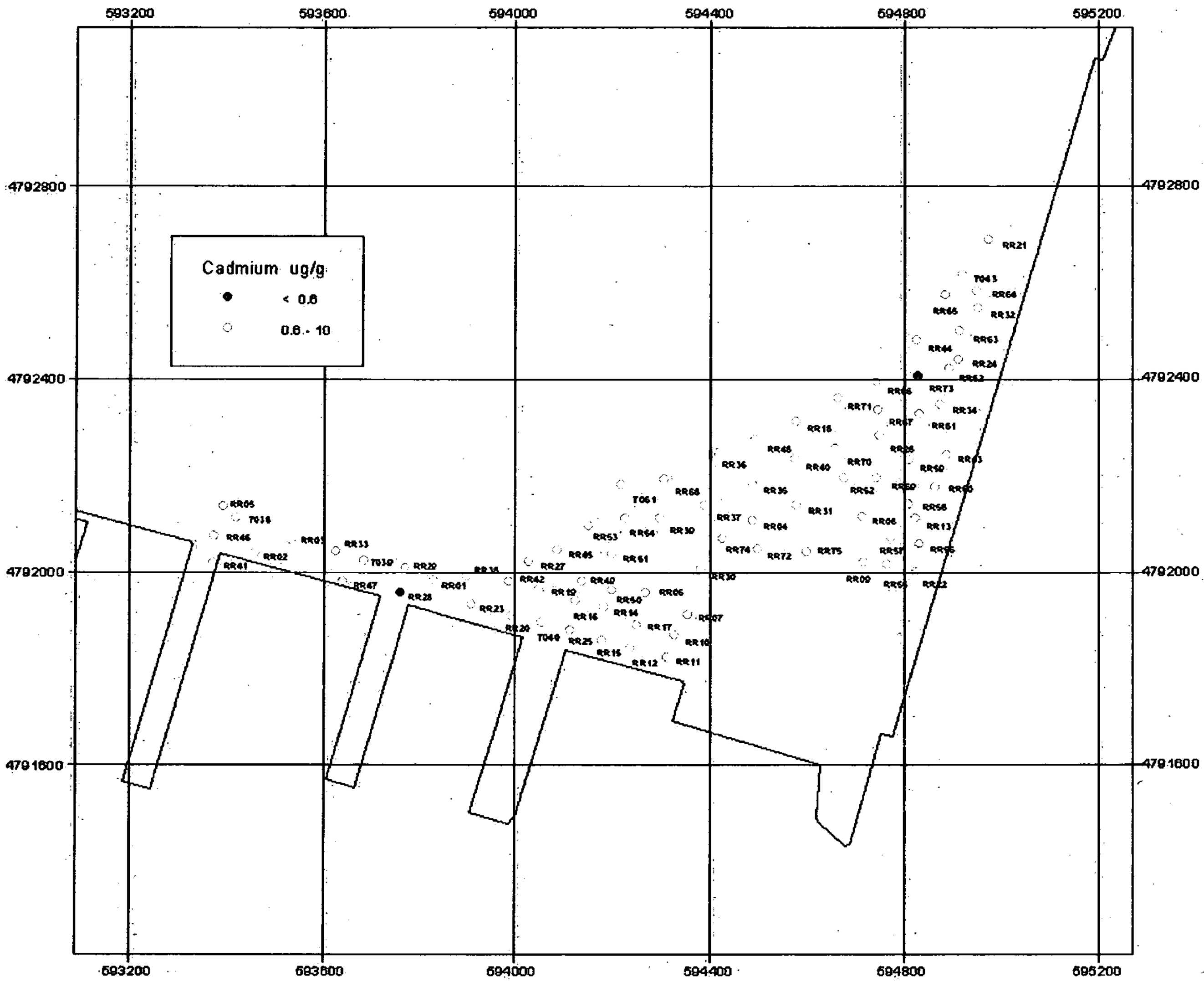


Figure B2. Exceedences of the LEL (0.6 μg/g) for cadmium in Randle Reef sediments.

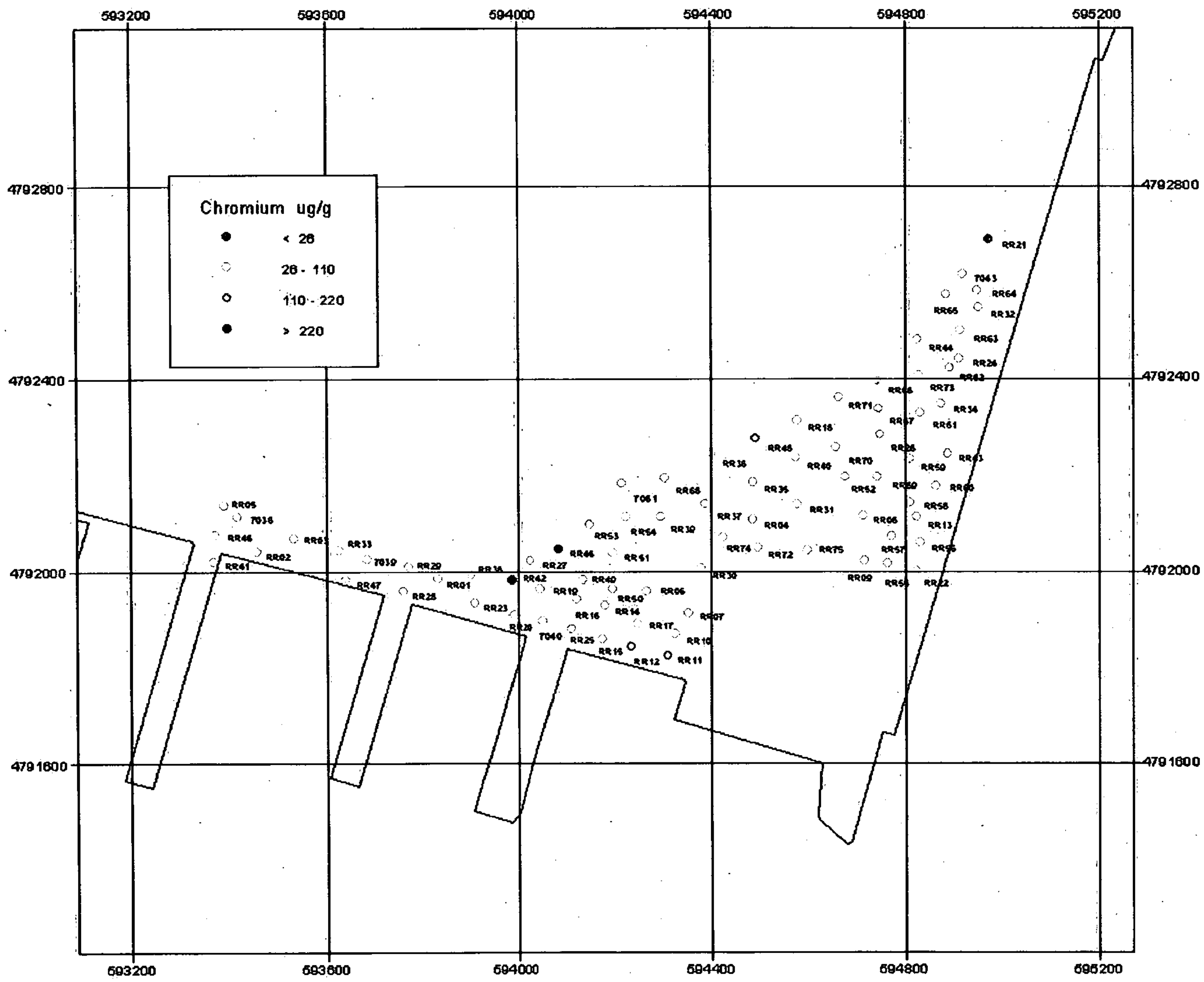


Figure B3. Exceedences of the LEL (26 μg/g) and SEL (110 μg/g) for chromium in Randle Reef sediments

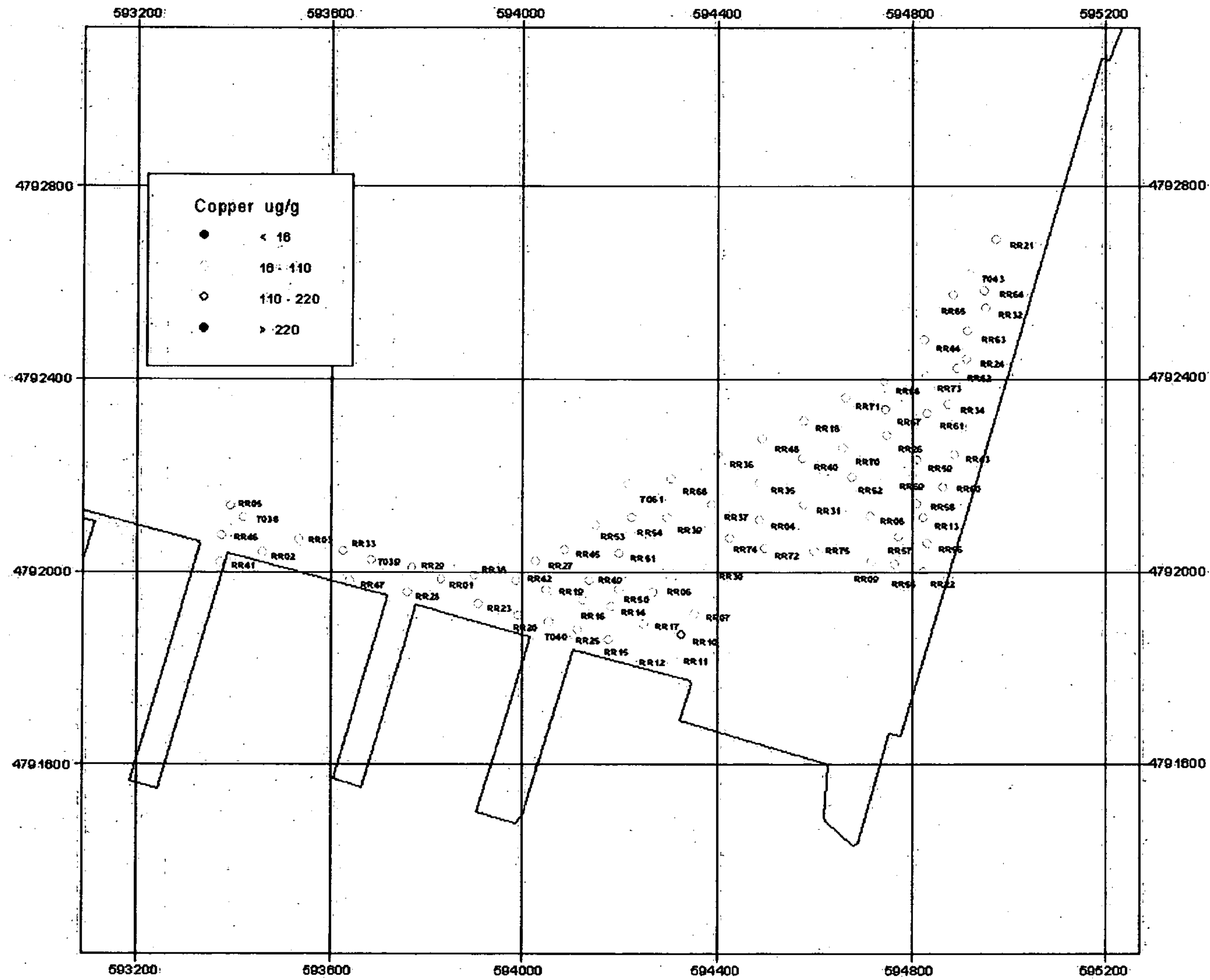


Figure B4. Exceedences of the LEL (16 μg/g) and SEL (110 μg/g) for copper in Randle Reef sediments.

