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18 August 2000

Mr. Jonathan Greco, Project Manager
Federal Projects Section
Division of Hazardous Waste Remediation
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

**RE: BASELINE ECOLOGICAL RISK ASSESSMENT REPORT
MASSAPEQUA CREEK AND PRESERVE
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK**

Dear Mr. Greco:

Enclosed please find 3 copies of the Final Baseline Ecological Risk Assessment Reports.

If you have any questions, or need additional information, please call me at 732-417-5800.

Very truly yours,

ROY F. WESTON, INC.

Paul Bovitz
Project Manager

WESTON
MANAGERS DESIGNERS/CONSULTANTS

# FINAL
# BASELINE ECOLOGICAL RISK ASSESSMENT REPORT
# MASSAPEQUA CREEK AND PRESERVE
# LIBERTY INDUSTRIAL FINISHING SITE
# FARMINGDALE, NEW YORK

18 August 2000

Prepared for:

U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

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# EXECUTIVE SUMMARY

A baseline ecological risk assessment (BERA) was conducted by Dames and Moore, Inc. on behalf of the Liberty CRI/FS group. Results of that assessment were presented in the *Draft Final Baseline Risk Assessment Report* dated May 19, 2000. The focus of the assessment was on potential ecological risks from surface waters and sediments of Massapequa Creek downstream of the zone of influence of the groundwater plume that originates at the Liberty Industrial Finishing Site in Farmingdale, New York. Various electroplating and metal finishing facilities operated at the facility between the 1940's and 1970's. The assessment focuses on potential off-site receptors of contamination from the facility. These include three areas: the East Branch of Massapequa Creek, a ponded area on site referred to as "Pond A" within Massapequa Creek, and Massapequa Creek below the confluence of the East and West Branches (referred to in this report as the "Main Stream"). The Main Stream includes several small ponds (Ponds 1 through 5). Analytical results were also reported for the West Branch of Massapequa Creek, which is thought to be outside of the influence of the site, and was referred to as a reference area in the 19 May 2000 report.

This report represents a revision of the 19 May 2000 report, based upon an independent review of the data and findings of the above report conducted by Roy F. Weston, Inc. at the request of Region II of the U.S. Environmental Protection Agency (U.S. EPA). The objectives were to evaluate the findings of the original report, and where appropriate, revise the text and formulate remedial recommendations for review by U.S. EPA. As a result, much of the original document text prepared by Dames and Moore has been incorporated into the present document. No new field or analytical data have been collected. The report has been prepared in consultation with U.S. EPA, and in accordance with published U.S. EPA guidance documents. It also incorporates comments made on the original report reviewing agencies participating in the Region II Biological Technical Assistance Group (BTAG).

In the assessment, surface water and sediment were analyzed for both inorganic and organic chemicals, and screened against appropriate ecologically based screening criteria or guidelines to identify potential ecological risks. Contaminants of potential concern (COPCs) in surface water were identified as those chemicals exceeding New York State Department of Environmental Conservation (NYSDEC) surface water criteria, and chemicals for which such criteira were not available. Chemicals detected in sediment at concentrations exceeding NYSDEC sediment quality criteria, and chemicals for which such criteria were unavailable were identified as COPCs in sediment. Chemicals known to be nutrients or essential at relatively high concentrations (e.g. sodium, potassium, and magnesium) were dropped from further consideration, as were chemicals that were higher at background locations than on site.

COPCs in surface water exceeding NYSDEC criteria were aluminum and lead in the West Branch (reference location); cadmium, chromium, manganese and zinc in the East Branch; aluminum, cadmium, iron and lead in Pond A; and aluminum, chromium, iron, lead, and manganese in the Main Stream. COPCs identified in the West Branch sediment as exceeding NYSDEC criteria were arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc. Cadmium, 1,1,1-TCA and acetone exceeded NYSDEC sediment criteria in the East Branch sediment. In Pond A, the following chemicals exceeded NYSDEC sediment quality criteria: arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, and zinc, as well as 1,1,1-TCA, acetone and toluene. In the Main Stream, the following chemicals exceeded NYSDEC sediment quality criteria: arsenic, barium, cadmium, chromium, copper, lead, manganese, and zinc.

Results of the screening assessment indicated that Pond A had the highest frequency of exceedances of NYSDEC sediment quality criteria for these chemicals. In addition, individual maximum concentrations of cadmium, copper, chromium, chromium IV, lead, and zinc had the highest magnitude of any exceedances in sediment within the aquatic areas potentially affected by the Liberty site.

The COPCs identified in the screening assessment were subsequently further investigated in a tiered approach. Because cadmium, copper, chromium, and lead had the highest frequency and magnitude of exceedances in sediment, and these were the focus of the 19 May 2000 assessment, the focus of the remainder of the assessment was on these metals. Four primary endpoints were evaluated:

(1) potential bioaccumulation of metals (particularly cadmium, chromium and lead) into aquatic biota, and potential population effects on target receptors as measured by hazard quotient modeling;

(2) potential organismic effects on fish inhabiting the water bodies investigated;

(3) toxicity of sediment contamination on benthic macroinvertebrates within the water bodies investigated;

(4) potential impacts of benthic macroinvertebrate community structure as a result of sediment contamination in water bodies influenced by the site.

To evaluate potential bioacccumulation to higher receptors, fish were collected from the water bodies of concern and concentrations of cadmium, chromium and lead were measured in their tissue. The mean + 95% upper confidence level of these concentration data were used as exposure point concentrations to evaluate potential risks of contaminated surface water and sediment to fish-eating birds (belted kingfisher) and mammals (raccoon), using an ingestion model. Results of the conservative hazard quotient model based on no observable adverse effect levels (NOAELs) indicated that kingfishers and raccoons would be at risk from fish contaminated with chromium and lead in Pond A.

When more realistic assumptions were used in the ingestion model (e.g. receptors are not assumed to forage exclusively in contaminated areas, and lowest observed adverse effect levels (LOAELs) are used as a toxicity reference value), the hazard quotients to all receptors were less than 1.0 for the three chemicals investigated (cadmium, chromium, and lead). Thus, no ecological risks to either receptor (kingfishers or raccoon) would be predicted for Pond A or the other areas of concern under the more realistic exposure scenario.

To evaluate potential risks to fish themselves, analytical data from whole fish and fish filet tissue were compared to toxicological body-burden data available in the literature (the lower $10^{th}$ percentile of the lowest effects body burden (LEBB) concentrations). Results indicated that the highest body burden collected from fish tissue within these water bodies would exceed the $10^{th}$ percentile of the LEBB concentrations for chromium, cadmium and lead, indicating the potential for risks may occur to fish. The highest fish tissue concentrations of chromium and lead were detected in fish tissue collected at location PA-03, within Pond A, while the highest concentration of cadmium in fish tissue was recorded at P5-01, in Pond 5 (1.3 mg/kg). The second highest concentration of cadmium in fish tissue was recorded in Pond A at a similar concentration (1.0 mg/kg).

Toxicity to benthic macroinvertebrates was measured by conducting bioassay tests on two representative test organisms, a midge (*Chironomus tentans*) and an amphipod (*Hyallela azteca*). Bioassays were first conducted in March 1999. Results of the 14-day flow-through test with the midge (*C. tentans*) failed to meet survival-acceptance criteria for control samples; hence the test results were rejected. In the amphipod test, no chronic (i.e., 28-day) adverse effect was found in *Hyalella azteca* exposed to the sediment from any of the ponds compared to sediment from the reference location. The reference location was subsequently criticized by U.S. EPA as being impacted from contamination. The maximum metals concentrations in the sediments tested (including Pond A) were: 464 mg/kg chromium, 140 mg/kg cadmium, 69 mg/kg copper, 1800 mg/kg lead, and 680 mg/kg zinc. These concentrations are below the maximum concentrations known to occur within the pond.

Additional bioassay testing was conducted in December 1999, in which test organisms were exposed to sediment from two stations within Pond A. The December 1999 tests were conducted because of the initial failure of the midge test and the fact that the March 1999 did not test the most contaminated sediments in Pond A. The maximum concentration of metals in the sediments tested in the December 1999 tests were 687 mg/kg chromium, 142 mg/kg cadmium, 908 mg/kg lead, and 618 mg/kg zinc. Thus the sediment concentrations tested were still below the maximum sediment concentrations reported in Pond A, which for cadmium ranged as high as 248 mg/kg. The December 1999 results for the midge test indicated no effects on survival, but decreased growth of *C. tentans* in both samples, relative to the laboratory control sample. The results of the amphipod test indicated survival of *H. azteca* exposed to sediment from Pond A was significantly reduced relative to the laboratory control in both samples tested. Reference sediment was not collected for the December 1999 test. As a result, the bioassay results must be considered incomplete. However available results indicated toxicity to benthic macroinvertebrates in Pond A.

Benthic macroinvertebrate community structure was investigated in November 1998 to determine if any adverse effects were apparent in the above water bodies at the population and community levels. Benthic macroinvertebrate abundance and diversity were investigated by collecting samples within five different ponds (Pond A, and Ponds 1-4) located downgradient of the Liberty site. One reference station (location unreported, but assumed to be in the West Branch) was investigated as well. All locations, including the reference location, showed low diversity and abundance for most taxa, with the exception of the most pollution-tolerant organisms, the tubificid worms, and midges. A total of four amphipods were collected at two different locations within the four ponds. The lowest diversity and abundance of benthic macroinvertebrates reported was at location PA-03A (a duplicate sample collected at location PA-03) within Pond A.

The structure of the benthic community reported by Dames and Moore was very different with respect to both diversity and abundance from results of a previous study conducted by NYSDEC (1995) in an area near Pond 4 in August 1994. The latter study reported that the streams should be considered "slightly impacted", and found a higher diversity and abundance of organisms, perhaps because of differences in microsites sampled. The NYSDEC (1995) study focused on riffle areas, so that results may not be directly comparable to the Dames and Moore survey results.

Conclusions based on the weight-of-evidence from these studies are presented below:

1. Analytical data from sediments indicate that Pond A has the highest concentrations of several metals (cadmium, chromium, copper, lead, and zinc) reported in this investigation, as well as the highest frequency and magnitude of exceedances of NYSDEC sediment quality criteria;

2. Hazard quotient modeling using a conservative model indicated that kingfishers and raccoons ingesting fish from Pond A are potentially at risk from ingestion of fish contaminated with chromium and lead from Pond A. However, running the model with more realistic assumptions indicated hazard quotients would be <1.0 for these receptors, and that risks from bioaccumulation are not significant.

3. Comparison of fish tissue data collected in Massapequa Creek and it associated ponds, with literature based toxicological body burden data, indicates that fish are potentially at ecological risk. The highest body burdens of chromium and lead were reported in fish collected from Pond A. The highest body burden of cadmium in fish was reported in Pond 5 (1.3 mg/kg), but a similar concentration (1.0 mg/kg) was also reported in Pond A.

4. Chronic amphipod bioassays using *H. azteca* conducted in March 1999 found no significant toxicity at seven different stations within the five different ponds, including Pond A, relative to a reference location. Significant toxicity could exist in Pond A relative to the lab control, but was not analyzed. Subsequent testing in December 1999 found survival of amphipods in two sediment samples collected within Pond A was significantly depressed relative to the laboratory control sample, and that growth of the midge (C. tentans) was significantly depressed relative to the laboratory control sample as well. No reference sediment was collected or compared in that study, and the most contaminated sediment in Pond A was not tested.

5. Studies of benthic macroinvertebrate community structure within the water bodies investigated indicate a pollution tolerant community with low diversity and abundance at all locations. However, the lowest diversity and abundance of benthic macroinvertebrates reported was at location PA-03A (a duplicate sample collected at location PA-03) within Pond A.

6. Based upon the weight of evidence presented, significant risks to aquatic biota are apparent in Pond A. While the bioassay data must be considered incomplete due to flaws in the study design and resultant comparisons made, the results do indicate toxicity to benthic macroinvertebrates in Pond A.

7. Because the bioassay results are incomplete, but do indicate toxicity in Pond A, preliminary remedial goals of 50 mg/kg cadmium and 260 mg/kg chromium are recommended for Pond A upon the basis of this assessment. These risk-based criteria area based upon the following information:

   - Toxicity was observed to *H. azteca* at concentrations of 99.9 mg/kg cadmium and 457 mg/kg chromium in one sample tested in December 1999, and at concentrations of 140 mg/kg cadmium and 687 mg/kg chromium in a second sample tested in December 1999.

   - The next lowest cadmium concentration at which no toxic effects were observed within the same water body (Pond A) was 55.4 mg/kg in the March 1999 bioassay with *H. azteca*, and the corresponding chromium concentration in that sample was 268 mg/kg in the same sample.

   - Given these concentrations of 55.4 mg/kg cadmium and 268 mg/kg chromium, risk based PRGs of 50 mg/kg and 260 mg/kg chromium should be protective of the environment.

   - While cadmium concentrations alone were poorly correlated with survival of *H. azteca,* the maximum cadmium concentrations observed in Pond A were 413 times higher than the NYSDEC screening criteria for cadmium in sediment. Similarly, the maximum chromium concentration in sediment within Pond A was 32 times greater than the screening criterion for sediment.

   - Several other metals were detected in Pond A sediments that could contribute to toxicity in complex, synergistic fashion.

   - While sediment ammonia was correlated with toxicity, the observed correlation was based upon only three points, and the concentrations measured in sediment were well below levels documented in the literature as causing toxicity to aquatic life.

- The AVS/SEM predictions conducted by Dames and Moore (2000) predict cadmium in Pond A sediments is bioavailable at levels capable of causing toxicity to *H. azteca*.

- Surface water concentrations of cadmium in Pond A indicate the metal is present at concentrations exceeding NYSDEC water quality criteria. The fact that cadmium was detected in the water column indicates it is potentially bioavailable to aquatic receptors at levels posing risks. Similarly, chromium was detected in surface water within the East Branch of Massapequa Creek (which leads into Pond A) at concentrations exceeding NYSDEC surface water quality criteria, indicating it is potentially bioavailable and may pose risks.

- Other measurement endpoints investigated (e.g. benthic macroinvertebrate diversity, fish tissue concentrations) are individually unsuitable for deriving a clean up recommendation based on contaminant concentrations in sediment.

# SECTION 1.0
# INTRODUCTION

## 1.1 OBJECTIVES

A baseline ecological risk assessment (BERA) was performed for the portion of Massapequa Creek that receives groundwater discharge from the Liberty Industrial Finishing Site through groundwater flow. The goal of this risk assessment was to develop a basis for making risk management decisions for Massapequa Creek.

The risk assessment objectives were developed following the latest available U.S. EPA guidance and concepts on ecological risk assessment (U.S. EPA 1997; 1998). In keeping with current guidance, the specific objectives of the study were to:

- Characterize the nature and extent of previous human activity-related conditions at the site;
- Identify distributions of chemicals of potential concern (COPCs) and quantify, to the extent practicable, impacts of those COPCs to receptors potentially inhabiting or utilizing the site; and
- Support development and evaluation of risk management alternatives and provide a risk-based framework for identifying further data needs (if any).

## 1.2 OVERVIEW OF THE ECOLOGICAL RISK ASSESSMENT PROCESS

The *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998) document outlines the fundamental approach by which ecological risk assessments are conducted. It consists of three principal steps: 1) problem formulation 2) analysis and 3) risk characterization. Each of these steps is followed by concurrence with reviewing agencies to reach a scientific management decision point (SMDP) concerning the direction taken during the next step. The SMDP could result in no further action if threats are likely to be negligible, or else could consist of specific recommendations for collecting additional information required for further defining risks. During this assessment, U.S. EPA was consulted throughout the process, to ensure concurrence regarding the technical approach and information required to address the objectives. Copies of pertinent correspondence are included in Appendix A.

Problem formulation, the first step of the ecological risk assessment process, establishes the goals, scope, and focus of the assessment (U.S. EPA, 1998). The ultimate goal of the problem formulation step is to develop a site conceptual model that identifies the potential chemical transport pathways, receptors, and the areas of primary concern. The *Ecological Risk Assessment Guidance for Superfund* (U.S. EPA, 1997) recommends that five issues be addressed when developing a site-specific conceptual model for a screening level risk assessment. These issues are:

1. Environmental setting and contaminants known at the site.
2. Contaminant fate and transport.
3. Mechanisms of toxicity associated with contaminants and potential receptors.
4. Complete exposure pathways.
5. Selection of endpoints to screen for risk.

The second step, analysis, includes the ecological effects evaluation and exposure estimate. This step comprises the data collection and analyses necessary to evaluate risks. Section 2 of this ERA report summarizes the toxicological data used to evaluate whether potential ecological risks are occurring that affect the endpoints identified during the problem formulation stage. It includes a description of the ecotoxicological benchmark values used to screen chemical data in soil, sediment and water, and determines whether the chemicals are present at levels posing potential ecological risks. These benchmarks are generally based on toxicological effects observed in past studies on plants or animals lower in the food chain such as invertebrates and/or fish. Section 3 also summarizes the toxicological input values for the hazard quotient models used to determine whether target receptors higher in the food chain (e.g., birds, mammals) are potentially at risk from contamination. In addition, it summarizes the exposure parameters for receptors of concern such as body weight, ingestion rate, area use factors, etc., used in these risk calculations are also presented in this section. In some cases, as for fish-eating birds and mammals, the calculations were based on the tissue concentration of prey items (fish) collected directly from the site.

The third step, risk calculation, is summarized in Section 4, and presents the results of the risk assessment. It includes screening level results used to identify contaminants of concern, as well as hazard quotient modeling results used to evaluate impacts to target receptors located higher in the food chain. The results of the assessment are discussed by area of concern (AOC), and specific receptors at risk from contaminants of concern are discussed. Remedial action recommendations are provided where appropriate based on these results. In accordance with federal guidance, the risk characterization step also includes an uncertainty analysis describing uncertainty associated with the data set, model inputs, and other assumptions made in the risk assessment.

Risk management decisions are made at the conclusion of the risk assessment process. Once agreement is reached regarding the interpretation of the results of the risk assessment, a risk management decision is reached regarding how to address the potential risks or the actual impacts shown.

## 1.3 ASSESSMENT APPROACH

A tiered or phased approach was taken toward assessing potential ecological risks, consistent with U.S. EPA guidance. The approach consisted of two primary steps: (1) a screening assessment in which contaminants of potential concern (COPCs) and potential complete exposure pathways were identified, and (2) a baseline risk assessment in which COPCs were subject to further investigation of potential risks. This assessment included collection of information along several lines of evidence to evaluate assessment endpoints identified during the problem formulation stage.

# SECTION 2.0
# PROBLEM FORMULATION

## 2.1 SITE CHARACTERIZATION

Various electroplating and metal finishing facilities operated from the 1940's through the 1970's at the Liberty Industrial Finishing Site (site), which is located in Farmingdale, New York. There are no visible streams or drainages on the property. The headwaters of Massapequa Creek are located approximately one-half mile south of the site. The creek has been altered from its natural state by the construction of culverts, storm sewers, and a series of detention ponds. The headwaters of Massapequa Creek consist of an East and West Branch (Figure 2-1). The two branches merge just north of the Southern State Parkway. Although the upper East and West branches of Massapequa Creek are seasonally dry, groundwater from the site apparently discharges to the East Branch of Massapequa Creek (Dames & Moore 2000). Downstream of the confluence of the East and West branches, Massapequa Creek feeds several small ponds and lakes (Pond A, and Ponds 1 through 5) and eventually empties into the South Oyster Bay about 5 miles south of the site. In this report the portion of Massapequa Creek below the confluence of the East and West Branches is referred to as the Main Stream. Several major highways (the Bethpage Parkway, the Southern State Parkway, and Sunrise Highway) run parallel to or cross Massapequa Creek and Massapequa Preserve located south of the site. The Massapequa Preserve is surrounded by both residential and commercial properties.

Massapequa Creek from Merrick Road north to its headwaters is classified by the NYSDEC as C(t)-trout water, and trout are annually stocked in Massapequa Creek. Habitat conditions in the headwaters of Massapequa Creek are probably unsuitable for brook trout due to the ephemeral flow conditions. Ponds A, and 1 through 5 are actively used for fishing, and species taken include carp, bluegill, sunfish, and bass. It is possible that people consume fish from these ponds. A warning sign at Pond 4 indicates that a NYSDOH health advisory is in effect for fish and wildlife from this water, based on chlordane, which is not a site constituent.

The flow of Massapequa Creek is sustained by groundwater discharge from the shallow portion of the water-table aquifer. The flow volume of Massapequa Creek and the length of its channel showing flow vary substantially between seasons. Stream-flow generally begins at an altitude corresponding to the seasonal water table elevation. During the spring and early summer months of 1997 and 1998, stream-flow was observed as far north as First Avenue. However, as the water table dropped during the summer and fall months of 1998, stream-flow was not observed at all north of the Southern State Parkway. During storm events, ephemeral flow occurs throughout the length of Massapequa Creek and is fed via numerous stormwater runoff sewers from the surrounding residential areas.

Pond A and Ponds 1 through 5 are several detention ponds that exist along the main stream course (Figure 2-1). These ponds are about 1 to 4 feet deep and were constructed to control localized flooding and silting of the streambed. These ponds have accumulated a moderate thickness (approx. 0.5 to 2.0 feet) of fine-grained sediment (generally fine sands and silt). Pond

1 appears to be cut off intentionally from the main stream course and has been allowed to silt-up and is now almost completely overgrown by reeds and cattails.

The (WESTON 1994) RI Report documented the on-site and off-site vegetative and faunal communities in detail. Palustrine forested wetlands were reported to exist along the upper reach of Massapequa Creek and were considered New York State regulated wetlands. The CRI/FS activities did not include any wetland delineation. Approximately one-half of the actual Liberty site is vegetated in various stages of ecological succession, the primary on-site plant communities observed being old field, fence rows, and mixed hardwood areas. The *old field* vegetative cover type was reported to be present in the western portion of the site. Most, if not all, of the plant species observed in the old field areas were considered to be weeds or undesirable species that are typical of disturbed areas. The *second growth hardwood forest* cover type was reported to be present in the northwestern portion of the site interspersed with the *old field* cover type. The areas occupied by second growth forest were historic disposal or fill areas not recently utilized by the site operations. The *fence row* cover type was reported to be present along the various site boundaries. These vegetative communities are not considered to be at risk from contamination, as the primary mode of transport is groundwater discharge.

No endangered/threatened plant species or unique plant communities were reported to be present on-site or adjacent to the site. A data search using the NYSDEC Natural Heritage data base did not indicate any endangered/threatened plant species or unique/sensitive plant communities on-site or within a one-half mile radius.

The wildlife observed on the site was reported to be typical of old field habitats and species typical of urban disposal areas (species included the eastern cottontail and raccoon). Field mice and rats were observed on-site during the CRI. Weston (1994) reported bird species observed during an Ecological Survey of Massapequa Creek and Preserve. A variety of common birds (e.g., herons, egrets, swans, geese, mallard, killdeer, doves, belted kingfisher, gray catbird) and mammals (e.g., raccoon, muskrat) were noted in the adjacent Massapequa Creek and Preserve. No threatened or endangered species of birds, mammals, reptiles, or amphibians were reported to be observed or indicated by data from the NYSDEC-Natural Heritage database.

## 2.2 AREAS OF CONCERN

Because the focus of this investigation is on potential ecological risks associated with contaminated groundwater discharge from the Liberty site, the areas of concern are aquatic habitats associated with Massapequa Creek. In this report these habitats are divided geographically into three areas:

1) East Branch of Massapequa Creek;

2) Pond A; and,

3) The Main Stream of Massapequa Creek, below the confluence of the East and West Branches. The Main Stream includes Ponds 1 through 5.

A fourth area, the West Branch of Massapequa Creek is also discussed as a potential reference location that is affected from adjacent urban runoff, but is not thought to be influenced by groundwater discharge from the site.

## 2.3 COMPLETE EXPOSURE PATHWAYS

### 2.3.1 Potential Contaminant Exposure Pathways

Potential contaminant exposure pathways were identified on the basis of the habitat types identified on the site, and the potential for contaminant transport to those habitats. In order for a complete exposure pathway to exist, the following components are necessary:

- A contaminant must be present in a form that is available for uptake to biological receptors through ingestion, inhalation or dermal exposure routes.
- Transport mechanisms must be present, allowing movement of contaminants to sensitive environmental areas or habitats utilized by wildlife.
- A receptor must be present that is potentially affected or stressed by the contaminant.

The potential exposure pathways identified at the site are summarized as follows:

- Contaminated Sediment and Water in Massapequa Creek and Ponds ⇒ benthic macroinvertebrates (addressed in the initial screening and baseline assessments) ⇒ fish inhabiting the creeks and ponds ingesting macroinvertebrates, water and sediment ⇒ piscivorous birds or mammals ingesting fish from the creek or ponds.
- Contaminated Sediment in Massapequa Creek and Ponds ⇒ wetland plants ⇒ herbivorous mammals.
- Contaminated Sediment and Surface Water in Massapequa Creek and Ponds ⇒ benthic macroinvertebrates ⇒ birds, amphibians and reptiles ⇒ raptors, carnivorous mammals ingesting birds, amphibians and reptiles.

On the basis of site conditions, the first pathway listed is considered the primary complete exposure pathway warranting evaluation at this site. The latter two pathways were not deemed significant routes of exposure. Although vegetation within the ponds is apparently abundant, the primary COPCs investigated (see Section 4.1) are not strong bioaccumulators in aquatic plants and hence a complete pathway to herbivorous mammals such as muskrats (*Ondatra zibethicus*) is not a primary concern at this site. The pathway from benthic macroinvertebrates to birds primarily affects shorebirds, which are not likely to use the site to a great degree given its habitat. The pathway from benthic macroinvertebrates to reptiles and amphibians is a viable one on the basis of habitat, but the assumption made is that the pathway from benthic macroinvertebrates to fish and piscivorous mammals and birds is a similar one that reasonably reflects risks to these other receptors. This assumption should be sufficiently conservative, since amphibians and reptiles also forage on terrestral insects and other food items, and thus forage on benthic macroinvertebrates to a lesser degree. Moreover, most amphibians and reptiles spend at least part of their lives on land.

## 2.4 TARGET RECEPTORS

To assess potential risks from these exposure pathways, several target receptor species or groups representative of these pathways were selected for further evaluation (Table 2-1). The target receptors cover different taxonomic groups, since contaminants may affect different taxa differently, or to a differing degree. They also represent species that have different diets, since contaminants can mobilize and accumulate differently through different food items (e.g. plants, animals, etc.). The target receptors were chosen on the basis of the following criteria:

- The degree the receptor is representative of the exposure pathway indicated (e.g. birds or mammals chosen to model the piscivorous fish pathway should be those ingesting a high proportion of fish in the diet);

- Likelihood of the species occurring on site or in the area, based upon habitat availability and/or prior observations;

- Availability of literature data on the species life history and contaminant effects;

- Position on the food chain and sensitivity to contamination (e.g. if data were available on more than one species, the more sensitive receptor was chosen so that the assessment would be conservative).

The resultant exposure pathways evaluated using these target receptors are summarized as follows:

- Sediments ⇒ benthic macroinvertebrates ⇒ bluegill sunfish, pumpkinseed sunfish, carp, and rainbow trout ⇒ belted kingfisher (*Megaceryle alcyon*), raccoon (*Procyon lotor*)

The target receptors were chosen to be representative of this primary complete exposure pathway on the basis of the major habitats to be protected at the site. Risks to the dominant fauna of Massapequa Creek were evaluated by considering potential risks to benthic invertebrates, both cold and warmwater fish, and the birds and mammals that may feed on them.

Benthic invertebrates were selected as target receptors for evaluating risks from sediment contamination because they are:

- In direct contact with sediment;
- Sessile; and
- Are close to the base of the aquatic food web that includes fish, and other higher consumers.

Benthic macroinvertebrates comprise a heterogeneous assemblage of taxa that inhabit the sediment, bottom substrates, submerged logs, debris, pilings vascular aquatic plants, and root masses of aquatic systems. The major taxonomic groups of freshwater macroinvertebrates include the insects, annelids, mollusks, flatworms, and crustaceans. Because they are found in a diversity of habitats, they are commonly used to evaluate the integrity of freshwater and marine systems. Benthic macroinvertebrates comprise several feeding groups, such as, collectors, shredders, grazers, scrapers, scavengers and predators. All feeding groups are typically found in a healthy aquatic system. These organisms are important components of aquatic food webs because they decompose detritus and provide a food source for higher level consumers, such as, fish.

Several species of fish were chosen as target receptors representative of the primary complete exposure pathway. These include bluegill sunfish, pumpkinseed sunfish, common carp, and rainbow trout. All of these species have been caught or are known to occur within Massapequa Creek. Fish that are exposed to the surface water and sediments in the creek and ponds could be exposed to COPCs largely by direct contact across the gills. The gills are responsible for oxygen uptake to maintain metabolism, and in aqueous media with low oxygen contents, a large amount of water must pass over the gills in order to supply this oxygen. Constituents in the water are simultaneously brought in contact with the gills, and are absorbed through the thin gill epithelium and into the body (Laurén 1990). Fish are also exposed to COPCs through dietary exposure, via ingestion of invertebrates and direct ingestion of sediment and surface water. While this may be a lesser exposure because of the low assimilation efficiency of the gut relative to the gills (Niimi and Dookhran 1989), it was incorporated into this assessment by directly measuring fish tissue concentrations.

Higher consumers are represented by two representative target receptors: the belted kingfisher and the raccoon. These are considered to be representative avian and mammalian piscivores, respectively, that utilize habitat similar to that provided by the Liberty site. The belted kingfisher is largely piscivorous and the raccoon, although an omnivore, is likely to consume fish along Massapequa Creek and Preserve.

## 2.5 HYPOTHESES AND ENDPOINTS

The central hypothesis to be tested is whether groundwater contamination from the Liberty site has resulted in ecological impacts to the surrounding ecosystem. This hypothesis was tested using a weight of evidence approach applied to several different endpoints. An *endpoint* is defined as an ecological characteristic (e.g., fish survival) that may be adversely affected by site contaminants (EPA 1992a). Endpoints may be manifested or measured at the community level (e.g. differences in community composition or species abundance between areas), population level (e.g. adverse effects on reproduction), organismic level (e.g. necrosis of the liver in fish), or cellular/subcellular level (e.g. presence of nuclear inclusion bodies in kidney cells). Table 2-2 summarizes endpoints used to test the central hypothesis in this risk assessment.

U.S. EPA (1998) guidance recommends that ERAs should be focused in a manner that site-relevant questions are posed and testable hypotheses are clearly stated, which could answer these questions. The following risk questions and associated testable hypotheses show the functional linkage between assessment and measures of effect for these exposure pathways.

Question: Are benthic macroinvertebrates in Massapequa Creek at risk from concentrations of COPCs in surface water and sediment?

Hypothesis: $H_0$: Benthic macroinvertebrates are not at risk from COPCs in sediment.

$H_a$: Benthic macroinvertebrates are at risk from COPCs, as evidenced by:

(1) COPCs present at concentrations greater than sediment quality criteria or guidelines;

(2) Bioassay results indicating survival and/or growth to two representative test organisms are significantly lower from laboratory control or reference populations unaffected by the site;

(3) Benthic macroinvertebrate survey results indicating diversity and abundance are lower in areas of higher contamination;

Question: Are fish present in Massapequa Creek or associated ponds at risk from surface water or sediment concentrations of COPCs?

Hypothesis: $H_0$: Fish are not at risk from contamination by COPCs.

$H_a$: Fish are at risk from concentrations of COPCs as evidenced by:

(1) Surface water concentrations of COPCs greater than the surface water screening criteria;

(2) Fish tissue concentrations of primary COPCs exceeding the lower $10^{th}$ percentile of literature based data showing adverse organismic or population effects.

Question: Are piscivorous bird and mammals at risk from levels of COPCs from ingestion of fish tissue, sediment and surface water in Massapequa Creek and associated ponds?

Hypothesis: $H_0$: Ingestion of fish, and incidental ingestion of sediment and surface water from Massapequa Creek and its associated ponds does not pose risks to piscivorous birds and mammals.

$H_a$: Ingestion of fish, and incidental ingestion of sediment and surface water from Massapequa Creek and its associated ponds poses risks to piscivorous birds and mammals, as evidenced by:

(1) Hazard quotient modeling results greater than 1.0, indicating the modeled dose to representative target receptors exceeds the no observable adverse effects level (NOAEL) or lowest observable adverse effect level (LOAEL).

## 2.6 SITE CONCEPTUAL MODEL

The culmination of the problem formulation process is the development of the site conceptual model (EPA 1992a). The site conceptual model (Figure 2-2) is a simplified graphic representation of the interaction between the sources of COPCs and the potentially complete pathways by which the target receptors could potentially be exposed to the COPCs. According to the conceptual model at the Liberty site, groundwater discharge has resulted in contamination of surface water and sediment. Benthic macroinvertebrates, near the base of the food chain, are exposed directly to contaminants present in sediment. Fish prey on the benthic macroinvertebrates, and are also exposed to COPCs via incidental ingestion of surface water and sediment, as well as through the water column via diffusion across the gill membrane. Exposure to higher receptors such as piscivorous birds and mammals occurs primarily through ingestion of fish, with some exposure from incidental ingestion of surface water and sediment.

SECTION 3.0
ECOLOGICAL EFFECTS EVALUATION

## 3.1 IDENTIFICATION OF CONTAMINANTS OF CONCERN

Potential ecological risks were evaluated using a phased approach (EPA 1997, 1998a). First, concentrations of chemicals detected in sediment and surface water potentially affected by the Liberty site were screened against appropriate ecologically-based criteria or guidelines for sediment and surface water. Chemicals found to exceed these criteria (and chemicals for which criteria do not exist) were termed COPCs. Subsequently, the exposure point concentrations for selected COPCs identified in surface water and sediment were used to model estimated exposures to site contaminants for upper trophic level receptors (e.g. raccoon and belted kingfisher). Results of the second phase were primarily used in conjunction with site-specific field studies (e.g. fish and benthic sampling) to evaluate assessment endpoints and ultimately develop remedial recommendations regarding the site.

Several studies have been conducted in Massapequa Creek, including Weston (1994) and Dames and Moore (2000). The analyses included Target Analyte List inorganics (TAL metals) and Target Compound List volatile organic chemicals (TCL VOCs) in surface water and sediments in the East branch of Massapequa Creek, the West Branch of Massapequa Creek, the ponds of Massapequa Preserve, and one off-site reference area (location unreported). The data that were used in this ERA are presented in Appendix A.

## 3.2 SCREENING CRITERIA/GUIDELINES

### 3.2.1 Surface Water Quality Criteria

In this assessment, concentrations of chemicals detected in surface water were compared to the NYSDEC Ambient Water Quality Standards and Guidance Values (NYSDEC 1998). For metals such as cadmium, chromium, copper, nickel, lead and zinc, the criteria are based upon hardness in the ambient waters. Criteria based upon water hardness were calculated using the appropriate equations presented in the criteria document (NYSDEC 1998) and using the observed minimum hardness of 33.5 mg $CaCO_3$/L, based on the mean measured hardness in both West Branch and Main Stream waters. Potential risks to aquatic organisms from tetrachloroethene are not covered by this document so that compound was screened against the guidance value found in Suter and Tsao (1996). The screening value in Suter and Tsao (1996) was calculated according to methods found in the Great Lakes Water Quality Initiative (U.S. EPA 1995) for Tier II Aquatic Life Criteria.

