Ecological Risk Assessment Supplement

Ashland/NSP Lakefront Site

Ashland, Wisconsin

WDNR No. 01RRTT
SEH No. WIDNR9401.09

February 2002

SHORT ELLIOTT HENDRICKSON INC
Multidisciplined.
Single Source.

421 Frenette Drive, Chippewa Falls, WI 54729-3374 715.720.6200 715.720.6300 FAX
architecture • engineering • environmental • transportation

February 19, 2002

RE: Ashland/NSP Lakefront Site
Ecological Risk Assessment Supplement
Ashland, Wisconsin
WDNR No. 01RRTT
SEH No. WIDNR9401.09

Mr. James R. Dunn, Project Manager
Wisconsin Department of Natural Resources
Bureau of Remediation and Redevelopment
810 W. Maple Street
Spooner, WI 54801

Dear Mr. Dunn:

Short Elliott Hendrickson Inc.® (SEH) is submitting the attached Ecological Risk Assessment Supplement. This report presents the results of the supplementary ecological risk assessment (ERA) activities performed in 2001 for the contaminated sediments offshore the Ashland/NSP Lakefront site. The results were integrated with the results of previous ERA studies at the site and current sediment quality guidelines to provide an updated ERA characterization of the site.

Please contact me at 715.720-6232 with any questions or comments you may have regarding this project.

Sincerely,

Cyrus W. Ingraham, P.E.
Principal

GGC/MJB/ls/TJ/JD
p:\proj\widnr\9401\rep\era supplement.doc

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6	James R. Dunn, Project Manager Wisconsin Department of Natural Resources Bureau of Remediation and Redevelopment 810 W. Maple Street Spooner, WI 54801
2	Jonathon Young Eagle Wisconsin Department of Natural Resources Bureau of Remediation and Redevelopment 101 S. Webster Street P.O. Box 7921 Madison, WI 53707
1	Lee Liebenstein, Contaminated Sediment Coordinator Wisconsin Department of Natural Resources Bureau of Watershed Management 101 S. Webster Street P.O. Box 7921 Madison, WI 53707
1	Jerry Winslow Xcel Energy 414 Nicollet Mall Minneapolis, MN 55401

Ecological Risk Assessment Supplement

Ashland/NSP Lakefront Site
Ashland, Wisconsin

Prepared for:
Wisconsin Department of Natural Resources
Spooner, Wisconsin

Prepared by:
Short Elliott Hendrickson Inc.
421 Frenette Drive
Chippewa Falls, WI 54729-3374
715.720.6200

I, John E. Guhl, hereby certify that I am a Hydrogeologist as that term is defined in s. NR 712.03(1) Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

John E. Guhl #120 2-19-2002

John E. Guhl, P.G. P.G. Number Date
Hydrogeologist

I, Gloria G. Chojnacki, hereby certify that I am a scientist as that term is defined in s. NR 712.03(3), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

Gloria Chojnacki 2-19-2002

Gloria G. Chojnacki, CHMM Date
Environmental Scientist

I, Mark J. Broses, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

31176 2-19-2002

Mark J. Broses, P.E. P.E. Number Date
Project Engineer

Executive Summary

Introduction

In 1998, Short Elliott Hendrickson Inc. (SEH) completed an Ecological Risk Assessment (ERA) of the contaminated sediments adjacent to the Ashland Lakefront Property for the Wisconsin Department of Natural Resources (WDNR). The 1998 ERA concluded that strong evidence exists that the current and future ecological risks are high associated with the contaminated sediments adjacent to the Ashland Lakefront Property.

A supplemental ERA was performed in 2001 to further validate and support conclusions regarding the ecological impacts from contaminants of concern in the sediment portion of the site, and to aid in determining clean-up goals for the sediments.

This report documents the activities and results of the supplemental ERA. Furthermore, this report updates the conclusions and recommendations of the 1998 ERA report to reflect the expanded site specific knowledge as well as recent literature regarding ecological risks associated with coal tar and polycyclic aromatic hydrocarbon (PAH) contaminated sediments.

Site Background

The Ashland Lakefront Property was created anthropogenically in the late 1800's and early 1900's by placement of various fill materials into Chequamegon Bay. The site was owned by various lumber companies until 1936. Fill materials consist largely of wood slabs, pieces, and sawdust mixed with earthen fill. The area immediately south of the Ashland Lakefront Property consists of a railroad right-of-way and a 30-foot high bluff. A manufactured gas plant (MGP) operated at the top of the bluff from the late 1800's until approximately 1947. During the time the MGP operated, a former ravine extending from the MGP site through the bluff to the southern edge of the Ashland Lakefront Property was filled.

Chequamegon Bay is located immediately to the north of the Ashland Lakefront Property. A marina jetty (Ellis Avenue Marina) located at the northwest corner of the property, and two jetties protecting a public boat landing form a small embayment immediately north of the Ashland Lakefront Property. The near shore sediments generally consist of a surface layer of unevenly distributed wood-related materials underlain by sands and silty sands.

Widespread volatile organic compound (VOC) and semi-volatile organic compound PAH contamination has been identified at the Ashland Lakefront Property, in the up gradient ravine area, in offshore sediments, and in a deep confined aquifer beneath the former MGP site. The MGP has been identified as the likely source of VOC and PAH contamination in the ravine area, the deep aquifer, the Ashland Lakefront Property, and the offshore sediments.

Historical site maps reveal an open sewer extending across the west side of the Ashland Lakefront Property was present until 1951. Relatively high concentrations of VOC and PAH contaminants are present in groundwater collected from the proximity of the former open sewer. This may indicate the former open sewer acted as a conduit for contaminant movement from the south side of the Ashland Lakefront Property into Chequamegon Bay and the associated near shore sediments.

Ecological Risk Assessment – Study Design

A weight-of-evidence approach was utilized to assess the potential existing and future ecological risks associated with the contaminated sediments to the benthic, aquatic, and terrestrial communities. Weight of evidence was accumulated in 1998 by several means including: 1) a literature search conducted to select relevant sediment effects benchmarks for evaluation of site data and identify ecological effects documented at other sites with similar contaminants and exposures; 2) sediment samples collected, analyzed, and compared to sediment effects benchmarks for the contaminants identified; 3) a survey conducted of the benthic community at contaminated and reference locations; 4) a series of laboratory bioassay toxicity tests conducted to characterize the effects of short term exposure to the contaminated and reference sediment samples; and 5) collection of fish for analysis of tissue chemical concentrations.

In 2001, additional sediment sampling, chemical analyses, and bioassay toxicity studies were performed.

Sediment Chemical Data Evaluation

In 1998 bulk sediment collected from the site sediment bioactive zone was analyzed for PAHs and VOCs. In 2001 bulk sediment collected from the site sediment was analyzed for PAHs, VOCs, phenolic compounds, and heterocyclic aromatic compounds (HAHs).

Chemical data was converted to toxic units to evaluate the cumulative effects of different chemicals in the contaminant mixture existing in the sediments. Chemical data, sediment survey results, and toxicity study results were integrated to assess the level of ecological risk associated with varying exposure levels at the site. The results of both bulk sediment dilutions and sediment elutriate dilutions were used to strengthen the exposure response characterization, and extrapolated to evaluate the potential effects across the contaminated sediment area with respect to the larger database of PAH and VOC concentrations.

Several sets of sediment effects benchmarks were identified in the literature search. Sediment chemical data was compared to several sets of probable effects levels for both dry weight units and normalized-to-organic-carbon (NOC) units. PAH and VOC benchmarks were exceeded for several chemicals at several locations in the shallow bioactive zone sediments and deeper sediments. Based on this comparison, it was concluded there was a high probability of adverse effects to aquatic life from the contaminated sediments.

Additionally, a water column sample collected during a 3-foot wave period exhibited PAH concentrations which exceeded secondary acute and chronic water quality criteria values.

Comparison of the site PAH concentrations to data in the literature from other sites indicated that PAHs may be accumulating in resident fish species, especially bottom feeders. Exposure of fish to the mutagenic PAH contaminants may result in fish tumors, impaired health, and ultimately, death. Results of 1998 fish tissue sampling revealed the presence of PAHs in fish collected from the site.

The sediment quality guidelines retained to compare relative toxicity of the PAH mixtures include: the consensus-based sediment quality guidelines (CBSQGs) developed by MacDonald, et al in 2000; and the draft equilibrium partitioning sediment quality guidelines (ESGs) developed by the USEPA in 2000. VOC, HAH, and phenolic toxicity was evaluated by comparison to EPA sediment quality advisory levels (SQALs), WDNR guidelines, and preliminary remediation goals (PRGs) developed by the Oak Ridge National Lab (ORNL).

Benthic Community Evaluation

Benthic community surveys were conducted in 1998 at two contaminated stations and two reference stations. Benthic community survey results were evaluated for richness, abundance and relative indices. Graphical analyses indicated that the community degradation as reflected in differences in indices between the reference and contaminated sites strongly correlates to the sum of dry weight toxic units for the PAH mixtures.

Bioassay Toxicity Study Evaluation

Bioassay toxicity studies were conducted in 1998 on several species sediment samples collected from the same two contaminated stations and reference stations. Bulk sediment toxicity tests were conducted on the following benthic species: on *Hyallela azteca*, *Chironomus tentans* and *Lumbriculus variegatus*. Sediment elutriate preparations from these sites were used in tests on *Pimephales promeles* and *Daphnia magna*.

Supplemental bioassay toxicity studies were conducted in 2001 using *Hyallela azteca*, *Chironomus tentans* and *Pimephales promeles* exposed to bulk sediments collected from four contaminated stations and two reference stations. Parallel tests were conducted utilizing a dilution methodology in which various proportions of sediments from impacted sites were mixed with sediments from reference sites to obtain a range of exposure concentrations.

Test results were evaluated for effects on survival and growth, and graphically compared to toxic units. Statistically significant differences in survival and/or growth were documented between each sample. Toxic effects appeared to correlate well to toxic units. Results from both the bulk sediment dilution tests and the sediment elutriate dilution tests supported the exposure concentration/effects characterization.

Results of literature search indicated that the toxic effects of certain PAHs may be enhanced by exposure to the ultraviolet (UV) component in sunlight. Comparison of phototoxic PAH concentrations at the site to reference levels in the literature indicated it was likely a phototoxic effect could be present at the site. Phototoxicity studies were performed in 1998 and 2001 in conjunction with standard toxicity test organisms exposed to bulk sediment or sediment elutriate samples collected from the site. Evidence of enhanced phototoxicity effects were shown for benthic organisms, zooplankton, and fish larvae.

Risk Characterization

The weight of evidence indicates that a strong potential exists for ecological risks to be high associated with the contaminated sediments in the bioactive zone and contaminated surface water over this zone. The weight of evidence includes: 1) coal tar-related contaminant concentrations in sediments exceeding several independent sediment effects benchmarks; 2) evidence of benthic community impairment in the contaminated areas as documented in field studies; 3) results of standard and photo-enhanced bioassay toxicity tests that indicate that the probability of ecological effects increase with exposure to increased contaminant concentrations in sediments and surface waters over the sediments; 4) the exceeding of secondary acute and chronic water quality criteria during heavy wave action, based on field sampling and in laboratory settling studies; 5) sediment concentrations of PAHs similar to those at other sites where bioaccumulation and mutagenic effects have been observed; and 6) evidence of PAH in fish tissues collected from the site.

The sum of toxic units for PAHs in the deeper sediments appears to be significantly higher than in the surficial bioactive zone. Future disturbance and exposure of the deeper contaminated sediments to the sediment-water interface and water column by either natural (e.g., storms, ice scouring) or uncontrolled anthropogenic (e.g., boat prop wash, shoreline maintenance) forces could potentially result in significant ecological impacts in and possibly beyond the localized contaminated sediment area.

Ecological impacts to the benthic organisms may include acute and chronic toxic effects from direct contact with and ingestion of impacted sediments, food, and water. Impacts to the fish community could include acute and chronic effects from ingesting contaminated food, or direct contact with contaminated sediments and water. Immature fish and eggs are expected to be especially susceptible to acute effects based on the results of the photo enhanced toxicity studies. Another potential impact to the fish community is the loss or reduction of the lower level benthic community food source in the contaminated area. Likewise the terrestrial community may suffer from exposure to the contaminated water and sediments, ingestion of contaminated food, or loss or reduction of food sources.

Based on integrating and weighing all the lines of evidence collected from all the steps and years of the ecological risk assessment process for the sediment portion of the Lakefront site, Preliminary Remediation Goals (PRGs) for the contaminated substrates present (wood chips and sand) were developed. Recognizing the uncertainties associated with the ecological risk assessment process prompted the establishment of what are believed to be scientifically sound, and as appropriate reasonably conservative, cleanup goals to protect the biotic resources of the embayment off the Lakefront property, Chequamegon Bay, and in turn the unique Lake Superior ecosystem.

Executive Summary (Continued)

Preliminary Remediation Goals (PRGs) for the contaminated substrates (wood chips and sand) developed for the site are as follows:

Sand Sediments:

Total PAHs: 1767 μg/kg DW or 161 μg/g OC; Total VOCs: 972 μg/kg DW or 97 μg/g OC.

The dry weight PAH PRG (1,767 μg/kg) for total PAHs is the average background value for sandy sediments in the bioactive zone reference samples. It is only slightly higher than the WDNR PAH TEC value (1,610 μg/kg) and should be protective. The value corresponds to a MacDonald CBSQG PEC-Q of less than 0.1, which should provide chronic protection and a low incidence of toxicity to benthic organisms.

The NOC PAH PRG (161 μg/g OC) is set at the WDNR TEC, and is approximately 1.5 times the average background value for sandy sediments in the bioactive zone reference samples. The value corresponds to a ESG TU of 1.4 which should provide chronic protection.

The dry weight VOC PRG (972 μg/kg) and NOC VOC PRG (97 μg/g OC) were set at the cumulative WDNR TECs for benzene, ethylbenzene, and toluene. The values are approximately 20 times greater than the background VOC concentrations.

Wood Chip Sediments:

Total PAHs: 9,750 μg/kg DW or 161 μg/g OC; Total VOCs: 972 μg/kg DW or 97 μg/g OC.

The dry weight PAH PRG (9,750 μg/kg) for total PAHs is the average background value for wood chip sediments in the bioactive zone reference samples. It is approximately 6 times higher than the WDNR PAH TEC value (1,610 μg/kg). The value corresponds to a MacDonald CBSQG PEC-Q of less than 0.3, which should provide limited chronic protection.

The NOC PAH PRG (161 μg/g OC) is set at the WDNR TEC, and is approximately twice the average background value for wood chip sediments in the bioactive zone reference samples. The value corresponds to a ESG TU of 1.4 which should provide chronic protection.

The dry weight VOC PRG (972 μg/kg) and NOC VOC PRG (97 μg/g OC) were set at the cumulative WDNR TECs for benzene, ethylbenzene, and toluene. The dry weight value is approximately 5 times greater than the background VOC concentrations. The NOC value is approximately 24 times greater than the background VOC concentrations.

Other MGP coal tar related organic chemicals (e.g., phenolics, HAHs) detected at the site that may contribute to toxicity are expected to be co-located with the PAHs and VOCs and would be addressed by the cleanup of PAH and VOC impacted sediments.

List of Abbreviations (Continued)

NEL	No Effects Level
NET	Northern Environmental Technology
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observed Adverse Effects Concentration
NOC	Normalized to Organic Carbon
NSE	No Standard Established
NSP	Northern States Power
ORNL	Oak Ridge National Lab
PAH	Polycyclic (or Polynuclear) Aromatic Hydrocarbons
PAL	Preventative Action Limit for Groundwater
PEC	Probable Effects Concentration
PEC-Q	PEC Quotient
PP	*Pimephales promelas*
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goal
Q	Quotient
RW	Reference Wood Sediment Sampling Station
RS	Reference Sand Sediment Sampling Station
SEH	Short Elliott Hendrickson Inc.
SEL	Severe Effects Level
SQAL	Sediment Quality Advisory Level
SQG	Sediment Quality Guideline
SQRT	Sediment Quality Remediation Target
SVOC	Semi Volatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TEC	Threshold Effects Concentration
TOC	Total Organic Carbon
TOSC	Technical Outreach Community Service
TPAH	Total Polynuclear Aromatic Hydrocarbons
TSP	Trisodium Phosphate
TU	Toxic Units
µg/kg	microgram / kilogram
µg/l	microgram / liter
URS	URS Corporation (formerly Dames & Moore)
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VOC	Volatile Organic Compound
WDNR	Wisconsin Department of Natural Resources
WWTP	Wastewater Treatment Plant
Xcel	Xcel Energy (formerly NSP)

List of Abbreviations

Abbreviations used in Ecological Risk Assessment Supplemental

AET	Apparent Effects Threshold
BCF	Bioconcentration Factor
BETX	Benzene, Ethylbenzene, Toluene, Xylene
CBSQG	Consensus Based Sediment Quality Guidelines
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
CT	*Chironomus tentans*
CW	Contaminated Wood Sediment Sampling Station
CS	Contaminated Sand Sediment Sampling Station
D&M	Dames & Moore
DHFS	Department of Health and Family Services - State of Wisconsin
DO	Dissolved Oxygen
DW	Dry Weight
EqP	Equilibrium Partitioning
EPA	Environmental Protection Agency (USEPA)
ERA	Ecological Risk Assessment
ERL	Effects Range Low
ERM	Effects Range Median
ES	Enforcement Standard for Groundwater
ESG	Equilibrium Partitioning Sediment Quality Guidelines
$\Sigma ESGTU_{FCV13}$	Sum of ESG Toxic Units for 13 PAHs * 11.5
FQAV	Freshwater Quality Advisory Levels
FS	Feasibility Study for Remedial Action Options
gpm	gallons per minute
HA	*Hyallela azteca*
HA-28	*Hyallela azteca* 28 day Toxicity Test
HAH	Heterocyclic Aromatic Hydrocarbon
HPAH	High Weight Polynuclear Aromatic Hydrocarbons
LEL	Low Effects Level
LOAEC	Lowest Observed Adverse Effects Concentration
LPAH	Low Weight Polynuclear Aromatic Hydrocarbons
LV	*Lumbriculus variegatus*
LSRI	Lake Superior Research Institute
MacD	MacDonald
mg/kg	milligram / kilogram
mg/l	milligram / liter
MFO	mixed function oxidase
MGP	Manufactured Gas Plant
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAPL	Non Aqueous Phase Liquid

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Ecological Risk Assessment Supplement

Ashland/NSP Lakefront Site

Prepared for Wisconsin Department of Natural Resources

1.0 Introduction

Short Elliott Hendrickson Inc. (SEH) was contracted by the Wisconsin Department of Natural Resources (WDNR) to perform supplemental ecological risk assessment (ERA) activities associated with contaminated sediments at the Ashland/NSP Lakefront Site (site).

This document was prepared in accordance with our Proposal to the WDNR (SEH, February 2001) and WDNR Agreement No. 9AME0000026, dated March 13, 2001.

The information presented is organized in general accordance with guidelines provided in the United States Environmental Protection Agency (USEPA) document, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final* (USEPA, 1997a).

1.1 Purpose

In October 1998 the "Ashland Lakefront Property – Contaminated Sediments Ecological Risk Assessment" (SEH, 1998c) concluded that the probability of high risks to aquatic resources exists in the offshore sediments. As described in a later section, the ERA was subject to critical review and comment by several interested parties.

The WDNR and the USEPA determined that supplemental ERA information was required to:

- further validate and support conclusions regarding the ecological impacts from contaminants of concern in the sediment portion of the site, and
- aid in determining clean-up goals for these sediments.

This report documents the activities and results of the supplemental ERA performed in 2001. Furthermore, this report updates the conclusions and recommendations of the 1998 ERA report to reflect the expanded site-specific knowledge as well as recent literature regarding ecological risk associated with coal tar and PAH contaminated sediments.

1.2 Scope of Work

The five basic components of the ERA including screening level risk analysis, problem formulation, study design, analysis, and risk characterization were defined and detailed in the "Ecological Risk Assessment" (SEH, 1998c). This supplement to the ERA continues to follow the ERA basic components and guidelines and focuses on the following scope of work in order to fulfill the purpose stated above.

- Review of several project documents from 1998 to 2001 related to the ERA;
- Review of current technical guidance documents related to ERA of freshwater sediment;
- Review of literature to identify potential impacts of heterocyclic aromatic hydrocarbons (HAHs) and phenolic compounds in sediments;
- Sediment sampling from six locations in the bioactive zone at the site;
- Dilution of selected sediment samples for use in bioassay toxicity tests to establish a range of contaminant concentrations for use in test exposures;
- Chemical analysis of the sediments and dilution mixtures;
- Bioassay Toxicity Tests on the sediments and dilution mixtures;
- Preparation of this summary report; and
- Presentation of the results at a future informational meeting.

2.0 Background Information

2.1 Site Location and Description

The Ashland Lakefront Property is located on Chequamegon Bay of Lake Superior, in Section 33, Township 48 North, Range 4 West in Ashland County, Wisconsin as shown in Figure 1, "Site Location." The latitude and longitude of the property is 46 35'41" North and 90 53'01" West. As shown on Figure 2, "Site Vicinity" the site is located in an active community surrounded by residences, schools, hotels, and public recreation areas.

The property currently consists of a city park (Kreher Park), comprised predominantly of mowed grass areas. A low brushy area is present on the south side of the property, and the building and structures from a former wastewater treatment plant (WWTP) are located on the north side of the property. A miniature golf course was constructed on the east side of the property in 1998.

A marina jetty extends to the north off the western edge of the property, and two jetties protecting a public boat landing extend to the north off the east edge of the property. These jetties form a somewhat protected embayment directly to the north of the Ashland Lakefront Property.

2.2 Current and Future Land Use Conditions

Area demographic information, provided by the City of Ashland, indicates that the city population has been decreasing over the past 20 to 30 years but has stabilized recently at 8,979 residents (based on January 1997 data). The area west of the lakefront property is mostly commercial with several hotels, the City marina and a power plant. The area south and east of the lakefront property is densely residential. Homes and occupants in the neighborhood are generally older and occupancy turnover is relatively infrequent. Our Lady of the Lake, a preschool through grade 8 school exists less than three blocks to the south of the lakefront property.

At this time, the Ashland Lakefront Property site is zoned CR, Conservancy District. One of the acceptable uses for this designation is as parkland. The area is readily accessed by the public and a majority of the site is mowed and maintained for public usage. An artesian well is located near Prentice Avenue on the eastern boundary of the site. Another artesian well is located near the marina on the western boundary of the site. The artesian wells are available for the public to fill containers for drinking water. The water from the artesian wells originates from the deep (Copper Falls) confined aquifer located beneath the site. There are restriction signs posted at the seep area, the lake and former waste water treatment plant warning against entry or swimming. A fence prevents entrance to the former waste water treatment plant and seep areas. However, no physical barrier exists at the shoreline to prevent swimming, wading, or fishing.

Based on the discussion with the City Engineer in 1998 and the "Ashland Wisconsin Waterfront Development Plan" (Discovery Group Ltd, undated), the City has future plans to expand the RV park which is immediately adjacent to the Ashland Lakefront Property to the east. Kreher Beach exists east of the former WWTP and boat landing and north of the RV park. Life guards are posted at Kreher Beach for seasonal swimming. The City of Ashland marina immediately west of the Ashland Lakefront Property, the RV park, Kreher Beach and boat

landing are heavily used during the summer months. Based on discussion with the City Engineer in 1998, the City has been opposed to commercial or residential development of the property.

Chequamegon Bay is an important recreational resource in the northern Wisconsin region. The bay receives significant usage from pleasure boaters, fishermen, swimmers, snowmobilers, and outdoorsmen.

2.3 Site History

The Ashland Lakefront Property was created in the late 1800's and early 1900's by placement of various fill materials into Chequamegon Bay which extended the former shoreline approximately 400 feet to the north. From the late 1800's until 1936 the site was owned by various lumber companies, including Barber Mill, W. R. Sutherland Mill, Pope Lumber, and John Schroeder Lumber. Lumber processing operations on the site had ceased, for the most part, by 1930. A number of individuals interviewed recall creosote wood treatment operations historically occurring in the vicinity of the site. However, no physical evidence of wood treatment facilities (e.g., historical maps, evidence of pits or tanks), has been identified on the site to-date. Ashland County assumed ownership of the site in 1936, and the City of Ashland has since acquired the site property.

A manufactured gas plant (MGP) was previously located on the Northern States Power (NSP, now Xcel Energy) property on the bluff to the south of the site. The MGP plant operations began sometime prior to 1886 and ended in approximately 1947. NSP acquired the property from LSDP in 1982. Structures historically located on the MGP site included gas holders, aboveground and underground naphtha tanks, oil tanks, gasol storage tanks, and purifiers. Secondary by-product materials were typically generated from MGPs (i.e., coal tar, polynuclear aromatic hydrocarbons (PAHs), pitch, light oils, volatile organic compounds (VOCs), and coal gas purifier wastes). Records are incomplete pertaining to the volumes and the disposition of the secondary by-product materials.

Prior to being filled in sometime between 1901 and 1923, a ravine historically ran from the MGP property, through the bluff, to the site. The ravine was a natural erosional feature which historically discharged surface water from the upper bluff area to Chequamegon Bay. Based on historical maps of the vicinity, the ravine was located east of North 3rd Avenue. The approximate location of the former ravine is depicted on Figure 2.

A 2" tar pipe was identified on an historic (1951) set of site drawings running from the former MGP property toward the Ashland Lakefront Property. The 2" pipe aligns with a historic "Waste Tar Dump" depicted at the Ashland Lakefront Property on the same set of site drawings. Additionally, a former open sewer ran across the western side of the park from 1901 until some time after 1951.

As documented in the "Investigation, Interim Remedial Action Options, and Design Report" (SEH, October 2001) for the Ashland NSP MGP Seep Area, a 12" diameter clay pipe provided a hydraulic connection between the upper bluff area to the seep area in Kreher Park. According to the "Environmental Forensic Investigation of Subsurface Pipes Containing Tar Residues Near a Former MGP in Ashland, WI – Final Report" (Battelle, 2002) the contamination identified in the vicinity of the former MGP on the upper bluff is consistent with the contamination down gradient from the pipes in Kreher Park.