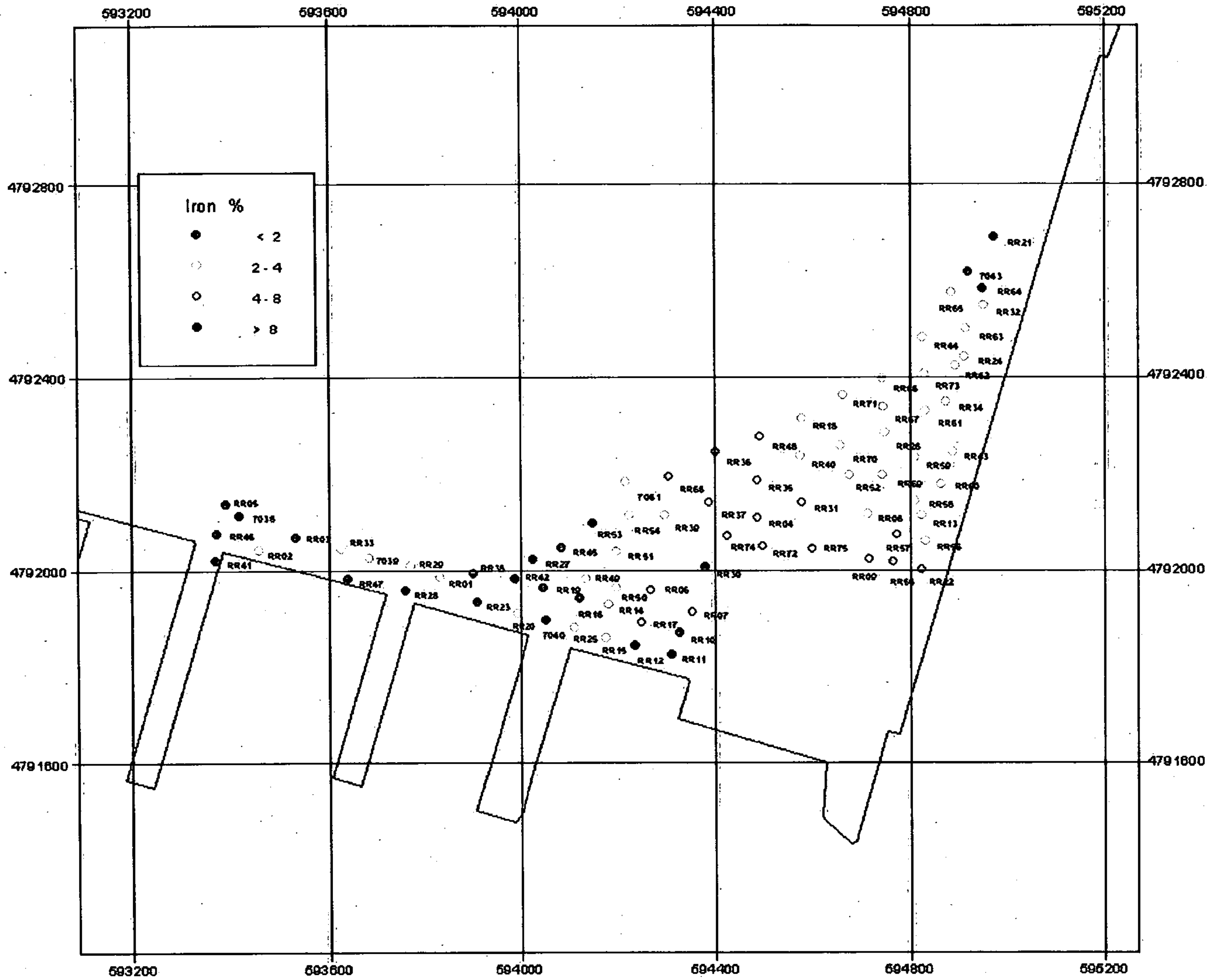


Figure B5. Exceedences of the LEL (2%) and SEL (4%) for iron in Randle Reef sediments.

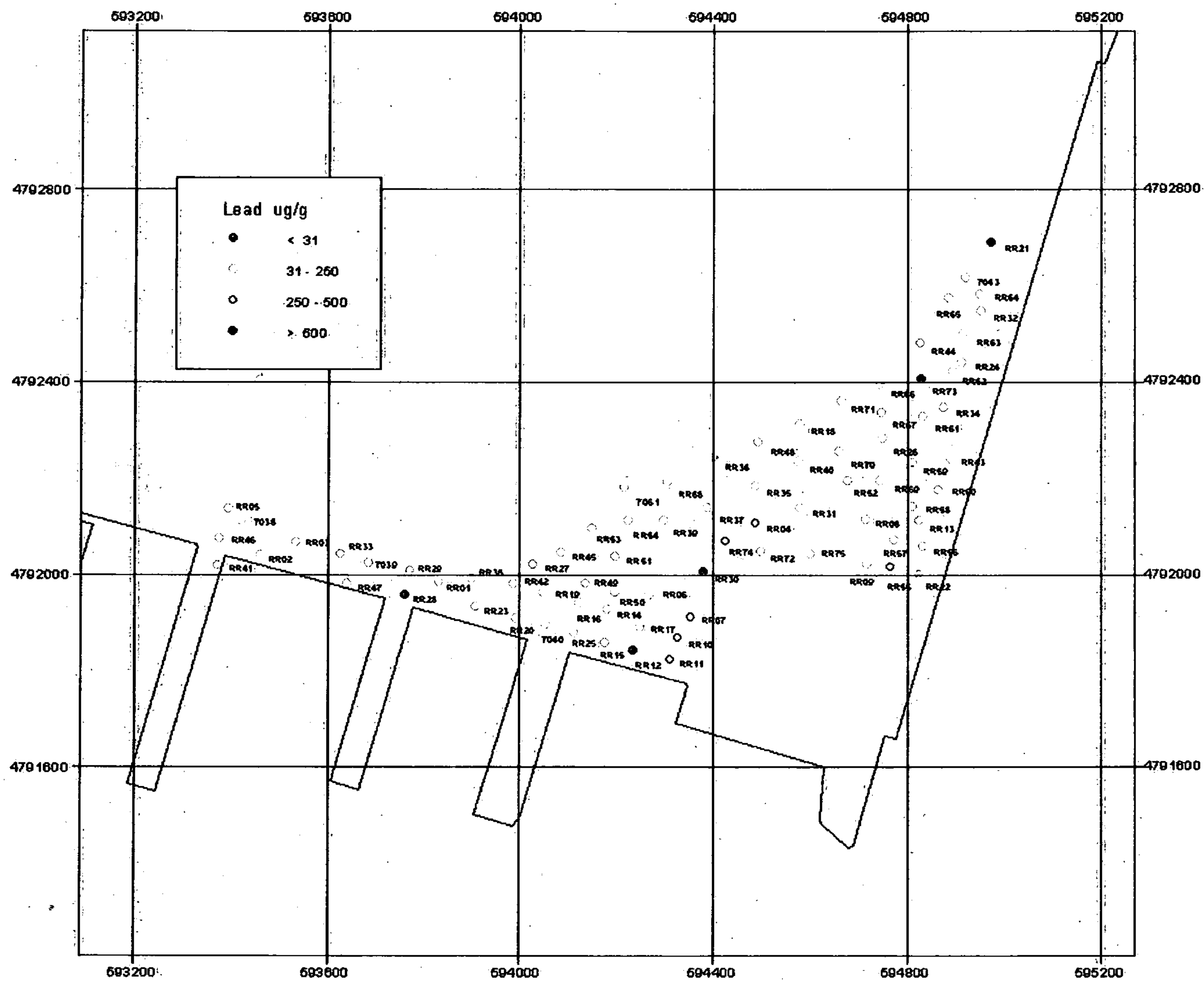


Figure B6. Exceedences of the LEL (31 µg/g) and SEL (250 µg/g) for lead in Randle Reef sediments.

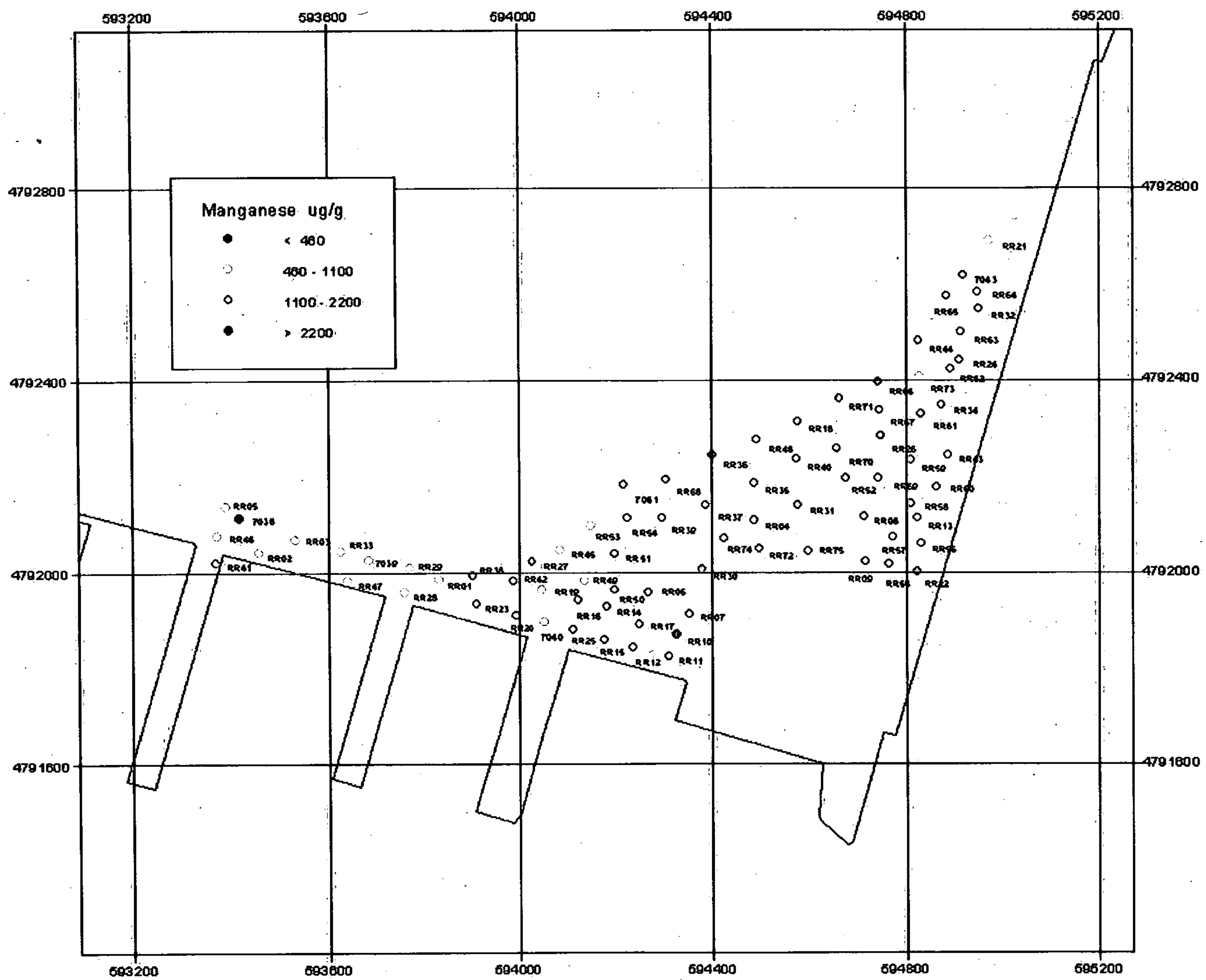


Figure B7. Exceedences of the LEL (460 µg/g) and SEL (1100 µg/g) for manganese in Randle Reef sediments.