Similarly there is no NYSDEC ecological (or human health) water quality criterion for MTBE. However, Mancini (1997) has summarized the available toxicity data and reported that the lowest concentration causing chronic effects on reproduction in *Daphnia magna* ($EC_{25}$=204,000 µg/L). This value, divided by a conversion factor of 10 (i.e. 20,400 ug/L), was used for screening purposes for that compound.

If the highest value in the Main Stream was greater than the screening value, the COPC was retained for further analysis. When the highest value was found in the West Branch, no further analysis was conducted, because such values were assumed to represent concentrations that are not affected by any potential site-related chemicals.

### 3.2.2 Sediment Quality Criteria

Concentrations of chemicals detected in sediment were compared to criteria for sediments listed in the Technical Guidance for Screening Contaminated Sediments (NYSDEC 1999). Two different categories of screening criteria are presented in this section, a Lowest Effect Level (LEL), below which toxicity is seldom found, and a Severe Effect Level (SEL), above which toxicity is nearly always found. The LEL was used as a screening guideline to identify COPCs in sediment. If there were no available guidelines for a chemical, then the marine apparent effects thresholds (AET; Buchman 1999) were used (Table 3-6). Both the Persaud et al. (1993) and Long and Morgan (1990) guidelines (which form the basis for the NYSDEC criteria) are considered guideline values that are useful to determine if further analyses of risk are necessary.

## 3.3 COMPARISON OF FISH TISSUE BURDEN DATA TO LITERATURE VALUES

The whole body concentrations of Cd, Cr and Pb analyzed in fish tissue collected from Massapequa Creek were compared to a subset of the comprehensive database of fish tissue chemical residues compiled by Jarvinen and Ankley (1999). The fish tissue concentrations collected from the site were compared to the lower $10^{th}$ percentile of the lowest effects body burden (LEBB) concentrations. The U.S. EPA considers this approach to be less conservative than the no effect body burdens found in Jarvinen and Ankley (1999), as follows (U.S. EPA, April 12, 2000):

> "Typically, a toxicological reference value (TRV) representing the 10th percentile of the LEBB values listed in the table above would be reasonable. As EPA Region II has used the No Observed Adverse Effect Levels (NOAELs) at several of its Superfund sites to calculate toxicological reference values for fish species (e.g., EPA, 1999), the calculation of a percentile of the effects concentrations is less conservative than the use of an NOAEL. The calculation of a percentile of the effects concentrations is also consistent with the approach used by NOAA to develop ER-L and ER-M guidelines for sediment concentrations (Long et al., 1995)."

The U.S. EPA also requested that this method should be applied to Cr and Pb. Unfortunately, there are no Cr data and there is only one datum for Pb in Jarvinen and Ankley (1999). Therefore, other data sources were reviewed.

## 3.4 HAZARD QUOTIENT MODELING TO HIGHER RECEPTORS

### 3.4.1 Overview

Contaminants of potential concern (COPC) identified during the initial screening assessment of sediment and surface water were retained for further analysis of risks. However, while normally hazard quotient modeling is conducted on all of these contaminants, the focus of this risk assessment is on those chemicals that were analyzed further by Dames and Moore during their 19 May 2000 risk assessment investigation. The focus of the assessment was therefore on cadmium, chromium and lead, with some discussion of copper, zinc and other metals. Information from the initial screening assessment on the remaining chemicals (summarized in Section 4.1) will be retained for use in making risk management decisions regarding the site.

The hazard quotient method was used in the second step of this risk assessment to estimate the potential risk for each contaminant detected via bioaccumulation to higher receptors. Hazard quotient modeling involves calculating potential risks to target receptors based on life history characteristics of the receptor(s) chosen, the exposure point concentration of the contaminant, and data on the likelihood of toxicological effects associated with the modeled dose.

The hazard quotient method compares the exposure point concentrations (dose to receptor) to toxicological effects or toxicity reference values (TRVs) and is expressed as a ratio per the following formula:

$$HQ = \frac{Dose}{TRV}$$

Where,

HQ = Hazard Quotient

Dose = Exposure Point Concentration x BCF x Ingestion Rate / Body Weight

(the entire dose is usually multiplied by an area use factor, representing the proportion of time the animal spends on the site or within the AOC being modeled)

TRV = Toxicity Reference Value, or a measure of the dose where harmful effects are observed

A hazard quotient (HQ) value of less than 1 indicates that the COPC alone is unlikely to cause adverse ecological effects. A HQ value of greater than 1 indicates the potential for ecological risks exists, and that the risk assessment process should therefore continue. In such a case more site-specific information may have to be gathered (e.g., fish tissue, toxicity tests, data on community structure, etc.).

Hazard quotient modeling of higher ecological receptors was conducted in two ways. The first involved using very conservative inputs in order to determine if the HQ was less than 1 under the most conservative assumptions. If such were the case, a legitimate case can be made for taking no further action toward the area of concern for that contaminant, since it would be very unlikely that the levels of contamination present posed ecological risks.

The second approach involved more realistic assumptions of risk, incorporating site-specific data, and assumptions based on more realistic exposive scenarios and toxicological reference values. The objective of this modeling approach was to more realistically determine the need for remedial activities at the site, and determine what potential clean up levels would be required to minimize the potential for risks identified using the conservative approach. This approach still incorporated several conservative assumptions.

### 3.4.2 Hazard Quotient Modeling Inputs

Hazard quotient modeling requires several inputs. Hazard quotient modeling was initially conducted using conservative inputs, to see if any of the primary COPCs could be dropped from further consideration within the different areas of concern investigated. Inputs used for the conservative model are summarized in Table 3-1.

To calculate the dose, one must first determine the exposure point concentration, or the concentration in sediment or surface water the organism is likely to be exposed. For the purposes of this risk assessment, the mean + 95% upper confidence interval was used for sediment, surface water and fish tissue collected within each area of concern evaluated (Table 3-1).

The second element of the dose is the intake rate of the contaminant. This is a function of the daily food ingestion rate for the target receptor being modeled, as well as the amount of the contaminant in the soil or sediment that is actually present in the food item. The food intake rate for each receptor was taken from the literature. The lowest of the mean ingestion rates for adult animals was used. To estimate the dose of the contaminant, the exposure point concentration in fish tissue collected at the site was used. The mean + 95% upper confidence interval of the contaminant in fish tissue was used as the exposure point concentration for the ingestion model. The resultant intake was divided by the lowest mean adult body weight found in the literature, to obtain a dose in mg/kg body weight/day.

The following approach was used to address sediment and water ingestion for each of the target receptors that may incidentally ingest sediment or water. Sediment and water ingestion rates are provided in the literature as a percentage of the diet. It was conservatively assumed that any sediment and water ingestion intake was in addition to 100% of the dietary (food) intake, and not part of the diet. For example, if a receptor ingests 100 g of dry weight food per day, and the sediment ingestion rate is equivalent to 3% of the diet, then the sediment ingestion rate is equal to 3 g dry weight/day. This amount is in addition to the dietary intake of 100 g dry weight food/day, totaling a solid material intake of 103 g per day. This ingestion rate was multiplied by the exposure point concentration for sediment or water, and then added to the dose before normalizing by body weight and area use factor.

The area use factor (AUF) represents the amount of time an individual target receptor may spend on site or within the AOC being modeled. It represents the portion of the home range of the receptor that falls within the site or the AOC. The maximum area use factor is 1.0, which implies that the organism spends 100% of its time on site or within the AOC modeled. For target receptors with small home ranges, the AUF is often close to 1. Similarly, larger, extensive areas of contamination are more likely to result in an AUF of 1, since they are more likely to occupy an individual's entire home range. For the conservative model, the AUF was assumed to be 1.0. For the more realistic exposure model, a true AUF was used based upon the animal's home range relative to the area of concern at the Liberty site.

Toxicological effects values for wildlife are dose-based levels of contamination that are not expected to cause adverse effects. Typically, these values are presented as milligrams contaminant per kilogram body weight per day (mg/kg BW/day) and compared to an equivalent receptor-specific cumulative dose or estimated daily intake of food, water, and sediment calculated from site-specific concentrations. Unfortunately, regulatory values for the protection of wildlife are not available. Thus, avian and mammalian toxicological effects values were obtained from peer-reviewed primary research articles and database searches. If primary research articles could not be obtained, data from secondary sources were used. Multiple references were screened; those references that were reviewed in detail are contained in the following discussion. To qualify for consideration, studies had to meet the following criteria:

- Test species similar to the target receptor.
- *In vivo* study.
- Oral administration via food, drinking water, or gavage (feeding study preferred).
- NOAEL or Lowest-Observed-Adverse Effect Level (LOAEL) identifiable.
- Population-level endpoints such as reproductive effects and mortality of adults or offspring.

Studies using the site-specific target receptors (i.e., kingfisher, raccoon) were preferentially sought. However, toxicological data for these target wildlife species were often unavailable. In such cases, where possible, literature data were used that were based on surrogate species taxonomically related to the target species, that have similar diets and digestive systems.

For those studies for which both a NOAEL and LOAEL were available, both the NOAEL and the LOAEL are presented. By definition, a NOAEL is that dose of a chemical at which there is no statistically or biologically significant increase in the frequency or severity of adverse effects between the exposed population and its appropriate control. By comparison, a LOAEL is the lowest dose of a chemical in a study or group of studies that produces biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control (Dourson and Stara 1983). Endpoints that could directly affect the target species at the population level were given preference (e.g., reproductive effects and mortality of adults or offspring) in establishing ecological significance. The next preference was given to serious histopathological effects (e.g., necrosis or damage to liver, kidney, or brain) that alter primary body functions. Studies on cellular or subcellular effects (e.g. enzyme reduction) were given less weight, since their significance to the population level is harder to determine. In the absence of preferred data, consideration was given to effects such as alterations in biochemical functions of an organ that could be correlated with decreased survivability and alterations in normal behavior resulting in decreased survivability of a receptor (e.g., impaired motor skills, increased reaction time, and altered feeding habits). Other effects such as altered body weight, decreased liver size, and increased blood chemistry are not readily associated with decreased survivability or longevity and were used only in the absence of the preferred toxicity data.

For the initial conservative HQ model, the NOAEL data were used to calculate hazard quotients and determine risks. For the more realistic exposure model, the less conservative LOAEL value was used in order to develop site-specific clean up criteria that would not be based on overly conservative assumptions regarding the potential impacts of site contamination.

### 3.4.3 Receptor Exposure Models

This section summarizes the model inputs used for the target receptors (i.e. kingfisher and raccoon) identified as indicators of the complete exposure pathways modeled for each area of concern.

#### *3.4.3.1 Raccoon*

Raccoons *(Procyon lotor)* are common and mostly nocturnal mammals inhabiting wooded areas near water, marshes, suburban areas, or virtually any area that can provide food, a den, and permanent water (Hoffmeister 1989; Jones and Birney 1988). Their dens are usually within 1,200 feet from a water supply but are situated in an area where the den can remain dry (Hoffmeister 1989). These dens may be in hollow trees, burrows, caves, crevices in rock, haystacks, chimneys, or under logs (Hoffmeister 1989; Schwartz and Schwartz 1981). During periods of heavy snow or ice, raccoons will den together for several days (Schwartz and Schwartz 1981), otherwise, they are normally solitary and remain active throughout the year (Jones and Birney 1988).

Raccoons are opportunistic omnivores consuming various food items such as berries, fruit, nuts, corn, seeds, aquatic and terrestrial invertebrates, eggs, frogs, snakes, fish, muskrats, and young waterfowl (Jones and Birney 1988; Schwartz and Schwartz 1981). Seasonal and local food availability appears to dictate dietary composition, although as a general rule, plant matter comprises a greater portion of the diet than does animal matter (Barbour and Davis 1974).

Breeding may occur from December through July, although most breeding occurs from January to March (Schwartz and Schwartz 1981; Jones and Birney 1988). Gestation lasts for approximately 63 days with litter sizes ranging from two to seven young (Barbour and Davis 1974). The young are weaned at 10 to 12 weeks, forage with the female parent well into the autumn, and are ready to breed their first winter (Barbour and Davis 1974). Natural predators of the raccoon include owls, hawks, bobcats, coyotes (Merritt 1987; Schwartz and Schwartz 1981). Most raccoons live less than 5 years in the wild (Schwartz and Schwartz 1981).

Exposure Profile

The following inputs were used for hazard quotient modeling of raccoon ingestion of site contaminants. Adult raccoons weigh from 3 to 15 kg (Merritt 1987; U.S. EPA 1993). The home range of this species varies from 12 to 12,350 acres (Merritt 1987).

The food ingestion rate for a raccoon is reported to be approximately 500 g/day (Newell 1987); the water ingestion rate is estimated to be approximately 0.083 g/g BW/day. To express the water ingestion rate in units of g/day, the water ingestion rate of 0.083 g/g BW/day was multiplied by the lowest reported body weight of 3 kg to yield a water ingestion rate of 24.9 g/day (24.9 ml/day).

A soil ingestion rate of 9.4 percent of the total diet has been reported for the raccoon (Beyer *et al.* 1994). To express this value in units of g/day, the soil ingestion rate of 9.4 percent was multiplied by the food ingestion rate of 500 g/day to yield a soil ingestion rate of 47 g/day.

#### *3.4.3.2 Belted Kingfisher*

The belted kingfisher *(Megaceryle alcyon)* is a pigeon-sized, territorial bird that is the only kingfisher present throughout most of North America (Bull and Farrand 1977; NGS 1987). Belted kingfishers inhabit rivers, lakes, and estuaries and are often seen patrolling a favorite sheltered section of a waterway for prey (NGS 1987). Food items include primarily shallow water fish, although crayfish, frogs, small snakes, salamanders, insects, crabs, and even mice may be consumed (Bull and Farrand 1977; Landrum et al. 1993). It is estimated that a pair of kingfishers with nearly fledged young requires approximately 90 fish per day to feed their offspring and themselves (Landrum et al. 1993).

This species is solitary with the exception of the nesting season. Breeding times for this species vary with locale. Unseasonably mild weather may initiate early nesting in the lower United States. The presence of herbaceous cover and good fishing habitat are the basis for the selection of breeding areas and nest sites. Nests consist of streambank or shoreline burrows and vary in length depending upon the soil texture. Although usually near water, nests have been found up to 1.6 km away from water. A clutch of six to seven eggs are usually laid between early April and mid-June. Incubation lasts for 25 days with nest occupation for an additional 23 days. The fledglings remain near the nest and juveniles disperse by mid-summer (Landrum et al. 1993).

Males generally do not readily leave their territories and will remain there throughout the winter as long as ice does not impede fishing. Females typically migrate southward and return to the same mate and nesting site every year. The likelihood of migration for both males and females appears to depend on the severity of the winter (Landrum et al. 1993).

Exposure Profile

The following inputs were used for hazard quotient modeling of kingfishers ingesting site contaminants. Adult belted kingfishers weigh from 113 to 215 g (Fry and Fry 1992). The lowest reported body weight of 113 g was assumed for this risk assessment. Although the home range of this species varies seasonally and is usually reported as kilometers of shoreline (Landrum et al. 1993), the home range was assumed to be approximately 160 acres (DeGraaf and Rudis 1993).

Food ingestion rates for adult kingfishers vary from 50 percent BW/day, and 60 g/day, to 0.5 g/g body weight/day (Newell 1987; U.S. EPA 1988; U.S. EPA 1993). The highest food ingestion rate of 60 g/day was assumed for this risk assessment.

A water ingestion rate of 0.11 g/g BW/day is estimated for this species (U.S. EPA 1993). To express this value in units of g/day, the water ingestion rate was multiplied by the lowest reported body weight, 113 g, to yield a water ingestion rate of 12.43 g/day (12.43 ml/day).

Belted kingfishers are reported to consume fish ranging in size from 25 to 178 mm in length (Sayler and Langler 1946). In keeping with the conservative approach of this risk assessment, the amount of sediment entrained in fish 178 mm long was predicted. The standard weight of a 178 mm bluegill was calculated to be 122.6 g based on the following algorithm relating length to weight (Hillman 1982):

$$\log \text{Weight (g)} = -5.374 + 3.316 \log \text{Length (mm)}$$

An incidental sediment ingestion rate could not be identified for the belted kingfisher. To evaluate this exposure pathway, a model was developed that predicted the amount of sediment, which may be entrained in the digestive system of a fish, the bluegill (*Lepomis machrochirus*). This was assumed to be the primary mechanism by which a piscivorous bird such as the belted kingfisher may incidentally ingest sediment. A study evaluating the stomach contents of 153 bluegills reported an average content of detritus and sediment to be 9.6 percent of the total diet (Kolehmainen 1974). A daily food ingestion rate of 1.75 percent of the body weight per day has been reported for the bluegill (Kolehmainen 1974). This provides a predicted intake rate of 2.15 g of food per day for a 122.6 g fish. If a conservative assumption is made that 9.6 percent of the food ingested is entirely sediment, it can be predicted that a fish of this size may contain 0.206 g of sediment in its digestive system.

For the purpose of this model, it was assumed that the level of sediment contained in the digestive system of a fish remains constant over time. This value (0.206 g) was divided by the predicted fish body weight (122.6 g) to express sediment entrained in fish digestive systems in units of grams of sediment per gram of fish body weight. This provided a value of 0.0017 g sediment/g body weight. When this value is multiplied by the food ingestion rate of the belted kingfisher (60 g/day), the predicted sediment ingestion rate for the kingfisher is 0.1 g/day. This value was multiple by the maximum sediment concentration within each area of concern. The resultant dose from sediment ingestion was added a separate term to the dose calculated from food ingestion in the hazard quotient ingestion model.

## 3.5 SITE-SPECIFIC BIOLOGICAL FIELD STUDIES

In addition to the habitat survey conducted at the Liberty site, additional site-specific biological field studies were conducted with the following objectives:

- Obtain site-specific data on tissue concentrations in fish to be used for hazard quotient modeling to piscivorous fish and mammals potentially using aquatic habitats on site; a second use of the data was to compare body burden levels in fish to literature based data to determine whether fish may be impacted by contamination;
- Collect sediment for use in laboratory bioassay testing using two representive benthic invertebrates;
- Collect data on the quality of aquatic habitat, and determine whether any potential impacts of contamination exist affecting benthic macroinvertebrate community structure in Massapequa Creek and its associated ponds.

Results of these studies were used collectively with the initial screening and hazard quotient modeling results to address risks to receptors using the endpoints identified in the problem formulation phase (Table 2-2), and ultimately to make risk management recommendations based upon a weight-of-evidence approach.

### 3.5.1 Fish Sampling

In order to evaluate the potential risk to birds and mammals that consume fish from Massapequa Creek, Dames & Moore collected whole fish and fish filets (November 1998) and measured the concentrations of Cd, Cr, and Pb. Fish were collected utilizing a Model 15-D Smith-Root backpack electrofishing unit. For each species utilized in the analysis, total length, whole body weight and fillet weight were recorded. For samples in which none of the individuals could be filleted (due to size limitations), only whole body analyses were conducted. All fish were filleted in accordance with the NYSDEC Bureau of Environmental Protection Fish Preparation Procedures for Contaminant Analysis (provided by P. Carella, NYSDEC). Only whole body data were used for comparison with literature-based toxicological values.

The maximum fish tissue data from each area of concern were used as inputs to the hazard quotient ingestion models, regardless of whether they were whole body concentrations or filet concentrations.

### 3.5.2 Bioassay Testing Using Benthic Macroinvertebrates

Bioassays were conducted on two occasions, once in March 1999 and again in December 1999. The bioassays were conducted by Aqua Survey, Inc. (Flemington, New Jersey), and used two different benthic invertebrate organisms, the amphipod, *Hyalella azteca*, and the midge, *Chironomus tentans*. The bioassay for *C. tentans* followed standard ASTM (ASTM 1996) and U.S. EPA (U.S. EPA 1994) protocols. Both bioassays were conducted as flow-through tests. The midge bioassay lasted 14-days and measured lethality and growth (weight increase), an indicator of sub-lethal effects.

### 3.5.3 Benthic Macroinvertebrate Survey

In November 1998, Dames & Moore conducted a survey of benthic macroinvertebrates to determine if any adverse effects were apparent at the population and community levels of biological organization. Benthic macroinvertebrate samples were collected at each station utilizing a standard-sized Ekman grab sampler (150mm x 150mm). The sampler was inserted into the sediment to a depth of approximately 20cm where the scoops were closed, the sample was retrieved and then placed into an internally and externally labeled sample container. Samples were immediately preserved in 15 percent formalin with Rose Bengal stain added to facilitate sorting and placed on ice and shipped to the laboratory for analysis. At the laboratory, samples were washed over a 500-μm sieve, and organisms sorted and enumerated.

Using this data, Dames & Moore enumerated 1) total organisms, 2) total taxa (species richness), and calculated 3) Shannon-Weaver Indices (H), and 4) Shannon-Weaver evenness (J) for each sample. No Ephemeropteran, Plecopteran or Tricopteran (EPT) organisms were present in these samples, therefore the EPT metric could not calculated.

Results of the community structure analysis were compared (generally) to contaminant levels within sediments of each area of concern, for use in evaluating potential risks according to a weight-of-evidence approach.

# SECTION 4.0
# RISK CHARACTERIZATION

## 4.1 SCREENING ASSESSMENT RESULTS

### 4.1.1 Surface Water Screening Results

#### *4.1.1.1 Comparison with NYSDEC Surface Water Criteria*

Table 4-1 presents results of the screening assessment of surface water samples collected from areas of concern within Massapequa Creek. The maximum concentrations of chemicals detected in any of the 9 samples collected were compared to NYSDEC surface water quality criteria. As indicated in the table, none of the organic compounds (volatile organics or semi-volatile organic compounds) exceeded the NYSDEC criteria in the samples collected. However, NYSDEC has not published criteria for several of these chemicals.

Several exceedances were noted for metals; the values are shaded in Table 4-1. In Pond A, near the base of the East Branch, exceedances were noted for aluminum, cadmium, iron and lead in the one surface water sample collected. The magnitude of these exceedances was less than 2.7 in all cases.

In the Main Stream of Massapequa Creek below Pond A, exceedances were noted for aluminum, cadmium, iron, lead and manganese. Fewer exceedances were noted, with aluminum, cadmium, and lead each exceeding the NYSDEC criteria at 2 of 9 locations, and iron and manganese each exceeding the NYSDEC criteria at 4 of 9 locations. Most of the exceedances were less than 2 times the criterion, but iron (2.55 times the criterion) and lead (4.95 times the criterion) were present at higher concentrations.

Table 4-2 summarizes those chemicals that did exceed NYSDEC surface water quality criteria. As can be seen in the table, exceedances were limited to the following metals: aluminum, cadmium, chromium, chromium VI, cobalt, copper, iron, lead, manganese, and zinc. Review of the frequency of exceedances in the East Branch (Table 4-1) indicates that aluminum (7/9), cadmium (5/9), and lead (7/9) had most widespread exceedances. Review of the magnitude of exceedances, comparing the maximum concentration detected to the NYSDEC criterion (Table 4-1) indicates that aluminum (4.17 times the criterion), cadmium (22.2 times the criterion), lead (11.2 times the criterion), and chromium (4.49 times the criterion) had the highest magnitude of exceedances.

#### *4.1.1.2 Comparison with West Branch Surface Water Data*

Contaminant concentrations in the West Branch indicate that it is impacted from local storm water runoff or other contaminant sources. However, the following organic compounds had slightly higher maximum values in the East Branch than in the West Branch: 1,1,1-

trichloroethene (1,1,1-TCE), 1,2-dichloroethene (1,2-DCE), dibromochloromethane, tetrachloroethene, and TCE.

In addition, of the metals exceeding the NYSDEC criteria in the East Branch, the following were detected in the East Branch in surface water at higher maximum concentrations: aluminum, cadmium, chromium, chromium VI, cobalt, copper, and lead. These metals can be considered site-related. Iron and manganese were higher in the West Branch than in the East Branch, Pond A and the Main Stream. Therefore, iron and manganese can be dropped as COPCs in surface water, as they are probably not site-related.

Several of the metals detected in surface water above NYSDEC criteria (e.g. aluminum, cadmium, chromium, etc.) were also detected in sediment within the East Branch, Pond A and Main Stream (see Section 4.1.2). This suggests that the metals are entering the water column from the sediment (in either total or dissolved form), since groundwater flows would enter the stream via pore water in the sediment.

### 4.1.2 Sediment Screening Results

#### *4.1.2.1 Comparison with NYSDEC Sediment Quality Criteria*

Table 4-3 provides results of the initial screening assessment of sediment analytical results from Massapequa Creek and its associated ponds. Review of the table indicates that of the organic compounds detected, only acetone and toluene exceeded NYSDEC sediment quality criteria. While acetone concentrations could be attributable to laboratory contamination, acetone was not detected in the West Branch. Acetone was detected in 1 of 10 locations in the East Branch, 5 of 10 locations in the Main Stream and 2 of 3 locations in Pond A. Toluene was detected in 1 of 10 locations in the East Branch, and 1 of 3 locations sampled in Pond A.

The following metals were detected in sediment from the East Branch at concentrations exceeding NYSDEC sediment quality criteria: cadmium, chromium, copper, lead, and silver (Table 4-3). In Pond A, these same metals exceeded the NYSDEC sediment quality criteria, as did chromium VI, manganese, mercury, nickel, and zinc. In the Main Stream, the following metals exceeded the NYSDEC sediment quality criteria: arsenic, cadmium, chromium, copper, lead, manganese, and zinc. In addition, other metals were detected for which no NYSDEC sediment quality criteria are available for comparison (Table 4-4).

Concentrations of metals in sediments within Pond A exhibited the greatest number of exceedances of the NYSDEC sediment quality criteria (Table 4-3). The concentrations present in Pond A also represented the highest magnitude of exceedances of the criteria within the areas of concern investigated.

The metals accounting for the highest numbers of exceedances within Pond A were cadmium (19 of 19 locations exceeded), chromium (18 of 19 locations exceeded), copper (17 of 19 locations exceeded), lead (18 of 19 locations exceeded), mercury (17 of 19 locations exceeded), nickel (15 of 19 locations exceeded) and zinc (17 of 19 locations exceeded). The metals whose maximum concentration detected in Pond A exhibited the highest magnitude of exceedances were cadmium (413 times the criterion), lead (37.4 times the criterion), and chromium (32.3 timesthe criterion). The latter three metals were the focus of additional studies investigating bioaccumulation of metals into fish tissue and subsequently higher receptors (see Section 4.4). The remaining metals were not retained in the assessment conducted by Dames and Moore, but with the exception of manganese, nickel and arsenic (see below) are retained in the present assessment for use in making risk management decisions on basis of a weight of the evidence approach.

#### *4.1.2.2 Comparison with West Branch Sediment Data*

Of the COPCs identified above as exceeding NYSDEC sediment quality guidelines within Massapequa Creek and its associated ponds, only manganese was detected in the West Branch sediment at higher concentrations. However, arsenic and nickel were detected at similar concentrations within the West Branch. It is proposed that manganese, arsenic and nickel should not be considered as site-related.

#### *4.1.2.3 Further Screening of Organic Chemicals Detected in Sediment*

The NYSDEC sediment quality criteria for organic chemicals were derived from co-occurrence, not from chemical-specific analyses. In addition, NYSDEC sediment quality criteria are not available for many organic chemicals. For this assessment, the screening of sediment quality for organic chemicals against NYSDEC sediment quality criteria was supplemented by deriving criteria that use the individual chemical's physical characteristics to predict bioavailability and toxicity. The concentrations of organic COPCs in pore water were estimated using equilibrium partitioning (EqP) and the toxicity of these pore water concentrations of chemicals was estimated using quantitative structure-activity relationships (QSARs; U.S. EPA 1988). EqP uses the octanol:water partition coefficient of organic chemicals to estimate how much of that chemical will be bound to organic carbon in sediments, and how much will be available to cause toxicity in the sediment pore water. The general EqP formula is to calculate a "safe" level of a COPC in sediment is:

$$COPC_{\text{Sediment}} = f_{OC} \times K_{OC} \times NOEC \qquad (1)$$

where:

$f_{OC}$ = fraction of total organic carbon (TOC);

$K_{oc}$ = organic carbon partition coefficient;

NOEC= water quality benchmark or TRV.

The $K_{oc}$ was estimated from the octanol:water partition coefficient ($K_{ow}$) of the organic chemical by using the following equation (DiToro et al. 1991):

$$\text{Log}_{10}(K_{oc}) = 0.00028 + 0.983 \log_{10}(K_{ow}) \qquad (2)$$

The QSAR used to predict pore water toxicity integrates the hydrophobic nature of a chemical and an organism's biological uptake process to predict the TRV (McCarty et al. 1992; DeWolf et al. 1988). This QSAR was used to estimate the 16-day no effect concentration (NOEC) for *Daphnia magna* reproduction from exposure to chlorinated alkanes and aromatics and to alcohol. The specific QSAR is:

$$(1/\log \text{Chronic NOEC}_{Daphnia} :\text{mol/L}) = 0.67 \log K_{ow} - 2.82 \quad (3)$$

The toxicity of organic chemicals depends entirely on the body burden achieved (Landrum et al. 1994; Verhaar et al. 1995), and this, in turn, is dependent upon the concentration of body lipids in the organism. Since *D. magna* is similar in lipid content to many benthic invertebrates, the toxicity found with *D. magna* is similar to that found in other benthic invertebrates when expressed as pore water concentrations. Therefore, *D. magna* is an appropriate surrogate for benthic invertebrates in general.

Table 4-5 shows the sediment COPC concentrations, and the De Wolf et al. (1988) QSAR-derived NOEC values, partitioned to 2% organic carbon. This screening is considered sufficiently conservative since site sediment TOC ranged from 8.3 to 17.2

As a result, acetone toluene and other oganic compounds detected are not considered to be COPCs.

### 4.1.3 Summary of Screening Assessment Results

Results of the screening assessment of surface water and sediment in Massapequa Creek and its associated ponds indicate that metals are the primary COPCs. The highest frequency and magnitude of exceedances of metals in surface water were for aluminum, cadmium, and lead. While only one surface water sample was collected in Pond A, it clearly had the highest and most widespread exceedances of metals in sediment. The highest frequency and magnitude of exceedances in sediment of Pond A were for cadmium, chromium, copper, lead, mercury, nickel, and zinc.

## 4.2 FISH BODY BURDEN RESULTS

To support the risk assessment to piscivorous birds and mammals, Dames & Moore collected whole fish and fish filets from Massapequa Creek (during November 1998) and measured the concentrations of Cd, Cr, and Pb (Table 4-6). A secondary objective was to compare these tissue concentrations with known toxicological effects data in the literature on body burden data in fish. The fish tissue data were screened against published summaries of body burdens from bioassays with different fish species, different durations, and different endpoints.

Based on a U.S. EPA-approved scope of work, warm water species of fish, common carp, bluegill sunfish, pumpkinseed, and sunfish were collected. All animals collected were adults. Only the whole fish data are reported here, since effects data cannot be directly compared to filet or carcass data. The highest measured concentrations of metals in fish from Massapequa Creek were 1.3 mg Cd/kg (P5-01), 4.0 mg Cr/kg (PA-03), and 6.8 mg Pb/kg wet fish weight (PA-03).

The concentrations of Cr, Cd, and Pb were considerably higher in fish collected from location PA-03 (Pond A) compared to the downstream locations. This difference was most pronounced for Pb in carp, as might be expected considering the feeding habits of this species. The carp is a bottom feeder, while sunfish tend to feed in the water column. At location PA-03, the order of relative concentration above the reference sample was Pb > Cr > Cd.

### 4.2.1 Cadmium

Results of the comparison between cadmium concentrations in fish tissue and effects data obtained from the literature are summarized in Figure 4-1. The complete dataset for Cd in fish, presented in Jarvinen and Ankley (1999), is shown in Table 4-7. These data are displayed in graphic form in Figure 4-1, indicating the frequency and cumulative frequency of the occurrence of NEBB and LEBB concentrations.

The 10% percentile of the Cd LEBB dataset is 0.33 mg/kg wet weight. Thus the highest and the mean concentrations of cadmium measured in whole fish from Massapequa Creek (1.3 mg/kg ww and 0.49 mg/kg ww, respectively) both exceed the $10^{th}$ percentile of the Cd LEBB dataset. Therefore, according to this method of analysis, fish could be potentially at risk from Cd in Massapequa Creek.

### 4.2.2 Chromium

Despite the reportedly comprehensive coverage of the Jarvinen and Ankley (1999) report, they did not find whole-fish body-burden data for Cr. However, Van der Putte et al. (1981) reported whole body Cr data for rainbow trout exposed in the laboratory. In addition, Eisler (1989) reported whole body Cr in wild pumpkinseed from Maryland, and Buhler et al. (1977) reported whole body Cr in wild rainbow trout from Washington State. Since these fish were collected live in the wild, these values can serve as an apparent NEBB for survival (Table 4-8).

Only one LEBB was available in the literature, estimated at 0.87 mg/kg wet weight, using the described method. The highest and the mean measured concentrations of Cr in fish (1.93 mg/kg and 0.94 mg/kg, respectively; Table 4-8) exceed this screening body burden. Therefore, according to this method of analysis, fish could be potentially at risk from Cr in Massapequa Creek.

### 4.2.3 Lead

Despite the reportedly comprehensive coverage of the Jarvinen and Ankley (1999) report, they cited only one study in which whole-body Pb was reported. However, Wong et al. (1981) reported whole body concentrations of tetramethylead in rainbow trout and Hodson et al. (1978) reported muscle, organ, and carcass burdens of Pb from wild rainbow trout as well as laboratory-exposed fish (Table 4-9).

Following the described protocol for deriving an LEBB yields a body-burden value of 0.4 mg Pb/kg or 0.25 mg ethyllead/kg (Table 4-9). Both the highest and the mean measured Pb concentration exceeded these screening body burdens. Therefore, according to this method of analysis, fish could be potentially at risk from Cr in Massapequa Creek.

### 4.2.4 Summary of Fish Body Burden Results

In summary, results of the body burden analysis indicate that fish in Massapequa Creek would be at risk from concentrations of cadmium, chromium, and lead. Fish tissue concentrations were highest within Pond A, indicating the greatest likelihood of risk.

## 4.3 HAZARD QUOTIENT MODELING RESULTS

### 4.3.1 Conservative Ingestion Model Results

Results of hazard quotient modeling to target receptors using an ingestion model with conservative inputs are summarized in Tables 4-10 through 4-11 for belted kingfisher and raccoon. Table 4-12 summarizes those contaminants and receptors that exceeded a hazard quotient of 1.0 at any location using the conservative model.

The results indicate that hazard quotients would exceed a value of 1.0 for kingfishers in the Main Stream of Massapequa Creek, as a result of ingestion of chromium-contaminated fish (hazard quotient of 1.5). In addition, kingfishers in Pond A would be at risk from ingestion of fish contaminated with chromium (hazard quotient of 2.6) and lead (hazard quotient of 1.1). Kingfishers foraging over the entire area would be at risk from cadmium, chromium and lead in fish (Table 4-10).