The WWTP for the City of Ashland was constructed on the site in 1951 and expanded in 1973. The WWTP has not been operated for several years. A clay core wall was constructed along the north and west boundaries of the WWTP to prevent lake water from infiltrating the facility. Based on borings performed by SEH, the clay core wall appears to be separated from the underlying Miller Creek soils by a layer of sand located 12 to 13 feet below ground surface (SEH boring TW-11). This sand layer may act as a hydraulically conductive conduit between the Ashland Lakefront Property and Chequamegon Bay at this location.

Historically, Chequamegon Bay has been utilized as an important commercial transportation route since the 1800's. Products and materials shipped to and from the Ashland area on Chequamegon Bay included iron ore, coal, pulpwood, and saw logs. In addition, logs were floated in to the Ashland area on Chequamegon Bay in the late 1800's and early 1900's for processing. A dredged shipping channel has been maintained in the bay since the late 1800's. The volume of commercial shipping on the bay has greatly decreased since the Upper Peninsula iron mining industry and northern Wisconsin lumbering industries have diminished.

A commercial dock formerly extended into Chequamegon Bay from the west end of the Ashland Lakefront Property. This dock was used for bringing wood materials to the lumber mills that were formerly located on the property. A log boom also historically extended into the bay from the north end of the property. The log boom was used to extract the floating logs from the bay for processing at the lumber mills.

2.4 Previous Studies and Reports

Contamination was identified on the Ashland Lakefront Property during an 1989 environmental assessment of the former WWTP. Since then, several investigations have been conducted to determine the extent of contamination in the vicinity of the site. Extensive contamination has been identified at the Ashland Lakefront Property, in the adjacent sediments, and up gradient in the ravine and in the vicinity of the former MGP. Contamination of the deep confined Copper Falls aquifer has also been identified beneath the former MGP.

The following reports prepared previously by SEH (for the WDNR) and Northern Environmental Technology (NET) summarize the investigative activities at and around the site, as well as evaluations of potential risks and remedial actions:

- Environmental Assessment Report - City of Ashland WWTP Site (NET, August 1989)
- Report of Test Pits at the Ashland WWTP (NET, September 1991)
- Remedial Investigation Interim Report - Ashland Lakefront Property (SEH, July 1994)
- Existing Conditions Report - Ashland Lakefront Property (SEH, February 1995)
- Draft Remediation Actions Options Feasibility Study - Ashland Lakefront Property (SEH, February 1996)
- Sediment Investigation Report - Ashland Lakefront Property (SEH, July 1996)
- Comprehensive Environmental Investigation Report - Ashland Lakefront Property (SEH, May 1997)
- Supplemental Investigation Report - Ashland Lakefront Property (SEH, March 1998)
- Baseline Human Health Risk Assessment - Ashland Lakefront Property (SEH, June 1998)
- Ecological Risk Assessment - Ashland Lakefront Property Contaminated Sediments (SEH, October 1998)
- Remedial Action Options Feasibility Study - Ashland Lakefront Property & Contaminated Sediments (SEH, December 1998)

Additionally, the following reports were produced by Dames & Moore Inc. (D&M, now URS Corporation) for NSP (now Xcel Energy):

- Final Report - Ashland Lakefront/NSP Project (D&M, March 1995)

- Draft Site Investigation Report and Remedial Action Plan for NSP (D&M, June 1995)
- Supplemental Groundwater Investigation Final Report for NSP (D&M, August 1996)
- Copper Falls Aquifer Groundwater Investigation for NSP (D&M, February, 1997)
- Remedial Action Plan - Lower Copper Falls Formation Aquifer for NSP (D&M, April 1998)
- Ecological Risk Assessment (Final Draft) (D&M, March 1999)

In 2001, the Technical Outreach Community Service (TOSC) produced the following independent report at the request of the Ashland/Bayfield County League of Voters and the Lake Superior Alliance:

- Review of Short Elliott Hendrickson, Inc. and Dames & Moore Ecological Risk Assessments of Contaminated Offshore Sediments in Ashland, Wisconsin (TOSC, May 2001).

The TOSC report stated that "it is the opinion of TOSC that the D&M assessment contained errors in calculations in the risk analysis that render its risk characterization invalid, and therefore the D&M conclusions concerning PAH impacts on aquatic organisms cannot be considered accurate. No major flaws were found with the SEH analysis."

Additional reports produced in the past year (2001/2002) in regards to this site include:

- Final Report Sediment Sample Results - NSP/Ashland Lakefront (URS, June 2001), prepared by URS (former D&M) for Xcel (former NSP).
- Investigation, Interim Remedial Action Options, and Design Report – Ashland NSP MGP Seep Area (SEH, October 2001), prepared by SEH for WDNR.
- Final Report - Environmental Forensic Investigation of Subsurface Pipes Containing Tar Residues Near a Former MGP in Ashland, WI (Battelle, January 2002), prepared by Battelle Memorial Institute for WDNR.

2.5 Physical Characteristics

2.5.1 Topography

The Ashland area is located in the Lake Superior Lowland physiographic province characterized by flat to undulating topography underlain by red glacial clay. Uplands lie to the south of Ashland and are characterized by rolling hilly topography and underlain by sand and gravel soils. Elevations in the Ashland area range from 601 feet MSL datum to approximately 700 feet MSL. Regional slope is generally to the north.

The Ashland Lakefront Property is a relatively flat terrace located below a 30 foot high lake bluff. Elevations of the terrace range from 601 MSL to approximately 610 MSL. The elevation of the upper bluff in the vicinity of the former ravine area is approximately 640 feet MSL.

2.5.2 Surface Water

The Ashland Lakefront Property is located on the shore of Chequamegon Bay. Regional surface water drainage flows to the north through Fish Creek and several small unnamed creeks and swales into Chequamegon Bay. Surface water at the site and in the upper bluff area flows either to the City of Ashland storm sewer system, or discharges directly to Chequamegon Bay.

The elevation of the lake bottom ranges between 600 MSL and 591 MSL in the area of contaminated sediments. The surface water elevation in Chequamegon Bay has fluctuated between 601 and 603 MSL over time. Historical water levels on Lake Superior and the other Great Lakes are currently at a historical low and it is possible the surface water elevation is less than 601; however a surface water elevation was not measured during this study.

The water depth over the MGP-contaminated sediment ranges from 0 to 12 feet, and averages approximately 6 feet. Waves up to five feet have been observed when winds are from the north off the open lake, and may be greater during storm events. Wave action and energy transferred to the contaminated bottom may result in disturbance, resuspension, and dispersion of contaminated sediments, non aqueous phase liquids (NAPLs), and pore water.

2.5.3 Geology

Soils in the Ashland area generally consist of surficial deposits underlain by red clay and silt deposits of the Miller Creek Formation. Thickness of the Miller Creek soils in the Ashland area ranges from approximately 15 to 50 feet based on local well logs. Miller Creek soils are underlain by interbedded glacial clays, sands and gravels of

the Copper Falls Formation. Thickness of the Copper Falls Formation is at least 130 feet based on local well logs.

Precambrian aged sandstone of the Oronto Group is likely the uppermost bedrock unit in the Ashland area. Thickness of the sandstone unit has not been determined. The Oronto sandstones are most likely underlain by Precambrian basalt.

Surficial soils at the Ashland Lakefront Property are underlain by a variety of fill materials, including wood waste (slabs and sawdust), solid waste (including concrete, bricks, bottles, glass, steel pieces, wire, and cinders), and earthen fill (including a buried clay berm along the shoreline on the northeast side of the site). Fill materials are underlain in places by a 0 to 5.5 foot thick layer of beach sand. Soils of the Miller Creek Formation are present below the fill and beach sand. The Miller Creek soils encountered at the Ashland Lakefront Property consist of clays and silts and range in thickness from 7 to 40 feet. Silty sand and gravel soils of the Copper Falls Formation are present beneath the Miller Creek soils. Thickness of the Copper Falls Formation at the site has not been determined. Bedrock has not been encountered to-date during investigation of the site.

Geology of the upper bluff area in the vicinity of the former ravine consists of earthen fill materials in the former ravine, with clay soils of the Miller Creek Formation on the flanks of the former ravine. Miller Creek clay soils are present at the base of the former ravine, however, the thickness of these soils has been measured at as little as four feet at one soil boring location. It is unknown whether the Miller Creek Formation exists along the entire base of the former ravine. Sand and gravel layers interbedded with silty clay lenses were encountered below the Miller Creek Formation.

Offshore geology adjacent to the site consists of a discontinuous layer of submerged wood chips on the lake bottom underlain by fine to medium grained sand sediments. The layer of wood chips ranges from 0 to seven feet in thickness, with an average thickness of approximately 9 inches. Some larger wood slabs and pieces have been observed at some locations. Some areas largely devoid of wood chips have also been observed in this area. The sand sediments are underlain by silts and clays of the Miller Creek Formation. The Copper Falls Formation was not encountered during investigation of offshore sediments.

2.5.4 Hydrogeology

A shallow saturated zone is typically found above the contact of the Miller Creek Formation and the overlying surficial soils. Thickness of this shallow saturated zone can locally be up to ten feet, but it is not commonly used as a water supply source. Three aquifers occur in the

Lake Superior Basin in the vicinity of Ashland; the Pleistocene sand and gravel aquifer (referred to herein as the Copper Falls aquifer), the Precambrian sandstone aquifer, and the Precambrian basalt aquifer.

The Copper Falls aquifer occurs at approximately 25 to 55 feet below ground surface in the Ashland area. Sandy till units within the aquifer yield low volumes of water (5 to 10 gpm), while sand and gravel lenses can yield up to 100 gpm. The Copper Falls aquifer is confined by the overlying cohesive Miller Creek soils. The Miller Creek Formation functions as an aquitard or confining unit hydraulically separating the shallow saturated zones and the Copper Falls aquifer. Wells screened in the Copper Falls aquifer frequently exhibit artesian conditions in the Ashland area, particularly close to the Chequamegon Bay shoreline. Static heads of more than 30 feet above the surface of Lake Superior have been reported at some locations along the Ashland shoreline. Thickness of the Copper Falls aquifer is over 100 feet based on deep piezometer boring information from site investigation.

The Precambrian sandstone aquifer is utilized as a municipal water supply source in several nearby communities (e.g., Washburn, Bayfield). Moderate to low permeabilities exist within the sandstone aquifer. Sandstone wells in the Ashland area typically yield between 5 and 50 gpm.

The Precambrian basalt aquifer produces moderate to low yields of groundwater. Yields are typically controlled by fracture densities within the bedrock. The basalt aquifer is commonly used as a water supply source south of Ashland where the aquifer occurs closer to the surface.

A shallow saturated zone is present within the soils and fill materials overlying the Miller Creek Formation at the Ashland Lakefront Property. The hydraulic conductivity of the shallow soils and fill materials ranges from approximately 0.1 to 5×10^{-5} cm/sec. The higher hydraulic conductivity values are typically found in locations with saturated wood waste fill. The horizontal hydraulic gradient is very flat (0.001 ft/ft to the north) due to the high hydraulic conductivities in the shallow soils at the Ashland Lakefront Property. Artesian conditions are present at the site in the Copper Falls aquifer. Head levels of approximately 17 feet above ground surface have historically been measured in an artesian well located on the Ashland Lakefront Property, indicating a strong upward gradient at this location.

Hydrogeology of the upper bluff includes low permeability conditions (3×10^{-6} to 4×10^{-8} cm/sec) in the Miller Creek clays comprising most of the shallow saturated soil in the area. Fill soils located in the former ravine exhibit hydraulic conductivities approximately 1,000 times higher than the surrounding Miller Creek soils. Horizontal hydraulic

gradient in the fill soils of the former ravine is approximately 0.09 ft/ft. Direction of groundwater flow in this location is to the north (toward the mouth of the former ravine).

Groundwater flows onto the ground surface at the base of the bluff in the proximity of the mouth of the former ravine in the form of a seep. Investigation of the seep area has revealed a significant mound of the groundwater table at this location. Water appears to move radially away from the seep in all directions. Consequently, it does not appear likely that unconfined water could be moving through shallow soils from the upper bluff area to provide the surface discharge which is ongoing at the seep. Based upon review of available data, it appears that water transmission via a pipe (or pipes) is the most plausible explanation for the occurrence of groundwater mounding in the vicinity of the seep.

Artesian conditions have not been identified in the Copper Falls aquifer in the vicinity of the former ravine area or the upper bluff area. An upward hydraulic gradient is present in the Copper Falls aquifer in the northern portion of the upper bluff area, and diminishes and eventually changes to a downward gradient to the south. The general direction of flow in the Copper Falls aquifer is to the north (toward Chequamegon Bay).

2.6 Nature and Extent of Contamination

Soil, groundwater, and sediment sample analysis has historically been utilized to define the degree and extent of subsurface contamination. In addition, observations of the presence or absence of non-aqueous phase liquids (NAPLs) have been made by SEH in several monitoring wells and piezometers. Detailed discussion of the analytical results for the site are presented in the previously listed reports. This section briefly discusses those results and also includes the results of TCLP sampling conducted at the site in 1998.

2.6.1 Soils

Soils at the Ashland Lakefront Property and in the former ravine area have been impacted by a variety of contaminants, including volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), and metals. The VOCs detected are predominantly comprised of benzene, ethylbenzene, toluene, and xylene (BETX) compounds and naphthalene. PAH compounds detected include most of the compounds analyzed on the EPA SW 846 8260 scan. Lead and arsenic were detected in some soil samples at elevated concentrations relative to background. Numerous exceedances of existing and proposed ch. NR 720 soil cleanup standards for VOCs and PAHs were noted.

Widespread VOC contamination has been identified in the shallow soils at the Ashland Lakefront Property and in the former ravine area. The VOCs consist predominantly of the BETX compounds as well as naphthalene. However, since naphthalene is also included as a parameter in the PAH range, naphthalene contamination will be discussed only in the PAH subsections to avoid redundancy. In addition, several areas of apparent grossly contaminated soils (e.g., "coal tar saturated soils" in Dames and Moore borings B-19 and B-20) which were not analyzed for total concentrations of VOCs (TCLP analysis was performed) were identified during investigation of the former ravine area. No TCLP exceedances for VOCs were identified in the soils analyzed from the former ravine area.

SEH collected a sample from the seep and a composite sample from the park for TCLP analysis for benzene. No TCLP exceedance was identified for either sample.

A wide range of PAH soil contaminants have been identified in shallow soil samples analyzed from the Ashland Lakefront Property and the former ravine area. PAH soil contamination generally begins near the shallow groundwater surface, and extends to the top of the Miller Creek Formation. The horizontal extent of shallow PAH impacted soils includes the soils in the former ravine area, and soils on the Ashland Lakefront Property extending north to the shoreline of Chequamegon Bay.

Metals contamination identified in the vicinity of the Ashland Lakefront Property includes scattered, potentially isolated areas of elevated lead concentrations. In addition, one soil sample analyzed from the site contained elevated concentrations of arsenic. These concentrations appear to be elevated above the natural levels of metals in the soils of Wisconsin. The scattered areas of metals contamination appear to be most prevalent along the northern portion of the Ashland Lakefront Property. One soil sample collected from the former ravine area contained concentrations of TCLP lead exceeding the TCLP standard for lead. TCLP samples collected by SEH in the park did not exceed the TCLP standards for lead or arsenic.

2.6.2 Groundwater

Groundwater at the Ashland Lakefront Property, in the former ravine area, and in the Copper Falls aquifer have been impacted by a variety of contaminants. A variety of VOCs (predominantly BETX compounds and naphthalene), PAHs, and metals (lead, iron, and manganese) were detected in groundwater samples collected during the investigation. Numerous exceedances of ch. NR 140 groundwater standards have been identified.

It is apparent that the distribution and concentration of groundwater contaminants is influenced by the presence of NAPL in the subsurface. A detailed discussion of NAPL contamination is presented in Section 2.6.3 of this report.

The groundwater analysis performed during investigation of the Ashland Lakefront Property and vicinity indicates the presence of widespread VOC groundwater contamination. Exceedances of ch. NR 140 Enforcement Standards (ES) for BETX have been identified at widespread locations in the vicinity. The VOCs most commonly detected in the shallow groundwater at the Ashland Lakefront Property include benzene, ethylbenzene, and xylene.

A wide range of PAH contaminants has been identified during the groundwater investigations of the vicinity. Exceedances of ch. NR 140 ESs for naphthalene and benzo(a)pyrene have been identified at widespread locations of the investigated area. Generally, the most prevalent PAH compound in the areas of impacted groundwater at the Ashland Lakefront Property, the former ravine area, and in the Copper Falls aquifer is naphthalene.

Several dissolved metals were detected at widespread locations during the groundwater investigations. Numerous ch. NR 140 ES exceedances were identified for iron. In addition, ch. NR 140 Preventive Action Limit (PAL) exceedances were identified in one or more groundwater samples for arsenic, cadmium, and lead. The distribution of dissolved metals in groundwater appears to be scattered, and does not appear to correlate with the distribution of groundwater VOC and PAH contaminants.

2.6.3 Non-Aqueous Phase Liquids

Significant quantities of NAPL were detected in piezometers MW-13A, MW-13B, and in monitoring wells TW-9 and MW-7. Piezometers MW-13A and MW-13B are located in the upper bluff area on St. Claire Street and are screened in the Copper Falls aquifer. Monitoring wells TW-9 and MW-7 are located at the base of the bluff on the Ashland Lakefront Property and are screened in the shallow saturated zone.

The results of SEH's NAPL evaluation clearly indicate the presence of significant quantities of NAPL in the subsurface of the upper bluff area and the Ashland Lakefront Property. Data collected during previous investigations, observations of test pits excavated at the Ashland Lakefront Property, and observations of sediment samples indicate the potential presence of NAPL across lake front property and offshore sediments.

The apparent low viscosity of the NAPL and emulsified NAPL observed in the monitoring wells and piezometers indicates the potential for significant mobility of NAPLs within the subsurface.

2.6.4 Sediments

Offshore sediments located immediately adjacent to the Ashland Lakefront Property have been impacted by PAH compounds and by VOCs (predominantly BETX compounds).

The concentrations of sediment contaminants identified adjacent to the Ashland Lakefront Property were compared to the Province of Ontario and NOAA guidelines for several PAHs and metals. Exceedances of Ontario and/or NOAA guidelines for one or more PAH compound were measured in sediment samples collected as far as 700 feet offshore. Exceedances of Ontario or NOAA guidelines were generally not identified for metals. Details regarding the exceedances of these guidelines is presented in the Sediment Investigation Report (SEH, 1996). The extent of sediment contamination is depicted on Figure 3, "1996 Extent of VOC and PAH Sediment Contamination". Downward movement of offshore contamination is limited by the Miller Creek Formation soils.

Generally, the extent of offshore VOC contamination is contiguous with the north shoreline of the Ashland Lakefront Property, forming three undulating lobes that extend up to 700 feet offshore. VOCs were generally not detected in offshore samples collected east of the Kreher Park boat landing or west of Ellis Avenue.

A composite sediment sample and a hotspot sediment sample (2400N, 1400E) were collected from for TCLP analysis for benzene. No TCLP exceedances for benzene were identified in these samples.

A wide range of PAH contaminants were identified in the offshore sediment and soil samples analyzed from adjacent to the Ashland Lakefront Property. The horizontal extent of offshore PAH impacts is approximately the same as that indicated for offshore VOC contamination. Downward movement of offshore PAH contaminants is limited by the Miller Creek Formation soils.

Offshore sediment and soil samples were analyzed for a variety of metals and select parameters, including arsenic, cadmium, chromium, copper, lead, nickel, zinc, and cyanide. The concentrations of metals analyzed were generally below background concentrations identified during previous investigations of pre-colonial Great Lakes sediments. No significant offshore metals contamination has been identified adjacent to the Ashland Lakefront Property.

During the 2001 sediment sampling activities documented in this report, sediment samples were also analyzed for phenolic compounds and HAHs. Several of these compounds were detected in the sediments as described later in this report.

2.7 Fate and Transport

A detailed evaluation of fate and transport processes is provided in the Comprehensive Investigation (SEH, May 1997). This section presents a brief summary. Based on the results of the investigations performed to-date, it is apparent that widespread contamination exists in the project area. The media affected by the contamination includes soil, sediment, surface water, and groundwater. Contaminant releases to air near the site have not been measured to-date, but are likely occurring to a limited extent under existing conditions. Volatile compounds are likely migrating in the vadose zone and venting to the atmosphere. Limited volatilization may also occur from impacted surface water (i.e., Chequamegon Bay and the seep).

VOC and PAH contaminants are found in the ravine fill, shallow groundwater, and the deeper Copper Falls aquifer in the dissolved phase, as an emulsion, and as immiscible liquids (NAPL). The NAPL measured in the Copper Falls aquifer may have migrated vertically downward through natural or man-made breaches in the clay aquitard (Miller Creek Formation) in the vicinity of the former ravine area. NAPL migration in the ravine fill likely occurred via manmade conduits and/or along the base of the former ravine area under the influence of gravity. The apparent low viscosity of the NAPL observed in the piezometers screened in the Copper Falls aquifer and monitoring wells screened in the shallow saturated zone indicates the potential for significant mobility within the subsurface.

Significant VOC and PAH concentrations are present in the dissolved phase in the shallow groundwater as well as in the Copper Falls aquifer. The soluble contaminants in the NAPL in the deep aquifer will dissolve in groundwater. The dissolved phase contaminants will continue to migrate by advection in groundwater toward the north.

The presence of NAPL in the shallow unconfined aquifer and ravine fill provide a continuous source of contaminants to groundwater. Dissolved phase contaminants migrate in the ravine fill and shallow unconfined aquifer by advection in groundwater. However, the degree of advective flow in the fill materials below the Ashland Lakefront Property is unknown. Water elevations measured in monitoring wells screened in the fill indicate a very low hydraulic gradient across the site due in part to the open or porous nature of the fill material. It is possible that movement of water within the fill is partially affected by water level fluctuations and water movement in the bay.

The presence of NAPL was also detected at the base of the shallow aquifer in areas below the Ashland Lakefront Property. In addition, an emulsion consisting of hydrocarbon droplets dispersed in water was detected in several of the wells and test pits at the Ashland Lakefront Property. Constituents in the NAPL and emulsion will continue to dissolve and contaminate the groundwater below this site.

The extent of VOC and PAH contaminated sediment in Chequamegon Bay appears to be confined to the nearshore (within 700 feet) environment north of the Ashland Lakefront Property. The mapped horizontal extent of PAH and VOC contaminated sediment roughly follows the configuration of the north shoreline of the Ashland Lakefront Property. Visual observation sampling and analysis of sediment to the west of the Ashland Lakefront Property and beyond 700 feet north of the north shoreline did not indicate the presence of PAH and VOC contaminated sediment. The mapped distribution of contaminated sediment in the bay is possibly due to periodic resuspension of the sediment caused by bioturbation, wave action, seiche effect, and the lateral transport of contaminants and sediment by longshore or littoral currents.

The physical-chemical characteristics of the constituents of interest detected during the sediment study suggest that concentrations of contaminants in sediments would be higher than the concentrations in the overlying water column. The high specific gravity, low solubility, and affinity for adsorption to sediment will tend to concentrate these contaminants in the sediment. Low molecular weight PAHs are more soluble and will be found in greater concentrations in the water column than high molecular weight PAHs. The PAH and VOC contaminated sediment is concentrated at the wood debris/sediment-water interface and concentrations generally decrease with depth. The presence of contaminated sediment and NAPLs across the surface of the lake bed is consistent with the physical-chemical characteristics of the contaminants. The distribution pattern of contaminants in the bay, and the minimal sedimentation above the wood or NAPL contaminated sediment, is consistent with periodic resuspension and redeposition physical processes likely occurring in the bay.

The areal extent of shallow subsurface contamination identified to-date at the Ashland Lakefront Property includes approximately ten impacted acres on the Kreher Park property, one impacted acre up gradient from the site in the former ravine area, and ten acres of impacted offshore sediments. Contamination has also been identified in the Copper Falls aquifer, however, the extent of contamination in this aquifer may require further delineation.

The organic chemistry of contaminants located in the Copper Falls aquifer, former ravine area, Ashland Lakefront Property, and offshore sediments is similar in that the contaminants consist a naphthalene-rich liquid containing a wide spectrum of PAH and VOC compounds. The variations in concentration and distribution of individual PAHs or VOCs are possibly attributable to different waste sources (e.g., MGP wastes vs. wood treatment wastes), historic changes in production processes or waste disposal practices (e.g., MGP switching from coal carbonization to carbureted water gas process), or geochemical or biodegradation processes. In addition, the presence or absence of NAPL along with the well sampling and analytical techniques used likely accounts for some of the temporal and spatial variability observed in groundwater concentration data.

The sources of shallow contamination and offshore contamination in the vicinity of the property have not been definitively identified to-date. The source of shallow contamination (except metals) in the former ravine area appears to be operations of the former MGP. It also appears that contaminated groundwater is migrating onto the Ashland Lakefront Property in the vicinity of the seep near the mouth of the former ravine area. It appears most likely that these contaminants are from MGP wastes historically placed in the ravine.

A potential additional source of contamination on the Ashland Lakefront Property is the material comprising the "Coal Tar Dump" depicted on a 1953 site drawing prepared by Greeley and Hanson. Whether the material located in this area is in fact coal tar, wood treatment residuals, or some combination of these wastes has not been determined. The potential also exists that wood treatment may have historically occurred at other locations on the Ashland Lakefront Property. However, conclusive evidence of this has not been found to-date.

The sediment contamination appears to be chemically and physically similar to the contaminants at the Ashland Lakefront Property and in the former ravine area. The source(s) of offshore organic contaminants are almost certainly one or more of the same source(s) as identified at the Ashland Lakefront Property. The mode of contaminant transport to the sediments was likely through subsurface seeps, historic discharge directly to the lake via pipes, historic surface water runoff, or possible discharge of contaminants from one or more of the aforementioned source areas through the historic open sewer. The offshore distribution of sediment contamination may be caused by various physical forces including; offshore and littoral currents, longshore drift, and NAPL dispersion coupled with sediment resuspension and settlement during periods of high wind and wave energy.