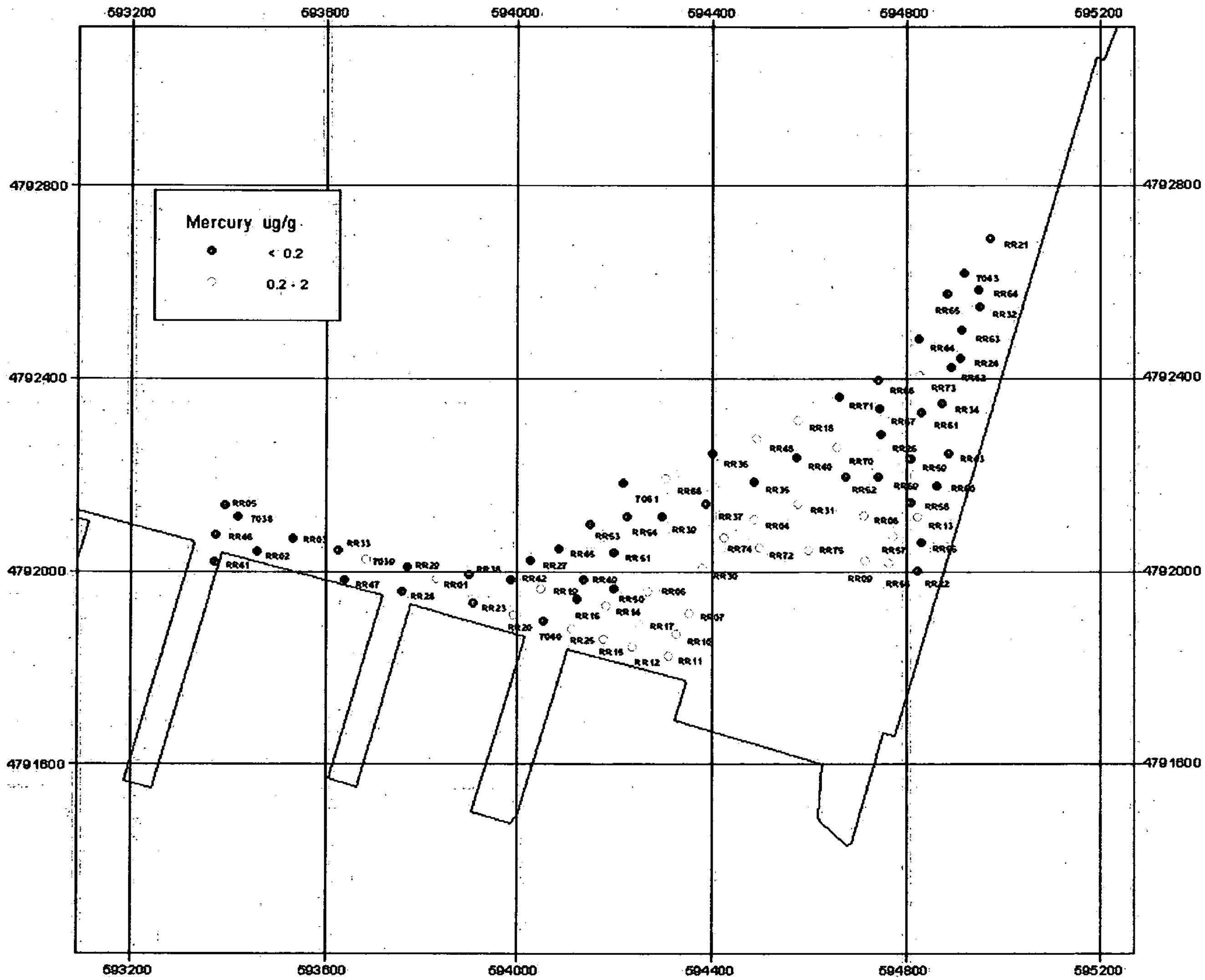


Figure B8. Exceedences of the LEL (0.2 μg/g) and SEL (2 μg/g) for total mercury in Randle Reef sediments.

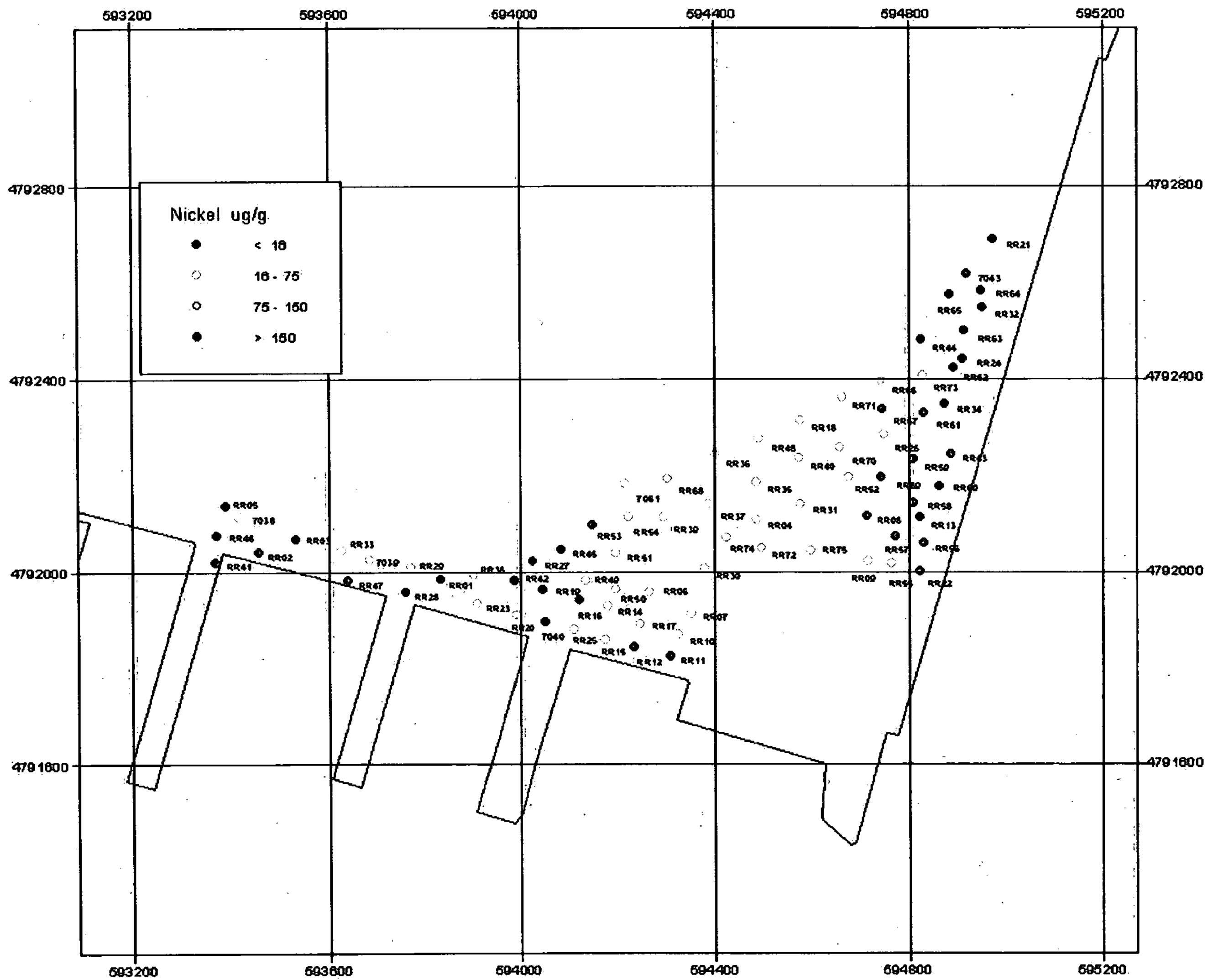


Figure B9. Exceedences of the LEL (16 µg/g) and SEL (75 µg/g) for nickel in Randle Reef sediments.

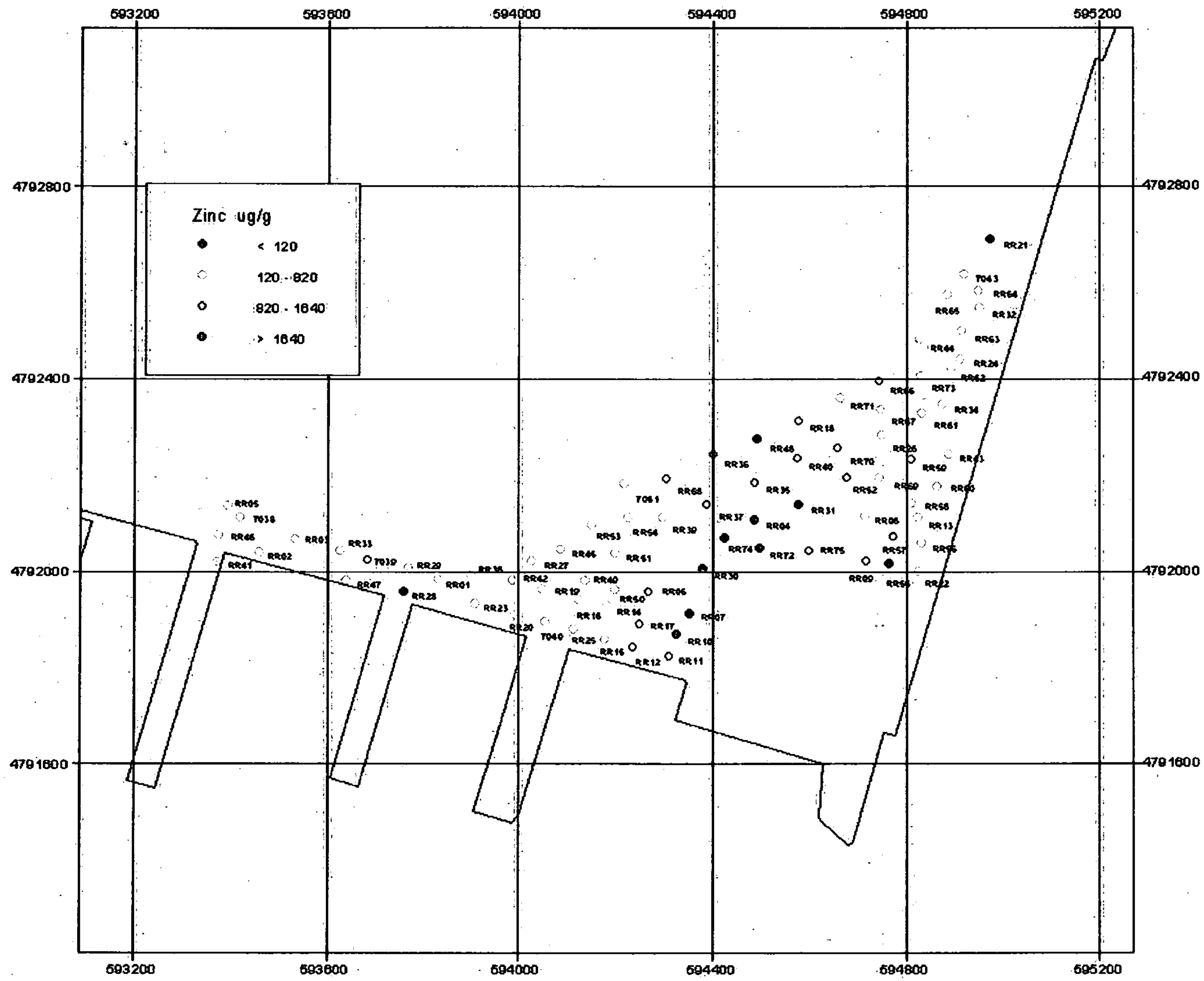


Figure B10. Exceedences of the LEL (120 µg/g) and SEL (820 µg/g) for zinc in Randle Reef sediments.