The results of the conservative modeling also indicated that raccoon would be at risk from ingestion of fish from the Main Stream that are contaminated with cadmium (hazard quotient of 6.5) and lead (hazard quotient of 5.1). In addition, they would be at risk from ingestion of fish in Pond A that are contaminated with cadmium (hazard quotient of 6.5) and lead (hazard quotient of 3.7). Moreover, raccoons foraging over the entire area would be at risk from ingestion of fish contaminated with cadmium and lead (Table 4-11).

### 4.3.2 Less Conservative Ingestion Model Results

Tables 4-13 and 4-14 present results of hazard quotient modeling using a less conservative model, with the objective of deriving site-specific clean-up criteria (if necessary) for sediment.

When less conservative assumptions are made (i.e. individual does not forage exclusively within the area of concern, and the LOAEL is an indicator of toxicological effects), then no hazard quotients exceed a value of 1.0 for either receptor in the areas of concern investigated. This more realistic exposure scenario indicates that kingfishers and raccoons are not likely to be at risk from ingestion of fish in Massapequa Creek or its associated ponds.

## 4.3.3 Summary of Hazard Quotient Modeling Results

Results of the hazard quotient modeling indicate that under the conservative model risks would be predicted to kingfishers and raccoon from ingestion of lead and chromium in fish. However, using more realistic assumptions, no risks would be predicted for Pond A or the Main Stream.

## 4.4 BENTHIC MACROINVERTEBRATE BIOASSAY TESTING RESULTS

Results of the March 1999 and December 1999 bioassay results are presented in Tables 4-15 and 4-16, respectively.

Toxicity to benthic macroinvertebrates was measured by conducting bioassay tests on two representative test organisms, a midge (*Chironomus tentans*) and an amphipod (*Hyallela azteca*). In the March 1999 bioassay, results of the 14-day flow-through test with the midge (*C. tentans*) failed to meet survival-acceptance criteria for control samples. As a result the test results were rejected.

In the amphipod test, no significant chronic (i.e., 28-day) adverse effect was found in *Hyalella azteca* exposed to sediment from any of the ponds, relative to the *reference* sample. However, the sample collected at location PA-03 had lower survival (73.8%) relative to the *laboratory control* (89%), but no statistical comparisons were reported between the two. The maximum metals concentrations in sediment samples that were tested were: 464 mg/kg chromium, 140 mg/kg cadmium, 69 mg/kg copper, 1800 mg/kg lead, and 680 mg/kg zinc. In contrast, the maximum metals concentrations reported in Pond A were 839 mg/kg chromium, 248 mg/kg cadmium, 162 mg/kg copper, 1160 mg/kg lead, and 801 mg/kg zinc. Hence, with the exception of lead and zinc concentrations, the maximum concentrations in sediment tested using the bioassays were about half the maximum concentrations detected in Pond A sediments.

Because of the failure of the March 1999 midge bioassay, and because higher metals concentrations have been reported in sediments that were tested, additional bioassay testing was conducted in December 1999, in which test organisms were exposed to sediment from two stations within Pond A. Two samples were submitted for testing "containing the metal concentrations closest to the mean concentrations and 95% UCL, respectively" (Dames and Moore 2000). The maximum concentration of metals in the sediments tested were 687 mg/kg chromium, 142 mg/kg cadmium, 908 mg/kg lead, and 618 mg/kg zinc. Therefore the sediment concentrations tested were still below the maximum sediment concentrations reported in Pond A.

The December 1999 results for the midge test indicated no significant effects on survival relative to the laboratory control. However growth of *C. tentans* was significantly decreased relative to the laboratory control in both samples (Table 4-16).

The results of the amphipod test indicated survival of *H. azteca* exposed to sediment from Pond A was significantly less than that of the laboratory control in both samples tested.

In summary, the December 1999 results of the bioassay tests show significant toxicity to *(H. azteca)* survival and *(C. tentans)* growth in Pond A at sediment concentrations of 140 mg/kg cadmium and 99 mg/kg cadmium, respectively. The next lowest cadmium concentration in sediment that was tested using bioassays is 93.5 mg/kg cadmium in the March 1999 bioassay test. No significant toxicity was observed at the concentration as compared to the laboratory control.

## 4.5 BENTHIC MACROINVERTEBRATE SURVEY RESULTS

Results of the benthic macroinvertebrate study are presented in Table 4-17. The survey results indicated that the dominant organisms found throughout Massapequa Creek and at the reference location consisted of tubificid worms, chironomids and some leeches. A few gammarid amphipods were also collected (i.e., a count of 4). No amphipods were found in Pond A or the reference station. While chironomids were relatively abundant in Pond A, none were found at the reference station.

With the exception of location P3-01, which had higher diversity than the other locations, diversity values were similar between locations. The reference location within the West Branch had a similar diversity value to that of the locations sampled within Massapequa Creek and its associated ponds. However, the reference area may have been impacted from stormwater runoff or other contaminant sources as indicated by the surface water and sediment data reported in Section 4.1.

The lowest diversity index was found at location PA-03A (a duplicate sample from location PA-03), and the least evenness was found at location PA-03.

In summary, the benthic macroinvertebrate survey results indicate a low diversity and abundance of taxa within Massapequa Creek, with the lowest diversity and abundance observed in Pond A. The results suggest that white impacts are widespread, the greatest impacts have occurred in Pond A.

Results of the benthic macroinvertebrate survey differed from those of a previous study conducted by NYSDEC in 1995. The latter study reported that the streams should be considered "slightly impacted". However, the NYSDEC study focused on riffle areas, and results may not be directly comparable to the Dames and Moore results.

## 4.6 UNCERTAINTY ANALYSIS

This section addresses the assumptions made in the risk assessment, and the potential sources of error associated with field and analytical measurements used in the calculation of risks. These sources of uncertainty include the effectiveness of the sampling approach and study design, validity of statistical comparisons, uncertainty concerning the derivation and application of screening criteria, hazard quotient modeling inputs, choice of receptors, and other elements of the assessment. Virtually every step in a risk assessment involves assumptions that contribute to the total uncertainty in the final evaluation of risk. The uncertainties incorporated in this risk analysis may have resulted in a higher or lower estimate of potential adverse ecological effects. However, in most cases conservative assumptions were made to insure that the process is protective of ecosystem health. While this approach to handling uncertainty may somewhat overestimate the risks, only those conservative assumptions compatible with sound scientific evidence or processes were used.

Uncertainties in ecological risk assessments may be identified as belonging to one or more of the four following categories: conceptual model formulation uncertainty, data and information uncertainty, natural variability (stochasticity), and error (U.S. EPA, 1992a). For the purposes of this assessment, these uncertainties are grouped as "general" uncertainties associated with the risk assessment process overall, including field measurements, uncertainties associated with the initial screening process, and uncertainties associated with hazard quotient modeling.

### 4.6.1 General Uncertainty

"General" uncertainties include the following: natural system variability, variability associated with media sampling, uncertainties associated with data evaluation and reduction, and uncertainties associated with extrapolation of results from target receptors evaluated.

**Natural System Variability**

- Factors unrelated to site contaminants may influence the number and composition of species that reproduce or forage on-site and the frequency of their exposure to site-related contamination. Examples of these types of factors include habitat modification in the vicinity of the site, natural population fluctuations, and the influence of off-site or background contamination on site populations.

- Fluctuations in seasonal or annual temperature, precipitation, and flow conditions may temporarily affect habitat suitability and subsequent receptor exposure.

- Seasonal variations in surface water such as dissolved oxygen content, and in sediment, such as organic carbon content, may affect the fate, transport, and bioavailability of COPCs.

- Seasonal variations in lipid composition of target receptors may affect the absorption and concentration of COPCs within an organism.

These factors are often not documented in the literature references cited, or if they are, may represent specific conditions that are not directly comparable to site conditions at the Liberty site. In addition, this variation could not be measured in detail at the site, within the scope of this study, which was to collect sufficient data to make an informed management decision regarding soil and sediment clean up levels required.

**Sampling Variability**

- Spatial and temporal variations in soil and sediment conditions (both physical and chemical) are often observed at very small scales. Given the heterogeneity of the environment, sample size and location may greatly affect the certainty associated with determination of effects.

- It is assumed that the results of sampling conducted during the Liberty RI and historical investigations is a valid representation of site conditions. Additional samples could be taken that could increase or decrease the sample contaminant means, but the assumption is that the sample mean approximates the true mean.

- Surface water grab samples represent instantaneous measurements of surface water conditions in Massapequa Creek and its associated ponds; thus they may not reflect chronic long-term water conditions.

- Fish samples collected are considered to be representative of the population present.

- Detected concentrations of COPCs in sediment and surface water may not be indicative of bioavailable concentrations. With the exception of the initial screening for dissolved metals, all other contaminant data used in the assessment were based upon the total concentration of the chemical present, as opposed to the bioavailable fraction. Both metals and organic compounds may bind to the sediment, making them less available to aquatic life, particularly higher receptors such as kingfishers or raccoons. Thus, risk to these receptors may be overestimated in some cases. An analysis of acid volatile sulfides and simultaneously extractable metals conducted by Dames and Moore suggests that not all of the metals present in sediment may be bioavailable. However, the relevance of AVS/SEM is limited primarily to anoxic layers of the sediment that are not inhabited by benthic macroinvertebrates or other biota of concern in this assessment.

- Calculating hazard quotients using total concentration data for sediment, as opposed to the bioavailable fraction is conservative, in that such an approach may overestimate risk. Most of the literature on toxicity effects used to derive NOAELs and LOAELs are based on studies using a particular form of a contaminant that might not actually be present in surface water or sediments of Massapequa Creek and its associated ponds.

**Data Evaluation and Reduction**

- For calculation of mean soil concentrations used in hazard quotient modeling, undetected values were included by substituting a value equivalent to the detection limit. This was known to bias the mean high, hence the analysis of risks is conservative, and tends to overestimate risk.

**Target Receptor Selection**

- Target receptors were selected to represent a variety of organisms with similar feeding and behavioral strategies and to assist in the evaluation of measurement endpoints. However, species-specific exposure within similar feeding groups may vary and result in differing risk potential. Target receptors were selected with the intent of optimizing exposure and assuming that a significant portion of their life-cycles was restricted to the area of contamination. The assumption that avian and mammalian target receptors spend a significant portion of their life cycles at the site (or a particular plume area) may be conservative.

- Hazard quotients were calculated for the piscivorous bird and mammal pathway in Massapequa Creek, where in fact this may not be a complete exposure pathway for upper portions that do not provide habitat for adult fish throughout the entire year. Conclusions based on hazard quotient calculations alone would tend to overestimate ecological risks.

### 4.6.2 Uncertainty Associated with the Screening Assessment

**Sediment Guidelines and Benchmark Comparisons**

In general, sediment guidelines or benchmarks do not address possible synergistic, antagonistic, or additive effects of contaminant mixtures; do not consider unmeasured chemicals; and are not useful for chemicals for which little or no toxicological information is available (Geisy and Hoke, 1990). The use of the NYSDEC sediment quality criteria, which are based largely upon Ontario Ministry of Environment (OMEE) LELs for evaluating the potential impacts of reported contaminant concentrations in sediment has the following general associated uncertainties:

- The guidelines are based on prior studies documented in the literature, and those studies cannot be considered representative of all sites or all conditions.

- Many studies used to develop chemical-specific sediment guidelines involved a complex mixture of contaminants. These mixtures most likely do not match the conditions in the potentially impacted areas of Massapequa Creek.

- The benchmarks used do not consider factors that influence chemical bioavailability (e.g., site-specific TOC or grain size).

- OMEE sediment quality guidelines are based on overt toxicity to benthic invertebrates and do not consider other potential effects such as bioaccumulation and subsequent effects on longer-lived species (Giesy and Hoke, 1990).

- Benchmarks or guidelines do not exist for all contaminants.

**Surface Water Criteria Comparisons**

The use of NYSDEC surface water quality criteria for evaluating the potential impacts of reported contaminant concentrations in surface water has the following general associated uncertainties:

- Many of the criteria are based upon the U.S. EPA freshwater chronic continuous criteria (CCC) may be biased either high or low (depending upon the chemical) because they are based on bioconcentration factors measured in laboratory studies. Laboratory studies produce bioconcentration factors for fish that are, at times, different from field measurements.

- The use of these criteria as a screening tool does not consider site-specific interactions with other chemicals present and cannot be interpreted as a direct measurement of site-specific bioavailability.

- The criteria do not account for the fact that the possibility that uptake from food may add to the contaminant intake from water alone.

### 4.6.3 Hazard Quotient Modeling Uncertainty

Numerous assumptions were made in the hazard quotient modeling both in calculating the daily dose of contaminant that the receptor receives, as well as in determining potential toxicological effects of that contaminant. Since in most cases site-specific receptor information was not available, assumptions were made regarding ingestion rates, frequency and location of exposure, and exposure point concentrations. In general, an effort was made to use assumptions that were conservative, yet realistic. The primary assumptions used in the exposure characterization are:

- Risks were calculated on a COPC-specific basis. Calculating risk in this manner does not account for additivity, synergism, or antagonism of specific COCs to which receptors are exposed. Calculating risks on a chemical-by-chemical basis may result in an under- or overestimation of total potential risk.

- The food ingestion route is the only exposure route evaluated in this analysis because there is limited information to assess other potential exposure routes such as dermal absorption and inhalation. Ingestion of water was not addressed, because the dose was expected to be insignificant relative to the amount of contaminant ingested in the food, or by incidental sediment and soil ingestion. Exposure via dermal absorption and inhalation may be of particular concern for species that clean themselves by rolling in any dry surface (i.e., river mink) (U.S. EPA, 1993a), but was not addressed in this assessment because it was expected to be insignificant relative to food ingestion.

- The highest mean food ingestion rates and lowest mean adult body weights were used to conservatively estimate exposure intakes for all target receptors. This approach most likely will tend to overestimate daily intake for nonbreeding, breeding, or individuals of a different age class upon which the literature data are based.

- Target receptors were assumed to consume 100% of single food item (e.g. herons were assumed to ingest 100% fish). This assessment is conservative, in that the receptor may take in food items (e.g. frogs) that have lower contaminant concentrations resulting from interspecific differences in uptake or ecological niches occupied.

- Sediment exposure was incorporated into calculations of risk based on ingestion (e.g. if sediment is reported in the literature as 5% of the total ingestion rate, and surface water is 2% of total ingestion, these were incorporated into estimates). However, the resultant calculation may overestimate the total amount of contaminants ingested, since these were added to total ingestion rate. Moreover, the contaminants present in sediment or soil that may be ingested directly are not in as bioavailable form as those present in the tissue of the food item.

- In the conservative model, it was assumed that the target receptors evaluated obtained 100% of their diet from site-impacted areas. Given the feeding ranges of these receptors, dietary changes during breeding, and other factors, this is a conservative assumption for the target receptors considered.

The use of toxicological data in hazard quotient modeling involves additional uncertainty. Toxicity data specific to target receptors were not available for any COPCs except fish; therefore, application of literature-derived toxicity data to the species of concern was necessary for use in calculating hazard quotients. When selecting toxicological data to compare with site-specific conditions, every effort was made to use data for the most closely related species to the target organisms. However, species sensitivity may vary even among closely related species. Variations in species sensitivity may be due to differences in some of the following factors: toxicity, tolerance thresholds, toxic symptoms exhibited, time period until toxic effects are observed, and metabolism of the ingested chemical. The primary uncertainties associated with toxicological values are as follows:

- In calculating toxicological values, adjustments were not applied to toxicity data to account for differences between the test species in the literature and the receptor being modeled, to account for differences in toxicological endpoints (e.g., NOAEL, and LOAEL). The possibility exists that the indicator species may be more sensitive to a certain chemical exposure than the test species. It may also be possible that the animal used in the laboratory or field study from which the toxicological value is derived may be more sensitive than the receptor species. Therefore, the toxicological value may be overly conservative, or may not be adequately protective.

- The medium in which a chemical is administered in toxicity tests can have a substantial effect on its gastrointestinal absorption (U.S. EPA 1988b). However, sufficient information was not available with which to make adjustments in bioavailability to account for these differences when calculating exposure doses for the target receptors. For example, if a toxicological value was derived from a study that used dietary exposure adjustments, the target receptor exposure dose would have to be calculated based on the relative bioavailability of the chemical in the study diet. An inability to account for differences in bioavailability may over- or underestimate potential hazards to target receptors.

- Conversion factors were used to reflect uncertainty associated with extrapolation of toxicological effects. These conversion factors are arbitrary "safety factors" that have no particular biological significance.

- The bioavailability and toxicity of metal ions to wildlife are dependent on the form in which they exist in the environment (i.e., speciation). Factors that determine the naturally occurring forms of metals include sediment texture, sediment and surface water chemistry, pH, redox potential, and solute and ligand concentrations. Because analytical procedures used to evaluate metal concentrations do not provide species-specific concentrations, the associated bioavailability and toxicity are difficult to assess. In this ecological risk assessment, the medium-specific concentration either as measured or as estimated, was conservatively considered to be completely bioavailable.

### 4.6.4 Uncertainty Associated with Body Burden Data for Fish

The use of field-measured body burdens of potentially toxic chemicals to assess risk to fish may be useful because issues of bioavailability may confound prediction of risk from water-borne or sediment-borne chemicals. Body burdens rely on only that portion of the exposure that actually entered the fish body; thus, the influence of bioavailability as a confounding factor is reduced. McCarty et al. (1992) and many others have shown that the use of body burdens is a more accurate predictor of acute toxicity of non-polar organic chemical to fish than water concentrations, and this has been extended (Mortimer and Connell 1995) to chronic exposures with certain non-polar organic chemicals. However, many authors have shown that this is not possible for either easily-metabolizable organic chemicals or metals.

Body burdens may be used to predict the risk from non-polar organic chemicals because they act by causing narcosis. Narcosis is thought to result from the dissolution of non-polar organic chemicals into the cell membrane. This causes changes in the fluidity of the cell membranes which interferes with the ion conductance that controls polarization and depolarization of the neuromuscular cells. This dissolution is dependent upon the attraction of the non-polar organic molecule to the non-polar portion of the fatty acids that comprise the cell membrane and can be estimated by the molecule's octanol-water partition coefficient. Unfortunately, no such mechanism can be applied to metals.

***Mechanisms of Metal Toxicity***

Metals such as Cd, Cu, and Hg act by binding to the sulfhydryl groups of ion transporting proteins, such as $Na^{+}$-$K^{+}$-ATPase and $Ca^{2+}$-ATPase. During acute exposures, toxicity can be entirely explained by the binding of these metals to the fish gill. In fact, Playle et al. (1993) have produced a model that explains and predicts the toxicity of Cd, and Cu by the binding kinetics of the fish gill. However, the fish gill typically comprises less than 5% of the whole body mass, and such small amounts of metal are capable of causing death through disruption of the ionoregulatory system of the gill, that no changes can be detected in whole body metal concentration.

If the concentration of metals is not sufficient to cause acute toxicity, metals may be distributed throughout the body and deposited in organs other than the gill. Apart from the gills, the organs that accumulate the highest concentrations of metals are the kidneys and liver, but smaller concentrations also accumulate in the muscle. The kidneys and liver typically comprise less than 5% of the total body mass (except for elasmobranchs [sharks] where the liver is very large), while the muscle comprises the majority of the whole-body mass. Therefore, large increases in kidney and liver metal concentration are required to cause a detectable increase in whole-body metal burden.

However, fish and other organisms may compensate and acclimate to chronic metal exposures. They do so, in part, by producing sacrificial metal-binding proteins, metallothioneins. In fact, the inducible production of metallothioneins can significantly decrease the acute toxicity of metals. At some concentration of metals between those causing acute toxicity and those causing no adverse effects, chronic toxicity occurs. This exposure level is insufficient to cause ionoregulatory disruption, but is greater than the ability of the gill, kidney, or liver to produce metallothioneins. At such concentrations, growth and/or reproduction may be reduced and populations may decrease. When exposure at this level continues for an extended period of time, populations disappear or are sustained by tributary populations. When this occurs over a shorter period of time, it is reflected in stunted growth and such pathologies as hepatitis, nephrocalcinosus, scoliosus, and lordosus.

***Caveats to the Use of Body Burden Data***

Recognizing the potential for misuse of the metal body burden data they compiled, Jarvinen and Ankley (1999) cautioned that Cd "toxicity is dictated not only by the final body residue but by the rate of accumulation" (i.e., acute vs. chronic and aqueous vs. dietary). They suggested that multi-generation studies might be needed to assess toxicity/tissue-residue relationships. This is not practical in a risk assessment focused on providing remedial recommendations for an individual site.

In their discussion of Cd, they also cautioned that fish "gill tissue might be the optimum body tissue to use in predictive cadmium/tissue residue relationships." They made similar precautionary statements concerning the use of gill tissue with regards to Cu, Hg, Ni, and Zn and called for multi-generational data for Cr, Pb, Ag, and V. With regards to Zn, they cautioned that whole body zinc residues are not good indicators of toxicity in surviving organisms, that gill tissue might be appropriate, and that natural variations occur. Only in the case of Al did these authors suggest that whole body tissue residues could be useful in predicting toxicity. In the first stuuy cited, the aluminum administered in the diet caused no adverse effects, and in the second study, only two data points were available and low pH was a contributing factor.

Different species of fish exhibit different sensitivities to metals when exposed under identical conditions. Therefore, different species either have different mechanisms that control bioavailability of the metal to the receptor(s) or different abilities to withstand the effects of the binding of metal to the receptor(s). However, if the use of whole-body burdens is scientifically viable, the internal concentration causing effects must be the same in terms of moles (or equivalents) per ligand bound. The method has associated uncertainty because the ligand concentration is unknown.

### 4.6.5 Uncertainty Associated with Bioassay Testing

The following uncertainties are associated with bioassay testing:

- Test organisms selected are assumed to be representative of the benthic macroinvertebrate community potentially at risk;
- Test conditions are controlled and hence seldom reflective of natural conditions;
- The reference sediment tested is assumed to be reflective of background conditions at the study area and does not itself represent impacted conditions.

In addition, the following specific uncertainties pertain to the bioassay testing results reported in this assessment.

Many factors may influence the results of bioassays such that they may not necessarily reflect *in situ* sediment conditions. Natural sediments exhibit a gradient from oxidized to anoxic conditions as the depth of the sediment core increases. This depth-dependent redox state in sediments has a large effect on metal speciation (and therefore bioavailability) as well as nitrogen (i.e., $NH_4^+$- $NH_3$) and sulfur (i.e.,$SO_4$ - $H_2S$) equilibria. When sediments are sampled and homogenized (and exposed to air), according to U.S. EPA and ATSM protocols, the natural redox gradient and AVS/SEM ratio is disrupted and new conditions are established that may not have existed prior to sampling and certainly did not exist prior to homogenization; whether these new conditions constitute any sort of equilibrium, or equivalence relative to their intact state, is unknown. Sae-Ma et al. (1998) showed that the toxicity of Cd to *C. tentans* decreased significantly as spiked sediment storage time increased because the Cd became less bioavailable as the sediment became more anoxic. Therefore, the disruption of the normal redox stratification adds considerable uncertainty to the results of bioassays.

The observed toxicity in the December 1999 results was poorly correlated with metals concentrations (see Appendix B), meaning there is significant uncertainty regarding cause of the toxicity. A number of other factors can contribute to toxicity in bioassay tests. These factors may represent field conditions, or may represent an artifact of the test itself. For example, according to Dames and Moore (2000), ammonia concentrations in the overlying test water

(December 1999 tests) were correlated with toxicity, suggesting ammonia could have played a role in the results. However, the results of this analysis cannot be considered conclusive since the regression is based on only three points, and the ammonia concentrations detected are far below those required to kill *H. azteca* in 96-h water-only bioassays (i.e., 96-h LC50 = 9.2-9.7 mg N/L). Also, the significance level of the ANOVA underlying the regression was not reported. Finally, it is not clear why ammonia levels in the December 1999 study that are less than those in the March 1999 study should cause toxicity. No adverse effects on survival were reported for *(H. azteca)* in the March 1999, yet ammonia levels were higher in that study.

Significant adverse effects on growth were found with *C. tentans*, but no growth effects were found with *H. azteca*. Henis et al. (1990) reported that Cd can inhibit feeding by chironomids, and this could cause growth inhibition. However, extrapolating these laboratory results to the field may be problematic since Groenendijk et al. (1999) have shown that chironomids living in metal-contaminated sediments can adapt to higher metal levels. Food availability and quality also affect bioassays, especially in organisms such as *C. tentans* that depends upon organic matter within the sediment (Lacey et al. 1999). Growth in *C. tentans* can differ significantly between locations even in the absence of any sediment impacts, solely due to differences in the source of the organic matter.

As with the toxicity to *H. azteca*, ammonia concentrations in the overlying test water (December 1999 tests) were correlated with effects on midge growth (Figure 5-2), although again the regression is based on only three points. In addition, the ammonia concentrations are again far below those required to kill *C. tentans* in 10-d water-only bioassays (i.e., 10-d LC50 = 532-704 mg N/L; Whiteman et al. 1996).

Additional uncertainty concerns the potential lack of correlation between the bulk sediment chemistry data and the actual concentration of metals in the pore water of the sediments, or in the case of *H. azteca*, the overlying surface water to which the organisms were exposed.

# SECTION 5.0
# RISK MANAGEMENT

The data collectively suggest that metals concentrations within Pond A pose ecological risks to benthic macroinvertebrates, and potentially fish as well. Of the assessment and measurement endpoints chosen to test the major hypotheses described in the Problem Formulation stage (see Section 2 and Table 2-2), the most relevant measurement endpoints for calculating risk based preliminary remedial goals (PRGs) for contaminated sediment are the bioassay testing results and the hazard quotient modeling results. Since the hazard quotient modeling results using realistic exposure estimates do not indicate a risk from bioaccumulation of metals to higher receptors such as kingfishers and raccoons, the bioassay data are the most applicable endpoint for deriving PRGs that are protective of benthic macroinvertebrates. If the PRG is protective of benthic macroinvertebrates, then the assumption is that it will also be protective of fish, since invertebrates are a major prey item of fish.

It should be stressed that the data provided in support of the 19 May 2000 risk assessment prepared by Dames and Moore, Inc. are incomplete. Only two field-collected sediment samples were collected for bioassay testing in December 1999, and the concentrations do not span the range of contamination detected in Pond A sediments. Moreover, results were compared only to a laboratory control as opposed to a legitimate reference location. Nevertheless, the existing available data do show toxicity to *H. azteca* (survival) and *C. tentans* (growth) at concentrations of 99 mg/kg and 140 mg/kg cadmium, respectively. The corresponding chromium concentrations at these locations were 457 mg/kg and 687 mg/kg, respectively.

The next concentration below that at which toxicity to *H. azteca or C. tentans* was not reported within the same water body (Pond A) is 55.4 mg/kg cadmium in the March 1999 *H. azteca* bioassay. The corresponding chromium concentration at that location is 268 mg/kg, measured in the same sample. Therefore, conservative risk-based criteria that may be used as PRGs for Pond A are 50 mg/kg cadmium and 260 mg/kg chromium. These PRGs are based on the following considerations:

- The weight of evidence collected suggests risks are occurring to aquatic biota in Pond A. The lowest diversity and abundance of benthic macroinvertebrates reported was at location PA-03A (a duplicate sample collected at location PA-03) within Pond A. The highest body burdens of chromium and lead were reported in fish collected from Pond A. The highest body burden of cadmium in fish was reported in Pond 5 (1.3 mg/kg), but a similar concentration (1.0 mg/kg) was also reported in Pond A. Toxicity to both *H. azteca* and *C. tentans* was observed in Pond A. Results of the screening assessment indicated that Pond A had the highest frequency of exceedances of NYSDEC sediment quality criteria for these chemicals. In addition, individual maximum concentrations of cadmium, copper, chromium, chromium IV, lead, and zinc in Pond A had the highest magnitude of any exceedances in sediment within the aquatic areas potentially affected by the Liberty site.

- Preliminary remedial goals are difficult to derive based upon several of the measurement endpoints evaluated (e.g. benthic macroinvertebrate community structure, tissue concentrations in fish, exceedances of screening criteria for sediment).

- Risk-based PRGs were therefore derived on the basis of bioassay data, which is incomplete, and based upon small sample sizes for each of the individual ponds. Because there is variability in grain size and TOC characteristics within and between these ponds, and a suitable reference location was not available for comparison with results, there is a need to be conservative in developing the PRGs. In addition, the need to be conservative arises from the fact that the highest concentrations of contaminants in these sediments were not tested using bioassays.

- Cadmium and chromium, while poorly correlated with toxicity, were clearly elevated in the samples that were toxic to *H. azteca* (survival) and *C. tentans* (growth) in the tests run in December 1999. Unlike lead and other metals, these metals are clearly site-related, and were detected in Pond A sediments at levels greatly exceeding ecologically-based sediment screening criteria. In Pond A, the maximum cadmium concentration in sediment exceeded the sediment quality criterion by 435 times, while the maximum chromium concentration exceeded the sediment quality criterion by 32 times. Cadmium concentrations exceeded the criterion in all 19 sediment samples collected, while chromium concentrations exceeded the criterion in 18 of 19 samples collected.

- In December 1999 bioassays, two sediment samples collected from Pond A (PA-10 and PA-13) exhibited significantly lower survival of *H. azteca* relative to the laboratory control (Table 4-16). These same two locations exhibited significantly lower growth of *C. tentans* relative to the laboratory control. No reference sediment was sampled or compared. The lowest cadmium concentration in these samples showing toxicity was 99.9 mg/kg, and the lowest chromium concentration was 457 mg/kg.

- The location with the next lowest concentration of these metals in Pond A where there was either no evidence of toxicity *or* no adverse effects on growth relative to the laboratory control was location PA-03 in the March 1999 bioassay. The cadmium concentration at that location was reported as 55.4 mg/kg, and the chromium concentration at that same location was 268 mg/kg. The growth of *H. azteca* in this sample was unaffected relative to the laboratory control. Thus, these data were used as a basis for developing the PRGs.

The following additional points were considered in focusing the development of PRGs on cadmium and chromium within Pond A:

- Several other metals were detected in Pond A sediments are collocated with cadmium and could contribute to toxicity in a complex, synergistic fashion.

- While sediment ammonia was correlated with toxicity, the observed correlation was based upon only three points, and was well below levels documented as causing toxicity to aquatic life. Moreover, no toxicity was observed in the March 1999 bioassay data, which had higher ammonia levels in the sediment.

- The AVS/SEM predictions conducted by Dames and Moore (2000) predict cadmium in Pond A sediments is bioavailable at levels capable of causing toxicity to *H. azteca*.

- Surface water concentrations of cadmium in Pond A indicate the metal is present at concentrations exceeding NYSDEC water quality criteria. The fact that cadmium was detected in the water column indicates it is potentially bioavailable to aquatic receptors at levels posing risks. Similarly, chromium was detected in surface water of the East Branch at concentrations exceeding the NYSDEC screening criteria.

# SECTION 6.0
# CONCLUSIONS

The following conclusions may be reached on the basis of this ERA:

- Surface water and screening data indicate that several metals exceed NYSDEC surface water and sediment quality criteria within Massapequa Creek and its associated ponds;
- Two organic compounds, acetone and toluene also exceeded NYSDEC criteria in sediment, but are not likely to pose ecological risks based on partitioning with organic carbon present;
- Pond A had the highest frequency and magnitude of exceedances of NYSDEC surface water and sediment criteria;
- The metals with the highest frequency and magnitude of exceedances were cadmium, chromium and lead, which were the focus of additional studies of fish tissue concentrations and bioaccumulation to higher receptors;
- Hazard quotient modeling to higher receptors using fish tissue concentrations from Massapequa Creek and its associated ponds indicated potential risks from chromium and lead in Pond A to belted kingfisher and raccoon using a conservative model based on no observed adverse effects levels (NOAELs) as toxicity reference values; risks were also noted to kingfishers from chromium, and to raccoons from cadmium and lead in the Main Stream.
- When a more realistic exposure model was run using lowest observed adverse effects levels (LOAELs) that did not assume individuals forage exclusively within contaminated areas, no risks to these receptors were predicted;
- Comparison of body burden data from fish tissue to the literature on toxicological effects indicated that fish collected from Pond A are potentially at risk from contamination by cadmium, chromium and lead;
- Bioassay testing results from December 1999 indicated that sediments from Pond A resulted in significantly reduced survival of the amphipod *Hyallela azteca* relative to the laboratory control. Because these results were not compared to a suitable reference population, and did the tests were not run on the full range of contamination present within Pond A, they cannot be considered complete.
- Results of the benthic macroinvertebrate survey indicated low diversity and abundance throughout Massapequa Creek and its associated ponds. However, the lowest diversity and abundance was present at Pond A.
- The combined weight of evidence approach indicates that risks appear to be occurring to benthic macroinvertebrates and fish in Pond A.

- Because the bioassay results are incomplete, but do indicate toxicity in Pond A, a risk-based PRG of 50 mg/kg cadmium and PRG of 260 mg/kg chromium is recommended for Pond A upon the basis of this assessment (see Section 5.0 above).