3.0 Site Model

The conceptual site model for the offshore contaminated sediments and surface water was initially constructed as part of the 1998 ERA Screening Level Problem Formulation (SEH, 1998a). The model was updated to reflect additional data collected for the sediment bioactive zone (0-6"), and results of the baseline ERA problem formulation in the 1998 ERA (SEH, 1998c).

3.1 Environmental Setting and Contaminants at the Site

3.1.1 Environmental Setting

As shown on Figure 2, the southern edge of the contaminated sediment area (site) consists of a riprapped shoreline. A marina jetty extends along the western edge of the site and two jetties protecting a public boat landing extend along the east edge of the site. These jetties form a somewhat protected embayment in the contaminated sediment area. The northern boundary of the site is open to Chequamegon Bay and not protected.

The offshore sediments adjacent to the Ashland Lakefront Property generally consist of a surficial layer comprised of wood chips underlain by sand and silty sand sediments. The layer of wood chips ranges from 0 to seven feet in thickness, with an average thickness of approximately 9 inches. Some larger wood slabs and pieces have been observed at some locations. Some areas largely devoid of wood chips have also been observed in this area. Contours depicting the thickness of the wood ships layer are presented on Figure 4, " Off Shore Wood Layer Thickness."

The aquatic habitat at the site is one of relatively shallow water and the immediate project area habitat is generally disturbed. No pristine wetland or littoral habitat is present nearshore due to the urban land use and disturbance.

Nearshore and terrestrial areas surrounding Ashland are relatively undisturbed and provide a variety of forested, wetland and littoral habitats. To the west of Ashland is the mouth of Fish Creek and a very large wetland complex (Maslowski and Prentice City Parks abut this habitat). The Fish Creek backwaters have high value habitat potential for fish spawning. Several other high quality forested creek habitats further west also drain into Chequamegon Bay within two to three miles of the Ashland Lakefront Property. Immediately east of Ashland, WI is the Bad River Indian Reservation. This large tract of land provides significant undisturbed terrestrial and littoral habitat inland and adjacent to Lake Superior, supporting several endangered species. Due to the diversity of habitats surrounding Ashland there is a high potential for use of the Ashland Lakefront area for mobile species

from the pelagic lake zone, such as various fish species as well as various birds and mammals who may forage in the Lakefront habitat.

3.1.2 Contaminants at the Site

Offshore VOC and PAH contamination was delineated in the sediments immediately north of the property during the 1996 sediment investigation (SEH, 1996). As shown on Figure 3, sediment samples were collected from the site at 80 locations during the 1996 investigation using a grid sampling design.

Select samples from each 1996 sampling station were analyzed for VOCs, semi-volatile organic compound PAHs, metals, cyanide, sulfide, and/or total organic carbon. Samples were also collected for geotechnical analysis and for an aerobic bioenumeration assay at select sampling locations. Data from the investigation is provided in Table 1, "1996 Sediment Investigation Chemical Data– Dry Weight"; Table 2, "1996 Sediment Investigation Organic Chemical Data – Normalized to Organic Carbon"; Table 3, "1996 Sediment Investigation Geotechnical Data"; and Table 4, "1996 & 1998 Microbial Enumeration Assay Results.

As shown on Figure 3, the VOC and PAH sediment contaminants were found to be contiguous with the existing shoreline, and extended out up to 700 feet from shore. Approximately 10 acres of sediments were identified as impacted adjacent to the property.

The contaminants of concern identified at the site during the 1996 sediment investigation were VOCs and PAHs. Concentrations of total VOCs ranged from non-detect to 1,756 mg/kg. The primary VOCs detected were the benzene, ethylbenzene, toluene, and xylene (BETX) compounds. The concentrations of total PAHs ranged from non-detect to 3,687 mg/kg. A wide range of PAH compounds were detected, with the most prevalent compound being naphthalene. The remaining parameters (metals and cyanide) analyzed during the 1996 investigation were not identified in concentrations to be of ecological concern, based on screening level comparison to benchmark concentrations.

Sampling of shallow sediments (0-6") conducted in 1998 confirmed the presence of PAHs and VOCs in the biologically active zone. Further sampling in the bioactive zone conducted in 2001 also detected the presence of phenolic compounds and HAHs. Chemical data is included in Table 5, "1998 & 2001 Sediment Bioactive Zone Chemical Data – Dry Weight and Normalized to Organic Carbon." Sampling locations are depicted on Figure 5, "1998 Sediment Bioactive Zone Sampling Locations" and Figure 6, "2001 Sediment Bioactive Zone Sampling Locations."

Vertically, the sediment contaminants generally appeared to be most concentrated at the interface of the wood chips layer (where present) and the underlying granular sediments. A generalized cross-section of offshore sediments is presented on Figure 7, "Typical Contaminated Sediment Profile and Geologic Cross Section." The contamination was generally present in the upper 10 feet of sediments. Concentrations generally decreased with depth, and disappear when the cohesive soils of the underlying Miller Creek formation were encountered.

The source of VOC and PAH contaminants in the near shore sediments is likely one or more of the landside sources that released contaminated materials in the vicinity of the Ashland Lakefront Property. The MGP formerly located to the south of the property has been identified as the source of up gradient and deep aquifer VOC and PAH contamination, as well as at least a portion of the contaminants at the Ashland Lakefront Property and offshore sediments.

One hypothesis is that contaminants may have migrated into offshore sediments via groundwater and/or through discharge from the open sewer formerly located at the site.

3.2 Contaminant Fate and Transport

Migration of contaminants presently in the offshore sediments is most likely an ongoing process. Contaminants may be migrating as dissolved chemicals, sorbed to organics and fine sediments, or in non-aqueous phase liquid (NAPL). Surface sheens observed during sampling activities indicate that fractionation of chemicals from the NAPL occurs when sediments are disturbed. The probable physical transport processes involved in offshore contaminant migration include bioturbation, ice scour, wave action, anthropogenic disturbance, seiche effect, shoreline configuration, and long shore or littoral currents. The interaction of wind, wave action, shoreline configuration, currents, water depth, and sediment properties determine areas of sediment resuspension, transport, and redeposition.

Bioturbation (mixing of sediments and sediment pore water by benthic organisms) is generally less understood than the other processes described, but likely plays a role in release and bioavailability of the sediment contaminants. Karickhoff et al. (1985) and Campbell et al. (1988) found that bioturbation effects are most pronounced in the upper 6 cm (2.5 inches) of sediment and not typically observed below about 20 cm (8 inches). Bioturbating organisms may include amphipods, molluscs, oligochaetes and chironomid larvae that interact with the sediments during their burrowing, feeding, irrigating, respiring, and defecating activities. The burrowing actions tend to loosen the surficial sediments, disrupt horizontal and vertical layering, and increase the potential for resuspension by low velocity currents. Excretion of contaminant laden pellets may also serve to release

suspended contaminants to the overlying water column. The borrow irrigating and pumping activities of Chironomid infaunal tube-dwelling insect larvae may significantly increase the flux of dissolved components across the sediment-water interface (Matisoff and Wang, 1998).

The predominant VOC contaminants identified in the near shore sediments are nonpolar organic molecules consisting of single ring aromatic structures. These molecules are typified by lower molecular weights, higher volatility, higher solubility, more bioavailability, and less hydrophobicity than the PAH contaminants also present in the sediments. Consequently, the VOC molecules exposed to the bioactive zone are much more likely to be removed from this layer of sediment over time due to volatilization, dissolution, and/or biodegradation than are the PAH contaminants. VOC contaminants present in sediments would likely be present in sediment porewater, and would be more easily released to the overlying water column than the PAHs. Even with these characteristics, the relatively high concentrations of the VOCs in the site sediments years after their likely deposition (as part of NAPL coal tars) needs to be noted.

The PAHs identified in the sediments are nonpolar organic molecules consisting of multiple fused aromatic ring structures. These compounds typically have relatively high molecular weights, are relatively insoluble and less bioavailable when compared to VOCs. PAHs are hydrophobic, and readily partition, especially if a source of organic solids is available. The fate and transport of PAHs is thus controlled in part by sediment organic solids.

There is generally a direct correlation between the molecular weight of a PAH and its affinity for binding with organic carbon or other sediment particles. Heavier PAHs (e.g., benzo-a-pyrene) are typically expected to be more tightly bound to solid particles than lighter (e.g., naphthalene) PAH compounds. Lighter PAHs are typically expected to be more mobile and likely to be present in sediment porewater, or to be present in the water column without resuspension of sediment particles occurring. Migration of the heavier PAHs is more likely expected to occur during resuspension, transport, and redeposition of the sediment particles to which the compounds are bound.

3.3 Ecotoxicity and Potential Receptors

PAHs vary substantially in toxicity and bioaccumulation by aquatic organisms. The non-specific mode or mechanism of toxic action of PAHs as neutral narcotizing agents to lower trophic levels in the food web is through toxicity-related impairments that effect the growth, reproduction, and survival of the organism. For those aquatic organisms with mixed function oxidase (MFO) enzyme systems, PAHs can be biotransformed into reactive intermediates that have a

specific mode of toxic action that is different from the non-specific, narcotizing action of the neutral parent PAH compound. A third form of toxic action is associated with certain PAHs that absorb UV light energy from solar radiation that results in photoenhanced toxicity to organisms that have the PAHs within their tissues. The presumed mode of action through which photoactivated toxicity of PAHs occurs in aquatic organisms is transfer of energy to molecular oxygen, thereby resulting in the formation of highly reactive singlet oxygen (Ankley et al. 1994).

Bioaccumulation of PAHs is highly species specific, being higher in algae, molluscs, and other species that are incapable of metabolizing PAHs. Bioconcentration factors (BCFs) tend to increase with increases in the PAH compound's molecular weight, octanol-water partitioning coefficient, and alkyl substitution.

PAHs can be metabolized and transformed by most aquatic organisms except shellfish (Eisler, 1987). In most fish, PAHs are rapidly metabolized, thus concentrations found in tissues are generally low. Invertebrates such as molluscs do not metabolize PAHs as efficiently and can accumulate elevated concentrations of PAHs in tissue. Bioaccumulation of PAHs and inability to metabolize PAHs by benthic invertebrates has been demonstrated in several studies. Many benthic invertebrates are deposit feeders that consume a large amount of silt and microdetritus and their uptake of PAHs could be large. This may constitute a major exposure route for PAHs to fish.

Although the MFO enzyme system effectively detoxifies certain organic compounds, some, such as certain PAH compounds are biotransformed to toxic reactive intermediates (diol-epoxides and phenol oxides), some of which are known to interact covalently with DNA, RNA, and protein. Cytotoxic, mutagenic, and carcinogenic effects of many PAHs are generally believed to be mediated through active epoxides formed by interaction with microsomal monooxygenas activity. These highly active arene oxides can interact with macromolecular tissue components and can be further metabolized or rearranged to phenols or various conjugates. They can also activate epoxide hydrolase to form dihydrodiols, which are precursors of biologically active diol epoxides, a group that has been implicated as an ultimate carcinogen (Eisler, 1987). Some studies have shown that PAH metabolites that are produced by certain invertebrates are poorly excreted and thus these invertebrates, exposed to PAHs, could be dietary sources of potentially bioactive PAH metabolites even when the parent PAHs have been eliminated (James, 1989).

Potential ecological receptors of concern in the nearshore environment adjacent to the Ashland Lakefront Property include following general groups: benthos, fish, zooplankton, phytoplankton, birds, and mammals.

Benthic organisms are of primary concern in the nearshore environment. These organisms dwell directly in sediment where analytical results indicate elevated concentrations of VOCs and PAHs are present. Fish, birds, and mammals that use the impacted sediment area as part of their foraging base, and other organisms within the aquatic food web may be exposed to site contaminants through direct contact with contaminated sediments or water, incidental ingestion of sediments and water, gill contact with water and suspended solids during respiration, or by consumption of contaminated food items.

3.4 Ecosystems Potentially at Risk

The ecosystems potentially at risk include systems associated with the aquatic habitat of Chequamegon Bay, and particularly, that part of the system associated with the near shore environment adjacent to the Ashland Lakefront Property. The biologic components potentially at risk from exposure to site contaminants include, but are not limited to: microbes, micro- and macrobenthic invertebrates indigenous to either the sand sediment substrate or the wood chips substrate, fish species, water column invertebrates, and birds and mammals that utilize the contaminated sediment area as forage area. The habitats potentially at risk would include near shore littoral habitats, and beach or water's edge habitats. The structure and functions of the ecosystems including one or more of these biologic or habitat components could potentially be at risk from impairments or impacts due to the effects of the contaminants in question.

Food web components were investigated for the Ashland Lakefront site and potential reference sites. Species for different trophic levels were itemized. In addition, effects based guidelines and criteria were summarized.

3.4.1 Fish Species

The U.S. Geological Survey's Biological Resources Division (previously part of the U.S. Fish and Wildlife Service) studied the structure and stability of the summer fish communities of Chequamegon Bay collected from 39 stations from 1973 to 1996 (Hoff and Bronte, 1997). Fifty-three taxa were identified during the study, but it was reported that the relative abundance for 16 taxa described most of the variability of the data for all taxa. Abundance data for the 16 species demonstrated that two communities existed in the bay; one inhabited shallow water (<3.0 m) while the other inhabited deeper water (> 3.0 m). No temporal patterns of change in the structure of either community were detected, so the study concluded that both

communities were stable throughout the 24 years of the study. The study results were based on the entire Chequamegon Bay and not small impacted embayments such as that off the Lakefront Property.

The WDNR has compiled a list of fish species present in Ashland Harbor and indicated how each of the listed species utilize the habitats within the harbor (Pratt, 1998). These data are summarized on Table 6, "Indigenous Fish Species, Ashland Harbor."

The USGS study used abundance data from only 16 taxa to analyze community structure in Chequamegon Bay fish communities. The results of the study indicated that seven species were more abundant in the shallow-water stations: smallmouth bass, logperch, mimic shiner, silver redhorse, black bullhead, johnny darter, and spottail shiner. Nine species were more abundant at the deep-water stations: bloater, longnose sucker, stocked lake trout, lake herring, spoonhead sculpin, lake whitefish, stocked splake, round whitefish, and rainbow smelt. No one species was shown to dominate, therefore indicating that community structure would be stable even with the loss of one of the abundant species. Of all these, the black bullhead and longnose sucker are known primarily for bottom feeding and thus are the two most likely to contact sediment contaminants.

3.4.2 Benthic and Zooplankton Community

The waters of Ashland Harbor can be classified as nearshore (less than 30 feet deep). Although the harbor area is open to Lake Superior, the limnology is more comparable to a warm water lake than the pelagic, oligotrophic zone typical of Lake Superior. Thermal stratification occurs. Total phosphorus can double through the summer season, corresponding to seasonal phytoplankton abundance. Organic nitrogen content is high, as is chemical oxygen demand (COD). Dissolved oxygen (DO) in the water column decreases over the summer period.

Benthic surveys (and phytoplankton surveys) conducted in the early 1970's for the harbor dredging area indicate that oligochaetes are relatively prominent in the summer. A sampling of six points for benthic macroinvertebrates was conducted under ice at the Ashland Lakefront site in the winter of 1998. Benthic macroinvertebrate taxonomic groups found included mollusks, crustaceans, chironomids, and oligochaetes.

3.5 Complete Exposure Pathways

Potential complete exposure pathways at the site include direct contact with contaminated sediments and/or pore water by benthic invertebrates, exposure of water column species (e.g., fish, zooplankton) to impacted surface water or sediments, and ingestion of contaminated food items, water, or suspended sediments by various organisms within the ecosystem.

The investigation results from problem formulation indicate that exposure routes relating to contaminated sediments, pore water, and food items can not be ruled out, and warrant further investigation. The exposure routes relating to contaminated surface water were indeterminate based on the problem formulation analytical results. Additional data was required to assess potential periodic mixing events and potential resuspension of contaminated sediments before exposure routes relating to surface water contaminants could be eliminated. The potential exposure routes relating to contaminated surface water were thus retained for further evaluation.

3.6 The Conceptual Model

A flow chart depicting how contaminants of concern can affect the aquatic ecosystem is presented in Figure 8, "Exposure Pathway Model Based on Trophic Levels at the Study Site." Contaminant exposure to detrivores will affect population levels through direct toxicity and the resulting loss or reduction in benthic species as a primary food source for bottom-feeding primary consumers or the uptake of contaminated food by these consumers. Of all the species identified in the Chequamegon Bay fish community, three are bottom-feeders, which would be the most directly affected by the loss or reduction of the food source or uptake of contaminated food. This exposure pathway thus has ramifications for the aquatic food web through changes in stability of the fish community. Direct exposure of contaminated substrates or water associated with these substrates to fish species that have larvae, eggs, and spawn at the site has implications to the health and survival of the fish species involved.

Another exposure pathway would be through effects on zooplankton as an intermediary component of the food chain leading to the highest aquatic trophic level in the Chequamegon Bay fish community. This exposure pathway is significant in that it leads to effects on piscivorous birds and mammals that tend to feed on the dominant gamefish.

3.7 Selection of Assessment Endpoints

Assessment endpoints are expressions of ecological values that are to be protected. These resources include those necessary for ecosystem function, those providing critical resources (e.g., habitat), and those perceived as valuable by humans (e.g., endangered species).

Based on identified potential ecological receptors and the result of the exposure pathways evaluation, the following assessment endpoints were identified during problem formulation.

- Survival and growth of benthic organisms.
- Benthic community health.

- Survival and growth of fish and water column organisms (phytoplankton and zooplankton).
- Survival and growth of piscivorous birds and mammals.

4.0 Screening Level ERA Summary

This section provides a summary of the screening level ERA conducted by SEH in 1998. Further detail regarding the screening level ERA is presented in the "Ashland Lakefront Property – Contaminated Sediments Ecological Risk Assessment" (SEH, 1998b).

The screening level problem formulation conducted in April 1998 was based on limited data collected during the initial sediment investigation (SEH, 1996). Chemical data from the 0 to 4 foot sediment depth interval from the 1996 delineation investigation was compared to screening level ecotoxicity values to assess the potential for adverse ecological effects. Sediment samples from the bioactive zone (0-6 inches) had not yet been collected.

Screening level ecotoxicity values used for comparison included the Ontario Provincial Sediment Quality Guidelines Severe Effect Levels (Ontario SELs) (Persaud, 1992) and the National Oceanic and Atmospheric Administration Guidelines Effects Range Medium (NOAA ERM) concentrations (Long and Morgan, 1991). The principal focus of the Ontario Guidelines is to protect the benthic macroinvertebrate community by setting safe levels for concentrations of metals, organic compounds, and some nutrients in sediments. The Ontario SELs are those chemical concentrations above which a significant negative effect on a large portion of benthic organisms is predicted. The NOAA Guidelines were developed to assess the potential adverse biological effects on a variety of marine and estuarine biota. NOAA ERMs are those chemical concentrations above which adverse effects to benthic organisms always or almost always may be expected.

NOAA ERMs are included on Table 1 and Ontario SELs are included on Table 2 for comparison to the chemical concentration at each sampling location. The Ontario SELs and NOAA ERMs were exceeded for PAHs at several of the 1996 sediment sampling locations. No exceedances were noted for metals. The Ontario and NOAA guidelines did not address VOCs.

Based on the results of the screening level exposure estimate and risk calculation, it appeared likely that ecological risks exist at the site due to impacts from contaminated sediments. The WDNR decided to proceed with a baseline ERA, as summarized in the next section.

Conservative assumptions, benchmarks, and screening level exposure estimates were used during the screening level ecological risk assessment. Additional information on the bioactive zone, contaminant toxicity, complete exposure pathways, and the effects of the wood chip layer were required to more adequately determine ecological risk at the site.

5.0 Baseline ERA Summary

This section provides a brief summary of the Baseline ERA conducted in 1998. Further detail regarding the input, assumptions, and benchmarks of the Baseline ERA can be found in the "Ashland Lakefront Property – Contaminated Sediments Ecological Risk Assessment" (SEH, 1998b).

5.1 Baseline ERA Problem Formulation

Several sets of sediment effects benchmarks were identified in the literature search. As shown on Table 7, "Comparison of Sediment Probable Effects Benchmarks," sediment chemical data was compared to several sets of probable effects levels for both dry weight units and normalized-to-organic-carbon (NOC) units. PAH and VOC benchmarks were exceeded for several chemicals at several locations in the shallow bioactive zone sediments and deeper sediments. Based on this comparison, it was concluded there was a high probability of adverse effects to aquatic life and human health from the contaminated sediments.

The sediment effects concentration benchmarks developed by Ingersoll, et al. (1996) for the USEPA were retained to compare relative toxicity of the PAH mixtures.

Comparison of the site PAH concentrations to data in the literature from other sites indicated that PAHs may be accumulating in resident fish species, especially bottom feeders. Exposure of fish to the mutagenic PAH contaminants may result in fish tumors, impaired health, and ultimately, death.

5.2 Baseline ERA Study Design

The site conceptual model described in Section 3 was constructed for the site. Assessment endpoints for the ERA study included: benthic organisms; pelagic and water column organisms; and piscivorous birds and mammals.

A weight-of-evidence approach was utilized in October 1998 to assess the potential existing and future ecological risks associated with the contaminated sediments to the benthic, aquatic, and terrestrial communities. Weight-of-evidence information was accumulated by several means including:

1. A literature search was conducted to select relevant sediment effects benchmarks for evaluation of site data and identify ecological effects documented at other sites with similar contaminants and exposures;
2. Sediment samples were collected from the bioactive zone (0 to 6"), analyzed, and compared to sediment effects benchmarks for the contaminants identified;
3. A survey was conducted of the benthic community at contaminated and reference locations; and
4. A series of laboratory toxicity tests was conducted to characterize the effects of short term exposure to the contaminated and reference sediments and sediment elutriates. Photoenhancement of PAHs was included as a testing component.

5.3 Baseline ERA Site Investigation

Chemical data for sediment samples collected from the bioactive zone was converted to toxic units to evaluate the cumulative effects of different chemicals in the contaminant mixture existing in the sediments. Specifically, the probable effects values calculated using effects range median values developed from 28 day sediment toxicity tests on *Hyallela azteca* (HA -28 ERM) (Ingersoll et al. 1996) were utilized to represent chemical specific toxic units. Dry weight and NOC toxic units were calculated by dividing the site chemical data by the HA-28 ERMs.

Chemical data, macroinvertebrate community survey results, and toxicity study results were integrated to assess the level of ecological risk associated with varying exposure levels at the site. The results of sediment elutriate dilutions were used to strengthen the exposure response characterization, and extrapolated to evaluate the potential effects across the contaminated sediment area with respect to the larger database of PAH and VOC concentrations.

Additionally, a water column sample collected during a high wind event that created 3-foot high waves on the Lakefront Property embayment exhibited PAH concentrations that exceeded secondary acute and chronic water quality toxicity values. Similarly, water samples collected during a laboratory sediment settling study in 1998 exhibited PAH concentrations that exceeded secondary acute and chronic water quality toxicity values. The concentrations of some of

the PAHs in the water column exceeded the toxicity values 11 days after test initiation. Data is presented in Table 8, "1998 Surface Water Chemical Data" and Table 9, "Contaminant Dispersion/Sediment Settling Study Results."

Sediment concentrations were also compared to sediment concentrations at other impacted sites where fish with tumors had been observed. As shown on Table 10, "Comparison to PAH Levels Associated with Tumors in Fish at Other Sites," many of the sediment sampling locations exhibited PAH concentrations that correlate with the presence of fish with tumors at other sites.

Benthic community surveys were conducted at two contaminated stations and two reference stations. Benthic community survey results were evaluated for a number of indices including richness and abundance, as shown in Table 11, "1998 Benthic Community Survey Results." Graphical analyses (included in Appendix A, "Excerpts from 1998 SEH ERA") indicated that the community degradation, as reflected in the difference in indices, strongly correlates to the sum of dry weight toxic units for PAHs for most of the indices. Figure 9, "Benthic Community Survey Indices vs. PAHs" illustrates the relationship between the survey results and PAH concentrations.

Toxicity studies were conducted on several species using sediment samples collected from the same two contaminated stations and reference stations as the benthic surveys. As summarized in Table 12, "1998 Bioassay Toxicity Test Results," whole sediment toxicity tests were conducted on the following benthic species: *Hyallela azteca* (amphipod), *Lumbriculus variegatus* (aquatic worm-oligochaete), and *Chironomus tentans* (midge larvae). Sediment elutriate toxicity tests were conducted on *Daphia magna* (zooplankton) and *Pimephales promeles* (fathead minnow larvae).

As shown in Appendix A, toxicity test results were evaluated for effects on survival and growth, and graphically compared to NOC toxic units. Statistically significant differences in survival and/or growth were documented between each sample. Toxic effects appeared to correlate well to toxic units. Elutriate dilution toxicity test results supported the toxic units exposure/effects characterization. Figure 10, "Bioassay Toxicity Test Results – Multiple Species" and Figure 11, "Bioassay Toxicity Test Results – Dilutions" provide illustrations of the relationship between the test results and the total PAH concentrations.

Results of literature search indicated that the toxic effects of certain PAHs may be enhanced by exposure to UV sunlight. Comparison of phototoxic PAH concentrations at the site to reference levels in the literature indicated the likelihood that a phototoxic effect could be

present at the site. Phototoxicity studies were performed in conjunction with standard toxicity test organisms exposed to sediment samples collected from the site. Evidence of enhanced phototoxicity effects were shown for benthic organisms, zooplankton, and fish larvae.

Graphical representation of the data (included in Appendix A) indicated that the toxic effects were directly related to the total concentrations of the phototoxic PAHs. Figure 12, "Bioassay Toxicity Test Results – UV Exposures" provides an illustration of the relationship between the test results and the total PAH concentrations.

5.4 Baseline Risk Characterization

The weight-of-evidence shown in Table 13, "1998 Sediment Quality Triad Analysis" indicates that a strong potential exists for ecological risks to be highly associated with the contaminated sediments in the bioactive zone.