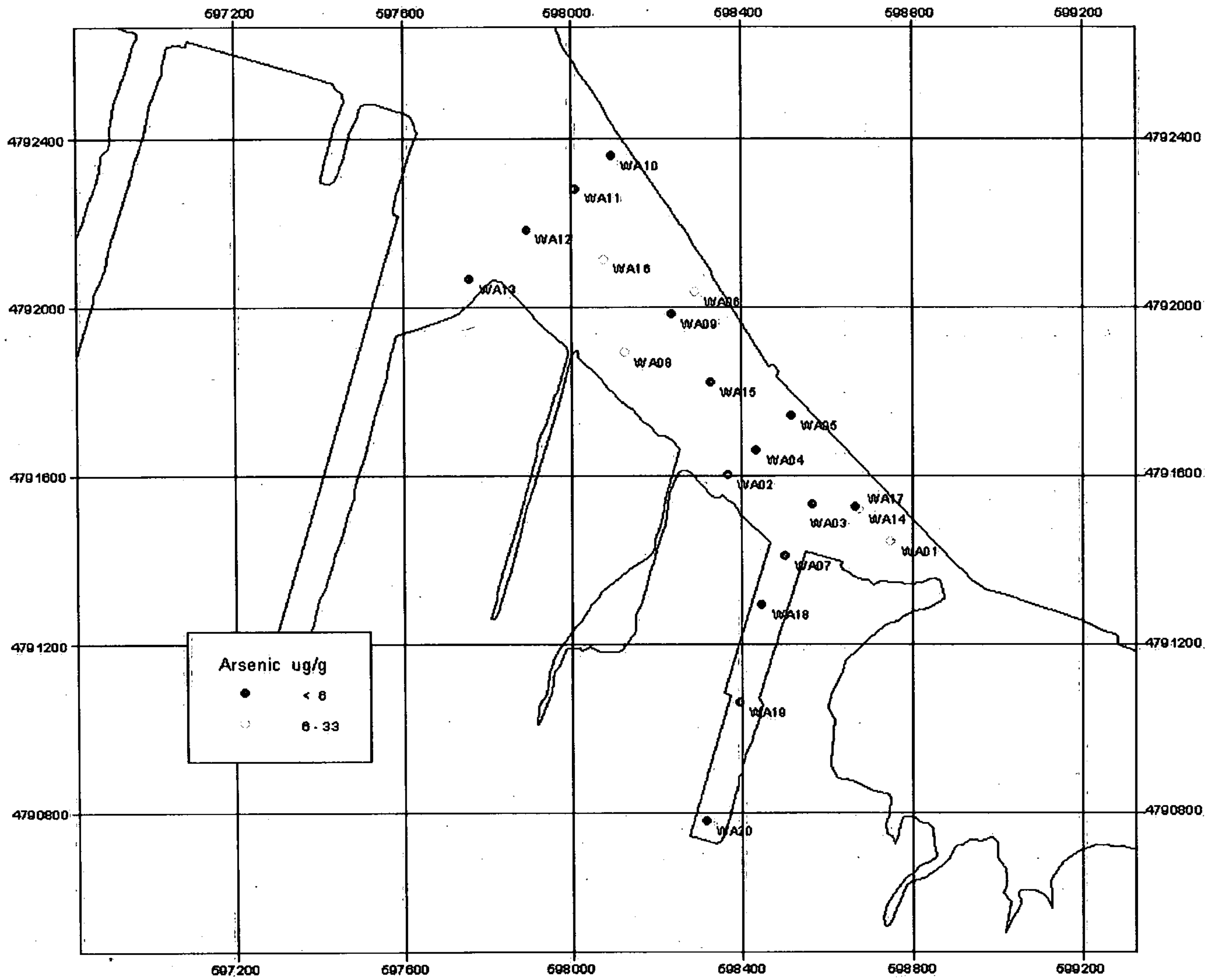


Figure B11. Exceedences of the LEL (6 µg/g) for arsenic in Windermere Arm sediments.

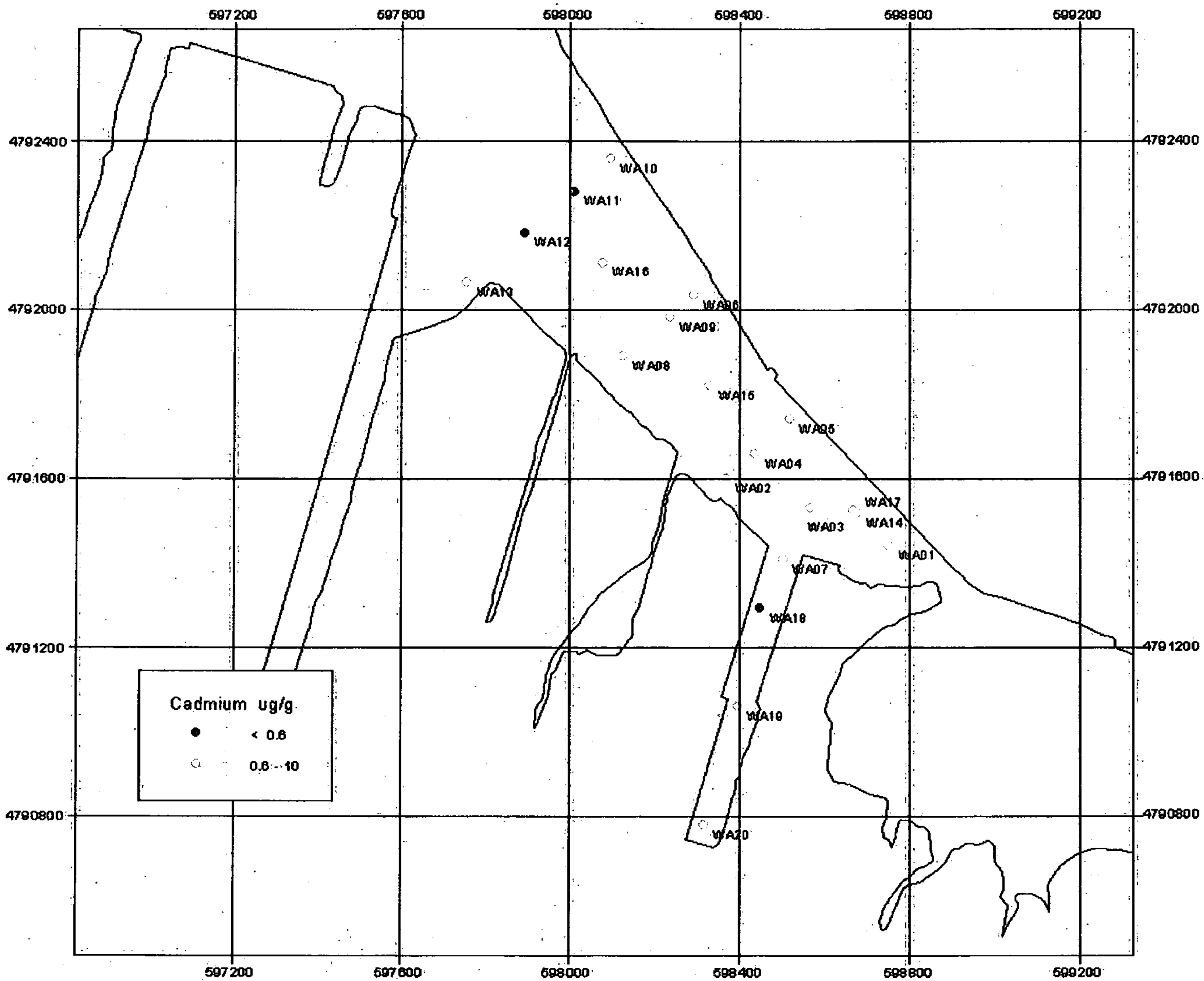


Figure B12. Exceedences of the LEL (0.6 µg/g) for cadmium in Windermere Arm sediments.

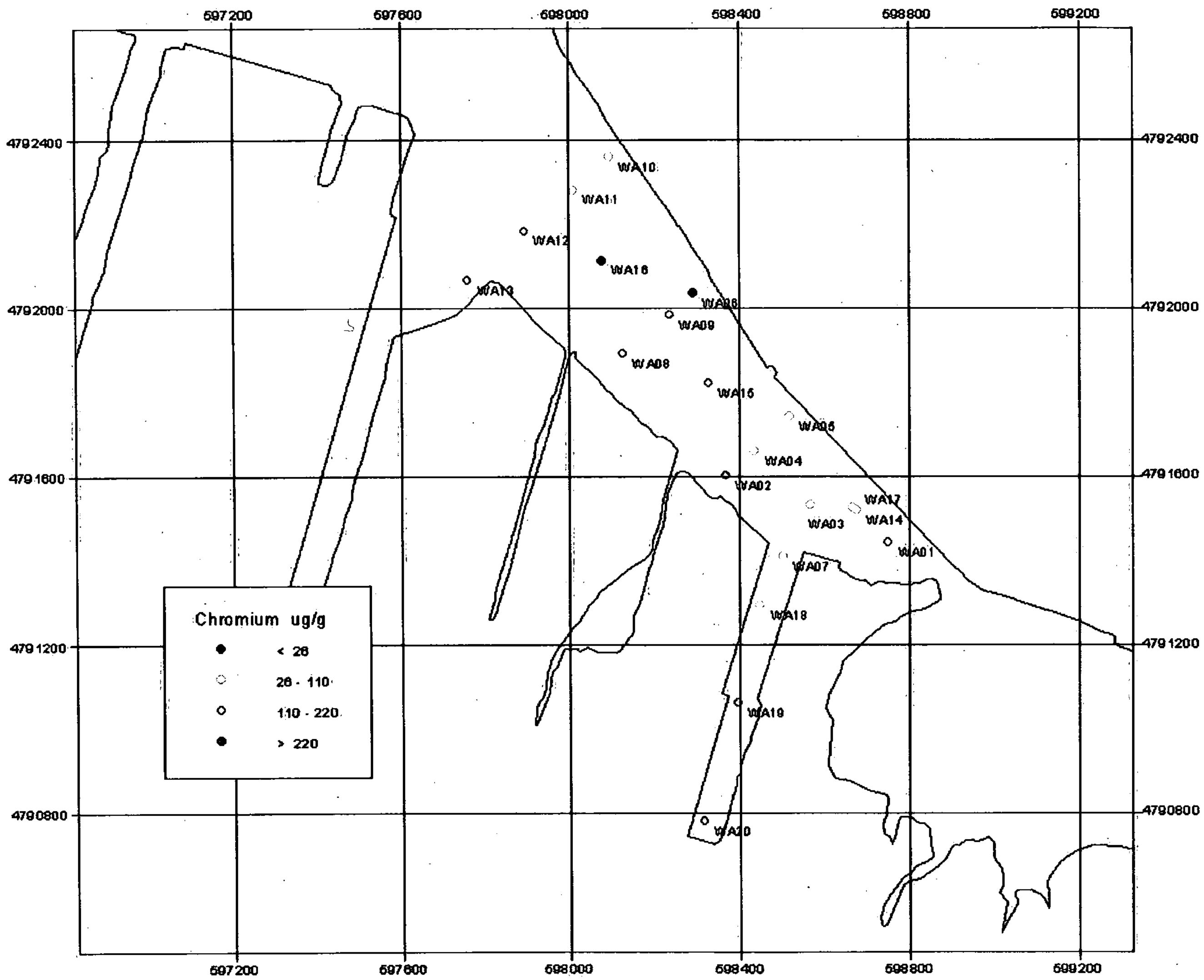


Figure B13. Exceedences of the LEL (26 µg/g) and SEL (110 µg/g) for chromium in Windermere Arm sediments.

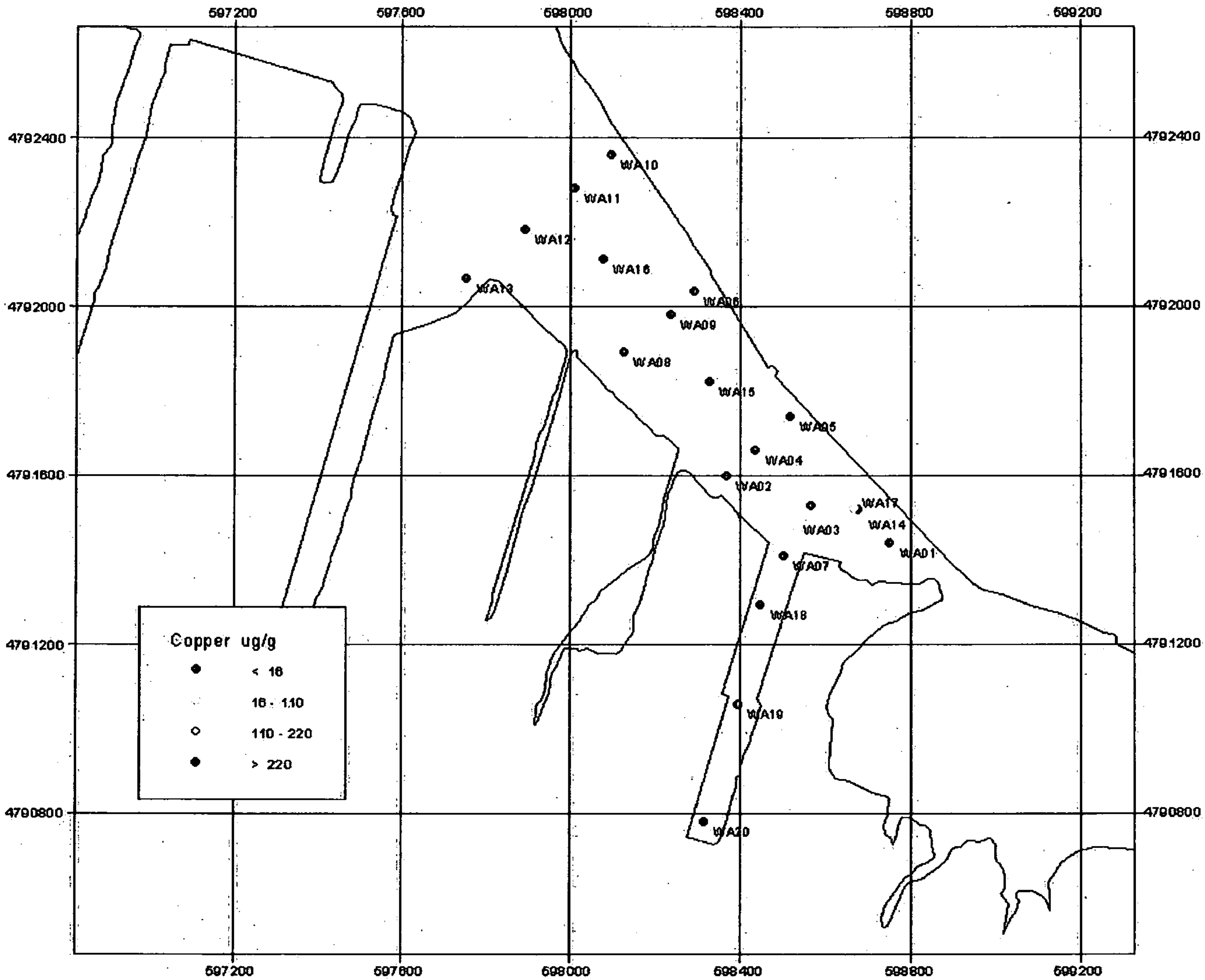


Figure B14. Exceedences of the LEL (16 µg/g) and SEL (110 µg/g) for copper in Windermere Arm sediments.