SECTION 7.0
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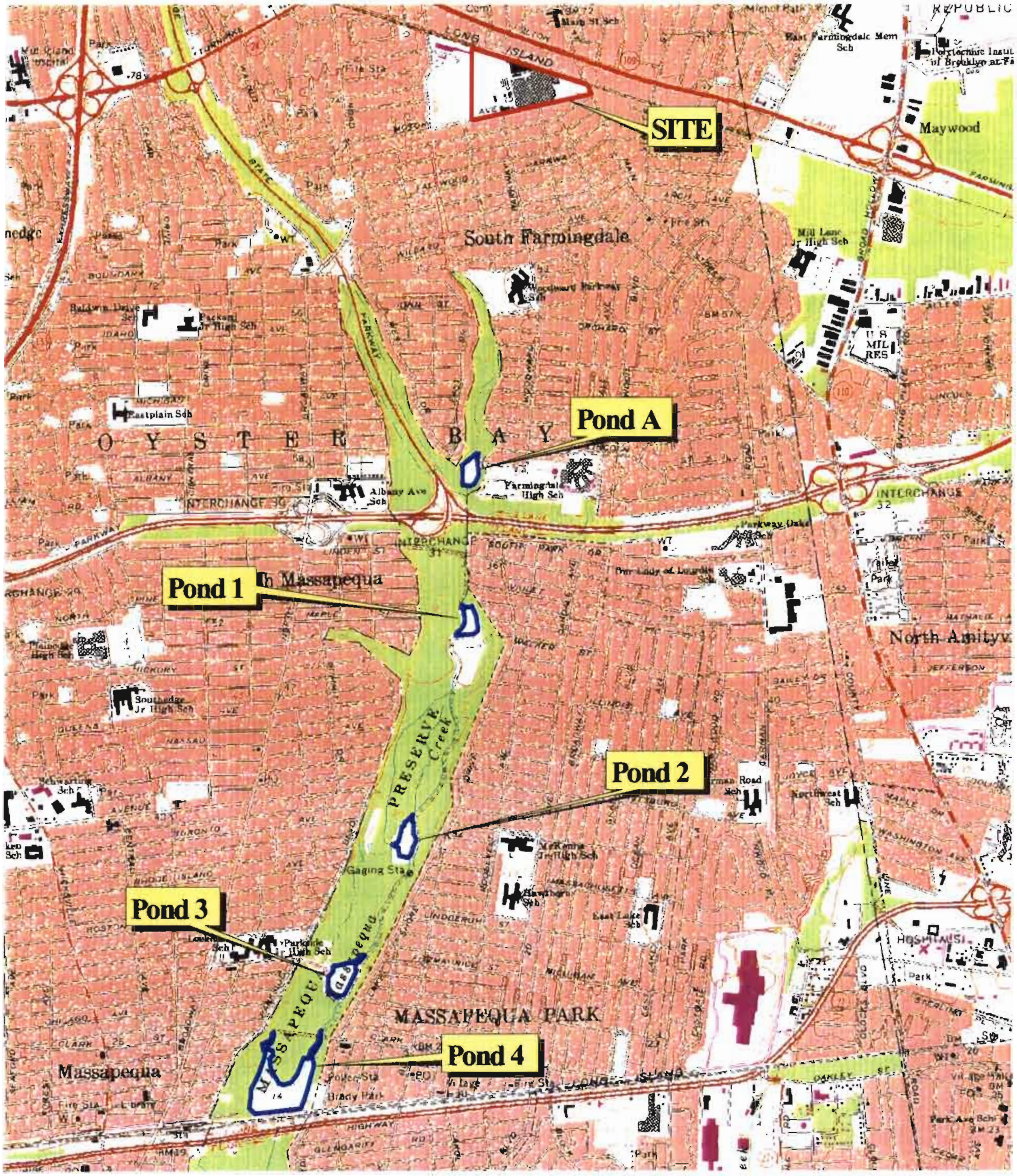
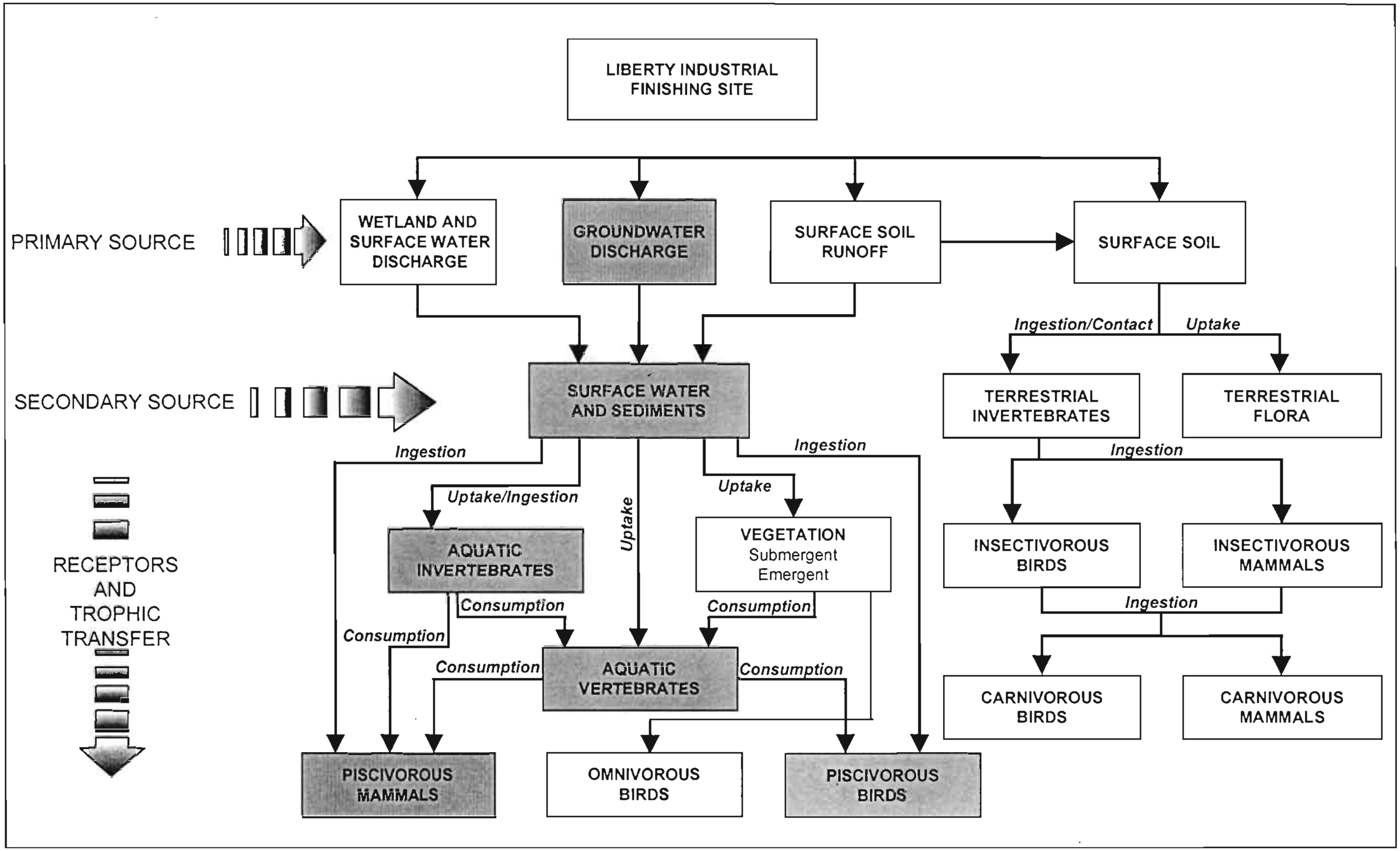



| | | | |
|---|---|---|---|
| 1000 0 1000 Feet | Liberty Industrial Finishing Site<br>Farmingdale, NY | U.S. Geological Survey Topographical Map<br>Amityville Quadrangle, 1966 | N |

| | | |
|---|---|---|
| WESTON<br>MANAGERS DESIGNERS/CONSULTANTS | **Figure 2-1**<br>**Site Location Map** | Approximate Site Boundary<br>Pond Boundary |




**LEGEND**

Prime Areas of Consideration

**LIBERTY INDUSTRIAL FINISHING SITE**
**FARMINGDALE, NY**

**FIGURE 2-2**

**SITE CONCEPTUAL MODEL**

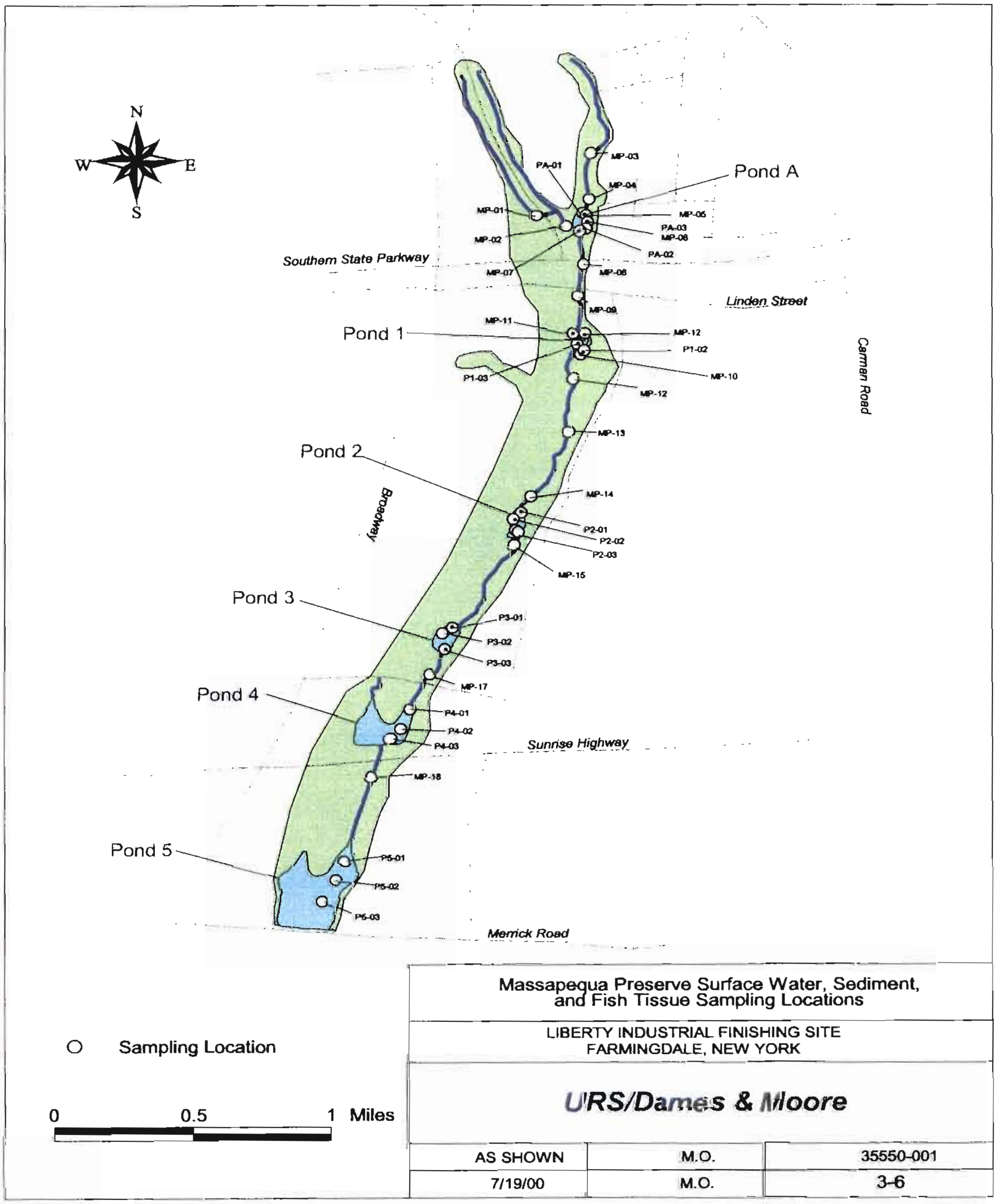



**Figure 4-1**
**Sample Location Map**

**Figure 4-2**

**Frequency and Cumulative Percentage of NEBB and LEBB Data for Cadmium in Fish (based on Jarvinen and Ankley 1999)**

**Liberty Industrial Finishing Site**

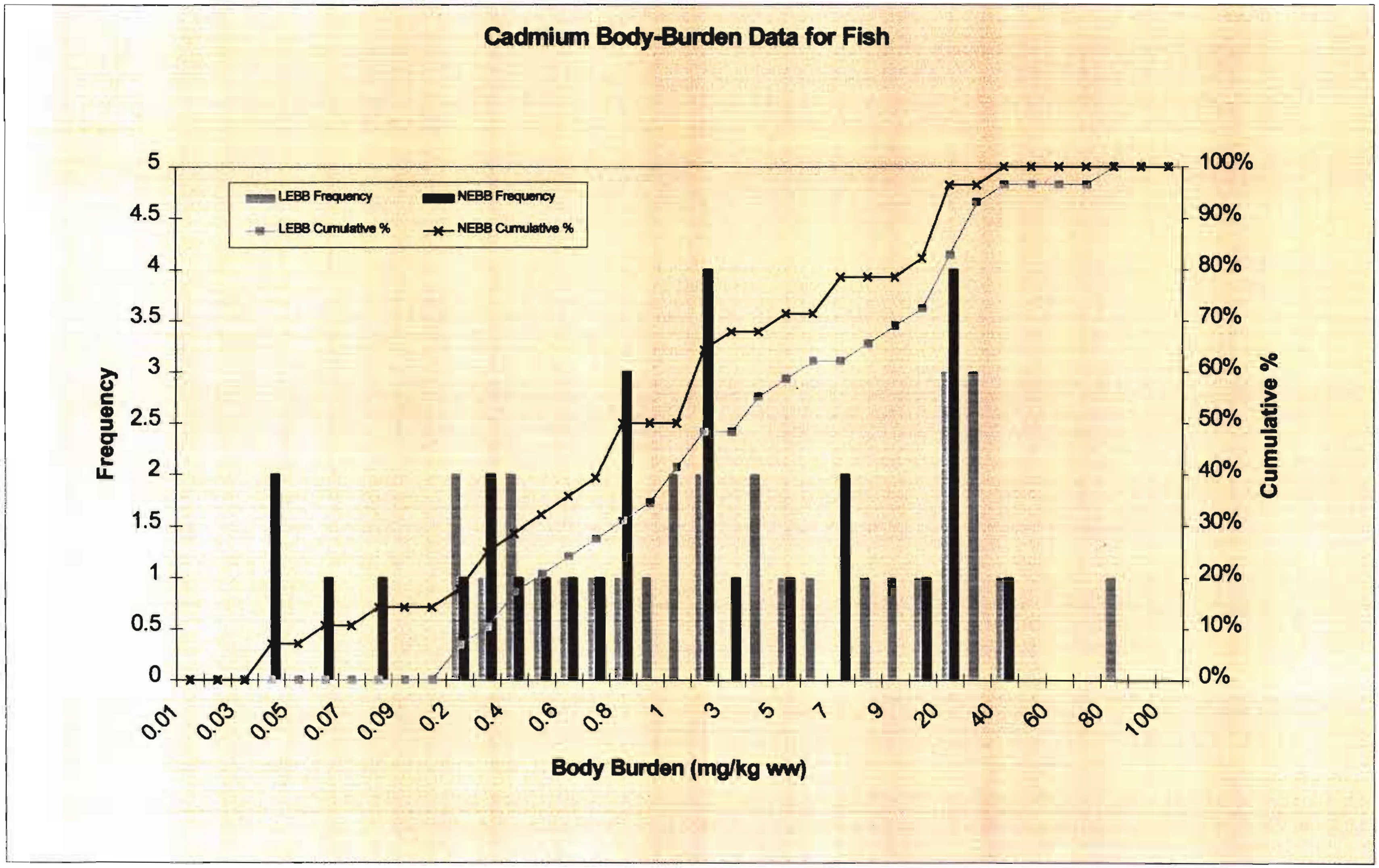


**Table 2-1**
**Summary of Target Receptors**
**Liberty Industrial Finishing Site**

| Receptor of Concern | Rationale |
|---|---|
| **<u>Terrestrial and Wetland:</u>** | |
| Belted Kingfisher | A species that is likely to feed on organisms directly exposed to impacted surface water and sediments. Known to nest locally. Has aesthetic value. There is toxicity information available for similar species. |
| Raccoon | Potential exposure through prey ingestion; toxicity information is available for similar species |
| **<u>Aquatic:</u>** | |
| Aquatic Invertebrates | Considered as a group, these species are potentially exposed through contact with surface water. |
| Benthic Invertebrates | This group of receptors has the greatest potential exposure through direct contact with sediments; potential for bioaccumulation of some chemicals; toxicity information is available for these and like species. |
| Fish | This group of receptors have a significant potential for exposure through direct contact with surface waters; potential for bioaccumulation of some chemicals; toxicity information is available for these and like species. |

**Table 2-2**
**List of Measurement Endpoints by Medium of Concern**
**Liberty Industrial Finishing Site**
**Ecological Risk Assessment**

| Medium of Concern | Primary Compounds of Concern | Target Receptor | Endpoint | Organization Level | Measurement Endpoint | Means of Measurement |
|---|---|---|---|---|---|---|
| Sediment/ Surface Water | Metals/other | Benthic Macroinvertebrates | Population changes affecting community structure | Population, Community | Toxicological effects on individual survival | Comparison with screening criteria/ guidelines for surface water and sediment. |
| Sediment | Metals | Benthic Macroinvertebrates | Population changes affecting community structure | Population, Community | Depressed diversity and abundance relative to reference location | Macroinvertebrate Surveys/ Indices |
| Sediment | Metals | Benthic Macroinvertebrates | Toxicological effects affecting individual survival | Organism Population | - Depressed survival relative to reference location or lab control<br>- Depressed growth relative to reference location or lab control | Bioassay Testing |
| Sediment/ Surface Water | Metals/other | Fish (Bluegill Sunfish, Pumpkinseed Sunfish, Carp, Rainbow Trout | Toxicological effects affecting individual survival | Organism | Toxicological effects on individual survival | Comparison with screening criteria/ guidelines for surface water and sediment |
| Sediment/ Surface Water | Metals | Fish (Bluegill Sunfish, Pumpkinseed Sunfish, Carp, Rainbow Trout | Toxicological effects affecting individual survival | Organism | Toxicological effects on individual survival | Comparison of fish concentration data with literature based toxicological data |
| Sediment/ Surface Water | Metals | Piscivorous Birds and Mammals | Toxicological effects affecting individual survival | Organism Population | Hazard Quotients greater than one (ingestion model) | Hazard quotient modeling based on LOAEL |

**Table 3-1**
**Summary of Assumptions Used in Hazard Quotient Models**
**Liberty Industrial Finishing Site**

| Input | Initial Conservative HQ Model | Less Conservative Model |
|---|---|---|
| Exposure Point Concentration | Higher value of Mean + 95% UCL or maximum concentration for each contaminant for each AOC | Higher value of Mean + 95% UCL or maximum concentration for each contaminant for each AOC |
| Ingestion Rate | Highest mean for adult animals | Highest mean for adult animals |
| Body Weight | Lowest mean for adult animals | Lowest mean for adult animals |
| Home Range | Smallest mean for adult animals | Smallest mean for adult animals |
| Area Use Factor | Assumed to be 1.0 for each Animal spends its entire life within the AOC | Area of AOC divided by Home Range |
| Toxicological Effects Value or TRV | NOAEL | LOAEL |

Notes:
AOC = Area of Concern.
UCL Upper confidence limit.
NOAEL No observed adverse effect level.
LOAEL Lowest observed adverse effect level.

**Table 3-2**
**Exposure-Point Concentrations for the Belted Kingfisher and Raccoon**
**Liberty Industrial Finishing Site**

| Receptor | Metal | Fish (mg/kg wet weight) Massapequa Creek | Fish (mg/kg wet weight) Pond A | Water (mg/L) Massapequa Creek | Water (mg/L) Pond A | Sediment (mg/kg dry weight) Massapequa Creek | Sediment (mg/kg dry weight) Pond A |
|---|---|---|---|---|---|---|---|
| Kingfisher | Cadmium | 1.12 (95%UCL) | 1.0 (Maximum) | 0.0198 (Maximum) | 0.001 (n=1) | 248[1] (Maximum) | 248 (Maximum) |
| | Chromium | 1.93 (95%UCL) | 4.0 (Maximum) | 0.0549 (Maximum) | 0.0061 (n=1) | 655 (95%UCL) | 839 (Maximum) |
| | Lead | 2.82 (95%UCL) | 6.8 (Maximum) | 0.0041 (95%UCL) | 0.0028 (n=1) | 1662 (95%UCL) | 1160 (Maximum) |
| Raccoon | Cadmium | 1.12 (95%UCL) | 1.0 (Maximum) | 0.0198 (Maximum) | 0.001 (n=1) | 248[1] (Maximum) | 248 (Maximum) |
| | Chromium | 1.93 (95%UCL) | 4.0 (Maximum) | 0.0549 (Maximum) | 0.0061 (n=1) | 655 (95%UCL) | 839 (Maximum) |
| | Lead | 2.82 (95%UCL) | 6.8 (Maximum) | 0.0041 (95%UCL) | 0.0028 (n=1) | 1662 (95%UCL) | 1160 (Maximum) |

1) The 95% UCL was greater than the maximum.

Table 4-1
Surface Water Screening Results
Liberty Industrial Finishing Site

| Analyte | SWSC (ug/L) | West Branch of Massapequa Creek | | | East Branch of Massapequa Creek | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentration (ug/L) | Max. Conc/SWSC (ug/L) | Frequency of Exceedances | Maximum Concentration (ug/L) | Max. Conc/SWSC (ug/L) | Frequency of Exceedances |
| 1,2-Dichlorobenzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,3-Dichlorobenzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,4-Dichlorobenzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,1,1-Trichloroethane | 220 | ND | --- | 0/5 | 0.5 | 0.0023 | 0/9 |
| 1,1,2,2-Tetrachloroethane | NB | ND | | 0/5 | ND | --- | 0/9 |
| 1,1,2-Trichloroethane | NB | ND | | 0/5 | ND | --- | 0/9 |
| 1,1-Dichloroethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,1-Dichloroethene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,2-Dibromo-3-chloropropane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,2-Dibromoethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,2-Dichloroethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 1,2-Dichloropropane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 2-Butanone | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 2-Hexanone | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| 4-Methyl-2-pentanone | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Acetone | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Benzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Bromochloromethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Bromodichloromethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Bromoform | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Bromomethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Carbon tetrachloride | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Chlorobenzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Chloroethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Chloroform | 7 | 0.3 | 0.043 | 0/5 | 0.3 | 0.04 | 0/9 |
| Chloromethane | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| cis-1,2-Dichloroethene | 5 | 0.1 | 0.02 | 0/5 | 0.6 | 0.12 | 0/9 |
| cis-1,3-Dichloropropene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Dibromochloromethane | 50 | 0.6 | 0.012 | 0/5 | 0.8 | 0.016 | 0/9 |
| Ethylbenzene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Methylene chloride | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| MTBE | 20400 | 40 | 0.0020 | 0/5 | 1 | 0.000049 | 0/9 |
| Styrene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Tetrachloroethene | 98 | 1 | 0.010 | 0/5 | 2 | 0.0204 | 0/9 |
| Toluene | 100 | ND | --- | 0/5 | ND | --- | 0/9 |
| trans-1,2-Dichloroethene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| trans-1,3-Dichloropropene | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Trichloroethene | 5 | 0.3 | 0.06 | 0/5 | 4 | 0.8 | 0/9 |
| Vinyl chloride | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Xylene (total) | NB | ND | --- | 0/5 | ND | --- | 0/9 |

Notes
NB = No available benchmark for this compound
NA = Not analyzed with in the [illegible]
ND = Not detected with [illegible]
All data was taken from the Weston [illegible] sampling event and the D+M [illegible] Data Contained R. Report
[illegible]
SWSC = Surface Water [illegible]
NYSDEC [illegible]

Table 4-1
(Continued)
Surface Water Screening Results
Liberty Industrial Finishing Site

| Analyte | SWSC (ug/L) | Pond A | | | Massapequa Creek (Main Stream) | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentration (ug/L) | Max. Conc/SWSC (ug/L) | Frequency of Exceedances | Maximum Concentrations (ug/L) | Max. Conc/SWSC (ug/L) | Frequency of Exceedances |
| 1,2-Dichlorobenzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,3-Dichlorobenzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,4-Dichlorobenzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,1,1-Trichloroethane | 220 | 0 1 | 0 000 | 0/1 | 0 2 | 0 001 | 0/9 |
| 1,1,2,2-Tetrachloroethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,1,2-Trichloroethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,1-Dichloroethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,1-Dichloroethene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,2-Dibromo-3-chloropropane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,2-Dibromoethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,2-Dichloroethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 1,2-Dichloropropane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 2-Butanone | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 2-Hexanone | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| 4-Methyl-2-pentanone | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Acetone | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Benzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Bromochloromethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Bromodichloromethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Bromoform | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Bromomethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Carbon tetrachloride | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Chlorobenzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Chloroethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Chloroform | 7 | 0 2 | 0 0286 | 0/1 | 0 2 | 0 029 | 0/9 |
| Chloromethane | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| cis-1,2-Dichloroethene | 5 | ND | --- | 0/1 | 0 4 | 0 08 | 0/9 |
| cis-1,3-Dichloropropene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Dibromochloromethane | 50 | ND | --- | 0/1 | ND | --- | 0/9 |
| Ethylbenzene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Methylene chloride | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| MTBE | 20400 | 24 | 0 00118 | 0/1 | 6 | 0.00029 | 0/9 |
| Styrene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Tetrachloroethene | 98 | 0 3 | 0 00306 | 0/1 | 0 4 | 0 0041 | 0/9 |
| Toluene | 100 | ND | --- | 0/1 | ND | --- | 0/9 |
| trans-1,2-Dichloroethene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| trans-1,3-Dichloropropene | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Trichloroethene | 5 | 0 3 | 0 06 | 0/1 | 0 4 | 0 08 | 0/9 |
| Vinyl chloride | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Xylene (total) | NB | ND | --- | 0/1 | ND | --- | 0/9 |

Notes
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June 2000 Continued RI Report
Chromium VI was not sampled in 1992
SWSC = Surface Water Screening Criteria (NYSDEC 1998, Suter and Tsao 1996)

Table 4-1
(Continued)
Surface Water Screening Results
Liberty Industrial Finishing Site

| Analyte | SWSC (mg/L) | West Branch of Massapequa Creek | | | East Branch of Massapequa Creek | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentration (mg/L) | Max. Conc/SWSC (mg/L) | Frequency of Exceedances | Maximum Concentration (mg/L) | Max. Conc/SWSC (mg/L) | Frequency of Exceedances |
| Aluminum | 100 | **201** | 2.01 | 3/5 | **417** | 4.17 | 7/9 |
| Antimony | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Arsenic | 190 | ND | --- | 0/5 | 4.2 | 0.022 | 0/9 |
| Barium | 1000 | 44.6 | 0.04 | 0/5 | 39.3 | 0.039 | 0/9 |
| Beryllium | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Cadmium | 0.89 | ND | --- | 0/5 | **19.8** | 22.2 | 5/9 |
| Calcium | NB | 18700 | --- | 0/5 | 20800 | --- | 0/9 |
| Chromium | 30.3 | ND | --- | 0/5 | **54.9** | 1.81 | 3/9 |
| Chromium VI | 11 | ND | --- | 0/2 | **49.4** | 4.49 | 2/2 |
| Cobalt | 5 | **5.1** | 1.02 | 1/5 | **6.5** | 1.3 | 2/9 |
| Copper | 3.5 | **4** | 1.1 | 3/5 | **13** | 3.71 | 1/9 |
| Iron | 300 | **1590** | 5.3 | 2/5 | **771** | 2.57 | 6/9 |
| Lead | 1.07 | **7** | 6.5 | 4/5 | **12** | 11.2 | 7/9 |
| Magnesium | NB | 4810 | --- | 0/5 | 3080 | --- | 0/9 |
| Manganese | 300 | **587** | 1.957 | 1/5 | **584** | 1.95 | 3/9 |
| Mercury | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Nickel | 20.6 | ND | --- | 0/5 | 2.3 | 0.11 | 0/9 |
| Potassium | NB | 8280 | --- | 0/5 | 2430 | --- | 0/9 |
| Selenium | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Silver | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Sodium | NB | 52600 | --- | 0/5 | 23300 | --- | 0/9 |
| Thallium | 8 | 7.3 | 0.91 | 0/5 | 5.4 | 0.68 | 0/9 |
| Vanadium | NB | ND | --- | 0/5 | ND | --- | 0/9 |
| Zinc | 32.6 | **110** | 3.4 | 1/5 | **34.5** | 1.06 | 1/9 |

Notes
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling
event and the D+M June, 2000 Continued RI Report
Chromium VI was not sampled in 1992
SWSC = Surface Water Screening Criteria
(NYSDEC 1998 Suter and Tsao 1996)

Table 4-1
(Continued)
Surface Water Screening Results
Liberty Industrial Finishing Site

| Analyte | SWSC (mg/L) | Pond A | | | Massapequa Creek (Main Stream) | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentration (mg/L) | Max. Conc/SWSC (mg/L) | Frequency of Exceedances | Maximum Concentrations (mg/L) | Max. Conc/SWSC (mg/L) | Frequency of Exceedances |
| Aluminum | 100 | **121** | 1 21 | 1/1 | **155** | 1 55 | 2/9 |
| Antimony | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Arsenic | 190 | ND | --- | 0/1 | 3 9 | 0 021 | 0/9 |
| Barium | 1000 | 29 4 | 0 0294 | 0/1 | 51 6 | 0 052 | 0/9 |
| Beryllium | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Cadmium | 0 89 | **1** | 1 12 | 1/1 | **1.2** | 1 35 | 2/9 |
| Calcium | NB | 14400 | --- | 0/1 | 16300 | --- | 0/9 |
| Chromium | 30 3 | 6 1 | 0 20 | 0/1 | 5 5 | 0 18 | 0/9 |
| Chromium VI | 11 | ND | --- | 0/1 | ND | --- | 0/9 |
| Cobalt | 5 | ND | --- | 0/1 | ND | --- | 0/9 |
| Copper | 3 5 | ND | --- | 0/1 | 3 1 | 0 89 | 0/9 |
| Iron | 300 | **302** | 1 01 | 1/1 | **764** | 2 55 | 4/9 |
| Lead | 1 07 | **2.8** | 2 62 | 1/1 | **5.3** | 4 95 | 2/9 |
| Magnesium | NB | 2850 | --- | 0/1 | 3170 | --- | 0/9 |
| Manganese | 300 | 86 1 | 0 287 | 0/1 | **386** | 1 29 | 4/9 |
| Mercury | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Nickel | 20 6 | ND | --- | 0/1 | 2 5 | 0 12 | 0/9 |
| Potassium | NB | 1800 | --- | 0/1 | 2140 | --- | 0/9 |
| Selenium | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Silver | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Sodium | NB | 18700 | --- | 0/1 | 42400 | --- | 0/9 |
| Thallium | 8 | 4 7 | 0 588 | 0/1 | 6 4 | 0 8 | 0/9 |
| Vanadium | NB | ND | --- | 0/1 | ND | --- | 0/9 |
| Zinc | 32 6 | 22 3 | 0 684 | 0/1 | 27 4 | 0 84 | 0/9 |

Notes
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June 2000 Continued RI Report
Chromium VI was not sampled in 1992
SWSC = Surface Water Screening Criteria (NYSDEC, 1998, Suter and Tsao, 1996)

Table 4-2
Summary of Chemicals in Surface Water Exceeding N\ SDEC Criteria
Liberty Industrial Finishing Site

| Analyte | West Branch (Reference) | East Branch | Pond A | Main Stream |
|---|---|---|---|---|
| Aluminum | X | X | X | X |
| Cadmium | ND | X | X | X |
| Calcium | NB | NB | NB | NB |
| Chromium | ND | X | | |
| Chromium VI | ND | X | ND | ND |
| Cobalt | X | X | ND | ND |
| Copper | X | X | ND | |
| Iron | X | X | X | X |
| Lead | X | X | X | X |
| Magnesium | NB | NB | NB | NB |
| Manganese | X | X | | X |
| Potassium | NB | NB | NB | NB |
| Sodium | NB | NB | NB | NB |
| Zinc | X | X | | |

**Notes:**
X = Detected above the NYSDEC sediment screening criterion.
NB = Analyte was detected, but no benchmark was available for this analyte.
ND = Not detected within this AOC.
Empty Cells indicate that the analyte was detected, but below the screening criterion.

