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Assessment of Sediment Dioxin/Furan and Dioxin-Like PCB Contamination and Biological Impacts in the Lower Trent River, 2006

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WSTD Contribution No. 08-503

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SUMMARY

Recent surveys by Environment Canada and the Ministry of the Environment have revealed levels of dioxins and furans (PCDD/Fs) above sediment quality guidelines in depositional areas of the lower Trent River (Bay of Quinte Area of Concern). In response, Environment Canada undertook a survey in May 2006 to determine whether biological impacts were associated with these or any other sediment contaminants.

Sediment quality assessment was based on multivariate techniques using data on benthic invertebrate community assemblages, the functional responses of laboratory organisms in toxicity tests, and the physical and chemical attributes of the sediment and overlying water. Data were compared to biological criteria developed previously for the Laurentian Great Lakes. With the presence of a persistent biomagnifiable sediment toxicant, its bioavailability and potential for effects on fish and wildlife through biomagnification were also assessed. This involved the comparison of benthic invertebrate contaminant concentrations to reference levels and to tissue residue guidelines for the protection of consumers of aquatic biota. A risk-based, decision-making framework for the management of sediment contamination, developed under the Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem, was applied to the results to evaluate sediment quality for each site.

Overlying water samples and surficial sediment samples (for physico-chemical analyses, benthic invertebrate analysis and laboratory toxicity tests) were collected at 11 Trent River and at 5 reference sites. Sediment and laboratory-exposed benthic invertebrate tissue (mayflies) were analyzed for PCDD/Fs and dioxin-like (DL) PCBs. Exposed and reference sites were compared in terms of contaminant concentrations in sediment and invertebrates.

Concentrations of PCDD/Fs and DL PCBs in the sediment, expressed as total toxic equivalents (TEQs), are above the federal Probable Effect Level at 2 sites by up to 1.7×. PCDD/Fs contribute from 96.8 to 99.7% of the total TEQ (DL PCBs contribute very little). Mayfly tissue PCDD/F TEQs are above the CCME Tissue Residue Guideline (TRG) for the protection of

wildlife consumers of aquatic biota at 6 of the Trent River 11 sites; DL PCB TEQs are above the TRG at all sites.

There is no evidence of severe toxicity. There is 'potential' toxicity to the oligochaete worm *Tubifex* at 6 sites due to the low percentage of hatched cocoons and/or low young production compared to reference. The cause of toxicity is not clear but does not appear to be related to PCDD/Fs or DL PCBs. Statistically, the toxicological response is most strongly related to a combination of metals and sediment nutrients; however, metal concentrations are generally low in the sediments.

There is no evidence of highly degraded benthic communities. Most Trent River benthic communities are either equivalent to reference or at most 'possibly different' from reference. One site is very different from reference, due to increased diversity and increased abundances of certain taxa.

Based on the decision-making framework, immediate management actions are not recommended at any site. However, the risk of biomagnification due to PCDD/Fs and DL PCBs should be fully assessed for the Lower Trent River area.

RÉSUMÉ

Les relevés récents faits par Environnement Canada et par le ministère ontarien de l'Environnement ont révélé des niveaux élevés de dioxines et de furanes (PCDD/F) qui dépassent les recommandations sur la qualité des sédiments dans les zones sédimentaires du cours inférieur de la rivière Trent (secteurs préoccupants de la baie de Quinte). En réponse, Environnement Canada a entrepris une étude pour déterminer si des effets biologiques étaient associés à ces polluants ou à tout autre polluant dans les sédiments.

L'évaluation de la qualité des sédiments était fondée sur des techniques multidimensionnelles faisant appel aux données sur les assemblages de communautés d'invertébrés benthiques, les réactions fonctionnelles des organismes en laboratoire dans des tests de toxicité et les attributs physiques et chimiques du sédiment et des eaux sus-jacentes. On a comparé les données aux critères biologiques élaborés précédemment pour les régions des Laurentides et des Grands Lacs. Compte tenu de la présence de substances sédimentaires toxiques persistantes et bioamplifiables, on en a aussi évalué la biodisponibilité et les effets possibles sur le poisson et la faune par la voie de la bioamplification. Il s'agissait de comparer des concentrations de polluants chez les invertébrés benthiques aux niveaux de référence et aux recommandations pour les résidus dans les tissus destinées à protéger les consommateurs de biotes aquatiques. Un cadre de prise de décision fondé sur les risques pour la gestion de la contamination des sédiments, élaboré sous l'égide de l'Accord Canada-Ontario concernant l'écosystème du bassin des Grands Lacs, a été appliqué aux résultats pour évaluer la qualité des sédiments à chaque site.

Des échantillons d'eau sus-jacente et de sédiments de surface (pour fins d'analyses physico-chimiques, de l'analyse des communautés d'invertébrés benthiques et des tests de toxicité en laboratoire) ont été recueillis à onze sites de la rivière Trent et à cinq sites de référence. Le sédiment et le tissu d'invertébrés benthiques exposés en laboratoire (éphéméroptères) ont été analysés à la recherche de PCDD/F et de BPC semblables aux dioxines. On a comparé les sites exposés et les sites de référence en fonction des concentrations de polluants dans les sédiments et chez les invertébrés.

Les concentrations de PCDD/F et de BPC semblables aux dioxines dans le sédiment, exprimées comme facteurs d'équivalence de la toxicité (FET) dépassent le niveau fédéral d'effet probable à deux sites jusqu'à 1,7 fois. Les PCDD/F contribuent de 96,8 à 99,7 % du total des FET, (les BPC semblables aux dioxines y contribuent très peu). Les FET totaux de PCDD/F dans les tissus d'éphéméroptères dépassent les recommandations du CCME pour les résidus dans les tissus (RRT) destinées à protéger les consommateurs fauniques des biotes aquatiques, à six des onze sites de la rivière Trent; les FET des BPC semblables aux dioxines dépassent les RRT à tous les sites.

Il n'y a pas de preuve de toxicité grave. Il y a une toxicité « potentielle » pour le ver oligochète *Tubifex* à six sites à cause du faible pourcentage des cocons couvés et/ou à une faible production de jeunes comparé à la référence. La cause de la toxicité n'est pas claire, mais elle ne semble pas se rattacher aux PCDD/F ou aux BPC semblables aux dioxines. Statistiquement, la réaction toxicologique est très nettement liée à une combinaison de métaux et de nutriments des sédiments; cependant, les concentrations de métaux sont généralement faibles dans les sédiments.

Il n'y a pas de preuve de communautés benthiques très dégradées. La plupart des communautés benthiques de la rivière Trent sont soit équivalentes à la référence ou au plus « peut-être différentes » de la référence. L'un des sites est très différent de la référence, à cause d'une diversité accrue et d'une plus grande abondance de certains taxons.

En se fondant sur le cadre de prise de décision, on ne recommande de mesures immédiates de gestion à aucun site. Cependant, le risque de bioamplification dû aux PCDD/F et aux PBC semblables aux dioxines devrait être intégralement évalué pour le secteur du cours inférieur de la rivière Trent.

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ACRONYMS AND ABBREVIATIONS

adj	adjusted
AOC	area of concern
BSAF	biota-sediment accumulation factor
BQ	Bay of Quinte
CCME	Canadian Council of Ministers of the Environment
DL	dioxin-like
dw	dry weight
GL	Great Lakes
GLWQA	Great Lakes Water Quality Agreement
IJC	International Joint Commission
inv	invertebrate
LEL	lowest effect level
max	maximum
may	mayfly
min	minimum
MOE	Ministry of the Environment (Ontario)
OCD	Octachlorodioxin
OCF	Octachlorofuran
PAH	polycyclic aromatic hydrocarbon
PB	Presqu'ile Bay
PCB	polychlorinated biphenyl
PCDD/F	polychlorinated dibenzodioxin/dibenzofuran
PEL	probable effect level
QA/QC	quality assurance/quality control
RAP	remedial action plan
ref	reference
sed	sediment
SEL	severe effect level
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TCDF	2,3,7,8-tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	toxic equivalency unit
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TP	total phosphorus
TRG	tissue residue guideline
wt	weight
ww	wet weight
$[x]_i$	concentration of substance *x* in matrix *i*

1 INTRODUCTION

1.1 Background

Sediment investigations by Environment Canada and the Ontario Ministry of the Environment in 2004 and 2005 revealed elevated levels of polychlorinated dibenzo-*p*-dioxins and dibenzofurans, or dioxins and furans commonly, in the sediments of the lower Trent River (Biberhofer 2006; Fletcher 2006). Dioxin/furan (PCDD/F) concentrations, expressed in toxic equivalent concentrations (TEQ), were above Canadian Sediment Quality Guidelines for the protection of aquatic life. A comprehensive survey undertaken in the Bay of Quinte Area of Concern in 2000, which involved an assessment of sediment and overlying water physico-chemical properties, benthic communities and laboratory toxicity, included six sites in the lower Trent River (Milani and Grapentine 2004). Benthic communities at these sites were "equivalent to reference" or "possibly different" than reference conditions, and sediments from 2 of the 6 sites were toxic. There was no concurrence of toxicity and benthos alteration and the reasons for toxicity were not determined. However, because organic contaminants were not measured in the sediments, their contribution to toxicity was unknown. The recent finding of elevated PCDD/Fs in the lower river sediment suggests the potential for biological effects and indicated a need for further investigation. Effects on the benthos as well as the potential transfer of contaminants through diet to higher trophic levels were primary concerns that needed to be evaluated.

1.2 Approach and Objectives for Study

Sediment contamination was assessed using the BEAST methodology (Reynoldson et al. 1995, 2000). This approach utilizes data from nearshore reference sites that were sampled from the Laurentian Great Lakes over a three-year period. Information on benthic communities (the type and number of invertebrate taxa present), selected habitat variables, and responses (survival, growth and reproduction) of four benthic invertebrates in laboratory sediment toxicity tests establish normal conditions for selected endpoints, and determine the range of 'normal' biological variability. Expected biological conditions at test sites are then predicted by applying relationships developed between biological and habitat conditions.

Objectives for this study included assessing conditions at sites in the lower Trent River following the risk-based, decision-making framework for the management of sediment contamination

recently developed by the Canada-Ontario Agreement Sediment Task Group (Chapman and Anderson 2005). The framework involves the evaluation of four lines of evidence (sediment chemistry, toxicity, benthic communities and the potential for contaminant biomagnification). The potential for food chain effects from PCDD/Fs associated with sediment was assessed from measurement of tissue concentrations of laboratory-exposed mayflies (*Hexagenia* spp.).

2 METHODS

2.1 Sample Collection and Handling

Sampling was conducted 15-18 May 2006. Site positions were obtained using a differentially corrected global positioning receiver (Northstar 751), receiving corrections from CD-GPS. Station positions and depth are provided in Table 1 and site locations are shown in Figure 1.

Sampling locations included:

(1) Upstream – 2 sites: BQ19, BQ9

(2) Lower Trent River, primary depositional area – 3 sites: TR01, 6508, TR03

(3) Lower Trent River, boat marina – 1 site: BQ2

(4) Lower Trent River, west side dock – 1 site: BQ1

(5) Lower Trent River, secondary depositional area – 2 sites: TR12, TR13

(6) Trenton Bay – 2 sites: 2036, 6507

(7) Local reference areas – 5 sites: 401, 402, 403, 1310, 1312

Prior to sediment collections, water samples were obtained using a van Dorn sampler, taken 0.5 meters from the bottom. Temperature, conductivity, pH, and dissolved oxygen were measured on site with YSI instruments. Samples for alkalinity, total phosphorus, total Kjeldahl nitrogen, nitrates/nitrites, and total ammonia were dispensed to appropriate containers and stored (4°C) for later analysis. Surficial (top 10 cm) sediment samples were collected for chemical and physical analyses, benthic invertebrate community analysis and laboratory sediment toxicity tests. A 40-cm × 40-cm mini-box corer was used to obtain the benthic invertebrate and sediment chemistry samples. Benthic community samples were subsampled from the mini-box core using 10-cm length × 6.5-cm diameter acrylic tubes. Samples were sieved through a 250-µm mesh screen and the residue preserved with 5% formalin for later identification. The remaining top 10 cm of

sediment from each box core was removed, homogenized in a Pyrex dish and allocated to containers for chemical and physical analyses of the sediment. At one site (Presqu'ile Bay reference site 403), where a mini-box corer could not be used due to the hard substrate, three Ponar grabs were collected for the benthic community and one Ponar grab was collected for chemical and physical properties of the sediment. Each benthic community Ponar sample was sieved in its entirety and the residue preserved as described above. Five petite Ponar grab samples were collected per site for the laboratory toxicity tests (approximately 2 L sediment per replicate). Each of the five sediment grabs was placed in separate plastic bag, sealed, and stored in a 10-L bucket. All samples were stored at 4°C. Environmental variables measured at each site are shown in Table 2. Details on sampling techniques and methods for sample collection are described in Reynoldson et al. (1998a, 1998b).

2.2 Sediment Water and Biota Analyses

Overlying Water

Overlying water samples were analyzed by the National Laboratory for Environmental Testing (NLET) in Burlington, Ontario, for alkalinity, total phosphorus, total Kjeldahl nitrogen, nitrates/nitrites and total ammonia by procedures outlined in Cancilla (1994) and NLET (2006).

Trace metals

Freeze dried sediment samples were analyzed for for trace elements (hot aqua regia extracted), major oxides (whole rock), total organic carbon, loss on ignition, total phosphorus, and total Kjeldahl nitrogen by Caduceon Enterprises (Ottawa, ON), using USEPA/CE (1981) standard methodologies or in house procedures.

Particle size

Freeze dried sediment samples were analyzed for percents gravel, sand, silt, clay, particle size mean, and particle size 25th and 75th percentiles by the Sedimentology Laboratory at Environment Canada (Burlington, ON) following the procedure of Duncan and LaHaie (1979).

Organic contaminants

Sediment and benthic invertebrate tissue samples (mayfly *Hexagenia* spp.) were analyzed for PCDD/Fs and DL PCBs by GC-HRMS by the Laboratory Service Branch of the Ontario

Ministry of the Environment (Etobicoke, ON) according to procedures outlined in OMOE (2005). Details of mayfly exposures to contaminated sediment are provided in Sections 2.4 and 2.5.

2.3 Taxonomic Identification

Benthic community samples were transferred to 70% ethanol after a minimum of 72 hours in formalin. Invertebrates in the benthic community samples were sorted and counted at the Invertebrate Laboratory at Environment Canada (Burlington, ON). Oligochaetes were slide mounted for identification. Organisms were identified to lowest practical level by BIOTAX (Etobicoke, ON).

2.4 Sediment Toxicity Tests

Four sediment toxicity tests were conducted at the Ecotoxicology laboratory at Environment Canada (Burlington, ON): *Chironomus riparius* 10-d survival and growth test, *Hyalella azteca* 28-day survival and growth test, *Hexagenia* spp. 21-day survival and growth test, and *Tubifex tubifex* 28-day adult survival and reproduction test. Sediment handling procedures and toxicity test methods are detailed elsewhere (Borgmann and Munawar 1989; Borgmann et al. 1989; Krantzberg 1990; Reynoldson et al. 1991, 1998b). For quality control purposes, each test set included control sediment, collected from Long Point Marsh, Lake Erie, which is comprised on average of 70.33% silt, 29.13% clay, 0.54% sand, and 8.1% total organic carbon. Tests passed an acceptability criterion based on percent control survival in Long Point sediment before being included in a data set, i.e., ≥ 80% for *H. azteca* and ≥70% for *C. riparius* (USEPA 1994; ASTM 1995), ≥80% for *Hexagenia* spp., and ≥75% for *T. tubifex* (Reynoldson et al. 1998b). Overlying water used in toxicity tests was City of Burlington tap water (Lake Ontario), which was charcoal filtered and aerated for a minimum of three days prior to use. Water characteristics included: conductivity 273 - 347 µS/cm; pH 7.5 - 8.5; hardness 120 - 140 mg/L; alkalinity 75 - 100 mg/L; 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 the completion of the test. 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, with the exception of *T. tubifex* test which was run in the dark.

2.5 Mayfly Contaminant Exposures

At the completion of the 21-day exposures in toxicity tests (described in Section 2.4), surviving *Hexagenia* were transferred to 2 L glass jars (20-30 mayflies per jar) with 1 L culture water for 24 hour gut clearing. Approximately 35 mg dw of prepared food (40% fish flake and 30% each of brewers yeast and cereal grass) was added to each jar to allow mayflies to purge their guts of sediment. After gut clearing, mayfly tissue was rinsed with deionized water, weighed and frozen (-20°C). Tissue was then freeze dried and reweighed. Samples were sent to the Laboratory Service Branch of the Ministry of the Environment in Etobicoke for analysis of PCDD/Fs and DL PCBs (see Section 2.2).

2.6 Data Analysis

2.6.1 BEAST analysis

Test sites were assessed using BEAST methodology (Reynoldson and Day 1998; Reynoldson et al. 2000). The BEAST model predicts the invertebrate community group that should occur at a test site based on natural environmental conditions. Multiple discriminant analysis was used to predict the test sites to one of five reference community groups using a previously computed relationship between five environmental variables (latitude, longitude, depth, total organic carbon, and alkalinity) and the community groups (Reynoldson et al. 1995, 2000). For each test site, the model assigned a probability of it belonging to each of five reference faunal groups. Community structure assessments were conducted at the family level, as this taxonomic detail is shown to be sensitive for the determination of stress (Reynoldson et al. 2000). All community data were adjusted to be equivalent to sampling by box corer. To adjust for the efficiency of the Ponar grab relative to the box core for reference site 403, benthic abundances were divided by 0.69, with the exception of the chironomids, oligochaetes, sphaeriids, nematodes and hirudinea, where 0.52, 0.55, 0.75, 0.64, and 0.71 were used, respectively. All counts were then adjusted to the area of the subsampling core tube (33.14 cm^2). Community data for the test sites were merged with the reference site invertebrate data of the matched reference group (group to which the test site has the highest probability of belonging) only and ordinated using hybrid multidimensional scaling (HMDS; Belbin 1993), with Bray-Curtis distance site × site association

matrices calculated from raw data. Toxicity data were analyzed using HMDS, with Euclidean distance site × site association matrices calculated from standardized data. Toxicity endpoints for the test sites were compared to those for all reference sites. (There are no distinct groups as with the community structure assessment.) Principal axis correlation (Belbin 1993) was used to identify relationships between habitat attributes and community or toxicity responses. This did not include organic contaminant data, which were not measured in the reference sediments. 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. Probability ellipses were constructed around reference sites, establishing four categories of difference from reference: equivalent /non-toxic (within the 90% probability ellipse), possibly different/ potentially toxic (between the 90 and 99% ellipses), different/toxic (between the 99 and 99.9% ellipses), and very different/severely toxic (outside the 99.9% ellipse). Test site toxicological 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).

Test data were analyzed in subsets to maintain the ratio of test: reference sites ≤0.10. Multiple discriminant analysis was performed and probability ellipses were produced using the software SYSTAT (Systat Software Inc. 2002). HMDS, principal axis correlation, and Monte-Carlo tests were performed using the software PATN (Blatant Fabrications Pty Ltd. 2001).

2.6.2 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 Great Lake reference sediments to which toxicological responses were compared), additional analyses of relationships between sediment toxicity (using toxicity test endpoints) and contaminant concentrations for Trent River 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 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 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., toxicity endpoints and concentrations of individual sediment contaminants). The sediment toxicity data for Trent River 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 9 metals (Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn) were ordinated by principal components analysis (PCA). The eigenanalysis was performed on the correlation matrix. Data for metal variables were log(x)-transformed.

The integrated descriptors of sediment toxicity (axes scores from the HMDS) and the most important individual toxicity endpoints were plotted against the integrated contaminant descriptors (from PCA) as well as individual log(x)-transformed sediment contaminants, nutrients and 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 individual toxicity response was assessed by fitting regression models using "best subset" procedures (Draper and Smith 1998; Minitab 2000). Models were fitted for (a) PCDD/Fs, (b) DL PCBs, (c) metals, (d) sediment nutrients and grain size, (e) overlying water nutrients, and then (f) all combinations of the best predictors from the five groups. (This procedure was used to avoid computational difficulties arising from working with multiple 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.

2.6.3 Biota-sediment accumulation factors

A biota-sediment accumulation factor (BSAF) was calculated for each of the PCDD/F and DL PCB compounds. A BSAF assumes that the concentration of contaminant in the organism is a

linear function of the contaminant concentration in the sediment. The BSAFs were calculated for all PCDD/F and PCB congeners using the following equation:

$$BSAF = C_{may} / (\%lipids/100) \div C_{sed} / (\%total\ organic\ carbon/100)$$

where

C_{may} = mean contaminant concentration in the mayflies

C_{sed} = mean contaminant concentration in the sediment

Due to an insufficient amount of mayfly tissue for lipid analysis in the present study, previously determined lipid values were considered for the BSAF calculations. Mayfly *Hexagenia* spp. lipid values ranged from 4.4 to 8.2% dry mass (n=9) with a mean value of 5.6% (Environment Canada 2002, Unpublished data). The mean value of 5.6% was used in all BSAF calculations.

2.7 Quality Assurance/Quality Control

Field replicate variability

Triplicate overlying water and sediment samples were collected at two randomly selected sites 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).

Laboratory

Quality control procedures for the Caduceon laboratory involved control charting of influences, standards, and blanks. 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, while duplicates were run 1 in 10 samples. Sample duplicate measurements of sediment metals, major oxides and nutrients were expressed as the relative percent difference ($= (x_1 - x_2)/ (x_1 + x_2)/2 \times 100$).

All PCDD/Fs and PCB data were corrected for surrogate recoveries by the Ministry of Environment laboratory. Method blanks and spiked blank matrix samples were processed with each set of 10 field samples.

Community structure sorting

To evaluate quality control measures for benthic invertebrate enumeration, each month, a randomly selected sorted sample was re-sorted, and the number of new organisms found counted. The percent of organisms missed (%OM) was calculated using the equation:

%OM = # Organisms missed / Total organisms found × 100

A desired sorting efficiency (as %OM) is ≤ 5% (or >95% recovery). If the %OM was > 5%, two more replicate samples were randomly selected and the %OM calculated. The average %OM was calculated based on the three re-sorted samples, and represents the standard sorting efficiency for that month. The average %OM is based on only one replicate sample if %OM is < 5%.

3 RESULTS AND DISCUSSION

3.1 Quality Assurance/Quality Control

Field replicates

Triplicate sediment and overlying water samples were collected at two sites: 6507 and 6508. 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. Variability among field-replicated sites, expressed as the coefficient of variation (CV), is shown in Appendix A, Table A1. The CVs are low, ranging overall from 0 to 37% (mean: 6%, median: 4%), not uncommon for field-replicated samples (samples taken from three separate box core drops). The highest variability is noted for silicon (37%, site 6507) and mercury (23 and 33%).

Laboratory quality control

Laboratory duplicate measurements for sediment variables are provided in Appendix A, Table A2. Sample duplicates were performed for four sites: 401 and 6508-3 (except TOC), and 6508-2 and BQ10 (TOC only). The overall mean relative percent difference (RPD) for sample duplicates measurements is low overall, ranging from 0 to 62% (mean: 5%, median: 2%; Table A3),

indicating good agreement between sample duplicates. Analyses and recoveries for three reference materials (LKSD-3, WH89-1, and STSD-4) are provided in Table A3. With the exception of molybdenum, trace metal recoveries range from 82 to 107% (LKSD-3 reference). Recovery of Mb is 50%, but is within the control limit of 49 – 93%. Recoveries range from 95 to 110% for major oxides (WH89-1 reference) and the recovery for mercury (STSD-4 reference) is 98% (Table A2). All recoveries are well within the control limits for each parameter.

For sediment samples, percent recoveries for labeled internal standards are generally good for most standards, ranging from 33 to 118% for PCDD/F congeners (median: 68%) (Table A4). For PCBs, there are some low values reported for PCB 77 (e.g., 5%, 7%) which are not typical. Lower values are also reported for the other tetra congener (PCB 81), although not as low as PCB 77. If the samples had some other co-extractables in them, these congeners may have pushed through the carbon during sample cleanup (Eric Reiner, pers. comm.). Overall however, recoveries were fair for the PCB congeners (median: 76%) (Table A4). For benthic invertebrate (mayfly) samples, percent recoveries range from 42 to 131% for PCDD/F congeners (median: 88%) and from 28 to 135% for PCB congeners (median: 82%) (Table A5).

Community structure sorting

The mean percent sorting efficiency for the community samples is 2.8%, which represents the average sorting efficiency of 1 to 3 sorters over a 5 month period. This is an acceptable low level, indicating that there was likely good recovery (>95%) of organisms in all samples.

3.2 Sediment and Water Physico-Chemical Properties

3.2.1 Overlying water

Conditions of overlying water 0.5 m above the sediment are shown in Table 3. Across all sites, the variable ranges are 94-203 mg/L for alkalinity, 267-534 µS/cm for conductivity, 1.5-10.6 mg/L for dissolved oxygen, 0.09-0.32 mg/L for nitrates/nitrites (NO_3/NO_2), 0.03-0.27 mg/L for total ammonia (NH_3), 7.8-8.3 for pH, 15.6-17.0°C for temperature, 0.38-1.46 mg/L for total Kjeldahl nitrogen (TKN), and 19.6-82.6 µg/L for total phosphorus. Site BQ9, located on the west side of the river across from Norampac (Figure 1), has the highest alkalinity and conductivity measurements (~2× higher than other test sites as well as reference sites). Site

6508, located in the embayment north of the marina (Figure 1), has low dissolved oxygen (1.2 mg/L), and the highest total phosphorus, TKN and NH_3 measurements. At the time of sampling, a white milky substance was noted coming from a culvert in the vicinity of site 6508. (This substance was not in the area of TR01, which was sampled on the same day, nor at TR03, which was sampled two days later.) Reference sites located in the Bay of Quinte (1310, 1312) have overall higher nitrogen levels (NO_3/NO_2 and TKN) than the reference sites collected from Presqu'ile Bay (PB). Total phosphorus concentrations are greater than the Interim Provincial Water Quality Objective of 20 µg/L (to avoid nuisance concentrations of algae in lakes) at all test sites except one (TR01) and at two of the five local reference sites (PB401 and PB402) (Table 3).

3.2.2 Sediment particle size

Particle size data for Trent River and reference sediment are shown in Table 4. Overall, test site sediments are dominated by silt (range: 0 to 66%, median 63%) and clay (range: 2.5 to 35%, median 30%). Some sites have an appreciable amount of sand (BQ9 - 97%; 2036 - 35%, TR13 - 25%); however, most test sites (7 of the 11) have < 10% (range: 1.7 to 98%, median 6.7%). There is no gravel at any site. Four of the five reference sites consist mainly of silt (54 to 74%) and clay (12 to 43%). One site (PB403) consists almost entirely of sand (88%). Substrate types are important as they can affect contaminant bioavailability, benthic community types, and toxicity test results.

3.2.3 Sediment trace metals and nutrients

Sediment nutrients and trace metal concentrations are provided in Table 5. Sediment nutrients are overall high at test sites, ranging from 2.6 to 10.6% (median: 8.8%) for total organic carbon (TOC), from 1570 to 10220 µg/g (median: 8677 µg/g) for TKN, and from 564 to 1680 µg/g (median: 1267 µg/g) for total phosphorus. The highest TOC and TKN are at site 6507, located in Trenton Bay (see Figure 1); TOC just slightly exceeds the Severe Effect Level (SEL, 10%) at 6507. The [TKN]s exceed the SEL (4800 µg/g) at 9 of the 11 test sites and 4 of the 5 reference sites. Sediment nutrient concentrations and select trace metals for Lake Ontario reference sites (n = 61; Reynoldson and Day 1998) are provided in Table 5 for comparison. The range for nutrients for Lake Ontario reference sites are: 0.5 to 12.9% (mean: 4.5%) for TOC; 460 to 12528 µg/g (mean: 4792 µg/g) for TKN, and; 80 to 3440 µg/g (mean 918 µg/g) for total phosphorus.

All test site nutrient concentrations are within the range observed for Lake Ontario reference sites.

Trace metal concentrations are generally low, although there are exceedences of the provincial guidelines (Persaud et al. 1993). The Lowest Effect Level (LEL) is exceeded for 3 to 8 metals at all 11 test sites except sites 2036 and BQ9, and for 1 to 7 metals at the 5 reference sites. As for sediment nutrients, site 6507 (Trenton Bay) has the greatest number of LEL exceedences for trace metals. There are no SEL exceedences for any metals with the exception of manganese for reference site 1310. Trace metal concentrations are within the range observed for Lake Ontario reference sites with the exception of mercury at 3 sites (6507, BQ2 and TR12 range: 0.47 to 0.56 μg/g; Lake Ontario range: 0.01 to 0.43 μg/g).

Surficial sediment samples (top 10 cm) were collected from 6 sites in the Trenton area in 2000 (Milani and Grapentine 2004). Table 6 shows a comparison of metal and nutrient concentrations for three concomitant sites (distances between sites are indicated). Similar concentrations are observed for most metals and nutrients at these sites; SEL exceedences (for TOC and TKN) are the same for each sampling year.

3.2.4 Sediment organic contaminants

Toxic Equivalency Units (TEQs)

PCDD/Fs and several PCB congeners and have been reported to cause a number of toxic responses similar to the most toxic dioxin 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (Van den Berg et al., 1998). Using toxic equivalency factors (TEFs), the toxicity relative to the toxicity of TCDD was determined for all sites using the following equation:

$$TEQ = \sum_{n=1}^{k} C_n \times TEF_n$$

C_n = concentration of PCDD/F or DL PCB congener

Within a sample, each congener concentration was multiplied by its respective TEF and all products are summed to give a total toxic equivalent concentration. This takes into consideration the unique concentrations and toxicities of the individual components within the dioxin, furan or

PCB mixture. The World Heath Organization (WHO) TEFs for fish were used in the calculation of the TEQ (Van den Berg et al. 1998). The TEQs were compared to the CCME Probable Effect Level (PEL) for PCDD/Fs (21.5 ng TEQ/kg).

Two sites have a TEQ above the PEL (Table 7): BQ2 and TR12 and (36.0 and 29.2 ng TEQ/kg, respectively). Site BQ2 is located in the marina and TR12 is located in a depositional area south of the marina (see Figure 1). Remaining sites have TEQs ranging from 1.1 to 18.1 ng TEQ/kg. The PCDD/F congeners contribute from 96.8 to 99.7% to the total TEQ, whereas DL PCBs contribute very little. Of the PCDD/F congeners, 1,2,3,7,8-pentachlorodioxin and 1,2,3,4,7,8-hexachlorodioxin have similar contributions (10-13 to 27-37%), followed by 2,3,4,7,8-pentachlorofuran (6 to 22%). TCDD and 2,3,7,8-tetrachlorodibenzofuran (TCDF) have similar contributions (from 1-2 to 5-7 %).