The weight-of-evidence includes:

1. Several independent sediment effects benchmarks were exceeded;
2. Evidence of benthic community impairment in the contaminated areas was found;
3. Results of standard and photo-enhanced toxicity tests that indicate effects to representative benthic and pelagic test organisms increased with increased exposure concentrations of contaminants;
4. Acute and chronic water quality toxicity values were exceeded during a period of heavy wind and wave action and during a laboratory settling test, the latter which could be used to simulate bottom disturbances of in situ sediments; and
5. Sediment concentrations of PAHs similar to those at other sites where bioaccumulation and mutagenic effects have been observed.

The sum of toxic units in the deeper sediments are indicative of potential future risk. Future disturbance and exposure of the deeper contaminated sediments to the water column by either natural forces (e.g. storms, ice scouring) or uncontrolled anthropogenic activities (e.g. boat prop wash, shoreline maintenance) could potentially result in significant ecological effects in and possibly beyond the localized contaminated sediment area for the foreseeable future.

Ecological impacts to the benthic community may include acute and chronic toxic effects from direct contact with and ingestion of impacted sediments, food, and water. Impacts to the fish community could include acute and chronic effects from ingesting contaminated food, or direct contact with contaminated sediments and water. Immature fish and eggs are expected to be especially susceptible to

acute effects based on the results of the photo enhanced toxicity studies. Another potential impact to the fish community is the loss or reduction of the lower level benthic community food source in the contaminated area. Likewise the terrestrial community may suffer from exposure to the contaminated water and sediments, ingestion of contaminated food, or loss of food source.

6.0 Supplemental Study Design

Design of the supplemental investigation of the Ashland Lakefront Property offshore sediments was based upon review of historical project documents and current technical literature regarding the ecological effects of sediments impacted by similar contaminants.

6.1 Review of Project Correspondence Pertaining to Baseline ERA

SEH reviewed the following correspondence which accumulated following submittal of the October 1998 ERA (SEH, 1998b):

- March 1, 1999 D&M Final Draft ERA for NSP (D&M, 1999);
- June 2, 1999 WDNR (Tom Janisch) Draft Review Comments to March 1999 D&M ERA;
- January 5, 2000 WDNR (Tom Janisch) response to D&M September 14, 1999 comments in regard to June 7, 1999 WDNR Comments;
- November 13, 2000 USEPA (Brenda Jones and David Brauner) Cursory Review to October 1998 ERA by SEH;
- December 13, 2000 WDNR (Tom Janisch) response to EPA November 13, 2000 comments;
- May 14, 2001 TOSC Review of SEH and D&M ERA's; and
- June 2001 URS Sediment Sampling Report.

The following subsections provide a brief summary of the major points of discussion, which included:

- 1998 Fish Tissue Results;
- Benthic Community Analysis;
- Equilibrium Partitioning Model;
- Other Organic Chemicals Present;
- Relevancy of Elutriate Exposures;
- Phototoxicity; and
- Contaminant Distribution in Sediments.

6.1.1 1998 Fish Tissue Results

In May 1998 and October 1998, the WDNR collected several fish from the vicinity of the site. Fish fillets or whole fish were analyzed for PAH compounds. This data had not been available for the October 1998 ERA by SEH, and first appeared in the project correspondence as Attachment A to June 1999 WDNR Review Comments. A copy of the attachment is included in Appendix B, "Excerpts from 1999-2001 WDNR Comments on ERA." Table 14, "1998 Fish Tissue Chemical Data" is an excerpt from the attachment.

Fish species collected included Shorthead Redhorse, Smallmouth Bass, Largemouth Bass, Rock Bass, Northern Pike, Walleye, Brown Trout, Rainbow Trout, White Sucker, Pumpkinseed, and White Sucker.

PAHs were detected in 40% of the fish collected, but not at concentrations which would be considered to pose a cancer risk for consumption by humans. The PAHs detected were low molecular weight PAHs including naphthalene, acenaphthene, anthracene, fluorene, and phenanthrene. Total PAH concentrations ranged as high as 483 μg/kg in the whole fish samples, and up to 319 μg/kg in the fillet samples.

PAHs can enter the body of the fish via various routes: gastro-intestinal uptake from water, suspended particulate matter or food, uptake through the gills or dermal contact with sediment. Upon uptake these PAHs will enter the bloodstream, and the largest fraction will be metabolised by the liver and temporarily stored in the gall bladder. The analysis of PAH accumulation levels in fish tissue is usually not feasible due to rapid transformation (metabolism) into more polar and easily excretable forms. The occurrence of biotransformation does not, however, imply that PAHs are relatively harmless to metabolising species. On the contrary, during metabolism some reactive intermediates can be formed that bind to proteins and DNA (Ariese, 1997).

As shown in Appendix B, the WDNR concluded that "the fish received some term of exposure to high levels of PAHs in the water column that was associated with a site highly contaminated in these compounds in the sediments" and that it is likely that "the primary site for exposure and uptake has to be considered the harbor site off the Ashland Lakefront property."

The May 2001 TOSC Review commented that "although the contaminated area is small compared to other contaminated sites and the frequency of contact with contaminated sediments is relatively low, mutageneity and carcinogenicity should not be ruled out as potential impacts of PAHs on fish populations.

6.1.2 Benthic Community Analysis

The WDNR June 1999 review comments included several pages of discussion regarding the 1998 benthic community survey. These have been excerpted and included in Appendix B.

As shown in Appendix B, the WDNR conducted a statistical analysis of the benthic survey indices (richness and abundance indices for total population, midges, and oligochaetes) for each substrate (wood and sand) that confirmed the SEH 1998 conclusions reached through qualitative evaluation of the data.

As shown in Appendix B, the WDNR provided further evaluation of the specific species identified in the benthic survey coupled with references to current literature. The WDNR evaluation indicated that the many of the species (midges, molluscs, oligochaetes, and crustaceans) are likely to bioaccumulate PAHs and may serve as a "biotic pathway making the PAHs available to upper trophic level organisms" such as fish, birds, bats, and amphibians.

6.1.3 Equilibrium Partitioning Model

In the 1998 ERA, SEH discussed the pending release of USEPA guidelines on the use of the equilibrium partitioning (EqP) model for PAHs. The EqP approach "takes into account the varying biological availability of chemicals in different sediments and allows for incorporation of the appropriate biological effects concentration to predict the concentration of a nonionic organic chemical in sediments that is protective of benthic organisms. In its assertion, EqP theory holds that nonionic chemicals in sediment partition between sediment organic carbon, interstitial water, and benthic organisms." (USEPA, 2000b).

The March 1999 ERA conducted by D&M attempted to apply the EqP model to the site. However, as documented by the WDNR in their June 1999 comments and confirmed by the May 2001 TOSC review, D&M applied the model incorrectly and their results were discounted.

"A correct application...yields TU values that are similar to those derived by SEH (1998) using its HA-28 benchmarks." (TOSC, 2001). "At all sampling locations except five, TU>3.3 indicating acute toxicity will occur with virtual certainty. Based on those criteria, toxicity from PAHs can be expected in most of the sediments offshore from the Ashland Lakefront Property." (TOSC, 2001).

In April 2000, the USEPA released Draft Equilibrium Partitioning Guidelines (ESGs) for the Protection of Benthic Organisms: PAH mixtures. Further discussion of these guidelines and their application at this site is provide in subsequent sections of this report.

6.1.4 Other Organic Chemicals Present

The June 1999 WDNR review comments provided a discussion of the occurrence of other organic chemical present with coal tar, as shown in Appendix B. The discussion indicated that it is likely that several oxygen, sulfur and nitrogen heterocyles may be associated with the coat tar contamination including quinoline, acridine, indole, pyridene, carbazole, dibenzothiophene, and dibenzofuran. Ecological impacts may be associated with several of the HAHs, including acute toxicity and mutageneity. (Krone 1986, Adams 1984, Rostad 1985, Schirmer 1999, Sved 1997, Padma 1998).

The WDNR June 1999 comments also indicated that the presence of phenolic compounds is also likely. This was also noted in the EPA November 2000 comments.

6.1.5 Relevancy of Elutriate Exposures

The June 1999 WDNR comments support the use of elutriate exposures in the ERA evaluation. One comment states that "elutriate testing is the most applicable tool that there is to simulate conditions or disturbed and suspended bottom sediments, woody material, and the NAPL phase releases. Davenport (1991) showed the utility of using elutriate testing to demonstrate the potential toxicity of suspended sediments in shallow sediments. Furthermore, the May 2001 TOSC review stated that "elutriate exposures conducted in the laboratory suggest aqueous concentrations of PAHs liberated from PAH sediments are toxic to aqueous organisms."

6.1.6 Phototoxicity

The January 2000 WDNR comments provided more than 30 pages of text (with literature references) to support the application of the phototoxicity bioassay study results when evaluating ecological risks to the shallow sediments at the site. An excerpt of these comments is included in Appendix B.

6.1.7 Contaminant Distribution in Sediments

In Winter 2001, URS collected sediment samples from 59 locations on the site. Sampling was conducted at two foot intervals to depths of at least 10 feet. Sediment samples were collected and analyzed for SVOCs (predominately PAHs) and VOCs. The Sediment Sample Results (URS, 2001) report concluded that distribution of contamination was consistent with that identified by SEH in 1996. Figures illustrating the sample locations and results are included in Appendix C, "Excerpts from 2001 URS Sediment Sampling Report."

6.2 Literature Review of Sediment Quality Guidelines

Since 1998, at least two major sets of sediment quality guidelines for PAHs in freshwater applications have been published. These are the:

- Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald, 2000); and
- Draft Equilibrium Partitioning Sediment Guidelines (USEPA, 2000b).

Each of these is described further in the subsections below. Also included is a discussion of the "WDNR Consensus-Based Sediment Quality Guidelines – Recommendations for Use and Application (WDNR, 2002)" which discusses the above guidelines, plus provides guidelines for other miscellaneous organic chemicals. Lastly, a brief discussion is provided on other guidelines available for evaluation of selected VOCs, HAHs, and phenolic compounds.

6.2.1 Consensus Based Freshwater Sediment Quality Guidelines

"Numerical sediment quality guidelines (SQGs) for freshwater ecosystems have previously been developed using a variety of approaches." "In an effort to focus on the agreement among these various published SQGs, consensus based SQGs were developed for 28 chemicals of concern in freshwater sediments (i.e. metals, PAHs, PCBs, and pesticides). For each contaminant of concern, two SQGs were developed from the published SQGs, including at threshold effect concentration (TEC) and a probable effect concentration (PEC)." (MacDonald, 2000).

The data used to create the HA-28 ERMs utilized in the 1998 ERA (SEH, 1998) were included in the development of the consensus based SQGs (CBSQG). According to Chris Ingersoll, the 2000 CBSQG PECs should be used in place of the 1996 HA-28 ERMs.

The PECs are SQGs that were established as concentrations of individual concentrations above which adverse effects in sediments are expected to frequently occur. (Ingersoll, 2001). A PEC of 22,800 µg/kg was established for total of 13 PAHs (acenaphthene, acenaphthylene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, benzo(a)anthracene, dibenzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene).

The USEPA recommends that sediment quality remediation targets (SQRTs) be set at mean CBSQG PEC Q <0.1 (e.g. 2,280 µg/kg total PAHs) if the site management goal is to provide a high level of protection for sediment dwelling organisms. Alternatively, the SQRTs could be set at a mean PEC-Q of <0.6 if the immediate goal for the site is to reduce the potential for acute toxicity and permit natural recovery

processes to further reduce contaminant concentrations. (USEPA, 2000d).

6.2.2 Equilibrium Partitioning Sediment Quality Guidelines for PAHs

The Equilibrium Partitioning Sediment Quality Guidelines (ESGs) for PAHs (USEPA, 2000b) were developed to assess the toxicological effects of PAH mixtures in sediments based upon the EqP model described in Section 6.1.3. The toxicities of mixtures of narcotic chemicals have been shown to be approximately additive, therefore combined toxic contributions of all PAHs in the mixture can be determined by summing the quotients of the concentration of each PAH in the sediment divided by its effect concentration (organic carbon basis) to determine the sum of these ESG Toxic Units (ESGTUs).

The ESG model for PAH mixtures was developed for 34 PAHs. If data is not available for the 34 PAHs, the $\Sigma ESGTU_{FCV13}$ should be calculated for 13 of the PAHs commonly analyzed (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene). The sum is multiplied by an uncertainty factor of 11.5 (USEPA, 2000b) to obtain an $\Sigma ESGTU_{FCV34}$ with 95% confidence. If the sum of the ESGTUs exceeds 1.0 the sediment guideline for the PAH mixture is exceeded and sensitive benthic organisms may be affected by PAHs.

As described in the guidance, it may be that an ESG is exceeded but the sediment does not appear toxic from bioassay toxicity tests. "These findings would not be mutually exclusive, because the inherent sensitivity of the two measures is different. ESGs are intended to protect relatively sensitive species against both acute and chronic effects, whereas toxicity tests are run with specific species that may or may not be sensitive to chemicals of concern, and often do not encompass the most sensitive endpoints (e.g. chronic survival, growth, or reproduction)." "The first step in interpreting this situation is to consider the magnitude of the ESG exceedance and the sensitivity of the test organism and endpoint to the suspect chemical. For example the acute-chronic ration used for the PAH ESG is 4.16; as such, if $\Sigma ESGTU_{FCV34} = 4$, one would expect lethal effects only for highly sensitive species. Between $\Sigma ESGTU_{FCV34}$ of 1 and 4, one would expect only chronic effects, unless the species was unusually sensitive. (USEPA, 2000b).

6.2.3 WDNR Sediment Quality Guideline Recommendations

The WDNR Consensus-Based Sediment Quality Guidelines – Recommendations for Use and Application (WDNR, 2002) recommends that the CBSQGs (MacDonald 2000) be utilized for screening contaminated sediment sites. However, the WDNR

recommends that the CBSQGs for organic compounds be normalized to organic carbon or expressed at dry weight concentrations at 1% TOC in sediments. The WDNR guidance recommends that the CBSQG TECs be utilized as the remediation objective for a site.

The WDNR guidelines also present PEC and TEC guideline values for other organic chemicals including benzene, toluene, xylene, dibenzofuran, phenol, and 2-methylphenol. These values are shown on Table 5.

6.2.4 Miscellaneous Organics

Sediment quality guidelines for VOC, HAHs, and phenolics have been given much less attention than PAHs. In addition to the WDNR guidelines described above, SQGs considered for these chemicals are drawn from the USEPA Sediment Quality Advisory Levels (SQALs) (USEPA, 1997b) and the Oak Ridge National Lab (ORNL) Preliminary Remediation Goals (PRGs) (Effroymson, 1997).

6.3 Assessment Endpoints

As described in Section 3.7, the assessment endpoints for this site include:

- Survival and growth of benthic organisms.
- Benthic community health.
- Survival and growth of fish and water column organisms (phytoplankton and zooplankton).
- Survival and growth of piscivorous birds and mammals.

6.4 Supplemental Study Measurement Endpoints

The measurement endpoints for the 2001 supplemental study include sediment contaminant chemistries and the toxic effects of impacted and reference site sediments on benthic and pelagic freshwater laboratory test organisms.

Evaluation of the historical and current measurement endpoints are integrated in the sections below for the assessment endpoints. ERA measurement endpoints in the 1998 ERA study included: benthic community metrics; sediment/water quality contaminant chemistry; evaluation of toxic effects of impacted and reference site sediments; and bio-accumulation of contaminants in fish bulk body tissue.

6.5 Field Sampling Plan

6.5.1 Sample Locations and Designations

During the last week of March 2001, sediment samples were collected from the bioactive zone (0-6" depth) of the lake bottom sediments at six locations including: two contaminated sandy sediment sites; one relatively clean sandy sediment site; two contaminated wood waste sediment sites; and one relatively clean wood waste site. The horizontal coordinates of the sampling locations are indicated on Figure 6. The sampling locations were selected based on previous field observations of shallow sediments prior to the sampling event.

The sediment samples were designated by the location from which they were collected on the horizontal grid shown on Figure 6 (e.g. 3100N/2300E.)

Designation of mixed dilution samples includes the % of mixture from the reference site location, and the % of mixture from the contaminated location. (e.g. 90% [3100N/2300E] – 10% [2500N/ 1700E.]) The chemical analytical laboratory's data management software limits the number of characters that can be used in the sample designation, therefore the chemical laboratory used only the % of mixture from the reference site and the first 2 numbers of the north and south grid locations (e.g. 90% [31N/23E]).

6.5.2 Sample Equipment and Procedures

SEH contracted with Superior Special Services Inc. (Superior) of Fond Du Lac, Wisconsin to assist with the sediment sampling. Sampling equipment with a pneumatic drive to close the clamshell sampler was used to prevent sampling problems in the wood waste areas.

The sediment samples were collected through the overlying lake ice. A polyethylene tarp and multiple sheets of 4'x8' plywood were placed around the sampling location to provide a working platform. The working platform limited potential contamination of the surrounding ice and facilitated site cleanup and decontamination procedures.

A two-foot diameter access hole was cut into the ice in the center of the platform. Superior lowered an underwater camera into the access hole to observe the sample location from the surface to identify any large sampling obstructions that may have been present. A pneumatically driven ponar dredge sediment sampling device was lowered into the hole and was used to collect sediment samples from the top 6 inches of the sediments.

New 30-gallon sealed polyethylene drums were used to containerize the sediment samples from each location. The sediment samples were passed through a 1/2-inch wire mesh screen prior to containerization to

remove large wood particles. Ten to 15 gallons of sediment were collected at each location. The location-specific polyethylene sample drum was sealed at the conclusion of the sampling event.

The sampling equipment was decontaminated and the sampling area cleaned at each discrete location after sediment sampling was completed. Shovels were used to remove any residual contamination from the ice surface, and visible sheen was removed from the surface water in the open holes. The holes were marked with lathe and flagging and covered with plywood to prevent accidental entry by pedestrians. Screened out waste materials, decontamination residue, and miscellaneous clean-up materials were disposed of in sealed 55 gallon steel drums.

6.5.3 Sample Handling and Storage

Ambient temperature was approximately 35 degrees F at the time of sample collection. The 30-gallon sediment sample containers were sealed, stored outside, and transported to LSRI via trailer. The samples were logged in at LSRI, and mechanically homogenized the same day. The homogenization process was conducted inside a vented room at the laboratory with a motor driven paddle wheel device.

On March 29, 2001, SEH collected samples from each homogenized sediment sample and submitted the samples to EnChem Inc. for preliminary chemical analysis (see discussion below). The homogenized samples were transferred to 3- gallon plastic buckets and stored in the LSRI freezer pending determination of sediment dilution mixture.

6.5.4 Investigative Waste Management

Measures were taken in the field designed to minimize release of contaminants to the environment during performance of the field investigation activities. Waste materials from the field sampling activities include sediment debris, wood chips, decontamination water, disposable health and safety equipment, and other garbage. All waste was collected in 55 gallon steel drums. The waste drums were sealed, labeled and placed near the waste drum storage area in the vicinity of the former wastewater treatment plant for future disposal.

6.6 Chemical Analysis and Biological Assay Study Plan

6.6.1 Chemical Analysis

SEH contracted with EnChem Inc. (EnChem) of Green Bay, Wisconsin (WDNR Lab ID # 405132750) to perform chemical analysis of the sediments.

Sediment samples were initially collected by SEH from a relatively "clean" sandy and a relatively clean woody sediment location, two contaminated sandy sediment locations, and two contaminated woody sediment locations. Samples from the homogenized sediments were sent to EnChem for preliminary chemical analysis to confirm that reference sample sites were relatively "clean" and to determine which of the contaminated sediments would be used for the dilution series. The preliminary sediment samples were conducted using standard Level 3 (non-Contract Laboratory Program [CLP]) quality methods. Preliminary chemical analyses performed on the initial homogenized sediment samples included PAHs, VOCs and Total Organic Carbon (TOC). Results of the preliminary chemical analyses are included in Table 5 and Appendix D, "Chemical Analysis Laboratory Reports."

On April 30, 2001 the most contaminated woody and sandy sediment samples (2400N/1400E and 2500N/1700E respectively) were volumetrically diluted and homogenized with the reference woody and sandy sediment samples in the following homogenized dilution mixtures: 100%, 50%, 25%, 10%, 1% (contaminated site sediments). A total of 14 diluted and undiluted samples were utilized for the bioassay toxicity tests. Additionally, 3 laboratory control sediments (silica sand, West Bearskin Lake, and a formulated sediment) were utilized for the bioassay toxicity tests.

Following performance of the sediment dilution mixtures, a larger matrix of chemical analyses were performed on all of the sediment mixtures (undiluted and diluted). The analyses were performed at CLP level 4 and include:

- PAHs;
- Phenolic Compounds;
- VOCs;
- TOC; and
- HAHs

Particle size analysis was not performed due to the woody nature of much of the sediments. The wood particles found in some of the sediment range in size from sawdust to large pieces. Wood may be at least 50% less dense than the soil particles also present in the sediments. Therefore the standard sieving and weighing procedures could not provide accurate data for the grain size analysis.

6.6.2 Bioassay Testing

SEH contracted with Lake Superior Research Institute (LSRI) of Superior, Wisconsin to perform the bioassay tests with the sediments.

Bioassay tests were conducted for each of the 14 diluted and undiluted sediment samples and three laboratory control sediments on the following freshwater species: *Pimephales promelas* fathead minnow larvae (PP), *Chironomus tentans* midge larvae (CT); and *Hyallella azteca* amphipod larvae (HA). The PP bioassay was a 7 day water column flow-through toxicity test using a combination of procedures generally following Test Method 1000.0 of EPA/600/4-91/002 (USEPA, 1994) and adapted from Test Method 100.2 of EPA/600/R-99/064 (USEPA, 2000a). Survival and growth data generated were compared to laboratory control. Mean survival and growth data were used for comparison to sediment chemistry data.

The CT bioassay was a 10 day whole sediment benthic toxicity test using procedures generally following Test Method 100.2 of EPA/600/R-99/064 (USEPA, 2000a). Survival and growth data generated were compared to laboratory control data. Mean survival and growth data were used for comparison to sediment chemistry data.

The HA bioassay was a 28 day whole sediment benthic toxicity test using procedures generally following the Test Method 100.4 of EPA/600/R-99/064 (USEPA, 2000a). Procedure for days 29 through 42 of Test Method 100.4 to evaluate reproduction was not completed. Survival and growth data generated were compared to laboratory control data. Mean survival and growth data were used for comparison to sediment chemistry data.

6.6.3 Photo-enhanced Bioassay Testing

A bioassay test was also conducted on the 14 diluted and undiluted sediment samples and control sediments to further evaluate the impacts of photo-enhanced toxicity of PAHs. The bioassay was run on HA for 28 days in accordance with the methods previously described above for HA, with the exception that the organisms are exposed to ultraviolet light radiation to mimic natural sunlight. Test organisms were exposed to approximately 50 to 80 μwatts/cm^2 UVA (320-370 nm) and 2 to 6 μwatts/cm^2 UVB (270-330 nm). On June 8, 2001, a mildly overcast day, UVA levels of 19 to 76 μwatts/cm^2 and UVB levels of <0.8 to 18 μwatts/cm^2 at depths of 0.5 to 1.6 m (1.6 to 5 feet) were measured in the Ashland harbor. Light intensity during the test was adjusted to mimic natural conditions at the site.

Survival and growth data generated are compared to laboratory control data. Mean survival and growth data are used for comparison to sediment chemistry data.

6.7 Quality Assurance Plan

Quality assurance is the overall plan for assuring reliability of field and analytical data, as well as assuring the logistical implementation of the work plan. Quality control is the routine application of procedures for obtaining prescribed standards of performance during field activities.

6.7.1 Field Activities Quality Assurance

Prior to the beginning of the day's field activities, a meeting was held at the site with SEH personnel, subcontractors, and WDNR personnel (if present) to review the planned activities, field conditions, and health and safety issues.

A daily field report was used to document field procedures and conditions. Information in the daily field report included the following: date; personnel; weather; equipment; calibrations performed; field screening results; sampling locations; sampling methods; decontamination procedures; sample identification; time/date of sample collection; description of samples; field preservations performed; field QC data; deviations from the work plan or special conditions; and any other significant observations.

In addition to the written log, a photographic log was also prepared to document field conditions and sampling procedures. Photographs and field reports are stored in the SEH project file.

Sampling equipment was decontaminated prior to use in the field or was disposable and dedicated to a single sample. Equipment reused in the field at different locations or sediment sampling depths was decontaminated prior to each reuse. The decontamination method involves a trisodium phosphate (TSP) wash, and a triple rinse of deionized water. Decontamination liquids are stored in a waste drum for future disposal.

In general, 10 percent of the samples were collected for laboratory duplicate samples. Samples were preserved (as required by method) and maintained on ice or at a temperature no greater than 4 degrees Celsius continuously from the time of sample collection until their receipt by the laboratory. Samples were shipped to the laboratory in insulated coolers accompanied by a methanol trip blank.

Individual labels describing the sample identification, location, sampler's name, date, preservatives, and other relevant information were attached to the sample container. All samples submitted for analysis were tracked using chain of custody procedures. Sample jars were racked from the laboratory, to the field, through sample collection, and back to the analytical laboratory. The chain of custody also documented relevant sampling and preservation information including collection, shipping and laboratory receipt times.

6.7.2 Chemical Laboratory Quality Assurance

EnChem is certified by the State of Wisconsin to perform the standard analyses proposed. EnChem's Wisconsin laboratory certification number is 405132750. EnChem has provided SEH with a statement of qualifications and a copy of its quality assurance program. These documents are stored in the SEH project file.

The preliminary chemical analyses were performed using Level 3 quality methods. The final chemical analyses on all of the sediment mixtures (diluted and non-diluted) were performed at CLP level and included project specific spike analyses. EnChem will store the CLP level QA/QC documentation for future retrieval, if necessary.