## Table 4-3
## Sediment Screening Results
## Liberty Industrial Finishing Site

| Analyte | SBVs | West Branch of Massapequa Creek | | | East Branch of Massapequa Creek | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentrations (ug/kg) | Max Conc/SBV (ug/kg) | Frequency of Exceedances | Maximum Concentrations (ug/kg) | Max Conc/SBV (ug/kg) | Frequency of Exceedances |
| 1,1,1-Trichloroethane | 1200 | 0.8 | 0.00067 | 0/5 | 2 | 0.0017 | 0/10 |
| 1,1,2,2-Tetrachloroethane | 1400 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,1,2-Trichloroethane | 1.2 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,1-Dichloroethane | 27 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,1-Dichloroethene | 31 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,2-Dichloroethane | 250 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,2-Dichloroethene (total) | 400 | ND | --- | 0/5 | ND | --- | 0/10 |
| 1,2-Dichloropropane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| 2-Butanone | 270 | ND | --- | 0/5 | ND | --- | 0/10 |
| 2-Hexanone | 22 | ND | --- | 0/5 | ND | --- | 0/10 |
| Acetone | 8.7 | ND | --- | 0/5 | **9** | 1.03 | 1/10 |
| Bromodichloromethane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Bromoform | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Bromomethane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Carbon tetrachloride | 47 | ND | --- | 0/5 | ND | --- | 0/10 |
| Chlorobenzene | 410 | ND | --- | 0/5 | ND | --- | 0/10 |
| Chloroethane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Chloroform | 22 | ND | --- | 0/5 | ND | --- | 0/10 |
| Chloromethane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| cis-1,3-Dichloropropene | 0.051 | ND | --- | 0/5 | ND | --- | 0/10 |
| Dibromochloromethane | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Ethylbenzene | 89 | ND | --- | 0/5 | ND | --- | 0/10 |
| Methylene chloride | 370 | ND | --- | 0/5 | ND | --- | 0/10 |
| Styrene | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Tetrachloroethene | 410 | 3 | 0.0073 | 0/5 | 1 | 0.0024 | 0/10 |
| Toluene | 50 | ND | --- | 0/5 | **53** | 1.06 | 1/10 |
| trans-1,3-Dichloropropene | 0.051 | ND | --- | 0/5 | ND | --- | 0/10 |
| Trichloroethene | 220 | ND | --- | 0/5 | ND | --- | 0/10 |
| Vinyl chloride | NB | ND | --- | 0/5 | ND | --- | 0/10 |
| Xylene (total) | 160 | ND | --- | 0/5 | ND | --- | 0/10 |

**Notes**:
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June, 2000 Continued RI Report
SBV = Sediment Benchmark Value
(NYSDEC, 1999, ORNL, 1997)

Table 4-3
(Continued)
Sediment Screening Results
Liberty Industrial Finishing Site

| Analyte | SBVs | Massapequa Creek (Main Stream) | | | Pond A | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentrations (ug/kg) | Max Con/SBV (ug/kg) | Frequency of Exceedances | Maximum Concentrations (ug/kg) | Max Conc/SBV (ug/kg) | Frequency of Exceedances |
| 1,1,1-Trichloroethane | 1200 | 3 | 0.0025 | 0/10 | 9 | 0.0075 | 0/3 |
| 1,1,2,2-Tetrachloroethane | 1400 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,1,2-Trichloroethane | 1.2 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,1-Dichloroethane | 27 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,1-Dichloroethene | 31 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,2-Dichloroethane | 250 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,2-Dichloroethene (total) | 400 | ND | --- | 0/10 | ND | --- | 0/3 |
| 1,2-Dichloropropane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| 2-Butanone | 270 | 8 | 0.030 | 0/10 | ND | --- | 0/3 |
| 2-Hexanone | 22 | ND | --- | 0/10 | ND | --- | 0/3 |
| Acetone | 8.7 | **35** | 4.02 | 5/10 | **84** | 9.66 | 2/3 |
| Bromodichloromethane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Bromoform | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Bromomethane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Carbon tetrachloride | 47 | 0.9 | 0.019 | 0/10 | ND | --- | 0/3 |
| Chlorobenzene | 410 | ND | --- | 0/10 | ND | --- | 0/3 |
| Chloroethane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Chloroform | 22 | ND | --- | 0/10 | ND | --- | 0/3 |
| Chloromethane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| cis-1,3-Dichloropropene | 0.051 | ND | --- | 0/10 | ND | --- | 0/3 |
| Dibromochloromethane | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Ethylbenzene | 89 | ND | --- | 0/10 | ND | --- | 0/3 |
| Methylene chloride | 370 | ND | --- | 0/10 | ND | --- | 0/3 |
| Styrene | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Tetrachloroethene | 410 | 2 | 0.0049 | 0/10 | 7 | 0.017 | 0/3 |
| Toluene | 50 | 5 | 0.1 | 0/10 | **62** | 1.24 | 1/3 |
| trans-1,3-Dichloropropene | 0.051 | ND | --- | 0/10 | ND | --- | 0/3 |
| Trichloroethene | 220 | 0.6 | 0.0027 | 0/10 | ND | --- | 0/3 |
| Vinyl chloride | NB | ND | --- | 0/10 | ND | --- | 0/3 |
| Xylene (total) | 160 | ND | --- | 0/10 | ND | --- | 0/3 |

Notes:
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June, 2000 Continued RI Report
SBV = Sediment Benchmark Value (NYSDEC, 1999, ORNL, 1997)

Table 4-3
(Continued)
Sediment Screening Results
Liberty Industrial Finishing Site

| Analyte | SBVs | West Branch of Massapequa Creek | | | East Branch of Massapequa Creek | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentrations (mg/kg) | Max Conc/SBV (mg/kg) | Frequency of Exceedances | Maximum Concentrations (mg/kg) | Max Conc/SBV (mg/kg) | Frequency of Exceedances |
| Aluminum | 18,000 | 8470 | 0 47 | 0/5 | 1470 | 0.082 | 0/10 |
| Antimony | 2 | ND | --- | 0/5 | ND | --- | 0/10 |
| Arsenic | 6 | **10.3** | 1.72 | 1/5 | 1.8 | 0.3 | 0/10 |
| Barium | 481 | 198 | 0 41 | 0/5 | 11.4 | 0.024 | 0/10 |
| Beryllium | NB | 0 93 | --- | 0/5 | 0 06 | --- | 0/10 |
| Cadmium | 0 6 | **7** | 11.7 | 4/5 | **5.3** | 8 83 | 7/10 |
| Calcium | NB | 5660 | --- | 0/5 | 2640 | --- | 0/10 |
| Chromium | 26 | **39.5** | 1 52 | 1/5 | **44.1** | 1.70 | 3/10 |
| Chromium VI | 26 | 4 6 | 0.18 | 0/5 | 7 3 | 0.28 | 0/10 |
| Cobalt | 101 | 35 2 | 0 35 | 0/5 | 2.6 | 0.026 | 0/10 |
| Copper | 16 | **90** | 5 63 | 3/5 | **37.1** | 2 32 | 4/10 |
| Iron | 20000 | **31500** | 1 58 | 1/5 | 6690 | 0 33 | 0/10 |
| Lead | 31 | **485** | 15 6 | 5/5 | **116** | 3.7 | 3/10 |
| Magnesium | NB | 1980 | --- | 0/5 | 1340 | --- | 0/10 |
| Manganese | 460 | **4510** | 9.80 | 4/5 | 78 | 0.17 | 0/10 |
| Mercury | 0.15 | **0.31** | 2 07 | 3/5 | ND | --- | 0/10 |
| Nickel | 16 | **42.4** | 2.65 | 1/5 | 7.7 | 0.48 | 0/10 |
| Potassium | NB | 570 | --- | 0/5 | 285 | --- | 0/10 |
| Selenium | 1.01 | ND | --- | 0/5 | 0.14 | 0.14 | 0/10 |
| Silver | 1 | ND | --- | 0/5 | **1.2** | 1.2 | 1/10 |
| Sodium | NB | 338 | --- | 0/5 | 116 | --- | 0/10 |
| Thallium | NB | 0 32 | --- | 0/5 | ND | --- | 0/10 |
| Vanadium | 571 | 48 1 | 0 084 | 0/5 | 8 4 | 0.015 | 0/10 |
| Zinc | 120 | **528** | 4.4 | 2/5 | 72 6 | 0.605 | 0/10 |

**Notes:**
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ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June, 2000 Continued RI Report
SBV = Sediment Benchmark Value (NYSDEC, 1999, ORNL, 1997)

Table 4-3
(Continued)
Sediment Screening Results
Liberty Industrial Finishing Site

| Analyte | SBVs | Massapequa Creek (Main Stream) | | | Pond A | | |
|---|---|---|---|---|---|---|---|
| | | Maximum Concentrations (mg/kg) | Max Con/SBV (mg/kg) | Frequency of Exceedances | Maximum Concentrations (mg/kg) | Max Conc/SBV (mg/kg) | Frequency of Exceedances |
| Aluminum | 18,000 | 10400 | 0.58 | 0/10 | 11400 | 0.63 | 0/19 |
| Antimony | 2 | ND | --- | 0/10 | ND | --- | 0/19 |
| Arsenic | 6 | **13.5** | 2.25 | 1/10 | **7.7** | 1.28 | 3/19 |
| Barium | 481 | 119 | 0 25 | 0/10 | 119 | 0.25 | 0/19 |
| Beryllium | NB | 0.79 | --- | 0/10 | 1.1 | --- | 0/19 |
| Cadmium | 0.6 | **17** | 28.3 | 7/10 | **248** | 413 | 19/19 |
| Calcium | NB | 2420 | --- | 0/10 | 4770 | --- | 0/19 |
| Chromium | 26 | **69.6** | 2 68 | 4/10 | **839** | 32.3 | 18/19 |
| Chromium VI | 26 | 16.6 | 0 64 | 0/10 | **136** | 5.23 | 1/19 |
| Cobalt | 101 | 4 5 | 0 045 | 0/10 | 11.4 | 0.11 | 0/19 |
| Copper | 16 | **37.8** | 2 36 | 4/10 | **162** | 10.1 | 17/19 |
| Iron | 20000 | 9470 | 0 47 | 0/10 | 17400 | 0.87 | 0/19 |
| Lead | 31 | **284** | 9 16 | 6/10 | **1160** | 37.4 | 18/19 |
| Magnesium | NB | 799 | --- | 0/10 | 2250 | --- | 0/19 |
| Manganese | 460 | , **2930** | 6 37 | 4/10 | **509** | 1.11 | 1/19 |
| Mercury | 0 15 | ND | --- | 0/10 | **1.2** | 8 | 17/19 |
| Nickel | 16 | 14.5 | 0 91 | 0/10 | **43.7** | 2.73 | 15/19 |
| Potassium | NB | 367 | --- | 0/10 | 695 | --- | 0/19 |
| Selenium | 1.01 | ND | --- | 0/10 | ND | --- | 0/19 |
| Silver | 1 | ND | --- | 0/10 | **2.2** | 2 2 | 14/19 |
| Sodium | NB | 1230 | --- | 0/10 | 456 | --- | 0/19 |
| Thallium | NB | ND | --- | 0/10 | 2.7 | --- | 0/19 |
| Vanadium | 571 | 19 3 | 0 034 | 0/10 | 50 | 0.088 | 0/19 |
| Zinc | 120 | **183** | 1 53 | 1/10 | **801** | 6.68 | 17/19 |

**Notes:**
NB = No available benchmark for this compound
NA = Not analyzed within this AOC
ND = Not detected within this AOC
All data was taken from the Weston 1992 sampling event and the D+M June, 2000 Continued RI Report
SBV = Sediment Benchmark Value (NYSDEC, 1999, ORNL, 1997)

## Table 4-4
## Summary of Chemicals in Sediment Exceeding NYSDEC Criteria
## Liberty Industrial Finishing Site

| Analyte | West Branch (Reference) | East Branch | Main Stream | Pond A |
|---|---|---|---|---|
| Acetone | ND | X | X | X |
| Toluene | ND | X | | X |
| Arsenic | X | ND | X | X |
| Beryllium | NB | NB | NB | NB |
| Cadmium | X | X | X | X |
| Calcium | NB | NB | NB | NB |
| Chromium | X | X | X | X |
| Chromium VI | | | | X |
| Copper | X | X | X | X |
| Iron | X | | | |
| Lead | X | X | X | X |
| Magnesium | NB | NB | NB | NB |
| Manganese | X | | X | X |
| Mercury | X | ND | ND | X |
| Nickel | X | | | X |
| Potassium | NB | NB | NB | NB |
| Silver | ND | X | ND | X |
| Sodium | NB | ND | NB | NB |
| Thallium | ND | ND | ND | NB |
| Zinc | X | | X | X |

**Notes:**
X = Detected above the sediment screening criterion.
NB = Analyte was detected, but no benchmark was available for this analyte.
ND = Not detected within this AOC.
Empty Cells indicate that the analyte was detected, but below the screening criterion.

## Table 4-5
## Highest Measured Sediment Organic Concentrations Compared to Derived Sediment Quality Criteria
## Liberty Industrial Finishing

| | Log $K_{ow}$ | Molecular Weight | Log$K_{oc}$ | Screening Criteria (mg/kg) | Site Conc. (mg/kg) |
|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | 2.48 | 133.40 | 2.44 | 7,155 | 9 |
| 2-Butanone | 0.29 | 72.11 | 0.29 | 732 | 19 |
| Carbon tetrachloride | 2.83 | 153.80 | 2.78 | 10,761 | 0.9 |
| Tetrachloroethene | 3.3 | 168.85 | 3.24 | 16,886 | 7 |
| Toluene | 2.75 | 92.14 | 2.70 | 6,067 | 62 |
| Trichloroethene | 2.42 | 133.40 | 2.38 | 6,836 | 0.6 |

**Notes:**
$K_{oc}$ = organic carbon partition coefficient.
$K_{ow}$ = octanol:water partition coefficient.
Conc. = concentration.
See section 4.1.2.3 for derivation of the above screening criteria.
mg/kg = milligrams per kilogram.

**Table 4-6**
**Concentrations of Metals in Whole Fish**
**from Massapequa Creek and the Reference Location**
**Liberty Industrial Finishing Site**

| Location | Species | Mean Length (cm) | COPC Concentration in Whole Fish mg/kg (wet weight) [Cd] | [Cr] | [Pb] |
|---|---|---|---|---|---|
| PA-03 | Carp | 20.9 (2) | 1.0 | 4.0 | 6.8 |
| | Sunfish | 10.2 (14) | 0.54 | 1.0 | 1.8 |
| P2-03 | Carp | 47.5 (1) | 0.30 | 0.28 | 1.0 |
| P3-01 | Carp | 24.1 (1) | 0.24 | 0.94 | 0.68 |
| | Sunfish | 10.0 (2) | 0.40 | 0.87 | 1.2 |
| P3-03 | Carp | 27.4 (2) | 0.20 | 0.47 | 1 |
| P4-01 | Carp | 27.2 (2) | 0.21 | 0.29 | 0.81 |
| | Sunfish | 14.4 (3) | 0.15 | 0.69 | 1.8 |
| P5-01 | Carp | 63.1 (1) | 1.3 | 0.24 | 0.71 |
| | Sunfish | 19.9 (3) | 0.06 | 0.64 | 0.81 |
| Mean Massapequa Presereve | | | 0.44 | 0.94 | 1.66 |
| 95% UCL | | | 1.12 | 1.93 | 2.82 |
| R1-01 | Carp | 76.5 (1) | 0.025 | 0.33 | 1 |
| | Sunfish | 16.6 (3) | 0.025 | 0.42 | 0.78 |

## Table 4-7
## Cadmium Data for Fish (from Jarvinen and Ankley 1999)

| Species | Exposure Duration (days) | NEBB (mg/kg ww) | Effect | LEBB (mg/kg ww) | Effect | Reference # in Jarvinen and Ankley (1999) | Life Stage | Test Site & Conditions | Exposure Route & Concentration | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| **BTAG Data:** | | | | | | | | | | |
| Rainbow trout | 29 | | | 1 | survival | 350 | 5-15 g | lab; static, aerated | water; 0.11 mg/L | soft water (70 mg/L as CaCO3) |
| Rainbow trout | 29 | | | 0.7 | survival | 350 | 5-15 g | lab; static, aerated | water; 0.11 mg/L | hard water (280 mg/L as CaCO3) |
| Rainbow trout | 210 | | | 0.96 | growth | 248 | 3.1 g | lab; flow-through | water; 4.8 µg/L | |
| Rainbow trout | 210 | 0.54 | growth | | | 248 | 3.1 g | lab; flow-through | water; 2.2 µg/L | |
| Rainbow trout | 84 | | | 1.6 | growth | 248 | 3.1 g | lab; flow-through | diet; 100 µg/g | |
| Rainbow trout | 84 | 0.47 | growth | | | 248 | 3.1 g | lab; flow-through | diet; 30 µg/g | |
| Brook trout | 84 | | | 0.25 | growth | 26 | embryo-juvenile | lab; flow-through | adult fish + water; 3.4 µg/L | third generation fish |
| Brook trout | 84 | 0.13 | growth | | | 26 | embryo-juvenile | lab; flow-through | adult fish + water; 1.7 µg/L | third generation fish |
| Brook trout | 60 | 0.04 | survival | | | 26 | embryo | lab; flow-through | adult fish + water; 3.4 µg/L | third generation fish |
| Brook trout | 30 | | | 0.14 | survival | 163, 164 | 2-3 mo.; 5 g | lab; flow-through | water; 3.6 µg/L | |
| Flagfish | 100 | | | 6 | survival | 420 | embryo-adult | lab; flow-through | water; 8.5 µg/L | |
| Flagfish | 100 | | | 4 | survival, growth | 418 | embryo-adult | lab; flow-through | water; 16 µg/L | residues were higher at 30 d than at 100 d. |
| Flagfish | 100 | | | 2 | reproduction | 418 | embryo-adult | lab; flow-through | water; 8.1 µg/L | |
| Flagfish | 100 | 1.2 | reproduction | | | 418 | embryo-adult | lab; flow-through | water; 4.1 µg/L | |
| Guppy | 30 | | | 8 | survival | 181 | 15 d | lab; renewal, 1 d | water; 45 µg/L | |

**Table 4-7**
**Cadmium Data for Fish (from Jarvinen and Ankley 1999)**
**(Continued)**

| Species | Exposure Duration (days) | NEBB (mg/kg ww) | Effect | LEBB (mg/kg ww) | Effect | Reference # in Jarvinen and Ankley (1999) | Life Stage | Test Site & Conditions | Exposure Route & Concentration | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Stickleback | 79 | | | 0.9 | survival | 351 | 969 mg | lab; renewal, 4 d | water; 0.8 µg/L | |
| Bluegill | 28 | 1.33 | growth | | | 92 | juvenile | lab; flow-through | water; 32.3 µg/L | |
| Perch | 40 | 0.075 | survival | | | 126 | fingerling | plastic tent; static, aerated, recirculated | water; 22 µg/L | radiotracer study, NEBB calculated from BCF |
| Dace | 112 | 0.69 | growth | | | 248 | 1.1 g | artificial stream; flow-through | water; 2.0 µg/L | |
| **Other Data:** | | | | | | | | | | |
| Brook trout | 30 | 0.75 | growth | | | 163, 164 | 2-3 mo.; 5 g | lab; flow-through | water; 60.6 µg/L | |
| Brook trout | 30 | | | 0.41 | survival | 163, 164 | 2-3 mo.; 5 g | lab; flow-through | water; 15.7 µg/L | |
| Flagfish | 100 | 2 | survival, growth | | | 418 | embryo-adult | lab; flow-through | water; 8.1 µg/L | residues were higher at 30 d than at 100 d |
| Guppy | 30 | | | 0.8 | survival | 181 | 19 d | lab; renewal, 3 d | diet; 170.6 µg/g | |
| Guppy | 30 | 0.8 | growth | | | 181 | 19 d | lab; renewal, 3 d | diet; 170.6 µg/g | |
| Guppy | 30 | 0.8 | survival | | | 181 | 19 d | lab; renewal, 3 d | diet; 125.9 µg/g | |
| Guppy | 25 | 4.8 | survival, growth | | | 181 | 15 d | lab; flow-through | water; 10 µg/L | |
| Bluegill | 180 | | | 0.35 | survival | 81 | juvenile | lab; renewal | water; 0.85 mg/L | |
| Bluegill | 180 | 0.35 | growth | | | 81 | juvenile | lab; renewal | water; 0.85 mg/L | |

## Table 4-7
## Cadmium Data for Fish (from Jarvinen and Ankley 1999)
## (Continued)

| Species | Exposure Duration (days) | NEBB (mg/kg ww) | Effect | LEBB (mg/kg ww) | Effect | Reference # in Jarvinen and Ankley (1999) | Life Stage | Test Site & Conditions | Exposure Route & Concentration | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Bluegill | 180 | 0.036 | survival | | | 81 | juvenile | lab; renewal | water; 0.08 mg/L | |
| Atlantic salmon | 158 | | | 4 | survival | 379 | embryo-alevin | lab; recirculating | water; 270 µg/L | 5°C |
| Atlantic salmon | 158 | 2 | survival | | | 379 | embryo-alevin | lab; recirculating | water; 90 µg/L | 5°C |
| Atlantic salmon | 158 | | | 0.4 | growth | 379 | embryo-alevin | lab; recirculating | water; 11 µg/L | 5°C |
| Atlantic salmon | 158 | 0.3 | growth | | | 379 | embryo-alevin | lab; recirculating | water; 2.8 µg/L | 5°C |
| Atlantic salmon | 92 | | | 0.56 | survival | 379 | embryo-alevin | lab; recirculating | water; 8.2 µg/L | 9.6°C |
| Atlantic salmon | 92 | 0.25 | survival | | | 379 | embryo-alevin | lab; recirculating | water; 2.5 µg/L | 9.6°C |
| Atlantic salmon | 92 | | | 0.12 | growth | 379 | embryo-alevin | lab; recirculating | water; 0.47µg/L | 9.6°C |
| Atlantic salmon | 92 | 0.06 | growth | | | 379 | embryo-alevin | lab; recirculating | water; 0.47µg/L | 9.6°C |
| Baltic herring | 15 | | | 36 | survival | 485 | embryo | lab; renewal, 2 d | water; 5 mg/L | (lower end of reported range) |
| Baltic herring | 15 | | | 77 | survival | 485 | embryo | lab; renewal, 2 d | water; 5 mg/L | (higher end of reported range) |
| Baltic herring | 15 | 19 | survival | | | 485 | embryo | lab; renewal, 2 d | water; 1 mg/L | (lower end of reported range) |
| Baltic herring | 15 | 38 | survival | | | 485 | embryo | lab; renewal, 2 d | water; 1 mg/L | (higher end of reported range) |

**Table 4-7**
**Cadmium Data for Fish (from Jarvinen and Ankley 1999)**
**(Continued)**

| Species | Exposure Duration (days) | NEBB (mg/kg ww) | Effect | LEBB (mg/kg ww) | Effect | Reference # in Jarvinen and Ankley (1999) | Life Stage | Test Site & Conditions | Exposure Route & Concentration | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Baltic herring | 15 | | | 24 | survival | 485 | embryo | lab; renewal, 2 d | water; 0.5 mg/L | salinity 5 ppt |
| Baltic herring | 15 | 7 | survival | | | 485 | embryo | lab; renewal, 2 d | water; 0.1 mg/L | salinity 5 ppt |
| Baltic herring | 15 | | | 19 | survival | 485 | embryo | lab; renewal, 2 d | water; 1.0 mg/L | salinity 16 ppt |
| Baltic herring | 15 | 11 | survival | | | 485 | embryo | lab; renewal, 2 d | water 0.5 mg/L | salinity 16 ppt |
| Garpike | 25 | | | 18 | survival | 483 | embryo | lab; static | water; 2.0 mg/L | (lower end of reported range) |
| Garpike | 25 | | | 28 | survival | 483 | embryo | lab; static | water; 2.0 mg/L | (higher end of reported range) |
| Garpike | 25 | 10 | survival | | | 483 | embryo | lab; static | water; 1.0 mg/L | (lower end of reported range); identical data reported as effect and no-effect body burdens |
| Garpike | 25 | 19 | survival | | | 483 | embryo | lab; static | water; 1.0 mg/L | (lower end of reported range); identical data reported as effect and no-effect body burdens |
| Garpike | 25 | | | 10 | survival | 483 | embryo | lab; static | water; 1.0 mg/L | (lower end of reported range); identical data reported as effect and no-effect body burdens |

**Table 4-7**
**Cadmium Data for Fish (from Jarvinen and Ankley 1999)**
**(Continued)**

| Species | Exposure Duration (days) | NEBB (mg/kg ww) | Effect | LEBB (mg/kg ww) | Effect | Reference # in Jarvinen and Ankley (1999) | Life Stage | Test Site & Conditions | Exposure Route & Concentration | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Garpike | 25 | | | 19 | survival | 483 | embryo | lab; static | water; 1.0 mg/L | (lower end of reported range); identical data reported as effect and no-effect body burdens |
| Garpike | 25 | 7 | survival | | | 483 | embryo | lab; static | water; 0.5 mg/L | (lower end of reported range) |
| Garpike | 25 | 11 | survival | | | 483 | embryo | lab; static | water; 0.5 mg/L | (higher end of reported range) |
| Seabass | 16 | | | 20.4 | survival | 405 | larvae-juvenile | lab; renewal, 2 d | water; 3.2 mg/L | residues in surviving fish |
| Seabass | 16 | | | 8.3 | survival | 405 | larvae-juvenile | lab; renewal, 2 d | water; 1.0 mg/L | residues in surviving fish |
| Seabass | 16 | | | 4.2 | survival | 405 | larvae-juvenile | lab; renewal, 2 d | water; 0.32 mg/L | residues in surviving fish |
| Seabass | 16 | 2.5 | survival | | | 405 | larvae-juvenile | lab; renewal, 2 d | water; 0.1 mg/L | |

## Table 4-8
## Screening-Level No Effect (NEBB) and Lowest Effect Body Burdens (LEBB) for Cr in Fish
## Liberty Industrial Finishing Site

| Species | Exposure Days | NEBB mg/kg wet weight | Endpoint | LEBB mg/kg wet weight | Endpoint | % Affected |
|---|---|---|---|---|---|---|
| Pumpkinseed | Field collected[1] | 5.7 | Survival | | | |
| Rainbow trout | Field collected[2] | 0.029 | Survival | | | |
| | Field collected[2] | 0.183 | Survival | | | |
| | 4[3] | 2.0 | Survival | | | |
| | 4[3] | 5.5 | Survival | 8.7 | Survival | 75 |

1) Eisler (1986); 2) Buhler et al. 1977); 3) Van der Putte et al. (1981)

## Table 4-9
## Screening-Level No Effect (NEBB) and Lowest Effect Body Burdens (LEBB) for Pb in Fish
## Liberty Industrial Finishing Site

| Species | Exposure Days | NEBB mg/kg wet weight | Endpoint | LEBB mg/kg wet weight | Endpoint | % Affected |
|---|---|---|---|---|---|---|
| Brook trout | 3 generations | 2.5- 5.2[1] | Growth | 4.0-8.8 | Growth | Reduced |
| | | 0.34 | Hatchability | 0.40 | Hatchability | Reduced |
| Rainbow trout | Field collected[3] | 1.78 | survival | | | |
| | 14 | | | 2.54[2] | Survival | 16.7 |

1) Holcombe et al. 1976; 2) tetramethyllead (Wong et al. 1981); 3) Hodson et al. 1978.

Table 4-10

Conservative Hazard Quotient Calculations for the Kingfisher

Liberty Industrial Finishing Site

| Contamina | Concentration in Sediment (a) (mg/kg) | Concentration in Surface Water (b) (mg/L) | Concentration in fish (c) (mg/kg) | FIR (kg/day) (d) | SIR (kg/day) (e) | WIR (kg/day) (f) | AUF (g) | Body Weight (h) (kg) | Dose (mg/kg BW/day) (i) | NOAEL (mg/kg BW/day) (k) | HQ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Stream** | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.1 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 0.7 | 1.5 | 0.51 |
| Chromium | 655 | 0.055 | 1.9 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 1.5 | 1.0 | **1.5** |
| Lead | 1662 | 0.004 | 2.9 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 2.6 | 3.9 | 0.69 |
| **Pond A** | | | | | | | | | | | |
| Cadmium | 248 | 0.001 | 1.0 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 0.7 | 1.5 | 0.47 |
| Chromium | 839 | 0.055 | 4.0 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 2.6 | 1.0 | **2.6** |
| Lead | 1160 | 0.003 | 6.8 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 4.3 | 3.9 | **1.1** |
| **Total Site** | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.0 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 0.7 | 1.5 | 0.5 |
| Chromium | 839 | 0.055 | 1.17 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 1.2 | 1.0 | **1.2** |
| Lead | 1662 | 0.004 | 1.4 | 0.068 | 0.0001 | 0.015 | 1.0 | 0.136 | 1.9 | 3.9 | 0.5 |

**Notes:**

UCL = Upper Confidence Limit.

(a) Sediment concentrations represent the greater of the maximum or 95% UCL values

Total site sediment concentrations represent the maximum reported value for each contaminant

(b) Surface water concentrations represent the greater of the maximum or 95% UCL values

Total site surface water concentrations represent the maximum reported value for each contaminant

(c) Fish concentrations represent the greater value of the maximum or 95% UCL (value taken from table 4-16 of the Dames and Moore ERA)

Total site fish concentrations for each contaminant were calculated using a weighted average of all fish sample results

(d) FIR = Food Ingestion Rate. The highest mean food ingestion rate from U.S. EPA (1993) was used in these calculations.

(e) SIR = Sediment Ingestion Rate. The sediment ingestion rate was calculated from sediment concentrations from Kolehmainen (1974)

that were taken from the bluegill and then multiplied by the food ingestion rate of the kingfisher

(f) WIR = Water Ingestion Rate. The highest mean water ingestion rate from U.S. EPA (1993) was used in these calculations

(g) AUF = Area Use Factor. A conservative AUF of 1 was used in these calculations

(h) BW = Body Weight. The lowest reported mean body weight from U.S. EPA (1993) was used in these calculations

(i) Dose = [(Concentration in sediment)(SIR)+(Concentration in fish)(FIR)+(Concentration in surface water)(WIR)/Body Weight] x (AUF)

(k) NOAEL = No Observed Adverse Effect Level (ORNL 1996). A NOAEL for chromium was based on studies using trivalent chromium

HQ = Hazard Quotient (Dose/NOAEL).

Table 4-11
Conservative Hazard Quotient Calculations for the Raccoon
Liberty Industrial Finishing Site

| Contaminant | Concentration in Sediment (a) (mg/kg) | Concentration in Surface Water (b) (mg/L) | Concentration in fish (c) (mg/kg) | FIR (kg/day) (d) | SIR (kg/day) (e) | WIR (kg/day) (f) | AUF (g) | Body Weight (h) (kg) | Dose (mg/kg BW/day) | NOAEL (mg/kg BW/day) (i) | HQ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Stream** | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.1 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 3.3 | 0.51 | **6.5** |
| Chromium | 655 | 0.055 | 1.9 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 8.7 | 1445 | 0.01 |
| Lead | 1662 | 0.004 | 2.8 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 21.7 | 4.2 | **5.1** |
| **Pond A** | | | | | | | | | | | |
| Cadmium | 248 | 0.001 | 1.0 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 3.3 | 0.51 | **6.5** |
| Chromium | 839 | 0.055 | 4.0 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 11.3 | 1445 | 0.01 |
| Lead | 1160 | 0.003 | 6.8 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 15.8 | 4.2 | **3.7** |
| **Total Site** | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.0 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 3.3 | 0.51 | **6.5** |
| Chromium | 839 | 0.055 | 1.17 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 10.9 | 1445 | 0.01 |
| Lead | 1662 | 0.004 | 1.4 | 0.5 | 0.047 | 0.025 | 1.0 | 3.67 | 21.5 | 4.2 | **5.1** |

**Notes:**

UCL = Upper Confidence Limit.

(a) Sediment concentrations represent the greater of the maximum or 95% UCL values

Total site sediment concentrations represent the maximum reported value for each contaminant

(b) Surface water concentrations represent the greater of the maximum or 95% UCL values

Total site surface water concentrations represent the maximum reported value for each contaminant.

(c) Fish concentrations represent the greater value of the maximum or 95% UCL (value taken from table 4-16 of the Dames and Moore ERA)

Total site fish concentrations for each contaminant were calculated using a weighted average of all fish sample results

(d) FIR = Food Ingestion Rate. (Newell, 1987).

(e) SIR = Sediment Ingestion Rate. The SIR was calculated by multiplying the soil ingestion rate reported in Beyer (1994) by the FIR

(f) WIR = Water Ingestion Rate The highest reported mean WIR from adult studies in U.S. EPA (1993) was used in these calcualtions

(g) AUF = Area Use Factor. A conservative AUF of 1 was used in these calculations

(h) The lowest reported mean body weight from adult studies in U.S. EPA (1993) was used in these calculations

Dose = [(Concentration in fish)(FIR)+(Concentration in sediment)(SIR)+Concentration in surface water)(WIR) Body Weight] x (AUF).

BW = Body Weight

(i) NOAEL = No Observed Adverse Effect Level (ORNL, 1996) The NOAEL for chromium is based on studies using trivalent chromium

HQ = Hazard Quotient (Dose NOAEL).

## Table 4-12
## Summary of Hazard Quotients Exceeding 1
## Conservative Model (NOAELs and AUF = 1)
## Liberty Industrial Finishing Site

| Main Stream | |
|---|---|
| **Analyte** | **Receptor** |
| Cadmium | Raccoon |
| Chromium | Beltea Kingfisher |
| Lead | Raccoon |
| **Pond A** | |
| **Analyte** | **Receptor** |
| Cadmium | Raccoon |
| Chromium | Belted Kingfisher |
| Lead | Raccoon, Belted Kingfisher |
| **Total Site** | |
| **Analyte** | **Receptor** |
| Cadmium | Raccoon |
| Chromium | Belted Kingfisher |
| Lead | Raccoon |

**Notes:**

NOAEL = No observed adverse effect level.

AUF = Area Use Factor.

Using the less conservative model based on LOAELs and actual AUFs, no hazard quotients exceeded 1.

Table 4-13

Less Conservative Hazard Quotient Calculations for the Kingfisher

Liberty Industrial Finishing Site

| Contaminant | Concentration in Sediment (a) (mg/kg) | Concentration in Surface Water (b) (mg/L) | Concentration in fish (c) (mg/kg) | FIR (kg/day) (d) | SIR (kg/day) (e) | WIR (kg/day) (f) | HR (acres) (g) | Area of AOC (h) (acres) | AUF (i) | Body Weight (k) (kg) | Dose (mg/kg BW/day) (l) | LOAEL (mg/kg BW/day) (m) | HQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Stream** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.1 | 0.068 | 0.0001 | 0.015 | 160 | 53.0 | 0.33 | 0.136 | 0.25 | 20.0 | 0.01 |
| Chromium | 655 | 0.055 | 1.9 | 0.068 | 0.0001 | 0.015 | 160 | 53.0 | 0.33 | 0.136 | 0.48 | 5.0 | 0.10 |
| Lead | 1662 | 0.004 | 2.9 | 0.068 | 0.0001 | 0.015 | 160 | 53.0 | 0.33 | 0.136 | 0.88 | 11.3 | 0.08 |
| **Pond A** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.001 | 1.0 | 0.068 | 0.0001 | 0.015 | 160 | 3.2 | 0.02 | 0.136 | 0.01 | 20.0 | 0.0007 |
| Chromium | 839 | 0.055 | 4.0 | 0.068 | 0.0001 | 0.015 | 160 | 3.2 | 0.02 | 0.136 | 0.05 | 5.0 | 0.01 |
| Lead | 1160 | 0.003 | 6.8 | 0.068 | 0.0001 | 0.015 | 160 | 3.2 | 0.02 | 0.136 | 0.09 | 11.3 | 0.01 |
| **Total Site** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.020 | 1.0 | 0.068 | 0.0001 | 0.015 | 160 | 56.2 | 0.35 | 0.136 | 0.2 | 20.0 | 0.01 |
| Chromium | 839 | 0.055 | 1.17 | 0.068 | 0.0001 | 0.015 | 160 | 56.2 | 0.35 | 0.136 | 0.4 | 5.0 | 0.08 |
| Lead | 1662 | 0.004 | 1.4 | 0.068 | 0.0001 | 0.015 | 160 | 56.2 | 0.35 | 0.136 | 0.7 | 11.3 | 0.06 |

**Notes:**

UCL - Upper Confidence Limit

(a) Sediment concentrations represent the greater of the maximum or 95% UCL values

Total site sediment concentrations represent the maximum reported value for each contaminant

(b) Surface water concentrations represent the greater of the maximum or 95% UCL values

Total site surface water concentrations represent the maximum reported value for each contaminant

(c) Fish concentrations represent the greater value of the maximum or 95% UCL (value taken from table 4-16 of the Dames and Moore ERA)

Total site fish concentrations for each contaminant were calculated using a weighted average of all fish sample results

(d) FIR - Food Ingestion Rate - The highest mean food ingestion rate from U.S. EPA (1993) was used in these calculations

(e) SIR - Sediment Ingestion Rate - The sediment ingestion rate was calculated from sediment concentrations from Kolehmainen (1974)

that were taken from the bluegill and then multiplied by the food ingestion rate of the kingfisher

(f) WIR - Water Ingestion Rate - The highest mean water ingestion rate from U.S. EPA (1993) was used in these calculations

(g) HR - Home Range - The lowest reported home range from DeGraaf and Rudis (1993) was used in these calculations.