The TEQs for Trent River are overall lower than those reported for Spanish Harbour and are similar to those reported for Jackfish Bay. The TEQs ranged from 26 to 196 ng TEQ/kg (up to 9× the PEL) in depositional areas of Spanish Harbour (Milani and Grapentine 2006a). In Moberly Bay (Eastern Arm of Jackfish Bay), which receives effluent from the pulp and paper mill at Terrace Bay via Blackbird Creek, TEQs ranged from to 28 to 57 ng TEQ/kg (Milani and Grapentine 2006b). Trent River TEQs are also below lake-wide averages of PCDD/Fs reported for Lake Ontario: 101 ng TEQ/kg (Marvin et al. 2002, 2004). However, International Toxic Equivalency Factors (ITEFs) were used in the calculation of the Marvin et al. (2002, 2004) TEQs, which would result in slightly higher TEQs than those calculated using the WHO TEFs for fish. In the current study, TEQs range from 1.1 to 36.0 ng TEQ/kg (median 8.9) using the WHO fish TEFs, and range from 1.4 to 96.2 ng TEQ/kg (median 14.7) using the ITEFs.

Congener Concentrations

Concentrations of individual PCDD/F and DL PCB congeners are also provided in Table 7. For the dioxin group, the higher-chlorinated PCDDs dominate; octachlorodioxin (OCD) is highest at all test sites, ranging from 1500 to 29000 pg/g. Reference site concentrations are much lower, ranging from 24 to 1400 pg/g (Table 7). Octachlorodioxins, however, contribute little to the TEQ (from 1.4 to 9.9%). The most toxic dioxin congeners – 2,3,7,8-tetrachlorodibenzo-*p*-dioxin

(TCDD) and 1,2,3,7,8-pentachlorodioxin (TEF = 1) – range from 0.13 to 1.20 pg/g and from 0.30 to 6.90 pg/g, respectively, at test sites. These two congeners contribute from 1.3 to 27% of the TEQ for test sites. Concentrations are lower at reference sites, ranging from 0.20 to 0.78 pg/g and from 0.72 to 1.50 pg/g for TCDD and 1,2,3,7,8-pentachlorodioxin, respectively. The highest concentrations are observed at BQ2 (which has the highest TEQ). Of the furan group, octachlorofuran (OCF) is highest, ranging from 11 to 4000 pg/g at test sites. Reference site concentrations are generally much lower, ranging from 3 to 93 pg/g. Octachlorofuran, however, contributes from only 0.1 to 1.4% to the TEQ for test sites. The more toxic 2,3,4,7,8-pentachlorofuran (TEF = 0.5), contributes from 6 to 19% of the TEQ for test sites.

Of the 12 DL PCBs, sediments consist mainly of mono-*ortho* PCBs: PCB 118 (test site range: 190 to 5900 pg/g) and PCB 105 (test site range: 86 to 3100 pg/g). These PCBs are lower at reference sites, ranging from 68 to 1800 pg/g (PCB 118) and from 29 to 780 pg/g (PCB 105). Non-*ortho* PCB 126, which is a more potent congener, ranges from 2 to 49 pg/g at test sites and from 0.7 to 16 pg/g at reference sites, and contributes from 50 to 67% of the total PCB TEQ. PCB 77, also a non-*ortho* congener, contributes from 18 to 35% of the total PCB TEQ. The PCBs, however, contribute ≤ 3% to the overall total TEQ.

3.3 Bioaccumulation in Mayfly Tissue

3.3.1 Dioxins and furans

Laboratory-exposed mayfly tissue [PCDD/F]s are shown Appendix B, Table B1. Similar to the sediment results, the higher-chlorinated PCDD/Fs dominate in the mayflies. For dioxins, [OCD]s are overall highest at test sites (range: 120 to 3700 pg/g dw, median 1000 pg/g), followed by 1,2,3,4,6,7,8-heptachlorodioxin (range: 21 to 450 pg/g, median 120 pg/g). For furans, [OCF]s are highest (range: 9.7 to 240 pg/g, median 61 pg/g), followed by 1,2,3,4,6,7,8-heptachlorofuran (median 27 pg/g) and TCDF (median 20 pg/g). Mayfly tissue residues, expressed as TEQs, are provided in Table 8. Several congener concentrations, while reported, are below the method detection limit (MDL) (italicized values in Table 8). The TCDD values are below detection at all sites (reference and test). The TEQs were compared to the CCME avian Tissue Residue Guideline (TRG), since an avian receptor (e.g., diving duck) could potentially feed directly on benthic invertebrates. The avian TRG for PCDD/Fs, derived by Environment Canada, is 4.75 ng

TEQ·kg^{-1} diet ww (CCME 2001a). The mammalian TRG of 0.79 ng TEQ·kg^{-1} diet ww, while lower, was not used in this case as there is not a direct feeding relationship between benthic invertebrates and mammalian receptors.

The mayfly TEQs for laboratory controls (Long Point, Lake Erie sediment) and reference sediment are all below the TRG. Laboratory control TEQs range from 0.95 to 1.21 ng/kg and reference site TEQs range from 1.09 to 2.39 ng/kg. The TEQs are higher at test sites, ranging from 3.37 to 14.40 ng/kg, exceeding the TRG at 6 of the 11 sites (by up to 3×). The highest TEQs are noted in Trenton Bay (sites 6507 and 2036). However, along the river, TEQs did not vary by more than ~2×, despite sediment concentrations of the higher chlorinated congeners (hepta- and octa-PCDD/Fs) being up to 42× higher in the lower areas of the river compared to the upstream areas (maximum concentrations in each of upstream and downstream areas considered). Congeners contributing most to the TEQ are TCDF (from 29 to 73%), 2,3,4,7,8-pentachlorofuran (from 13 to 36%), and 2,3,4,7,8-pentachlorofuran (from 6 to 22%). The contribution of TCDD is 0 to 20%; however, as mentioned above, mayfly values for TCDD are below detection limits at all sites and therefore results should be interpreted with caution as there is greater uncertainty with values below the MDL.

Biota-sediment accumulation factors

Sediments are an important source of organic (hydrophobic) compounds such as PCDD/Fs (and PCBs) to aquatic organisms. Biota-sediment accumulation factors (BSAFs) are an indication of chemical bioavailability (Niimi 1996). BSAFs reduce site variability due to differences in total organic carbon concentration and allow differences in organic contaminant bioaccumulation between sites (and species) to be examined (Ankley et al. 1992).

BSAFs for the PCDD/F congeners are provided in Appendix B, Table B1. Accumulation relative to sediment concentrations is highest in the lower chlorinated congeners. For the dioxin group, BSAFs are <1 at all sites for 4 highly chlorinated congeners: 1,2,3,6,7,8-hexachlorodioxin, 1,2,3,7,8,9-hexachlorodioxin, 1,2,3,4,6,7,8-heptachlorodioxin and octachlorodioxin (Table B1). (The BSAFs for 1,2,3,4,7,8-hexachlorodioxin are just above 1 at 2 of the 16 sites.) For the furan group, BSAFs are <1 for 2 highly chlorinated congeners:

1,2,3,4,6,7,8-heptachlorofuran and octachlorofuran and BSAFs for 1,2,3,4,7,8,9-heptachlorofuran and 1,2,3,4,7,8-hexachlorofuran are < 1 at most sites (Table B1). As with the dioxin group, the lower chlorinated furan congeners have BSAFs >1 at the majority of sites. The highest BSAFs are for TCDD (BSAF range: 1.6 to 16.2, median 7.6). Generally, the greater the number of chlorine atoms, the greater the potential for the contaminant to accumulate in sediments or organisms. However, large molecules with logged octanol-water partition coefficients (K_{ow}) >6 usually result in lower bioaccumulation (Loonen et al. 1997; Gobas et al. 1992). This is consistent with the current study where OCD (K_{ow} =8.2; Loonen et al. 1997) BSAFs are < 1, whereas TCDD (K_{ow}=6.8; Loonen et al. 1997) BSAFs are >1. It is important to note again that the mayfly TCDD values are below the MDL at all sites. The formal designation of the MDL based on EPA methods is 3× standard deviation observed at very low concentrations. Thus, 'real' values can be obtained below the detection limit, although the measurement error is larger closer to the detection limit.

3.3.2 Dioxin-like PCBs

Mayfly DL PCB accumulation from the Trent River sediment appears to follow a similar pattern to sediment concentrations, with PCB 118 (range 8500 to 16000 pg/g dw), PCB 105 (range 2700 to 4600 pg/g dw) and PCB 77 (range 1100 to 2300 pg/g dw) dominating (Appendix B, Table B2). The [DLPCB]s are slightly lower at reference sites, ranging from 7700 to 13000 pg/g and from 2200 to 2800 pg/g for PCB 118 and PCB 105, respectively. PCB 77, which is a more potent non-*ortho* PCB, ranges from 1100 to 2300 pg/g for Trent River sites and from 520 to 1300 pg/g for reference sites. PCB 77 contributes from 92 to 94% of the PCB TEQ, while PCB 126 contributes very little, in contrast to that observed for the sediments (PCB 126 contributed most to the TEQ - see above).

Mayfly tissue [DLPCB]s, expressed in TEQs, are provided in Table 8. The avian TRG for DL PCBs, derived by Environment Canada, is 2.4 ng TEQ·kg^{-1} diet ww (CCME 2001b). The TEQs for the laboratory controls are all below the TRG, ranging from 0.6 to 2.2 ng/kg. Reference site TEQs range from 0.6 to 11.2 ng/kg; 4 of the 5 reference sites exceed the TRG (by up to 4.7×). Along the river, PCB TEQs did not vary by more than ~2×; TEQs range from 9.7 ng/kg in the Marina (site BQ2) to 19.7 ng/kg in Trenton Bay (site 2036). All test sites are above both the

TRG (by up to 8×) and the 99th percentile for the reference sites (11.1 ng TEQ/kg) with the exception of BQ2.

Biota-sediment accumulation factors

BSAFs for the DL PCB congeners are provided in Appendix B; Table B2. BSAFs for all PCB congeners is at or > 1, ranging overall from 1.0 to 31.7 (median 3.3). (For PCB 169, results should be interpreted with caution, as mayfly tissue values were below the MDL at half the sites.) Overall highest BSAFs are noted for mono-*ortho* PCBs: PCB 118 (range: 2.7 to 29.3, median 6.4); PCB 123 (range: 2.0 to 25.4, median 5.9), and; PCB 114 (range: 2.3 to 25.2, median 5.4). These PCBs are less toxic than the non-*ortho* PCBs (e.g. PCBs 77, 81, 126 & 169). These results suggest that PCBs (and certain PCDD/Fs) have a higher affinity for mayfly lipid than sediment TOC in these exposures.

3.3.3 Validity of tissue residue measurements from lab tests

While it is assumed that tissue residues measured in laboratory tests on field collected sediments are similar to those that would occur in the field, this assumption may be questionable due to limitations of laboratory methods (e.g., steady states may not be achieved for some lipophilic compounds in relatively short exposure durations). Loonen et al. (1997) compared exposure of PCDD-contaminated sediment to the oligochaete worm *L. variegatus* for 28 days to repeated exposures after 21 months of sediment aging. They found BSAFs to be significantly lower (32 to 53% lower) when the PCDDs were in contact with the sediment for 21 months even though sediment concentrations were the same (Loonen et al. 1997). Lyytikäinen et al. (2003), however, found laboratory-exposed results very comparable to exposure under natural conditions. Accumulation of PCDD/Fs in oligochaetes (*L. variegatus*) exposed in the laboratory to contaminated river sediments were compared to resident chironomids collected from these sediments in the field. A statistically significant correlation was found in PCDD/F congener composition between the chironomids and oligochaetes ($r = 0.66$, $P < 0.001$). Ankley et al. (1992) evaluated uptake of PCBs in 30-day laboratory-exposed *L. variegatus* and native oligochaetes (consisting primarily of *L. hoffmeisteri and L. cervix*). They found that lab exposures provided a fairly accurate prediction of field exposed concentrations for total PCBs. BSAFs for total PCBs were 0.84 and 0.87 for lab-exposed and native oligochaetes, respectively. For PCB homologues,

BSAFs for the higher chlorinated homologues (≥6 chlorines) tended to be slightly higher for the native oligochaetes (range: 0.79 to 2.15) than the lab exposed oligochaetes (range: 0.57 to 1.03). Ingersoll et al. (2003) found similar concentrations of PAHs in *L. variegatus* exposed in the laboratory to field-contaminated sediment and in native oligochaetes collected from the field. They concluded that lab tests can be extrapolated to the field with a reasonable degree of certainty but that behavioural differences in field-collected organisms (e.g. native organisms collected inhabiting sediment vs. those collected from debris above the sediment) can modify bioaccumulation.

In the current study, accumulation in laboratory-exposed mayflies above reference levels and guideline values is an indication that PCDD/Fs and DL PCBs could concentrate in the food web at levels that can cause adverse effects. However, the determination of whether biomagnification and adverse effects to higher trophic level organisms (fish, wildlife) are actually occurring is beyond the scope of this study, and would need to be addressed by a more comprehensive assessment such as a detailed risk assessment.

3.4 Benthic Invertebrate Community

Ten of the 11 test sites have the highest probability of belonging to Great Lakes Reference Group 1 based on the BEAST model and five habitat attributes (Table 9). The probabilities for these test sites are very high, ranging from 93% to 99% (mean 98%). All five reference sites are also predicted to Group 1, with probabilities of reference group membership ≥ 98% for 4 of the 5 sites. Presqu'ile Bay reference site 403 only has a low probability (50%) of belonging to Group 1, likely due to the low TOC (0.6%) at this site compared to the mean TOC for Group 1 reference sites (3%). Total organic carbon is one of the five environmental variables used in the multiple discriminant analysis to predict sites to one of five reference community groups (see Section 2.5). Reference Group 1 has 108 sites: 39 from Georgian Bay, 24 from North Channel, 21 from Lake Ontario, 16 from Lake Erie, 4 from Lake Huron, and 4 from Lake Michigan. This group is characterized mainly by Chironomidae (midge – 39.9% occurrence), followed by Tubificidae (oligochaete worm – 16.7% occurrence) and Sphaeriidae (fingernail clam – 14.5% occurrence). To a lesser degree, Asellidae (isopod – 5.5% occurrence), Naididae (oligochaete worm – 4.3% occurrence), and Sabellidae (polychaete worm – 3.6% occurrence) also occur.

Haustoriidae (amphipod), Valvatidae (snail), Dreissenidae (zebra mussel) and Gammaridae (amphipod) occur, but infrequently (1.6 to 2.2% occurrence).

Site BQ9 (located upstream on the west side of the river across from Norampac – see Figure 1) has a 72% probability of belonging to Great Lakes Reference Group 4 (Table 9). This site has very high alkalinity (203 mg/L; Table 3), ~2× higher than the other sites, which likely explains why BQ9 does not group with the other test sites. (Group 4 has the highest mean alkalinity of all Great Lakes reference groups.) Alkalinity is one of the five environmental variables used in the multiple discriminant analysis to predict sites to one of five reference community groups (see Section 2.5). Reference Group 4 has 21 sites: 18 from Lake Michigan, 1 from each of Lake Ontario, Lake Huron, and Lake Superior. This group is characterized mainly by Haustoriidae (65.1% occurrence), followed by Lumbriculidae (oligochaete worm – 12.7% occurrence), Sphaeriidae (9.6% occurrence), Tubificidae (5.7% occurrence), Enchytraeidae (oligochaete worm – 3.9% occurrence), and Chironomidae (1.5% occurrence).

Trent River sites are dominated by Chironomidae, Tubificidae, and Naididae, which are present at all sites (Table 10). Chironomidae are represented by 65 taxa, Tubificidae by 9 taxa, and Naididae by 19 taxa. Complete invertebrate abundances are provided in Appendix C, Table C1.

With the exception of three sites, chironomid abundances at the Trent River sites are similar or lower compared to the reference group mean. Sites 2036 and BQ9 have quite high abundances (~8 and 40× reference mean, respectively). Chironomids are also in increased abundance at 3 of the 4 reference sites (up to 5×). More predominant genera include *Procladius*, *Paratendipes*, and *Tanytarsus* (Appendix C, Table C1). Generally, tubificid worms consist mainly of the unidentifiable immatures (with and without chaetal hairs), followed by *Aulodrilus pigueti*, typical of silty mesotrophic areas. There are increased abundances of tubificids (from ~3 to 7×) at 7 of the 11 Trent River sites.

Macroinvertebrate family diversity ranges from 5 to 16 taxa (Table 10); 3 Trent River sites (BQ2, BQ10 and TR12) are below the Reference Group 1 mean of 8 taxa, but are within 2 standard deviations (SD) of the mean. Taxon diversity at 2 of the 5 references sites are also

below the reference mean. Site 2036, located in Trenton Bay, is the most diverse test site, with the highest abundances of chironomids, naidids, asellids and has the second highest tubificid abundance. Site BQ10 (located farthest up in the river) is least diverse with decreased abundances of all major taxa.

The mean relative abundances of the predominant macroinvertebrate taxa (chironomids, tubificids, naidids, amphipods and sphaeriids) are shown in Figure 2. Within each sampling area (where there are two or more sites), high variation in the macroinvertebrate community composition is evident, most notable in the primary depositional area and in the Trenton Bay area. In the primary depositional area (3 sites), chironomid composition varies between 10 to 33%, and tubificids from 13 to 49%. The bulk of the macroinvertebrate community at one site (TR01) is comprised mainly of "other" taxa, including the gastropod Hydrobiidae, a minor reference Group 1 taxon (Gp. 1 mean = 0.3), and taxa not typically included in these assessments (e.g., mites). Within the Trenton Bay area, one site's (6507) community is ~83% oligochaete worms (tubificids and naidids) and 0% amphipods, while the other site's (2036) is 33% oligochaete worms and 5% amphipods.

Results of the BEAST benthic invertebrate community evaluation are summarized in Table 10. Three separate ordinations were performed each with a subset of 1 to 10 Trent River or reference sites. Stress values for the ordinations, which indicate how effectively among-site similarities are represented by three axes compared to all invertebrate family variables, ranged from 0.14 to 0.16 (which is fair). Ordination results are provided in Appendix D.

Trent River sites fall into the following bands of similarity to reference conditions: (Table 10):

Band 1 (equivalent to reference):	5 sites
Band 2 (possibly different):	5 sites
Band 3 (different):	0 sites
Band 4 (very different):	1 sites

Reference sites collected from Mallory Bay, Hay Bay and Presqu'ile Bay are equivalent to Great Lakes reference.

Macroinvertebrate families that are maximally correlated with the ordination axes are: Tubificidae (r^2=0.69), Chironomidae (r^2=0.56), and to a lesser extent Naididae (r^2=0.18) and Hydrobiidae (r^2=0.17) (Figure D1). For site BQ9 (has the highest probability of belonging to Reference Group 4), families most highly correlated to axes include Ceratopogonidae (r^2=0.80), Hydrobiidae (r^2=0.79) and Tubificidae (r^2=0.77) (Figure D2). Sites that are outside the 90% ellipse (6507, 6508, TR01, TR13, 2036) have increased abundances of Tubificidae, Naididae (2036) and/or Hydrobiidae depending on site orientation along the taxon vector lines direction (Figure D1). Site BQ9, which is in Band 4, is most different from reference due to its greatest distance from the reference centroid in ordination space (Figure D2). This site is associated with increased abundances of Tubificidae, Hydrobiidae, and Ceratopogonidae (site is oriented along the vector line in similar direction) as well as decreased Enchytraeidae (site is oriented along the vector line in the opposite direction) (Figure D2). The relationship between the community response and habitat variables was examined by correlation of the ordination of the community data and the habitat information. For the ordination shown in Figure D1 (10 sites), there are no high correlations ($r^2 \leq 0.18$). Some sites are associated with elevated sediment phosphorus (as P_2O_5), which is the most highly correlated variable (Figure D1). For the ordination shown in Figure D2 (involving site BQ9 alone), correlations are higher (r^2: 0.26 to 0.49) and significant (from the Monte Carlo permutations) for Pb, overlying water TKN and As. However, no environmental variables appear associated with the movement of BQ9 outside of reference.

Table 11 shows a comparison of the predominant benthic invertebrate family abundances for three concomitant sites sampled in 2000 and 2006. Generally the agreement is fair, with sites falling in the same BEAST band (e.g., Band 2 for site 2036), or the next band (e.g., Band 2 in 2006 vs. Band 1 in 2000 for sites 6507 and 6508). Taxon diversity is higher in 2006, most notably for site 6508, due to the presence of very few numbers (0.1 to 0.9 per cm^2) of isopods (Asellidae), fingernail clams, (Sphaeriidae), mayflies (Caenidae), caddisflies (Hydroptilidae), phantom midge (Chaoboridae), amphipod (Hyalellidae) and snails (Planorbidae), which were absent in 2000. Sites 6508 and 6507 also have greater abundances of tubificid worms in 2006, and along with the higher taxon diversity, explain their movement farther away from reference. For site 2036, the number of taxa found was similar between years; however, tubificid and

chironomid abundances were 4.4× and 13× higher, respectively, in 2006. Sites were within 2 to 9 m apart between years; therefore, differences could reflect small scale heterogeneity.

3.5 Sediment Toxicity

Mean species survival, growth and reproduction for toxicity tests is provided in Table 12. The established numerical criteria for each category (non-toxic, potentially toxic and toxic) for each species are also included. Water quality data (for dissolved oxygen, pH, temperature, ammonia and conductivity) measured at the start and end of the tests are provided in Appendix E, Table E1. There were no unusual readings throughout the tests except for low dissolved oxygen concentrations for the *Hexagenia* test with site 6508 on day 21 (1.7 mg/L) and for the *Tubifex* test with site 403 on day 28 (4.6 mg/L) (Table E1). This low dissolved oxygen did not appear to affect toxicity for these tests. Dissolved oxygen readings were ≥ 7 mg/L for all remaining tests.

Values for two endpoints are below the numerical guidelines derived from the Great Lakes reference sites: *Tubifex* percent cocoons hatched (Table 12) and *Tubifex* young production (Table 12, Figure 3). Reduced cocoon hatching (28.1 to 34.9%) was evident at 6 Trent River sites; mean percent cocoons hatched for Great Lakes reference sites is 57%. Reduced *Tubifex* young production (0.3 to 6.7 young per adult worm) is evident at 4 sites; mean number of young per adult for Great Lakes reference sites is 29. Reduced young production is most severe for site TR12 (Figure 3). Since the ability of *Tubifex* to produce cocoons is not affected (i.e., the number of cocoons produced is similar to the GL reference mean), this suggests impairment in embryogenesis (development of the worm inside the cocoon), which subsequently reduced the number of young at these sites. There could also be toxicity to the very small *Tubifex* worms. *Hyalella*, *Chironomus*, and *Hexagenia* showed no evidence of toxicity.

The BEAST assessment of sites was performed using the integrated survival, growth and reproduction 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 10 variables, ranged from 0.098 to 0.099. Ordination results for integrated endpoints (in subsets of 8 test and reference sites) are summarized in plots with two of the three axes in Appendix F. Five of the 10 toxicity endpoints are significantly related to the ordination axes ($p \leq 0.05$):

Chironomus survival (Crsu, r^2: 0.90 to 0.93); *Hyalella* survival (Hasu, r^2: 0.87); *Tubifex* %cocoons hatched (Tthtch, r^2: 0.86 to 0.87); *Tubifex* young production (Ttyg, r^2: 0.79 to 0.82), and; *Tubifex* survival (Ttsu, r^2: 0.11 to 0.12). Sites in Band 2 are associated with a lower percentage of hatched *Tubifex* cocoons hatched and lower young production (i.e., sites are located along the same vector line as these endpoints in the opposite direction; Appendix F, Figures F1 and F2). The relationship between the toxicological response and habitat variables was examined by principal axis correlation of the ordinated toxicity data and the habitat information. Correlations are not high ($r^2 \leq 0.16$); Hg is the most highly correlated variable in both ordinations and elevated Hg appears to be associated with the movement of some sites outside of reference (Figures F1 and F2).

Trent River site fall into the following bands of toxicity relative to reference conditions: (Table 12):

Band 1 (non-toxic):	5 sites
Band 2 (potentially toxic):	6 sites
Band 3 (toxic):	0 sites
Band 4 (severely toxic):	0 sites

Reference sites collected from Presqu'ile Bay (n=3) and Bay of Quinte (Mallory and Hay Bays, n=2) fall in Band 1 (non-toxic).

Table 13 shows a comparison of toxicological endpoints for Trent River sites 6507, 6508 and 2036, sampled in 2000 and 2006. Two of the three sites sampled in 2000 were acutely toxic to the amphipod *Hyalella* (21 – 57% survival) resulting in a toxic (6508; Band 3) or severely toxic (6507; Band 4) categorization. There was no toxicity evident to *Hyalella* in 2006 at these sites. Differences are also noted for *Tubifex* endpoints. For site 6508, the number of young produced is almost 3-fold higher in 2006 although cocoon production and cocoon hatching success are similar in 2000 and 2006. For sites 6507 and 2036, however, cocoon production is slightly higher in 2006 but the percent hatch is much lower in 2006 (27 – 35%) compared to 2000 (44 – 58%), and as a result, *Tubifex* young production is also lower in 2006. These differences likely reflect

small scale heterogeneity although it is possible there may be some improvement in sediment quality as evidenced by the lack of acute toxicity in 2006.

Sediment Toxicity and Contaminant Concentrations

Examination of relationships between sediment toxicity and sediment contaminants both graphically and by regression analysis may aid in identifying possible causes of toxicity attributable to organic compounds as well as inorganic compounds, sediment nutrients and sediment grain size.

Hybrid multi-dimensional scaling of toxicity endpoints

The ordination of the multiple measurements of sediment toxicity by HMDS for the Trent River and five reference sites alone produced two descriptors of sediment toxicity (Figure 4). These axes represent the original 10-dimensional among-site resemblances well (stress = 0.07). Principal axis correlation produces a vector for each toxicity endpoint along which the projections of sites in ordination space are maximally correlated. *Tubifex* young production (Ttyg, r^2=0.96) and percent cocoons hatched (Tthtch, r^2=0.93) are the most significant ($p \leq 0.05$) endpoints and are positively correlated to Axis 2 (Figure 4). Therefore, the greater the toxicity to *Tubifex* reproduction, the lower its score for Axis 2 (e.g., sites BQ2, BQ10, TR12 and TR13). The most highly correlated environmental variables include mercury (Hg; r^2 = 0.56), lead (Pb; r^2 = 0.48), copper (Cu; r^2=0.44), zinc (Zn; r^2=0.37) and the TEQ (r^2 = 0.36). Sites that show toxicity to *Tubifex* (located in the lower quadrants of the ordination) are associated with elevated metals (e.g., Hg, Cd and Pb) and elevated TEQ.

Integrated toxicity descriptors – contaminant relationships

Nine metals (Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn) were ordinated by principal components analysis (PCA). The first principal component (PC1) accounts for 65% of the total variation, and the second (PC2) accounts for 20%. The remaining components each account for ≤8.5%. All measurement variables are negatively loaded for PC1. Most loadings are of a similar magnitude (-0.245 to -0.405) with the exception perhaps of Ni (-0.148). The first component – denoted as "metPC1" –describes well general metal contamination. Sites elevated in metals score low for PC1.

The integrated descriptors of sediment toxicity (Axes 1 and 2 scores "ToxAxis1" and "ToxAxis2" from the HMDS) were plotted against the contaminant descriptors metPC1, the total toxic equivalent (sum of TEQs for PCDD/Fs and DL PCBs), and individual physical and chemical (organic/inorganic) variables (the latter was log(x) - transformed to improve linearity or, for particle size data, arcsine square root(x) - transformed). Regression analysis reveals that the strongest relationship is for Axis 2, where the total toxic equivalent explains only ~26% of the variability:

ToxAxis2 = 1.20 - 1.28 TEQ; Adjusted R^2=25.8%, p=0.026

Greater variability (~73%) is explained by a combination of metals and sediment nutrients:

ToxAxis2 = 31.9 - 4.66 Cr + 7.80 Fe - 4.82 Zn - 6.36 Total P (sediment) + 11.7 TOC; Adjusted R^2=73.4%, p=0.002

Predictors with negative coefficients are potentially toxic to *Tubifex* young production.

Individual toxicity descriptors - contaminant relationships

The relationships among individual toxicological response variables were evaluated by plotting the most significant endpoint (e.g., *Tubifex* number of young per adult) against concentrations of individual physical and organic/inorganic chemical variables. The most significant relationship accounts for ~74% of the variability in *Tubifex* young production:

Tubifex Young/Adult = 3.71 - 3.22 Cr - 2.87 Cu + 1.94 Ni + 2.14 Zn; Adjusted R^2=73.8%, p=0.001

Predictor coefficients that are negative indicate that decreased *Tubifex* young reproduction is related to increased concentrations.

Potential causes of toxicity

Although bulk and extractable concentrations of contaminants in sediment are imperfect indicators of bioavailability (Luoma and Carter 1991), up to ~74% of the variability in toxicity of Trent River sediments is explained by the regression models. Regression of the toxicity descriptor Axis 2 and the regression of individual toxicity response (*Tubifex* young production)

with individual contaminant, grain size and nutrient variables produce very similar strength relationships.

Predictors with coefficients indicating decrease in toxicity with increase in contaminant concentration do not suggest causal relationships. These include positive contaminant coefficients for ToxAxis2, and positive coefficients for the reproduction response. After excluding predictors not indicative of toxicity relationships, toxicity to *Tubifex* is most strongly associated with Cr and Cu, and perhaps Zn and sediment total phosphorus. Total organic carbon, which is known to affect contaminant bioavailability, is significant for the integrated ToxAxis 2 descriptor relationship. While metals best explain toxicity in the equation shown above, observed metal concentrations in sediment are generally too low to account for toxicity to *Tubifex*.

West et al. (1997) exposed the midge *Chironomus tentans* and oligochaete worm *Lumbriculus variegatus* to three dietary concentrations of TCDD (30, 300, 3000 ng TCDD/g TOC)) in life cycle tests. No significant effects on survival, growth, or reproduction were observed in *C. tentans* (maximum tissue residue of 144 ng/g ww) or *L. variegatus* (maximum tissue residue of 174 ng/g ww). These maximum tissue residues are many orders of magnitude higher than the tissue residues found in mayflies in the current study. The maximum mayfly tissue residue for TCDD is 4 pg/g dw at site 6507 (Appendix A, Table A1), which converts to 0.65 pg/g ww. (Mayflies from reference site 401 have a slightly higher concentration of 4.2 pg/g dw.) It would therefore appear unlikely that the chronic toxicity to *Tubifex* in the current study was caused by TCDD, although TCDD accumulation in *Tubifex* was not measured.