Matrix spike analysis provides information about the effect of the sample matrix on digestion and measurement methodology. All matrix spikes are performed in duplicate. Matrix spike and matrix spike duplicate (MS/MSD) sample pairs were selected in advance in coordination with the laboratory to ensure ample sample volume.

MS/MSD pairs are analyzed at a rate of at least one pair per batch of up to 20 samples. The MS/MSD samples were collected in the same manner as the other samples, labeled appropriately, and identified as such on the chain-of-custody forms.

Upon arrival at the laboratory, the MS/MSD samples were spiked with appropriate analytes and analyzed according to the referenced method. Results from the analysis of MS/MSD samples were be used to evaluate the effect of the matrix on precision and accuracy. The percent recoveries were calculated for each of the analytes detected and used to assess analytical accuracy. The relative percent difference between MS and MSD samples was be calculated and used to assess analytical precision.

Analytical data from the laboratory was submitted to SEH in both electronic and hardcopy form (included in Appendix D). Data summary tables were constructed from the electronic files to minimize potential for manual data transfer errors.

6.7.3 Bioassay Laboratory Quality Assurance

LSRI has performed bioassays for several State of Wisconsin ERAs performed on sediments from inland waters. LSRI provided SEH with a statement of qualifications and a copy of its quality assurance program. These documents are stored in the SEH project file.

LSRI performed laboratory control tests with silica sand, formulated sediment, and natural sediment from a clean reference site, West Bearskin Lake, near Grand Marais, Minnesota. Each bioassay test was performed with a minimum of 5 replicates. Measurement endpoint results for each of the test sites were compared to published test

acceptability criteria for the control sites to determine the overall performance criteria of the animals and the test system. LSRI has provided details of statistical analyses of the test data with its report.

Analytical data from the laboratory was submitted to SEH in both electronic and hardcopy form. Data summary tables were constructed from the electronic files to minimize potential for manual data transfer errors.

7.0 Supplemental Site Investigation

This section summarizes the results of 2001 supplemental ERA investigation. The results of the chemical analysis and bioassay testing are evaluated and compared to previously collected data to assess site specific exposure-response effects.

7.1 Site Investigation Comments

Field sampling activities were conducted in the near shore sediments of the Ashland Lakefront Property in March 2001.

7.1.1 Changing Field Conditions

Field sampling activities progressed according to the work plan. No changes to the work plan were required during the field sampling event.

7.1.2 Unexpected Nature or Extent of Contamination

The sediment sample locations were selected based on previous field observations and contaminant measurements in the site sediments. In order to determine which sediment samples would be used for the chemical analysis and bioassay dilution series, sediment samples were mechanically homogenized the day of collection and representative samples of the sediments were submitted to the analytical laboratory. for preliminary chemical analysis. No unexpected conditions were encountered during sampling activities

7.2 Analysis of Ecological Exposures and Effects

The analysis phase of the ERA consists of technical evaluation of data on existing and potential exposures and ecological effects at the site (USEPA, 1997a). Results of the supplemental investigation was evaluated and integrated with information gathered in previous investigations to support and update ecological risks associated with the site.

7.2.1 Characterizing Exposures

Results from the supplemental chemical analysis are presented below. Laboratory reports for the chemical analyses are included in Appendix D, "Chemical Analysis Laboratory Results." Sediment concentrations for VOCs and semivolatile compounds (including PAHs, HAHs and phenolic compounds) are presented in Table 5 for

the sediment samples collected in the supplemental investigation. Chemical data for the toxicity test dilution series is included in Table 15, "Sediment Toxicity Test Chemical Data – Dry Weight," and Table 16, "Sediment Toxicity Test Chemical Data – Normalized to Organic Carbon." Dry weight and NOC toxic units are calculated for each sample location to allow comparison of exposure levels to ecological effects

Consensus-Based PEC-Q's (McDonald, 2000) and ESGTUs (USEPA, 2000b) were calculated for the appropriate PAH compounds. In addition, ORNL PRG and EPA SQALs were compared to the VOCs. Since a total VOC benchmark was not available, the total VOC TUs are simply the sum of the calculated individual BTEX chemical TUs. Calculation tables are included in Appendix E, "Calculations."

7.2.2 Characterizing Ecological Effects

Two different analyses were considered in the ERA Supplemental Investigation to characterize the effects of contaminated sediment on biota encountering contaminated sediments. The analyses included: comparison of sediment contaminant concentrations to sediment effects benchmarks and laboratory toxicity indices upon test organism exposure to a range of contaminant concentrations in sediment from the discrete locations sampled in this investigation.

7.2.2.1 Chemical Data

As indicated on Table 15, dry weight BETX data was compared to ORNL PRG benchmarks and dry weight PAH data for each sampled location was compared to Consensus-Based PEC DW benchmarks (MacDonald, 2000). On a dry weight basis, several PRGs were exceeded for BETX at each of the contaminated sand and wood locations and dilution series.

Dry weight PAH data exceeded all individual Consensus-Based PECs at each of the contaminated sand and wood locations. In both the sand and wood dilution series, individual Consensus-Based PECs were exceeded for all chemicals at most of the dilutions. Only at the 1% dilution for both sand and wood were many of the individual chemical Consensus-Based PEC-Qs less than 1.0. In addition pyrene exceeded its individual Consensus-Based PEC at the reference wood location. When evaluating PAH Consensus-Based PEC-Qs, all contaminated sand and wood locations exceeded 1.0, indicating the probability of high incidences of toxicity in the form of reduced growth reproduction, and/or survival of benthic organisms present.

As indicated on Table 16, NOC BETX data was compared to EPA SQAL benchmarks and NOC PAH data was compared to HA-28 ERM (Ingersoll, 1996) and ESG benchmarks. On a NOC basis, several SQALs for BETX were exceeded at the two contaminated sand locations and in the contaminated sand #1 dilution series.

Sediment concentrations above the various benchmark values are in the probable effects range for adverse effects. As the concentration rises above the benchmark values and toxic units increases, the potential for increased incidences of toxicity and of adverse effects increases as well. Based on toxic units calculation and comparison to several DW and NOC benchmarks, it appears likely that either acute and/or chronic adverse effects would be found at each sample location within the limits of sediment contamination area shown on Figure 3.

7.2.2.2 Laboratory Bioassay Toxicity Studies

Table 17, "Summary of Bioassay Toxicity Test Results" summarizes the results of the toxicity studies documented in Appendix F, "Lake Superior Research Institute Bioassay Report". Survival and growth of immature organisms was compared for each sampled location, dilution series, and three control sediments. Figures 10 through 12 graphically present the results of the tests. In general, linear regression trend lines indicate that as the chemical contaminant concentrations and toxic units go up, survival and growth decrease for all three species tested.

Figures 12 compares the survival and growth of the toxicity test organism *Hyalella azteca* (HA) with and without exposure to UV light as compared to either DW or NOC toxic units of the chosen benchmark values. Exposure to UV light increased toxicity and reduced survival of *H. azteca* with increased mortality observed at 100% concentration. Exposure to UV light increased the toxicity by approximately 4 times compared to the laboratory light exposure results in both substrates.

7.2.2.3 Evidence of Causality

A review of Figures 10 through 12 indicates that ecological effects are strongly related to the concentration of the PAH contaminants and associated toxic units in the sediments. In general, the greatest survival is seen in the control and reference samples.

7.3 Summary

Field sampling was conducted in March 2001. Sediment samples were homogenized and submitted to laboratories for chemical analysis and bioassay toxicity studies. Comparison to sediment quality guideline benchmark values indicates that the coal tar-related contaminant concentrations in the sediment samples were likely to have adverse effects to benthic organisms. Comparison of 2001 toxicity study results and 1998 benthic community survey results indicate that

ecological impacts correlate strongly to the level of PAH and VOC contamination. UV toxicity study results indicate that toxicity is greatly increased by the presence of simulated UVA and UVB wavelengths from sun light.

8.0 Supplemental Risk Characterization

8.1 Introduction

Risk characterization is the final phase of the risk assessment process and includes two major components: risk estimation and risk description (USEPA, 1997). The risk estimation section integrates the results of all the lines of evidence collected during the ERA studies to provide a weight of evidence in order to estimate the current and future risks associated with the contaminated sediment area. The risk description summarizes the risks to the benthic, aquatic, and terrestrial communities. Finally, uncertainties associated with the risk characterization are summarized.

8.2 Risk Estimation

Data from the literature reviews, toxicity studies, benthic community survey, and chemical analysis are integrated to assess the level of risk for each of the sediment sampling stations. The assessment of risk is then extrapolated to discuss potential effects across the contaminated area as related to the larger database for coal tar contaminant concentrations across the site.

8.2.1 Exposure Response

Strong correlation of ecological response to the contaminant exposures was clearly demonstrated for both the survey data and toxicity tests with respect to toxic units, as illustrated in Figures 10 through 12.

8.2.1.1 Exposure Response – DW Concentrations

Review of the data set presented in Table 18, "Bioassay Toxicity Test Results Sorted by DW PAH Concentrations" indicates that generally the percent of toxicity test results with significantly significant reductions increases as the total PAH concentrations increase. This effect is graphically illustrated on Figure 10.

8.2.1.2 Exposure Response – NOC Concentrations

Review of the data set presented in Table 19, "Bioassay Toxicity Test Results Sorted by NOC PAH Concentrations" indicates that generally percent of toxicity test results with significantly significant reductions increases as the total PAH concentrations increase. This effect is graphically illustrated on Figure 10.

8.2.1.3 Exposure Response – 2001 Contaminated Sand Dilution Series

As shown on Table 16, as the dilution series increased in contamination concentrations (reference sand to contaminated sand), the overall occurrence of adverse impacts for the bioassay tests also increased. This effect is graphically illustrated on Figure 11.

8.2.1.4 Exposure Response – 2001 Contaminated Wood Dilution Series

As shown on Table 16, as the dilution series increased in contamination concentrations (reference wood to contaminated wood), the overall occurrence of adverse impacts for the bioassay tests also increased. This effect is graphically illustrated on Figure 11.

8.2.1.5 Exposure Response – 1998 Elutriate Dilution Series

To further examine the correlation of exposure-response, a series of 7 day elutriate toxicity tests were run on *Pimephales promelas* fathead minnow fry at varying dilutions (6.25%, 12.5%, 25%, and 50%) for the CW and CS elutriates. As shown on Table 12, survival fractions had previously been shown to be less than 0.05 for both the CW and CS 100% elutriate solutions. Survival remained low in all of the CW elutriate dilution tests. The survival fraction was less than 0.80 for the 50% and 25% CS elutriate dilutions, and 0.85 for the 12.5 % dilution. The survival fraction was 0.95 for the 6.25% CS elutriate dilution. These results indicate that the survival fraction is consistent for samples from different locations and substrates with similar NOC toxic units.

As illustrated on the figure in Appendix A, the survival fractions from the 1998 elutriate dilution PP tests were compared to the relative sum of HA-28 toxic units (NOC Toxic Units x %Dilution) for each elutriate dilution. The correlation between the toxic units and survival fraction was very strong when the results of the PP elutriate tests are compared. A survival fraction of 0.85 for the 12.5% CS elutriate (14.9 NOC PAH TUs) concurred well with the survival fraction of 0.83 for the 100% RW elutriate (14.4 NOC PAH TUs). Likewise the survival fraction of 0.95 for the 6.25% CS elutriate (7.4 NOC PAH TUs) concurred well with the survival fraction of 0.93 for the 100% RS elutriate (7.1 NOC PAH TUs).

8.2.2 Risk Estimation Summary

The integrated weight-of-evidence from the ERA provides strong evidence of contaminant induced degradation at each of the sediment sampling stations within the 1996 limits of contamination.

Review of the ecological response to contaminant exposure levels from the ERA studies indicates that significant impacts (>20%) are observed at sediment sampling stations where the PAH and VOC contaminant concentrations exceed background levels.

The following figures illustrate the distribution PAH and BTEX concentrations (and toxic units) in the contaminated sediments at various depths.

- Figure 13, "PAH Toxic Units in Sediment 0-6" Bioactive Zone"
- Figure 14, "PAH Toxic Units in Sediment 0'-4' Interval
- Figure 15, "PAH Toxic Units in Sediment 4-10' Intervals "
- Figure 16, "BTEX Toxic Units in Sediment 0-6" Bioactive Zone"
- Figure 17, "BTEX Toxic Units in Sediment 0'-4' Interval"
- Figure 18, "BTEX Toxic Units in Sediment 4'-10' Intervals"

The URS figures in Appendix C, show similar distributions (dry weight only) for SVOCs (PAH) and VOCs (BETX). NOC based concentrations and distributions cannot be calculated or shown because URS apparently did not analyze any of their samples for total organic carbon (TOC) content. Therefore, this key influencing factor related to coal tar contaminant availability, exposure, and effects to biota is not available for consideration.

It is reasonable to extrapolate that that acute and/or chronic toxicity effects observed for the study sites are also associated with other sample locations that exceed background conditions.

8.3 Risk Description

Table 20, "Summary of Ecological Risk Assessment Weight of Evidence" summarizes risks to the benthic, aquatic, and terrestrial communities which are potentially associated with the sediment contamination.

8.3.1 Threshold for Effects on Assessment Endpoints

Based on the data set produced in this ERA, it appears that ecological impacts are likely to occur and increase when PAH and VOC contaminant concentrations increasingly exceed background levels.

8.3.1.1 PAH and VOC concentrations

Table 21, "Preliminary Remediation Goals for Sediments" lists the lowest observed adverse effect concentration (LOAEC) and no observed adverse effect concentrations (NOAEC) for each bioassay toxicity test (1998 and 2001). The table splits out the LOAEC and NOAEC by the substrate type (wood or sand) and provides both dry weight and normalized to organic carbon values.

8.3.1.2 LC50s

LSRI calculated LC50 rations for each of the 2001 dilution series, as shown on Table 21. LC50's are not considered to be protective of the respective organisms, but to provide an upper limit reference for concentrations at which 50% acute toxicity would be expected over the duration of a short term bioassay toxicity tests. The LC50s are an order of magnitude higher than the CBSQG PECs for PAHs. This is reasonable since the PECs are based on 20% acute effects observed in short term toxicity tests.

8.3.1.3 MacDonald CBSQGs

Review of Table 18 indicates that acute toxicity test results were generally observed where sediment sample CBSQG PEC-Qs were greater than 1. This observation supports the applicability of the CBSQGS to the site.

8.3.1.4 ESG TUs

Review of Table 19 indicates that acute toxicity test results were generally observed where sediment sample ESG TUs were greater than 4.16 (the acute to chronic ratio). This observation supports the applicability of the ESG TUs to the site.

8.3.2 Likelihood of Risk

The likelihood of significant ecological risks and impacts to the benthic invertebrate community and pelagic invertebrate and fish community is considered high. The VOC and PAH sediment concentration at many locations at this site exceed a variety of independently developed sediment effects benchmarks. Toxicity test results and benthic community survey results support this conclusion.

The likelihood of risk to the benthic community from chronic exposures is high because the benthic organisms are generally sedentary and confined to small areas of bottom sediments. Likewise the risk to the pelagic community from acute toxicity is high for immature species such as fish if spawning and egg deposition occurs on the surface of sediments that are contaminated. Risks to eggs and larvae are increased concurrent with disturbance of the contaminated sediments. Because the area is in a relatively shallow area, penetration of UV light is expected to further increase the ecological impacts at the site by enhancing the toxicity of certain PAHs. Translucent immature organisms exposed to UV-toxic PAHs are not expected to survive well in the contaminated sediment area.

Additionally, as shown on Table 10, PAH concentrations in the shallow sediments at this site are within the range for other sites where fish tumors have been observed. The likelihood of risk to the mature aquatic community or terrestrial community is not presumed to be as

high because chronic exposures and incidence of acute exposures are less likely for mobile species. Results of 1998 fish tissue studies support the assumption that uptake of PAHs from the contaminated sediments is occurring.

8.3.3 Additional Risk Information

Additional information is presented to consider future risk scenarios associated with the deeper contamination.

8.3.3.1 Other Organic Contaminants

As shown on Table 5 and 16, several other organic contaminants besides PAHs and VOCs were detected at the site. These include the HAHs Dibenzothiophene, Carbazole, and Dibenzofuran. Phenolic compounds detected include 2-fluorobiphenyl, 4-Methylphenol, and Phenol. In general, these compounds appear to be co-located with PAH and VOC compounds. Concentrations increased as the corresponding PAH concentrations increased.

As shown on Table 16, some of these chemicals exceeded SQGs. However in most case the SQG exceedance was much less than the corresponding SQG exceedance for PAHs at the sampling location.

8.3.3.2 Potential for Natural Recovery

The potential for the natural recovery of the contaminated sediments is low for many reasons including: limited sediment deposition in the high energy nearshore area; presence of NAPLs; contaminant diffusion; low microbial degrader populations; and very long half lives for many of the long chain PAHs. A relatively large mass of PAH and VOC contaminants exist in the sediments to at least 10 foot depth. Because of the concentration gradient, these contaminants are expected to migrate upward to the surface water. This is expected to be a long term process based on the slow desorption rates from the mass of NAPL and organic carbon present.

Below the six inch bioactive zone, microbial processes are expected to be anoxic or anaerobic. Anaerobic and aerobic microbial enumeration assays were conducted for the purposes of evaluating the potential for natural or enhanced bioremediation of contaminants in the sediments as part of the remedial action options feasibility study (FS). These results are presented in Table 4.

The results indicate that low total microbial populations and very low degrader populations are expected to be present in the contaminated sediments, and that natural degradation is unlikely to occur at significant rates. The enumerated populations generally correlate inversely to the sum of toxic units present. The effects to nutrient and energy recycling from lower order ecological impacts to microbial

degraders and the detrital food chain populations by the sediment contaminants has not been explored.

Long chain, high molecular weight PAHs such as benzo(a)pyrene and benzo(a)anthracene are generally considered to be biorecalcitrant, and not expected to biodegrade quickly in sediments without pretreatment with oxidizing agents to chemically break bonds. Current research is being conducted to explore the in situ anaerobic biodegradation of long chain PAHs beneath sediment caps. However, conclusive evidence has not yet been documented regarding the success of natural microbial degradation of long chain PAHs.

In the hypoxic or anoxic conditions of the sediments most PAHs are generally quite stable and may persist indefinitely in oxygen poor water basins or anoxic sediments.

The high levels of contaminants present which are integrated into the bottom substrates and present in the surface as NAPL coal tars, were likely released and deposited into the embayment decades ago. That these conditions still exist after so long a period of time would indicate that dependence cannot be put on natural attenuation as the primary remediation approach to deal with the problem in any effective manner.

8.3.3.3 Potential for Exposure to Deeper Sediments

The potential for disturbance of and subsequent exposure to the deeper more contaminated sediments is high. Potential disturbing activities include bioturbation from benthic macroinvertebrates, anthropogenic disturbance from shoreline maintenance or boat props, and heavy storm or northerly wind-induced wave actions where wave energies are transferred to the bottom of the water column over the sediments.

PAHs are adsorbed to the fines and the fines do not settle quickly. Concentrations of contaminants associated with suspended sediment and water exceeded the NAWQ acute and chronic toxicity values in the study as shown in Tables 7 and 8.

Furthermore, analysis of the wood waste areas indicates that the woody sediment sample from the 0 to 6 inch interval at RW had a specific gravity of 1.49 compared to the specific gravity of 2.65 for the sand sample collected from the 0 to 6 inch interval at RS. The 1998 geotechnical data is presented in Table 3. This supports the hypothesis that the wood waste sediments are more prone to be moved around on the surface of the contaminated sediments, exposing the underlying contamination to the surface water.

8.3.3.4 Potential for Risk beyond the Study Area

The contaminated sediments present risks to aquatic communities beyond the study area. In a hypothetical situation, an intense storm could move into the bay with heavy waves that cause major disturbance, mixing, and resuspension of the sediments and NAPL. The effects of phototoxicity coupled with the exposure to the PAH contaminated suspended sediments and NAPL could result in severe impacts to the aquatic community beyond the limits of the study area.

8.3.4 Risk Description Summary

Based upon the review of literature and results of the 1998 and 2001 ERA study, ecological risk associated with the contaminated sediments are likely to be high for both current and future scenarios. Impacts to benthic organisms and immature fish are expected to be present the highest risks. Natural attenuation of the contamination is expected to be a very minimal over a long period of time.

8.4 Uncertainty Analyses

Several sources of uncertainties are associated with ERAs. Categories of uncertainty include: conceptual model uncertainties; natural variation and parameter error; and model error.

8.4.1 Conceptual Model Uncertainties

Conceptual model uncertainties may be associated with the exposure pathways, chemicals of concern, and exposed components.

8.4.1.1 Exposure Pathways

Exposure pathways examined were limited to the direct exposure to sediments in the bioactive zone (0 to 6 inches) and overlying surface waters. However, exposures may occur deeper if tubificids and other oligochaetes burrow deeper into the sediments and expose the deeper contaminants.

8.4.1.2 Chemicals of Concern

Comparison of contaminants to sediment effects benchmarks was primarily related to PAHs, and to a lesser extent VOCs. The contamination is suspected to be associated with historical MGP waste. Many other chemicals were identified to be present including phenols and HAHs, which are also likely associated with the coal tar residuals in the sediment. These chemicals also contribute to the overall toxicity of the sediments.

Non-aqueous phase liquids (NAPL) have been observed in sediments during previous sampling events. The NAPLs have a strong hydrocarbon odor and cause sheening. The NAPLs are suspected to be MGP waste residue and likely contain a myriad of concentrated chemicals. The effects of exposure to the NAPLs was not directly

evaluated in the ERA. One highly contaminated sample suspected to contain NAPL was collected for a 1998 toxicity study of *Chironomus tentans*. As shown on Table 12, survival rates were 0.0 for this exposure. The 1998 FS estimated that the volume of NAPL at the site may range upward from 17,000 gallons of residual NAPL.

8.4.1.3 Exposed Components

The exposure of a variety of potential terrestrial organisms, aquatic plants, and phytoplankton to the contaminated sediments was not directly evaluated in this ERA. Exposure to the contaminants may also present a risk to these components.

8.4.2 Natural Variation

Natural variation uncertainties include substrate differences, spatial variation, and seasonal effects.

8.4.2.1 Substrate Differences

Variations exist in the sediments in the study area with regards to organic matter, organic content, and grain size. These variations likely have some effect on the benthic community and availability of contaminants. Ammonia releases due to the degradation of wood materials may also cause impacts to the benthic communities. Reference samples were collected from both the wood and sand areas to evaluate the potential effects. Review of the data indicates that substrate effects are less pronounced than the contaminant effects.

8.4.2.2 Seasonal Effects

The richness and abundance of the benthic community likely varies with respect to season. Based on literature review, the May 1998 sampling timeframe was optimal for community survey. Furthermore, it was not feasible to wait later in the year for community survey due to project schedule.

8.4.2.3 Spatial Effects

The four stations examined for the 1998 sediment quality triad analysis collected represent a 10 acre area. In 2001, five additional sampling stations were evaluated for chemical analysis and bioassay toxicity studies. Spatial variations are expected to occur over the entire area. This is evident in comparison of toxic units across the site, distribution of wood chip thickness, and variation of community abundance for replicates collected from the 1998 CW station.

8.4.2.4 Local Variation

The laboratory analysis for total organic carbon in the dilution sediments indicated a great deal of variation. Furthermore the dilution series dry weight chemical concentrations did not directly correspond to the volumetric dilutions. This is likely due to presence of large chunks of organic matter and/or NAPL globules that could not be addressed with the homogenization procedures utilized.

8.4.2.5 Chemical Results and Equilibrium Effects

Comparison of the March 29, 2001 preliminary sediment chemical results to the April 30, 2001 final sediment mixture results indicates that the bulk sediment concentrations for PAHs and VOCs increased. It is not clear whether this was a function of the laboratory analysis or due to equilibrium effects which were likely occurring after the sediment homogenization activities.

8.4.3 Model Limitations

Uncertainties related to the model include representativeness of the toxicity test species, test duration; limitations of comparative benchmarks, and statistical limitations.

8.4.3.1 Representativeness of Organisms for Toxicity Studies

Organisms selected for evaluation of sediment toxicity were based on recommended EPA methods. These organisms have been successfully used in the past at other Great Lakes sites to predict toxicity. It has not been confirmed whether all of the test species are actually present in the local environment. However, the toxic effects observed are expected to represent effects on similar species.

8.4.3.2 Duration of Tests

The toxicity tests were only run for 10 days and 28 days. If the tests had been run for a longer duration it is expected that toxic effects would have been more clearly demonstrated for the less contaminated stations.

8.4.3.3 Benchmark Limitations

Several sediment effects benchmarks and SQGs were evaluated. None of the benchmarks or SQGs were developed specifically for the unique aspects of the Chequamegon Bay environment. Benchmarks are not 100% effective at predicting toxicity.

8.4.3.4 Statistical Limitations

It was not economically feasible to collect replicate samples for chemical analysis, and the number of replicate samples were limited for the community survey and toxicity tests. The limited data set is not considered to be statistically powerful.

8.5 Risk Characterization Summary

The integrated weight of evidence from the ERA provides strong evidence of contaminant induced degradation at each of the sediment sampling stations within the limits of contamination shown on Figure 2.

Comparison of the toxic unit threshold values to the remaining sediment chemical data indicates that much of the study area poses current and future ecological risks. This conclusion is further supported by the fact the sediment concentrations exceed several other independent sediment effects benchmarks, as well as total PAH values at other sites where tumors have been identified on fish.

It is unlikely the sediment contamination will naturally attenuate in the near future. The microbial degrader populations are reduced in the area of contamination. Furthermore, long chain PAHs are expected to degrade only at very slow rates in the natural primarily anoxic sediment environment. High contaminant concentrations and NAPLs have been present in the sediments for decades and will continue to be present indefinitely unless remediated.

Future risks to the environment exist because the deeper sediments are more contaminated than those in bioactive zone, and a potential exists for disturbance from natural and anthropogenic forces. Studies indicate that if the sediments are agitated and resuspended, water quality will exceed the NAWQ values for acute and chronic toxicity.