(h) The approximate areas of the Main Stream and Pond A were calculated using Figure 3-44 and 3-64 of the June 2000 Continued RI Report

(i) AUF - Area Use Factor (AOC area/Home Range), all areas are given in acres

(k) BW - Body Weight - The lowest reported mean body weight from U.S. EPA (1993) was used in these calculations

(l) Dose - [(Concentration in sediment)(SIR) + (Concentration in fish)(FIR) + (Concentration in surface water)(WIR)/Body Weight] x (AUF)

(m) LOAEL - Lowest Observed Adverse Effect Level (ORNL, 1996) - A LOAEL for chromium was based on studies using trivalent chromium

HQ - Hazard Quotient (Dose/LOAEL)

Table 4-14
Less Conservative Hazard Quotient Calculations for the Raccoon
Liberty Industrial Finishing Site

| Contaminant | Concentration in Sediment (a) (mg/kg) | Concentration in Surface Water (b) (mg/L) | Concentration in fish (c) (mg/kg) | FIR (kg/day) (d) | SIR (kg/day) (e) | WIR (kg/day) (f) | HR (acres) (g) | Area of AOC (h) (acres) | AUF (i) | Body Weight (k) (kg) | Dose (mg/kg BW/day) (l) | LOAEL (mg/kg BW/day) (m) | HQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Stream** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.0198 | 1.1 | 0.5 | 0.047 | 0.0249 | 96.3 | 53 | 0.55 | 3.67 | 1.8 | 5.1 | 0.36 |
| Chromium | 655 | 0.055 | 1.9 | 0.5 | 0.047 | 0.0249 | 96.3 | 53 | 0.55 | 3.67 | 4.8 | 14450 | 0.0003 |
| Lead | 1662 | 0.0041 | 2.8 | 0.5 | 0.047 | 0.0249 | 96.3 | 53 | 0.55 | 3.67 | 11.9 | 42.3 | 0.28 |
| **Pond A** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.001 | 1.0 | 0.5 | 0.047 | 0.0249 | 96.3 | 3.2 | 0.03 | 3.67 | 0.11 | 5.09 | 0.02 |
| Chromium | 839 | 0.055 | 4.0 | 0.5 | 0.047 | 0.0249 | 96.3 | 3.2 | 0.03 | 3.67 | 0.38 | 14450 | 0.00003 |
| Lead | 1160 | 0.0028 | 6.8 | 0.5 | 0.047 | 0.0249 | 96.3 | 3.2 | 0.03 | 3.67 | 0.52 | 42.3 | 0.01 |
| **Total Site** | | | | | | | | | | | | | |
| Cadmium | 248 | 0.0198 | 1.0 | 0.5 | 0.047 | 0.0249 | 96.3 | 56.2 | 0.58 | 3.67 | 1.9 | 5.09 | 0.38 |
| Chromium | 839 | 0.055 | 1.17 | 0.5 | 0.047 | 0.0249 | 96.3 | 56.2 | 0.58 | 3.67 | 6.4 | 14450 | 0.0004 |
| Lead | 1662 | 0.0041 | 1.4 | 0.5 | 0.047 | 0.0249 | 96.3 | 56.2 | 0.58 | 3.67 | 12.5 | 42.3 | 0.30 |

**Notes:**

UCL Upper Confidence Limit
(a) Sediment concentrations represent the greater of the maximum or 95% UCL values
Total site sediment concentrations represent the maximum reported value for each contaminant
(b) Surface water concentrations represent the greater of the maximum or 95% UCL values
Total site surface water concentrations represent the maximum reported value for each contaminant
(c) Fish concentrations represent the greater value of the maximum or 95% UCL (value taken from table 4-16 of the Dames and Moore ERA)
Total site fish concentrations for each contaminant were calculated using a weighted average of all fish sample results
(d) FIR Food Ingestion Rate. (Newell, 1987).
(e) SIR Sediment Ingestion Rate The SIR was calculated by multiplying the soil ingestion rate reported in Beyer (1994) by the FIR
(f) WIR Water Ingestion Rate. The highest reported mean WIR from adult studies in U.S. EPA (1993) was used in these calculations
(g) HR Home Range. The lowest reported mean home range based on adult studies in U.S. EPA (1993) was used in these calculations
(h) AUF Area Use Factor (AOC area/Home Range), all areas are given in acres
(i) The approximate areas of Main Stream and Pond A were calculated using Figures 3-44 and 3-64 of the June 2000 Continued RI Report
(k) The lowest reported mean body weight from adult studies in U.S. EPA (1993) was used in these calculations
(l) Dose [(Concentration in fish)(FIR) + (Concentration in sediment)(SIR) + Concentration in surface water)(WIR/Body Weight] x (AUF)
BW Body Weight
(m) LOAEL Lowest Observed Adverse Effect Level (ORNL, 1996) The LOAEL for chromium is based on studies using trivalent chromium
HQ Hazard Quotient (Dose/LOAEL)

**Table 4-15**
**Metals Concentrations and Results of March 1999 Bulk Sediment Bioassays with *H. azteca***

| | Cr mg/kg | Cd mg/kg | Cu mg/kg | Ni mg/kg | Pb mg/kg | Zn mg/kg | *H. azteca* % Survival | *H. azteca* Growth (mm) |
|---|---|---|---|---|---|---|---|---|
| Control | NA | NA | NA | NA | NA | NA | 98 | 3.26 |
| Reference | 14.8 | 1.5 | 32.1 | 16.7 | 209 | 178 | 80 | 3.28 |
| PA-03 | 268 | 55.4 | 122 | 27.9 | 532 | 569 | 73.8 | 3.74 |
| P1-02 | 345 | 93.5 | 104 | 33.4 | 1370 | 585 | 91.3 | 3.19 |
| P2-03 | 196 | 68.3 | 82.9 | 24.8 | 754 | 486 | 95.0 | 3.56 |
| P3-01 | 147 | 13.7 | 82 | 34.5 | 631 | 141 | 97.5 | 3.36 |
| P3-03 | 160 | 63.5 | 73.7 | 21.5 | 689 | 419 | 97.5 | 3.72 |
| P4-01 | 259 | 10.3 | 39.5 | 12.5 | 276 | 134 | 91.3 | 3.11 |
| P4-03 | 72.1 | 22.1 | 39.7 | 15.6 | 311 | 224 | 74 | 3.72 |
| P5-01 | 88.9 | 31.2 | 74.1 | 20.5 | 647 | 508 | 91.3 | 3.23 |

Notes:
No significant differences in toxicity were noted between samples and reference location samples.
No statistical comparisons were reported against the laboratory control.
Metals concentration in sediments are from Dames & Moore Draft CRI Report, 2000.
Toxicity results are from Aqua Survey, 1999a and 1999b.

Table 4-16
Metals Concentrations and Results of December 1999 Sediment Bioassays
with *H. azteca* and *C. tentans*

| Location | Grain Size % < #200 | TOC (mg/kg) | Cr (mg/kg) | Cd (mg/kg) | Pb (mg/kg) | Zn (mg/kg) | *C. tentans* % Survival | *C. tentans* Growth (mg) | *H. azteca* % Survival | *H. azteca* Growth (mm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | NA | NA | NA | NA | NA | NA | 89 | 0.95 | 91 | 2.93 |
| PA-10 | 64 | 181,000 | 687 | 142 | 908 | 618 | 93 | 0.79* | 78* | 2.79 |
| PA-13 | 52 | 152,000 | 457 | 99.9 | 651 | 518 | 90 | 0.64*2 | 64* | 2.78 |

* Statistically Significant Difference from the laboratory control.
No reference sample was collected or compared.
TOC  Total organic carbon

## Table 4-17
## Summary of Benthic Macroinvertebrate Results (Nov. 2, 1998)

| | Location | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **Reference** | **PA-03** | **PA-03A** | **P1-02** | **P1-02A** | **P2-03** | **P2-03A** | **P3-01** | **P3-01A** | **P3-03** | **P4-01** | **P5-01** |
| Platyhelminthes | | | | | | | | | | | | |
| Turbellaria | | | | | | | | | | | 2 | |
| Nematomorpha | | | | | | | 1 | 1 | | | | |
| Annellida | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | |
| Haplotaxida | | | | | | | | | | | | |
| Tubificidae | 2 | 4 | 12 | 11 | | 4 | 17 | 4 | 3 | 12 | 52 | 3 |
| Hirudinea | | | | | | | | | | | | |
| Rhynchobedellida | | | | | | | | | | | | |
| Glossiphoniidae | | | | 2 | 5 | 1 | 1 | 1 | 2 | | | |
| Piscicolidae | | | | | 7 | | | | | | | 1 |
| Isopoda | | | | | | | | | | | | |
| Assellidae | | | | | | | | | | | | |
| *Lirceus* | | | | 1 | | | 1 | | | | | |
| Amphipoda | | | | | | | | | | | | |
| Gammaridae | | | | | | | | | | | | |
| *Gammarus* | | | | | | | | | 3 | | 1 | |
| Insecta | | | | | | | | | | | | |
| Diptera | | | | | | | | | | | | |
| Chironomidae | | 4 | 4 | | | 3 | 12 | 1 | 1 | 2 | 9 | 2 |
| Gastropoda | | | | | | | | | | | | |
| Unionidae | | | | | | | | | | | | |
| *Amblema* | 3 | | | | | | | | | | 3 | |
| Planorbidae | | | | | | | | | | | | |

## Table 4-17
## Summary of Benthic Macroinvertebrate Results (Nov. 2, 1998)
## (continued)

| | Location | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxa | Reference | PA-03 | PA-03A | P1-02 | P1-02A | P2-03 | P2-03A | P3-01 | P3-01A | P3-03 | P4-01 | P5-01 |
| *Planorbella* | | | | | | | | | | | | |
| Total Specimens | 5 | 8 | 16 | 14 | 12 | 8 | 31 | 6 | 10 | 16 | 67 | 6 |
| Total Taxa | 2 | 2 | 2 | 3 | 2 | 3 | 4 | 3 | 5 | 4 | 5 | 3 |
| Shannon-Weaver diversity Index (H') | 0.292 | 0.301 | 0.244 | 0.285 | 0.295 | 0.423 | 0.339 | 0.377 | 0.654 | 0.357 | 0.336 | 0.439 |
| Shannon-Weaver evenness (J) | 0.971 | 1.000 | 0.811 | 0.597 | 0.980 | 0.887 | 0.662 | 0.790 | 0.935 | 0.593 | 0.480 | 0.923 |

# APPENDIX A

## Dames and Moore Analytical Data Massapequa Creek and Ponds (1992-1999)

1) **Surface Water Analytical Data**

   **1998 Data:** **from Draft CRI Report (Dames & Moore, June5, 2000)**

   **1992 Data:** **from RI Report (Roy F. Weston, 1994)**

2) **Sediment Analytical Data**

   **1998-1999 Data:** **from Draft CRI Report (Dames & Moore, June 5, 2000)**

   **1992 Data:** **from RI Report (Roy F. Weston, 1994)**

# Surface Water Analytical Data (1998)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-01-SW 04/07/1998 | MP-02-SW 04/07/1998 | MP-03-SW 04/07/1998 | MP-04-SW 04/07/1998 | MP-06-SW 04/07/1998 | MP-08-SW 04/07/1998 | MP-09-SW 04/07/1998 | MP-10-SW 04/07/1998 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | East Branch | East Branch | Pond A | Mass Creek | Mass Creek | Mass Creek |
| Cyanide | GEN | µg/l | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hardness | GEN | mg/L | 33.5 | 46 | 55.1 | 48.5 | 47.7 | 43.5 | 44.1 | 42.9 |
| Aluminum | MET | µg/l | 171 B | 84.1 U | 84.1 U | 84.1 U | 121 B | 98.7 B | 89.5 B | 102 B |
| Antimony | MET | µg/l | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U |
| Arsenic | MET | µg/l | 2.8 U | 2.8 U | 2.8 U | 4.2 B | 2.8 U | 2.8 U | 2.9 B | 2.8 U |
| Barium | MET | µg/l | 32 B | 30.6 B | 39.3 B | 31.9 B | 29.4 B | 25.1 B | 24.5 B | 21.1 B |
| Beryllium | MET | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Cadmium | MET | µg/l | 0.4 U | 0.4 U | 19.8 | 8.7 | 1 B | 1.2 B | 1.1 B | 0.61 B |
| Calcium | MET | µg/l | 10000 | 13500 | 17000 | 15000 | 14400 | 13400 | 13500 | 13000 |
| Chromium | MET | µg/l | 1.1 U | 1.1 U | 54.9 | 30 | 6.1 B | 5.5 B | 4.2 B | 2.5 B |
| Chromium VI | MET | µg/l | 10 U | 10 U | 49.4 | 24.3 | 10 U | 10 U | 10 U | 10 U |
| Cobalt | MET | µg/l | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U |
| Copper | MET | µg/l | 2.9 U | 2.9 U | 2.9 U | 2.9 U | 2.9 U | 2.9 U | 3.1 B | 2.9 U |
| Iron | MET | µg/l | 108 | 57.2 B | 52.1 B | 81 B | 302 | 764 | 510 | 321 |
| Lead | MET | µg/l | 7 | 2 U | 2 U | 2 U | 2.8 B | 2 U | 2 U | 2 U |
| Magnesium | MET | µg/l | 2060 B | 2980 B | 3080 B | 2680 B | 2850 B | 2430 B | 2520 B | 2530 B |
| Manganese | MET | µg/l | 80.3 | 11 B | 426 | 213 | 86.1 | 375 | 386 | 286 |
| Mercury | MET | µg/l | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Nickel | MET | µg/l | 2.1 U | 2.1 U | 2.3 B | 2.1 U | 2.1 U | 2.1 U | 2.5 B | 2.2 B |
| Potassium | MET | µg/l | 1660 B | 2110 B | 2060 B | 1930 B | 1800 B | 1690 B | 1670 B | 1650 B |
| Selenium | MET | µg/l | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U |
| Silver | MET | µg/l | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U |
| Sodium | MET | µg/l | 25700 | 22400 | 23300 | 20000 | 18700 | 17500 | 19700 | 18600 |
| Thallium | MET | µg/l | 8.2 B | 7.3 B | 5.4 B | 4.5 U | 4.7 B | 5.6 B | 6.3 B | 4.5 U |
| Vanadium | MET | µg/l | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U |
| Zinc | MET | µg/l | 19.4 B | 19.1 B | 34.5 | 32.6 | 22.3 | 18.3 B | 27.4 | 16 B |
| 1,2-Dichlorobenzene | SVOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,3-Dichlorobenzene | SVOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 1,4-Dichlorobenzene | SVOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 1,1,1-Trichloroethane | VOC | µg/l | 0.3 U | 0.5 U | 0.3 U | 0.5 | 0.1 J | 0.2 J | 0.2 J | 0.3 U |
| 1,1,2,2-Tetrachloroethane | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 1,1,2-Trichloroethane | VOC | µg/l | 0.3 U | 0.5 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethane | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 1,1-Dichloroethene | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |

# Surface Water Analytical Data (1998)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-01-SW 04/07/1998 | MP-02-SW 04/07/1998 | MP-03-SW 04/07/1998 | MP-04-SW 04/07/1998 | MP-06-SW 04/07/1998 | MP-08-SW 04/07/1998 | MP-09-SW 04/07/1998 | MP-10-SW 04/07/1998 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | East Branch | East Branch | Pond A | Mass Creek | Mass Creek | Mass Creek |
| 1,2-Dibromo-3-chloropropane | VOC | µg/l | 0.2 U | 0.3 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| 1,2-Dibromoethane | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,2-Dichloroethane | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,2-Dichloropropane | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 2-Butanone | VOC | µg/l | 1 U | 2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 2-Hexanone | VOC | µg/l | 1 U | 2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 4-Methyl-2-pentanone | VOC | µg/l | 1 U | 2 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Acetone | VOC | µg/l | 0.8 U | 2 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U |
| Benzene | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Bromochloromethane | VOC | µg/l | 0.2 U | 0.4 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Bromodichloromethane | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Bromoform | VOC | µg/l | 0.4 U | 0.7 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U |
| Bromomethane | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Carbon tetrachloride | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Chlorobenzene | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Chloroethane | VOC | µg/l | 0.3 U | 0.7 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroform | VOC | µg/l | 0.3 J | 0.6 U | 0.3 J | 0.2 J | 0.2 J | 0.1 J | 0.1 J | 0.3 U |
| Chloromethane | VOC | µg/l | 0.3 U | 0.5 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| cis-1,2-Dichloroethene | VOC | µg/l | 0.1 J | 0.6 U | 0.6 | 0.3 | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| cis-1,3-Dichloropropene | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Dibromochloromethane | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Ethylbenzene | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Methylene chloride | VOC | µg/l | 0.4 U | 0.7 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U |
| MTBE | VOC | µg/l | 3 | 40 | 0.6 J | 1 | 24 | 5 | 6 | 4 |
| Styrene | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Tetrachloroethene | VOC | µg/l | 1 | 0.5 | 0.2 J | 0.2 J | 0.3 | 0.1 J | 0.1 J | 0.2 U |
| Toluene | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 J | 0.1 J | 0.2 U |
| trans-1,2-Dichloroethene | VOC | µg/l | 0.3 U | 0.6 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| trans-1,3-Dichloropropene | VOC | µg/l | 0.3 U | 0.5 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Trichloroethene | VOC | µg/l | 0.3 J | 0.7 U | 2 | 1 | 0.3 J | 0.3 J | 0.3 J | 0.2 J |
| Vinyl chloride | VOC | µg/l | 0.2 U | 0.5 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| Xylene (total) | VOC | µg/l | 0.8 U | 2 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U |

Abbreviations: ND = not detected; BKG = background as determined from west branch samples; MP = Massapequa Preserve
µg/L = microgram per Liter; Hardness is expressed in mg/L $CaCO_3$

# Surface Water Analytical Data (1998)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-11-SW 04/07/1998 | MP-12-SW 04/07/1998 | MP-13-SW 04/07/1998 | MP-14-SW 04/07/1998 | MP-14-SW-DUP 04/07/1998 | MP-15-SW 04/07/1998 | Maximum Concentration | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | BKG | MP |
| Cyanide | GEN | µg/l | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | ND | ND |
| Hardness | GEN | mg/L | 33.9 | 49.1 | 53.8 | 53.4 | | 52.6 | 33.5 (MIN) | 33.9 (MIN) |
| Aluminum | MET | µg/l | 90.3 B | 84.1 U | 84.1 U | 84.1 U | 155 B | 84.1 U | 171 | 155 |
| Antimony | MET | µg/l | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U | 4.4 U | ND | ND |
| Arsenic | MET | µg/l | 3 B | 3.9 B | 2.8 U | 2.9 B | 2.8 U | 3.3 B | ND | 4.2 |
| Barium | MET | µg/l | 51.6 B | 24.6 B | 23.2 B | 24.4 B | 26.2 B | 26.8 B | 32 | 51.6 |
| Beryllium | MET | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| Cadmium | MET | µg/l | 0.57 B | 0.62 B | 0.4 U | 0.42 B | 0.4 U | 0.4 U | ND | 19.8 |
| Calcium | MET | µg/l | 9310 | 14900 | 16300 | 16300 | 15300 | 16100 | 13500 | 17000 |
| Chromium | MET | µg/l | 1.1 U | 1.6 B | 1.1 U | 1.4 B | 1.3 B | 1.1 U | ND | 54.9 |
| Chromium VI | MET | µg/l | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | ND | 49.4 |
| Cobalt | MET | µg/l | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U | 1.3 U | ND | ND |
| Copper | MET | µg/l | 2.9 U | 2.9 U | 2.9 U | 2.9 U | 2.9 B | 2.9 U | ND | 3.1 |
| Iron | MET | µg/l | 73.5 B | 280 | 241 | 113 | 367 | 149 | 108 | 764 |
| Lead | MET | µg/l | 3.2 | 2 U | 2 U | 2 U | 5.3 | 2 U | 7 | 5.3 |
| Magnesium | MET | µg/l | 2580 B | 2880 B | 3170 B | 3090 B | 2910 B | 3000 B | 2980 | 3170 |
| Manganese | MET | µg/l | 270 | 291 | 327 | 230 | 361 | 296 | 80.3 | 426 |
| Mercury | MET | µg/l | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | ND | ND |
| Nickel | MET | µg/l | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | 2.1 U | ND | 2.5 |
| Potassium | MET | µg/l | 1390 B | 2140 B | 2140 B | 2010 B | 1950 B | 1870 B | 2110 | 2140 |
| Selenium | MET | µg/l | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | 4.2 U | ND | ND |
| Silver | MET | µg/l | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U | 1.4 U | ND | ND |
| Sodium | MET | µg/l | 42400 | 24300 | 24700 | 23900 | 21800 | 23300 | 25700 | 42400 |
| Thallium | MET | µg/l | 4.5 U | 5.2 B | 5.5 B | 4.9 B | 6.4 B | 4.5 U | 7.3 | 6.4 |
| Vanadium | MET | µg/l | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | 2.6 U | ND | ND |
| Zinc | MET | µg/l | 16.6 B | 17.5 B | 12 B | 15.7 B | 22.4 | 24.6 | 19.4 | 34.5 |
| 1,2-Dichlorobenzene | SVOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| 1,3-Dichlorobenzene | SVOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| 1,4-Dichlorobenzene | SVOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| 1,1,1-Trichloroethane | VOC | µg/l | 0.3 U | 0.1 J | 0.1 J | 0.1 J | 0.1 J | 0.3 U | ND | ND |
| 1,1,2,2-Tetrachloroethane | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | 0.5 |
| 1,1,2-Trichloroethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| 1,1-Dichloroethane | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| 1,1-Dichloroethene | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |

# Surface Water Analytical Data (1998)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-11-SW 04/07/1998 | MP-12-SW 04/07/1998 | MP-13-SW 04/07/1998 | MP-14-SW 04/07/1998 | MP-14-SW-DUP 04/07/1998 | MP-15-SW 04/07/1998 | Maximum Concentration BKG | MP |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | | |
| 1,2-Dibromo-3-chloropropane | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| 1,2-Dibromoethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| 1,2-Dichloroethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| 1,2-Dichloropropane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| 2-Butanone | VOC | µg/l | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | ND | ND |
| 2-Hexanone | VOC | µg/l | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | ND | ND |
| 4-Methyl-2-pentanone | VOC | µg/l | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | ND | ND |
| Acetone | VOC | µg/l | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | ND | ND |
| Benzene | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Bromochloromethane | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| Bromodichloromethane | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| Bromoform | VOC | µg/l | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | ND | ND |
| Bromomethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Carbon tetrachloride | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| Chlorobenzene | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | ND | ND |
| Chloroethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Chloroform | VOC | µg/l | 0.1 J | 0.1 J | 0.1 J | 0.2 J | 0.1 J | 0.1 J | ND | ND |
| Chloromethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 | 0.3 |
| cis-1,2-Dichloroethene | VOC | µg/l | 0.3 U | 0.4 | 0.3 | 0.3 | 0.2 J | 0.2 J | ND | ND |
| cis-1,3-Dichloropropene | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.1 | 0.6 |
| Dibromochloromethane | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Ethylbenzene | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Methylene chloride | VOC | µg/l | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | ND | ND |
| MTBE | VOC | µg/l | 0.8 J | 4 | 3 | 3 | 3 | 2 | ND | ND |
| Styrene | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 40 | 24 |
| Tetrachloroethene | VOC | µg/l | 0.2 U | 0.4 | 0.3 | 0.2 J | 0.3 | 0.3 | ND | ND |
| Toluene | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 1 | 0.4 |
| trans-1,2-Dichloroethene | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| trans-1,3-Dichloropropene | VOC | µg/l | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | ND | ND |
| Trichloroethene | VOC | µg/l | 0.3 U | 0.4 | 0.4 | 0.3 J | 0.3 J | 0.3 J | ND | ND |
| Vinyl chloride | VOC | µg/l | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.3 | 2 |
| Xylene (total) | VOC | µg/l | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | 0.8 U | ND | ND |

Abbreviations ND = not detected; BKG = background as determined from west branch samples; MP = Massapequa Preserve
µg/L = microgram per Liter; Hardness is expressed in mg/L $CaCO_3$

# Surface Water Analytical Results (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | | Units | SW-01 04/01/1992 | SW-02 04/01/1992 | SW-03 04/01/1992 | SW-04 04/01/1992 | SW-05 04/01/1992 | SW-06 04/01/1992 |
|---|---|---|---|---|---|---|---|---|
| | | | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch |
| 2-Hexanone | VOC | µg/l | U | U | U | U | U | U |
| 4-Methyl-2-pentanone | VOC | µg/l | U | U | U | U | U | U |
| Acetone | VOC | µg/l | U | U | U | U | U | U |
| Benzene | VOC | µg/l | U | U | U | U | U | U |
| Bromodichloromethane | VOC | µg/l | U | U | U | U | U | U |
| Bromoform | VOC | µg/l | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ |
| Bromomethane | VOC | µg/l | U | U | U | U | U | U |
| Carbon disulfide | VOC | µg/l | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ |
| Carbon tetrachloride | VOC | µg/l | U | U | U | U | U | U |
| Chlorobenzene | VOC | µg/l | U | U | U | U | U | U |
| Chloroethane | VOC | µg/l | U | U | U | U | U | U |
| Chloroform | VOC | µg/l | U | U | U | U | U | U |
| Chloromethane | VOC | µg/l | U | U | U | U | U | U |
| cis-1,3-Dichloropropene | VOC | µg/l | U | U | U | U | U | U |
| Dibromochloromethane | VOC | µg/l | U | 0 8 J | U | U | U | U |
| Ethylbenzene | VOC | µg/l | U | U | U | U | U | U |
| Methylene chloride | VOC | µg/l | U | U | U | U | U | U |
| Styrene | VOC | µg/l | U | U | U | U | U | U |
| Tetrachloroethene | VOC | µg/l | U | U | U | U | U | U |
| Toluene | VOC | µg/l | U | U | U | U | 2 J | 2 J |
| trans-1,3-Dichloropropene | VOC | µg/l | U | U | U | U | U | U |
| Trichloroethene | VOC | µg/l | U | U | U | U | U | U |
| Vinyl chloride | VOC | µg/l | U | U | U | U | 4 J | 3 J |
| Xylene (total) | VOC | µg/l | U | U | U | U | U | U |

Notes. All qualifiers are defined as in the 1994 RI report.
All data and qualifiers are as received in electronic format from EPA's subcontrcator Roy F. Weston.

Abbreviations. ND = not detected; µg/L = microgram per Liter; BKG = background as defined by west branch samples
MP = Massapequa Creek

# Surface Water Analytical Results (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | | Units | SW-01 04/01/1992 | SW-02 04/01/1992 | SW-03 04/01/1992 | SW-04 04/01/1992 | SW-05 04/01/1992 | SW-06 04/01/1992 |
|---|---|---|---|---|---|---|---|---|
| | | | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch |
| Cyanide | GEN | μg/l | U | U | U | U | U | U |
| Aluminum | MET | μg/l | 417 | 381 | 356 | 305 | 286 | 266 |
| Antimony | MET | μg/l | U | U | U | U | U | U |
| Arsenic | MET | μg/l | U | U | U | U | U | U |
| Barium | MET | μg/l | 4.6 B2 | 3.9 B2 | 5.9 B2 | 7.9 B2 | 15.7 B2 | 22.3 B2 |
| Beryllium | MET | μg/l | 1 UJ | 1 UJ | 1 UJ | 1 UJ | 1 UJ | 1 UJ |
| Cadmium | MET | μg/l | U | U | U | U | 10.8 | 8.9 |
| Calcium | MET | μg/l | 20700 | 20800 | 19600 | 18300 | 16900 | 17500 |
| Chromium | MET | μg/l | 9.7 B2J | U | U | U | 29.2 | 44.9 |
| Cobalt | MET | μg/l | 5.1 B2 | U | U | U | 6.5 B2 | U |
| Copper | MET | μg/l | 13 B2J | 4 UJ | 4 UJ | 4 UJ | 4 UJ | 4 UJ |
| Iron | MET | μg/l | 738 | 694 | 581 | 525 | 331 | 238 |
| Lead | MET | μg/l | 1.4 B2 | 2.2 B2WJ | 2.1 B2 | 2.7 B2 | 2.9 B2WJ | 2.4 B2J |
| Magnesium | MET | μg/l | 635 B2 | 599 B2 | 728 B2 | 981 B2 | 1510 B2 | 2270 B2 |
| Manganese | MET | μg/l | 16.1 | 13.8 B2 | 18.4 | 40.3 | 214 | 426 |
| Mercury | MET | μg/l | U | U | U | U | U | U |
| Nickel | MET | μg/l | U | U | U | U | U | U |
| Potassium | MET | μg/l | 639 B2 | U | 871 B2 | U | 1410 B2 | 1960 B2 |
| Selenium | MET | μg/l | U | U | U | U | U | U |
| Silver | MET | μg/l | U | U | U | U | U | U |
| Sodium | MET | μg/l | 7540 | 7930 | 8490 | 10500 | 12500 | 15000 |
| Thallium | MET | μg/l | 1 UWJ | 1 UWJ | 1 UWJ | 1 UWJ | 1 UWJ | 1 UWJ |
| Vanadium | MET | μg/l | U | U | U | U | U | U |
| Zinc | MET | μg/l | 12.8 B2 | U | 14.2 B2 | 7.1 B2 | 14.3 B2J | 20 J |
| 1,1,1-Trichloroethane | VOC | μg/l | U | U | U | U | U | U |
| 1,1,2,2-Tetrachloroethane | VOC | μg/l | U | U | U | U | U | U |
| 1,1,2-Trichloroethane | VOC | μg/l | U | U | U | U | U | U |
| 1,1-Dichloroethane | VOC | μg/l | U | U | U | U | U | U |
| 1,1-Dichloroethene | VOC | μg/l | U | U | U | U | U | U |
| 1,2-Dichloroethane | VOC | μg/l | U | U | U | U | U | U |
| 1,2-Dichloroethene (total) | VOC | μg/l | U | U | U | U | U | U |
| 1,2-Dichloropropane | VOC | μg/l | U | U | U | U | 1 J | U |
| 2-Butanone | VOC | μg/l | U | U | U | U | U | U |

# Surface Water Analytical Results (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | | Units | SW-07 04/01/1992 | SW-08 04/01/1992 | SW-09 04/01/1992 | SW-10 04/01/1992 | Maximum Concentration BKG | Maximum Concentration MP |
|---|---|---|---|---|---|---|---|---|
| | | | East Branch | West Branch | West Branch | West Branch | BKG | MP |
| Cyanide | GEN | µg/l | U | U | U | U | ND | ND |
| Aluminum | MET | µg/l | 370 | 201 | 109 B2 | 103 B2 | 201 | 417 |
| Antimony | MET | µg/l | U | U | U | U | ND | ND |
| Arsenic | MET | µg/l | U | U | U | U | ND | ND |
| Barium | MET | µg/l | 28.8 B2 | 22.9 B2 | 31.5 B2 | 44.6 B2 | 44.6 | 28.8 |
| Beryllium | MET | µg/l | 1 UJ | 1 UJ | 1 UJ | 1 UJ | ND | ND |
| Cadmium | MET | µg/l | 4 9 B2 | U | U | U | ND | 10.8 |
| Calcium | MET | µg/l | 17700 | 18700 | 15400 | 17900 | 18700 | 20800 |
| Chromium | MET | µg/l | 30.5 | U | U | U | ND | 44.9 |
| Cobalt | MET | µg/l | U | U | U | 5.1 B2 | 5.1 | 6.5 |
| Copper | MET | µg/l | 4 UJ | 4 UJ | 4 UJ | 4 UJ | ND | 13 |
| Iron | MET | µg/l | 771 | 562 | 191 | 1590 | 1590 | 771 |
| Lead | MET | µg/l | 12 | 3.6 | 2.2 B2 | 3.8 | 3.8 | 12 |
| Magnesium | MET | µg/l | 2760 B2 | 3710 B2 | 3890 B2 | 4810 B2 | 4810 | 2760 |
| Manganese | MET | µg/l | 584 | 136 | 130 | 587 | 587 | 584 |
| Mercury | MET | µg/l | U | U | U | U | ND | ND |
| Nickel | MET | µg/l | U | U | U | U | ND | ND |
| Potassium | MET | µg/l | 2430 B2 | 3440 B2 | 4330 B2 | 8280 | 8280 | 2430 |
| Selenium | MET | µg/l | U | U | U | U | ND | ND |
| Silver | MET | µg/l | U | U | U | U | ND | ND |
| Sodium | MET | µg/l | 20600 | 36800 | 41000 | 52600 | 52600 | 20600 |
| Thallium | MET | µg/l | 1 UWJ | 1 UWJ | 1 UWJ | 1 UWJ | ND | ND |
| Vanadium | MET | µg/l | U | U | U | U | ND | ND |
| Zinc | MET | µg/l | 14.2 B2J | 14.2 B2J | 10 B2J | 110 | 110 | 20 |
| 1,1,1-Trichloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| 1,1,2,2-Tetrachloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| 1,1,2-Trichloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| 1,1-Dichloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| 1,1-Dichloroethene | VOC | µg/l | U | U | U | U | ND | ND |
| 1,2-Dichloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| 1,2-Dichloroethene (total) | VOC | µg/l | U | U | U | U | ND | ND |
| 1,2-Dichloropropane | VOC | µg/l | U | U | U | U | ND | 1 |
| 2-Butanone | VOC | µg/l | U | U | U | U | ND | ND |

## Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | MP-01-SE 04/08/98 | MP-02-SE 04/08/98 | MP-03-SE 04/08/98 | MP-03-SE-DUP 04/08/98 | MP-04-SE 04/08/98 | MP-08-SE 04/08/98 | MP-09-SE 04/08/98 | MP-10-SE 04/08/98 | MP-11-SE 04/08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | East Branch | East Branch | East Branch | Mass Creek | Mass Creek | Mass Creek | Mass Creek |
| TT Sample ? | | | | | | | | | | | |
| TT Sample Accepted ? | | | | | | | | | | | |
| AVS/SEM Sample ? | | | | | | | | | | | |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | 55000 | 146000 | 1910 | 2340 | 1550 | 11600 | 33300 | 24000 | 9870 |
| Aluminum | MET | mg/kg | 4900 | 8470 | 617 | 611 | 611 | 1290 | 2980 | 2090 | 1370 |
| Antimony | MET | mg/kg | 1.7 U | 2.7 U | 1.1 U | 1.1 U | 1 U | 1.2 U | 1.5 U | 1.5 U | 1.2 U |
| Arsenic | MET | mg/kg | 3.9 | 10.3 | 0.68 U | 0.7 U | 0.66 U | 1.5 B | 2.6 B | 1.7 B | 1.1 B |
| Barium | MET | mg/kg | 150 | 198 | 3.4 B | 3.3 B | 3.3 B | 119 | 36.3 B | 19.4 B | 18.7 B |
| Beryllium | MET | mg/kg | 0.93 | 0.83 B | 0.06 B | 0.05 B | 0.05 U | 0.16 B | 0.21 B | 0.28 B | 0.18 B |
| Cadmium | MET | mg/kg | 1.2 | 7 | 0.76 B | 0.79 B | 0.74 B | 6.4 | 5 | 13.9 | 2 |
| Calcium | MET | mg/kg | 1080 | 5660 | 172 B | 187 B | 146 B | 661 B | 1290 B | 520 B | 347 B |
| Chromium | MET | mg/kg | 11.3 | 39.5 | 18.4 | 19.7 | 18 | 34.9 | 32.9 | 53.4 | 20 |
| Chromium VI | MET | mg/kg | 4.6 | 2 U | 7.3 | 6.8 | 7 | 14.5 | 14.3 | 16.6 | 7.8 |
| Cobalt | MET | mg/kg | 5.8 | 35.2 | 0.32 U | 0.38 B | 0.3 U | 3.2 B | 2.1 B | 2.2 B | 1.4 B |
| Copper | MET | mg/kg | 27.4 | 90 | 3.7 B | 4.8 B | 2.9 B | 15.4 | 19.2 | 15.8 | 10.3 |
| Iron | MET | mg/kg | 7350 | 31500 | 1110 | 1890 | 850 | 4290 | 5900 | 3280 | 2880 |
| Lead | MET | mg/kg | 485 | 403 | 22.2 | 18 | 11.8 | 103 | 177 | 242 | 92.6 |
| Magnesium | MET | mg/kg | 424 | 1980 B | 160 B | 129 B | 73.9 B | 237 B | 699 B | 282 B | 206 |
| Manganese | MET | mg/kg | 4510 | 3220 | 12.6 | 16.5 | 22.5 | 2350 | 396 | 89.7 | 151 |
| Mercury | MET | mg/kg | 0.18 | 0.31 B | 0.06 U | 0.07 U | 0.06 U | 0.07 U | 0.09 U | 0.09 U | 0.07 U |
| Nickel | MET | mg/kg | 11.4 | 42.4 | 2 B | 1.7 B | 1.5 B | 4.6 B | 6.1 B | 5.7 B | 3 B |
| Potassium | MET | mg/kg | 172 | 570 B | 94.3 B | 91.1 B | 87.3 B | 133 B | 367 B | 155 B | 117 B |
| Selenium | MET | mg/kg | 1.6 U | 2.6 U | 1 U | 1.1 U | 0.99 U | 1.1 U | 1.4 U | 1.4 U | 1.2 U |
| Silver | MET | mg/kg | 0.54 U | 0.87 U | 0.34 U | 0.35 U | 0.33 U | 0.37 U | 0.47 U | 0.47 U | 0.38 U |
| Sodium | MET | mg/kg | 201 | 338 B | 118 U | 121 U | 113 U | 129 B | 171 B | 163 U | 172 B |
| Thallium | MET | mg/kg | 1.7 U | 2.8 U | 1.1 U | 1.1 U | 1.1 U | 1.2 U | 1.5 U | 1.5 U | 1.2 U |
| Vanadium | MET | mg/kg | 16.8 | 48.1 | 2.2 B | 2.3 B | 1.5 B | 7.3 B | 11.9 B | 9.5 B | 6.5 B |
| Zinc | MET | mg/kg | 104 | 528 | 16.1 | 17.2 | 13.4 | 59 | 78.8 | 89.5 | 30.5 |

# Surface Water Analytical Results (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | | Units | SW-07 04/01/1992 | SW-08 04/01/1992 | SW-09 04/01/1992 | SW-10 04/01/1992 | Maximum Concentration | |
|---|---|---|---|---|---|---|---|---|
| | | | East Branch | West Branch | West Branch | West Branch | BKG | MP |
| 2-Hexanone | VOC | µg/l | U | U | U | U | ND | ND |
| 4-Methyl-2-pentanone | VOC | µg/l | U | U | U | U | ND | ND |
| Acetone | VOC | µg/l | U | U | U | U | ND | ND |
| Benzene | VOC | µg/l | U | U | U | U | ND | ND |
| Bromodichloromethane | VOC | µg/l | U | U | U | U | ND | ND |
| Bromoform | VOC | µg/l | 10 UJ | 10 UJ | 10 UJ | 10 UJ | ND | ND |
| Bromomethane | VOC | µg/l | U | U | U | U | ND | ND |
| Carbon disulfide | VOC | µg/l | 10 UJ | 10 UJ | 10 UJ | 10 UJ | ND | ND |
| Carbon tetrachloride | VOC | µg/l | U | U | U | U | ND | ND |
| Chlorobenzene | VOC | µg/l | U | U | U | U | ND | ND |
| Chloroethane | VOC | µg/l | U | U | U | U | ND | ND |
| Chloroform | VOC | µg/l | U | U | U | U | ND | ND |
| Chloromethane | VOC | µg/l | U | U | U | U | ND | ND |
| cis-1,3-Dichloropropene | VOC | µg/l | U | U | U | U | ND | ND |
| Dibromochloromethane | VOC | µg/l | U | U | U | U | ND | ND |
| Ethylbenzene | VOC | µg/l | U | U | U | U | ND | 0.8 |
| Methylene chloride | VOC | µg/l | U | U | U | U | ND | ND |
| Styrene | VOC | µg/l | U | U | U | U | ND | ND |
| Tetrachloroethene | VOC | µg/l | 0.6 J | U | U | U | ND | ND |
| Toluene | VOC | µg/l | U | U | U | U | ND | 2 |
| trans-1,3-Dichloropropene | VOC | µg/l | U | U | U | 0.6 J | 0.6 | ND |
| Trichloroethene | VOC | µg/l | 2 J | U | U | U | ND | ND |
| Vinyl chloride | VOC | µg/l | U | U | U | U | ND | 4 |
| Xylene (total) | VOC | µg/l | U | U | U | U | ND | ND |

Notes. All qualifiers are defined as in the 1994 RI report.
All data and qualifiers are as received in electronic format from EPA's subcontrcator Roy F. Weston.