The lack of sensitivity of invertebrates to PCDD/Fs and DL PCBs is reported in several studies (West et al. 1997; Borgmann et al. 1990; Dillon et al. 1990). These compounds are known to induce aryl hydrocarbon hydroxylase in fish and mammals; however, the aryl hydrocarbon (Ah) receptor does not appear to be present in invertebrates thus explaining their insensitivity (West et al. 1997; Borgmann et al. 1990; Dillon et al. 1990).

3.6 Canada Ontario Decision-Making Framework

A risk-based, decision-making framework for the management of sediment contamination was developed by the Canada Ontario Agreement Sediment Task Group using four lines of evidence (sediment chemistry, toxicity, benthic community and biomagnification potential). This decision framework was developed from the Sediment Triad and BEAST frameworks, and is described in Chapman and Anderson (2005). The overall assessment of a test site is achieved by integrating the information obtained both within and among the four lines of evidence (16 possible outcome assessments). This framework was applied to the Trent River study.

The decision matrix for the weight of evidence categorization of Trent River sites is shown in Table 14. For the sediment chemistry column, sites with exceedences of a sediment quality guideline (SQG) – low are indicated by "◐"; sites with SQG-high exceedences by "●". For the toxicity column, sites where multiple endpoints exhibit major toxicological effects are indicated by "●"; sites where one endpoint exhibits a major effect or multiple endpoints exhibit minor effects are indicated by "◐"; sites where minor toxicological effects observed in no more than one endpoint by "○". For the benthos alteration column, sites determined from BEAST analyses as different or very different from reference are indicated by "●"; sites determined as possibly different from reference by "◐". For the biomagnification potential column, mayfly TEQs that are above the TRG and above the 99th percentile of reference site TEQs are indicated by "◐". Sites with no SQG exceedences, benthic communities equivalent to reference conditions, or mayfly TEQs lower than the criteria are indicated by "○".

The outcome assessments for Trent River sites are the following (Table 14):

Management actions

This is not indicated at any site.

Determine reasons for sediment toxicity

This is indicated at 5 sites: BQ10 (upstream), BQ2 (marina), TR12 and TR13 (secondary depositional area) and 2036 (Trenton Bay) due to decreased hatching of *Tubifex* cocoons and decreased young production. While site 6507 falls in Band 2 (potentially toxic) from the BEAST

assessment, only one endpoint (*Tubifex* percent cocoons hatched) exhibits a minor toxicological effect; therefore, determining reasons for sediment toxicity is not indicated for this site. Toxicological response is most highly correlated with elevated mercury; however, [Hg]s are not unusually high (0.14 – 0.53 µg/g) and for 2036, there are no exceedences of SQGs. Further regression analyses indicate that metals (Cu, Cr) and perhaps sediment nutrients are most highly correlated to toxicity response but again metals levels are generally low in the sediments. The cause of toxicity remains unclear.

Determine reasons for benthos alteration

This is not indicated at any site. While some sites are "possibly different" than reference, benthos alteration is not deemed to be detrimental. In some cases, sites appear to be mildly altered due to enrichment.

Fully assess risk of biomagnification

This is indicated at 10 of the 11 Trent River sites. PCDD/Fs in sediment are elevated above the PEL at 1 of the 10 sites (TR12). Site BQ2 (Marina) has sediment PCDD/Fs elevated above the PEL but no adverse effect is indicated in the biomagnification potential column. All 10 sites have biomagnification potential due to PCBs, while 6 of the 10 sites have biomagnification potential due to PCDD/Fs.

4 CONCLUSIONS

4.1 Sediment Contaminant Concentrations

Dioxins & furans/Dioxin-like PCBs

- The Probable Effect Level (21.5 ng TEQ/kg) is exceeded at 2 of the 11 Trent River sites: BQ2 (located in the marina) and TR12 (located in the secondary depositional area). The TEQs for these two sites are 29 and 36 ng TEQ/kg.
- The PCDD/F TEQ contributes from 96 to 99% of the total toxic equivalent. Dioxin-like PCBs contribute very little.

Trace metals and nutrients

- Nutrient levels are high in Trent River sediments. Total organic carbon ranges from to 2.6 to 10.6%, and Total Kjeldahl Nitrogen ranges from 1570 to 10660 µg/g. The provincial Severe Effect Level for TKN is exceeded at 7 of the 11 Trent River sites.
- Trace metal concentrations are generally low, with exceedences of the provincial Lowest Effect Level for 3 to 8 metals at 9 of the 11 Trent River sites. There are no Severe Effect Level exceedences at test sites.
- Trace metal concentrations are within the range observed for Lake Ontario reference sites with the exception of mercury at 3 sites (6507, BQ2 and TR12 range: 0.47 to 0.56 µg/g; Lake Ontario reference range: 0.01 to 0.43 µg/g).

4.2 Community Structure

- There is no evidence of highly degraded benthic communities.
- 10 of the 11 Trent River benthic communities are "equivalent" to reference (5 sites) or at most "possibly different" than reference (5 sites).
- 1 site is very different from reference due to increased diversity and increased abundance of some taxa while decreased abundance of others.
- In some cases, sites appear to be mildly altered due to enrichment.

4.3 Sediment Toxicity

- There is no evidence of severe toxicity.
- 6 Trent River sites are "potentially toxic" due to low *Tubifex tubifex* reproduction compared to reference.
- Although chronic toxicity to *Tubifex* is most highly correlated to metals (not PCDD/Fs or DL PCBs), metal concentrations are not unusually high and therefore the cause of toxicity remains unclear.

4.4 Biomagnification Potential

- PCDD/F TEQs in laboratory-exposed mayflies exceed the TRG at 6 of the 11 sites (by up to 3×). These 6 sites also exceed the 99th percentile of the TEQ for the reference sites.

- PCB TEQs exceed the TRG at all 11 sites (by up to 8×). The TEQs for all Trent River sites except 1 exceed both the TRG and the 99th percentile of the TEQ for the reference sites.
- Accumulation in laboratory-exposed mayflies indicates that PCDD/Fs and DL PCBs could concentrate in the food web at levels that can cause adverse effects. The determination of whether biomagnification and adverse effects to higher trophic level organisms (fish, wildlife) are actually occurring in the Trent River is beyond the scope of this study, and would need to be addressed by a more comprehensive assessment such as a detailed risk assessment.

4.5 Canada Ontario Decision-Making Framework

- The risk of biomagnification due to PCDD/Fs and DL PCBs in the lower Trent River needs to be fully investigated.

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Table 1. Trent River and reference site positions (NAD83) and water depth (m).

Site ID	Description	Easting	Northing	Depth
401	Presqu'ile Bay Reference	282910.3	4876922.3	3.3
402	Presqu'ile Bay Reference	283935.4	4875942.5	0.4
403	Presqu'ile Bay Reference	282477.3	4875979.9	0.6
1310	Hay Bay Reference	333514.2	4882049.8	7.3
1312	Mallory Bay Reference	336511.1	4884772.6	5.9
BQ10	Upstream	292531.0	4887935.4	3.4
BQ9	Upstream	292732.1	4887282.8	0.8
TR01	Primary depositional area	294190.3	4886450.8	2.7
6508	Primary depositional area	294194.6	4886432.1	2.9
TR03	Primary depositional area	294232.5	4886390.9	4.1
BQ2	Marina	294500.8	4886185.5	1.7
BQ1	West side dock	294095.5	4886102.8	1.6
TR12	Secondary depositional area	294552.7	4885986.4	3.4
TR13	Secondary depositional area	294611.5	4885915.1	3.0
2036	Trenton Bay	294930.3	4885522.3	2.1
6507	Trenton Bay	295260.4	4884087.2	3.4

BQ=Bay of Quinte; PB = Presqu'ile Bay

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

Field	Water	Sediment	Mayfly Tissue
Northing	Alkalinity	Trace Metals	Dioxins/Furans
Easting	Conductivity	Major Oxides	Dioxin-like PCBs
Depth	Dissolved Oxygen	Percents Clay, Silt, Sand, & Gravel	
	pH	Total Phosphorus	
	Temperature	Total Kjeldahl Nitrogen	
	Total Kjeldahl Nitrogen	Total Organic Carbon	
	Nitrates/Nitrites	Loss on Ignition	
	Total Phosphorus	Dioxins/Furans	
	Total Ammonia	Dioxin-like PCBs	

Table 3. Physico-chemical conditions of overlying water in the Trent River and reference areas. Highlighted values for total phosphorus exceed the interim Provincial Water Quality Objective of 20µg/L.

Site	Alkalinity mg/L	Conductivity µS/cm	Dissolved O_2	NH_3 mg/L	NO_3/NO_2 mg/L	pH	Temp °C	Total Kjeldahl N mg/L	Total P µg/L
Lake Ontario Reference[a]	95	-	8.4	0.015	0.173	8.4	10.0	0.370	19.9
PB Ref. 401	106	300	7.5	0.078	0.034	8.4	15.8	0.627	33.8
PB Ref. 402	106	301	9.2	0.064	0.033	8.4	15.3	0.583	25.0
PB Ref. 403	106	298	10.4	0.048	0.020	8.6	15.6	0.485	13.7
Ref. 1310	98	286	9.8	0.031	0.311	8.0	10.9	0.335	12.1
Ref. 1312	106	285	9.1	0.040	0.217	8.1	15.0	1.440	15.2
BQ10	114	301	8.9	0.037	0.238	7.8	16.4	0.524	34.9
BQ9	203	534	10.6	0.035	0.316	8.3	15.6	0.414	47.0
TR01	107	275	10.4	0.038	0.197	8.1	17.0	0.430	19.6
6508	107	305	1.5	0.266	0.209	8.0	16.7	1.456	82.6
TR03	105	270	10.0	0.028	0.163	8.2	16.5	0.406	23.3
BQ2	94	267	6.8	0.054	0.090	8.3	17.0	1.010	25.9
BQ1	109	284	10.4	0.035	0.180	7.9	16.4	0.393	23.2
TR12	107	272	6.5	0.037	0.176	7.9	16.5	0.390	24.3
TR13	104	271	10.0	0.032	0.175	8.0	16.4	0.375	21.6
2036	104	269	9.4	0.032	0.177	8.0	16.4	0.401	35.8
6507	107	271	2.1	0.058	0.176	7.9	16.3	0.735	34.0

[a] Reynoldson and Day 1998, n = 61; BQ=Bay of Quinte; PB = Presqu'ile Bay

Table 4. Physical characteristics of Trent River and reference sediment (top 10 cm).

Site	% Sand	% Silt	% Clay	% Gravel	Particle size mean
PB Ref. 401	2.3	71.8	25.9	0	11.8
PB Ref. 402	3.4	68.4	28.2	0	11.8
PB Ref. 403	87.9	0.0	12.1	0	202.1
Ref. 1310	7.5	53.8	38.7	0	11.0
Ref. 1312	3.6	53.8	42.5	0	7.9
BQ10	16.5	61.9	21.6	0	21.5
BQ9	97.5	0.0	2.5	0	282.3
TR01	5.3	64.7	30.0	0	12.4
6508	4.4	65.1	30.6	0	12.6
TR03	6.0	63.0	31.0	0	12.3
BQ2	1.7	65.7	32.6	0	9.7
BQ1	6.7	65.7	27.6	0	15.1
TR12	8.9	55.7	35.4	0	12.0
TR13	24.6	48.0	27.4	0	23.3
2036	35.0	44.3	20.7	0	35.3
6507	2.5	63.9	33.6	0	11.4

BQ=Bay of Quinte; PB = Presqu'ile Bay

Table 5. Trace metal and nutrient concentrations in Trent River and reference sediment. Values > the Severe Effect Level (SEL) are highlighted.

						Reference					Upstream		1° depositional			Marina	W. dock	2° depositional		Bay	
Parameter	Units	M.D.L.	Reference Method	SEL	Lake Ontario Range[a]	401	402	403	1310	1312	BQ10	BQ9	TR01	6508[b]	TR03	BQ2	BQ1	TR12	TR13	2036	6507[b]
Aluminum (Al)	%	10	EPA 6010			0.498	0.374	0.132	1.25	1.35	0.613	0.254	0.604	0.685	0.65	0.818	0.519	0.746	0.588	0.478	0.912
Antimony (Sb)	µg/g	5	EPA 6010			< 5	8	6	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Arsenic (As)	µg/g	5	EPA 6010	33		< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	12	< 5	< 5	< 5	< 5	< 5
Barium (Ba)	µg/g	1	EPA 6010			96	67	17	205	202	80	37	111	110	99	115	102	116	92	66	126
Beryllium (Be)	µg/g	0.2	EPA 6010			0.2	< 0.2	< 0.2	0.6	0.6	0.3	< 0.2	0.3	0.3	0.3	0.4	0.2	0.3	0.3	0.2	0.4
Bismuth (Bi)	µg/g	5	EPA 6010			< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Cadmium (Cd)	µg/g	0.5	EPA 6010	10	0.1-3.9	0.5	< 0.5	< 0.5	0.7	0.6	0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	< 0.5	< 0.5	< 0.5	< 0.5	1
Calcium (Ca)	%	10	EPA 6010			15.9	14.4	7.74	2.41	2.19	9.06	6.85	7.94	6.88	6.22	8.68	8.22	5.86	6.88	6.07	3.01
Chromium (Cr)	µg/g	1	EPA 6010	110	5-122	25	21	37	38	46	37	22	25	28	27	50	28	40	30	25	55
Cobalt (Co)	µg/g	1	EPA 6010		0.5-35	4	3	1	15	12	5	2	4	5	5	7	4	5	4	4	7
Copper (Cu)	µg/g	1	EPA 6010	110	2-91	26	20	5	28	31	33	6	27	32	28	85	17	76	37	16	34
Iron (Fe)	%	10	EPA 6010	4		1.1	0.8	0.4	2.2	2.3	1.2	0.6	1.2	1.3	1.3	2.2	1.1	1.4	1.2	1.0	1.8
Lead (Pb)	µg/g	5	EPA 6010	250	1-133	25	32	< 5	34	28	43	7	34	32	32	124	29	39	34	18	53
Magnesium (Mg)	%	10	EPA 6010			0.61	0.477	0.295	1.07	1.05	0.557	0.259	0.446	0.48	0.422	0.559	0.399	0.48	0.415	0.397	0.59
Manganese (Mn)	µg/g	1	EPA 6010	1100		323	228	106	1190	941	289	206	540	589	490	273	549	502	480	367	744
Mercury (Hg)	µg/g	0.005	EPA 7471A	2	0.012-0.43	0.08	0.08	0.005	0.105	0.095	0.135	0.025	0.11	0.095	0.37	0.53	0.11	0.465	0.39	0.155	0.557
Molybdenum (Mo)	µg/g	1	EPA 6010			1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	µg/g	1	EPA 6010	75	3-95	13	9	25	26	26	12	5	11	11	9	14	9	13	10	7	17
Potassium (K)	%	30	EPA 6010			0.106	0.087	0.027	0.269	0.295	0.111	0.037	0.109	0.119	0.106	0.153	0.096	0.114	0.104	0.091	0.151
Silicon (Si)	µg/g	1	EPA 6010			190	160	269	210	284	511	338	717	265	618	437	579	687	647	330	318
Silver (Ag)	µg/g	0.2	EPA 6010			0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2	0.4	0.4	0.3	1.4	< 0.2	3.8	0.8	< 0.2	0.8
Sodium (Na)	%	20	EPA 6010			0.153	0.137	0.122	0.149	0.167	0.071	0.016	0.023	0.17	0.024	0.029	0.023	0.022	0.021	0.191	0.164
Strontium (Sr)	µg/g	1	EPA 6010			256	202	100	59	60	131	87	111	100	94	132	109	92	101	88	57
Tin (Sn)	µg/g	10	EPA 6010			< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	20	10	< 10	< 10
Titanium (Ti)	µg/g	1	EPA 6010			230	136	198	716	724	274	168	255	265	228	281	218	237	233	228	373
Vanadium (V)	µg/g	1	EPA 6010		10-117	15	8	6	31	31	15	7	15	17	14	24	13	16	14	12	24
Yttrium (Y)	µg/g	0.5	EPA 6010			6.9	6.2	4.4	13.4	12.7	9	4.5	8.9	9.7	8.8	9.2	8	9.3	8.3	7.8	14.0
Zinc (Zn)	µg/g	1	EPA 6010	820	13-482	80	71	10	125	117	129	31	103	100	93	317	86	134	85	60	147
Zirconium (Zr)	µg/g	0.1	EPA 6010			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Aluminum (Al_2O_3)	%	0.01	IN-HOUSE		4.4-14.9	5.3	5.0	8.6	9.2	9.8	8.4	8.2	6.8	7.4	7.4	7.5	6.7	8.2	8.0	9.2	9.2
Barium (BaO)	%	0.001	IN-HOUSE			0.033	0.024	0.046	0.06	0.061	0.038	0.039	0.038	0.039	0.037	0.033	0.038	0.04	0.039	0.044	0.048
Calcium (CaO)	%	0.01	IN-HOUSE		1.8-29.3	26	25.9	12.7	4.5	4.07	14.2	11.2	13.2	11.2	11.1	13.2	14.5	9.8	11.2	10.1	5.7
Chromium (Cr_2O_3)	%	0.01	IN-HOUSE			< 0.01	< 0.01	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	0.01
Iron (Fe_2O_3)	%	0.05	IN-HOUSE		1.7-11.6	2.5	2.2	1.7	4.4	4.9	3.0	1.9	3.0	3.1	3.3	4.4	3.0	3.2	2.9	2.7	4.1
Magnesium (MgO)	%	0.01	IN-HOUSE		0.6-3.0	1.5	1.3	1.1	2.3	2.4	1.5	1.0	1.3	1.4	1.4	1.5	1.3	1.4	1.3	1.3	1.7
Manganese (MnO)	%	0.01	IN-HOUSE		0.04-3.3	< 0.01	< 0.01	< 0.01	0.78	0.4	< 0.01	< 0.01	< 0.01	0.06	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.14
Phosphorus (P_2O_5)	%	0.03	IN-HOUSE			2.95	3.19	1.27	4.14	4.81	3.44	2.21	3.97	4.11	4.78	4.77	3.99	5.12	3.9	3.56	4.08
Potasium (K_2O)	%	0.01	IN-HOUSE			2.3	2.2	3.6	4.4	4.7	3.3	3.3	2.8	2.9	2.9	2.9	2.7	3.1	3.1	3.6	3.6
Silica (SiO_2)	%	0.01	IN-HOUSE		20.9-81.2	24.9	24.8	58.7	46.8	47.3	41.6	56.6	37.3	39.6	39.3	36.0	37.0	41.9	42.0	50.8	43.2
Sodium (Na_2O)	%	0.01	IN-HOUSE			2.8	2.6	7.5	3.6	3.2	5.0	6.4	3.7	3.9	3.7	3.0	3.6	4.1	4.5	6.3	4.5
Titanium (TiO_2)	%	0.01	IN-HOUSE			0.75	0.78	0.93	1.35	1.53	1.08	0.85	0.98	1.02	1.02	1.04	0.97	1.06	1.04	1.19	1.34
Loss on Ignition (LOI)	%	0.05	IN-HOUSE		1.7-38.7	35.1	36.6	10.1	24.6	24.3	24.1	11.8	30.9	30.1	30.3	30.4	31	27.4	24.4	16.5	26.7
Whole Rock Total	%		IN-HOUSE			103	104	105	107	108	105	103	104	105	105	104	105	105	102	105	104
Total Organic Carbon	% by wt	0.1	LECO	10	0.5-12.9	7.4	8.2	0.6	6.8	8.6	6.6	2.6	9.1	8.7	9.5	9.2	8.8	9.2	7.4	4.2	10.6
Total Kjeldahl Nitrogen	µg/g	0.05	EPA 351.2	4800	460-12528	8960	8350	963	9140	10000	5890	1570	9710	8677	9310	7270	9230	9520	6770	4510	10220
Phosphorus-Total	µg/g	0.01	EPA 365.4	2000	80-3440	903	970	411	1350	1320	1000	564	1330	1233	1420	1400	1290	1680	1180	1190	1267

[a] µg/g; Reynoldson and Day 1998 (n=61) [b] values represent the mean of three field replicates

Table 6. Comparison of 2006 sediment metal and nutrient concentrations to 2000 concentrations (concomitant sites). Highlighted values exceed the provincial Severe Effect Level.

Site	1° depositional 6508 (6 m apart)		Bay 6507 (2 m apart)		Bay 2036 (9 m apart)	
Year	**2000[a]**	**2006**	**2000[a]**	**2006**	**2000[a]**	**2006**
As	<5	<5	<5	<5	<5	<5
Cd	<1	<0.5	6..0	1.03	<1	<0.5
Cr	26.0	28.3	48.0	55.3	9.2	25.0
Cu	39.0	32.0	38.0	34.3	13.6	16.0
Fe	1.5	1.3	2.2	1.8	0.8	1.0
Hg	0.2	0.1	0.3	0.6	0.1	0.2
Mn	394	589	945	744	225	367
Ni	14.0	11.3	21.0	17.3	9.8	7.0
Pb	33	32	52	53	26	18
Zn	122	100	165	147	99	60
Total Kjeldahl N	7160	8677	15700	10220	2760	4510
Total Organic C	9.0	8.7	11.8	10.6	3.0	4.2
Total P	1410	1233	1630	1267	1020	1190

[a] Milani and Grapentine 2004

Table 7. Concentrations of dioxins and furans, dioxin-like PCBs (pg/g dw), and toxic equivalents (ng TEQ·kg^{-1}) in Trent River and reference sediment. The World Heath Organization toxic equivalency factors for fish were used in the calculation of the TEQ (non-detects were assigned zero). Highlighted values exceed the federal Probable Effect Level of 21.5 ng TEQ/kg.

	Reference					Upstream		1° depositional			Marina	W. Dock	2° depositional		Bay	
Parameter	**401**	**402**	**403**	**1310**	**1312**	**BQ10**	**BQ9**	**TR01**	**6508[a]**	**TR03**	**BQ2**	**BQ1**	**TR12**	**TR13**	**2036**	**6507[a]**
2,3,7,8-Tetra CDD	0.8	0.6	0.2	0.5	0.4	0.4	0.1	0.4	0.9	0.6	1.2	0.4	0.4	0.5	0.1	0.7
1,2,3,7,8-Penta CDD	1.4	1.2	0.7	1.5	1.4	1.3	0.3	2.5	2.2	2.6	6.9	1.7	2.9	2.3	0.6	2.9
1,2,3,4,7,8-Hexa CDD	1.8	1.4	0.7	2.5	2.1	2.3	0.4	5.6	5.1	5.9	19.0	2.8	7.5	5.4	0.9	5.9
1,2,3,6,7,8-Hexa CDD	4.8	3.0	0.7	7.1	5.2	7.3	0.9	31.0	28.7	31.0	74.0	12.0	130.0	38.0	4.6	26.7
1,2,3,7,8,9-Hexa CDD	5.4	3.8	1.1	6.7	6.6	7.0	0.9	14.0	13.3	11.0	48.0	8.0	24.0	15.0	2.3	16.7
1,2,3,4,6,7,8-Hepta CDD	97	55	4.2	180	130	220	23	1100	960	1100	2200	380	3000	1400	150	730
Octa CDD	640	360	24	1400	1200	2000	160	12000	10067	12000	19000	4000	29000	15000	1500	6500
2,3,7,8-Tetra CDF	11.0	5.8	0.7	21.0	17.0	18.0	1.0	19.0	19.3	19.0	17.0	18.0	18.0	15.0	9.2	36.0
1,2,3,7,8-Penta CDF	2.4	1.6	0.6	4.5	3.5	3.2	0.3	3.6	3.6	3.8	5.2	3.2	4.9	3.2	1.7	8.7
2,3,4,7,8-Penta CDF	2.8	1.8	0.7	3.8	3.2	2.8	0.3	3.0	3.1	3.1	4.7	2.6	3.5	2.6	1.3	5.6
1,2,3,4,7,8-Hexa CDF	5.4	3.2	0.8	5.9	5.0	4.0	0.5	6.6	6.5	6.6	14.0	4.2	20.0	6.6	1.7	9.5
1,2,3,6,7,8-Hexa CDF	2.4	2.0	0.7	3.7	3.0	2.9	0.4	4.2	4.0	4.8	23.0	3.1	6.3	3.3	1.0	10.7
2,3,4,6,7,8-Hexa CDF	2.1	1.3	0.6	2.8	2.5	2.1	0.3	2.7	2.8	3.2	8.7	2.0	6.1	2.6	0.7	4.5
1,2,3,7,8,9-Hexa CDF	0.4	0.3	0.5	0.4	0.3	0.3	0.1	0.4	0.5	0.7	2.0	0.5	1.0	0.6	0.2	1.4
1,2,3,4,6,7,8-Hepta CDF	28.0	15.0	1.6	43.0	32.0	35.0	4.3	220.0	193.3	220.0	420.0	80.0	750.0	310.0	24.0	146.7
1,2,3,4,7,8,9-Hepta CDF	1.4	1.0	0.5	2.2	1.6	2.1	0.3	12.0	10.4	12.0	25.0	5.0	42.0	16.0	1.3	8.7
Octa CDF	46	29	3	93	60	96	11	1300	1037	1300	1500	380	4000	1900	120	453
TEQ Dioxins/Furans	6.7	4.8	2.0	8.6	7.3	7.2	1.1	14.9	14.2	15.5	**35.8**	8.7	**29.0**	15.8	3.4	17.6
Non-*ortho* PCBs																
33'44'-TetraCB-(PCB77)	300	220	11	340	240	740	30	600	643	650	670	650	570	550	340	1700
344'5-TetraCB-(PCB81)	6.9	5.7	0.44	7	5.1	20	0.79	13.0	15.0	14.0	13	15.0	13.0	11.0	7.7	42.3
33'44'5-PentaCB-(PCB126)	15	16	0.7	15	12	25	1.5	21.0	22.3	21.0	30	21.0	21.0	17.0	9.9	49.3
33'44'55'-HexaCB-(PCB169)	1.4	1.3	0.16	1.4	1.3	1.4	0.22	1.4	1.5	1.4	2.6	1.4	1.4	1.1	0.7	2.3
Mono-*ortho* PCBs																
233'44'-PentaCB-(PCB105)	780	780	29	760	570	1700	86	1400	1433	1400	2100	1400	1400	1200	730	3100
2344'5-PentaCB-(PCB114)	38	43	1.6	36	28	98	4.6	79	78	75	120	80	73	65	39	190
23'44'5-PentaCB-(PCB118)	1800	1700	68	1600	1300	3300	190	2800	2667	2900	5900	2900	2600	2500	1400	5367
23'44'5'-PentaCB-(PCB123)	65	73	2.4	67	51	130	7.3	110	113	120	270	110	110	93	51	260
233'44'5-HexaCB-(PCB156)	140	140	4.8	160	120	300	16	260	260	260	630	250	250	220	110	567
233'44'5'-HexaCB-(PCB157)	35	33	1.3	33	26	60	3.9	53	55	55	130	51	55	46	23	111
23'44'55'-HexaCB-(PCB167)	64	65	2.3	60	46	110	7.1	96	94	95	260	84	89	76	39	170
233'44'55'-HeptaCB-(PCB189)	15	14	0.5	15	12	23	2.0	22	21	21	69	19	20	18	7.9	40
TEQ PCBs	0.12	0.12	0.01	0.13	0.10	0.24	0.01	0.20	0.21	0.20	0.27	0.20	0.19	0.17	0.10	0.49
TEQ - TOTAL	6.9	4.9	2.0	8.8	7.4	7.4	1.1	15.1	14.4	15.7	**36.0**	8.9	**29.2**	16.0	3.5	18.1

[a] value represents the mean of three field replicates

Table 8. Concentrations of dioxins and furans, dioxin-like PCBs (converted to pg/g ww) and toxic equivalents (ng TEQ·kg^{-1}) in laboratory-exposed mayfly tissue. Highlighted TEQs exceed the CCME avian tissue residue guideline. Reported values that are italicized values are below the method detection limit.

	Lab Controls				Reference Sites				
Parameter	**Lab1**	**Lab2**	**Lab3**	**Lab4**	**Ref 401**	**Ref 402**	**Ref 403**	**Ref 1310**	**Ref 1312**
2378-tetrachlorodioxin	*0.57*	*0.53*	*0.37*	*0.45*	*0.68*	*0.45*	*0.48*	*0.61*	*0.53*
12378-pentachlorodioxin	0.18	0.16	0.29	0.23	0.24	0.15	*0.11*	0.23	0.15
123478-hexachlorodioxin	0.19	*0.12*	0.19	*0.14*	0.26	*0.12*	*0.12*	0.19	*0.14*
123678-hexachlorodioxin	0.19	0.16	0.23	0.18	0.31	0.23	*0.12*	0.36	0.21
123789-hexachlorodioxin	0.31	*0.13*	0.27	0.23	0.48	0.19	0.32	0.53	0.39
1234678-heptachlorodioxin	0.74	0.74	0.76	0.79	4.52	1.78	1.05	4.36	3.55
Octachlorodioxin	1.78	2.42	2.58	3.07	25.85	10.02	3.55	24.23	25.85
2378-tetrachlorofuran	0.27	0.37	0.44	0.40	1.34	0.74	0.63	1.44	1.34
12378-pentachlorofuran	0.29	*0.16*	0.44	0.34	0.40	0.27	0.42	0.47	0.32
23478-pentachlorofuran	0.32	0.27	0.52	0.44	0.55	0.34	0.27	0.47	0.39
123478-hexachlorofuran	0.31	0.24	0.48	0.31	0.45	0.24	0.24	0.48	0.36
123678-hexachlorofuran	0.26	0.16	0.39	0.19	0.31	0.24	0.73	0.36	0.26
234678-hexachlorofuran	0.23	*0.11*	0.26	0.16	0.29	0.16	*0.10*	0.24	0.16
123789-hexachlorofuran	0.18	*0.12*	0.19	0.13	0.19	0.14	*0.12*	0.23	*0.11*
1234678-heptachlorofuran	0.44	0.37	0.65	*0.47*	1.37	0.66	0.44	1.21	0.99
1234789-heptachlorofuran	0.23	*0.14*	0.24	0.15	0.29	0.18	0.19	0.27	*0.16*
Octachlorofuran	*0.39*	*0.36*	0.50	0.44	2.10	0.76	0.50	1.62	1.45
TEQ Dioxins/Furans	0.95	0.85	1.47	1.21	2.39	1.37	1.08	2.40	2.05
TRG avian 4.75 ng/kg ww									
Non-*ortho* PCBs									
3,3',4,4'-tetrachlorobiphenyl (PCB77)	25.8	9.0	19.4	40.4	210.0	161.6	143.8	84.0	88.9
3,4,4',5-tetrachlorobiphenyl (PCB81)	1.2	0.7	0.8	1.1	2.7	2.6	21.0	2.1	1.2
3,3'4,4',5-pentachlorobiphenyl (PCB126)	0.7	0.5	0.8	0.6	3.7	3.4	2.3	2.6	2.1
3,3'4,4'55'-hexachlorobiphenyl (PCB169)	*0.2*	*0.2*	0.6	*0.2*	*0.3*	*0.2*	*0.2*	*0.3*	*0.2*
Mono-*ortho* PCBs									
2,3,3'4,4'-pentachlorobiphenyl (PCB105)	339.3	177.7	137.3	150.2	436.2	420.0	452.3	355.4	355.4
2,3,4,4',5-pentachlorobiphenyl (PCB114)	25.8	16.2	11.1	12.4	27.5	27.5	38.8	25.8	25.8
2,3'4,4',5-pentachlorobiphenyl (PCB118)	1292.4	807.8	565.4	630.0	1389.3	1389.3	2100.2	1243.9	1243.9
2'3,4,4',5-pentachlorobiphenyl (PCB123)	67.9	30.7	19.4	19.4	59.8	58.2	72.7	51.7	33.9
2,3,3'4,4'5-hexachlorobiphenyl (PCB156)	13.6	8.7	7.4	7.8	37.2	38.8	21.0	42.0	40.4
2,3,3'44'5'-hexachlorobiphenyl (PCB157)	3.1	2.1	1.9	1.9	12.9	11.5	6.0	10.2	9.4
23',44',55'-hexachlorobiphenyl (PCB167)	7.8	5.3	3.9	4.0	19.4	22.6	12.8	19.4	16.2
233'44'55'-heptachlorobiphenyl (PCB189)	0.6	0.5	0.5	0.6	2.9	3.2	1.2	3.2	*8.9*
TEQ PCBs	1.5	0.6	1.2	2.2	**11.2**	**8.7**	**9.6**	**4.7**	0.6
TRG avian 2.4 ng/kg ww									

Table 8. Continued.