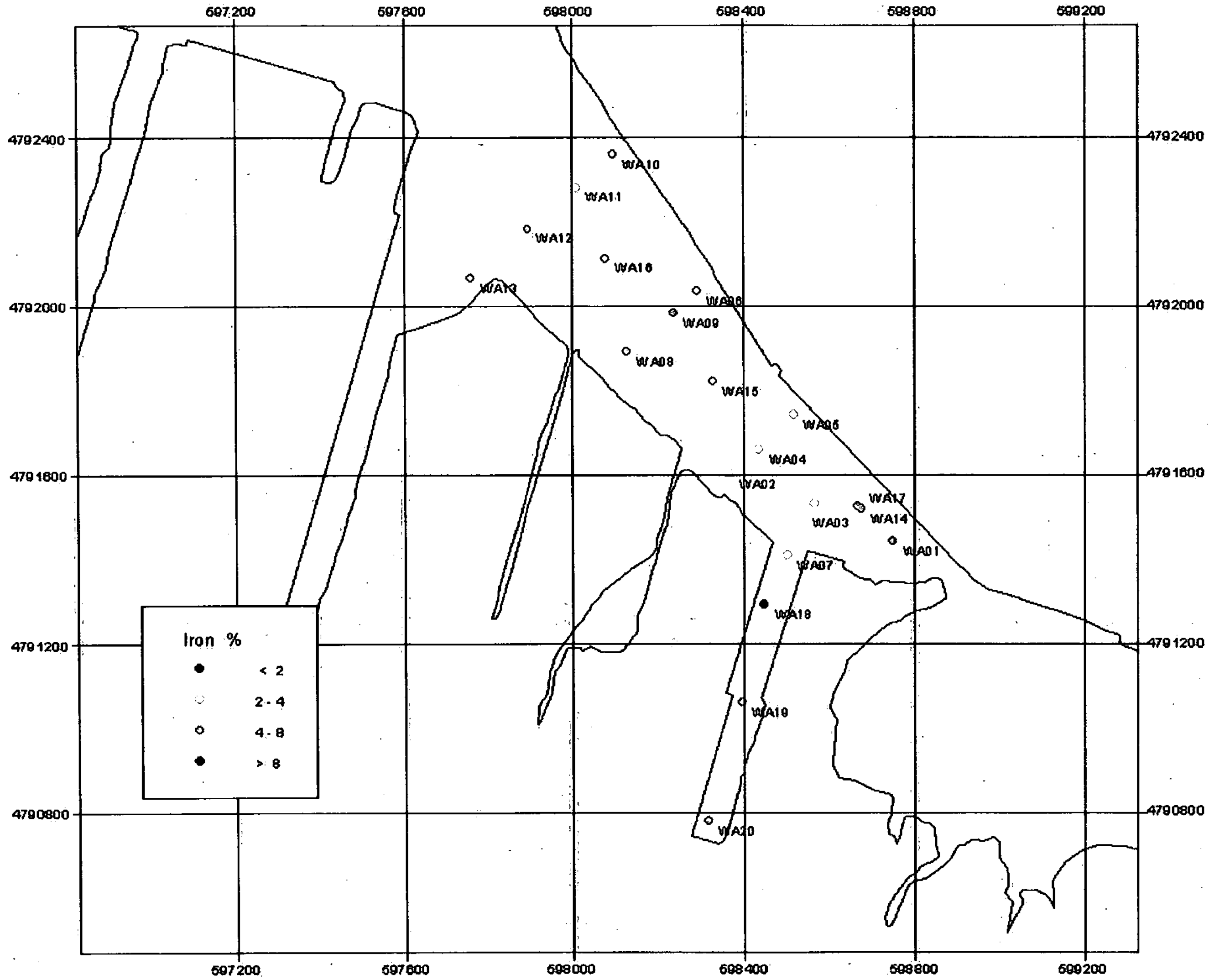


Figure B15. Exceedences of the LEL (2%) and SEL (4%) for iron in Windermere Arm sediments.

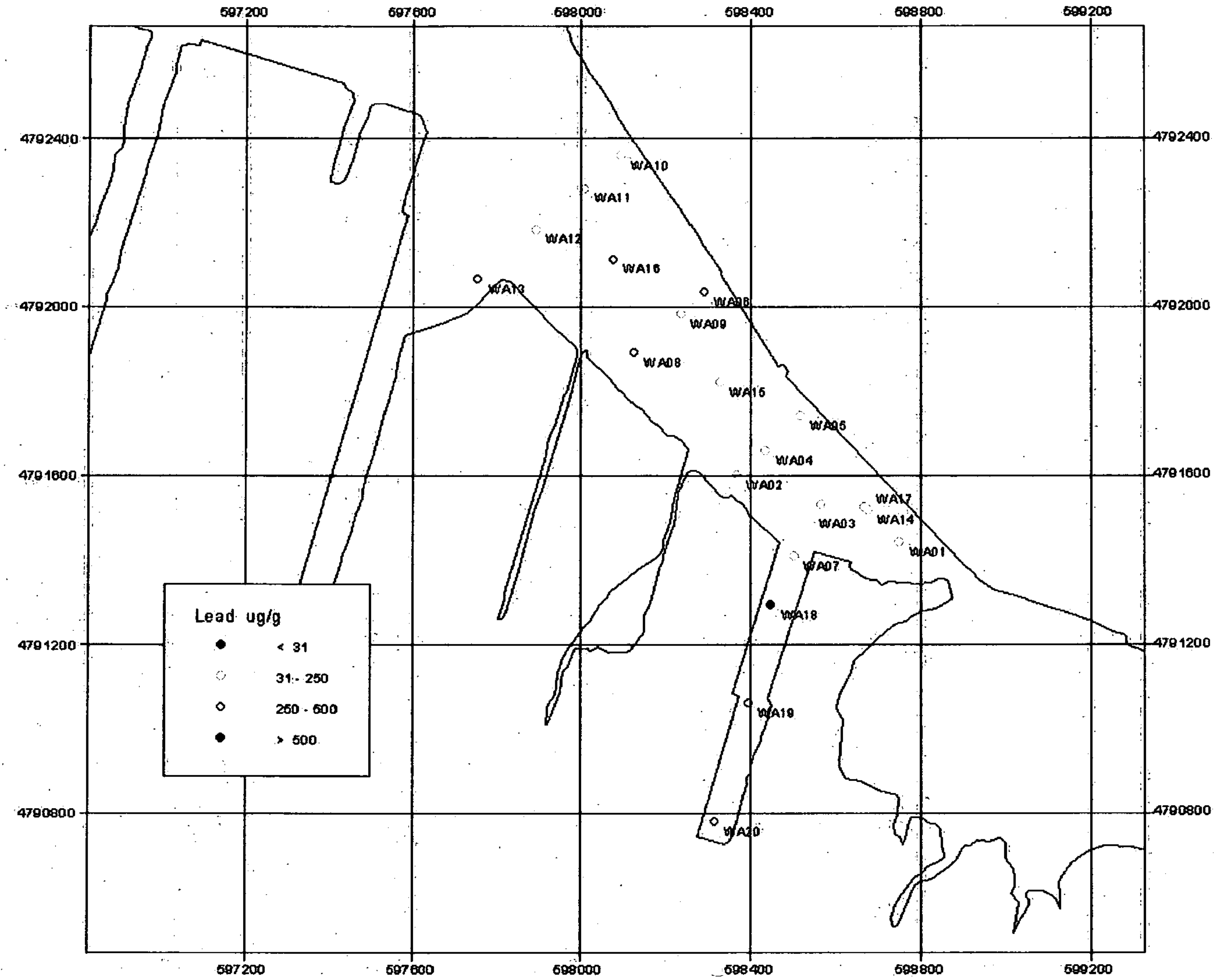


Figure B16. Exceedences of the LEL (31 μg/g) and SEL (250 μg/g) for lead in Windermere Arm sediments.

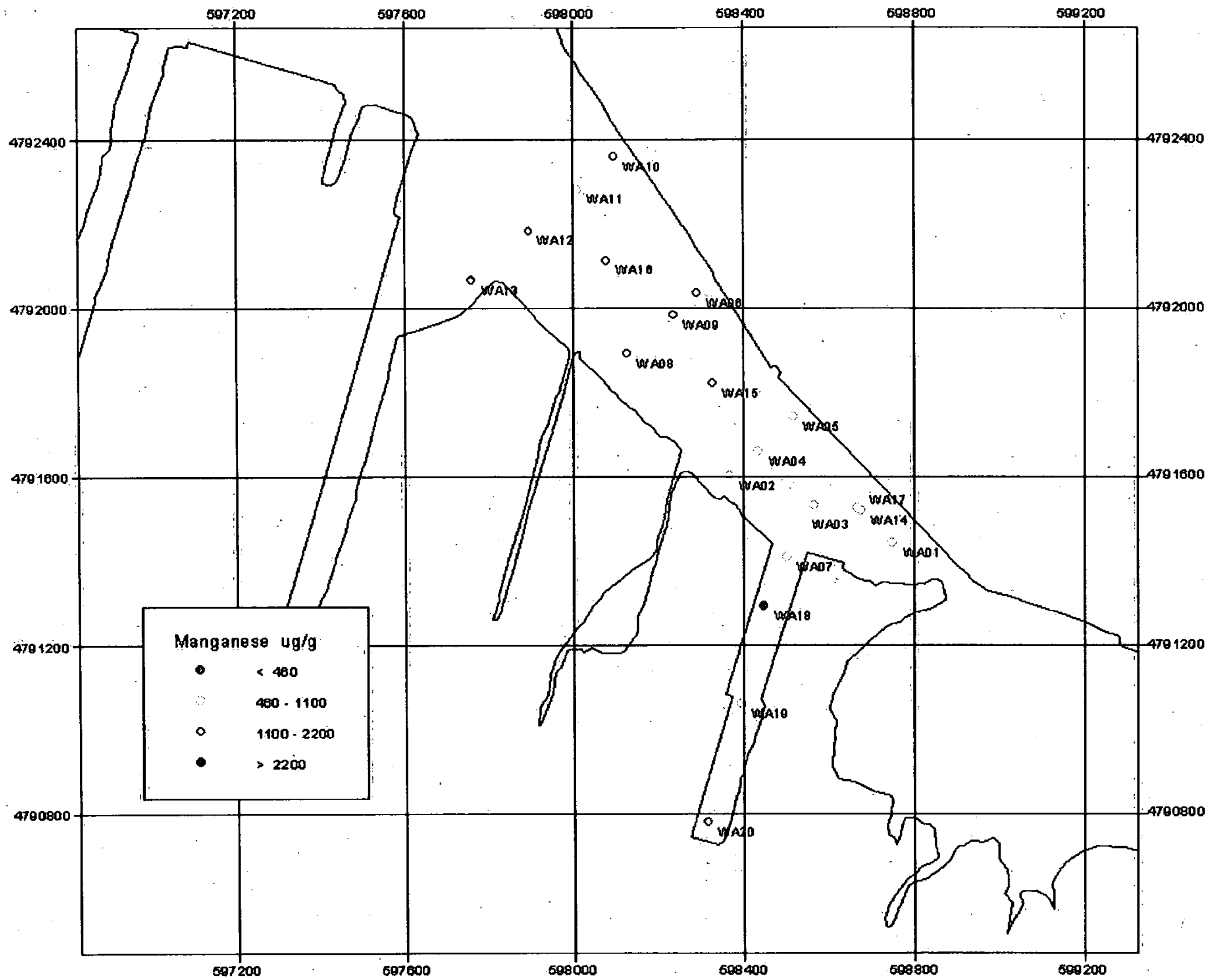


Figure B17. Exceedences of the LEL (460 μg/g) and SEL (1100 μg/g) for manganese in Windermere Arm sediments.