9.0 Risk Management

9.1 Introduction

The results of the ERA indicate that current and future risks exist associated with the contaminated sediments. Decisions will need to be made related to selecting a management strategy to reduce or eliminate these risks. Any risk management decisions made will need to take into consideration that coastal, nearshore zones such as the embayment off the Lakefront Property are one of the systems that support the Lake Superior basin's biological diversity. Much more needs to be learned about the aquatic communities in these systems - their diversity and composition, distribution, condition and conservation needs, to target protection activities more effectively. One of the primary goals of the National Contaminated Sediment Management Strategy (USEPA, 1997b) is to reduce the volume and effects of existing contaminated sediments to aquatic systems and to humans.

9.2 Preliminary Remediation Goals

Sediment preliminary remediation goals will likely be directed at remediation of the offshore area of contamination to initially meet levels at or near background levels (if an ex-situ remediation strategy is employed) for sandy or wood chip sediments.

As shown in Table 21, the impacts to sandy sediments and wood chip sediments were considered separately. For each bioassay toxicity test category, a NOAEC and LOAEC type was determined. The mean value of the NOAEC and LOAEC was calculated to provide a conservative estimate of the level at which impacts, other than minimal impacts, would not be expected to occur. This mean value was compared to the average reference background concentrations for the sediment type, and also to the WDNR recommended threshold effect concentration (TEC) (WDNR, 2002) for the contaminant type. The highest value was selected as the PRG for the sediment type.

Note that background concentrations for each substrate were calculated using only the reference sites, because in most cases analysis of other background sediment samples outside the limits of contamination result in "non-detect" results. Use of the references sites was deemed reasonable because the ecological impacts at these sites appear to be minimal when compared to the grossly contaminated substrate within the 1996 limits of contamination.

9.2.1 PRGs for Sand Sediments

The PRGs recommended for the Sand Sediments are

Total PAHs: 1767 µg/kg DW or 161 µg/g OC;

Total VOCs: 972 µg/kg DW or 97 µg/g OC.

The dry weight PAH PRG (1,767 µg/kg) for total PAHs is the average background value for sandy sediments in the bioactive zone reference samples. It is only slightly higher than the WDNR PAH TEC value (1,610 µg/kg) and should be protective. The value corresponds to a MacDonald CBSQG PEC-Q of less than 0.1, which should provide chronic protection and a low incidence of toxicity to benthic organisms.

The NOC PAH PRG (161 µg/g OC) is set at the WDNR TEC, and is approximately 1.5 times the average background value for sandy sediments in the bioactive zone reference samples. The value corresponds to a ESG TU of 1.4 which should provide chronic protection.

The dry weight VOC PRG (972 µg/kg) and NOC VOC PRG (97 µg/g OC) were set at the cumulative WDNR TECs for benzene, ethylbenzene, and toluene. The values are approximately 20 times greater than the background VOC concentrations.

9.2.2 PRGs for Wood Chip Sediments

The PRGs recommended for the Wood Chip Sediments are:

Total PAHs: 9,750 µg/kg DW or 161 µg/g OC; and

Total VOCs: 972 µg/kg DW or 97 µg/g OC.

The dry weight PAH PRG (9,750 µg/kg) for total PAHs is the average background value for wood chip sediments in the bioactive zone reference samples. It is approximately 6 times higher than the WDNR PAH TEC value (1,610 µg/kg). The value corresponds to a MacDonald CBSQG PEC-Q of less than 0.3, which should provide limited chronic protection.

Levels of PAHs associated with the selected wood chip reference sites for both 1998 and 2001 indicates that these sites are likely influenced by the site contamination. Even though the reference wood sites were selected to be outside the identified limits of the site contamination, the characteristics of the wood chips (low specific gravities) makes them moveable in the bottom currents and flows over the bottom area. The wood chips sampled may have at one time been associated with the highly contaminated sediments within the identified boundaries and then transported outside of the boundaries in bottom currents.

The NOC PAH PRG (161 µg/g OC) is set at the WDNR TEC, and is approximately twice the average background value for wood chip sediments in the bioactive zone reference samples. The value corresponds to a ESG TU of 1.4 which should provide chronic protection.

The dry weight VOC PRG (972 µg/kg) and NOC VOC PRG (97 µg/g OC) were set at the cumulative WDNR TECs for benzene, ethylbenzene, and toluene. The dry weight value is approximately 5 times greater than the background VOC concentrations. The NOC value is approximately 24 times greater than the background VOC concentrations.

9.3 Ecological Risk Management

A Remedial Action Options Feasibility Study (FS) (SEH, 1998d) was previously performed to evaluate remedial action options to reduce the risk to the human health and the environment related to the lakefront property and offshore sediment contamination. The results of this supplemental ERA study support the assumptions of the sediment remediation strategy outlined in the 1998 FS.

The 1998 FS assumed that sediment cleanup would remediate contaminated sediments within the 1996 limits of contamination shown on Figure 3. The FS conservatively assumed that sediments contamination as deep as 10 feet below the lake bottom would be addressed. The volume of contaminated sediments over the 10 acre area was estimated to be 152,000 cubic yards, including 4,000 cubic yards of wood waste and 17,000 to 84,000 gallons of residual tar NAPL.

Several remedial options were considered for the contaminated sediments. The options include combinations of the following approaches: institutional and access controls; engineering controls; capping and confinement; in-situ treatment; partial or complete removal; ex situ treatment; beneficial reuse; and offsite disposal. The lowest cost option (besides "no action") included breakwater installation coupled with access restriction and institutional controls. The highest cost option included a breakwater, phased sediment dredging, treatment, and disposal.

9.3.1 Other Risk Management Considerations

The 1998 FS attempted to evaluate and balance several factors including but not limited to: short term and long term effectiveness; short term and long term risks (human and ecological); technical and regulatory implementability; short and long term site uses; restoration time frames; and economic feasibility.

9.3.2 Ecological Impacts of Remedial Options

Many of the options considered have the potential to increase the risk from short term exposures to contaminated sediments. As discussed previously, significant disturbance could result in the resuspension of contaminated fine sediments and exceedances of acute toxicity values. Therefore, most of the options considered the installation of a permanent breakwater to facilitate control over wave and ice effects and to limit the potential for exposures.

The use of silt curtains alone to limit aqueous exposures is not recommended. Several examples of the failure of silt curtains to control aqueous releases were cited at the May 2001 USEPA Contaminated Sediments Forum (USEPA, 2001c). Silt curtains are often used to control release of suspended solids during navigational dredging projects. Environmental remediation projects differ markedly from navigational dredging, in that the disturbance of the contaminated sediments and NAPLs is likely to release both dissolved and adsorbed chemicals to the water column.

Most of the options being considered would result in the current local offshore ecosystem being drastically changed either via removal or capping, but it is expected that remediation will provide long term benefits to the larger ecosystem. Depending on the type of remediation, modified habitats will recover over time to support aquatic communities to the degree that the conditions allow. Preventing access to the contamination will reduce the potential effects of direct toxicity, phototoxicity, bioaccumulation and food chain transfers, and mutageneity. Organisms (fish, insects, etc.) will not be able to deposit eggs or larvae in contaminated sediments where chance of survival is probably low.

9.3.3 Monitoring

Monitoring will be required during site remediation to determine if clean-up objectives are being met and to limit the potential for unacceptable short term exposures.

Ecological risks during site remediation will be linked to water quality and suspended solids. Monitoring will be required to prevent release of toxics beyond the area of disturbance.

10.0 Summary of Ecological Risk Assessment

The purpose of the ERA was to evaluate the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to potential chemical stressors previously identified in sediments located adjacent to the Ashland Lakefront Property.

Conservative assumptions and screening level exposure estimates used during the screening level ecological risk assessment indicated it was likely that ecological risks exist at the site due to impacts from contaminated sediments. Additional information on the bioactive zone, contaminant toxicity, complete exposure pathways, and the effects of the wood chips layer were required to adequately determine ecological risk at the site.

A study design was developed in 1998 to assess the ecological risks via the Sediment Quality Triad, as well as other lines of evidence. The integrated weight-of-evidence from the ERA provides strong evidence of contaminant induced degradation to the biota at the site. Review of the ecological response to contaminant exposure levels from the ERA studies indicates that significant impacts (>20%) are observed when contamination levels at the site exceed background levels.

Results of the 1998 fish tissue study and 2001 supplemental ERA activities support the findings and conclusions of the 1998 ERA.

Comparison of the existing chemical data to several independent sets of sediment quality guidelines implies that much of the study area poses current and future ecological risks to the benthic and pelagic communities. This conclusion is further supported by the fact the sediment concentrations exceed total PAH values at other sites where tumors have been identified on fish. The 1998 fish tissue study conducted by the WDNR confirms that uptake of PAH into local fish is occurring.

It is unlikely the sediment contamination will naturally attenuate in the near future. Future risks to the environment exist because the deeper sediments are more contaminated than those in bioactive zone, and a potential exists for bottom disturbances from natural and anthropogenic forces.

As in any study of the natural environment, various uncertainties exist. These were acknowledged and addressed by analyzing several measurement endpoints at various levels of exposure.

11.0 Discussion and Recommendations

The current state of the science of ecological risk assessment and management of contaminated sediments is very dynamic. Research is being conducted at many levels by government agencies, national laboratories, and academic centers. SEH attempted to review the relevant literature and discussed concepts with recognized experts in government and academia. As the state of the science moves forward, SEH recommends the assumptions and conclusions of this ERA be reviewed and updated prior to implementation of remedial actions.

Given the current state of the science, the whole ecological risk assessment process and the available tools used in this process have inherent levels of uncertainty associated with their application. The uncertainty associated with the overall risk assessment process can be reduced by weighing and integrating the assessment tools and lines of evidence.

Based on integrating and weighing all the lines of evidence collected from all the steps and years of the ecological risk assessment process for the sediment portion of the Lakefront site, Preliminary Remediation Goals (PRGs) for the contaminated substrates present (wood chips and sand) were developed. Recognizing the uncertainties associated with the ecological risk assessment process prompted the establishment of what are believed to be scientifically sound, and as appropriate reasonably conservative, cleanup goals to protect the biotic resources of the embayment off the Lakefront property, Chequamegon Bay, and in turn the unique Lake Superior ecosystem.

The 1998 and 2001 ERA studies have conclusively shown that the probability for adverse ecological impacts from the contaminated sediments is high.

Additional evidence that could be collected to further substantiate this risk assessment could include benthic invertebrate PAH tissue analysis, caged fish studies, fish bile analysis for PAH metabolites, and/or a wildlife exposures analysis. However, SEH does not recommend these studies be conducted as the existing weight of evidence gathered to date appears to conclusive enough to warrant remediation.

The WDNR and DHFS may wish to update the HHRA to incorporate human health risks associated with water quality impacts expected when sediments are disturbed.

12.0 Standard of Care

The conclusions and recommendations contained in this report were arrived at in accordance with generally accepted professional engineering practice at this time and location. Other than this, no warranty is implied or intended.

GGC/MJB/ls/TJ/JD

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Table 1
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines			Grid Location/Depth (ft)/Date																										
				2100N 1000E	2300N 800E	2300N 1000E	2300N 1300E		2300N 1400E		2300N 1500E		2300N 1600E	2300N 1700E	2400N 1200E	2400N 1300E	2400N 1400E	2400N 1600E	2400N 1700E	2400N 2000E	2400N 2100E		2500N 1300E	2500N 1400E	2500N 1500E		2500N 1600E	2500N 1700E	
	NOAA ERM	MacD CBSQG PEC	MacD CBSQG TEC	4-6	0-4	4-8	0-4	4-6	0-4	6-8	0-4	8-10	0-4	0-4	4-6	0-4	0-4	0-4	0-4	6-8	0-4	4-6	0-4	0-4	0-4	6-8		0-4	6-8
				3/12/96	3/6/96	6/6/96	3/8/96	3/8/96	3/7/96	3/7/96	3/6/96	3/6/96	3/12/96	3/8/96	3/12/96	3/8/96	3/7/96	3/12/96	3/8/96	3/12/96	3/9/96	3/9/96	3/8/96	3/7/96	3/7/96	3/7/96	3/12/96	3/8/96	3/8/96
PAHs[1] (mg/kg)																														
Acenaphthene	0.65	NSE	NSE	BDL	BDL	BDL	23	1.13	23	8.84	120	0.35	82	27	BDL	47	71	21	76	220	BDL	41	53	23	29	0.36	BDL	23	BDL
Acenaphthylene	NSE	NSE	NSE	BDL	BDL	BDL	3.73	BDL	BDL	0.77	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.27	130	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	0.95	0.845	0.057	BDL	BDL	BDL	14	0.35	9.93	3.96	49	BDL	35	10	BDL	16	30	9.03	37	140	BDL	18	19	7.72	9.12	BDL	BDL	7.86	BDL
Benzo(a)Anthracene	1.6	1.05	0.108	BDL	BDL	BDL	15	BDL	4.92	2.02	BDL	BDL	13	BDL	BDL	6.41	BDL	3.36	18	67	1.46	7.66	BDL	4.54	5.04	BDL	BDL	3.89	BDL
Benzo(a)Pyrene	2.5	1.45	0.150	BDL	BDL	BDL	12	BDL	4.24	1.79	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13	49	1.41	BDL	BDL	4.15	4.69	BDL	BDL	3.32	BDL
Benzo(b)Fluoranthene	NSE	NSE	NSE	BDL	BDL	BDL	10	BDL	BDL	1.39	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	36	1.54	BDL	BDL	2.93	3.41	BDL	BDL	BDL	BDL
Benzo(g,h,i)Perylene	NSE	NSE	NSE	BDL	BDL	BDL	5.76	BDL	BDL	0.84	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	2.8	1.29	0.166	BDL	BDL	BDL	15	BDL	4.9	1.88	BDL	BDL	12	BDL	BDL	6.71	BDL	3.32	17	62	1.69	7.41	BDL	4.42	5.04	BDL	BDL	3.98	BDL
Fluoranthene	3.6	2.23	0.423	BDL	BDL	BDL	6.73	0.31	13	4.81	45	0.45	31	9.01	BDL	17	30	8.15	36	160	3.97	19	21	11	14	BDL	BDL	11	BDL
Fluorene	0.64	0.536	0.077	BDL	BDL	BDL	13	0.46	11	4.83	55	BDL	43	13	BDL	20	32	11	45	180	BDL	24	23	11	12	BDL	BDL	11	BDL
Indeno(1,2,3-cd)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	5.5	BDL	BDL	0.82	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.98	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methyl Naphthalene	NSE	NSE	NSE	BDL	BDL	BDL	24	1.31	21	7.81	140	BDL	110	26	BDL	54	79	30	96	460	BDL	57	61	20	23	0.48	BDL	20	BDL
2-Methyl Naphthalene	0.67	NSE	NSE	BDL	BDL	BDL	32	1.81	29	10	180	0.34	140	54	BDL	73	110	35	110	520	BDL	65	84	28	32	0.73	BDL	27	BDL
Naphthalene	2.1	0.561	0.176	BDL	BDL	BDL	38	2.69	48	9.2	240	BDL	150	73	BDL	100	200	35	130	600	1.57	76	130	36	45	1.39	0.44	41	0.3
Phenanthrene	1.38	1.17	0.204	BDL	BDL	BDL	39	1.19	30	12	140	0.75	98	31	BDL	52	90	25	89	420	3.69	54	65	28	35	BDL	BDL	30	BDL
Pyrene	2.2	1.52	0.195	BDL	BDL	BDL	34	0.44	16	6	57	0.59	33	11	BDL	25	36	8.08	37	160	3.23	22	28	16	19	BDL	BDL	14	BDL
2,6-Dimethnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	13	0.47	9.8	4.51	62	BDL	51	13	BDL	20	32	13	42	160	BDL	15	23	8.97	9.87	BDL	BDL	7.75	BDL
Benzo(e)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	8.32	BDL	BDL	1.05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.02	34	1.58	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Ethylnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	16	0.64	13	5.69	79	BDL	64	18	BDL	29	43	15	53	220	BDL	29	32	12	14	BDL	BDL	12	BDL
1-Methylphenanthrene	NSE	NSE	NSE	BDL	BDL	BDL	9.09	BDL	4.69	2.12	23	BDL	21	BDL	BDL	6.42	14	6.15	23	69	BDL	10	BDL	3.68	4.31	BDL	BDL	4.31	BDL
Total PAHs	35	22.8	1.610	BDL	BDL	BDL	337.13	10.8	242.48	90.33	1190	2.48	883	285.01	BDL	472.54	767	223.09	847.29	3687	21.12	445.07	539	221.41	264.48	2.96	0.44	220.11	0.3
LPAHs	NSE	NSE	NSE	BDL	BDL	BDL	215.73	10.05	194.73	67.61	1065	1.44	773	265	BDL	411	687	194.03	685.27	3050	5.26	379	490	174.69	208.99	2.96	0.44	179.61	0.3
HPAHs	NSE	NSE	NSE	BDL	BDL	BDL	121.4	0.75	47.75	22.72	125	1.04	110	20.01	BDL	61.54	80	29.06	162.02	637	15.86	66.07	49	46.72	55.49	BDL	BDL	40.5	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines			Grid Location/Depth (ft)/Date																													
				2500N 1800E			2500N 1900E	2500N 2000E	2500N 2100E		2500N 2200E	2500N 2300E		2500N 2600E		2600N 1200E	2600N 1300E	2600N 1400E		2600N 1500E	2600N 1600E	2600N 1700E	2600N 1800E	2600N 1900E		2600N 2000E	2600N 2100E	2600N 2300E	2600N 2500E	2600N 2700E	2700N 1300E	2700N 1500E
	NOAA ERM	MacD CBSQG PEC	MacD CBSQG TEC	0-4	6-8	8-10	0-4	0-4	0-4	6-8	4-6	6-8	8-10	0-4	6-8	0-4	0-4	0-4	6-8	0-4	0-4	0-4	0-4	0-4	6-8	4-6	0-4	6-8	0-4	0-4	0-4	0-4
				3/11/96	3/11/96	3/11/96	3/8/96	3/11/96	3/9/96	3/9/96	3/9/96	3/10/96	3/10/96	3/11/96	3/11/96	3/8/96	3/7/96	3/7/96	3/7/96	3/12/96	3/12/96	3/8/96	3/11/96	3/9/96	3/9/96	3/11/96	3/9/96	3/10/96	3/11/96	3/11/96	3/7/96	3/7/96
PAHs[1] (mg/kg)																																	
Acenaphthene	0.65	NSE	NSE	0.85	2.25	BDL	31	BDL	BDL	BDL	BDL	19	0.53	BDL	BDL	BDL	79	21	BDL	BDL	BDL	BDL	0.56	9.37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Acenaphthylene	NSE	NSE	NSE	BDL	0.31	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	0.95	0.845	0.057	BDL	1.2	BDL	13	BDL	BDL	BDL	BDL	9.13	BDL	BDL	BDL	BDL	30	8.31	BDL	BDL	BDL	BDL	BDL	4.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)Anthracene	1.6	1.05	0.108	BDL	0.44	BDL	BDL	BDL	BDL	BDL	BDL	4.14	BDL	BDL	BDL	BDL	21	4.4	BDL	BDL	BDL	BDL	BDL	1.63	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)Pyrene	2.5	1.45	0.150	BDL	0.33	BDL	BDL	BDL	BDL	BDL	BDL	3.14	BDL	BDL	BDL	BDL	19	4.02	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(b)Fluoranthene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14	2.81	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(g,h,i)Perylene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	2.8	1.29	0.166	BDL	0.41	BDL	BDL	BDL	BDL	BDL	BDL	3.74	BDL	BDL	BDL	BDL	20	4.35	BDL	BDL	BDL	BDL	BDL	1.53	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	3.6	2.23	0.423	BDL	1.14	BDL	10	BDL	BDL	BDL	BDL	9.76	BDL	BDL	BDL	BDL	46	12	BDL	BDL	BDL	BDL	BDL	4.1	BDL	BDL	BDL	BDL	BDL	BDL	0.54	BDL
Fluorene	0.64	0.536	0.077	0.42	1.41	BDL	15	BDL	BDL	BDL	BDL	12	BDL	BDL	BDL	BDL	38	9.96	BDL	BDL	BDL	BDL	BDL	5.33	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.77	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methyl Naphthalene	NSE	NSE	NSE	0.97	2.29	BDL	41	BDL	0.32	BDL	0.37	27	1.39	BDL	BDL	BDL	63	19	BDL	BDL	BDL	BDL	0.98	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Methyl Naphthalene	0.67	NSE	NSE	1.1	2.68	BDL	51	0.32	0.47	BDL	0.46	31	1.6	BDL	BDL	BDL	85	26	BDL	BDL	BDL	BDL	1.01	14	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	2.1	0.561	0.176	1.3	2.4	BDL	58	0.41	1.06	BDL	0.83	36	2.14	BDL	BDL	BDL	79	37	BDL	BDL	BDL	BDL	2.19	16	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	1.38	1.17	0.204	0.96	3.22	BDL	35	BDL	BDL	BDL	BDL	27	BDL	BDL	BDL	0.34	100	29	BDL	BDL	BDL	BDL	BDL	11	0.5	BDL	BDL	BDL	BDL	BDL	0.52	BDL
Pyrene	2.2	1.52	0.195	BDL	1.28	BDL	13	BDL	BDL	BDL	BDL	12	BDL	BDL	BDL	BDL	59	15	BDL	BDL	BDL	BDL	BDL	4.55	BDL	BDL	BDL	BDL	BDL	BDL	0.62	BDL
2,6-Dimethnaphthalene	NSE	NSE	NSE	0.33	1.08	BDL	14	BDL	BDL	BDL	BDL	6.85	BDL	BDL	BDL	BDL	33	8.52	BDL	BDL	BDL	BDL	BDL	4.58	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(e)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Ethylnaphthalene	NSE	NSE	NSE	0.43	1.32	BDL	20	BDL	BDL	BDL	BDL	14	0.51	BDL	BDL	BDL	46	12	BDL	BDL	BDL	BDL	BDL	6.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methylphenanthrene	NSE	NSE	NSE	BDL	0.66	BDL	6.43	BDL	BDL	BDL	BDL	5.05	BDL	BDL	BDL	BDL	14	3.81	BDL	BDL	BDL	BDL	BDL	2.15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total PAHs	35	22.8	1.610	BDL	BDL	BDL	307.43	0.73	1.85	BDL	1.66	219.81	6.17	BDL	BDL	0.34	777.77	217.18	BDL	BDL	BDL	BDL	4.74	95.38	0.5	BDL	BDL	BDL	BDL	BDL	1.68	BDL
LPAHs	NSE	NSE	NSE	BDL	BDL	BDL	278	0.73	1.85	BDL	1.66	181.98	6.17	BDL	BDL	0.34	553	170.79	BDL	BDL	BDL	BDL	4.74	81.42	0.5	BDL	BDL	BDL	BDL	BDL	0.52	BDL
HPAHs	NSE	NSE	NSE	BDL	BDL	BDL	29.43	BDL	BDL	BDL	BDL	37.83	BDL	BDL	BDL	BDL	224.77	46.39	BDL	BDL	BDL	BDL	BDL	13.96	BDL	BDL	BDL	BDL	BDL	BDL	1.16	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines			Grid Location/Depth (ft)/Date																								
				2700N 160E	2700N 1700E	2700N 1800E		2700N 1900E	2700N 2000E	2700N 2100E	2700N 2200E		2700N 2300E	2700N 2500E	2800N 1300E	2800N 1400E	2800N 1500E	2800N 1600E	2800N 1700E	2800N 1800E	2800N 1900E	2800N 2000E	2800N 2100E	2800N 2200E	2800N 2300E	2800N 2400E	2800N 2500E
	NOAA ERM	MacD CBSQG PEC	MacD CBSQG TEC	0-4	0-4	0-4	4-6	0-4	4-6	0-4	4-6	6-8	4-6	8-10	0-4	6-8	0-4	0-4	0-4	0-4	0-4	0-4	0-4	4-6	0-4	0-4	0-4
				3/12/96	3/8/96	3/11/96	3/11/96	3/9/96	3/11/96	3/9/96	3/11/96	3/11/96	3/10/96	3/12/96	3/7/96	3/7/96	3/7/96	3/12/96	3/8/96	3/11/96	3/9/96	3/11/96	3/9/96	3/11/96	3/10/96	3/10/96	3/10/96
PAHs[1] (mg/kg)																												
Acenaphthene	0.65	NSE	NSE	BDL	BDL	0.41	7.63	9.81	220	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.41	2.25	BDL	BDL	BDL	11	BDL	BDL
Acenaphthylene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	22	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	0.95	0.845	0.057	BDL	BDL	BDL	4.54	4.02	99	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.26	BDL	BDL	BDL	5.79	BDL	BDL
Benzo(a)Anthracene	1.6	1.05	0.108	BDL	BDL	BDL	2.14	BDL	37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.63	BDL	BDL	BDL	3.24	BDL	BDL
Benzo(a)Pyrene	2.5	1.45	0.150	BDL	BDL	BDL	1.6	BDL	26	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.42	BDL	BDL	BDL	2.72	BDL	BDL
Benzo(b)Fluoranthene	NSE	NSE	NSE	BDL	BDL	BDL	1.23	BDL	19	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.36	BDL	BDL	BDL	2.03	BDL	BDL
Benzo(g,h,i)Perylene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.35	BDL	BDL
Chrysene	2.8	1.29	0.166	BDL	BDL	BDL	1.91	BDL	36	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.57	BDL	BDL	BDL	3.23	BDL	BDL
Fluoranthene	3.6	2.23	0.423	BDL	BDL	BDL	4.82	3.52	90	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.37	BDL	BDL	BDL	7.17	BDL	BDL
Fluorene	0.64	0.536	0.077	BDL	BDL	BDL	4.76	5.27	130	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.42	BDL	BDL	BDL	6.85	BDL	BDL
Indeno(1,2,3-cd)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methyl Naphthalene	NSE	NSE	NSE	BDL	BDL	0.86	6.37	12	290	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.9	2.52	BDL	BDL	BDL	13	BDL	BDL
2-Methyl Naphthalene	0.67	NSE	NSE	BDL	BDL	0.83	7.58	15	330	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.89	3.09	BDL	BDL	BDL	15	BDL	BDL
Naphthalene	2.1	0.561	0.176	BDL	BDL	1.89	4.05	18	350	BDL	BDL	BDL	0.42	BDL	BDL	BDL	BDL	BDL	BDL	3.1	3.25	BDL	BDL	BDL	15	BDL	BDL
Phenanthrene	1.38	1.17	0.204	BDL	BDL	BDL	12	12	250	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.39	3.32	BDL	BDL	BDL	17	BDL	BDL
Pyrene	2.2	1.52	0.195	BDL	BDL	BDL	5.07	3.85	100	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.56	BDL	BDL	BDL	8.08	BDL	BDL
2,6-Dimethnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	3.81	4.24	120	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.13	BDL	BDL	BDL	3.92	BDL	BDL
Benzo(e)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.76	BDL	BDL
2-Ethylnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	4.77	5.57	150	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.48	BDL	BDL	BDL	7.52	BDL	BDL
1-Methylphenanthrene	NSE	NSE	NSE	BDL	BDL	BDL	2.78	2.13	59	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.72	BDL	BDL	BDL	2.85	BDL	BDL
Total PAHs	35	22.8	1.610	BDL	BDL	3.99	75.06	95.41	2328	BDL	BDL	BDL	0.42	BDL	BDL	BDL	BDL	BDL	BDL	5.69	25.35	BDL	BDL	BDL	127.51	BDL	BDL
LPAHs	NSE	NSE	NSE	BDL	BDL	3.99	55.51	85.91	1961	BDL	BDL	BDL	0.42	BDL	BDL	BDL	BDL	BDL	BDL	5.69	19.72	BDL	BDL	BDL	95.08	BDL	BDL
HPAHs	NSE	NSE	NSE	BDL	BDL	BDL	19.55	9.5	367	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.63	BDL	BDL	BDL	32.43	BDL	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines			Grid Location/Depth (ft)/Date																										
				2900N 1400E	2900N 1500E	2900N 1600E	2900E 1700E	2900N 1800E	2900N 1900E	2900N 2000E	2900N 2100E	2900N 2200E	2900N 2300E		2900N 2400E	2900N 2500E	3100N 1300E	3100N 1500E		3100N 1700E		3100N 1900E		3100N 2100E		3100N 2300E		3500N 1500E		3500N 2000E
	NOAA ERM	MacD CBSQG PEC	MacD CBSQG TEC	0-4	2-4	0-4	0-4	4-6	0-4	0-2	0-4	0-4	0-4	10-12	4-6	0-4	8-10	0-4	6-8	0-4	6-8	0-4	6-8	0-4	8-10	0-4	12-14	6-8	16-18	4-6
				3/7/96	3/12/96	3/12/96	3/8/96	3/11/96	3/9/96	3/11/96	3/9/96	3/11/96	3/10/96	3/10/96	3/10/96	3/10/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	2/27/96	2/28/96	3/11/96
PAHs[1] (mg/kg)																														
Acenaphthene	0.65	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Acenaphthylene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	0.95	0.845	0.057	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)Anthracene	1.6	1.05	0.108	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(a)Pyrene	2.5	1.45	0.150	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(b)Fluoranthene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(g,h,i)Perylene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	2.8	1.29	0.166	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	3.6	2.23	0.423	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluorene	0.64	0.536	0.077	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methyl Naphthalene	NSE	NSE	NSE	0.89	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Methyl Naphthalene	0.67	NSE	NSE	1.24	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	2.1	0.561	0.176	2.34	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	1.38	1.17	0.204	0.48	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	2.2	1.52	0.195	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2,6-Dimethnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(e)Pyrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2-Ethylnaphthalene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1-Methylphenanthrene	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total PAHs	35	22.8	1.610	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
LPAHs	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
HPAHs	NSE	NSE	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines	Grid Location/Depth (ft)/Date																										
		2100N 1000E	2300N 800E	2300N 1000E	2300N 1300E		2300N 1400E		2300N 1500E		2300N 1600E	2300N 1700E	2400N 1200E	2400N 1300E	2400N 1400E	2400N 1600E	2400N 1700E	2400N 2000E	2400N 2100E		2500N 1300E	2500N 1400E	2500N 1500E		2500N 1600E	2500N 1700E	
	ORNL PRG	4-6	0-4	4-8	0-4	4-6	0-4	6-8	0-4	8-10	0-4	0-4	4-6	0-4	0-4	0-4	0-4	6-8	0-4	4-6	0-4	0-4	0-4	6-8		0-4	6-8
		3/12/96	3/6/96	3/6/96	3/8/96	3/8/96	3/7/96	3/7/96	3/6/96	3/6/96	3/12/96	3/8/96	3/12/96	3/8/96	3/7/96	3/12/96	3/8/96	3/12/96	3/9/96	3/9/96	3/8/96	3/7/96	3/7/96	3/7/96	3/12/96	3/8/96	3/8/96
VOCs[2] (µg/kg)																												
Benzene	160	BDL	BDL	BDL	6,900	440	1,100	120	1,900	BDL	1,300	3,000	BDL	520	5,900	2,700	55,000	4,300	96	220	5,100	BDL	BDL	BDL	BDL	BDL	BDL
n-Butylbenzene	NSE	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	640	--	--	--	--	--	--	BDL	--	--	--	--
Ethylbenzene	5,400	BDL	BDL	BDL	47,000	750	8,800	200	5,500	35	3,300	16,000	BDL	15,000	29,000	14,000	510,000	140,000	470	19,000	88,000	270	1,100	BDL	250	38,000	BDL
Isopropylbenzene	NSE	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	1,500	--	--	--	--	--	--	BDL	--	--	--	--
p-Isopropyltoluene	NSE	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	450	--	--	--	--
n-Propylbenzene	NSE	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	600	--	--	--	--	--	--	BDL	--	--	--	--
Toluene	50	BDL	BDL	BDL	2,800	BDL	1,900	39	1,200	BDL	2,000	5,000	BDL	2,100	13,000	4,700	220,000	37,000	300	1,700	18,000	48	BDL	39	BDL	4,100	BDL
1,1,1-Trichloroethane	NSE	--	760	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	BDL	--	--	--	--
1,2,4-Trimethylbenzene	NSE	BDL	BDL	BDL	17,000	160	4,300	64	4,000	BDL	1,800	8,600	BDL	7,800	11,000	8,800	290,000	120,000	410	20,000	37,000	240	930	BDL	84	24,000	BDL
1,3,5-Trimethylbenzene	NSE	BDL	BDL	BDL	5,900	53	1,500	BDL	1,500	BDL	590	2,700	BDL	2,600	4,000	2,900	91,000	40,000	160	6,700	12,000	94	460	BDL	34	8,000	BDL
Total Xylenes	16	BDL	BDL	BDL	44,000	580	7,800	172	5,700	BDL	3,600	17,600	BDL	14,900	24,300	16,200	590,000	180,000	700	27,000	81,000	237	1,050	BDL	184	38,000	BDL