	Upstream		1° depositional			Marina	W. dock	2° depositional		Bay	
Parameter	**BQ10**	**BQ9**	**TR01**	**6508**	**TR03**	**BQ2**	**BQ1**	**TR12**	**TR13**	**2036**	**6507**
2378-tetrachlorodioxin	*0.42*	*0.26*	*0.45*	*0.45*	*0.32*	*0.52*	*0.31*	*0.42*	*0.48*	*0.45*	*0.65*
12378-pentachlorodioxin	0.27	0.24	0.52	0.24	0.31	0.57	0.23	0.34	0.45	0.26	0.27
123478-hexachlorodioxin	0.27	0.16	0.36	0.26	0.27	0.94	0.18	0.40	0.57	*0.14*	0.27
123678-hexachlorodioxin	0.58	0.32	1.36	1.03	0.94	3.39	0.53	1.53	2.75	0.32	0.90
123789-hexachlorodioxin	0.53	0.32	0.68	0.37	0.47	2.10	0.37	0.82	1.31	0.26	0.74
1234678-heptachlorodioxin	9.21	3.39	24.23	22.62	15.83	72.70	8.08	30.69	61.39	5.65	19.39
Octachlorodioxin	58.16	19.39	210.02	210.02	127.63	597.74	63.00	258.48	565.43	45.23	161.55
2378-tetrachlorofuran	4.68	3.23	2.75	6.46	3.07	1.78	2.42	2.75	3.39	7.75	8.72
12378-pentachlorofuran	4.36	3.55	0.50	5.82	0.37	0.61	0.36	0.45	0.65	7.75	9.85
23478-pentachlorofuran	1.62	1.31	0.66	1.94	0.57	0.69	0.50	0.61	0.87	2.42	3.07
123478-hexachlorofuran	3.23	2.75	0.50	4.36	0.44	0.84	0.31	0.50	0.78	5.98	7.92
123678-hexachlorofuran	1.13	0.90	0.40	1.24	0.31	1.26	0.27	0.47	0.76	1.78	2.75
234678-hexachlorofuran	0.31	0.27	0.34	0.29	0.24	0.74	0.21	0.42	0.48	0.27	0.45
123789-hexachlorofuran	0.23	0.19	0.21	0.19	*0.11*	0.23	0.14	0.14	0.24	0.37	0.44
1234678-heptachlorofuran	1.78	1.28	4.36	4.52	3.39	12.60	1.94	5.17	10.66	2.10	5.01
1234789-heptachlorofuran	0.36	0.31	0.44	0.63	0.27	0.94	0.19	0.44	0.87	0.57	0.90
Octachlorofuran	2.10	1.57	15.83	14.70	9.85	37.16	4.52	15.02	38.77	3.23	9.05
TEQ Dioxins/Furans	**7.61**	**5.61**	4.32	**9.99**	4.21	3.97	3.37	4.13	**5.43**	**12.12**	**14.40**
TRG avian 4.75 ng/kg ww											
Non-*ortho* PCBs											
3,3',4,4'-tetrachlorobiphenyl (PCB77)	290.8	210.0	226.2	242.3	290.8	177.7	355.4	226.2	274.6	371.6	258.5
3,4,4',5-tetrachlorobiphenyl (PCB81)	4.8	4.0	3.2	3.1	3.6	2.1	5.2	2.1	2.9	4.2	3.1
3,3'4,4',5-pentachlorobiphenyl (PCB126)	6.6	2.6	5.2	5.5	5.8	4.8	5.0	4.5	5.3	6.5	4.7
3,3'4,4'55'-hexachlorobiphenyl (PCB169)	0.6	*0.5*	0.6	0.5	*0.5*	0.6	*0.3*	0.5	0.7	0.5	0.5
Mono-*ortho* PCBs											
2,3,3'4,4'-pentachlorobiphenyl (PCB105)	727.0	468.5	517.0	646.2	743.1	452.3	710.8	436.2	484.7	630.0	581.6
2,3,4,4',5-pentachlorobiphenyl (PCB114)	45.2	40.4	32.3	43.6	53.3	27.5	45.2	25.8	29.1	38.8	38.8
2,3'4,4',5-pentachlorobiphenyl (PCB118)	1938.6	1938.6	1583.2	2100.2	2584.8	1550.9	2100.2	1373.2	1470.1	1534.7	1938.6
2'3,4,4',5-pentachlorobiphenyl (PCB123)	74.3	64.6	46.8	71.1	63.0	51.7	69.5	38.8	67.9	59.8	63.0
2,3,3'4,4'5-hexachlorobiphenyl (PCB156)	100.2	38.8	72.7	79.2	92.1	108.2	88.9	64.6	75.9	74.3	71.1
2,3,3'44'5'-hexachlorobiphenyl (PCB157)	22.6	8.7	16.2	17.8	19.4	24.2	19.4	14.7	17.8	16.2	16.2
23',44',55'-hexachlorobiphenyl (PCB167)	43.6	19.4	32.3	35.5	38.8	48.5	37.2	27.5	30.7	24.2	30.7
233'44'55'-heptachlorobiphenyl (PCB189)	7.4	2.9	5.5	5.5	6.0	11.0	5.5	4.8	6.1	5.0	4.5
TEQ PCBs	**15.8**	**11.2**	**12.2**	**13.1**	**15.6**	**9.7**	**18.9**	**12.0**	**14.6**	**19.7**	**13.8**
TRG avian 2.4 ng/kg ww											

Table 9. Probabilities of Trent River and reference sites belonging to 1 of 5 Great Lakes faunal groups. The highest probability for each site is in bold.

Site	Probability of Group Membership				
	Group 1	Group 2	Group 3	Group 4	Group 5
Ref 401	**0.976**	0.015	0.002	0.000	0.007
Ref. 402	**0.985**	0.010	0.001	0.000	0.004
Ref. 403	**0.504**	0.076	0.411	0.000	0.010
Ref. 1310	**0.975**	0.011	0.004	0.000	0.011
Ref. 1312	**0.985**	0.007	0.001	0.000	0.007
BQ10	**0.965**	0.021	0.004	0.000	0.010
BQ9	0.116	0.145	0.004	**0.724**	0.011
TR01	**0.988**	0.007	0.001	0.000	0.005
6508	**0.985**	0.008	0.001	0.000	0.006
TR03	**0.988**	0.006	0.000	0.000	0.005
BQ2	**0.992**	0.004	0.001	0.000	0.003
BQ1	**0.987**	0.008	0.001	0.000	0.005
TR12	**0.987**	0.007	0.000	0.000	0.005
TR13	**0.979**	0.011	0.002	0.000	0.007
2036	**0.926**	0.032	0.031	0.000	0.011
6507	**0.991**	0.004	0.000	0.000	0.004

Table 10a. Mean abundance of prominent invertebrate families (per 33 cm^2), taxon diversity, and BEAST difference-from-reference band for Trent River sites predicted to Great Lakes reference Group 1. Reference sites from Bay of Quinte (BQ) and Presqu'ile Bay (PB) are shown for comparison. Predicted families that are absent from test sites are highlighted.

Family	GL Ref	Reference					Upstream	1° depositional			Marina	W. dock	2° depositional		Bay	
	Group 1 Mean	401	402	403	1310	1312	BQ10	TR01	6508[a]	TR03	BQ2	BQ1	TR12	TR13	2036	6507[a]
No. Taxa (±2 SD)	8 (2 – 14)	7	16	11	6	11	5	13	9	12	7	9	7	10	14	16
Chironomidae	13.4	6.4	36.0	16.0	20.4	67.0	1.8	2.0	6.6	21.0	2.0	4.4	11.6	12.4	106.6	3.6
Tubificidae	5.6	2.0	11.2	2.3	6.0	16.6	2.6	2.6	27.1	20.2	3.8	3.0	20.4	14.8	29.6	23.3
Sphaeriidae	4.9	0.0	0.2	0.0	0.0	4.2	0.2	0.0	0.7	0.6	0.0	0.0	0.2	0.0	1.4	0.1
Asellidae	1.8	0.4	0.2	0.2	0.0	0.4	0.0	0.0	0.9	0.2	0.0	1.6	0.0	0.4	9.0	0.0
Naididae	1.4	0.0	11.4	6.9	11.8	3.0	0.4	2.0	7.8	12.2	0.6	0.6	7.4	12.2	61.2	4.5
Sabellidae	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
BEAST BAND	-	1	1	1	1	1	1	2	2	1	1	1	1	2	2	2

[a]values represent the mean of three field replicates.

Table 10b. Mean abundance of prominent invertebrate families (per 33 cm^2), taxon diversity, and BEAST difference-from-reference band for Trent River site predicted to Great Lakes reference Group 4. Predicted families that are absent from test sites are highlighted.

Family	GL Ref	Upstream
	Group 4 Mean	BQ9
No. Taxa (±2 SD)	6 (3 – 9)	11
Haustoriidae	58.9	0.0
Lumbriculidae	11.5	0.0
Sphaeriidae	8.7	0.8
Tubificidae	5.2	36.6
Enchytraeidae	3.5	1.6
Chironomidae	1.3	53.0
BEAST BAND	-	4

Table 11. Comparison of select family abundances (per 33cm^2), taxon diversity and BEAST difference-from-reference band to 2000 data (concomitant sites).

Site	**1° depositional 6508 (6 m apart)**		**Bay 6507 (2 m apart)**		**Bay 2036 (9 m apart)**	
Year	**2000[a]**	**2006**	**2000[a]**	**2006**	**2000[a]**	**2006**
BEAST BAND	1	2	1	2	2	2
No. Taxa	6	14	6	9	15	16
Tubificidae	3.4	27.1	15.4	23.3	6.8	29.6
Chironomidae	3.0	6.6	4.0	3.6	8.2	106.6
Sphaeriidae	0	0.7	0	0.1	0.2	1.4

[a] Milani and Grapentine 2004

Table 12. Mean percent survival, growth (mg dry wt) and reproduction in Trent River and reference sediment and BEAST difference-from-reference band. Toxicity based on numerical guidelines is highlighted red and potential toxicity is highlighted blue.

Site	*C. riparius* %survival	*C. riparius* growth	*H. azteca* %survival	*H. azteca* growth	*Hexagenia* %survival	*Hexagenia* growth	*T. tubifex* %survival	*T. tubifex* No. cocoons/adult	*T. tubifex* %hatch	*T. tubifex* No. young/adult	**BEAST BAND**
Great Lakes Reference Mean	87.1	0.35	85.6	0.50	96.2	3.03	97.9	9.9	57.0	29.0	-
Ref. 401	93.3	0.395	90.7	0.287	100	2.966	100	11.3	58.8	28.5	1
Ref. 402	96.0	0.428	96.0	0.333	98	3.928	100	11.7	55.5	26.2	1
Ref. 403	96.0	0.386	97.3	0.570	100	3.970	100	10.6	54.2	34.5	1
Ref. 1310	95.0	0.361	91.1	0.489	100	3.190	100	11.6	58.1	24.0	1
Ref. 1312	85.3	0.346	96.0	0.704	100	2.728	100	10.8	55.1	21.8	1
Upstream BQ10	90.7	0.416	88.0	0.447	100	3.620	100	10.9	***28.1***	***6.7***	2
Upstream BQ9	89.3	0.410	97.3	0.685	100	4.960	100	11.6	51.2	39.4	1
1° dep. TR01	88.0	0.362	98.7	0.759	100	3.494	100	12.2	50.0	25.8	1
1° dep. 6508	78.7	0.425	98.7	0.860	100	4.120	100	12.6	52.4	31.6	1
1° dep. TR03	86.7	0.414	96.0	0.834	100	4.486	100	12.3	51.1	32.1	1
Marina BQ2	97.3	0.360	80.0	0.404	100	3.240	100	10.2	***28.2***	***1.8***	2
W. dock BQ1	93.3	0.355	90.7	0.742	100	4.370	100	11.0	36.7	17.5	1
2° dep. TR12	88.0	0.403	93.3	0.738	100	3.716	100	11.2	***29.9***	**0.3**	2
2° dep. TR13	92.0	0.385	97.3	0.773	98	3.360	100	11.4	***32.1***	***4.1***	2
Bay 2036	80.0	0.345	98.7	0.533	100	3.548	100	11.7	**26.8**	11.7	2
Bay 6507	86.7	0.397	96.0	0.705	100	2.428	100	11.2	***34.9***	10.1	2
Non-toxic[a]	≥67.7	0.49 – 0.21	≥67.0	0.75 – 0.23	≥85.5	5.0 – 0.9	≥88.9	12.4 – 7.2	78.1 – 38.1	46.3 – 9.9	-
Potentially toxic	67.6 – 58.8	0.20 – 0.14	66.9 – 57.1	0.22 – 0.10	85.4 – 80.3	0.8 – 0	88.8 – 84.2	7.1 – 5.9	38.0 – 28.1	9.8 – 0.8	-
Toxic	**< 58.8**	**< 0.14**	**< 57.1**	**< 0.10**	**< 80.3**	-	**< 84.2**	**< 5.9**	**< 28.1**	**< 0.8**	-

[a] The upper limit for non-toxic category is set using 2 × SD of the mean and indicates excessive growth or reproduction.

Table 13. Comparison of survival, reproduction and BEAST difference-from-reference band to 2000 data (concomitant sites).

Site	**1° depositional 6508 (6 m apart)**		**Bay 6507 (2 m apart)**		**Bay 2036 (9 m apart)**	
Year	**2000[a]**	**2006**	**2000[a]**	**2006**	**2000[a]**	**2006**
BEAST BAND	3	1	4	2	2	2
Tubifex No. Cocoons/ Adult	11.1	12.6	10.6	11.2	10.9	11.7
Tubifex % Cocoons Hatched	54	52	58	35	44	27
Tubifex No. Young/ Adult	10.9	31.6	16.5	10.1	19.8	11.7
Hyalella % Survival	57.3	98.7	21.3	96.0	84.0	98.7

[a] Milani and Grapentine 2004

Table 14. Decision matrix for weight-of-evidence categorization of Trent River sites. Reference sites are shown for comparison. For the sediment chemistry column, sites with exceedences of the federal Probable Effect Level (PEL) for dioxins and furans are indicated by "●"; sites with metal exceedences of the provincial Lowest Effect Level (LEL) by "◉". For the toxicity column, sites where multiple endpoints exhibit major toxicological effects are indicated by "●"; sites where one endpoint exhibits a major effect or multiple endpoints exhibit minor effects are indicated by "◉"; sites where minor toxicological effects observed in no more than one endpoint by "O". For the benthos alteration column, sites determined from BEAST analyses as different or very different from reference, respectively, are indicated by "●"; and sites determined as possibly different from reference by "◉". Sites with no SQG exceedences or benthic communities equivalent to reference conditions are indicated by "O". Some sites show possible benthos alteration but are not recommended for further action; in these cases, the benthos alteration was not judged to be detrimental (decreased taxon richness, reduced average abundance).

Site	Sediment Chemistry	Toxicity	Benthos Alteration[a]	Biomagnification Potential[b] *Mayflies*	Exceeding LEL (metals)	Exceeding SEL/PEL	Assessment
Reference							
401	◉	O	O	O	Cu	-	No further actions needed
402	◉	O	O	O	Cu, Pb	-	No further actions needed
403	◉	O	O	O	Cr, Ni	-	No further actions needed
1310	◉	O	O	O	Cd, Cr, Cu, Pb, Mn, Ni, Zn	-	No further actions needed
1312	◉	O	O	O	Cr, Cu, Mn, Ni	-	No further actions needed
Upstream							
BQ10	◉	◉	O	◉[1,2]	Cr, Cu, Pb, Zn	TKN[3]	Determine reasons for sediment toxicity and fully assess risk of biomagnification
BQ9	O	O	●[c]	◉[1,2]	-	-	Fully assess risk of biomagnification
Primary depositional area							
TR01	◉	O	◉[c]	◉[2]	Cu, Mn, Pb	TKN[3]	Fully assess risk of biomagnification
6508	◉	O	◉[c]	◉[1,2]	Cr, Cu, Mn, Pb	TKN[3]	Fully assess risk of biomagnification
TR03	◉	O	O	◉[2]	Cr, Cu, Hg, Mn, Pb	TKN[3]	Fully assess risk of biomagnification
Marina							
BQ2	●	◉	O	O	Cd, Cr, Cu, Hg, Pb, Zn	Dioxins/Furans	Determine reasons for sediment toxicity
West side dock							
BQ1	◉	O	O	◉[2]	Cr, Cu, Mn	TKN[3]	Fully assess risk of biomagnification

Table 14. Continued.

Site	Sediment Chemistry	Toxicity	Benthos Alteration[a]	Biomagnification Potential[b] *Mayflies*	Exceeding LEL (metals)	Exceeding SEL/PEL	Assessment
Secondary depositional area							
TR12	●	◉	○	◉[2]	Cr, Cu, Hg, Mn, Pb, Zn	Dioxins/Furans	Determine reasons for sediment toxicity and fully assess risk of biomagnification
TR13	◉	◉	◉[c]	◉[1,2]	Cr, Cu, Hg, Mn, Pb	TKN[3]	Determine reasons for sediment toxicity and fully assess risk of biomagnification
Trenton Bay							
2036	○	◉	◉[d]	◉[1,2]	-	-	Determine reasons for sediment toxicity and fully assess risk of biomagnification
6507	◉	○[e]	◉[c]	◉[1,2]	Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn	TKN[3], TOC[4]	Fully assess risk of biomagnification

[a] Benthos alteration may be the result of other factors, either natural (e.g., competition/predation, habitat differences) or human-related (e.g., water column contamination) (Chapman and Anderson 2005)
[b] Value > the TEQ and the 99th percentile for reference sites; TEQs were calculated using avian TEFs, ND=0 (WHO 1998).
[c] Sites that show possible benthos alteration but not judged to be detrimental.
[d] Enrichment
[e] Minor toxicological effect in one endpoint only
[1] Dioxins/Furans; [2] Dioxin-like PCBs; [3] Total Kjeldahl Nitrogen; [4] Total Organic Carbon

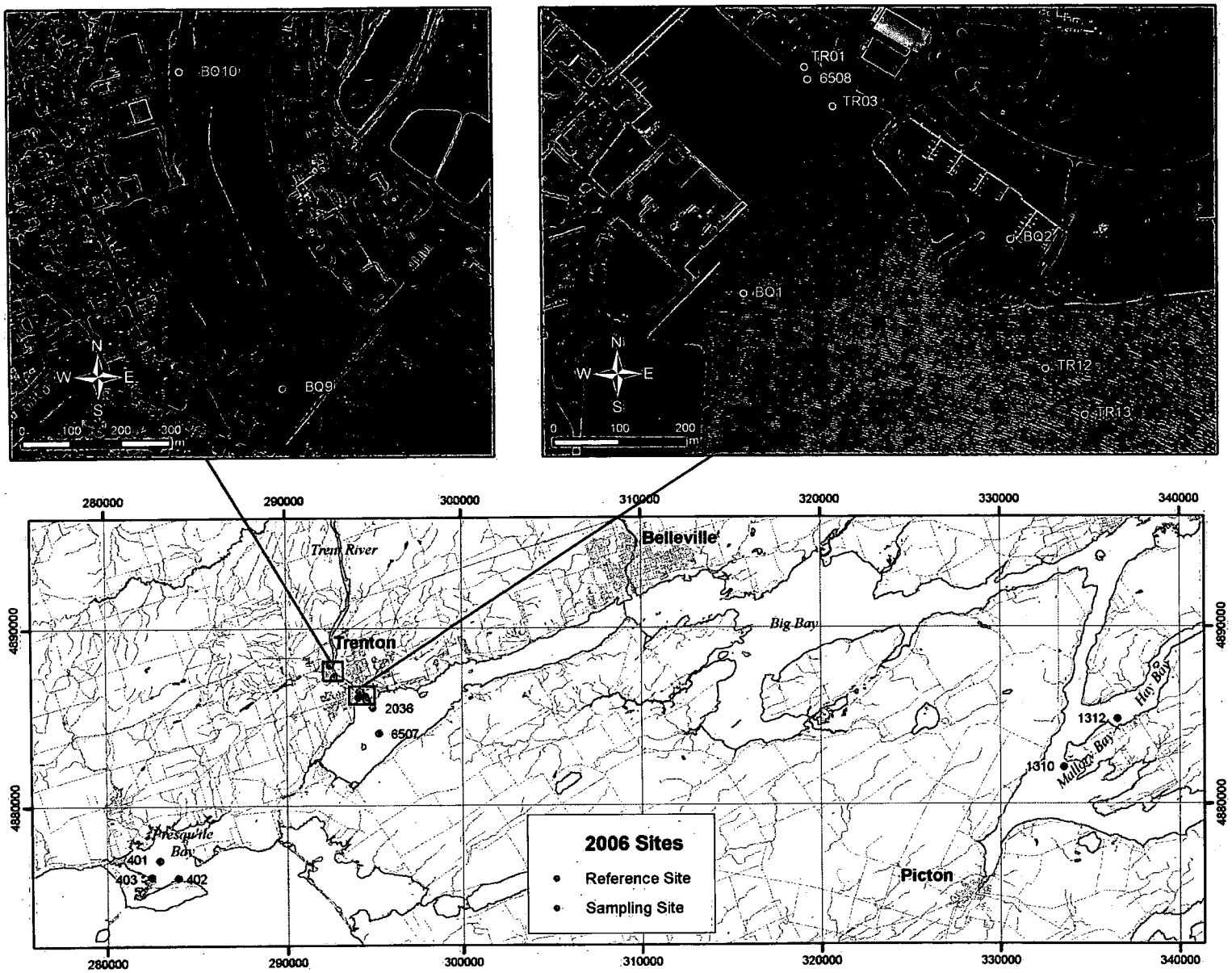

Figure 1. Sampling sites in the Trent River and reference areas.

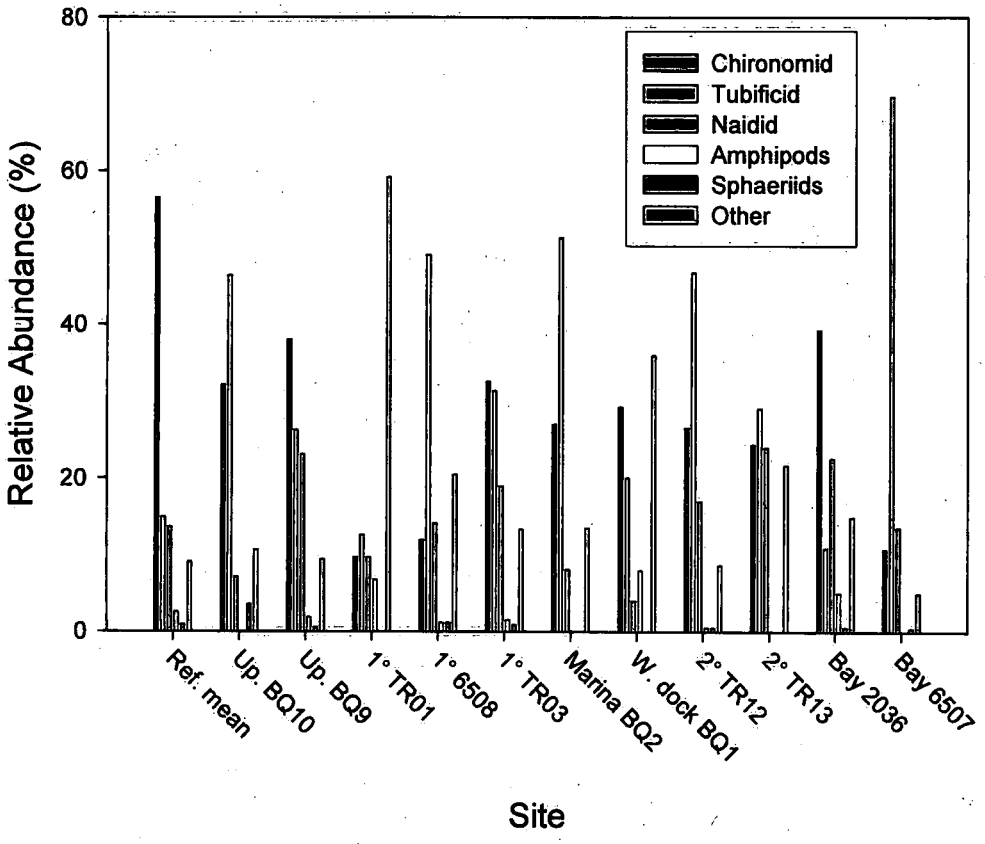

Figure 2. Mean relative abundance of dominant benthic macroinvertebrate groups collected in Trent River and reference areas.

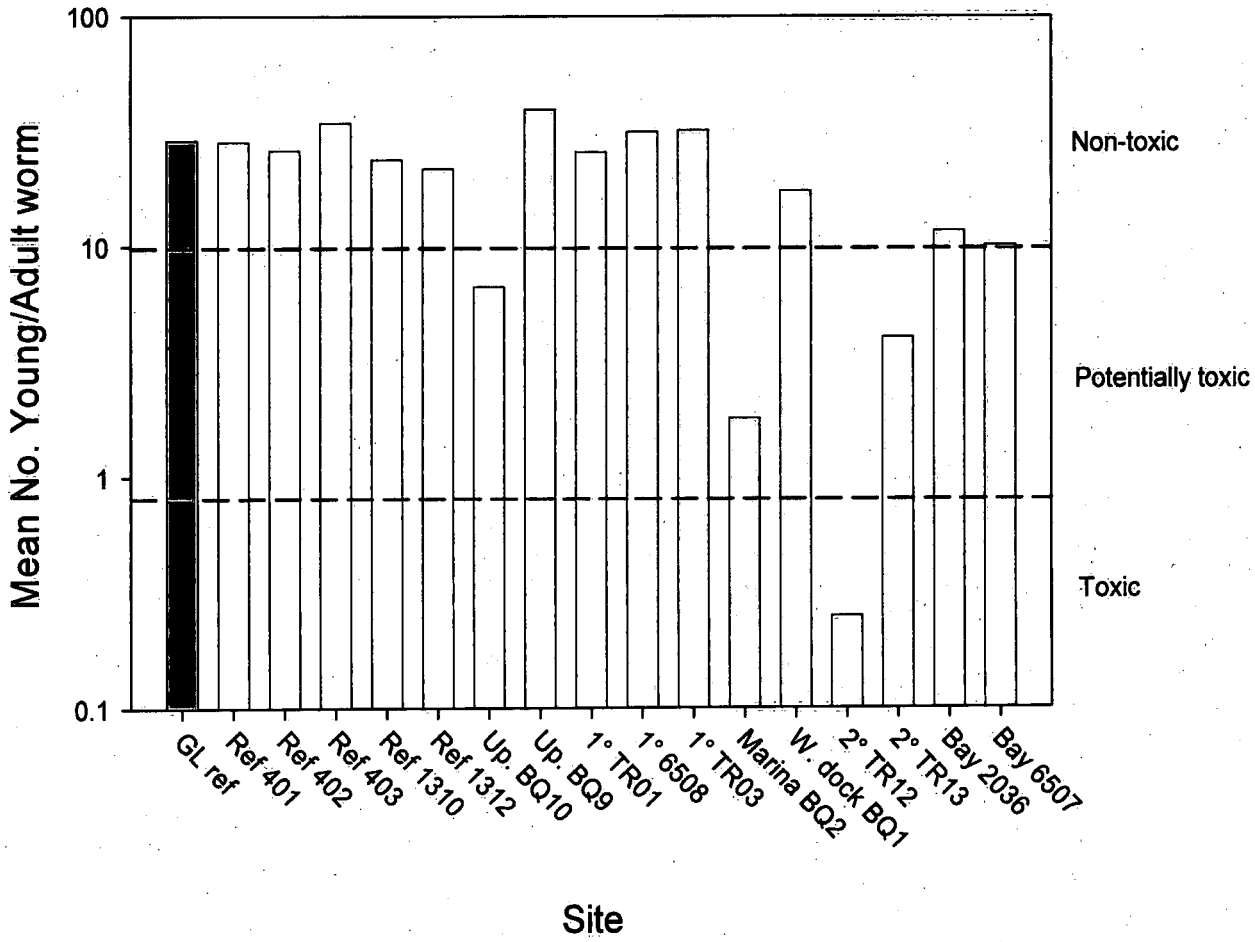

Figure 3. Mean *Tubifex tubifex* young production for Trent River and reference sediment. Green bar = mean value for Great Lakes reference sites (n=105); Yellow bars = Presqu'ile Bay (PB) and Bay of Quinte (BQ) reference sites. Grey bars are Trent River sites. The blue dotted line represents the potentially toxic line, and the red line represents the toxic line, based on numeric guidelines (Reynoldson and Day 1998). Values between the red and blue lines are in the potentially toxic category, values below the red line are in toxic category and values above the blue line are in the non-toxic category.