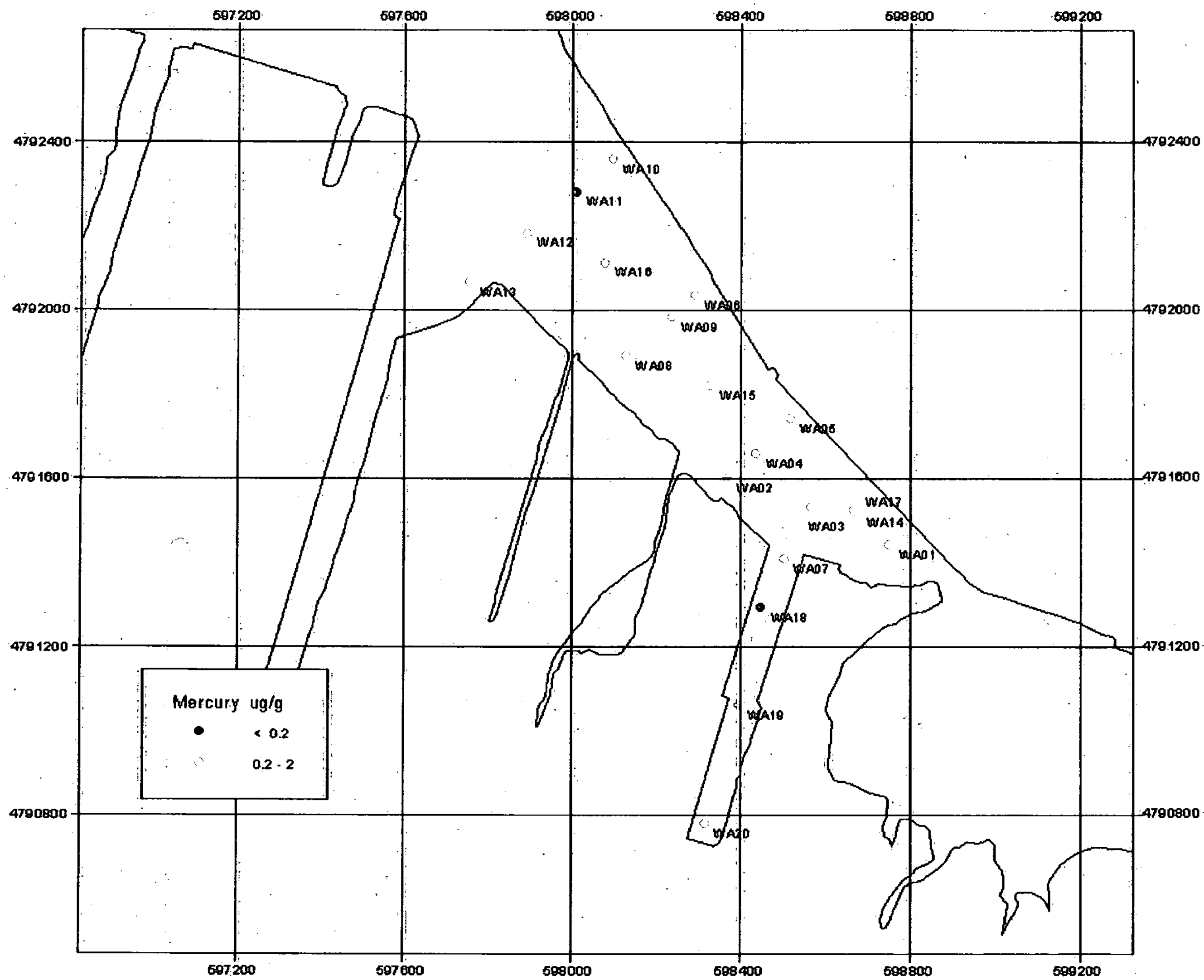


Figure B18. Exceedences of the LEL (0.2 µg/g) and SEL (2 µg/g) for total mercury in Windermere Arm sediments.

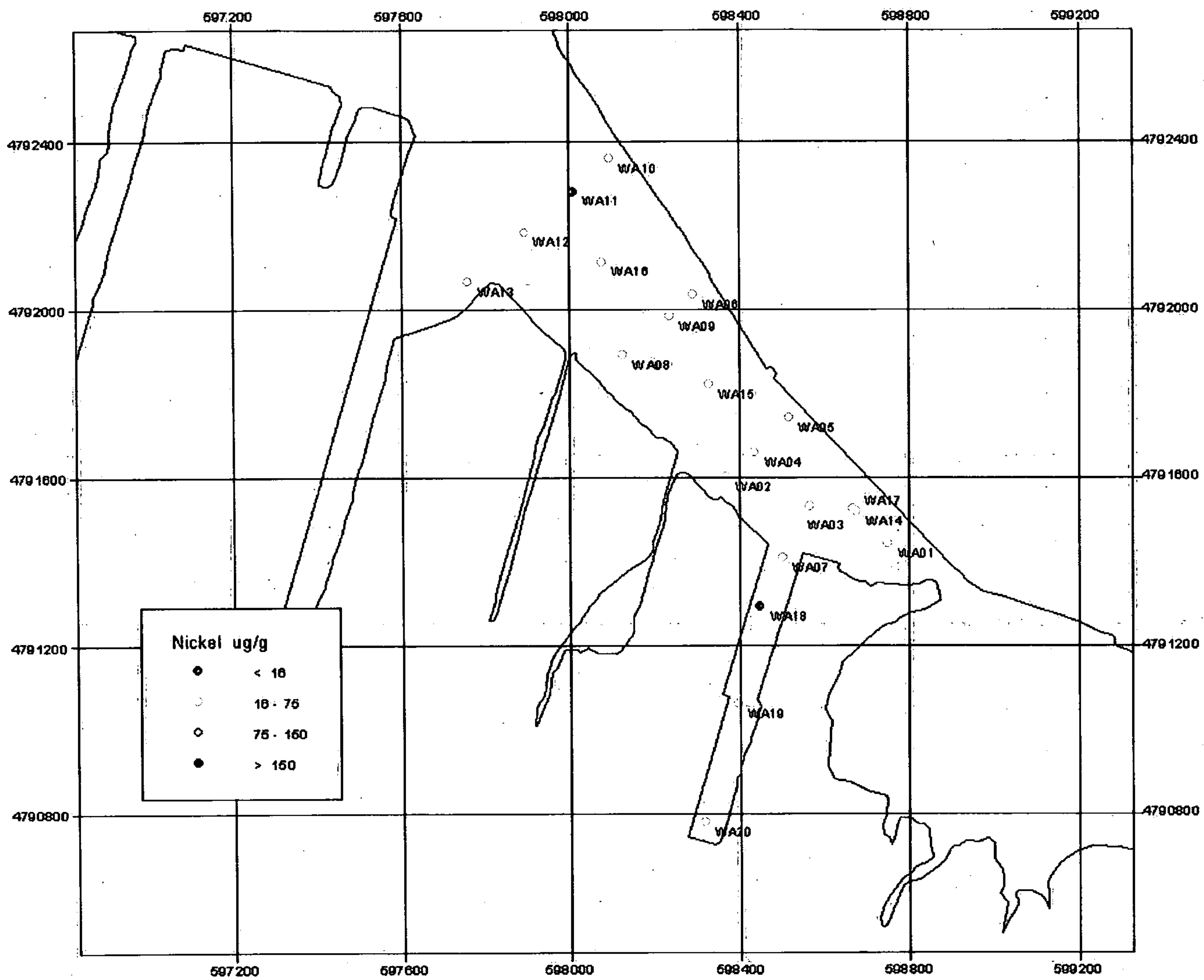


Figure B19. Exceedences of the LEL (16 µg/g) and SEL (75 µg/g) for nickel in Windermere Arm sediments.

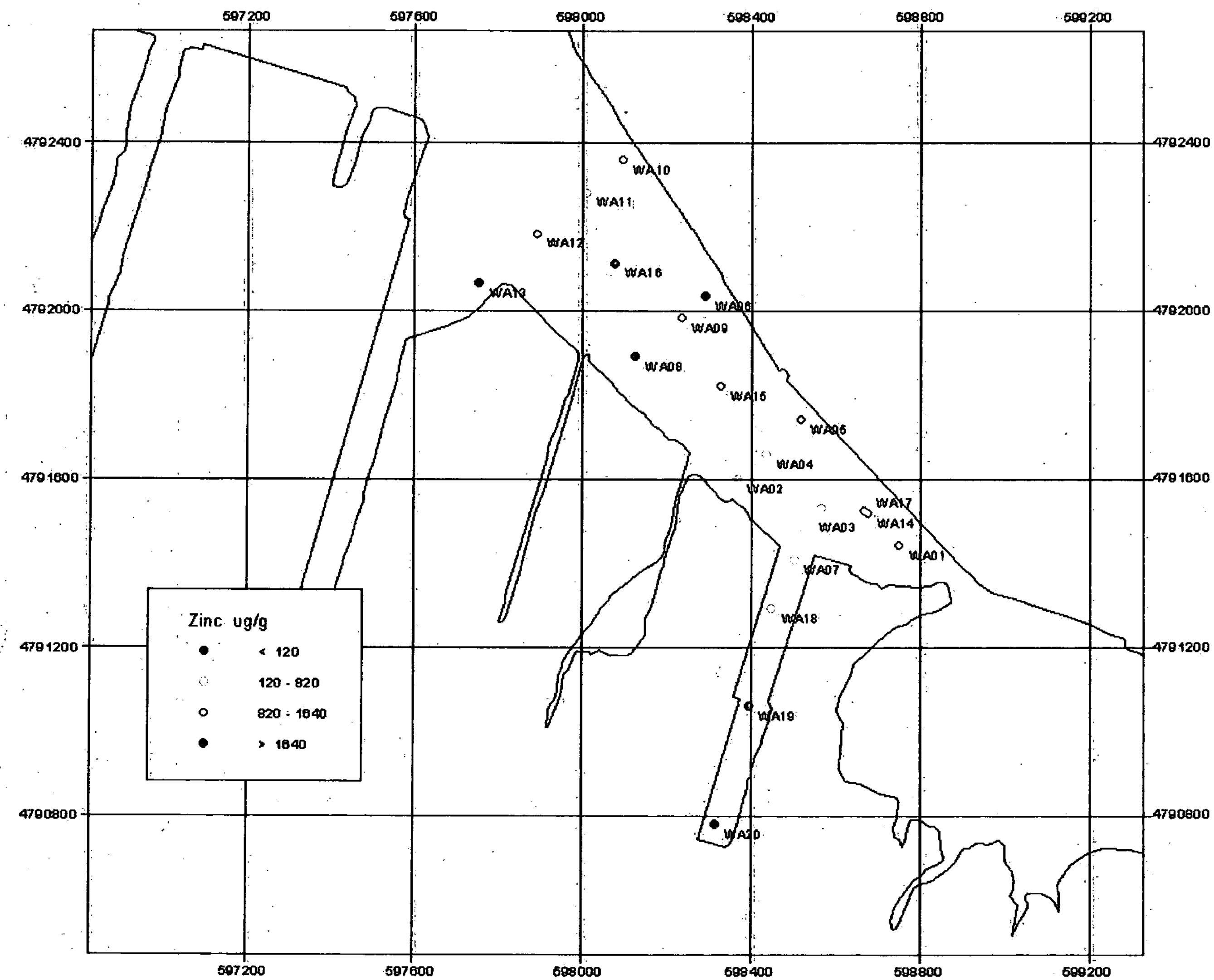


Figure B20. Exceedences of the LEL (120 µg/g) and SEL (820 µg/g) for zinc in Windermere Arm sediments.