Abbreviations: ND = not detected, µg/L = microgram per Liter; BKG = background as defined by west branch samples
MP = Massapequa Creek.

## Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-01-SE 04/08/98 | MP-02-SE 04/08/98 | MP-03-SE 04/08/98 | MP-03-SE-DUP 04/08/98 | MP-04-SE 04/08/98 | MP-08-SE 04/08/98 | MP-09-SE 04/08/98 | MP-10-SE 04/08/98 | MP-11-SE 04/08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | East Branch | East Branch | East Branch | Mass Creek | Mass Creek | Mass Creek | Mass Creek |
| 1,1,1-Trichloroethane | VOC | µg/Kg | 20 U | 0.8 J | 2 J | 0.4 J | 1 J | 14 U | 1 J | 18 U | 3 J |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,1,2-Trichloroethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,1-Dichloroethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,1-Dichloroethene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,2-Dichloroethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 1,2-Dichloropropane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 2-Butanone | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| 2-Hexanone | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 8 J | 14 U |
| Acetone | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Bromodichloromethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 9 JB | 9 JB | 10 JB | 35 B | 8 JB |
| Bromoform | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Bromomethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Carbon tetrachloride | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Chlorobenzene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 0.9 J | 14 U |
| Chloroethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Chloroform | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Chloromethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| cis-1,3-Dichloropropene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Dibromochloromethane | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Ethylbenzene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Methylene chloride | VOC | µg/Kg | 20 U | 3 U | 2 U | 3 U | 3 U | 14 U | 17 U | 18 U | 14 U |
| Styrene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 1 U | 1 U | 0.9 U |
| Tetrachloroethene | VOC | µg/Kg | 3 J | 2 J | 1 J | 13 U | 0.2 J | 14 U | 17 U | 18 U | 14 U |
| Toluene | VOC | µg/Kg | 0.7 U | 33 U | 12 U | 13 U | 12 U | 14 U | 2 J | 18 U | 2 J |
| trans-1,3-Dichloropropene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 5 J | 14 U |
| Trichloroethene | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |
| Vinyl chloride | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 0.6 J | 18 U | 14 U |
| Xylene (total) | VOC | µg/Kg | 20 U | 33 U | 12 U | 13 U | 12 U | 14 U | 17 U | 18 U | 14 U |

Notes:
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 Indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations: TT = toxicity test; AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | MP-12-SE 04/08/98 | MP-13-SE 04/08/98 | MP-14-SE 04/08/98 | MP-15-SE 04/08/98 | MP-17 11/03/98 | MP-18 11/03/98 | MP-05-SE 04/08/98 | MP-06-SE 04/08/98 | MP-07-SE 04/08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Pond A | Pond A | Pond A |
| TT Sample ? | | | | | | | | | | | |
| TT Sample Accepted ? | | | | | | | | | | | |
| AVS/SEM Sample ? | | | | | | | | | | | |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | 10300 | 3360 | 1610 | 3000 | 180000 | 74400 | 2300 | 165000 | 13400 |
| Aluminum | MET | mg/kg | 713 | 762 | 411 | 620 | 4830 | 10400 | 483 | 11400 | 1010 |
| Antimony | MET | mg/kg | 1.1 U | 1.2 U | 1 U | 0.99 U | 7.3 U | 2.3 U | 1.1 U | 3 U | 1.3 U |
| Arsenic | MET | mg/kg | 0.67 U | 0.78 U | 0.64 U | 0.63 U | 6.7 U | 13.5 | 0.67 U | 7.7 | 0.82 U |
| Barium | MET | mg/kg | 8.3 B | 4.3 B | 2.9 B | 5.2 B | 73.7 B | 62.1 B | 4.2 B | 116 B | 8.8 B |
| Beryllium | MET | mg/kg | 0.1 B | 0.1 B | 0.05 U | 0.05 B | 0.79 B | 0.31 B | 0.05 U | 1 B | 0.1 B |
| Cadmium | MET | mg/kg | 0.1 U | 0.55 B | 0.46 B | 0.84 B | 17 | 2.9 B | 0.78 B | 248 | 6.6 |
| Calcium | MET | mg/kg | 281 B | 373 B | 122 B | 255 B | 2420 B | 2020 B | 162 B | 4190 | 450 B |
| Chromium | MET | mg/kg | 5.7 | 10.5 | 1.9 B | 4.8 | 69.6 | 18.6 | 24.8 | 839 | 37.1 |
| Chromium VI | MET | mg/kg | 2.6 | 2 U | 2 U | 2 U | NA | NA | 8.4 | 136 | 22.6 |
| Cobalt | MET | mg/kg | 3.5 B | 1.7 B | 0.45 B | 0.31 B | 4.5 B | 3.3 B | 0.31 U | 11.4 B | 0.65 B |
| Copper | MET | mg/kg | 12 | 19.8 | 1.2 B | 2.9 B | 37.8 B | 33.3 | 3.4 B | 162 | 9.6 |
| Iron | MET | mg/kg | 2100 | 1720 | 668 | 442 | 9470 | 9290 | 727 | 17400 | 2000 |
| Lead | MET | mg/kg | 25.4 | 20.9 | 3.5 | 10.9 | 284 | 76.6 | 17.7 | 1160 | 48.8 |
| Magnesium | MET | mg/kg | 328 B | 201 B | 103 B | 43.2 B | 799 B | 320 B | 78.5 B | 2250 B | 149 B |
| Manganese | MET | mg/kg | 540 | 52.1 | 32.2 | 92.4 | 2930 | 1740 | 9.7 | 509 | 27.6 |
| Mercury | MET | mg/kg | 0.06 U | 0.07 U | 0.06 U | 0.06 U | 0.52 U | 0.16 U | 0.06 U | 0.51 | 0.08 U |
| Nickel | MET | mg/kg | 1.3 B | 1.4 B | 0.76 B | 0.99 B | 14.5 B | 7.6 B | 1.2 B | 43.7 | 2.8 B |
| Potassium | MET | mg/kg | 130 B | 119 B | 76.9 B | 67.9 B | 308 U | 96.9 U | 73.7 B | 575 B | 112 B |
| Selenium | MET | mg/kg | 1 U | 1.2 U | 0.96 U | 0.95 U | 7.3 U | 2.3 U | 1 U | 2.8 U | 1.2 U |
| Silver | MET | mg/kg | 0.33 U | 0.39 U | 0.32 U | 0.32 U | 2 U | 0.62 U | 0.34 U | 1.8 B | 0.41 U |
| Sodium | MET | mg/kg | 115 U | 134 U | 111 U | 109 U | 1230 B | 377 B | 116 U | 446 B | 142 U |
| Thallium | MET | mg/kg | 1.1 U | 1.3 U | 1 U | 1 U | 9 U | 2.8 U | 1.1 U | 3 U | 1.3 U |
| Vanadium | MET | mg/kg | 3.4 B | 3.3 B | 0.59 U | 0.78 B | 19.3 B | 12.1 B | 1.5 B | 50 | 4.4 B |
| Zinc | MET | mg/kg | 6.5 | 13.3 | 6.7 | 14.5 | 183 | 102 | 16.2 | 801 | 37.5 |

# Sediment Analytical Data (1998-1999)
# Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | MP-12-SE 04/08/98 | MP-13-SE 04/08/98 | MP-14-SE 04/08/98 | MP-15-SE 04/08/98 | MP-17 11/03/98 | MP-18 11/03/98 | MP-05-SE 04/08/98 | MP-06-SE 04/08/98 | MP-07-SE 04/08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Mass Creek | Pond A | Pond A | Pond A |
| 1,1,1-Trichloroethane | VOC | µg/Kg | 12 U | 2 J | 11 U | 12 U | | | 0.9 J | 9 J | 15 U |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,1,2-Trichloroethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,1-Dichloroethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,1-Dichloroethene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,2-Dichloroethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 1,2-Dichloropropane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 2-Butanone | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| 2-Hexanone | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 19 J | 15 U |
| Acetone | VOC | µg/Kg | 8 JB | 13 JB | 9 JB | 12 U | | | 12 U | 34 U | 15 U |
| Bromodichloromethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 84 B | 23 B |
| Bromoform | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Bromomethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Carbon tetrachloride | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Chlorobenzene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Chloroethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Chloroform | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Chloromethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| cis-1,3-Dichloropropene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Dibromochloromethane | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Ethylbenzene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Methylene chloride | VOC | µg/Kg | 0.7 U | 0.7 U | 0.6 U | 12 U | | | 12 U | 34 U | 15 U |
| Styrene | VOC | µg/Kg | 12 U | 14 U | 11 U | 1 U | | | 1 U | 34 U | 1 U |
| Tetrachloroethene | VOC | µg/Kg | 2 J | 0.7 J | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Toluene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 7 J | 1 J |
| trans-1,3-Dichloropropene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 53 |
| Trichloroethene | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Vinyl chloride | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |
| Xylene (total) | VOC | µg/Kg | 12 U | 14 U | 11 U | 12 U | | | 12 U | 34 U | 15 U |

Notes.
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations: TT = toxicity test; AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | PA-01-SE 06/26/98 | PA-02-SE 06/26/98 | PA-03 11/03/98 | PA-03 03/25/99 | PA-05 12/16/99 | PA-06 12/16/99 | PA-07 12/16/99 | PA-08 12/16/99 | PA-09 12/16/99 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A |
| TT Sample ? | | | | | YES | YES | | | | | |
| TT Sample Accepted ? | | | | | | YES [1] | | | | | |
| AVS/SEM Sample ? | | | | | YES | | | | | | |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | | | 152000 | 207000 | 169000 | 80600 | 103000 | 120000 | 152000 |
| Aluminum | MET | mg/kg | 8630 | 8880 | 6420 | 7420 | 10300 | 7180 | 6180 | 8760 | 10500 |
| Antimony | MET | mg/kg | 2.9 U | 2.2 U | 2.3 U | 4.9 U | 3.6 U | 2.9 U | 2.3 U | 2.5 U | 2.9 U |
| Arsenic | MET | mg/kg | 7.3 | 7.2 | 3.4 B | 5.9 B | 2.6 U | 2.1 U | 1.7 J | 1.8 U | 2.1 U |
| Barium | MET | mg/kg | 56 9 B | 76.6 B | 69.9 B | 91.7 B | 104 J | 46.8 J | 78 J | 56.2 J | 66.2 J |
| Beryllium | MET | mg/kg | 0.8 B | 0.65 B | 0.53 B | 0.66 B | 0.71 J | 0.64 J | 0.5 J | 0.78 J | 1.1 J |
| Cadmium | MET | mg/kg | 67.4 | 109 | 119 | 55 4 | 55.8 | 32.8 | 71.3 | 33.5 | 45.3 |
| Calcium | MET | mg/kg | 2070 B | 2710 | 2890 B | 4770 | 2710 J | 2180 J | 3810 | 2050 J | 2250 J |
| Chromium | MET | mg/kg | 776 | 599 | 464 | 268 | 735 | 401 | 290 | 463 | 558 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 3.9 B | 7.3 B | 5.5 B | 5.2 B | 4.4 J | 2.6 J | 4.1 J | 3.8 J | 4.5 J |
| Copper | MET | mg/kg | 117 | 75.9 | 94 | 122 | 135 | 89.2 | 92.3 | 108 | 126 |
| Iron | MET | mg/kg | 7400 | 11800 | 10200 | 13100 | 11500 | 6930 | 9590 | 7900 | 8630 |
| Lead | MET | mg/kg | 1140 | 588 | 692 | 532 | 980 | 688 | 674 | 902 | 779 |
| Magnesium | MET | mg/kg | 1150 B | 1660 B | 1230 B | 1730 B | 1670 J | 1060 J | 1610 J | 1190 J | 1430 J |
| Manganese | MET | mg/kg | 87.2 | 400 | 316 | 307 | 143 | 64.1 | 279 | 139 | 158 |
| Mercury | MET | mg/kg | 0.6 | 0.29 | 0.25 B | 0.27 B | 1.1 | 0.95 | 0.69 | 1.2 | 1.1 |
| Nickel | MET | mg/kg | 18.9 B | 24.5 | 25.1 | 27.9 B | 23.9 J | 12.5 J | 22.1 | 16.8 J | 19 4 J |
| Potassium | MET | mg/kg | 312 B | 365 B | 96.6 U | 438 B | 349 J | 171 J | 230 J | 225 J | 182 J |
| Selenium | MET | mg/kg | 2.5 U | 1.9 U | 2 3 U | 4 4 U | 3 1 U | 2.6 U | 2 U | 2.2 U | 2.5 U |
| Silver | MET | mg/kg | 1.3 B | 0 83 B | 1 1 B | 1.5 U | 1.6 J | 1.1 J | 1.7 J | 2.2 J | 1.8 J |
| Sodium | MET | mg/kg | 304 U | 232 U | 456 B | 409 B | 268 U | 221 U | 170 U | 191 U | 216 U |
| Thallium | MET | mg/kg | 2.7 B | 1.7 U | 2 8 U | 4.1 U | 3 3 U | 2.8 U | 2.1 U | 2.4 U | 2.7 U |
| Vanadium | MET | mg/kg | 39.9 | 33.6 | 30 1 B | 35 3 B | 49.5 | 29.5 J | 30.9 | 38.2 | 35.1 |
| Zinc | MET | mg/kg | 232 | 379 | 410 | 569 | 308 | 146 | 433 | 211 | 242 |

Sediment Analytical Data (1998-1999)
Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | PA-01-SE 06/26/98 | PA-02-SE 06/26/98 | PA-03 11/03/98 | PA-03 03/25/99 | PA-05 12/16/99 | PA-06 12/16/99 | PA-07 12/16/99 | PA-08 12/16/99 | PA-09 12/16/99 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A |
| 1,1,1-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethene | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloropropane | VOC | µg/Kg | | | | | | | | | |
| 2-Butanone | VOC | µg/Kg | | | | | | | | | |
| 2-Hexanone | VOC | µg/Kg | | | | | | | | | |
| Acetone | VOC | µg/Kg | | | | | | | | | |
| Bromodichloromethane | VOC | µg/Kg | | | | | | | | | |
| Bromoform | VOC | µg/Kg | | | | | | | | | |
| Bromomethane | VOC | µg/Kg | | | | | | | | | |
| Carbon tetrachloride | VOC | µg/Kg | | | | | | | | | |
| Chlorobenzene | VOC | µg/Kg | | | | | | | | | |
| Chloroethane | VOC | µg/Kg | | | | | | | | | |
| Chloroform | VOC | µg/Kg | | | | | | | | | |
| Chloromethane | VOC | µg/Kg | | | | | | | | | |
| cis-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Dibromochloromethane | VOC | µg/Kg | | | | | | | | | |
| Ethylbenzene | VOC | µg/Kg | | | | | | | | | |
| Methylene chloride | VOC | µg/Kg | | | | | | | | | |
| Styrene | VOC | µg/Kg | | | | | | | | | |
| Tetrachloroethene | VOC | µg/Kg | | | | | | | | | |
| Toluene | VOC | µg/Kg | | | | | | | | | |
| trans-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Trichloroethene | VOC | µg/Kg | | | | | | | | | |
| Vinyl chloride | VOC | µg/Kg | | | | | | | | | |
| Xylene (total) | VOC | µg/Kg | | | | | | | | | |

Notes
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations. TT = toxicity test; AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

Sediment Analytical Data (1998-1999)
Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | PA-10 12/16/99 | PA-11 12/16/99 | PA-12 12/16/99 | PA-13 12/16/99 | PA-14 12/16/99 | DUP-1 =(PA-06) 12/16/99 | DUP-2 (=PA-08) 12/16/99 | P1-01-SE 06/26/98 | P1-02 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond 1 | Pond 1 |
| 1,1,1-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethene | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloropropane | VOC | µg/Kg | | | | | | | | | |
| 2-Butanone | VOC | µg/Kg | | | | | | | | | |
| 2-Hexanone | VOC | µg/Kg | | | | | | | | | |
| Acetone | VOC | µg/Kg | | | | | | | | | |
| Bromodichloromethane | VOC | µg/Kg | | | | | | | | | |
| Bromoform | VOC | µg/Kg | | | | | | | | | |
| Bromomethane | VOC | µg/Kg | | | | | | | | | |
| Carbon tetrachloride | VOC | µg/Kg | | | | | | | | | |
| Chlorobenzene | VOC | µg/Kg | | | | | | | | | |
| Chloroethane | VOC | µg/Kg | | | | | | | | | |
| Chloroform | VOC | µg/Kg | | | | | | | | | |
| Chloromethane | VOC | µg/Kg | | | | | | | | | |
| cis-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Dibromochloromethane | VOC | µg/Kg | | | | | | | | | |
| Ethylbenzene | VOC | µg/Kg | | | | | | | | | |
| Methylene chloride | VOC | µg/Kg | | | | | | | | | |
| Styrene | VOC | µg/Kg | | | | | | | | | |
| Tetrachloroethene | VOC | µg/Kg | | | | | | | | | |
| Toluene | VOC | µg/Kg | | | | | | | | | |
| trans-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Trichloroethene | VOC | µg/Kg | | | | | | | | | |
| Vinyl chloride | VOC | µg/Kg | | | | | | | | | |
| Xylene (total) | VOC | µg/Kg | | | | | | | | | |

Notes.
[1] YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
[2] YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
[3] indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations: TT = toxicity test; AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | PA-10 12/16/99 | PA-11 12/16/99 | PA-12 12/16/99 | PA-13 12/16/99 | PA-14 12/16/99 | DUP-1 =(PA-06) 12/16/99 | DUP-2 (=PA-08) 12/16/99 | P1-01-SE 06/26/98 | P1-02 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond A | Pond 1 | Pond 1 |
| TT Sample ? | | | YES | | | YES | | | | | YES |
| TT Sample Accepted ? | | | YES 2 | | | YES 2 | | | | | |
| AVS/SEM Sample ? | | | | | | | | | | | YES |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | 181000 | 175000 | 157000 | 152000 | 127000 | 83000 | 108000 | | 166000 |
| Aluminum | MET | mg/kg | 10700 | 10900 | 10900 | 9020 | 7300 | 7600 | 8640 | 5250 | 15700 |
| Antimony | MET | mg/kg | 3.5 U | 3.1 U | 2.5 U | 2.7 U | 2.7 U | 3.5 U | 2.6 U | 2.8 U | 3.2 U |
| Arsenic | MET | mg/kg | 2.5 U | 2.2 U | 1.8 U | 2 U | 1.9 U | 2.5 U | 1.9 U | 8.1 | 10.6 |
| Barium | MET | mg/kg | 119 J | 112 J | 98.1 J | 94.2 J | 76.3 J | 50.2 J | 58.1 J | 59 B | 158 B |
| Beryllium | MET | mg/kg | 0.91 J | 0.73 J | 0 87 J | 0.73 J | 0.6 J | 0.74 J | 0.72 J | 0.54 B | 1.7 B |
| Cadmium | MET | mg/kg | 142 | 61.7 | 141 | 99.9 | 78.7 | 37.5 | 25.8 | 25.6 | 131 |
| Calcium | MET | mg/kg | 3760 | 3010 J | 2440 J | 2810 J | 2460 J | 2510 J | 1880 J | 1340 B | 3780 B |
| Chromium | MET | mg/kg | 687 | 637 | 614 | 457 | 333 | 428 | 466 | 160 | 449 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 8.8 J | 5.5 J | 6 4 J | 6 4 J | 6.5 J | 3.3 J | 3.3 J | 5.6 B | 21.3 B |
| Copper | MET | mg/kg | 155 | 148 | 136 | 131 | 108 | 97 | 104 | 42.3 | 132 |
| Iron | MET | mg/kg | 15200 | 13700 | 12200 | 11700 | 10100 | 7440 | 8420 | 8220 | 23100 |
| Lead | MET | mg/kg | 908 | 906 | 930 | 651 | 474 | 764 | 768 | 684 | 1860 |
| Magnesium | MET | mg/kg | 1870 J | 1880 J | 1620 J | 1520 J | 1250 J | 1120 J | 1230 J | 719 B | 2240 B |
| Manganese | MET | mg/kg | 285 | 208 | 144 | 206 | 205 | 69.6 | 130 | 290 | 1960 |
| Mercury | MET | mg/kg | 1.2 | 1.2 | 1 | 0.97 | 0.9 | 1.1 | 1 | 0.19 B | 0.72 |
| Nickel | MET | mg/kg | 36.7 | 26.3 | 26.1 | 29 | 26.3 | 13.6 J | 16.7 J | 14.8 B | 43 1 |
| Potassium | MET | mg/kg | 316 J | 695 J | 395 J | 324 J | 274 J | 161 J | 234 J | 276 B | 178'B |
| Selenium | MET | mg/kg | 3 U | 2.7 U | 2 2 U | 2 4 U | 2.3 U | 3.1 U | 2.3 U | 2.4 U | 3 2 U |
| Silver | MET | mg/kg | 1.8 J | 2 J | 1 8 J | 1.4 J | 1.1 J | 0.98 J | 1.8 J | 0.62 U | 1.1 B |
| Sodium | MET | mg/kg | 288 J | 231 U | 188 U | 206 U | 201 U | 263 U | 196 U | 293 U | 622 B |
| Thallium | MET | mg/kg | 3.2 U | 2.9 U | 2.3 U | 2.6 U | 2.5 U | 3.3 U | 2.4 U | 2.1 U | 4 U |
| Vanadium | MET | mg/kg | 46 | 49.8 | 42.1 | 37.2 | 29.1 | 31 J | 37 | 28.1 | 67.6 |
| Zinc | MET | mg/kg | 618 | 417 | 382 | 518 | 455 | 162 | 218 | 227 | 731 |

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | P1-02-SE 06/26/98 | P1-02-SE 03/25/99 | P1-03-SE 06/26/98 | P2-01-SE 06/26/98 | P2-02-SE 06/26/98 | P2-03 11/03/98 | P2-03-SE 06/26/98 | P2-03-SE 03/25/99 | P3-01 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 1 | Pond 1 | Pond 1 | Pond 2 | Pond 2 | Pond 2 | Pond 2 | Pond 2 | Pond 3 |
| TT Sample ? | | | | YES | | | | YES | | YES | YES |
| TT Sample Accepted ? | | | | YES [1] | | | | | | YES [1] | |
| AVS/SEM Sample ? | | | | | | | | YES | | | YES |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | | 164000 | | | | 105000 | | 188000 | 172000 |
| Aluminum | MET | mg/kg | 7700 | 11300 | 4790 | 6000 | 8000 | 2020 | 7960 | 8500 | 5010 |
| Antimony | MET | mg/kg | 4.7 U | 5.1 U | 3 U | 4.8 U | 4.4 U | 2.8 U | 6.4 U | 7.2 U | 6.6 U |
| Arsenic | MET | mg/kg | 9.3 | 10.6 | 4.9 B | 7.4 B | 12.2 | 2.6 U | 11.3 B | 7.6 B | 6.1 U |
| Barium | MET | mg/kg | 127 B | 138 B | 34 B | 38.7 B | 68.1 B | 23.8 B | 86.8 B | 96.9 B | 51.9 B |
| Beryllium | MET | mg/kg | 0.63 B | 1.4 B | 0 55 B | 0.82 B | 1.3 B | 0.43 B | 1.2 B | 1.7 B | 0.91 B |
| Cadmium | MET | mg/kg | 33.1 | 93.5 | 22 2 | 30.1 | 32.1 | 20.9 | 47.6 | 68.3 | 11.7 |
| Calcium | MET | mg/kg | 3190 B | 3040 B | 1720 B | 2390 B | 2560 B | 1420 B | 3480 B | 4480 B | 2140 B |
| Chromium | MET | mg/kg | 226 | 345 | 139 | 141 | 202 | 48.7 | 195 | 196 | 84.8 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 8.2 B | 16.7 B | 3.8 B | 7.9 B | 8.3 B | 3.4 B | 12.9 B | 14.6 B | 5.2 B |
| Copper | MET | mg/kg | 90.4 | 104 | 62 8 | 36 | 53.9 | 19.2 | 61.9 | 32.9 | 45.6 |
| Iron | MET | mg/kg | 10100 | 17400 | 5110 | 7580 | 10900 | 3720 | 15000 | 16400 | 10200 |
| Lead | MET | mg/kg | 664 | 1370 | 723 | 376 | 748 | 186 | 787 | 754 | 334 |
| Magnesium | MET | mg/kg | 1320 B | 1690 B | 642 B | 749 B | 1100 B | 317 B | 1170 B | 1430 B | 753 B |
| Manganese | MET | mg/kg | 226 | 2350 | 87.4 | 560 | 238 | 298 | 1040 | 1440 | 722 |
| Mercury | MET | mg/kg | 0.49 | 0.24 U | 0 26 B | 0 24 B | 0.39 B | 0.2 U | 0.3 U | 0.34 U | 0.47 U |
| Nickel | MET | mg/kg | 20.6 B | 33.4 B | 8 1 B | 11.1 B | 19.6 B | 6.1 B | 23.3 B | 24.8 B | 18 B |
| Potassium | MET | mg/kg | 461 B | 419 B | 280 B | 423 B | 458 B | 120 U | 520 B | 433 B | 279 U |
| Selenium | MET | mg/kg | 4.1 U | 4.5 U | 2 6 U | 4 2 U | 3.9 U | 2.8 U | 5.6 U | 6.4 U | 6.6 U |
| Silver | MET | mg/kg | 1 U | 1.5 U | 0 68 U | 1.1 U | 0.99 U | 0.76 U | 1.4 U | 2 2 U | 1.8 U |
| Sodium | MET | mg/kg | 520 B | 390 B | 319 U | 504 U | 466 U | 471 B | 672 U | 489 B | 1230 B |
| Thallium | MET | mg/kg | 3.6 U | 4.3 U | 2.3 U | 3.6 U | 3.4 U | 3.5 U | 4.9 U | 6 U | 8 2 U |
| Vanadium | MET | mg/kg | 43.2 B | 51 | 22 7 B | 27 B | 42 4 | 8 B | 34.1 B | 36.8 B | 23.1 B |
| Zinc | MET | mg/kg | 307 | 585 | 113 | 133 | 292 | 132 | 333 | 486 | 134 |

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | P1-02-SE 06/26/98 | P1-02-SE 03/25/99 | P1-03-SE 06/26/98 | P2-01-SE 06/26/98 | P2-02-SE 06/26/98 | P2-03 11/03/98 | P2-03-SE 06/26/98 | P2-03-SE 03/25/99 | P3-01 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 1 | Pond 1 | Pond 1 | Pond 2 | Pond 2 | Pond 2 | Pond 2 | Pond 2 | Pond 3 |
| 1,1,1-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethene | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloropropane | VOC | µg/Kg | | | | | | | | | |
| 2-Butanone | VOC | µg/Kg | | | | | | | | | |
| 2-Hexanone | VOC | µg/Kg | | | | | | | | | |
| Acetone | VOC | µg/Kg | | | | | | | | | |
| Bromodichloromethane | VOC | µg/Kg | | | | | | | | | |
| Bromoform | VOC | µg/Kg | | | | | | | | | |
| Bromomethane | VOC | µg/Kg | | | | | | | | | |
| Carbon tetrachloride | VOC | µg/Kg | | | | | | | | | |
| Chlorobenzene | VOC | µg/Kg | | | | | | | | | |
| Chloroethane | VOC | µg/Kg | | | | | | | | | |
| Chloroform | VOC | µg/Kg | | | | | | | | | |
| Chloromethane | VOC | µg/Kg | | | | | | | | | |
| cis-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Dibromochloromethane | VOC | µg/Kg | | | | | | | | | |
| Ethylbenzene | VOC | µg/Kg | | | | | | | | | |
| Methylene chloride | VOC | µg/Kg | | | | | | | | | |
| Styrene | VOC | µg/Kg | | | | | | | | | |
| Tetrachloroethene | VOC | µg/Kg | | | | | | | | | |
| Toluene | VOC | µg/Kg | | | | | | | | | |
| trans-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Trichloroethene | VOC | µg/Kg | | | | | | | | | |
| Vinyl chloride | VOC | µg/Kg | | | | | | | | | |
| Xylene (total) | VOC | µg/Kg | | | | | | | | | |

Notes:
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations: TT = toxicity test, AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | P3-01-SE 06/26/98 | P3-01-SE 03/25/99 | P3-02-SE 06/26/98 | P3-03 11/03/98 | P3-03-SE 06/26/98 | P3-03-SE 03/25/99 | P4-01 11/03/98 | P4-01 03/25/99 | P4-02 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 4 | Pond 4 | Pond 4 |
| TT Sample ? | | | | YES | | YES | | YES | YES | YES | |
| TT Sample Accepted ? | | | | YES [1] | | | | YES [1] | | YES [1] | |
| AVS/SEM Sample ? | | | | | | YES | | | YES | | |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | | 185000 | | 138000 | | 174000 | 164000 | 179000 | 93300 |
| Aluminum | MET | mg/kg | 5360 | 8500 | 5590 | 7150 | 8290 | 7350 | 16400 | 14100 | 6240 |
| Antimony | MET | mg/kg | 3.1 U | 6.9 U | 3.3 U | 3.8 U | 3.8 U | 6.6 U | 2.9 U | 5.2 U | 2.2 U |
| Arsenic | MET | mg/kg | 7.1 | 8.8 B | 6.2 | 3.5 U | 9.5 | 4.4 U | 10.6 | 9.6 B | 4 B |
| Barium | MET | mg/kg | 38.3 B | 71.1 B | 28 B | 32.9 B | 46.8 B | 59.3 B | 202 | 132 B | 74.6 B |
| Beryllium | MET | mg/kg | 0.71 B | 1.7 B | 0 58 B | 1.3 B | 1 B | 1.7 B | 2.3 B | 2.4 B | 1 B |
| Cadmium | MET | mg/kg | 20.3 | 13.7 | 1.1 B | 55.8 | 33.7 | 63.5 | 39.9 | 10.3 | 42.4 |
| Calcium | MET | mg/kg | 2590 B | 3180 B | 1250 B | 2630 B | 3030 B | 5330 B | 5620 | 4550 B | 2840 B |
| Chromium | MET | mg/kg | 89.2 | 147 | 95 5 | 159 | 141 | 160 | 414 | 259 | 137 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 5 B | 8.9 B | 2.7 B | 6.8 B | 6.9 B | 8.7 B | 15.6 B | 9 B | 7.6 B |
| Copper | MET | mg/kg | 30.8 | 82 | 30.4 | 64.3 | 48 | 73.7 | 48.1 | 39 5 | 55.5 |
| Iron | MET | mg/kg | 7880 | 17700 | 8340 | 10300 | 11000 | 12900 | 15700 | 13200 | 10900 |
| Lead | MET | mg/kg | 405 | 631 | 265 | 792 | 636 | 689 | 358 | 276 | 522 |
| Magnesium | MET | mg/kg | 831 B | 1200 B | 718 B | 1200 B | 1160 B | 1270 B | 1480 B | 1220 B | 941 B |
| Manganese | MET | mg/kg | 198 | 2130 | 342 | 152 | 80.2 | 260 | 7540 | 1690 | 684 |
| Mercury | MET | mg/kg | 0.19 B | 0.33 U | 0.25 B | 0.28 B | 0.35 B | 0.31 U | 0.3 B | 0 29 B | 0.29 B |
| Nickel | MET | mg/kg | 12.8 B | 34.5 B | 9.8 B | 20.7 B | 20.3 B | 21.5 B | 18.1 B | 12.5 B | 20.1 B |
| Potassium | MET | mg/kg | 338 B | 473 B | 366 B | 161 U | 491 B | 377 B | 123 U | 355 B | 94.8 U |
| Selenium | MET | mg/kg | 2 7 U | 6.1 U | 2.9 U | 3.8 U | 3 3 U | 5.9 U | 2.9 U | 5 | 2.2 U |
| Silver | MET | mg/kg | 0.69 U | 2.1 U | 0 73 U | 1 U | 0.84 U | 2 U | 0.79 U | 1.6 U | 0.6 U |
| Sodium | MET | mg/kg | 325 U | 460 B | 346 U | 582 B | 398 U | 442 B | 550 B | 381 B | 414 B |
| Thallium | MET | mg/kg | 2.4 U | 5.8 U | 2.5 U | 4.7 U | 2 9 U | 5.5 U | 3.6 U | 4.3 U | 2.8 U |
| Vanadium | MET | mg/kg | 22.6 B | 38.9 B | 19 5 B | 28.1 B | 29 7 B | 31.4 B | 39.7 | 32.4 B | 23.9 B |
| Zinc | MET | mg/kg | 161 | 141 | 45 | 296 | 249 | 419 | 210 | 134 | 321 |