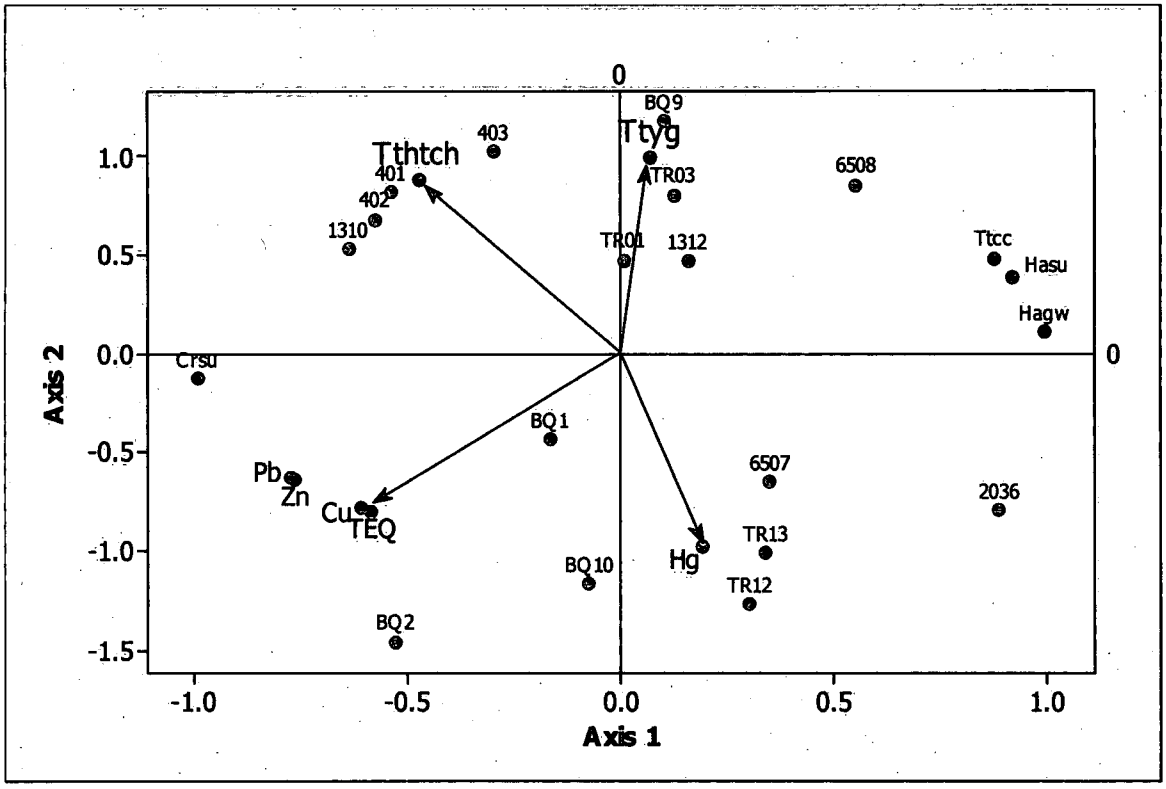

Figure 4. Toxicity of sediment from Trent River and reference sites (2006) represented by 2-dimensional hybrid multidimensional scaling. Site scores (red points) are shown with important toxicity endpoint (blue points) and contaminant concentration (green points) principal axis correlation projections. The contributions of most significant toxicity endpoints and environmental variables are shown as vectors.

Appendix A Quality Assurance/Quality Control

Table A1. Coefficients of variation (CV) for field-replicated sites.

Parameter	Units	6507-1	6507-2	6507-3	Mean	SD	CV	6508-1	6508-2	6508-3	Mean	SD	CV
Aluminum	µg/g	9400	9150	8820	9123	291	3	6820	6840	6890	6850	36	1
Antimony	µg/g	< 5	< 5	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Arsenic	µg/g	< 5	< 5	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Barium	µg/g	125	125	128	126	2	1	111	109	111	110	1	1
Beryllium	µg/g	0.5	0.4	0.4	0	0	13	0.3	0.3	0.3	0	0	0
Bismuth	µg/g	< 5	< 5	< 5	-	-	-	< 5	< 5	< 5	-	-	-
Cadmium	µg/g	1.1	1	1	1	0	6	< 0.5	< 0.5	< 0.5	-	-	-
Calcium	µg/g	26000	33800	30600	30133	3921	13	73900	71900	60500	68767	7229	11
Chromium	µg/g	59	52	55	55	4	6	31	29	25	28	3	11
Cobalt	µg/g	7	7	7	7	0	0	5	5	5	5	0	0
Copper	µg/g	36	34	33	34	2	4	33	35	28	32	4	11
Iron	µg/g	18700	18000	18300	18333	351	2	13400	13200	13500	13367	153	1
Lead	µg/g	55	52	52	53	2	3	32	33	31	32	1	3
Magnesium	µg/g	6030	5810	5800	5880	130	2	4980	4990	4520	4830	269	6
Manganese	µg/g	795	655	783	744	78	10	511	516	739	589	130	22
Mercury	µg/g	0.76	0.505	0.405	1	0	33	0.12	0.08	0.085	0	0	23
Molybdenum	µg/g	< 1	< 1	< 1	-	-	-	< 1	< 1	< 1	-	-	-
Nickel	µg/g	19	16	17	17	2	9	11	13	10	11	2	13
Phosphorus	µg/g	1160	1110	1160	1143	29	3	1130	1120	1160	1137	21	2
Potassium	µg/g	1560	1500	1460	1507	50	3	1160	1190	1210	1187	25	2
Silicon	µg/g	275	230	450	318	116	37	241	285	269	265	22	8
Silver	µg/g	0.8	0.8	0.7	1	0	8	0.4	0.4	0.3	0	0	16
Sodium	µg/g	1820	1650	1460	1643	180	11	1620	1800	1600	1673	110	7
Strontium	µg/g	53	60	58	57	4	6	107	104	90	100	9	9
Tin	µg/g	< 10	< 10	< 10	-	-	-	< 10	< 10	< 10	-	-	-
Titanium	µg/g	379	391	349	373	22	6	275	269	252	265	12	4
Vanadium	µg/g	24	24	23	24	1	2	17	17	16	17	1	3
Yttrium	µg/g	14.4	13.9	13.6	14	0	3	9.9	9.8	9.5	10	0	2
Zinc	µg/g	152	146	144	147	4	3	100	104	97	100	4	4
Zirconium	µg/g	< 0.1	< 0.1	< 0.1	-	-	-	< 0.1	< 0.1	< 0.1	-	-	-
Aluminum (Al2O3)	%	9.04	9.07	9.58	9	0	3	7.6	7.66	7.07	7	0	4
Barium (BaO)	%	0.047	0.047	0.05	0	0	4	0.040	0.04	0.037	0	0	4
Calcium (CaO)	%	4.94	6.24	5.86	6	1	12	11.8	11.8	10.1	11	1	9
Chromium (Cr2O3)	%	0.01	0.01	0.01	0	0	0	< 0.01	< 0.01	< 0.01	-	-	-
Iron (Fe2O3)	%	4.16	4.06	4.22	4	0	2	3.16	3.13	3.13	3	0	1
Magnesium (MgO)	%	1.69	1.64	1.69	2	0	2	1.44	1.43	1.34	1	0	4
Manganese (MnO)	%	0.14	< 0.01	0.14	-	-	-	< 0.01	< 0.01	0.06	-	-	-
Phosphorus (P2O5)	%	4.16	3.88	4.2	4	0	4	4.03	4.06	4.24	4	0	3
Potasium (K20)	%	3.53	3.52	3.65	4	0	2	3.02	3.03	2.73	3	0	6
Silica (SiO2)	%	41.4	42.9	45.2	43	2	4	40.3	41.4	37.0	40	2	6
Sodium (Na2O)	%	4.33	4.41	4.71	4	0	4	4.1	4.18	3.41	4	0	11
Titanium (TiO2)	%	1.33	1.31	1.38	1	0	3	1.06	1.06	0.95	1	0	6
Loss on Ignition	%	27.1	26.8	26.3	27	0	2	27.5	28.6	34.2	30	4	12
Whole Rock Total	%	102	104	107	104	3	2	104	106	104	105	1	1
TOC	% by wt	10.8	10.4	10.5	11	0	2	8.4	8.5	9.2	9	0	5
TKN	µg/g	10800	10100	9760	10220	530	6	8600	8840	8590	8677	142	2
Phosphorus-Total	µg/g	1290	1260	1250	1267	21	2	1230	1260	1210	1233	25	2
						Mean	6.0					Mean	6.2

CV = coefficient of variation

SD = standard deviation

Table A2. Sample recoveries for reference material and standards (Caduceon Environmental Laboratories).

CADUCEON ENVIRONMENTAL LABORATORIES, 2378 HOLLY LANE, OTTAWA, ONTARIO, K21V 7P1

QC I.D.:	Various	**CLIENT:**	Environment Canada-AEC
SAMPLE MATRIX:	Sediment	**BATCH NUMBER:**	B06-26668
DATE SUBMITTED:	1-Sep-06	**DATE ANALYZED:**	Various
DATE REPORTED:	25-Sep-06	**REPORT TO:**	Danielle Milani

PARAMETERS	**QC Sample Recovery Calculation**				
	Raw Data (µg/g)			**QC Sample Recovery**	
LKSD-3	**QC Result**	**Reference Value**	**Lab Mean**	**% Recovery**	**Control Limits**
Silver	2.31	2.4	2.3	**96**	50 - 117
Arsenic	21.8	23	23.2	**95**	83 - 121
Barium	157	N/A	170.9	**92**	81 - 118
Beryllium	0.533	N/A	0.5	**107**	47 - 153
Cadmium	0.52	0.6	0.6	**87**	83 - 114
Cobalt	27.9	30	29.2	**93**	51 - 114
Chromium	45.8	51	47.8	**90**	54 - 125
Copper	29.7	34	34.3	**87**	79 - 116
Iron	28850	35000	30115	**82**	74 - 102
Manganese	1187	1220	1268	**97**	71 - 100
Molybdenum	1	2	1.1	**50**	49 - 93
Nickel	40	44	43.1	**91**	0 - 224
Lead	23.2	26	24.9	**89**	72 - 107
Strontium	23.2	N/A	26	**89**	76 - 124
Titanium	930	N/A	994	**94**	49 - 151
Vanadium	46.1	55	49.2	**84**	50 - 87
Zinc	129	139	136.6	**93**	76 - 98
STSD-4					
Mercury	0.910	0.930	0.924	**98**	77 - 122
WH89-1					
Aluminum (Al2O3)	11.5	12.1	11.6	**95**	75 - 125
Barium (BaO)	0.29	0.29	0.28	**99**	75 - 125
Calcium (CaO)	5.83	5.9	5.7	**99**	75 - 125
Chromium (Cr2O3)	0.03	0.03	0.03	**100**	75 - 125
Iron (Fe2O3)	6.78	6.9	6.62	**98**	75 - 125
Magnesium (MgO)	3.44	3.5	3.4	**98**	75 - 125
Manganese (MnO)	1.35	1.38	1.34	**98**	75 - 125
Phosphorus (P2O5)	2.35	2.48	2.43	**95**	75 - 125
Potasium (K20)	4.46	4.51	4.43	**99**	75 - 125
Silica (SiO2)	59.3	60.5	59	**98**	75 - 125
Sodium (Na2O)	4.39	4.0	4.09	**110**	75 - 125
Titanium (TiO2)	2.52	2.57	2.47	**98**	75 - 125

Table A3. Relative percent differences for laboratory duplicate samples (Caduceon Environmental Laboratories).

			Client ID:		401	401	R.P.D.	650801	650801	R.P.D.	650802	650802	R.P.D.	65BQ10	65BQ10	R.P.D.
			Sample ID:		B06-26668-1	B06-26668-1Dup.		B06-26668-10	B06-26668-10 Dup.		B06-26668-11	B06-26668-11 Dup.		B06-26668-20	B06-26668-20 Dup.	
Parameter	Units	M.D.L.	Reference Method	Date Analyzed												
Aluminum	µg/g	10	EPA 6010	13-Sep-06	4980	4740	**5**	6840	-	-	6890	6470	**6**	6130	-	-
Antimony	µg/g	5	EPA 6010	13-Sep-06	< 5	< 5	**0**	< 5	-	-	< 5	< 5	**0**	< 5	-	-
Arsenic	µg/g	5	EPA 6010	13-Sep-06	< 5	< 5	**0**	< 5	-	-	< 5	< 5	**0**	< 5	-	-
Barium	µg/g	1	EPA 6010	13-Sep-06	96	92	**4**	109	-	-	111	106	**5**	80	-	-
Beryllium	µg/g	0.2	EPA 6010	13-Sep-06	0.2	0.2	**0**	0.3	-	-	0.3	0.3	**0**	0.3	-	-
Bismuth	µg/g	5	EPA 6010	13-Sep-06	< 5	< 5	**0**	< 5	-	-	< 5	< 5	**0**	< 5	-	-
Cadmium	µg/g	0.5	EPA 6010	13-Sep-06	0.5	0.5	**0**	< 0.5	-	-	< 0.5	< 0.5	**0**	0.5	-	-
Calcium	µg/g	10	EPA 6010	13-Sep-06	159000	153000	**4**	71900	-	-	60500	59600	**1**	90600	-	-
Chromium	µg/g	1	EPA 6010	13-Sep-06	25	24	**4**	29	-	-	25	23	**8**	37	-	-
Cobalt	µg/g	1	EPA 6010	13-Sep-06	4	4	**0**	5	-	-	5	5	**0**	5	-	-
Copper	µg/g	1	EPA 6010	13-Sep-06	26	25	**4**	35	-	-	28	29	**4**	33	-	-
Iron	µg/g	10	EPA 6010	13-Sep-06	10800	10400	**4**	13200	-	-	13500	12900	**5**	12200	-	-
Lead	µg/g	5	EPA 6010	13-Sep-06	25	23	**8**	33	-	-	31	30	**3**	43	-	-
Magnesium	µg/g	10	EPA 6010	13-Sep-06	6100	5800	**5**	4990	-	-	4520	4280	**5**	5570	-	-
Manganese	µg/g	1	EPA 6010	13-Sep-06	323	311	**4**	516	-	-	739	723	**2**	289	-	-
Mercury	µg/g	0.005	EPA 7471A	19-Sep-06	0.08	0.08	**0**	0.08	-	-	0.085	0.100	**16**	0.135	-	-
Molybdenum	µg/g	1	EPA 6010	13-Sep-06	1	1	**0**	< 1	-	-	< 1	< 1	**0**	< 1	-	-
Nickel	µg/g	1	EPA 6010	13-Sep-06	13	12	**8**	13	-	-	10	10	**0**	12	-	-
Phosphorus	µg/g	5	EPA 6010	13-Sep-06	800	782	**2**	1120	-	-	1160	1130	**3**	990	-	-
Potassium	µg/g	30	EPA 6010	13-Sep-06	1060	1020	**4**	1190	-	-	1210	1090	**10**	1110	-	-
Silicon	µg/g	1	EPA 6010	13-Sep-06	190	218	**14**	285	-	-	269	510	**62**	511	-	-
Silver	µg/g	0.2	EPA 6010	13-Sep-06	0.2	0.3	**40**	0.4	-	-	0.3	0.3	**0**	< 0.2	-	-
Sodium	µg/g	20	EPA 6010	13-Sep-06	1530	1670	**9**	1800	-	-	1600	1800	**12**	710	-	-
Strontium	µg/g	1	EPA 6010	13-Sep-06	256	245	**4**	104	-	-	90	88	**2**	131	-	-
Tin	µg/g	10	EPA 6010	13-Sep-06	< 10	< 10	**0**	< 10	-	-	< 10	< 10	**0**	< 10	-	-
Titanium	µg/g	1	EPA 6010	13-Sep-06	230	235	**2**	269	-	-	252	206	**20**	274	-	-
Vanadium	µg/g	1	EPA 6010	13-Sep-06	15	15	**0**	17	-	-	16	15	**6**	15	-	-
Yttrium	µg/g	0.5	EPA 6010	13-Sep-06	6.9	6.6	**4**	9.8	-	-	9.5	9.1	**4**	9	-	-
Zinc	µg/g	1	EPA 6010	13-Sep-06	80	84	**5**	104	-	-	97	94	**3**	129	-	-
Zirconium	µg/g	0.1	EPA 6010	13-Sep-06	< 0.1	< 0.1	**0**	< 0.1	-	-	< 0.1	< 0.1	**0**	< 0.1	-	-
Aluminum (Al2O3)	%	0.01	IN-HOUSE	13-Sep-06	5.25	5.23	**0.4**	7.66	-	-	7.07	6.99	**1.1**	8.36	-	-
Barium (BaO)	%	0.001	IN-HOUSE	13-Sep-06	0.033	0.032	**3.1**	0.04	-	-	0.037	0.037	**0**	0.038	-	-
Calcium (CaO)	%	0.01	IN-HOUSE	13-Sep-06	26.0	24.7	**5.1**	11.8	-	-	10.1	9.9	**2.0**	14.2	-	-
Chromium (Cr2O3)	%	0.01	IN-HOUSE	13-Sep-06	< 0.01	< 0.01	**0**	< 0.01	-	-	< 0.01	< 0.01	**0**	< 0.01	-	-
Iron (Fe2O3)	%	0.05	IN-HOUSE	13-Sep-06	2.47	2.39	**3.3**	3.13	-	-	3.13	3.10	**1.0**	2.96	-	-
Magnesium (MgO)	%	0.01	IN-HOUSE	13-Sep-06	1.47	1.41	**4.2**	1.43	-	-	1.34	1.31	**2.3**	1.53	-	-
Manganese (MnO)	%	0.01	IN-HOUSE	13-Sep-06	< 0.01	< 0.01	**0**	< 0.01		-	0.06	0.04	**40.0**	< 0.01	-	-
Phosphorus (P2O5)	%	0.03	IN-HOUSE	13-Sep-06	2.95	2.78	**5.9**	4.06	-	-	4.24	4.19	**1.2**	3.44	-	-
Potasium (K2O)	%	0.01	IN-HOUSE	13-Sep-06	2.26	2.19	**3.1**	3.03	-	-	2.73	2.70	**1.1**	3.26	-	-
Silica (SiO2)	%	0.01	IN-HOUSE	13-Sep-06	24.9	24.2	**2.9**	41.4	-	-	37.0	37.4	**1.1**	41.6	-	-
Sodium (Na2O)	%	0.01	IN-HOUSE	13-Sep-06	2.78	2.66	**4.4**	4.18	-	-	3.41	2.74	**21.8**	4.96	-	-
Titanium (TiO2)	%	0.01	IN-HOUSE	13-Sep-06	0.75	0.74	**1.3**	1.06	-	-	0.95	0.96	**1.0**	1.08	-	-
Loss on Ignition	%	0.05	IN-HOUSE	13-Sep-06	35.1	35.8	**2.0**	28.6	-	-	34.2	34.1	**0.3**	24.1	-	-
Whole Rock Total	%		IN-HOUSE	13-Sep-06	103	102	**0.8**	106	-	-	104	103	**0.8**	105	-	-
TOC	% by wt	0.1	LECO	20-Sep-06	7.4	-	-	8.5	8.9	**5**	9.2	-	-	6.6	7.0	**6**
TKN	µg/g	0.05	EPA 351.2	13-Sep-06	8960	8810	**1.7**	8840	-	-	8590	8220	**4.4**	5890	-	-
Phosphorus-Total	µg/g	0.01	EPA 365.4	13-Sep-06	903	898	**0.6**	1260	-	-	1210	1180	**2.5**	1000	-	-
						Mean	**4**		**Mean**	**5**		**Mean**	**6**		**Mean**	**6**

R.P.D. = Relative Percent Difference

Table A4. Percent recovery for labelled internal standards for sediment samples (Ministry of the Environment, Laboratory Service Branch).

#	Dioxin / Furan Congener	C145808-0001	C145808-0002	C145808-0003	C145808-0004	C145808-0005	C145808-0006	C145808-0007	C145808-0008	C145808-0009	C145808-0010	C145808-0011	C145808-0012	C145808-0013	C145808-0014	C145808-0015	C145808-0016	C145808-0017	C145808-0018	C145808-0019	C145808-0020
1	13C-2378 TCDF	41	49	58	55	49	54	54	58	59	67	48	56	60	67	63	53	33	49	67	67
2	13C-12378 PeCDF	49	54	64	61	54	57	63	66	63	72	54	63	67	77	68	68	40	58	77	76
3	13C-23478 PeCDF	55	58	66	64	58	61	67	68	60	75	59	70	73	83	77	79	46	65	90	81
4	13C-123478 HxCDF	62	63	83	76	70	75	79	73	118	84	66	76	80	94	83	92	51	74	95	91
5	13C-123678 HxCDF	61	63	81	74	69	73	79	72	116	83	64	77	78	92	84	91	51	74	94	91
6	13C-234678 HxCDF	61	63	75	72	65	69	75	72	83	82	64	75	78	92	84	92	53	75	95	89
7	13C-123789 HxCDF	60	64	68	70	61	64	73	73	68	87	64	77	81	92	87	93	54	76	93	94
8	13C-1234678 HpCDF	61	66	82	75	68	71	77	74	111	79	70	83	83	98	88	99	57	75	99	95
9	13C-1234789 HpCDF	55	59	67	68	57	59	71	69	74	78	68	78	83	96	87	100	59	76	105	96
10	13C-2378 TCDD	45	52	65	62	56	59	60	66	65	75	48	59	63	70	66	57	36	51	67	72
11	13C-12378 PeCDD	45	47	60	56	50	53	59	61	54	66	44	56	61	71	64	64	39	53	71	68
12	13C-123478 HxCDD	57	60	77	71	63	68	74	72	112	83	59	69	71	84	75	83	47	66	86	79
13	13C-123678 HxCDD	57	59	75	68	61	67	72	73	110	82	59	68	70	83	73	81	46	64	83	79
14	13C-1234678 HpCDD	54	57	67	65	57	60	68	70	82	85	61	70	77	89	81	93	55	71	98	89
15	13C-OCDD	38	38	41	47	38	37	46	51	45	51	53	60	66	73	65	73	44	58	78	70
	PCB Congener																				
16	13C-344'5-tetraPCB (81)	39	44	33	68	65	69	31	78	64	53	47	58	73	69	69	45	31	46	59	70
17	13C-33'44'-tetraPCB (77)	32	19	7	58	40	62	5	74	38	22	49	61	71	71	71	49	34	50	62	72
18	13C-2'344'5-pentaPCB (123)	88	83	79	71	83	75	87	75	59	60	102	94	101	100	92	99	86	62	76	90
19	13C-23'44'5-pentaPCB (118)	89	82	80	71	83	76	87	73	59	59	101	95	101	100	93	99	87	63	76	91
20	13C-2344'5-pentaPCB (114)	83	76	79	72	83	75	82	68	57	59	102	96	101	97	93	99	86	61	73	93
21	13C-233'44'-pentaPCB (105)	71	71	59	60	66	60	68	58	48	46	79	81	84	68	52	77	65	45	61	72
22	13C-33'44'5-pentaPCB (126)	62	63	80	83	81	82	85	93	79	89	66	85	97	106	101	86	60	88	97	102
23	13C-23'44'55'-hexaPCB (167)	79	87	79	80	74	69	84	68	57	71	113	101	94	97	93	90	78	72	74	93
24	13C-233'44'5-hexaPCB (156)	70	64	83	79	80	77	79	61	55	75	116	104	101	94	97	98	86	70	65	99
25	13C-233'44'5'-hexaPCB (157)	56	55	68	63	61	63	58	48	41	75	111	106	73	58	53	69	60	42	51	78
26	13C-33'44'55'-hexaPCB (169)	74	69	95	93	91	90	104	106	86	102	75	88	105	118	107	108	71	101	105	112
27	13C-233'44'55'-heptaPCB (189)	89	83	81	81	80	74	92	70	63	74	108	101	95	39	93	93	87	66	80	99

Table A5. Percent recovery for labelled internal standards for benthic invertebrate samples (Ministry of the Environment, Laboratory Service Branch).

#	Dioxin / Furan Congener	C146273-0001	C146273-0002	C146273-0003	C146273-0004	C146273-0005	C146273-0006	C146273-0007	C146273-0008	C146273-0009	C146273-0010	C146273-0011	C146273-0012	C146273-0013	C146273-0014	C146273-0015	C146273-0016	C146273-0017	C146273-0018	C146273-0019	C146273-0020
1	13C-2378 TCDF	65	63	66	61	55	42	63	65	59	69	74	63	82	72	67	57	55	69	71	63
2	13C-12378 PeCDF	91	91	92	81	74	71	88	92	84	94	94	77	101	90	85	92	77	102	94	88
3	13C-23478 PeCDF	97	96	100	88	89	77	107	107	101	110	94	77	99	89	80	85	80	94	98	83
4	13C-123478 HxCDF	91	88	92	79	67	77	85	86	84	93	84	73	86	79	78	92	74	103	91	87
5	13C-123678 HxCDF	92	89	90	77	66	77	85	85	84	94	84	74	84	78	76	91	75	103	91	86
6	13C-234678 HxCDF	90	90	90	77	68	77	85	87	87	95	81	69	85	74	73	92	75	100	85	84
7	13C-123789 HxCDF	102	101	103	84	76	90	98	98	96	105	88	69	89	78	80	93	76	101	89	84
8	13C-1234678 HpCDF	120	119	122	96	92	98	107	112	114	119	100	84	92	90	92	106	81	116	101	95
9	13C-1234789 HpCDF	129	131	129	106	96	106	117	124	121	127	102	82	88	90	88	113	85	125	106	97
10	13C-2378 TCDD	72	69	72	64	59	50	70	70	65	76	82	68	88	78	74	67	61	77	76	69
11	13C-12378 PeCDD	92	87	93	76	79	76	91	92	87	94	94	74	98	88	81	93	75	101	92	84
12	13C-123478 HxCDD	90	89	88	74	68	80	88	86	87	95	81	70	83	75	76	89	70	97	86	82
13	13C-123678 HxCDD	92	89	88	75	68	81	86	86	87	95	82	71	87	76	77	90	71	97	85	84
14	13C-1234678 HpCDD	124	115	114	107	93	99	112	116	115	122	96	76	98	83	89	99	77	109	97	87
15	13C-OCDD	118	120	114	107	93	99	110	111	110	110	86	59	72	67	67	83	60	88	76	67
	PCB Congener																				
16	13C-344'5-tetraPCB (81)	50	54	62	55	47	28		51	53	55	75	70	77	80	112	31	43	44	56	56
17	13C-33'44'-tetraPCB (77)	56	59	69	58	51	33		56	58	64	75	72	78	80	108	36	46	48	60	60
18	13C-2'344'5-pentaPCB (123)	89	81	89	81	90	78		82	96	88	93	86	73	88	78	78	73	76	121	118
19	13C-23'44'5-pentaPCB (118)	91	78	89	79	89	76		82	99	86	96	83	74	81	72	76	68	72	115	114
20	13C-2344'5-pentaPCB (114)	90	79	86	83	88	79		81	100	83	85	70	62	73	63	63	61	70	94	99
21	13C-233'44'-pentaPCB (105)	82	74	79	77	81	70		75	87	78	69	64	53	64	58	62	56	65	82	91
22	13C-33'44'5-pentaPCB (126)	72	74	82	67	59	56		78	85	87	87	75	85	88	121	64	70	75	83	82
23	13C-23'44'55'-hexaPCB (167)	105	95	101	89	104	91		95	92	96	96	75	75	87	81	82	75	85	98	98
24	13C-233'44'5-hexaPCB (156)	101	92	94	90	97	93		97	99	90	91	73	74	81	71	76	71	80	87	91
25	13C-233'44'5'-hexaPCB (157)	104	92	95	93	100	92		96	96	92	74	65	59	68	65	73	64	73	74	85
26	13C-33'44'55'-hexaPCB (169)	87	93	100	80	71	79		93	109	104	96	84	93	99	135	84	83	93	98	102
27	13C-233'44'55'-heptaPCB (189)	119	110	112	109	118	112		115	112	110	125	95	99	113	110	108	94	115	125	117

Appendix B Concentrations of Dioxins, Furans and PCBs in Sediment and Mayfly Tissue, and Biota-Sediment Accumulation Factors

Table B1. Concentrations of dioxins and furans in sediment and benthic invertebrate (mayfly) tissue. Biota-sediment accumulation factors are provided. BSAF values >1 are highlighted.