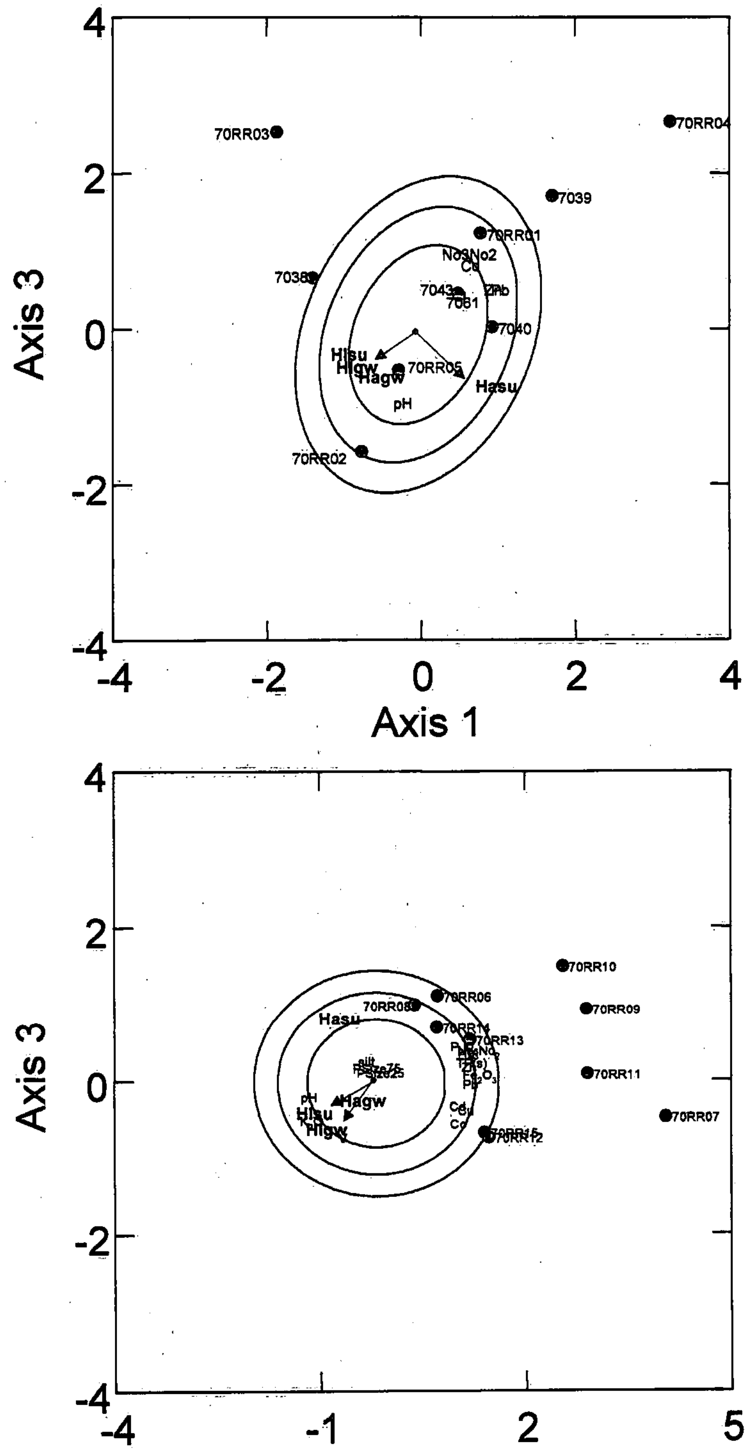


Figure C1. Comparisons of sediment toxicity at Randle Reef sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses): 1st and 2nd Randle Reef site subsets. Toxicity is in terms of NMDS axis scores. Locations relative to the origin of labels for toxicity test endpoints and habitat attributes indicate directions of increase in values for these variables among Randle Reef and reference sites. Arrows by labels indicate toxicity endpoints that are most associated with differences between Randle Reef and reference sites.

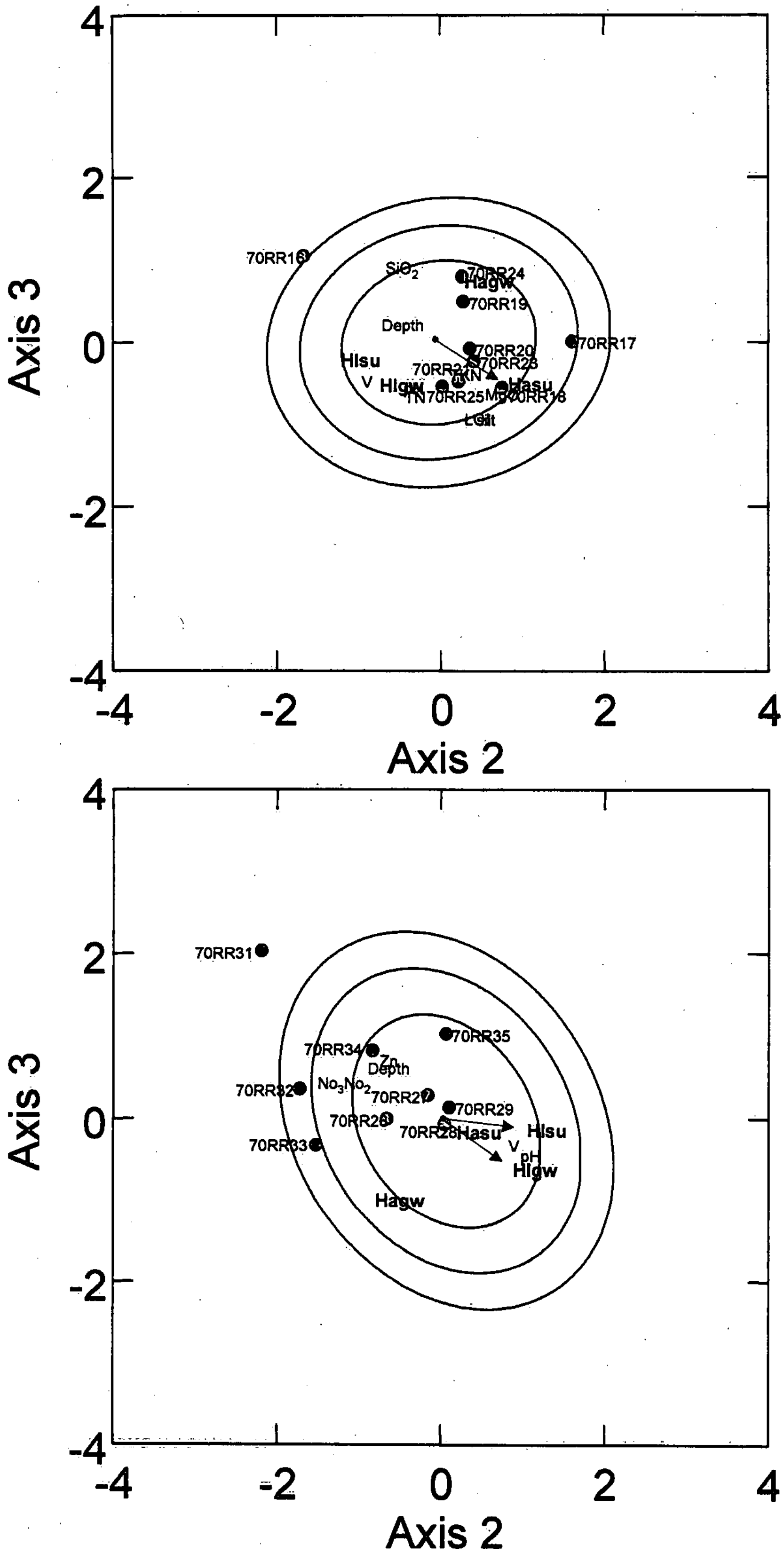


Figure C2. Comparisons of sediment toxicity at Randle Reef sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses): 3rd and 4th Randle Reef site subsets. See Figure C1 for explanation.

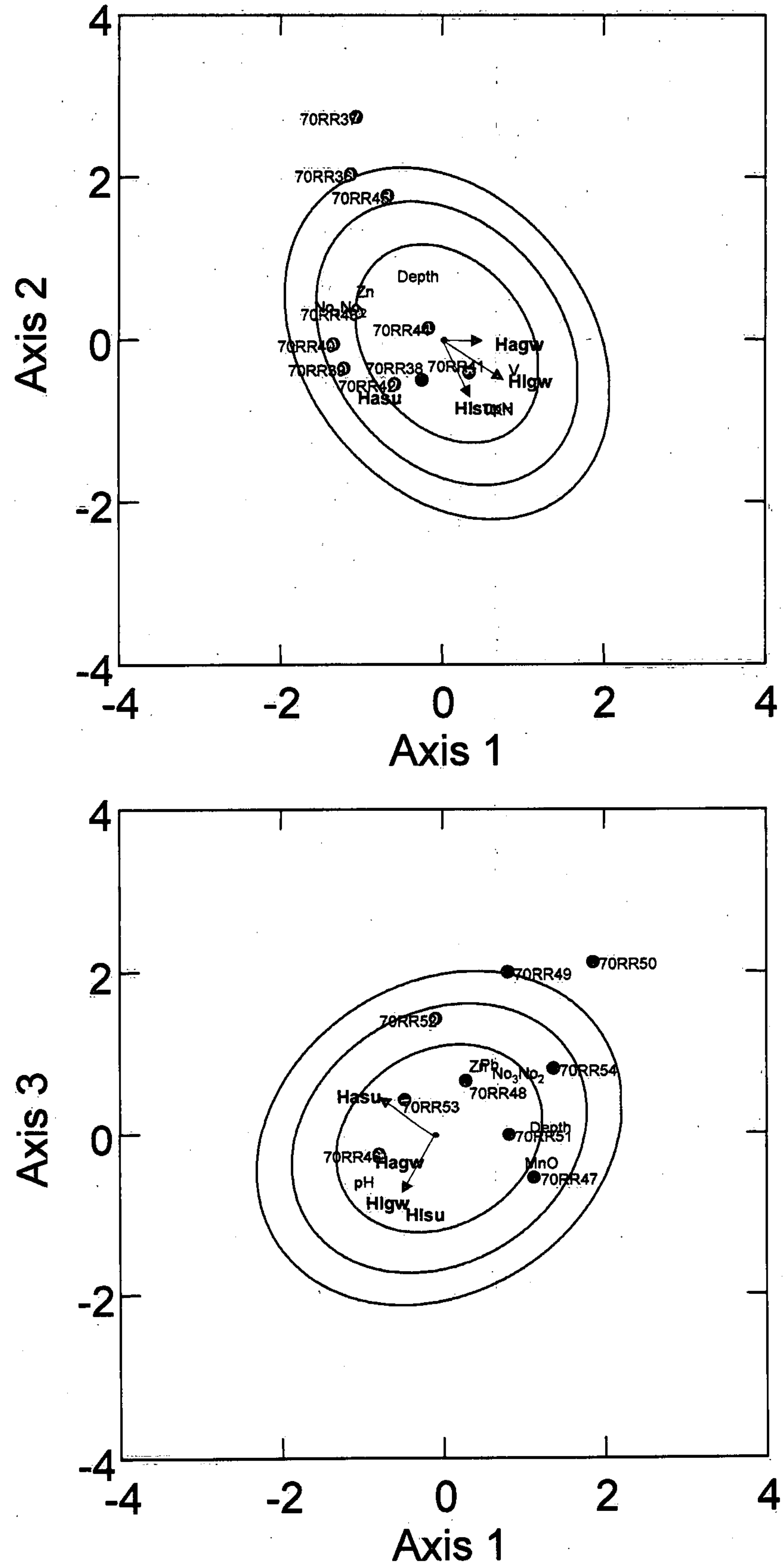
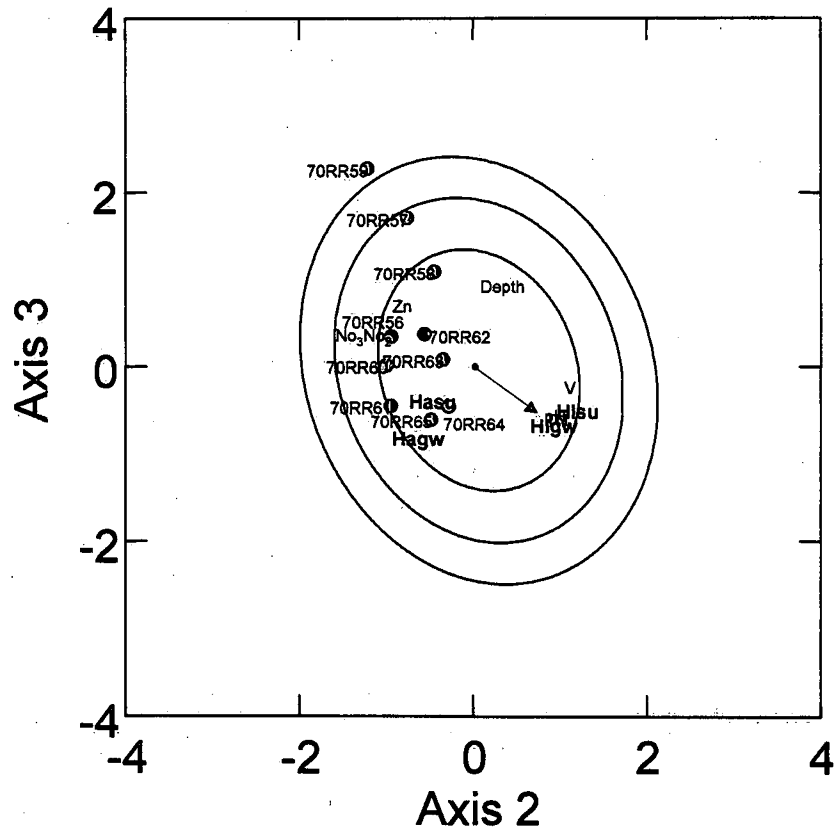