Analytical Parameters	Sediment Quality Guidelines	Grid Location/Depth (ft)/Date																										
		2500N 1800E		2500N 1900E	2500N 2000E	2500N 2100E		2500N 2200E	2500N 2300E		2500N 2600E		2600N 1200E	2600N 1300E	2600N 1400E		2600N 1500E	2600N 1600E	2600N 1700E	2600N 1900E		2600N 2000E	2600N 2100E	2600N 2300E	2600N 2500E	2600N 2700E	2700N 1300E
	ORNL PRG	6-8	8-10	0-4	0-4	0-4	6-8	4-6	6-8	8-10	0-4	6-8	0-4	0-4	0-4	6-8	0-4	0-4	0-4	0-4	6-8	4-6	0-4	6-8	0-4	0-4	0-4
		3/11/96	3/11/96	3/8/96	3/11/96	3/9/96	3/9/96	3/9/96	3/10/96	3/10/96	3/11/96	3/11/96	3/8/96	3/7/96	3/7/96	3/7/96	3/12/96	3/12/96	3/8/96	3/9/96	3/9/96	3/11/96	3/9/96	3/10/96	3/11/96	3/11/96	3/7/96
VOCs[2] (µg/kg)																											
Benzene	160	8,900	74	BDL	BDL	BDL	BDL	BDL	140	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	750	57	BDL	BDL	BDL	BDL	BDL	BDL
n-Butylbenzene	NSE	--	--	1,000	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	5,400	120,000	77	9,300	BDL	BDL	BDL	84	8,700	120	BDL	BDL	BDL	660	890	BDL	BDL	BDL	BDL	13,000	65	BDL	BDL	BDL	BDL	BDL	BDL
Isopropylbenzene	NSE	--	--	1,600	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	--	--	--	--
p-Isopropyltoluene	NSE	--	--	2,300	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	--	--	--	--
n-Propylbenzene	NSE	--	--	230	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	--	--	--	--
Toluene	50	42,000	BDL	300	BDL	BDL	BDL	BDL	1,300	BDL	BDL	BDL	BDL	BDL	84	BDL	BDL	BDL	BDL	3,200	51	BDL	BDL	BDL	BDL	BDL	220
1,1,1-Trichloroethane	NSE	--	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	NSE	73,000	BDL	6,800	BDL	BDL	BDL	92	10,000	52	BDL	BDL	BDL	2,700	730	BDL	BDL	BDL	BDL	7,900	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,3,5-Trimethylbenzene	NSE	22,000	BDL	2,200	BDL	BDL	BDL	34	3,600	BDL	BDL	BDL	BDL	1,300	320	BDL	BDL	BDL	BDL	2,400	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Xylenes	16	130,000	50	11,200	BDL	BDL	BDL	143	12,700	155	BDL	BDL	BDL	1,140	920	BDL	BDL	BDL	BDL	15,000	43	BDL	BDL	BDL	BDL	BDL	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines	Grid Location/Depth (ft)/Date																									
		2700N 1400E	2700N 1500E	2700N 1600E	2700N 1700E	2700N 1800E		2700N 1900E	2700N 2000E	2700N 2100E	2700N 2200E		2700N 2300E	2700N 2500E	2800N 1300E	2800N 1400E		2800N 1500E	2800N 1600E	2800N 1700E	2800N 1900E	2800N 2000E	2800N 2100E	2800N 2200E	2800N 2300E	2800N 2400E	2800N 2500E
	ORNL PRG	0-4	0-4	0-4	0-4	0-4	4-6	0-4	4-6	0-4	4-6	6-8	4-6	8-10	0-4	0-4	6-8	0-4	0-4	0-4	0-4	0-4	0-4	4-6	0-4	0-4	0-4
		3/7/96	3/7/96	3/12/96	3/8/96	3/11/96	3/11/96	3/9/96	3/11/96	3/9/96	3/11/96	3/11/96	3/10/96	3/12/96	3/7/96	3/6/96	3/7/96	3/12/96	3/12/96	3/8/96	3/9/96	3/11/96	3/9/96	3/11/96	3/10/96	3/10/96	3/10/96
VOCs[2] (µg/kg)																											
Benzene	160	BDL	BDL	BDL	BDL	BDL	BDL	390	2,700	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
n-Butylbenzene	NSE	--	BDL	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	5,400	35	BDL	BDL	BDL	480	180	24,000	180,000	BDL	BDL	BDL	410	BDL	BDL	BDL	BDL	BDL	BDL	BDL	590	BDL	BDL	BDL	950	BDL	BDL
Isopropylbenzene	NSE	--	BDL	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
p-Isopropyltoluene	NSE	--	BDL	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
n-Propylbenzene	NSE	--	BDL	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	50	88	96	BDL	38	BDL	BDL	2,400	17,000	54	BDL	BDL	53	BDL	200	94	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NSE	--	200	--	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	NSE	280	BDL	BDL	BDL	250	89	13,000	130,000	BDL	BDL	BDL	280	BDL	BDL	BDL	BDL	BDL	BDL	BDL	590	BDL	BDL	BDL	1,300	BDL	BDL
1,3,5-Trimethylbenzene	NSE	130	BDL	BDL	BDL	77	BDL	4,500	38,000	BDL	BDL	BDL	100	BDL	BDL	BDL	BDL	BDL	BDL	BDL	200	BDL	BDL	BDL	530	BDL	BDL
Total Xylenes	16	80	BDL	BDL	BDL	560	192	28,100	192,000	BDL	BDL	BDL	520	BDL	BDL	BDL	BDL	BDL	BDL	BDL	760	BDL	BDL	BDL	1,410	BDL	BDL

Analytical Parameters	Sediment Quality Guidelines	Grid Location/Depth (ft)/Date																											
		2900N 1400E	2900N 1500E		2900N 1600E	2900N 1700E	2900N 1800E	2900N 1900E	2900N 2000E	2900N 21003	2900N 2200E	2900N 2300E		2900N 2400E	2900N 2500E	3100N 1300E		3100N 1500E		3100N 1700E		3100N 1900E		3100N 2100E		3100N 2300E		3500N 1500E		3500N 2000E
	ORNL PRG	0-4	2-4	6-8	0-4	0-4	4-6	0-4	0-2	0-4	0-4	0-4	10-12	4-6	0-4	0-4	8-10	0-4	6-8	0-4	6-8	0-4	6-8	0-4	8-10	0-4	12-14	6-8	16-18	4-6
		3/7/96	3/12/96	3/12/96	3/12/96	3/8/96	3/11/96	3/9/96	3/11/96	3/9/96	3/11/96	3/10/96	3/10/96	3/10/96	3/10/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	3/12/96	2/27/96	2/28/96	3/11/96
VOCs[2] (µg/kg)																														
Benzene	160	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
n-Butylbenzene	NSE	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--
Ethylbenzene	5,400	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Isopropylbenzene	NSE	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--
p-Isopropyltoluene	NSE	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--
n-Propylbenzene	NSE	BDL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--
Toluene	50	130	BDL	BDL	76	BDL	BDL	74	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,1,1-Trichloroethane	NSE	250	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	BDL	--	--
1,2,4-Trimethylbenzene	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1,3,5-Trimethylbenzene	NSE	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Xylenes	16	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 1 (Continued)
1996 Sediment Investigation Chemical Data - Dry Weight

Analytical Parameters	Sediment Quality Guidelines			Grid Location/Depth (ft)/Date									
	NOAA ERM	MacD CBSQG PEC	MacD CBSQG TEC	2300N 800E	2400N 1600E	2500N 1500E	2500N 1800E	2500N 1900E	2600N 1500E	2700N 1500E	2700N 1700E	2800N 1800E	2900N 1400E
				0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4	0-4
				3/6/96	3/12/96	3/7/96	3/11/96	3/8/96	3/12/96	3/7/96	3/8/96	3/11/96	3/7/96
Metals (mg/kg)													
Arsenic	85	33	9.8	1.2	1.1	1	1	0.5	1.2	--	1.3	0.9	1
Cadmium	9.0	5.0	0.99	BDL	BDL	BDL	BDL	BDL	BDL	--	0.1	BDL	BDL
Chromium	145	111	43.4	3.7	3.3	4.6	4.5	2.6	7.3	--	5.9	3.4	5.2
Copper	390	149	31.6	2	1.9	2.8	2.6	1.2	3.9	--	3.2	1.4	3
Lead	110	128	35.8	1.2	1.4	1.5	3.3	0.8	2.5	--	2.2	1	2.4
Nickel	50	48	22.7	3.9	2.6	3.9	3.1	2.1	5.5	--	4.1	2.3	4.2
Zinc	270	459	121	5.7	5.7	9.7	7.8	3.5	12	--	8.7	6.8	9.3
Indicators (mg/kg)													
Total Organic Carbon				BDL	1,200	--	>16,000	1,700	1,100	9,100	2,600	2,700	2,500
Total Cyanide				BDL	19	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulfide				BDL	BDL	--	--	BDL	BDL	BDL	BDL	BDL	44

*MacDonald CBSQC TECand PEC for total PAHs are total of 13 PAHs including acenaphthene, achnaphthylene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, benzo(a)anthracene, dibelze(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene

BDL = Below laboratory detection limit

-- = Not analyzed for

[1] = PAH list is not complete; PAHs not listed are BDL

[2] = VOC list is not complete; VOCs not listed are BDL

Compiled by: JJT Checked by: KEA

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Table 2 - 1996 Sediment Investigation Chemical Data Normalized to Organic Carbon
0 - 4 ft Interval

	Sediment Quality Guidelines		Grid Location/Depth													
	Ontario SEL	WDNR TEC	2300N 1300E 0 - 4	2300N 1400E 0 - 4	2300N 1500E 0 - 4	2300N 1600E 0 - 4	2300N 1700E 0 - 4	2400N 1300E 0 - 4	2400N 1400E 0 - 4	2400N 1600E 0 - 4	2400N 1700E 0 - 4	2400N 2100E 0 - 4	2500N 1300E 0 - 4	2500N 1400E 0 - 4	2500N 1500E 0 - 4	2500N 1700E 0 - 4
PAHs (ug/g TOC)																
Acenapthene		0.67	5,610	5,610	29,268	20,000	6,585	11,463	17,317	5,122	18,537		12,927	5,610	7,073	5,610
Acenapthylene		0.59	910								1,773					
Anthracene	370	5.72	3,415	2,422	11,951	8,537	2,439	3,902	7,317	2,202	9,024		4,634	1,883	2,224	1,917
Benzo(a)anthracene	1,480	10.8	3,659	1,200		3,171		1,563		820	4,390	356		1,107	1,229	949
Benzo(a)pyrene	1,440	15	2,927	1,034							3,171	344		1,012	1,144	810
Benzo(b)flouranthene		24	2,439								2,439	376		715	832	
Benzo (ghi) perylene	320	17	1,405													
Chrysene	460	16.6	3,659	1,195		2,927		1,637		810	4,146	412		1,078	1,229	971
Flouranthene	1,020	42.3	1,641	3,171	10,976	7,561	2,198	4,146	7,317	1,988	8,780	968	5,122	2,683	3,415	2,683
Fluorene	160	7.74	3,171	2,683	13,415	10,488	3,171	4,878	7,805	2,683	10,976		5,610	2,683	2,927	2,683
Indeno(123-cd)pyrene	320	20	1,341									239				
1-Methylnaphthalene			5,854	5,122	34,146	26,829	6,341	13,171	19,268	7,317	23,415		14,878	4,878	5,610	4,878
2-Methylnaphthalene		2.02	7,805	7,073	43,902	34,146	13,171	17,805	26,829	8,537	26,829		20,488	6,829	7,805	6,585
Naphthalene		17.6	9,268	11,707	58,537	36,585	17,805	24,390	48,780	8,537	31,707	383	31,707	8,780	10,976	10,000
Phenanthrene	950	20.4	9,512	7,317	34,146	23,902	7,561	12,683	21,951	6,098	21,707	900	15,854	6,829	8,537	7,317
Pyrene	850	19.5	8,293	3,902	13,902	8,049	2,683	6,098	8,780	1,971	9,024	788	6,829	3,902	4,634	3,415
2,6-Dimethylnaphthalene			3,171	2,390	15,122	12,439	3,171	4,878	7,805	3,171	10,244		5,610	2,188	2,407	1,890
Benzo(e)pyrene			2,029								1,956	385				
2-Ethylnaphthalene			3,902	3,171	19,268	15,610	4,390	7,073	10,488	3,659	12,927		7,805	2,927	3,415	2,927
1-Methylphenanthrene			2,217	1,144	5,610	5,122		1,566	3,415	1,500	5,610			898	1,051	1,051
Total PAHs	10,000	161	82,227	59,141	290,244	215,366	69,515	115,254	187,073	54,412	206,656	5,151	131,463	54,002	64,507	53,685

Table 2 - 1996 Sediment Investigation Chemical Data Normalized to Organic Carbon (continued)
0 - 4 ft Interval

	Sediment Quality Guidelines		Grid Location/Depth															
	Ontario SEL	WDNR TEC	2500N 1800E 0 - 4	2500N 1900E 0 - 4	2500N 2000E 0 - 4	2500N 2100E 0 - 4	2500N 1200E 0 - 4	2600N 1300E 0 - 4	2600N 1400E 0 - 4	2600N 1800E 0 - 4	2600N 1900E 0 - 4	2700N 1300E 0 - 4	2700N 1800E 0 - 4	2700N 1900E 0 - 4	2800N 1800E 0 - 4	2800N 1900E 0 - 4	2800N 2300E 0 - 4	2900N 1400E 0 - 4
PAHs (ug/g TOC)																		
Acenapthene		0.67	207	7,561				19,268	5,122	137	2,285		100	2,393	100	549	2683	
Acenapthylene		0.59																
Anthracene	370	5.72		3,171				7,317	2,027		985			980		307	1412	
Benzo(a)anthracene	1,480	10.8						5,122	1,073		398					154	790	
Benzo(a)pyrene	1,440	15						4,634	980							102	663	
Benzo(b)flouranthene		24						3,415	685							88	495	
Benzo (ghi) perylene	320	17						2,439									329	
Chrysene	460	16.6						4,878	1,061		373					139	788	
Flouranthene	1,020	42.3		2,439				11,220	2,927		1,000	132		859		334	1749	
Fluorene	160	7.74	102	3,659				9,268	2,429		1,300			1,285		346	1671	
Indeno(123-cd)pyrene	320	20						2,139										
1-Methylnaphthalene			237	10,000		78		15,366	4,634	239	2,683		210	2,927	220	615	3171	217
2-Methylnaphthalene		2.02	268	12,439	78	115		20,732	6,341	246	3,415		202	3,659	217	754	3659	302
Naphthalene		17.6	317	14,146	100	259		19,268	9,024	534	3,902		461	4,390	756	793	3659	571
Phenanthrene	950	20.4	234	8,537			83	24,390	7,073		2,683	127		2,927	95	810	4146	117
Pyrene	850	19.5		3,171				14,390	3,659		1,110	151		939		380	1971	
2,6-Dimethylnaphthalene			80	3,415				8,049	2,078		1,117			1,034		276	956	
Benzo(e)pyrene								3,171									429	
2-Ethylnaphthalene			105	4,878				11,220	2,927		1,488			1,359		361	1834	
1-Methylphenanthrene				1,568				3,415	929		524			520		176	695	
Total PAHs	10,000	161	1,551	74,983	178	451	83	189,700	52,971	1,156	23,263	410	973	23,271	1388	6183	31100	1207

Table 2 - 1996 Sediment Investigation Chemical Data Normalized to Organic Carbon (continued)
4 -10 ft Interval

	Sediment Quality Guidelines		*Grid Location/Depth*															
	Ontario SEL	WDNR TEC	2300N 1300E 4 - 6	2300N 1400E 6 - 8	2300N 1500E 8 - 10	2400N 2000E 6 - 8	2400N 2100E 4 - 6	2500N 1500E 6 - 8	2500N 1700E 6 - 8	2500N 1800E 6 - 8	2500N 2200E 6 - 8	2500N 2300E 6 - 8	2500N 2300E 8 - 10	2600N 1900E 6 - 8	2700N 1800E 4 - 6	2700N 2000E 4 - 6	2700N 2300E 4 - 6
PAHs (ug/g TOC)																	
Acenapthene		1	276	2,156	85	53,659	10,000	88		549		4,634	129		1,861	53,659	
Acenapthylene		1		188		31,707				76						5,366	
Anthracene	370	6	85	966		34,146	4,390			293		2,227			1,107	24,146	
Benzo(a)anthracene	1,480	11		493		16,341	1,868			107		1,010			522	9,024	
Benzo(a)pyrene	1,440	15		437		11,951				80		766			390	6,341	
Benzo(b)flouranthene		24		339		8,780									300	4,634	
Benzo (ghl) perylene	320	17		205													
Chrysene	460	17		459		15,122	1,807			100		912			466	8,780	
Flouranthene	1,020	42	76	1,173	110	39,024	4,634			278		2,380			1,176	21,951	
Fluorene	160	8	112	1,178		43,902	5,854			344		2,927			1,161	31,707	
Indeno(123-cd)pyrene	320	20		200													
1-Methylnaphthalene			320	1,905		112,195	13,902	117		559	90	6,585	339		1,554	70,732	
2-Methylnaphthalene		2	441	2,439	83	126,829	15,854	178		654	112	7,561	390		1,849	80,488	
Naphthalene		18	656	2,244		146,341	18,537	339	73	585	202	8,780	522		988	85,366	102
Phenanthrene	950	20	290	2,927	183	102,439	13,171			785		6,585		122	2,927	60,976	
Pyrene	850	20	107	1,463	144	39,024	5,366			312		2,927			1,237	24,390	
2,6-Dimethylnaphthalene			115	1,100		39,024	3,659			263		1,671			929	29,268	
Benzo(e)pyrene				256		8,293											
2-Ethylnaphthalene			156	1,388		53,659	7,073			322		3,415	124		1,163	36,585	
1-Methylphenanthrene				517		16,829	2,439			161		1,232			678	14,390	
Total PAHs	10,000	161	2,634	22,032	605	899,268	108,554	722	73	5,468	405	53,612	1,505	122	18,307	567,805	102

Table 2 1996 Sediment Investigation Data Normalized to Organic Carbon (continued)

Grid Location/ Depth (ft)

	WDNR TEC	2300N 1300E	2300N 1400E	2300N 1500E	2300N 1600E	2300N 1700E	2400N 1300E	2400N 1400E	2400N 1600E	2400N 1700E	2400N 2100E	2500N 1300E
	EPA SQAL	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4
Average TOC (mg/kg)		4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100
VOCs (ug/g TOC)	(ug/g TOC)											
Benzene	5.7	1,683	268	463	317	732	127	1,439	659	13,415	23	1,244
Ethylbenzene	480.0	11,463	2,146	1,341	805	3,902	3,659	7,073	3,415	124,390	115	21,463
Toluene	89.0	683	463	293	488	1,220	512	3,171	1,146	53,659	73	4,390
Xylenes	2.5	10,732	1,902	1,390	878	4,293	3,634	5,927	3,951	143,902	171	19,756