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | P3-01-SE 06/26/98 | P3-01-SE 03/25/99 | P3-02-SE 06/26/98 | P3-03 11/03/98 | P3-03-SE 06/26/98 | P3-03-SE 03/25/99 | P4-01 11/03/98 | P4-01 03/25/99 | P4-02 11/03/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 3 | Pond 4 | Pond 4 | Pond 4 |
| 1,1,1-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1,2-Trichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,1-Dichloroethene | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethane | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | | | | | | | | | |
| 1,2-Dichloropropane | VOC | µg/Kg | | | | | | | | | |
| 2-Butanone | VOC | µg/Kg | | | | | | | | | |
| 2-Hexanone | VOC | µg/Kg | | | | | | | | | |
| Acetone | VOC | µg/Kg | | | | | | | | | |
| Bromodichloromethane | VOC | µg/Kg | | | | | | | | | |
| Bromoform | VOC | µg/Kg | | | | | | | | | |
| Bromomethane | VOC | µg/Kg | | | | | | | | | |
| Carbon tetrachloride | VOC | µg/Kg | | | | | | | | | |
| Chlorobenzene | VOC | µg/Kg | | | | | | | | | |
| Chloroethane | VOC | µg/Kg | | | | | | | | | |
| Chloroform | VOC | µg/Kg | | | | | | | | | |
| Chloromethane | VOC | µg/Kg | | | | | | | | | |
| cis-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Dibromochloromethane | VOC | µg/Kg | | | | | | | | | |
| Ethylbenzene | VOC | µg/Kg | | | | | | | | | |
| Methylene chloride | VOC | µg/Kg | | | | | | | | | |
| Styrene | VOC | µg/Kg | | | | | | | | | |
| Tetrachloroethene | VOC | µg/Kg | | | | | | | | | |
| Toluene | VOC | µg/Kg | | | | | | | | | |
| trans-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | | | |
| Trichloroethene | VOC | µg/Kg | | | | | | | | | |
| Vinyl chloride | VOC | µg/Kg | | | | | | | | | |
| Xylene (total) | VOC | µg/Kg | | | | | | | | | |

Notes:
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations. TT = toxicity test, AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

## Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York



| Parameter | | Units | P4-03 11/03/98 | P5-01 11/03/98 | P5-01 03/25/99 | P5-02 11/03/98 | P5-03 11/03/98 | R1-01 11/03/98 | R1-01 03/25/99 | Maximum Concentration | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 4 | Pond 5 | Pond 5 | Pond 5 | Pond 5 | Reference | Reference | BKG [3] | MP |
| TT Sample ? | | | | YES | YES | | | YES | YES | | |
| TT Sample Accepted ? | | | | | YES [1] | | | | YES [1] | | |
| AVS/SEM Sample ? | | | | YES | | | | YES | | | |
| Cyanide | GEN | mg/kg | | | | | | | | | |
| Total Organic Carbon | GEN | mg/kg | 102000 | 82800 | 101000 | 157000 | 170000 | 135000 | 104000 | 146000 | 207000 |
| Aluminum | MET | mg/kg | 4980 | 4580 | 5470 | 10600 | 9630 | 3370 | 6620 | 8470 | 16400 |
| Antimony | MET | mg/kg | 3 U | 2.4 U | 7.8 U | 11.2 U | 8.2 U | 4.2 U | 5.2 U | ND | ND |
| Arsenic | MET | mg/kg | 2.7 U | 7 | 11.7 B | 12.9 B | 10.7 B | 3.9 U | 8.7 B | 10.3 | 13.5 |
| Barium | MET | mg/kg | 57.5 B | 44.4 B | 78.9 B | 250 B | 127 B | 36.2 B | 69.2 B | 198 | 250 |
| Beryllium | MET | mg/kg | 0.59 B | 0.67 B | 0.97 B | 1.5 B | 1.4 B | 0.47 B | 0.94 B | 0.94 | 2.4 |
| Cadmium | MET | mg/kg | 22.1 | 28.5 | 31.2 | 59.7 | 43.1 | 1 | 1.5 B | 7 | 248 |
| Calcium | MET | mg/kg | 1850 B | 1920 B | 4500 B | 6590 B | 4360 B | 2510 B | 3430 B | 5660 | 6590 |
| Chromium | MET | mg/kg | 72.1 | 77.3 | 88.9 | 158 | 139 | 12 | 14.8 | 39.5 | 839 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA | 4.6 | 136 |
| Cobalt | MET | mg/kg | 4.7 B | 6.5 B | 8.9 B | 20.9 B | 17.4 B | 5.4 B | 9.5 B | 35.2 | 21.3 |
| Copper | MET | mg/kg | 39.7 | 44.7 | 74.1 | 121 | 103 | 25.2 | 32.1 | 90 | 162 |
| Iron | MET | mg/kg | 7800 | 9940 | 17800 | 31200 | 28600 | 10300 | 13100 | 31500 | 31200 |
| Lead | MET | mg/kg | 311 | 648 | 647 | 1070 | 708 | 159 | 209 | 485 | 1860 |
| Magnesium | MET | mg/kg | 816 B | 683 B | 1580 B | 1990 B | 1480 B | 598 B | 722 | 1980 | 2250 |
| Manganese | MET | mg/kg | 763 | 182 | 722 | 16600 | 1830 | 398 | 874 B | 4510 | 16600 |
| Mercury | MET | mg/kg | 0.21 U | 0.26 B | 0.38 U | 0.78 U | 0.82 B | 0.29 U | 0.25 | 0.31 | 1.2 |
| Nickel | MET | mg/kg | 15.6 B | 14.3 B | 20.5 B | 47.4 B | 43.3 B | 15.7 | 16.7 U | 42.4 | 47.4 |
| Potassium | MET | mg/kg | 126 U | 103 U | 414 U | 476 U | 350 U | 180 U | 295 B | 570 | 695 |
| Selenium | MET | mg/kg | 3 U | 2.4 U | 6.9 U | 11.2 U | 8.2 U | 4.2 U | 4.6 U | ND | ND |
| Silver | MET | mg/kg | 0.8 U | 0.66 U | 2.4 U | 3 U | 2.2 U | 1.1 U | 1.6 U | ND | 2.2 |
| Sodium | MET | mg/kg | 523 B | 400 B | 566 B | 2030 B | 1540 B | 806 | 475 B | 806 | 2030 |
| Thallium | MET | mg/kg | 3.7 U | 3 U | 6.5 U | 14 U | 10.2 U | 5.3 U | 4.3 U | ND | ND |
| Vanadium | MET | mg/kg | 17.9 B | 27.3 B | 39.6 B | 60.4 B | 43.5 B | 13.1 | 20.4 B | 48.1 | 67.6 |
| Zinc | MET | mg/kg | 224 | 321 | 508 | 736 | 611 | 126 | 178 | 528 | 801 |

# Sediment Analytical Data (1998-1999)
## Massapequa Creek and Ponds, Nassau County, New York

| Parameter | | Units | P4-03 11/03/98 | P5-01 11/03/98 | P5-01 03/25/99 | P5-02 11/03/98 | P5-03 11/03/98 | R1-01 11/03/98 | R1-01 03/25/99 |
|---|---|---|---|---|---|---|---|---|---|
| | | | Pond 4 | Pond 5 | Pond 5 | Pond 5 | Pond 5 | Reference | Reference |
| 1,1,1-Trichloroethane | VOC | µg/Kg | | | | | | | |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | | | | | | | |
| 1,1,2-Trichloroethane | VOC | µg/Kg | | | | | | | |
| 1,1-Dichloroethane | VOC | µg/Kg | | | | | | | |
| 1,1-Dichloroethene | VOC | µg/Kg | | | | | | | |
| 1,2-Dichloroethane | VOC | µg/Kg | | | | | | | |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | | | | | | | |
| 1,2-Dichloropropane | VOC | µg/Kg | | | | | | | |
| 2-Butanone | VOC | µg/Kg | | | | | | | |
| 2-Hexanone | VOC | µg/Kg | | | | | | | |
| Acetone | VOC | µg/Kg | | | | | | | |
| Bromodichloromethane | VOC | µg/Kg | | | | | | | |
| Bromoform | VOC | µg/Kg | | | | | | | |
| Bromomethane | VOC | µg/Kg | | | | | | | |
| Carbon tetrachloride | VOC | µg/Kg | | | | | | | |
| Chlorobenzene | VOC | µg/Kg | | | | | | | |
| Chloroethane | VOC | µg/Kg | | | | | | | |
| Chloroform | VOC | µg/Kg | | | | | | | |
| Chloromethane | VOC | µg/Kg | | | | | | | |
| cis-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | |
| Dibromochloromethane | VOC | µg/Kg | | | | | | | |
| Ethylbenzene | VOC | µg/Kg | | | | | | | |
| Methylene chloride | VOC | µg/Kg | | | | | | | |
| Styrene | VOC | µg/Kg | | | | | | | |
| Tetrachloroethene | VOC | µg/Kg | | | | | | | |
| Toluene | VOC | µg/Kg | | | | | | | |
| trans-1,3-Dichloropropene | VOC | µg/Kg | | | | | | | |
| Trichloroethene | VOC | µg/Kg | | | | | | | |
| Vinyl chloride | VOC | µg/Kg | | | | | | | |
| Xylene (total) | VOC | µg/Kg | | | | | | | |

| Maximum Concentration | |
|---|---|
| BKG [3] | MP |
| 0.8 | 9 |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | 19 |
| ND | ND |
| ND | 84 |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| ND | ND |
| 3 | ND |
| ND | 7 |
| ND | 53 |
| ND | 0 6 |
| ND | ND |
| ND | ND |

Notes:
1 YES indicates that the Hyallela azteca 28-day test was accepted, but the Chironomus tentans 14-day test was rejected.
2 YES indicates that both the Hyallela azteca 28-day test and the Chironomus tentans 14-day test was accepted.
3 indicates that the samples from the West Branch of Massapequa Creek were used to derive background concentrations.

Abbreviations: TT = toxicity test; AVS/SEM = acid volatile sulfide/simultaneously extracted metals, mg/kg = milligram per kilogram, µg/kg = microgram per kilogram

# Sediment Analytical Data (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | Parameter Class | Units | SD-01 04/01/1992 | SD-02 04/01/1992 | SD-03 04/01/1992 | SD-04 04/01/1992 | SD-05 04/01/1992 | SD-06 04/01/1992 | SD-07 04/01/1992 |
|---|---|---|---|---|---|---|---|---|---|
| | | | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch |
| Cyanide | GEN | mg/kg | U | U | U | U | U | U | U |
| Total Organic Carbon | GEN | mg/kg | 3260 | 14900 J | 1030 | 1380 | 1030 | 1030 | 3480 |
| Aluminum | MET | mg/kg | 1050 | 1470 | 1110 | 979 | 733 | 608 | 644 |
| Antimony | MET | mg/kg | U | U | U | U | U | U | U |
| Arsenic | MET | mg/kg | 1.8 | 1.1 B2 | 0.88 B2 | 0.64 B2 | 0.53 B2 | 0.26 B2 | 0.17 B2 |
| Barium | MET | mg/kg | 6.3 B2 | 11.1 B2 | 7.1 B2 | 6.9 B2 | 2.1 B2 | 3.4 B2 | 3 2 B2 |
| Beryllium | MET | mg/kg | U | U | U | U | U | U | U |
| Cadmium | MET | mg/kg | U | U | 5.3 | 3.2 | 2.2 | U | 1.8 |
| Calcium | MET | mg/kg | 2640 EJ | 1020 B2E | 598 B2E | 392 B2E | 227 B2E | 260 B2E | 541 B2E |
| Chromium | MET | mg/kg | 10.7 | 23 1 | 33.1 | 22.2 | 44.1 | 28 | 24.4 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 1.7 B2 | 2 6 B2 | 1.7 B2 | 1.4 B2 | U | 1.8 B2 | 2 3 B2 |
| Copper | MET | mg/kg | 37.1 J | 35 2 J | 16.9 J | 25.5 J | 6.5 | 3.6 B2 | 1 7 B2 |
| Iron | MET | mg/kg | 6690 | 3810 | 2780 | 2650 | 1400 | 1190 | 721 |
| Lead | MET | mg/kg | 78.9 | 116 | 111 | 28.6 | 23.2 | 10.3 | 10.6 |
| Magnesium | MET | mg/kg | 1340 J | 380 B2 | 244 B2 | 306 B2 | 116 B2 | 225 B2 | 254 B2 |
| Manganese | MET | mg/kg | 49.6 | 25 4 | 78 | 24 1 | 51.8 | 44.5 | 17 4 |
| Mercury | MET | mg/kg | U | U | U | U | U | U | U |
| Nickel | MET | mg/kg | U | 7 7 B2 | U | 6 B2 | U | 5.6 B2 | U |
| Potassium | MET | mg/kg | U | U | 175 B2 | 285 B2 | U | U | 163 B2 |
| Selenium | MET | mg/kg | U | U | 0.14 B2 | U | U | U | U |
| Silver | MET | mg/kg | 1.2 B2 | U | U | U | U | U | U |
| Sodium | MET | mg/kg | 36.4 B2 | 116 B2 | 23.2 B2 | 38 B2 | 29.3 B2 | 26.6 B2 | 63.5 B2 |
| Thallium | MET | mg/kg | 0.13 UWJ | 0.15 UWJ | 0 12 UWJ | 0.12 UWJ | 0.12 UWJ | U | U |
| Vanadium | MET | mg/kg | 7.7 B2 | 7.3 B2 | 6 B2 | 8.4 B2 | 1.2 B2 | 2.7 B2 | U |
| Zinc | MET | mg/kg | 52.4 EJ | 72.6 EJ | 40 6 EJ | 25 EJ | 10 EJ | 7.2 EJ | 8 EJ |

# Sediment Analytical Data (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | Parameter Class | Units | SD-01 04/01/1992 | SD-02 04/01/1992 | SD-03 04/01/1992 | SD-04 04/01/1992 | SD-05 04/01/1992 | SD-06 04/01/1992 | SD-07 04/01/1992 |
|---|---|---|---|---|---|---|---|---|---|
| | | | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch | East Branch |
| 1,1,1-Trichloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,1,2-Trichloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,1-Dichloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,1-Dichloroethene | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,2-Dichloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | U | U | U | U | U | U | U |
| 1,2-Dichloropropane | VOC | µg/Kg | U | U | U | U | U | U | U |
| 2-Butanone | VOC | µg/Kg | U | U | U | U | U | U | U |
| 2-Hexanone | VOC | µg/Kg | U | U | U | U | U | U | U |
| Acetone | VOC | µg/Kg | U | U | U | U | U | U | U |
| Bromodichloromethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| Bromoform | VOC | µg/Kg | U | U | U | U | U | U | U |
| Bromomethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| Carbon tetrachloride | VOC | µg/Kg | U | U | U | U | U | U | U |
| Chlorobenzene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Chloroethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| Chloroform | VOC | µg/Kg | U | U | U | U | U | U | U |
| Chloromethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| cis-1,3-Dichloropropene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Dibromochloromethane | VOC | µg/Kg | U | U | U | U | U | U | U |
| Ethylbenzene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Methylene chloride | VOC | µg/Kg | U | U | U | U | U | U | U |
| Styrene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Tetrachloroethene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Toluene | VOC | µg/Kg | U | U | U | U | U | U | 62 |
| trans-1,3-Dichloropropene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Trichloroethene | VOC | µg/Kg | U | U | U | U | U | U | U |
| Vinyl chloride | VOC | µg/Kg | U | U | U | U | U | U | U |
| Xylene (total) | VOC | µg/Kg | U | U | U | U | U | U | U |

Notes: All qualifiers are defined as in the 1994 RI report.
All data and qualifiers are as received in electronic format from EPA's subcontrcator Roy F. Weston.
NA = not analyzed; ND = not detected; mg/kg = milligram per kilogram; µg/kg = microgram per kilogram

# Sediment Analytical Data (1992)
## Massapequa Creek, Nassau County, New York

| Parameter | Parameter Class | Units | SD-08 04/01/1992 | SD-09 04/01/1992 | SD-10 04/01/1992 | Maximum Concentrations | |
|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | West Branch | East Branch | West Branch |
| Cyanide | GEN | mg/kg | 5.7 UJ | U | U | ND | ND |
| Total Organic Carbon | GEN | mg/kg | 10800 | 1060 | 3190 | 14900 | 10800 |
| Aluminum | MET | mg/kg | 2230 J | 1090 | 941 | 1470 | 2230 |
| Antimony | MET | mg/kg | 20.1 UJ | U | U | ND | ND |
| Arsenic | MET | mg/kg | 5.4 SJ | 1 5 | 2 | 1.8 | 5.4 |
| Barium | MET | mg/kg | 110 J | 14 2 B2 | 22 2 B2 | 11.1 | 110 |
| Beryllium | MET | mg/kg | 0.46 UJ | U | 0.27 UJ | ND | 0.46 |
| Cadmium | MET | mg/kg | 3.3 J | U | 1.1 B2 | 5.3 | 3.3 |
| Calcium | MET | mg/kg | 3380 EJ | 199 B2E | 1280 B2E | 2640 | 3380 |
| Chromium | MET | mg/kg | 10.6 J | 4 3 | 16.1 | 44.1 | 16.1 |
| Chromium VI | MET | mg/kg | NA | NA | NA | NA | NA |
| Cobalt | MET | mg/kg | 15 2 B2J | 4.6 B2 | 5.6 B2 | 2.6 | 15.2 |
| Copper | MET | mg/kg | 31.3 J | 3.9 B2 | 15.9 J | 37.1 | 31.3 |
| Iron | MET | mg/kg | 16200 J | 10100 | 11100 | 6690 | 16200 |
| Lead | MET | mg/kg | 227 J | 116 | 70.6 | 116 | 227 |
| Magnesium | MET | mg/kg | 671 B2J | 158 B2 | 740 B2 | 1340 | 740 |
| Manganese | MET | mg/kg | 3820 J | 573 | 401 | 78 | 3820 |
| Mercury | MET | mg/kg | 0 27 J | U | U | ND | 0.27 |
| Nickel | MET | mg/kg | 14.4 B2J | U | 11 3 | 7.7 | 14.4 |
| Potassium | MET | mg/kg | 484 B2J | 184 B2 | 235 B2 | 285 | 484 |
| Selenium | MET | mg/kg | 0 23 UJ | U | U | 0.14 | ND |
| Silver | MET | mg/kg | 1 8 UJ | U | U | 1.2 | ND |
| Sodium | MET | mg/kg | 245 B2J | 34.2 B2 | 76.4 B2 | 116 | 245 |
| Thallium | MET | mg/kg | 0.32 B2WJ | 0.12 UWJ | 0.14 UWJ | ND | 0.32 |
| Vanadium | MET | mg/kg | 14.8 B2J | 5 5 B2 | 8.2 B2 | 8.4 | 14.8 |
| Zinc | MET | mg/kg | 188 EJ | 21 5 EJ | 64 9 EJ | 72.6 | 188 |

# Sediment Analytical Data (1992)
## Massapequa Creek, Nassau County, New York



| Parameter | Parameter Class | Units | SD-08 04/01/1992 | SD-09 04/01/1992 | SD-10 04/01/1992 | Maximum Concentrations | |
|---|---|---|---|---|---|---|---|
| | | | West Branch | West Branch | West Branch | East Branch | West Branch |
| 1,1,1-Trichloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| 1,1,2,2-Tetrachloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| 1,1,2-Trichloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| 1,1-Dichloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| 1,1-Dichloroethene | VOC | µg/Kg | U | U | U | ND | ND |
| 1,2-Dichloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| 1,2-Dichloroethene (total) | VOC | µg/Kg | U | U | U | ND | ND |
| 1,2-Dichloropropane | VOC | µg/Kg | U | U | U | ND | ND |
| 2-Butanone | VOC | µg/Kg | U | U | U | ND | ND |
| 2-Hexanone | VOC | µg/Kg | U | U | U | ND | ND |
| Acetone | VOC | µg/Kg | U | U | U | ND | ND |
| Bromodichloromethane | VOC | µg/Kg | U | U | U | ND | ND |
| Bromoform | VOC | µg/Kg | U | U | U | ND | ND |
| Bromomethane | VOC | µg/Kg | U | U | U | ND | ND |
| Carbon tetrachloride | VOC | µg/Kg | U | U | U | ND | ND |
| Chlorobenzene | VOC | µg/Kg | U | U | U | ND | ND |
| Chloroethane | VOC | µg/Kg | U | U | U | ND | ND |
| Chloroform | VOC | µg/Kg | U | U | U | ND | ND |
| Chloromethane | VOC | µg/Kg | U | U | U | ND | ND |
| cis-1,3-Dichloropropene | VOC | µg/Kg | U | U | U | ND | ND |
| Dibromochloromethane | VOC | µg/Kg | U | U | U | ND | ND |
| Ethylbenzene | VOC | µg/Kg | U | U | U | ND | ND |
| Methylene chloride | VOC | µg/Kg | U | U | U | ND | ND |
| Styrene | VOC | µg/Kg | U | U | U | ND | ND |
| Tetrachloroethene | VOC | µg/Kg | U | U | U | ND | ND |
| Toluene | VOC | µg/Kg | U | U | U | 62 | ND |
| trans-1,3-Dichloropropene | VOC | µg/Kg | U | U | U | ND | ND |
| Trichloroethene | VOC | µg/Kg | U | U | U | ND | ND |
| Vinyl chloride | VOC | µg/Kg | U | U | U | ND | ND |
| Xylene (total) | VOC | µg/Kg | U | U | U | ND | ND |

Notes
All qualifiers are defined as in the 1994 RI report.
All data and qualifiers are as received in electronic format from EPA's subcontrcator Roy F. Weston.
NA = not analyzed; ND = not detected, mg/kg = milligram per kilogram; µg/kg = microgram per kilogram

# APPENDIX B

## Dames and Moore Derivation of Potential Sediment Cleanup Levels for Cadmium and Chromium

The results of sediment toxicity testing, using the March 1999 sample set (Hyallela azteca 28-day test) and the December 1999 sample set (*Hyallela azteca* 28-day test and *Chironomus tentans* 14-day test) are presented and discussed in Section 5.2 of the BERA.

The March 1999 sample set included sediment samples from Pond A through Pond 5 and from one reference sample location. The December 1999 sample set included two sediment samples from Pond A only. A total of ten samples were available for evaluating threshold concentrations at which adverse effects (defined here as survival of less than 80 percent of the exposed organisms) may be expected. If identifiable, such a threshold concentration for a particular constituent may be considered a potential or preliminary cleanup level for the pond sediments. Note, however, that Section 5.2.1 of the BERA presents a detailed discussion as to why the results of the sediment toxicity tests need to be evaluated with some caution and that not one particular factor alone is likely to determine the outcome of these tests. In fact, such a threshold evaluation is by definition limited in its scope and validity, because only a handful of parameters (namely, TAL metals concentrations and certain intrinsic test parameters) were actually measured. Therefore, this evaluation needs to content with the fact that only a few important, but by no means a full range of relevant parameters that may have influenced the outcome of toxicity tests were measured. Thus, this evaluation (as required by USEPA, April 12, 2000) is difficult and fraught with uncertainty.

The evaluation in this Appendix combines the results of the March 1999 and December 1999 toxicity tests for *Hyalella azteca*. The *Chironomus tentans* tests were not considered for this evaluation, since results from only two samples were available.

Figure B-1 shows a cross plot of observed cadmium concentrations in the bulk sediment samples and the corresponding survival percentages for the Hyalella azteca tests. Plotted also are the ranges (minimum, mean, and maximum concentrations) of cadmium concentrations in Pond A through Pond 5. The correlation between cadmium concentrations and survival is poor (signified by a $r^2$ of 0.149); however, there appears to be a rough coincidence of greater cadmium concentrations with lesser percentages of survival. Using the 80% survival criterion as a critical level, the regression line indicates that approximately 120 mg/kg cadmium may correspond to adverse effects. Using the first incidence of survival less than 80% as a critical level, a cadmium concentration of approximately 55 mg/kg may be derived as corresponding to adverse effects. Clearly, the uncertainty in this analysis is significant and not further evaluated here.

Figure B-2 shows a cross plot of observed chromium concentrations in the bulk sediment samples and the corresponding survival percentages for the Hyalella azteca tests. Plotted also are the ranges (minimum, mean, and maximum concentrations) of chromium concentrations in Pond A through Pond 5. The correlation between chromium concentrations and survival is poor (signified by a $r^2$ of 0.243); however, there appears to be a rough coincidence of greater chromium concentrations with lesser percentages of survival. Using the 80% survival criterion as a critical level, the regression line indicates that approximately 490 mg/kg chromium may correspond to adverse effects. Using the first incidence of survival less than 80% as a critical level, a chromium concentration of approximately 268 mg/kg may be derived as corresponding to adverse effects. Clearly, the uncertainty in this analysis is significant and not further evaluated here.

The correlations of other measured metal concentrations (e.g., zinc, lead) was even less convincing than the ones shown in Figures B-1 and B-2.

Thus, the results of this evaluation may be summarized as follows:

| Constituent | Reasonable Minimum Threshold Concentration mg/kg | Reasonable Maximum Threshold Concentration mg/kg |
|---|---|---|
| Cadmium | 55 | 120 |
| Chromium | 268 | 490 |

Comparing the plotted ranges of cadmium concentrations in the pond sediments to these potential minimum and maximum threshold concentrations ('cleanup levels') it is apparent that only Pond A has a mean and concentration range that overlaps with the interval of cadmium 'cleanup levels' (55 to 120 mg/kg). Similarly, the interval of chromium 'cleanup levels' (268 to 490 mg/kg) overlaps with the observed concentration range and mean of sediments in Pond A, and with the upper range of observed chromium concentrations in Ponds 1 and 4. Note that the generic Effects Range-Medium (ER-M) for chromium is 370 mg/kg, and therefore lies within the range of potential 'cleanup levels' as derived in this analysis.

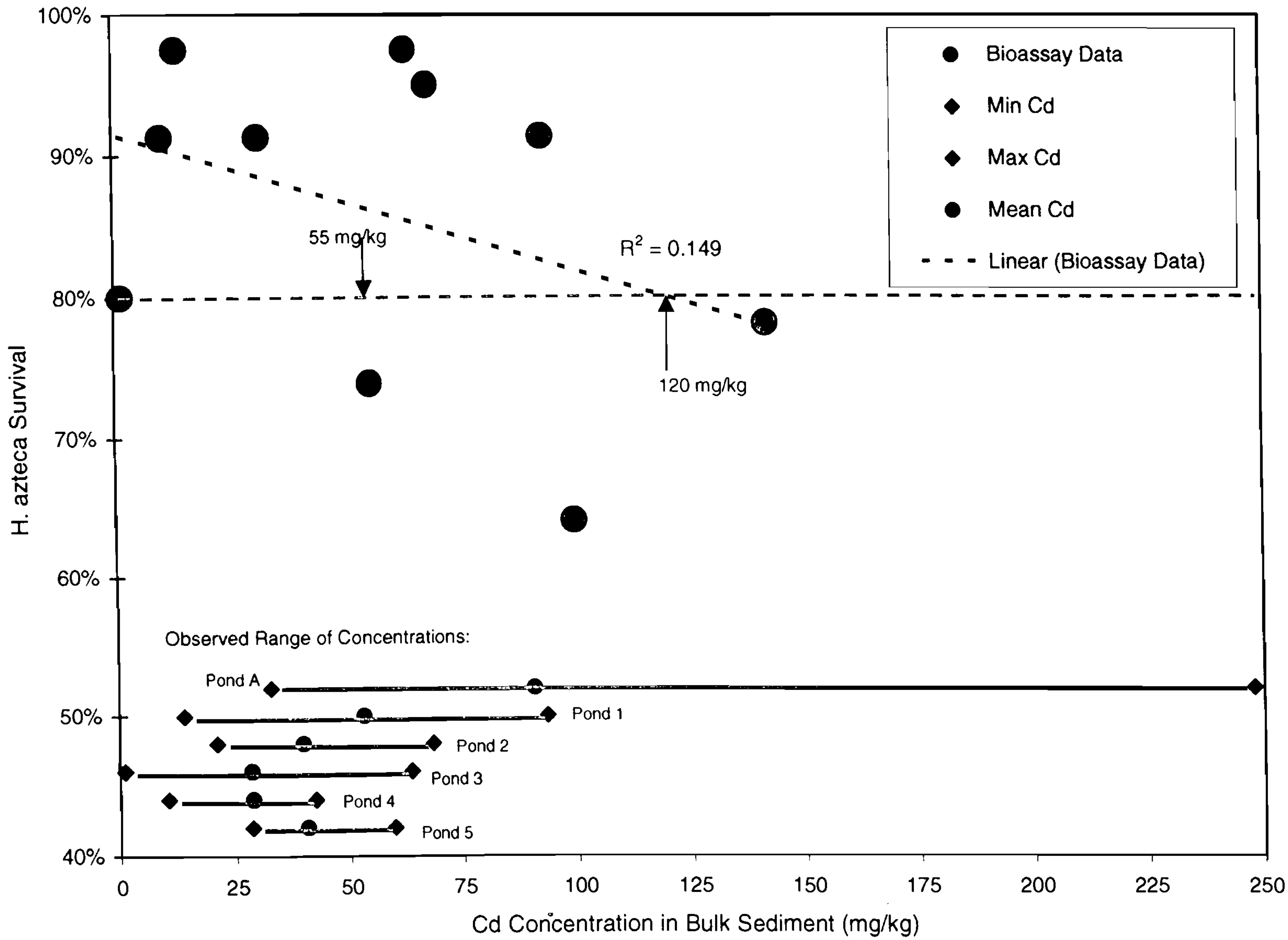


Figure B-1
Relevant Data for Derivation of Cd Sediment Criterion

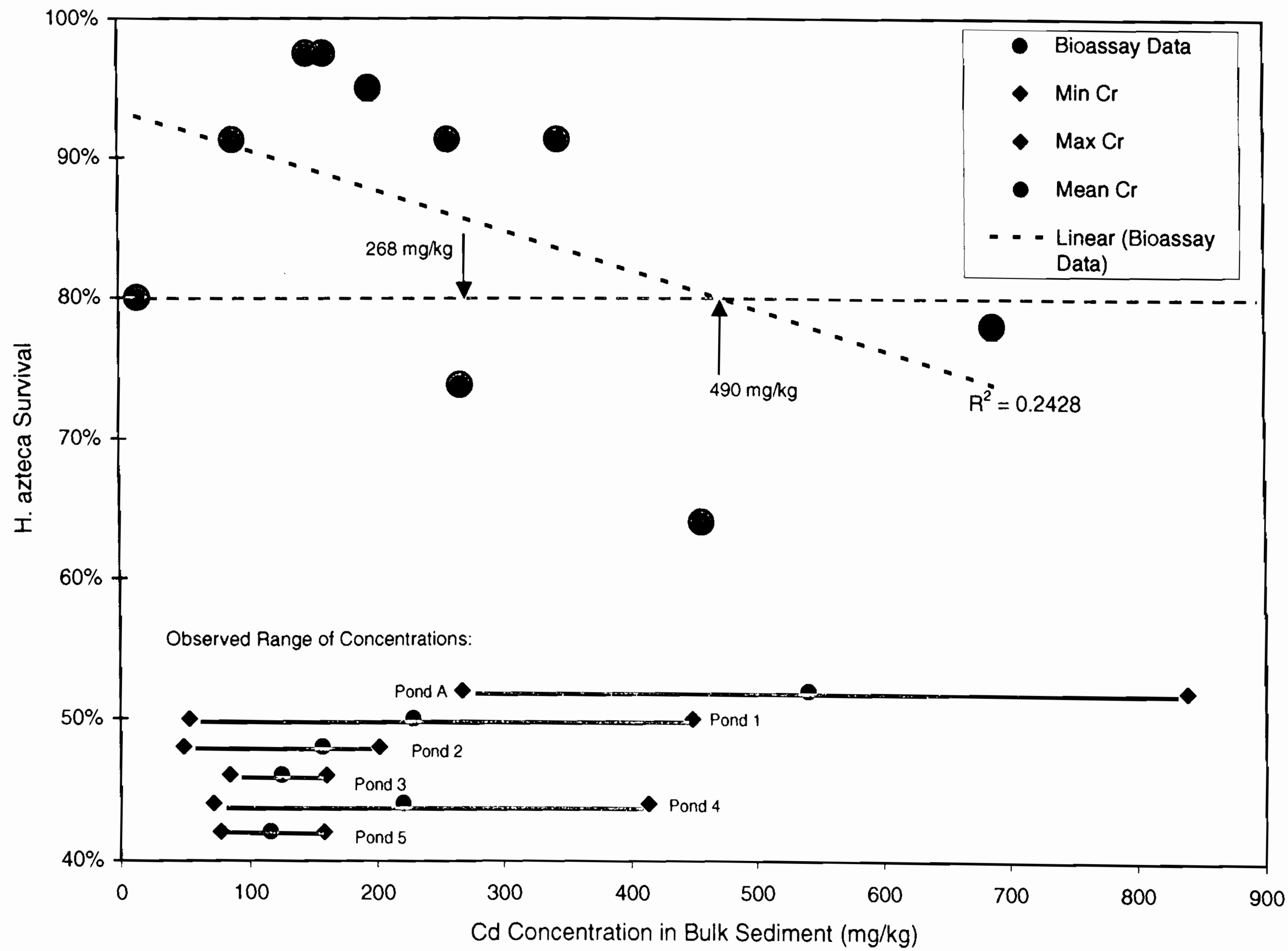


Figure B-2
Relevant Data for Derivation of Cr Sediment Criterion