Figure C3. Comparisons of sediment toxicity at Randle Reef sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses): 5th and 6th Randle Reef site subsets. See Figure C1 for explanation.



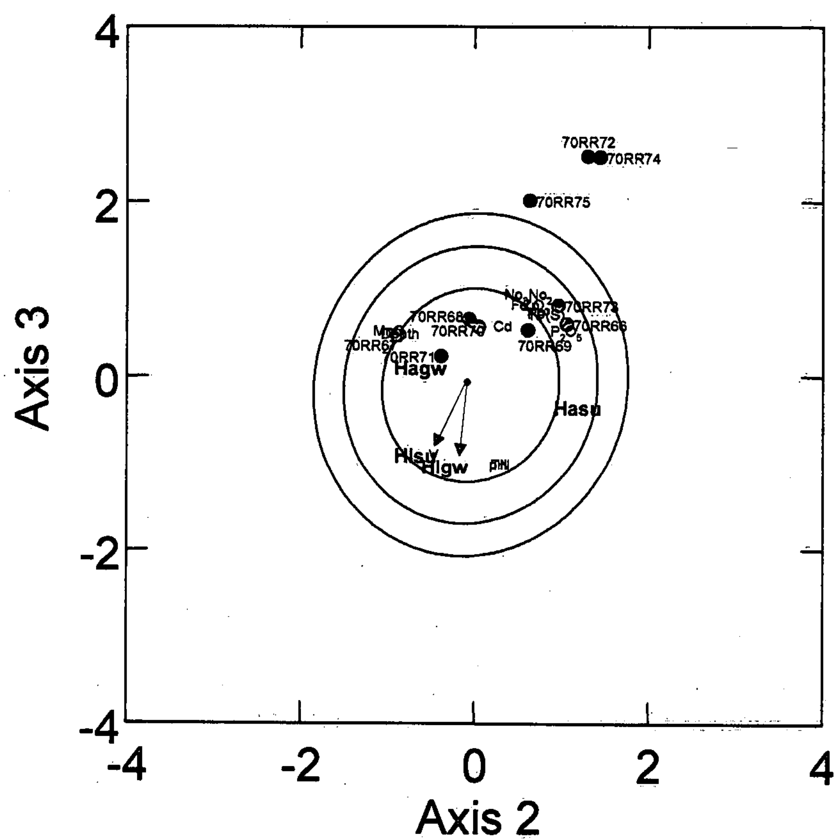


Figure C4. Comparisons of sediment toxicity at Randle Reef sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses): 7[th] and 8[th] Randle Reef site subsets. See Figure C1 for explanation.

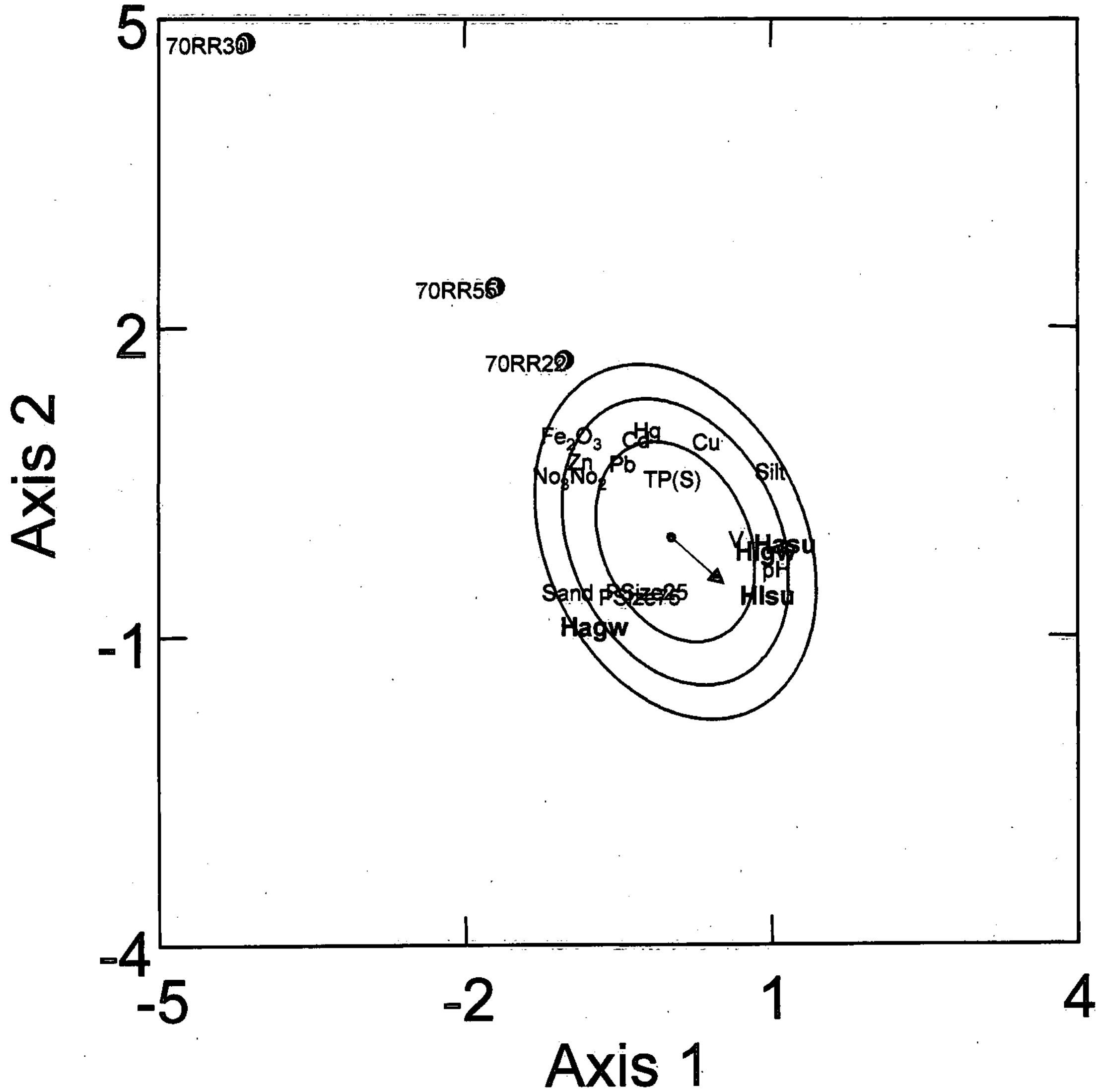


Figure C5. Comparisons of sediment toxicity at Randle Reef sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses): 9th Randle Reef site subset. See Figure C1 for explanation.

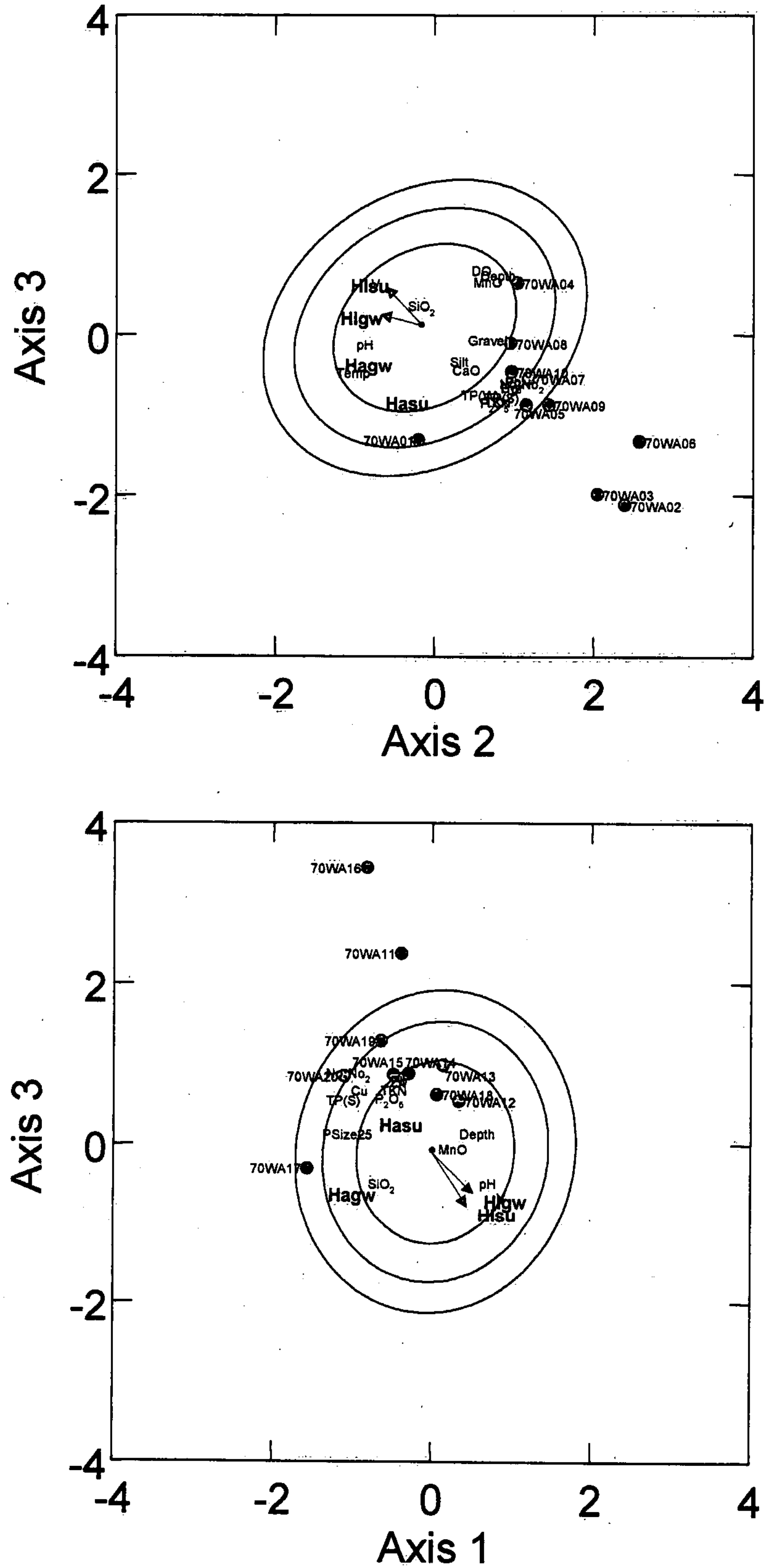


Figure C6. Comparisons of sediment toxicity at Windermere Arm sites (solid circles) to reference site toxicity (90, 99 and 99.9% probability ellipses). See Figure C1 for explanation.

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