TCDF							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	36	5.6	54	964.3	340.7	2.8
6508	8.7	19	5.6	40	714.3	222.6	3.2
2036	4.2	9.2	5.6	48	857.1	219.0	3.9
TR01	9.1	19	5.6	17	303.6	208.8	1.5
TR03	9.5	19	5.6	19	339.3	200.0	1.7
TR12	9.2	18	5.6	17	303.6	195.7	1.6
TR13	7.4	15	5.6	21	375.0	202.7	1.9
BQ1	8.8	18	5.6	15	267.9	204.5	1.3
BQ2	9.2	17	5.6	11	196.4	184.8	1.1
BQ9	2.6	1	5.6	20	357.1	38.5	9.3
BQ10	6.6	18	5.6	29	517.9	272.7	1.9
401	7.4	11	5.6	8.3	148.2	148.6	1.0
402	8.2	5.8	5.6	4.6	82.1	70.7	1.2
403	0.6	0.7	5.6	3.9	69.6	116.7	0.6
1310	6.8	21	5.6	8.9	158.9	308.8	0.5
1312	8.6	17	5.6	8.3	148.2	197.7	0.7

23478-pentachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	5.6	5.6	19	339.3	53.0	6.4
6508	8.7	3.1	5.6	12	214.3	35.7	6.0
2036	4.2	1.3	5.6	15	267.9	31.0	8.7
TR01	9.1	3	5.6	4.1	73.2	33.0	2.2
TR03	9.5	3.1	5.6	3.5	62.5	32.6	1.9
TR12	9.2	3.5	5.6	3.8	67.9	38.0	1.8
TR13	7.4	2.6	5.6	5.4	96.4	35.1	2.7
BQ1	8.8	2.6	5.6	3.1	55.4	29.5	1.9
BQ2	9.2	4.7	5.6	4.3	76.8	51.1	1.5
BQ9	2.6	0.33	5.6	8.1	144.6	12.7	11.4
BQ10	6.6	2.8	5.6	10	178.6	42.4	4.2
401	7.4	2.8	5.6	3.4	60.7	37.8	1.6
402	8.2	1.8	5.6	2.1	37.5	22.0	1.7
403	0.6	0.65	5.6	1.7	30.4	108.3	0.3
1310	6.8	3.8	5.6	2.9	51.8	55.9	0.9
1312	8.6	3.2	5.6	2.4	42.9	37.2	1.2

TCDD							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	0.7	5.6	4	71.4	6.7	10.7
6508	8.7	0.9	5.6	2.8	50.0	10.3	4.9
2036	4.2	0.13	5.6	2.8	50.0	3.1	16.2
TR01	9.1	0.37	5.6	2.8	50.0	4.1	12.3
TR03	9.5	0.57	5.6	2	35.7	6.0	6.0
TR12	9.2	0.39	5.6	2.6	46.4	4.2	11.0
TR13	7.4	0.45	5.6	3	53.6	6.1	8.8
BQ1	8.8	0.44	5.6	1.9	33.9	5.0	6.8
BQ2	9.2	1.2	5.6	3.2	57.1	13.0	4.4
BQ9	2.6	0.13	5.6	1.6	28.6	5.0	5.7
BQ10	6.6	0.38	5.6	2.6	46.4	5.8	8.1
401	7.4	0.78	5.6	4.2	75.0	10.5	7.1
402	8.2	0.59	5.6	2.8	50.0	7.2	6.9
403	0.6	0.2	5.6	3	53.6	33.3	1.6
1310	6.8	0.51	5.6	3.8	67.9	7.5	9.0
1312	8.6	0.4	5.6	3.3	58.9	4.7	12.7

12378-pentachlorodioxin							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	2.9	5.6	1.7	30.4	27.1	1.1
6508	8.7	2.2	5.6	1.5	26.8	25.0	1.1
2036	4.2	0.58	5.6	1.6	28.6	13.8	2.1
TR01	9.1	2.5	5.6	3.2	57.1	27.5	2.1
TR03	9.5	2.6	5.6	1.9	33.9	27.4	1.2
TR12	9.2	2.9	5.6	2.1	37.5	31.5	1.2
TR13	7.4	2.3	5.6	2.8	50.0	31.1	1.6
BQ1	8.8	1.7	5.6	1.4	25.0	19.3	1.3
BQ2	9.2	6.9	5.6	3.5	62.5	75.0	0.8
BQ9	2.6	0.3	5.6	1.5	26.8	11.5	2.3
BQ10	6.6	1.3	5.6	1.7	30.4	19.7	1.5
401	7.4	1.4	5.6	1.5	26.8	18.9	1.4
402	8.2	1.2	5.6	0.91	16.3	14.6	1.1
403	0.6	0.72	5.6	0.69	12.3	120.0	0.1
1310	6.8	1.5	5.6	1.4	25.0	22.1	1.1
1312	8.6	1.4	5.6	0.92	16.4	16.3	1.0

12378-pentachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	8.7	5.6	61	1089.3	82.6	13.2
6508	8.7	3.6	5.6	36	642.9	41.5	15.5
2036	4.2	1.7	5.6	48	857.1	40.5	21.2
TR01	9.1	3.6	5.6	3.1	55.4	39.6	1.4
TR03	9.5	3.8	5.6	2.3	41.1	40.0	1.0
TR12	9.2	4.9	5.6	2.8	50.0	53.3	0.9
TR13	7.4	3.2	5.6	4	71.4	43.2	1.7
BQ1	8.8	3.2	5.6	2.2	39.3	36.4	1.1
BQ2	9.2	5.2	5.6	3.8	67.9	56.5	1.2
BQ9	2.6	0.33	5.6	22	392.9	12.7	31.0
BQ10	6.6	3.2	5.6	27	482.1	48.5	9.9
401	7.4	2.4	5.6	2.5	44.6	32.4	1.4
402	8.2	1.6	5.6	1.7	30.4	19.5	1.6
403	0.6	0.63	5.6	2.6	46.4	105.0	0.4
1310	6.8	4.5	5.6	2.9	51.8	66.2	0.8
1312	8.6	3.5	5.6	2	35.7	40.7	0.9

123478-hexachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	9.5	5.6	49	875.0	89.6	9.8
6508	8.7	6.5	5.6	27	482.1	74.5	6.5
2036	4.2	1.7	5.6	37	660.7	40.5	16.3
TR01	9.1	6.6	5.6	3.1	55.4	72.5	0.8
TR03	9.5	6.6	5.6	2.7	48.2	69.5	0.7
TR12	9.2	20	5.6	3.1	55.4	217.4	0.3
TR13	7.4	6.6	5.6	4.8	85.7	89.2	1.0
BQ1	8.8	4.2	5.6	1.9	33.9	47.7	0.7
BQ2	9.2	14	5.6	5.2	92.9	152.2	0.6
BQ9	2.6	0.51	5.6	17	303.6	19.6	15.5
BQ10	6.6	4	5.6	20	357.1	60.6	5.9
401	7.4	5.4	5.6	2.8	50.0	73.0	0.7
402	8.2	3.2	5.6	1.5	26.8	39.0	0.7
403	0.6	0.75	5.6	1.5	26.8	125.0	0.2
1310	6.8	5.9	5.6	3	53.6	86.8	0.6
1312	8.6	5	5.6	2.2	39.3	58.1	0.7

Table B1. Continued.

123678-hexachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	10.7	5.6	17	303.6	100.9	3.0
6508	8.7	4.0	5.6	7.7	137.5	46.4	3.0
2036	4.2	0.96	5.6	11	196.4	22.9	8.6
TR01	9.1	4.2	5.6	2.5	44.6	46.2	1.0
TR03	9.5	4.8	5.6	1.9	33.9	50.5	0.7
TR12	9.2	6.3	5.6	2.9	51.8	68.5	0.8
TR13	7.4	3.3	5.6	4.7	83.9	44.6	1.9
BQ1	8.8	3.1	5.6	1.7	30.4	35.2	0.9
BQ2	9.2	23	5.6	7.8	139.3	250.0	0.6
BQ9	2.6	0.39	5.6	5.6	100.0	15.0	6.7
BQ10	6.6	2.9	5.6	7	125.0	43.9	2.8
401	7.4	2.4	5.6	1.9	33.9	32.4	1.0
402	8.2	2	5.6	1.5	26.8	24.4	1.1
403	0.6	0.68	5.6	4.5	80.4	113.3	0.7
1310	6.8	3.7	5.6	2.2	39.3	54.4	0.7
1312	8.6	3	5.6	1.6	28.6	34.9	0.8

123478-hexachlorodioxin							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	5.9	5.6	1.7	30.4	55.8	0.5
6508	8.7	5.1	5.6	1.6	28.6	59.1	0.5
2036	4.2	0.93	5.6	0.84	15.0	22.1	0.7
TR01	9.1	5.6	5.6	2.2	39.3	61.5	0.6
TR03	9.5	5.9	5.6	1.7	30.4	62.1	0.5
TR12	9.2	7.5	5.6	2.5	44.6	81.5	0.5
TR13	7.4	5.4	5.6	3.5	62.5	73.0	0.9
BQ1	8.8	2.8	5.6	1.1	19.6	31.8	0.6
BQ2	9.2	19	5.6	5.8	103.6	206.5	0.5
BQ9	2.6	0.4	5.6	0.99	17.7	15.4	1.1
BQ10	6.6	2.3	5.6	1.7	30.4	34.8	0.9
401	7.4	1.8	5.6	1.6	28.6	24.3	1.2
402	8.2	1.4	5.6	0.72	12.9	17.1	0.8
403	0.6	0.72	5.6	0.74	13.2	120.0	0.1
1310	6.8	2.5	5.6	1.2	21.4	36.8	0.6
1312	8.6	2.1	5.6	0.87	15.5	24.4	0.6

234678-hexachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	4.5	5.6	2.8	50.0	42.3	1.2
6508	8.7	2.8	5.6	1.8	32.1	32.2	1.0
2036	4.2	0.72	5.6	1.7	30.4	17.1	1.8
TR01	9.1	2.7	5.6	2.1	37.5	29.7	1.3
TR03	9.5	3.2	5.6	1.5	26.8	33.7	0.8
TR12	9.2	6.1	5.6	2.6	46.4	66.3	0.7
TR13	7.4	2.6	5.6	3	53.6	35.1	1.5
BQ1	8.8	2	5.6	1.3	23.2	22.7	1.0
BQ2	9.2	8.7	5.6	4.6	82.1	94.6	0.9
BQ9	2.6	0.25	5.6	1.7	30.4	9.6	3.2
BQ10	6.6	2.1	5.6	1.9	33.9	31.8	1.1
401	7.4	2.1	5.6	1.8	32.1	28.4	1.1
402	8.2	1.3	5.6	1	17.9	15.9	1.1
403	0.6	0.56	5.6	0.61	10.9	93.3	0.1
1310	6.8	2.8	5.6	1.5	26.8	41.2	0.7
1312	8.6	2.5	5.6	1	17.9	29.1	0.6

123678-hexachlorodioxin							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	26.7	5.6	5.6	100.0	252.4	0.4
6508	8.7	28.7	5.6	6.4	114.3	330.1	0.3
2036	4.2	4.6	5.6	2	35.7	109.5	0.3
TR01	9.1	31	5.6	8.4	150.0	340.7	0.4
TR03	9.5	31	5.6	5.8	103.6	326.3	0.3
TR12	9.2	130	5.6	9.5	169.6	1413.0	0.1
TR13	7.4	38	5.6	17	303.6	513.5	0.6
BQ1	8.8	12	5.6	3.3	58.9	136.4	0.4
BQ2	9.2	74	5.6	21	375.0	804.3	0.5
BQ9	2.6	0.93	5.6	2	35.7	35.8	1.0
BQ10	6.6	7.3	5.6	3.6	64.3	110.6	0.6
401	7.4	4.8	5.6	1.9	33.9	64.9	0.5
402	8.2	3	5.6	1.4	25.0	36.6	0.7
403	0.6	0.74	5.6	0.77	13.8	123.3	0.1
1310	6.8	7.1	5.6	2.2	39.3	104.4	0.4
1312	8.6	5.2	5.6	1.3	23.2	60.5	0.4

123789-hexachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	1.4	5.6	2.7	48.2	13.6	3.6
6508	8.7	0.5	5.6	1.2	21.4	5.9	3.6
2036	4.2	0.17	5.6	2.3	41.1	4.0	10.1
TR01	9.1	0.44	5.6	1.3	23.2	4.8	4.8
TR03	9.5	0.66	5.6	0.67	12.0	6.9	1.7
TR12	9.2	0.95	5.6	0.85	15.2	10.3	1.5
TR13	7.4	0.57	5.6	1.5	26.8	7.7	3.5
BQ1	8.8	0.46	5.6	0.85	15.2	5.2	2.9
BQ2	9.2	2.0	5.6	1.4	25.0	21.7	1.2
BQ9	2.6	0.1	5.6	1.2	21.4	3.8	5.6
BQ10	6.6	0.31	5.6	1.4	25.0	4.7	5.3
401	7.4	0.35	5.6	1.2	21.4	4.7	4.5
402	8.2	0.29	5.6	0.86	15.4	3.5	4.3
403	0.6	0.52	5.6	0.77	13.8	86.7	0.2
1310	6.8	0.4	5.6	1.4	25.0	5.9	4.3
1312	8.6	0.31	5.6	0.66	11.8	3.6	3.3

123789-hexachlorodioxin							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	16.7	5.6	4.6	82.1	157.7	0.5
6508	8.7	13.3	5.6	2.3	41.1	153.6	0.3
2036	4.2	2.3	5.6	1.6	28.6	54.8	0.5
TR01	9.1	14	5.6	4.2	75.0	153.8	0.5
TR03	9.5	11	5.6	2.9	51.8	115.8	0.4
TR12	9.2	24	5.6	5.1	91.1	260.9	0.3
TR13	7.4	15	5.6	8.1	144.6	202.7	0.7
BQ1	8.8	8	5.6	2.3	41.1	90.9	0.5
BQ2	9.2	48	5.6	13	232.1	521.7	0.4
BQ9	2.6	0.93	5.6	2	35.7	35.8	1.0
BQ10	6.6	7	5.6	3.3	58.9	106.1	0.6
401	7.4	5.4	5.6	3	53.6	73.0	0.7
402	8.2	3.8	5.6	1.2	21.4	46.3	0.5
403	0.6	1.1	5.6	2	35.7	183.3	0.2
1310	6.8	6.7	5.6	3.3	58.9	98.5	0.6
1312	8.6	6.6	5.6	2.4	42.9	76.7	0.6

Table B1. Continued.

1234678-heptachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	147	5.6	31	553.6	1388.0	0.4
6508	8.7	193	5.6	28	500.0	2226.5	0.2
2036	4.2	24	5.6	13	232.1	571.4	0.4
TR01	9.1	220	5.6	27	482.1	2417.6	0.2
TR03	9.5	220	5.6	21	375.0	2315.8	0.2
TR12	9.2	750	5.6	32	571.4	8152.2	0.1
TR13	7.4	310	5.6	66	1178.6	4189.2	0.3
BQ1	8.8	80	5.6	12	214.3	909.1	0.2
BQ2	9.2	420	5.6	78	1392.9	4565.2	0.3
BQ9	2.6	4.3	5.6	7.9	141.1	165.4	0.9
BQ10	6.6	35	5.6	11	196.4	530.3	0.4
401	7.4	28	5.6	8.5	151.8	378.4	0.4
402	8.2	15	5.6	4.1	73.2	182.9	0.4
403	0.6	1.6	5.6	2.7	48.2	266.7	0.2
1310	6.8	43	5.6	7.5	133.9	632.4	0.2
1312	8.6	32	5.6	6.1	108.9	372.1	0.3

1234789-heptachlorofuran							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	8.7	5.6	5.6	100.0	82.6	1.2
6508	8.7	10.4	5.6	3.9	69.6	119.8	0.6
2036	4.2	1.3	5.6	3.5	62.5	31.0	2.0
TR01	9.1	12	5.6	2.7	48.2	131.9	0.4
TR03	9.5	12	5.6	1.7	30.4	126.3	0.2
TR12	9.2	42	5.6	2.7	48.2	456.5	0.1
TR13	7.4	16	5.6	5.4	96.4	216.2	0.4
BQ1	8.8	5	5.6	1.2	21.4	56.8	0.4
BQ2	9.2	25	5.6	5.8	103.6	271.7	0.4
BQ9	2.6	0.3	5.6	1.9	33.9	11.5	2.9
BQ10	6.6	2.1	5.6	2.2	39.3	31.8	1.2
401	7.4	1.4	5.6	1.8	32.1	18.9	1.7
402	8.2	0.95	5.6	1.1	19.6	11.6	1.7
403	0.6	0.53	5.6	1.2	21.4	88.3	0.2
1310	6.8	2.2	5.6	1.7	30.4	32.4	0.9
1312	8.6	1.6	5.6	0.98	17.5	18.6	0.9

1234678-heptachlorodioxin							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	730	5.6	120	2142.9	6908.5	0.3
6508	8.7	960	5.6	140	2500.0	11055.7	0.2
2036	4.2	150	5.6	35	625.0	3571.4	0.2
TR01	9.1	1100	5.6	150	2678.6	12087.9	0.2
TR03	9.5	1100	5.6	98	1750.0	11578.9	0.2
TR12	9.2	3000	5.6	190	3392.9	32608.7	0.1
TR13	7.4	1400	5.6	380	6785.7	18918.9	0.4
BQ1	8.8	380	5.6	50	892.9	4318.2	0.2
BQ2	9.2	2200	5.6	450	8035.7	23913.0	0.3
BQ9	2.6	23	5.6	21	375.0	884.6	0.4
BQ10	6.6	220	5.6	57	1017.9	3333.3	0.3
401	7.4	97	5.6	28	500.0	1310.8	0.4
402	8.2	55	5.6	11	196.4	670.7	0.3
403	0.6	4.2	5.6	6.5	116.1	700.0	0.2
1310	6.8	180	5.6	27	482.1	2647.1	0.2
1312	8.6	130	5.6	22	392.9	1511.6	0.3

OCF							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	453	5.6	56	1000.0	4290.2	0.2
6508	8.7	1037	5.6	91	1625.0	11938.6	0.1
2036	4.2	120	5.6	20	357.1	2857.1	0.1
TR01	9.1	1300	5.6	98	1750.0	14285.7	0.1
TR03	9.5	1300	5.6	61	1089.3	13684.2	0.1
TR12	9.2	4000	5.6	93	1660.7	43478.3	0.0
TR13	7.4	1900	5.6	240	4285.7	25675.7	0.2
BQ1	8.8	380	5.6	28	500.0	4318.2	0.1
BQ2	9.2	1500	5.6	230	4107.1	16304.3	0.3
BQ9	2.6	11	5.6	9.7	173.2	423.1	0.4
BQ10	6.6	96	5.6	13	232.1	1454.5	0.2
401	7.4	46	5.6	13	232.1	621.6	0.4
402	8.2	29	5.6	4.7	83.9	353.7	0.2
403	0.6	2.7	5.6	3.1	55.4	450.0	0.1
1310	6.8	93	5.6	10	178.6	1367.6	0.1
1312	8.6	60	5.6	9	160.7	697.7	0.2

OCD							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	6500	5.6	1000	17857.1	61514.2	0.3
6508	8.7	10067	5.6	1300	23214.3	115930.9	0.2
2036	4.2	1500	5.6	280	5000.0	35714.3	0.1
TR01	9.1	12000	5.6	1300	23214.3	131868.1	0.2
TR03	9.5	12000	5.6	790	14107.1	126315.8	0.1
TR12	9.2	29000	5.6	1600	28571.4	315217.4	0.1
TR13	7.4	15000	5.6	3500	62500.0	202702.7	0.3
BQ1	8.8	4000	5.6	390	6964.3	45454.5	0.2
BQ2	9.2	19000	5.6	3700	66071.4	206521.7	0.3
BQ9	2.6	160	5.6	120	2142.9	6153.8	0.3
BQ10	6.6	2000	5.6	360	6428.6	30303.0	0.2
401	7.4	640	5.6	160	2857.1	8648.6	0.3
402	8.2	360	5.6	62	1107.1	4390.2	0.3
403	0.6	24	5.6	22	392.9	4000.0	0.1
1310	6.8	1400	5.6	150	2678.6	20588.2	0.1
1312	8.6	1200	5.6	160	2857.1	13953.5	0.2

Ct lipid-corrected tissue concentration
Cs TOC-corrected sediment concentration

Table B2. Concentrations of dioxin-like PCBs in sediment and benthic invertebrate (mayfly) tissue. Biota-sediment accumulation factors are provided.

PCB 77							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	1700	5.6	2300	41071.4	16088.3	2.6
6508	8.7	643	5.6	1500	26785.7	7408.8	3.6
2036	4.2	340	5.6	1600	28571.4	8095.2	3.5
TR01	9.1	600	5.6	1400	25000.0	6593.4	3.8
TR03	9.5	650	5.6	1800	32142.9	6842.1	4.7
TR12	9.2	570	5.6	1400	25000.0	6195.7	4.0
TR13	7.4	550	5.6	1700	30357.1	7432.4	4.1
BQ1	8.8	650	5.6	2200	39285.7	7386.4	5.3
BQ2	9.2	670	5.6	1100	19642.9	7282.6	2.7
BQ9	2.6	30	5.6	1300	23214.3	1153.8	20.1
BQ10	6.6	740	5.6	1800	32142.9	11212.1	2.9
401	7.4	300	5.6	1300	23214.3	4054.1	5.7
402	8.2	220	5.6	1000	17857.1	2682.9	6.7
403	0.6	11	5.6	890	15892.9	1833.3	8.7
1310	6.8	340	5.6	520	9285.7	5000.0	1.9
1312	8.6	240	5.6	550	9821.4	2790.7	3.5

PCB 81							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	42.3	5.6	26	464.3	400.6	1.2
6508	8.7	15.0	5.6	19	339.3	172.7	2.0
2036	4.2	7.7	5.6	19	339.3	183.3	1.9
TR01	9.1	13	5.6	20	357.1	142.9	2.5
TR03	9.5	14	5.6	22	392.9	147.4	2.7
TR12	9.2	13	5.6	13	232.1	141.3	1.6
TR13	7.4	11	5.6	18	321.4	148.6	2.2
BQ1	8.8	15	5.6	32	571.4	170.5	3.4
BQ2	9.2	13	5.6	13	232.1	141.3	1.6
BQ9	2.6	0.79	5.6	25	446.4	30.4	14.7
BQ10	6.6	20	5.6	30	535.7	303.0	1.8
401	7.4	6.9	5.6	17	303.6	93.2	3.3
402	8.2	5.7	5.6	16	285.7	69.5	4.1
403	0.6	0.44	5.6	130	2321.4	73.3	31.7
1310	6.8	7	5.6	13	232.1	102.9	2.3
1312	8.6	5.1	5.6	7.7	137.5	59.3	2.3

PCB 105							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	3100	5.6	3900	69642.9	29337.5	2.4
6508	8.7	1433	5.6	4000	71428.6	16506.7	4.3
2036	4.2	730	5.6	3600	64285.7	17381.0	3.7
TR01	9.1	1400	5.6	3200	57142.9	15384.6	3.7
TR03	9.5	1400	5.6	4600	82142.9	14736.8	5.6
TR12	9.2	1400	5.6	2700	48214.3	15217.4	3.2
TR13	7.4	1200	5.6	3000	53571.4	16216.2	3.3
BQ1	8.8	1400	5.6	4400	78571.4	15909.1	4.9
BQ2	9.2	2100	5.6	2800	50000.0	22826.1	2.2
BQ9	2.6	86	5.6	2900	51785.7	3307.7	15.7
BQ10	6.6	1700	5.6	4500	80357.1	25757.6	3.1
401	7.4	780	5.6	2700	48214.3	10540.5	4.6
402	8.2	780	5.6	2600	46428.6	9512.2	4.9
403	0.6	29	5.6	2800	50000.0	4833.3	10.3
1310	6.8	760	5.6	2200	39285.7	11176.5	3.5
1312	8.6	570	5.6	2200	39285.7	6627.9	5.9

Table B2. Continued.

PCB 114							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	190	5.6	240	4285.7	1798.1	2.4
6508	8.7	78	5.6	270	4821.4	902.1	5.3
2036	4.2	39	5.6	240	4285.7	928.6	4.6
TR01	9.1	79	5.6	200	3571.4	868.1	4.1
TR03	9.5	75	5.6	330	5892.9	789.5	7.5
TR12	9.2	73	5.6	160	2857.1	793.5	3.6
TR13	7.4	65	5.6	180	3214.3	878.4	3.7
BQ1	8.8	80	5.6	280	5000.0	909.1	5.5
BQ2	9.2	120	5.6	170	3035.7	1304.3	2.3
BQ9	2.6	4.6	5.6	250	4464.3	176.9	25.2
BQ10	6.6	98	5.6	280	5000.0	1484.8	3.4
401	7.4	38	5.6	170	3035.7	513.5	5.9
402	8.2	43	5.6	170	3035.7	524.4	5.8
403	0.6	1.6	5.6	240	4285.7	266.7	16.1
1310	6.8	36	5.6	160	2857.1	529.4	5.4
1312	8.6	28	5.6	160	2857.1	325.6	8.8

PCB 118							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	5367	5.6	9500	169642.9	50788.6	3.3
6508	8.7	2667	5.6	13000	232142.9	30710.2	7.6
2036	4.2	1400	5.6	12000	214285.7	33333.3	6.4
TR01	9.1	2800	5.6	9800	175000.0	30769.2	5.7
TR03	9.5	2900	5.6	16000	285714.3	30526.3	9.4
TR12	9.2	2600	5.6	8500	151785.7	28260.9	5.4
TR13	7.4	2500	5.6	9100	162500.0	33783.8	4.8
BQ1	8.8	2900	5.6	13000	232142.9	32954.5	7.0
BQ2	9.2	5900	5.6	9600	171428.6	64130.4	2.7
BQ9	2.6	190	5.6	12000	214285.7	7307.7	29.3
BQ10	6.6	3300	5.6	12000	214285.7	50000.0	4.3
401	7.4	1800	5.6	8600	153571.4	24324.3	6.3
402	8.2	1700	5.6	8600	153571.4	20731.7	7.4
403	0.6	68	5.6	13000	232142.9	11333.3	20.5
1310	6.8	1600	5.6	7700	137500.0	23529.4	5.8
1312	8.6	1300	5.6	7700	137500.0	15116.3	9.1

PCB 123							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	260	5.6	370	6607.1	2460.6	2.7
6508	8.7	113	5.6	440	7857.1	1305.2	6.0
2036	4.2	51	5.6	390	6964.3	1214.3	5.7
TR01	9.1	110	5.6	290	5178.6	1208.8	4.3
TR03	9.5	120	5.6	390	6964.3	1263.2	5.5
TR12	9.2	110	5.6	240	4285.7	1195.7	3.6
TR13	7.4	93	5.6	420	7500.0	1256.8	6.0
BQ1	8.8	110	5.6	430	7678.6	1250.0	6.1
BQ2	9.2	270	5.6	320	5714.3	2934.8	1.9
BQ9	2.6	7.3	5.6	400	7142.9	280.8	25.4
BQ10	6.6	130	5.6	460	8214.3	1969.7	4.2
401	7.4	65	5.6	370	6607.1	878.4	7.5
402	8.2	73	5.6	360	6428.6	890.2	7.2
403	0.6	2.4	5.6	450	8035.7	400.0	20.1
1310	6.8	67	5.6	320	5714.3	985.3	5.8
1312	8.6	51	5.6	210	3750.0	593.0	6.3

Table B2. Continued.

PCB 126							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	49	5.6	40	714.3	466.9	1.5
6508	8.7	22	5.6	34	607.1	257.2	2.4
2036	4.2	9.9	5.6	29	517.9	235.7	2.2
TR01	9.1	21	5.6	32	571.4	230.8	2.5
TR03	9.5	21	5.6	36	642.9	221.1	2.9
TR12	9.2	21	5.6	28	500.0	228.3	2.2
TR13	7.4	17	5.6	33	589.3	229.7	2.6
BQ1	8.8	21	5.6	31	553.6	238.6	2.3
BQ2	9.2	30	5.6	30	535.7	326.1	1.6
BQ9	2.6	1.5	5.6	16	285.7	57.7	5.0
BQ10	6.6	25	5.6	41	732.1	378.8	1.9
401	7.4	15	5.6	23	410.7	202.7	2.0
402	8.2	16	5.6	21	375.0	195.1	1.9
403	0.6	0.7	5.6	14	250.0	116.7	2.1
1310	6.8	15	5.6	16	285.7	220.6	1.3
1312	8.6	12	5.6	13	232.1	139.5	1.7

PCB 156							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	567	5.6	460	8214.3	5362.8	1.5
6508	8.7	260	5.6	490	8750.0	2994.2	2.9
2036	4.2	110	5.6	440	7857.1	2619.0	3.0
TR01	9.1	260	5.6	450	8035.7	2857.1	2.8
TR03	9.5	260	5.6	570	10178.6	2736.8	3.7
TR12	9.2	250	5.6	400	7142.9	2717.4	2.6
TR13	7.4	220	5.6	470	8392.9	2973.0	2.8
BQ1	8.8	250	5.6	550	9821.4	2840.9	3.5
BQ2	9.2	630	5.6	670	11964.3	6847.8	1.7
BQ9	2.6	16	5.6	240	4285.7	615.4	7.0
BQ10	6.6	300	5.6	620	11071.4	4545.5	2.4
401	7.4	140	5.6	230	4107.1	1891.9	2.2
402	8.2	140	5.6	240	4285.7	1707.3	2.5
403	0.6	4.8	5.6	130	2321.4	800.0	2.9
1310	6.8	160	5.6	260	4642.9	2352.9	2.0
1312	8.6	120	5.6	250	4464.3	1395.3	3.2

PCB 157							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	111	5.6	100	1785.7	1053.6	1.7
6508	8.7	55	5.6	110	1964.3	633.4	3.1
2036	4.2	23	5.6	100	1785.7	547.6	3.3
TR01	9.1	53	5.6	100	1785.7	582.4	3.1
TR03	9.5	55	5.6	120	2142.9	578.9	3.7
TR12	9.2	55	5.6	91	1625.0	597.8	2.7
TR13	7.4	46	5.6	110	1964.3	621.6	3.2
BQ1	8.8	51	5.6	120	2142.9	579.5	3.7
BQ2	9.2	130	5.6	150	2678.6	1413.0	1.9
BQ9	2.6	3.9	5.6	54	964.3	150.0	6.4
BQ10	6.6	60	5.6	140	2500.0	909.1	2.8
401	7.4	35	5.6	80	1428.6	473.0	3.0
402	8.2	33	5.6	71	1267.9	402.4	3.2
403	0.6	1.3	5.6	37	660.7	216.7	3.0
1310	6.8	33	5.6	63	1125.0	485.3	2.3
1312	8.6	26	5.6	58	1035.7	302.3	3.4

Table B2. Continued.

PCB 167							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	170	5.6	150	2678.6	1608.8	1.7
6508	8.7	94	5.6	220	3928.6	1078.7	3.6
2036	4.2	39	5.6	190	3392.9	928.6	3.7
TR01	9.1	96	5.6	200	3571.4	1054.9	3.4
TR03	9.5	95	5.6	240	4285.7	1000.0	4.3
TR12	9.2	89	5.6	170	3035.7	967.4	3.1
TR13	7.4	76	5.6	190	3392.9	1027.0	3.3
BQ1	8.8	84	5.6	230	4107.1	954.5	4.3
BQ2	9.2	260	5.6	300	5357.1	2826.1	1.9
BQ9	2.6	7.1	5.6	120	2142.9	273.1	7.8
BQ10	6.6	110	5.6	270	4821.4	1666.7	2.9
401	7.4	64	5.6	120	2142.9	864.9	2.5
402	8.2	65	5.6	140	2500.0	792.7	3.2
403	0.6	2.3	5.6	79	1410.7	383.3	3.7
1310	6.8	60	5.6	120	2142.9	882.4	2.4
1312	8.6	46	5.6	100	1785.7	534.9	3.3

PCB 169							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	2.3	5.6	3.3	58.9	21.5	2.7
6508	8.7	1.5	5.6	3	53.6	16.9	3.2
2036	4.2	0.66	5.6	3.2	57.1	15.7	3.6
TR01	9.1	1.4	5.6	3.8	67.9	15.4	4.4
TR03	9.5	1.4	5.6	2.9	51.8	14.7	3.5
TR12	9.2	1.4	5.6	3.4	60.7	15.2	4.0
TR13	7.4	1.1	5.6	4.6	82.1	14.9	5.5
BQ1	8.8	1.4	5.6	2	35.7	15.9	2.2
BQ2	9.2	2.6	5.6	3.5	62.5	28.3	2.2
BQ9	2.6	0.22	5.6	2.9	51.8	8.5	6.1
BQ10	6.6	1.4	5.6	3.8	67.9	21.2	3.2
401	7.4	1.4	5.6	1.7	30.4	18.9	1.6
402	8.2	1.3	5.6	1	17.9	15.9	1.1
403	0.6	0.16	5.6	1.5	26.8	26.7	1.0
1310	6.8	1.4	5.6	1.7	30.4	20.6	1.5
1312	8.6	1.3	5.6	1.1	19.6	15.1	1.3

PCB 189							
Site	TOC	Csed	%lipid	Cmayfly	Ct	Cs	BSAF
6507	10.6	40.0	5.6	31	553.6	378.5	1.5
6508	8.7	21.0	5.6	34	607.1	241.8	2.5
2036	4.2	7.9	5.6	28	500.0	188.1	2.7
TR01	9.1	22	5.6	34	607.1	241.8	2.5
TR03	9.5	21	5.6	37	660.7	221.1	3.0
TR12	9.2	20	5.6	30	535.7	217.4	2.5
TR13	7.4	18	5.6	38	678.6	243.2	2.8
BQ1	8.8	19	5.6	34	607.1	215.9	2.8
BQ2	9.2	69	5.6	68	1214.3	750.0	1.6
BQ9	2.6	2	5.6	18	321.4	76.9	4.2
BQ10	6.6	23	5.6	46	821.4	348.5	2.4
401	7.4	15	5.6	18	321.4	202.7	1.6
402	8.2	14	5.6	20	357.1	170.7	2.1
403	0.6	0.5	5.6	7.2	128.6	83.3	1.5
1310	6.8	15	5.6	20	357.1	220.6	1.6
1312	8.6	12	5.6	55	982.1	139.5	7.0

Appendix C Benthic Invertebrate Abundances

Table C1. Abundance of invertebrate families (per 33 cm^2, area of core tube).

Trent River Study May 2006	Sample: 0401					Sample: 0402					Sample: 0403					Sample: 1310					Sample: 1312				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COELENTERATA																									
Hydra																5	1						1		
TURBELLARIA																									
OLIGOCHAETA																									
Arcteonais lomondi						2	1				41	45	17			1		1		1				1	
Amphichaeta leydigi											13	3	2												
Aulodrilus americanus																						1			1
Aulodrilus limnobius																					1				1
Aulodrilus pigueti							3	4		2	1	1				12	1	2	2	4	2	10	21	24	4
Aulodrilus pluriseta																1									
Chaetogaster diaphanus							1					2				2									
Chaetogaster diastrophus						2	3	2	2	1	4	2													
Dero digitata												2				4		1				2	2	2	1
Dero flabelliger																									
Dero nivea								3					1												
Enchytreidae																									
Ilyodrilus templetoni													1									2			
Limnodrilus hoffmeisteri			1						1	1	1	1	1												
Limnodrilus profundicola																									
Lumbriculus variegatus																					1			1	
Nais bretscheri																									
Nais communis																									
Nais elinguis																									
Nais pardalis																									
Nais simplex							7	10	4																
Nais variabilis							2	2			1	3	1												
Pristina leidyi													1												
Quistadrilus multisetosus																						3	1		4
Slavina appendiculata						1	7	2	2		1					1		3	1	2					
Specaria josinae								1			21	16	8			5		2	1	2		3	2	1	1
Stylaria lacustris								2																	
Tubificidae [lar.]						3	1			1	1							1				1			
Tubificidae - hairs	3	1	5			3	12	2	1	8	13	10	16			2			3		2	2			
Tubificidae + hairs						2	1	3	5	3	6	7	4			2						2	1		
Vejdovskyella comata																									
Vejdovskyella intermedia																17	1	4	10						
NEMATOMORPHA							1																		
POLYCHAETA																									
Aeolosoma																									
Manayunkia speciosa																									
HIRUNDINEA																									
Alboglossiphonia heteroclita																									
Desserobdella phalera																									
Helobdella stagnalis																									
ISOPODA																									
Caecidotea [imm.]	1	1							1		2	2	1									1		1	
Lirceus lineatus												1													
AMPHIPODA																									
Gammarus fasciatus												2													
Gammarus pseudolimnaeus							1		1		11	37													
Hyalella azteca		1						1	1		2	49													
HYDRACHNIDA																									
Arrenurus						1																			
Atractides												1													
Axonopsis																									
Forelia																1	1		1						
Halacaridae																									
Hydrachnida [Prostigmata]								1			1														
Hydrochoreutes																									
Hydrodroma																									
Koenikea						1																			
Krendowskia											1														
Lebertia												10													
Limnesia	1										1								1				1		
Neumania																							1		
Oribatida									1	1		3				1	1	2		2					
Oxus							1				2														
Piona crassa [to be entered w/ Piona]																									
Piona						1			1			3	1			1	2	1	2		1		3	3	
Torrenticola												17													
Unionicola																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 0401					Sample: 0402					Sample: 0403					Sample: 1310					Sample: 1312				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COLLEMBOLA																									
Isotomidae																									
TARDIGRADA																									
ODONATA																									
Enallagma hageni												1													
Enallagma sp.																									
Epicordulia princeps																									
Ischnura verticalis																									
EPHEMEROPTERA																									
Caenis punctata							5	6	4	1	3	10													
Ephemerellidae [young]																								1	
NEUROPTERA																									
Climacia areolaris																									
LEPIDOPTERA																									
Pyralidae																									
PLECOPTERA [early instar]																									
TRICHOPTERA																									
Agraylea																									
Hydroptila												3													
Leptocerus americanus	1					1	2	3	3																
Nectopsyche albida												1													
Nectopsyche exquisita								1																	
Oecetis cinerascens												1													
Oecetis sp.							1																		
Orthotrichia								1	1			2													
Oxyethira																									
COLEOPTERA																									
Dubiraphia						1		1																	
Lutrochus																									
Stenelmis																									
DIPTERA:Ceratopogonidae																									
Bezzia/Palpomyia						1		4	5																
Mallochohelea									2			1													
Nilobezzia																									
Sphaeromias											1														
DIPTERA:Chironomidae																									
Ablabesmyia (s. str.) mallochi								1			2	9													
Ablabesmyia (s. str.) monilis	1						1		1				4												
Coelotanypus concinnus																									
Conchapelopia												1													
Guttipelopia guttipennis																									
Labrundinia neopilosella																									
Larsia berneri																									
Larsia decolorata																									
Pentaneura									1																
Procladius (Hototanypus)						5	2	1	3	2	10	16	9			7	11	3	10	4	5	9	16	9	7
Procladius (Psilo.) bellus																3	4	2	1	1	9	18	25	27	20
Tanypus (s. str.) punctipennis						3	1	3	1		1														
Cardiocladius																									
Corynoneura							1																		
Cricotopus (s. str.) tremulus grp																									
Cricotopus (Iso.) elegans																									
Cricotopus (Iso.) sylvestis grp							1	1	2																
Diplocladius																									
Eukiefferiella devonica grp																									
Hydrobaenus																									
Nanocladius (s. str.) alternantherae																									
Nanocladius (s. str.) distinctus																									
Orthocladius (Orthocladius)		1																							
Orthocladinae [Chironomidae]								1				3													
Parachaetocladius																									
Parakiefferiella								1	3			1													
Psectrocladius (s.str.) psilopterus grp																									
Psectrocladius (Psectrocladius)						1		2	1																
Smittia																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 0401					Sample: 0402					Sample: 0403					Sample: 1310					Sample: 1312				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
DIPTERA:Chironomidae																									
Synorthocladius semivirens																									
Thienemanniella																									
Chironomini [Chironomidae]						1		2			2	3													
Chironomus (Chironomus)	4		3	4			8	13	4	1	17	191	6			13									
Chironomus (s. str.) salinaris grp	10		4	1																					
Cladopelma								2		1	3	3	1				1		1	1	2			1	
Cryptochironomus											6	5	4			1									
Cryptotendipes						1	4	5	1	1	1														
Dicrotendipes neomodestus																									
Dicrotendipes modestus													1												
Dicrotendipes tritomus							1	6	6																
Einfeldia natchitocheae												2													
Endochironomus subtendens																									
Glyptochironomus (Cauto.) dreisbachi																									
Microtendipes pedellus grp								1																	
Nilothauma												1													
Parachironomus	2		1	1				2	4				1												
Paralauterbomiella nigrohalteralis											2	2	3												
Paratendipes albimanus grp											1	2													
Phaenopsectra																									
Polypedilum (s. str.) angulum								1					1												
Polypedilum (s. str.) bergi																									
Polypedilum (T.) halterale grp						1		6	4		11	27	3			1	5	3	1	1	4	8	15	13	14
Polypedilum (T.) scalaenum grp											1	1													
Polypedilum (Uresipedilum)																									
Pseudochironomus fulviventris											1	3													
Stictochironomus																									
Tribelos jucundum													1												
Xenochironomus xenolabis																									
Zavreliella marmorata																									
Cladotanytarsus											3	1	1												
Constempellina											1					3	5		4	1	7	17	25	19	13
Paratanytarsus							5	16	21	4	1	9													
Rheotanytarsus								1	1																
Stempellinella																									
Tanytarsus						3	3	4	6	1	8	14	5			4	2		7	2	9	7	13	15	8
DIPTERA:Chaoboridae																									
Chaoborus (S.) albatus		1																							
Chaoborus (S.) punctipennis								1									2	4	1	2			1		
DIPTERA:Cecidomyiidae																									
DIPTERA:Ephydridae																									
Hydrellia																									
DIPTERA:Psychodidae																									
GASTROPODA																									
Amnicola limosa								1			6	10	1												
Gyraulus deflectus																									
Physidae [imm.]								1																	
Planorbidae [imm.]							2	2	1													3			
Probythinella emarginata																									
Pyrgulopsis lustrica								2	1	1	15	2	4												
Valvata [poor cond.]																									
Valvata tricarinata									1																
Valvata lewisi																							2		
Valvata sincera								1														1			
BIVALVIA																									
Dreissena bugensis																1	2						1	2	
Dreissena polymorpha	1																								
Musculium partumeium																									
Pisidium casertanum																									
Pisidium compressum																									
Pisidium adamsi									1																
Pisidium henslowanum																									
Pisidium lilljeborgi																					1	3	4	5	1
Pisidium lilljeborgi f. cristatum																									
Pisidium punctatum																									
Pisidium supium																						1		1	4
Pisidium nitidum																						1			
MISC: non-aquatic [not entered]																									
egg cases																							3		

Table C1 cont'd.

Trent River Study May 2006	Sample: 650800					Sample: 650801					Sample: 650802					Sample: 2036					Sample: 65BQ1				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COELENTERATA																									
Hydra		1					2			1			1												
TURBELLARIA																1				1					
OLIGOCHAETA																									
Arcteonais lomondi	1	2	2	4	1		1																		
Amphichaeta leydigi																									
Aulodrilus americanus																									
Aulodrilus limnobius																									
Aulodrilus pigueti	6		3	5	2	5	7	7	3	6	1			1	12	6	5	5	4	22					
Aulodrilus pluriseta																									
Chaetogaster diaphanus	8		5	4			2	1		3				1	9	13	1	2	1	7					
Chaetogaster diastrophus																1			1	1					
Dero digitata			1	1		1								1	2	2	1			1					
Dero flabelliger																									
Dero nivea	2		1	2	2	1		1		1					5	1			1	1					
Enchytreidae																		1		1					
Ilyodrilus templetoni			2			1	1						1												
Limnodrilus hoffmeisteri	1	1			2	1	1				1		4	1		1		1							
Limnodrilus profundicola														2											
Lumbriculus variegatus																									
Nais bretscheri																	1								
Nais communis	1																			2					
Nais elinguis																2				1					
Nais pardalis	1								1	1							1		1	2					
Nais simplex	2								1			1				12	5	17	7	54					
Nais variabilis							1										1			4					
Pristina leidyi	2		1																2	3					
Quistadrilus multisetosus			1	3	2				1	2					2	1	4	8	1	14		3	1	1	2
Slavina appendiculata	1									3					5	2	4		1	5					
Specaria josinae																5	5	3	2	6					
Stylaria lacustris	11	4		3	1	1	4		1	1	5			1	4	28	8	23	8	57		3			
Tubificidae [Iar.]	1			3	8	2	3	1	3						5	2		2		3					
Tubificidae - hairs	12	17	41	1	20	4	30	4	21	7	2	3	2	2	9	5	2	2	5	16		4	2		1
Tubificidae + hairs	9	7	17	13	6	12	19	2	7	9	6	2		1	10	7	6	7	7	12		1			
Vejdovskyella comata																									
Vejdovskyella intermedia																									
NEMATOMORPHA																									
POLYCHAETA																									
Aeolosoma																				1					
Manayunkia speciosa																									
HIRUNDINEA																									
Alboglossiphonia heteroclita																									
Desserobdella phalera																									
Helobdella stagnalis																1				3					
ISOPODA																									
Caecidotea [imm.]	1	1	1	2		1	1	1	3	2						11		4	5	25	1	1	1	1	4
Lirceus lineatus																									
AMPHIPODA																									
Gammarus fasciatus																									
Gammarus pseudolimnaeus																									
Hyalella azteca	4		5				1								2	2	5	9	4	49	1	3		2	
HYDRACHNIDA																									
Arrenurus			1								1														
Atractides																									
Axonopsis															4					2					
Forelia										2															
Halacaridae																				5					
Hydrachnida [Prostigmata]																1									
Hydrochoreutes																		1		1	1	1		2	
Hydrodroma																									
Koenikea																1				3					
Krendowskia																									
Lebertia																									
Limnesia	1	1	1	3		1		1							1					2			1		1
Neumania																									
Oribatida										2										5					
Oxus														1		1						1			
Piona crassa [to be entered w/ Piona]										1															
Piona		1	5	3	2	3	5	2		9		2		1	3	2	3	7		11		2	1		2
Torrenticola																			1						
Unionicola															2					1					

Table C1 cont'd.

Trent River Study May 2006	Sample: 650800					Sample: 650801					Sample: 650802					Sample: 2036					Sample: 65BQ1				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COLLEMBOLA																									
Isotomidae																									
TARDIGRADA																									
ODONATA																									
Enallagma hageni																									
Enallagma sp.																						1			
Epicordulia princeps	1																								
Ischnura verticalis																				1					
EPHEMEROPTERA																									
Caenis punctata				1												2	2	2	1	4		2			
Ephemerellidae [young]																									
NEUROPTERA																									
Climacia areolaris																				1					
LEPIDOPTERA																									
Pyralidae																									
PLECOPTERA [early instar]																									
TRICHOPTERA																									
Agraylea																									
Hydroptila																									
Leptocerus americanus	1	1		1	1					1	1				6	11	1	5	5	45					
Nectopsyche albida																				2					
Nectopsyche exquisita																									
Oecetis cinerascens																		1							
Oecetis sp.																				1					
Orthotrichia										2						1	1	1	2	5					
Oxyethira																1									
COLEOPTERA																									
Dubiraphia																7			4	3					
Lutrochus																									
Stenelmis																									
DIPTERA:Ceratopogonidae																									
Bezzia/Palpomyia																1	1	1		4		2			2
Mallochohelea																									
Nilobezzia																									
Sphaeromias																									
DIPTERA:Chironomidae																									
Ablabesmyia (s. str.) mallochi																3		2	1	1					
Ablabesmyia (s. str.) monilis															3	4	1	2	1	4					
Coelotanypus concinnus																									
Conchapelopia																									
Guttipelopia guttipennis																									
Labrundinia neopilosella				2			1				1	1													
Larsia berneri	1																								
Larsia decolorata																		1		1					
Pentaneura																									
Procladius (Holotanypus)	1			2	1		2	5	3	1	4	1	1	1	1	13	5	10	9	15	2	1	2	1	3
Procladius (Psilo.) bellus	2			1	1				1										2	1					
Tanypus (s. str.) punctipennis							1	1							1	2									
Cardiocladius				1																					
Corynoneura																									
Cricotopus (s. str.) tremulus grp																		2							
Cricotopus (Iso.) elegans																									
Cricotopus (Iso.) sylvestis grp																									
Diplocladius																									
Eukiefferiella devonica grp																									
Hydrobaenus																									
Nanocladius (s. str.) alternantherae															1				1	2					
Nanocladius (s. str.) distinctus																									
Orthocladius (Orthocladius)		1														3		2		2					
Orthocladinae [Chironomidae]			1														1								
Parachaetocladius																									
Parakiefferiella					1															1					
Psectrocladius (s.str.) psilopterus grp																				1					
Psectrocladius (Psectrocladius)																									
Smittia																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 650800					Sample: 650801					Sample: 650802					Sample: 2036					Sample: 65BQ1				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
DIPTERA:Chironomidae																									
Synorthocladius semivirens														1		2		7	3	21					
Thienemanniella																		1	3	2					
Chironomini [Chironomidae]																									
Chironomus (Chironomus)			1				1	1								1	1	2	2	1					
Chironomus (s. str.) salinaris grp																									
Cladopelma			1		1	1	1								1	1	1	3	1	1		3		1	3
Cryptochironomus																					1				
Cryptotendipes																									
Dicrotendipes neomodestus																				1					
Dicrotendipes modestus																1									
Dicrotendipes tritomus															1					2					
Einfeldia natchitocheae												1			2		1				1		1		
Endochironomus subtendens													1					1	1	3					
Glyptochironomus (Caulo.) dreisbachi														1				1		1					
Microtendipes pedellus grp																									
Nilothauma																1									
Parachironomus	1		1	1									1		2	1	2	1	1	2				1	
Paralauterbomiella nigrohalteralis																									
Paratendipes albimanus grp		1	4	1		2	2		2	1					1	26	14	23	30	63				1	
Phaenopsectra					1												1	2		1					
Polypedilum (s. str.) angulum																									
Polypedilum (s. str.) bergi																									
Polypedilum (T.) halterale grp																2			1	2					
Polypedilum (T.) scalaenum grp																				1					
Polypedilum (Uresipedilum)																									
Pseudochironomus fulviventris																1									
Stictochironomus																									
Tribelos jucundum																									
Xenochironomus xenolabis																		1	1	1					
Zavreliella marmorata																				1				1	
Cladotanytarsus																									
Constempellina																				3					
Paratanytarsus	3			3							1				1	2	2	7	2	13					
Rheotanytarsus																13	5	13	5	23					
Stempellinella																6	2	1	4	4					
Tanytarsus	2		1	2	1		1		2	2					3	19	12	15	5	39					
DIPTERA:Chaoboridae																									
Chaoborus (S.) albatus				1			1						1												
Chaoborus (S.) punctipennis																									
DIPTERA:Cecidomyiidae																									
DIPTERA:Ephydridae																									
Hydrellia																									1
DIPTERA:Psychodidae																									
GASTROPODA																									
Amnicola limosa	14	1	4	5	1	6	1	1	5	4					6	10	5	5	3	34				1	
Gyraulus deflectus															3					2					
Physidae [imm.]																						1			
Planorbidae [imm.]																									
Probythinella emarginata																									
Pyrgulopsis lustrica	2		3	2	4		2	1		3				1		4	2	1	1	5					
Valvata [poor cond.]				1							1														
Valvata tricarinata	3		1		6		1	2		1					2	3	1			3					
Valvata lewisi																									
Valvata sincera	1				1			1	1																
BIVALVIA																									
Dreissena bugensis																									
Dreissena polymorpha																1				8					
Musculium partumeium								1									1		1						
Pisidium casertanum	1									1															
Pisidium compressum							2		1											1					
Pisidium adamsi																									
Pisidium henslowanum																			1						
Pisidium lilljeborgi					1			1								1									
Pisidium lilljeborgi f. cristatum																									
Pisidium punctatum																									
Pisidium supium																									
Pisidium nitidum																		2							
MISC: non-aquatic [not entered]																	1								
egg cases																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 65BQ2					Sample: 65BQ9					Sample: 65BQ10					Sample: 65TR01					Sample: 65TR03				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COELENTERATA																									
Hydra		2																	1		2				
TURBELLARIA																									
OLIGOCHAETA																									
Arcteonais lomondi															1										
Amphichaeta leydigi						8	9	17	14	8															
Aulodrilus americanus																									
Aulodrilus limnobius						3		1																	
Aulodrilus pigueti					1	8	9	6	7	2					1						7		4	2	2
Aulodrilus pluriseta																									
Chaetogaster diaphanus						4	1	2		2											16	1		1	2
Chaetogaster diastrophus																									
Dero digitata						2			2	1			1										1		
Dero flabelliger																									
Dero nivea	2			1																	1		1		3
Enchytreidae								5	1	2							1								
Ilyodrilus templetoni													1								2				
Limnodrilus hoffmeisteri		2	4			6	2	3	4			1	2												1
Limnodrilus profundicola																									
Lumbriculus variegatus																									
Nais bretscheri									1																
Nais communis																									
Nais elinguis																									
Nais pardalis						4	10	9	2	5											1				
Nais simplex							1	4	1	1									1		17			1	1
Nais variabilis								1													5				3
Pristina leidyi																									
Quistadrilus multisetosus						3	1	1		1	1								3		7	3	2		1
Slavina appendiculata						16	5	18	4	6											3			1	1
Specaria josinae																									
Stylaria lacustris							1			2						1		2	4	2	1	1			
Tubificidae [Iar.]						5	3	3		2	2					4				1	1				
Tubificidae - hairs	3	3	1	1	3	30	15	37	14	10		3				1					12	1	16	5	4
Tubificidae + hairs		1				2	3		1	1	1				1	1		2	1		10	1	13		7
Vejdovskyella comata																									
Vejdovskyella intermedia																									
NEMATOMORPHA																									
POLYCHAETA																									
Aeolosoma										1															
Manayunkia speciosa																									
HIRUNDINEA																									
Alboglossiphonia heteroclita																			1						
Desserobdella phalera																									
Helobdella stagnalis																									
ISOPODA																									
Caecidotea [imm.]							1																		
Lirceus lineatus																							1		
AMPHIPODA																									
Gammarus fasciatus																									
Gammarus pseudolimnaeus							12		1																
Hyalella azteca																1		1	5		5				
HYDRACHNIDA																									
Arrenurus									1												1				1
Atractides																									
Axonopsis																									
Forelia									4		2								1						1
Halacaridae										1														1	
Hydrachnida [Prostigmata]																									
Hydrochoreutes																					1				
Hydrodroma																									
Koenikea						1				1						1							1		
Krendowskia						1																			
Lebertia																									
Limnesia						1		1								1	1		1	1	2				1
Neumania																									
Oribatida						2			1																
Oxus							1											1							
Piona crassa [to be entered w/ Piona]																	1				1				
Piona						1	4	2	6	1						4	2	2	2	4	2		2	2	1
Torrenticola																									
Unionicola																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 65BQ2					Sample: 65BQ9					Sample: 65BQ10					Sample: 65TR01					Sample: 65TR03				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COLLEMBOLA																									
Isotomidae						1																			
TARDIGRADA							3		1	1															
ODONATA																									
Enallagma hageni																									
Enallagma sp.																									
Epicordulia princeps																									
Ischnura verticalis																									
EPHEMEROPTERA																									
Caenis punctata																									
Ephemerellidae [young]																									
NEUROPTERA																									
Climacia areolaris																									
LEPIDOPTERA																									
Pyralidae						2		1	1	1															
PLECOPTERA [early instar]						1	1		1																
TRICHOPTERA																									
Agraylea							1																		
Hydroptila																									
Leptocerus americanus																1				1	2				
Nectopsyche albida																					1				
Nectopsyche exquisita																									
Oecetis cinerascens																									
Oecetis sp.																									
Orthotrichia																									
Oxyethira							1	1		1															1
COLEOPTERA																									
Dubiraphia							1	2	2	1															
Lutrochus																									
Stenelmis						1			1	1															
DIPTERA:Ceratopogonidae																									
Bezzia/Palpomyia						1			1	1															
Mallochohelea																									
Nilobezzia		1																							
Sphaeromias																									
DIPTERA:Chironomidae																									
Ablabesmyia (s. str.) mallochi																									
Ablabesmyia (s. str.) monilis								1									1				1				
Coelotanypus concinnus																									
Conchapelopia																									
Guttipelopia guttipennis							1																		
Labrundinia neopilosella																									
Larsia berneri																									
Larsia decolorata																									
Pentaneura																									
Procladius (Holotanypus)					1	1								1	1						4		5	1	3
Procladius (Psilo.) bellus									1			1	1	1							1	1	1	2	1
Tanypus (s. str.) punctipennis			1			1	3	1	3	2												1	3		
Cardiocladius																									
Corynoneura																									
Cricotopus (s. str.) tremulus grp							1	2		2															
Cricotopus (Iso.) elegans							1		1																
Cricotopus (Iso.) sylvestis grp								1																	
Diplocladius							1																		
Eukiefferiella devonica grp																									
Hydrobaenus								2		1															
Nanocladius (s. str.) alternantherae																					1				
Nanocladius (s. str.) distinctus																					2				
Orthocladius (Orthocladius)					2		3	3	1	1									1						
Orthocladinae [Chironomidae]						1		1													1				
Parachaetocladius								1																	
Parakiefferiella							1		1	1															
Psectrocladius (s.str.) psilopterus grp							2														1				
Psectrocladius (Psectrocladius)																									
Smittia										1															

Table C1 cont'd.

Trent River Study May 2006	Sample: 65BQ2					Sample: 65BQ9					Sample: 65BQ10					Sample: 65TR01					Sample: 65TR03				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
DIPTERA:Chironomidae																									
Synorthocladius semivirens																									
Thienemanniella						1																			
Chironomini [Chironomidae]						1	1		1	1															
Chironomus (Chironomus)						5	15	7	9	3											2				
Chironomus (s. str.) salinaris grp																									
Cladopelma						6	9	2	13	2			2			1					3		7	4	2
Cryptochironomus									1	1															
Cryptotendipes	1							2	2																
Dicrotendipes neomodestus																			1	1					
Dicrotendipes modestus																							1		
Dicrotendipes tritomus						2															2				
Einfeldia natchitocheae				1				2	1												2	3	1	1	2
Endochironomus subtendens																									
Glyptochironomus (Caulo.) dreisbachi																									
Microtendipes pedellus grp						1	1		1																
Nilothauma																									
Parachironomus			1			1											1								
Paralauterbomiella nigrohalteralis																									
Paratendipes albimanus grp						13	22	18	12	6		1				1			1		6	1	3	1	2
Phaenopsectra										1															
Polypedilum (s. str.) angulum																									
Polypedilum (s. str.) bergi																						1			
Polypedilum (T.) halterale grp									3					1											
Polypedilum (T.) scalaenum grp						1	1	1	1	1															
Polypedilum (Uresipedilum)																									
Pseudochironomus fulviventris																									
Stictochironomus						5	6		1	4															
Tribelos jucundum																									
Xenochironomus xenolabis																									
Zavreliella marmorata						1	1		1																1
Cladotanytarsus						2			1	1															
Constempellina							2																		
Paratanytarsus		2			1												1		1		13	1			
Rheotanytarsus																					7	3			
Stempellinella																					1			1	
Tanytarsus						7	5	4	5	6											2	2			1
DIPTERA:Chaoboridae																									
Chaoborus (S.) albatus																				1					
Chaoborus (S.) punctipennis																									
DIPTERA:Cecidomyiidae							1																		
DIPTERA:Ephydridae																						1			
Hydrellia						1			1																
DIPTERA:Psychodidae									1																
GASTROPODA																									
Amnicola limosa					1	1		2	1						1	4	4	2	1	6			2		2
Gyraulus deflectus																			2		2	1			
Physidae [imm.]																		1							
Planorbidae [imm.]																			1						
Probythinella emarginata																				1					
Pyrgulopsis lustrica																1	3		2	1	2	1			2
Valvata [poor cond.]																	1			2	2	1	3		5
Valvata tricarinata																			2						
Valvata lewisi																			1						
Valvata sincera																									
BIVALVIA																									
Dreissena bugensis																									
Dreissena polymorpha																									
Musculium partumeium																									
Pisidium casertanum																							1		
Pisidium compressum																									
Pisidium adamsi																									
Pisidium henslowanum						1			1																
Pisidium lilljeborgi																									
Pisidium lilljeborgi f. cristatum							1		1																
Pisidium punctatum																					1				1
Pisidium supium																									
Pisidium nitidum												1													
MISC: non-aquatic [not entered]																								1	
egg cases																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 65TR12					Sample: 65TR13					Sample: 650700					Sample: 650701					Sample: 650702				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COELENTERATA																									
Hydra																									
TURBELLARIA																									
OLIGOCHAETA																									
Arcteonais lomondi		1				1		2														4	1	2	
Amphichaeta leydigi														1	1										1
Aulodrilus americanus																									
Aulodrilus limnobius																									
Aulodrilus pigueti	5	4	12	28	5	7	7	6	7	7	3	3	9	8	8	2	4	1		3	16	8	10	2	9
Aulodrilus pluriseta																									
Chaetogaster diaphanus			2	5				1	10	6	2	1		1		4						2	1		1
Chaetogaster diastrophus		1																					1		
Dero digitata											1	1	1		1		1					3			1
Dero flabelliger													1	1		1			1	4			3	2	1
Dero nivea				2												2				1		1	1		3
Enchytreidae																									
Ilyodrilus templetoni						3						2									1	1			
Limnodrilus hoffmeisteri						1	1			1											1			1	
Limnodrilus profundicola																									
Lumbriculus variegatus																									
Nais bretscheri																									
Nais communis						1																			
Nais elinguis										1															
Nais pardalis				1			2		1	1															
Nais simplex				1				1	11	2															
Nais variabilis		1		2				4	11	1			2						1				1		
Pristina leidyi																									
Quistadrilus multisetosus		1		2					1	1													1		
Slavina appendiculata			2	7	2	1	1	1					1												
Specaria josinae	1	1			3					1							1					1			
Stylaria lacustris				5					2													2			2
Tubificidae [lar.]			1	2	2	2	1	3	1	1			4									2	1		2
Tubificidae - hairs	6	4	3	5	2	5	3		1	2	3	1	14	7	12	10	12	30	2	10	8	40	37	10	7
Tubificidae + hairs	4	3	3	5	5	2		4	4	3		3	6	1	1	3	1	7		4	2	5	3	5	3
Vejdovskyella comata															1										
Vejdovskyella intermedia														1									1		
NEMATOMORPHA																									
POLYCHAETA																									
Aeolosoma																									
Manayunkia speciosa			1																						
HIRUNDINEA																									
Alboglossiphonia heteroclita																									
Desserobdella phalera							1																		
Helobdella stagnalis																									
ISOPODA																									
Caecidotea [imm.]								1	1																
Lirceus lineatus																									
AMPHIPODA																									
Gammarus fasciatus																									
Gammarus pseudolimnaeus																									
Hyalella azteca				1																					
HYDRACHNIDA																									
Arrenurus										1															
Atractides																									
Axonopsis																									
Forelia				1																					
Halacaridae																									
Hydrachnida [Prostigmata]																									
Hydrochoreutes													1	1		1								1	
Hydrodroma										1															
Koenikea										2															
Krendowskia																									
Lebertia																									
Limnesia				1		1		1																	
Neumania																									
Oribatida																									
Oxus	1			1	1																				
Piona crassa [to be entered w/ Piona]																									
Piona		1	3	4					1						1						1				
Torrenticola																									
Unionicola																									

Table C1 cont'd.

Trent River Study May 2006	Sample: 65TR12					Sample: 65TR13					Sample: 650700					Sample: 650701					Sample: 650702				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
COLLEMBOLA																									
Isotomidae																									
TARDIGRADA																									
ODONATA																									
Enallagma hageni																									
Enallagma sp.																									
Epicordulia princeps																									
Ischnura verticalis																									
EPHEMEROPTERA																									
Caenis punctata							1																		
Ephemerellidae [young]																									
NEUROPTERA																									
Climacia areolaris																									
LEPIDOPTERA																									
Pyralidae																									
PLECOPTERA [early instar]																									
TRICHOPTERA																									
Agraylea																									
Hydroptila																									
Leptocerus americanus							1												1						
Nectopsyche albida																									
Nectopsyche exquisita																									
Oecetis cinerascens																									
Oecetis sp.																									
Orthotrichia																2									
Oxyethira																									
COLEOPTERA																									
Dubiraphia																									
Lutrochus		1																							
Stenelmis																									
DIPTERA:Ceratopogonidae																									
Bezzia/Palpomyia									1																
Mallochohelea																									
Nilobezzia																									
Sphaeromias																									
DIPTERA:Chironomidae																									
Ablabesmyia (s. str.) mallochi							1																		
Ablabesmyia (s. str.) monilis																									
Coelotanypus concinnus			1																1	1					
Conchapelopia																									
Guttipelopia guttipennis																									
Labrundinia neopilosella																									
Larsia berneri																									
Larsia decolorata																									
Pentaneura																									
Procladius (Holotanypus)	1	1	2	2	5						3	2	1		1		1	2		2	2	1		3	1
Procladius (Psilo.) bellus		1	2	4				4															2		
Tanypus (s. str.) punctipennis								1																	
Cardiocladius								1																	
Corynoneura																									
Cricotopus (s. str.) tremulus grp																									
Cricotopus (Iso.) elegans																									
Cricotopus (Iso.) sylvestis grp																									
Diplocladius																									
Eukiefferiella devonica grp				1																					
Hydrobaenus																									
Nanocladius (s. str.) alternantherae											1														
Nanocladius (s. str.) distinctus																									
Orthocladius (Orthocladius)								1		1															
Orthocladinae [Chironomidae]																									
Parachaetocladius																									
Parakiefferiella																									
Psectrocladius (s.str.) psilopterus grp																									
Psectrocladius (Psectrocladius)																									
Smittia																			1						

Table C1 cont'd.

Trent River Study May 2006	Sample: 65TR12					Sample: 65TR13					Sample: 650700					Sample: 650701					Sample: 650702				
TAXA LIST	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5	Rep.1	Rep.2	Rep.3	Rep.4	Rep.5
DIPTERA:Chironomidae																									
Synorthocladius semivirens																									
Thienemanniella																									
Chironomini [Chironomidae]																									
Chironomus (Chironomus)				2	1			1	3	1			1	2	1		1			1					
Chironomus (s. str.) salinaris grp																									
Cladopelma	1	5	1	5	2	1			2				1												
Cryptochironomus																									
Cryptotendipes			2		1	1																			1
Dicrotendipes neomodestus																									
Dicrotendipes modestus																									
Dicrotendipes tritomus																									
Einfeldia natchitocheae			5	2	2						1														1
Endochironomus subtendens																									
Glyptochironomus (Caulo.) dreisbachi																									
Microtendipes pedellus grp																									
Nilothauma																									
Parachironomus	1						1	1		1									1						
Paralauterborniella nigrohalteralis				1																					
Paratendipes albimanus grp	1		1		1	11	7	5	6	4															
Phaenopsectra																									
Polypedilum (s. str.) angulum																									
Polypedilum (s. str.) bergi																									
Polypedilum (T.) halterale grp			2											1			2			2		1			
Polypedilum (T.) scalaenum grp																									
Polypedilum (Uresipedilum)										1															
Pseudochironomus fulviventris																									
Stictochironomus																									
Tribelos jucundum																									
Xenochironomus xenolabis																									
Zavreliella marmorata																									
Cladotanytarsus																									
Constempellina											2		1												
Paratanytarsus								1	1		3			1		2	1			2					
Rheotanytarsus							1																		
Stempellinella																									
Tanytarsus				2		2	1	1																	
DIPTERA:Chaoboridae																									
Chaoborus (S.) albatus													1												
Chaoborus (S.) punctipennis											3	2	1			2				1		1		2	
DIPTERA:Cecidomyiidae																									
DIPTERA:Ephydridae																									
Hydrellia																									
DIPTERA:Psychodidae																									
GASTROPODA																									
Amnicola limosa			1	1	2	5	4	7	8	7						1	2								
Gyraulus deflectus																									
Physidae [imm.]																									
Planorbidae [imm.]																									
Probythinella emarginata																				1					
Pyrgulopsis lustrica																									
Valvata [poor cond.]																									
Valvata tricarinata						2	1	2	1	6															
Valvata lewisi																									
Valvata sincera																									
BIVALVIA																									
Dreissena bugensis																									
Dreissena polymorpha																1									3
Musculium partumeium																									
Pisidium casertanum																									
Pisidium compressum																									
Pisidium adamsi																									
Pisidium henslowanum																									
Pisidium lilljeborgi																									
Pisidium lilljeborgi f. cristatum																									1
Pisidium punctatum		1																							
Pisidium supium																									
Pisidium nitidum												1													
MISC: non-aquatic [not entered]									1						1										
egg cases																									

Appendix D BEAST Community Ordinations

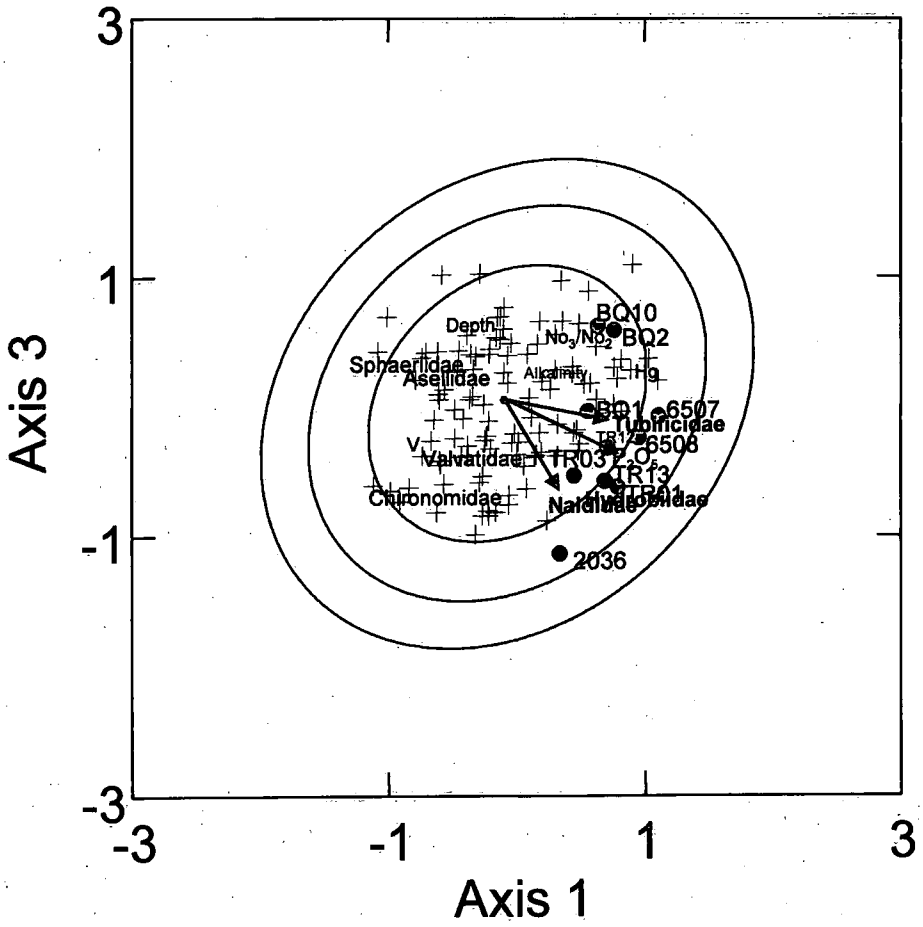

Figure D1. Ordination of a subset of Trent River sites using benthic community data (family abundance). Site scores are plotted on axes 1 & 3 with 90% (smallest ellipse), 99% (middle ellipse), and 99.9% (largest ellipse) probability ellipses for Group 1 reference sites (reference site scores are shown as cross hairs). The contributions of most significant families and environmental variables are shown as vectors. Stress = 0.16.

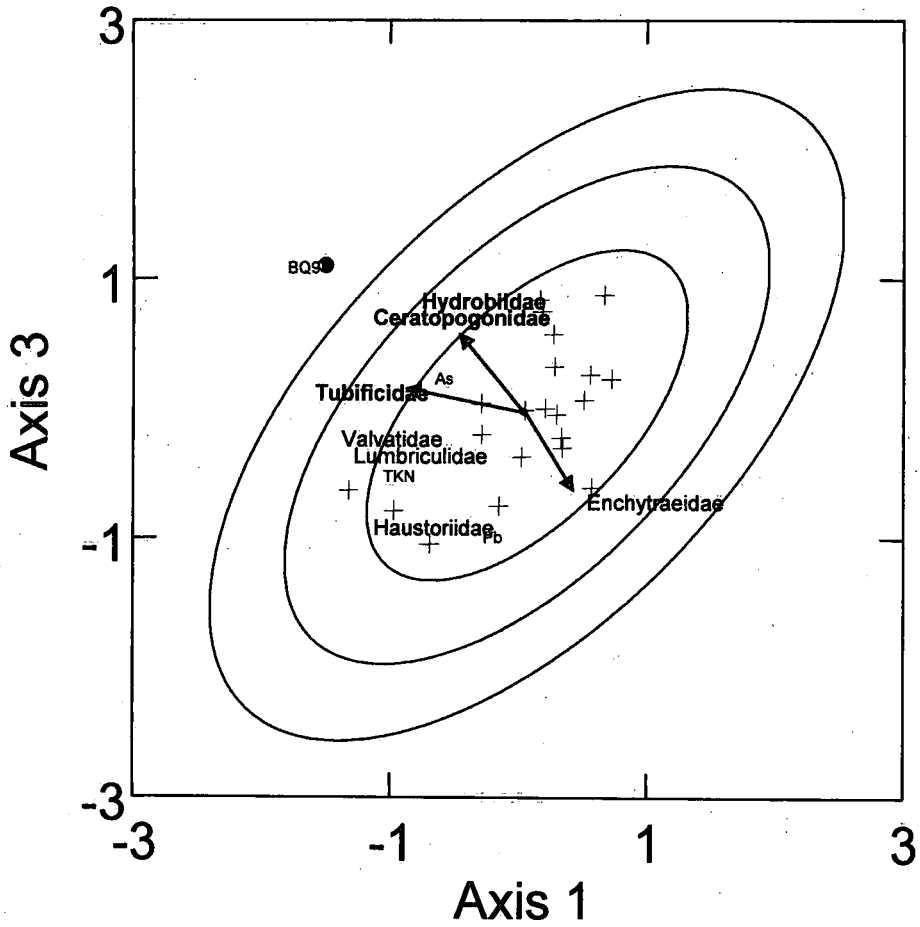

Figure D2. Ordination of Trent River site BQ9 using benthic community data (family abundance). Site scores are plotted on axes 1 & 3 with 90% (smallest ellipse), 99% (middle ellipse), and 99.9% (largest ellipse) probability ellipses for Group 4 reference sites (reference site scores are shown as cross hairs). The contributions of most significant families and environmental variables are shown as vectors. Stress = 0.14.

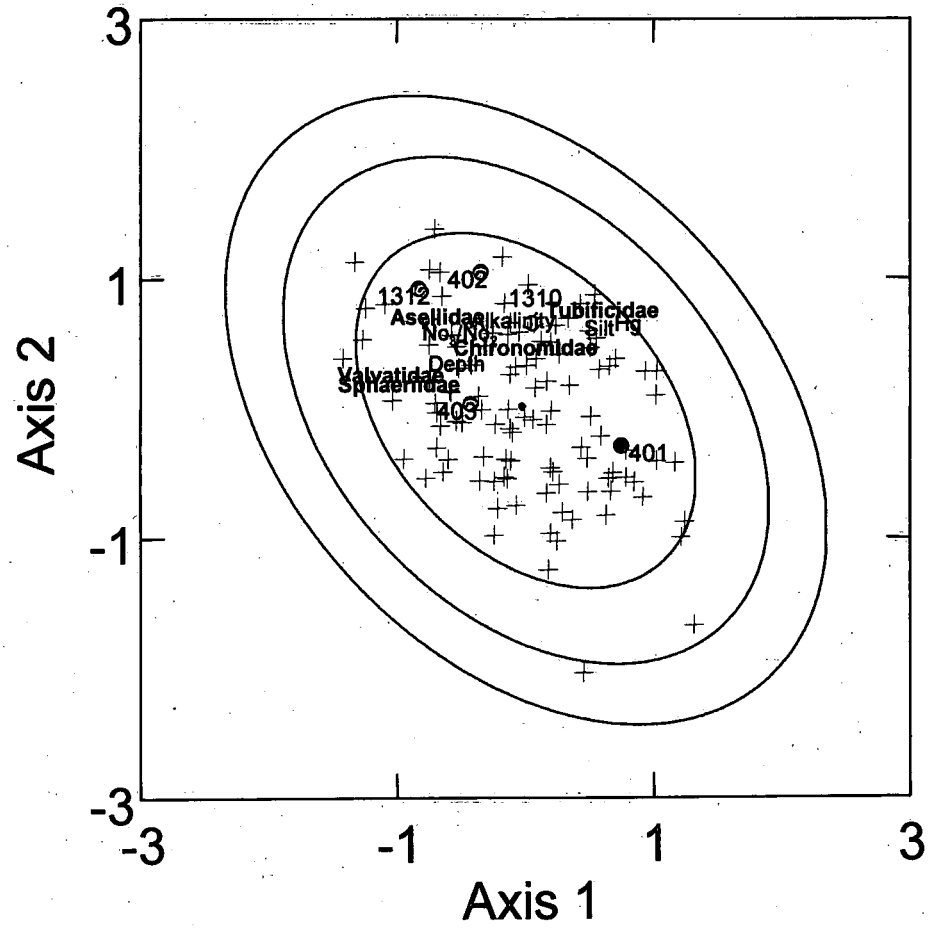

Figure D3. Ordination of Bay of Quinte and Presqu'ile Bay reference sites using benthic community data (family abundance). Site scores are plotted on axes 1 & 2 with 90% (smallest ellipse), 99% (middle ellipse), and 99.9% (largest ellipse) probability ellipses for Group 1 reference sites (reference site scores are shown as cross hairs). Stress = 0.16.

Appendix E Toxicity Test Water Quality

Table E1. Water quality parameters measured in toxicity tests.

Chironomus riparius

	Day O					Day 10				
Site	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)
401	8.4-8.5	450-490	22.3	7.8-8.0	0	8.4-8.5	510-600	22.4-22.6	7.6-7.8	0
402	8.4-8.5	420-470	22.3-22.6	7.7-7.9	0	8.4-8.5	480-510	22.3-22.5	7.6-7.9	0
403	8.3-8.5	380-430	22.2-22.6	7.6-8.0	0	8.3-8.4	410-480	22.2-22.4	7.5-8.1	0
1310	8.3	400-500	22.3-22.5	7.7-8.0	0	8.3	440-520	22.4	7.6-7.8	0
1312	8.3	500-520	22.1-22.2	7.7-8.1	0	8.1-8.3	500-550	22.8-22.9	7.6-7.9	0
6507	8.3	430-490	22.1-22.3	7.8-8.0	0	8.1-8.2	440-500	22.8-22.9	7.6-7.9	0
6508	8.3-8.5	390-480	22.1-22.2	7.8-8.0	0	8.2	470-530	22.8-22.9	7.6-7.8	0
2036	8.3-8.5	420-490	22.1-22.3	7.6-8.0	0	8.3	500-580	22.7-22.8	7.8-7.9	0
TR01	8.1-8.3	460-580	22.1-22.2	7.9-8.1	0	8.1	430-550	21.6-21.8	8.2-8.3	0
TR03	8.1-8.2	390-530	22.1-22.3	7.6-8.0	0	8.1	410-450	21.5-21.9	8.0-8.2	0
TR12	8.1	430-530	22.1-22.4	7.8-8.0	0	8.1	420-510	21.3-21.6	8.3-8.4	0
TR13	8.1	430-500	22.2-22.3	7.7-7.9	0	8.1	430-520	21.3-21.6	8.2-8.5	0
BQ1	7.9-8.0	380-460	22.5-22.6	7.7-7.8	0	8.2-8.3	410-490	22.4-22.5	7.7-7.9	0
BQ2	7.8-8.0	400-520	22.4-22.7	7.7-7.8	0.5-1.0	8.0-8.1	420-550	22.3-22.4	7.8-8.1	0
BQ9	8.0-8.1	330-360	22.5-22.6	7.6-7.8	0	8.1-8.2	390-470	22.2-22.4	7.8-7.9	0
BQ10	8.1	430-480	22.5-22.6	7.7-7.8	0	8.1	450-600	22.3-22.4	7.8-7.9	0

Hyalella azteca

	Day 0					Day 28				
Site	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)
401	8.5	450-460	22.3-22.5	8.2-8.3	0	7.9-8.0	420-530	22.4	7.7-8.0	0
402	8.5	420-490	22.4-22.6	8.0-8.1	0	8.0	350-500	22.5-22.6	7.7-7.9	0
403	8.5	400-450	22.4-22.6	7.8-8.0	0	7.9-8.1	270-500	22.2-22.4	7.8-8.0	0
1310	8.3-8.4	390-470	22.6-22.7	7.7-8.0	0	8.0	360-540	22.2-22.4	7.8-8.0	0
1312	8.3	480-520	22.1-22.4	7.9-8.1	0	8.1-8.2	430-490	22.6-22.7	7.6-7.9	0
6507	8.3	420-460	22.1-22.4	7.8-8.2	0	8.1	370-480	22.5	7.7-8.0	0
6508	8.3-8.4	410-450	22.1-22.4	7.9-8.1	0	8.1	410-520	22.4-22.6	7.7-7.9	0
2036	8.3-8.4	400-470	22.4-2.5	7.8-8.0	0	8.1	450-570	22.6	7.6-7.9	0
TR01	8.2-8.3	440-580	22.7-22.8	7.9-8.1	0	8.1	450-530	22.6-22.7	7.5-7.9	0
TR03	8.1-8.2	410-470	22.6-22.7	7.9-8.0	0	7.9-8.1	390-520	22.5-22.7	7.4-8.0	0
TR12	8.0-8.1	470-510	22.6-22.7	7.8-8.0	0	7.9-8.0	340-520	22.6-22.7	7.3-8.0	0
TR13	8.0-8.1	440-490	22.5-22.7	7.8-8.0	0	7.9-8.0	470-510	22.4-22.6	7.9-8.0	0
BQ1	8.2-8.3	380-480	22.5	7.7-7.9	0	8.3	390-480	22.3-22.4	7.9-8.0	0
BQ2	8.1-8.2	410-560	22.5	7.6-7.8	0	8.3	390-590	22.4-22.5	8.0-8.2	0
BQ9	8.3	350-410	22.4-22.5	7.6-7.8	0	8.1-8.2	340-440	22.4-22.5	7.7-8.1	0
BQ10	8.2	440-510	22.4-22.5	7.5-7.8	0	8.2-8.3	390-500	22.5-22.6	8.0-8.2	0

Table E1. Continued.

***Hexagenia* spp.**

	Day 0					Day 21				
Site	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)
401	8.4	460-480	21.9-22.0	8.0-8.1	0	8.1-8.2	680-730	22.1-22.2	7.8-7.9	0
402	8.4	430-480	21.9-22.1	7.8-8.1	0	8.1-8.2	570-640	22.0-22.2	7.8-7.9	0
403	8.3-8.4	390-430	22.1-22.2	7.9-8.1	0	8.2-8.3	570-630	22.1-22.2	7.8-7.9	0
1310	8.3	410-490	22.0	7.6-8.1	0	8.1	610-660	22.2-22.4	7.7-7.9	0
1312	8.4-8.5	450-510	22.0-22.1	8.0-8.2	0	8.1-8.2	570-620	22.1-22.4	7.8-8.0	0
6507	8.3	440-490	22.0-22.3	7.9-8.2	0	8.1	510-580	22.0-22.2	7.8-7.9	0
6508	8.3-8.4	410-440	22.1-22.3	8.0-8.1	0	7.4-8.1	530-620	22.1-22.4	1.7-7.7	0
2036	8.4-8.5	400-470	22.0-22.4	7.9-8.1	0	8.0-8.1	550-640	22.1-22.5	7.5-7.8	0
TR01	8.1-8.2	460-590	22.2-22.5	8.0-8.1	0	7.9-8.1	580-650	22.1-22.3	8.2-8.4	0
TR03	8.1	410-490	22.4-22.5	7.9-8.0	0	7.8-7.9	590-700	22.3	7.9-8.1	0
TR12	8.1	430-500	22.4-22.6	7.9-8.0	0	7.8	530-730	22.2-22.3	8.0-8.1	0
TR13	8.0-8.1	420-460	22.4-22.6	7.9	0	7.8-7.9	510-630	22.2-22.3	7.9-8.1	0
BQ1	8.1-8.2	400-450	22.5	7.8-8.0	0	8.2-8.3	560-620	22.1-22.3	7.8-8.6	0
BQ2	8.1	410-530	22.5	7.9-8.0	0	8.1	550-700	22.0-22.1	8.1-8.2	0
BQ9	8.1-8.2	370-380	22.5-22.6	7.7-8.0	0	8.0-8.1	500-530	22.1-22.3	7.8-8.2	0
BQ10	8.1-8.2	440-530	22.5	7.8-7.9	0	7.9-8.0	510-640	21.9-22.3	7.9-8.3	0

Tubifex tubifex

	Day 0					Day 28				
Site	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)	pH	Conductivity µS/cm	Temp. (°C)	D.O. (mg/L)	NH_3 (mg/L)
401	8.5-8.7	450-490	22.5-22.6	7.8-8.0	0	7.9-8.0	430-520	21.3-21.6	7.9-8.1	0
402	8.4-8.5	480-490	22.5	7.9-8.0	0	8.0-8.1	280-450	21.1-21.3	8.0-8.3	0
403	8.3-8.4	380-420	22.4-22.5	4.6-7.9	0	7.8-8.0	290-460	22.2-21.7	7.3-7.8	0
1310	8.4-8.5	410-430	22.3-22.5	7.5-7.9	0	8.4-8.5	510-600	21.0-21.5	7.6-8.0	0
1312	8.1-8.2	370-460	22.0-22.1	7.3-7.5	0	8.0-8.2	550-620	22.5-22.7	7.3-7.7	0
6507	8.2-8.3	390-410	21.8-22.1	7.6-7.8	0	8.0-8.1	360-510	22.4-22.5	7.5-7.9	0
6508	8.2-8.3	390-430	21.7-22.4	7.6-8.0	0	8.0-8.1	320-470	22.3-22.4	7.5-8.0	0
2036	8.1-8.3	400-480	21.9-22.1	7.4-7.6	0	8.1	480-620	22.5-22.7	7.5-7.9	0
TR01	7.8-8.0	400-460	21.9-22.1	7.2-7.6	0	8.1-8.2	410-590	22.4-22.6	7.6-7.7	0
TR03	7.8-8.1	400-450	21.8-22.2	7.5-7.7	0	7.8-8.0	360-470	22.6-22.8	7.2-7.7	0
TR12	8.1-8.2	420-470	21.8-22.1	7.0-7.6	0	7.8-8.1	420-600	22.7-22.8	7.1-7.6	0
TR13	8.1-8.3	380-450	21.7-22.3	7.0-7.4	0	7.9-8.0	550-610	22.4-22.7	7.5-7.8	0
BQ1	8.1-8.3	390-440	21.3-22.0	8.2-8.5	0	8.1-8.2	370-440	22.1-22.4	7.8-8.0	0
BQ2	8.0-8.1	400-480	21.7-21.9	8.1-8.4	0	8.1-8.2	380-480	22.1-22.4	7.6-7.9	0
BQ9	8.2	450-510	22.0-22.5	7.6-7.8	0	8.1	320-480	22.3-22.4	7.2-7.6	0
BQ10	8.3	450-610	21.7-21.9	7.9-8.3	0	8.1	280-630	22.1-22.2	7.4-7.8	0

Appendix F BEAST Toxicity Ordinations

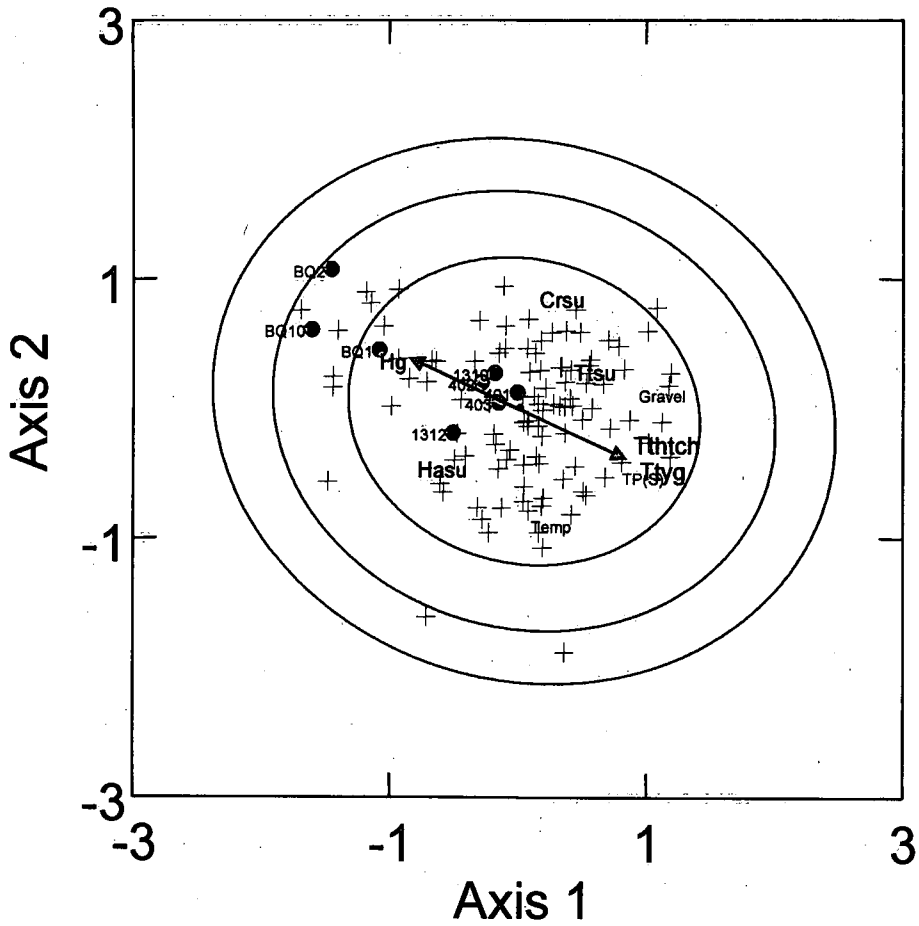

Figure F1. Assessment of a subset of Trent River and reference sites using 10 toxicity test endpoints summarized on Axes 1 and 2, showing 90%, 99%, and 99.9% probability ellipses around reference sites (individual scores are shown as cross hairs). The contribution of the most significant endpoint and environmental variables are shown with arrows. [*Tubifex* hatch (Tthtch), *Tubifex* young production (Ttyg), *Tubifex* survival (Ttsu), *Hyalella* survival (Hasu), *Chironomus* survival (Crsu)]. Stress level = 0.098.

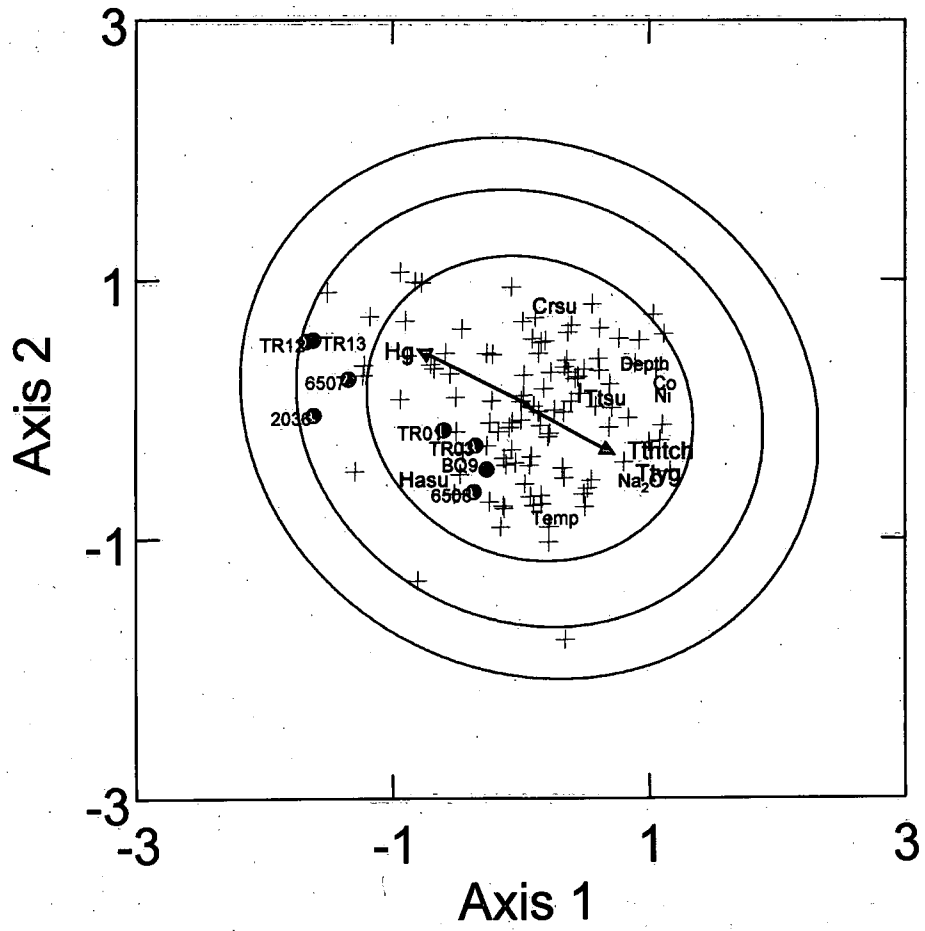

Figure F2. Assessment of a subset of Trent River sites using 10 toxicity test endpoints summarized on Axes 1 and 2, showing 90%, 99%, and 99.9% probability ellipses around reference sites (individual scores are shown as cross hairs). The contribution of the most significant endpoint and environmental variables are shown with arrows. [*Tubifex* hatch (Ttht), *Tubifex* young production (Ttyg), *Tubifex* survival (Ttsu), *Hyalella* survival (Hasu), *Chironomus* survival (Crsu)]. Stress level = 0.099.

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