	WDNR TEC	2500N 1400E	2500N 1500E	2500N 1700E	2500N 1900E	2500N 2200E	2600N 1300E	2600N 1400E	2600N 1900E	2700N 1300E	2700N 1400E	2700N 1500E
	EPA SQAL	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4
Average TOC (mg/kg)		4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100
VOCs (ug/g TOC)	(ug/g TOC)											
Benzene	5.7								183			
Ethylbenzene	480.0	66	268	9,268	2,268	20	161	217	3,171		9	
Toluene	89.0	12		1,000	73			20	780	54	21	23
Xylenes	2.5	58	256	9,268	2,732	35	278	224	3,659		20	

	WDNR TEC	2700N 1700E	2700N 1800E	2700N 1900E	2700N 2100E	2800N 1300E	2800N 1400E	2800N 1900E	2800N 2300E	2900N 1400E	2900N 1600E	2900N 1900E
	EPA SQAL	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4	0 - 4
Average TOC (mg/kg)		4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100
VOCs (ug/g TOC)	(ug/g TOC)											
Benzene	5.7			95								
Ethylbenzene	480.0		117	5,854				144	232			
Toluene	89.0	9		585	13	49	23			32	19	18
Xylenes	2.5		137	6,854				185	344			

NOC VOCs (ug/g TOC) 4-6 ft, 6-8 ft, 8 -10 ft intervals - 1996 data

	WDNR TEC	2300N 1300E	2300N 1400E	2300N 1500E	2400N 2000E	2400N 2100E	2500N 1500E	2500N 1800E	2500N 1800E	2500N 2200E	2500N 2300E	2500N 2300E
	EPA SQAL	4 - 6	6 - 8	8 - 10	6 - 8	4 - 6	6 - 8	6 - 8	8 - 10	4 - 6	6 - 8	8 - 10
Average TOC (mg/kg)		4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100
VOCs (ug/g TOC)	(ug/g TOC)											
Benzene	5.7	107	29		1,049	54		2,171	18		34	
Ethylbenzene	480.0	183	49	9	34,146	4,634		29,268	19	20	2,122	29
Toluene	89.0		10		9,024	415	10	10,244			317	
Xylenes	2.5	141	42		43,902	6,585		31,707	12	35	3,098	38

	WDNR TEC	2600N 1900E	2700N 1800E	2700N 2000E	2700N 2300E
	EPA SQAL	6 - 8	4 - 6	4 - 6	4 - 6
Average TOC (mg/kg)		4,100	4,100	4,100	4,100
VOCs (ug/g TOC)	(ug/g TOC)				
Benzene	5.7	14		659	
Ethylbenzene	480.0	16	44	43,902	100
Toluene	89.0	12		4,146	13
Xylenes	2.5	10	47	46,829	127

Table 3 - 1996 Sediment Investigation Geotechnical Data

Sample Collection Date	Location:		Interval (ft)	Field Log Description	Soil Classification	% Gravel	% Sand	% Silt	% Clay	% Clay +Silt	Moisture Content %	L.O.I. Organic Content %	Specific Gravity	Falling Head Perm,Kv (cm/s)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio
			0 - 0.5 ft														
5/98	2600N	2100E	0 -0.5	wood chips	not classified (nc)								1.49				
5/98	2800N	2500E	0 - 0.5	sand with trace wood chips	Poorly Graded Sand with Silt, SP-SM	6.6	83.5			9.9			2.65				
			0 - 4 ft														
3/96	2100N	1000E	0 - 2	chips	nc						145.7	53.7					
3/96	2300N	1000E	0 - 4	silty sand with wood chips	nc						51.2	8.8					
3/96	2400N	1200E	0 - 4	wood chips and sand	nc						21.2	16.4					
3/96	2500N	2100E	0 - 4	wood chips and sand	nc						160.0						
3/96	2600N	1700E	0 - 4	silty sand with trace wood chips	Silty Sand, SM	0.0	86.2			13.8	20.9						
3/96	2600N	2200E	0 - 4	wood chips and sand	nc						247.4	12.2					
3/96	2700N	2100E	0 - 4	wood chips and silty sand	nc						247.4	15.0					
3/96	2800N	2000E	0 - 4	wood chips and sand	nc						198.5	61.2					
3/96	2800N	2200E	0 - 4	wood chips and silty sand	nc						329.8	21.1					
3/96	2900N	1800E	0 - 4	wood chips and sand	nc						192.4	53.6					
3/96	3100N	1300E	0 - 4	wood chips and sand	Silty Sand, SM	0.5	84.0			15.5	27.4						
			4 -10 ft														
3/96	2400N	1200E	4 - 6	sand and silt	Silty Sand, SM	0	65.9			34.1	24.0						
3/96	2400N	1200E	8 - 10	stiff silt	Silt, ML	0	0.1	88.1	11.8	99.9	21.1						
3/96	2500N	2100E	4 - 6	sand	Silty Sand, SM	0.4	85.7			13.9							
3/96	2500N	2600E	8 - 10	sand	Silty Sand, SM	9.9	69.6			20.5	22.0						
3/96	2600N	1200E	4 - 6	silty sand	Silty Sand, SM	8.2	69.9			21.9	21.2						
3/96	2600N	1200E	6 - 8	clay	Lean Clay with Sand, CL	0.0	17.2	50.0	32.9	82.9	25.5						
3/96	2700N	1700E	6 - 8	clay	nc						17.6						
3/96	2700N	2100E	4 - 6	silty sand	Silty Sand, SM	6.3	78.7			15.0	18.5						
3/96	2700N	2100E	6 - 8	clay	Sandy Lean Clay, Cl	0.0	38.7	36.8	24.5	61.3	18.0						
3/96	2900N	1500E	4 - 6	sand	Poorly Graded Sand with Silt, SP-SM	1.3	86.6			12.1	21.5						
3/96	2900N	2000E	6 - 8	silty sand	Silty Sand, SM	0.3	74.3			25.4	24.2						
3/96	3100N	1500E	8 - 10	clay	nc						20.0						
3/96	3100N	2300E	6 - 8	silty sand	Silty Sand, SM	0.0	75.4			24.6	24.6						
			10 - 24 ft														
3/96	2100N	1000E	15 - 17	clay	Clayey Sand, SC	0.3	50.7	29.4	19.6	49	13.8		2.70	3.0 E-08	137.00	120.30	0.37
3/96	2400N	1200E	20 - 24	stiff silt	Silt, ML	0	0.1	84.3	15.6	99.9	21.0						
3/96	2500N	2600E	10 - 12	sand and silt	Silt, ML	0	14.2	67.1	18.7	85.8	18.7						
3/96	2700N	2500E	13 - 15	clay	Sandy Lean Clay, Cl	0.5	30.1	42.5	26.9	69.4	19.8	2.7		1.5 E-08	131.60	109.80	0.53
3/96	2900N	1500E	13 - 15	clay	Lean Clay with Sand, CL	0.0	27.7	44.5	27.8	72.3	19.7		2.60	2.1E-08	123.00	102.80	0.51
3/96	2900N	2000E	13 - 15	clay	Sandy Lean Clay, Cl	0.0	36.4	35.5	28.1	63.6	17.7		2.70	3.5 E-08	134.90	114.70	0.48
3/96	3100N	2300E	12 - 14	silty sand and clay	Lean Clay with Sand, CL	0.0	21.3	32.7	46.0	78.7	23.4						
3/96	3500N	2000E	13 - 15	clay	Lean Clay with Sand, CL	0	17.2	37.3	45.5	82.8	26.7		2.78	1.4E-08	128.10	101.10	0.74

Table 4 1996 & 1998 Microbial Enumeration Assay Results

	Recommended Passive Remediation Value	1998 Anaerobic Microbial Enumeration Assay Results (Mean)		
Sample ID		BE-1	BE-2	BE-3
Grid Location		2400N 1400E	2600N 1900E	2600N 2100E
Sample Interval (ft)		2-3	2-3	2-3
In Contaminated Area?		yes	yes	no
Micobial Populations				
Total Population (cfu/g)		< 1E+02	4.5 E+03	5.2E+03
Degrader Populaion (cfu/g) (2)	>1E+06	< 1E+02	< 1E+02	1.2 E+02
Does degrader population meet bio-engineering norms to support passive remediation?	>1E+06	no	no	no

		1996 Aerobic Microbial Enumeration (3) Assay Results (Mean)					
Sample ID		BIO-1	BIO-2	BIO-3	BIO-4	BIO-5	BIO-6
Grid Location		2300N 1600E	2400N 1600E	2400N 2000E	2400N 2000E	2500N 1600E	2900N 1600E
Sample Interval (ft)		0 - 4	0 - 4	0 - 4	4 - 8	0 - 4	0 - 4
In Contaminated Area?		yes	yes	yes	yes	yes	no
Micobial Populations							
Total Population (cfu/g)		7.0E+04	7.4 E+05	3.7E+06	8.3E+03	2.3E+04	1.8E+04
Degrader Population (cfu/g) (4)	>1E+06	2.2E+03	4.8E+03	1.5E+04	5.1E+01	3.4E+02	5.5+02
Does degrader population meet bio-engineering norms to support passive remediation?	>1E+06	no	no	no	no	no	no

1. Laboratory Report for Anaerobic Enumeration is included as Appendix E to the SEH October 1998 ERA report.
2. Samples were analyzed by Biorenewal using coal tar as the sole carbon source for enumerating the degrader populations.
3. Laboratory Report for Aerobic Enumeration is included as Appendix E to the SEH July 1996 Sediment Investigation report.
4. Samples were analyzed by Biorenewal using creosote as the sole carbon source for enumerating the degrader populations.

Table 5 1998 & 2001 Sediment Bioactive Zone Chemical Data - Dry Weight and Normalized to Organic Carbon

	Winter 98 Samples										Spring 98 Samples			
Grid Location	2600N 2100E	2600N 1400E	2600N 2100E	2600N 1400E	2400N 2100E	2500N 1800E	2400N 1400E	2430N 2630E	2420N 2780E	2100N 0800E	2400N 1400E	2550N 1450E	2600N 2100E	2600N 2500E
Depth (inches)	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"
ID:	SD-1	SD-3	SD-4	SD-6	SD-7	SD-8	SD-9	EB-W	EB-E	WB-E	CW	CS	RW	RS
Date Collected:	Jan-98	Jan-98	Jan-98	Jan-98	Jan-98	Jan-98	Feb-98	Jan-98	Jan-98	Jan-98	May-98	May-98	May-98	May-98
Total Organic Carbon														
TOC (mg/kg)		43,000	12,000	53,000	50,000	54,000	38,000	1,000	930	89,000	17,000	2,500	57,000	4,600
TOC (%)		4.3%	1.2%	5.3%	5.0%	5.4%	3.8%	0.1%	0.1%	8.9%	1.7%	0.3%	5.7%	0.5%
Dry Weight Values														
PAH (ug/kg)														
Acenapthene		440	ND	2,000	450	230	19,000	ND	ND	ND	17,000	110	48	ND
Acenapthylene		900	ND	1,400	ND	ND	ND	ND	ND	ND	3,800	ND	85	ND
Anthracene		560	ND	2,400	700	160	160,000	ND	ND	ND	15,000	81	130	ND
Benzo(a)anthracene		4,000	54	9,200	6,700	550	45,000	ND	ND	2,300	24,000	59	450	51
Benzo(a)pyrene		5,500	ND	10,000	8,200	540	35,000	ND	ND	2,700	28,000	73	540	62
Benzo(e)pyrene														
Benzo(b)flouranthene		3,500	ND	5,700	7,600	580	14,000	ND	ND	ND	16,000	38	560	50
Benzo(k)flouranthene		2,600	ND	5,700	5,900	430	23,000	ND	ND	ND	16,000	46	370	37
Benzo (ghi) perylene		3,200	ND	5,400	5,300	240	16,000	ND	ND	3,100	11,000	ND	280	31
Chrysene		3,100	46	7,200	6,200	530	36,000	ND	ND	2,400	21,000	54	470	46
Dibenzoe(a,h) Anthracene		ND	ND	ND	ND	ND	ND	ND	ND	ND	3,000	ND	85	ND
Flouranthene		2,900	93	10,000	6,800	550	97,000	ND	ND	3,700	36,000	97	910	39
Fluorene		480	ND	1,600	ND	ND	100,000	ND	ND	ND	10,000	62	85	ND
Indeno(123-cd)pyrene		2,500	ND	4,700	4,800	250	14,000	ND	ND	ND	9,400	ND	260	27
1-Methyinaphthalene		340	ND	900	ND	190	ND	ND	ND	ND	12,000	99	170	ND
2-Methyinaphthalene		650	ND	1,200	ND	240	470,000	ND	ND	ND	15,000	120	240	ND
Naphthalene		810	ND	1,500	ND	ND	770,000	ND	ND	ND	19,000	160	230	ND
Phenanthrene		1,600	71	8,600	ND	650	340,000	ND	ND	3,200	46,000	270	690	23
Pyrene		5,200	140	20,000	9,800	1,100	140,000	ND	ND	4,500	68,000	190	940	58
Total PAHs		38,280	404	97,500	62,450	6,340	2,279,000	ND	ND	21,900	370,200	1,459	6,543	424
Heterocyclic Aromatic Hydrocarbons (ug/kg)														
Dibenzothiophene														
Carbazole														
Dibenzofuran														
Phenolic Compounds (ug/kg)														
2-Fluorobiphenyl														
4-Methylphenol														
Phenol														
Volatile Organic Compounds (ug/kg)														
Benzene	ND	ND	ND	ND	130	ND	1,200	ND	ND	ND	540	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	660	ND	ND	ND	85	ND	ND	ND
Toluene	72	270	260	270	420	ND	60	ND	ND	110	76	ND	320	44
Xylenes	ND	ND	ND	ND	ND	ND	670	ND	ND	ND	230	ND	ND	ND

	Spring 2001 Samples												
Grid Location	3100N/2300E	3100N/2300E	2500N/1700E	2500N/1700E	2500N/1600E	2500N/1600E	3100N/1500E	3100N/1500E	2400N/1400E	2400N/1400E	2400N/1700E	2400N/1700E	2400N/1700E Duplicate
Depth (inches)	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"
ID:	Ref. Sand	Ref. Sand	Sand #1	Sand #1	Sand #2	Sand #2	Ref. Wood	Ref. Wood	Wood #1	Wood #1	Wood #2	Wood #2	Wood #2 Dup.
Date Collected:	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Apr-01
Total Organic Carbon													
TOC (mg/kg)	22,000	21,000	18,000	38,000	1,600	1,900	46,000	190,000	280,000	480,000	250,000	260,000	190,000
TOC (%)	2.2%	2.1%	1.8%	3.8%	0.2%	0.2%	4.6%	19.0%	28.0%	48.0%	25.0%	26.0%	19.0%
Dry Weight Values													
PAH (ug/kg)													
Acenapthene	ND	16	30,000	88,000	11,000	28,000	32	100	22,000	48,000	3,000	7,500	7,400
Acenapthylene	32	98	2,000	5,200	650	1,400	74	410	4,100	8,800	550	1,200	1,300
Anthracene	21	52	16,000	23,000	5,100	7,900	51	220	18,000	34,000	1,600	3,300	3,700
Benzo(a)anthracene	78	280	6,600	18,000	2,400	5,300	200	1,100	18,000	44,000	2,200	5,600	6,500
Benzo(a)pyrene	120	350	6,200	14,000	2,400	4,100	290	1,400	20,000	36,000	2,600	4,600	5,100
Benzo(e)pyrene		250		9,100		2,400		990		21,000		2,900	3,300
Benzo(b)flouranthene	78	210	2,700	8,300	860	1,900	150	860	7,000	18,000	1,400	3,300	3,400
Benzo(k)flouranthene	100	230	6,700	11,000	2,300	3,000	240	910	15,000	22,000	2,000	3,300	3,800
Benzo (ghi) perylene	76	270	2,900	8,500	1,000	2,300	160	940	8,200	18,000	1,300	2,800	3,000
Chrysene	88	230	7,500	18,000	2,500	4,900	200	910	16,000	32,000	2,000	4,300	4,800
Dibenzoe(a,h) Anthracene	ND	58	ND	1,500	ND	380	ND	240	1,600	3,500	280	710	780
Flouranthene	110	260	18,000	51,000	6,300	15,000	240	1,100	34,000	87,000	3,300	9,800	10,000
Fluorene	ND	14	13,000	30,000	4,200	9,700	30	77	12,000	23,000	1,300	3,100	3,400
Indeno(123-cd)pyrene	52	180	1,600	5,700	650	1,500	110	740	5,700	13,000	930	2,200	2,400
1-Methyinaphthalene		25		73,000		20,000		110		29,000		7,900	7,700
2-Methyinaphthalene		38		120,000		34,000		180		41,000		8,100	8,500
Naphthalene	32	31	85,000	160,000	17,000	33,000	170	190	21,000	31,000	6,100	9,200	9,400
Phenanthrene	78	120	45,000	120,000	18,000	38,000	160	520	51,000	120,000	4,900	12,000	14,000
Pyrene	120	400	25,000	72,000	8,500	22,000	280	1,600	46,000	130,000	3,800	12,000	13,000
Total PAHs	985	3,110	268,200	836,300	62,860	234,780	2,367	12,597	299,600	759,300	37,260	103,810	111,580
Heterocyclic Aromatic Hydrocarbons (ug/kg)													
Dibenzothiophene		ND		5,100		1,900		ND		12,000		1,500	980
Carbazole		ND		2,200		210		ND		ND		580	490
Dibenzofuran		ND		3,000		830		52		3,700		980	600
Phenolic Compounds (ug/kg)													
2-Fluorobiphenyl		77		73		69		75		77		74	72
4-Methylphenol		ND		ND		ND		690		ND		350	200
Phenol		93		ND		ND		980		1,900		450	250
Volatile Organic Compounds (ug/kg)													
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	2,000	530	630	150	140
Ethylbenzene	ND	ND	5,300	2,800	1,600	990	ND	ND	1,400	450	910	180	180
Toluene	ND	ND	ND	ND	ND	ND	ND	28	100	28	ND	41	41
Xylenes	ND	ND	5,200	2,590	1,900	960	ND	ND	1,640	530	850	180	184

Table 5 (continued) 1998 & 2001 Sediment Bioactive Zone Chemical Data - Dry Weight and Normalized to Organic Carbon

	Winter 98 Samples										Spring 98 Samples			
Grid Location	2600N 2100E	2600N 1400E	2600N 2100E	2600N 1400E	2400N 2100E	2500N 1600E	2400N 1400E	2430N 2630E	2420N 2780E	2100N 0900E	2400N 1400E	2550N 1450E	2600N 2100E	2600N 2600E
Depth (inches)	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 9"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"
ID:	SD-1	SD-3	SD-4	SD-6	SD-7	SD-8	SD-9	EB-W	EB-E	WB-E	CW	CS	RW	RS
Date Collected:	Jan-98	Jan-98	Jan-98	Jan-98	Jan-98	Jan-98	Feb-98	Jan-98	Jan-98	Jan-98	May-98	May-98	May-98	May-98
Total Organic Carbon														
TOC (mg/kg)	no data	43,000	12,000	53,000	50,000	54,000	38,000	1,000	930	89,000	17,000	2,500	57,000	4,600
TOC (%)		4%	1%	5%	5%	5%	4%	0.1%	0.1%	9%	2%	0.3%	6%	0.5%
NOC Values														
PAH (ug/g OC)														
Acenapthene		10		38	9	4	500				1,000	44	1	
Acenapthylene		21		26							224		1	
Anthracene		13		45	14	3	4,211				882	32	2	
Benzo(a)anthracene		93	5	174	134	10	1,184			26	1,412	24	8	11
Benzo(a)pyrene		128		189	164	10	921			30	1,647	29	9	13
Benzo(e)pyrene														
Benzo(b)flouranthene		81		108	152	11	368				941	15	10	11
Benzo(k)flouranthene		60		108	118	8	605				941	18	6	8
Benzo (ghi) perylene		74		102	106	4	421			35	647		5	7
Chrysene		72	4	136	124	12	947			27	1,235	22	8	10
Dibenzoa(a,h) Anthracene											176		1	
Flouranthene		67	8	189	136	10	2,553			42	2,118	39	16	8
Fluorene		11		30			2,632				588	25	1	
Indeno(123-cd)pyrene		58		89	96	5	368				553		5	6
1-Methylnaphthalene		8		17		4					706	40	3	
2-Methylnaphthalene		15		23		4	12,368				882	48	4	
Naphthalene		19		28			20,283				1,118	64	4	
Phenanthrene		37	6	162		12	8,947			36	2,706	108	12	5
Pyrene		121	12	377	196	20	3,684			51	4,000	76	16	13
Total PAHs		890	34	1,840	1,249	117	59,974			246	21,776	584	115	92
Heterocyclic Aromatic Hydrocarbons (ug/g OC)														
Dibenzothiophene														
Carbazole														
Dibenzofuran														
Phenolic Compounds (ug/g OC)														
2-Fluorobiphenyl														
4-Methylphenol														
Phenol														
Volatile Organic Compounds (ug/g OC)														
Benzene					3		32				32			
Ethylbenzene							17				5			
Toluene		6	22	5	8		2			1.2	4		6	10
Xylenes							18				14			

	Spring 2001 Samples															
Grid Location	3100N/2300E	3100N/2300E	2500N/1700E	2500N/1700E	2500N/1600E	2500N/1600E	3100N/1500E	3100N/1500E	2400N/1400E	2400N/1400E	2400N/1700E	2400N/1700E	2400N/1700E	2400N/1700E Duplicate
Depth (inches)	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"	0 - 6"
ID:	Ref. Sand	Ref. Sand	Sand #1	Sand #1	Sand #2	Sand #2	Ref. Wood	Ref. Wood	Wood #1	Wood #1	Wood #1	Wood #2	Wood #2	Wood #2 Dup.
Date Collected:	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01	Mar-01	Apr-01
Total Organic Carbon														
TOC (mg/kg)	22,000	21,000	18,000	36,000	1,600	1,900	46,000	190,000	280,000	480,000	250,000	260,000	190,000	
TOC (%)	2%	2%	2%	4%	0.2%	0.2%	5%	19%	28%	48%	25%	26%	19%	
NOC Values														
PAH (ug/g OC)														
Acenapthene		1	1,667	2,444	6,875	14,737	1	1	79	100	12	29	39	
Acenapthylene	1	5	111	144	406	737	2	2	15	18	2	5	7	
Anthracene	1	2	889	639	3,188	4,158	1	1	64	71	6	13	19	
Benzo(a)anthracene	4	13	367	500	1,500	2,789	4	6	64	92	9	22	34	
Benzo(a)pyrene	5	17	344	389	1,500	2,158	6	7	71	75	10	18	27	
Benzo(e)pyrene		12		253		1,263		5		44		11	17	
Benzo(b)flouranthene	4	10	150	231	538	1,000	3	5	25	38	6	13	18	
Benzo(k)flouranthene	5	11	372	306	1,438	1,579	5	5	54	46	8	13	20	
Benzo (ghi) perylene	3	13	161	236	625	1,211	3	5	29	38	5	11	16	
Chrysene	4	11	417	500	1,563	2,579	4	5	57	67	8	17	25	
Dibenzoa(a,h) Anthracene		3		42		200		1	6	7	1	3	4	
Flouranthene	5	12	1,000	1,417	3,938	7,895	5	6	121	181	13	38	53	
Fluorene		1	722	833	2,625	5,105	1	0	43	48	5	12	18	
Indeno(123-cd)pyrene	2	9	89	158	406	789	2	4	20	27	4	8	13	
1-Methylnaphthalene		1		2,028		10,526		1		60		30	41	
2-Methylnaphthalene		2		3,333		17,895		1		85		31	45	
Naphthalene	1	1	4,722	4,444	10,625	17,368	4	1	75	65	24	35	49	
Phenanthrene	4	6	2,500	3,333	11,250	20,000	3	3	182	250	20	46	74	
Pyrene	5	19	1,389	2,000	5,313	11,579	6	8	164	271	15	46	68	
Total PAHs	45	148	14,900	23,231	51,788	123,568	51	66	1,070	1,582	149	399	587	
Heterocyclic Aromatic Hydrocarbons (ug/g OC)														
Dibenzothiophene				142		1,000				25		6	5	
Carbazole				61		111						2	3	
Dibenzofuran				83		437		0.3		8		4	3	
Phenolic Compounds (ug/g OC)														
2-Fluorobiphenyl		4		2		36		0.4		0.2		0.3	0.4	
4-Methylphenol								4				1.3	1.1	
Phenol		4						5		4		2	1.3	
Volatile Organic Compounds (ug/g OC)														
Benzene									7	1.1	3	0.6	0.7	
Ethylbenzene			294	78	1,000	521			5	0.9	4	0.7	0.9	
Toluene								0.1	0.4	0.1		0.2	0.2	
Xylenes			289	72	1,188	505			6	1.1	3	0.7	1.0	

Table 6
Indigenous Fish Species, Ashland Harbor

Common Name	Scientific Name	Spawning	Rearing	Transitory
Alewife	*Alosa pseudoharengus*	X	X	X
American eel	*Anguilla rostrata*			X
Black bullhead	*Ictalurus melas*	X	X	X
Black crappie	*Pomosix nigromaculatus*	X	X	X
Blacknose shiner	*Notropis heterolepis*			X
Bluntnose minnow	*Pimephales notatus*			X
Brook stickleback	*Eucalia inconstans*	X	X	X
Brook trout	*Salvelinus fontinalis*			X
Brown bullhead	*Ictalurus nebulosus*	X	X	X
Brown trout	*Salmo trutta*		X	X
Burbot	*Lota lota*		X	X
Carp	*Carassius auratus*	X	X	
Central mudminnow	*Umbra limi*	X	X	X
Chinook salmon	*Oncorhynchus tshawytscha*			X
Coho salmon	*Oncorhynchus kisutch*			X
Common shiner	*Notropis comutus*		X	X
Creek chub	*Semotilus atromaculatus*			X
Emerald shiner	*Notropis atherinoides*	X	X	X
Eurasian ruffe	*Gymnocephalus cemuus*			X
Johnny darter	*Etheostoma nigrum*	X	X	X
Lake herring	*Coregonus artedi*			X
Lake sturgeon	*Acipenser fulvescens*			X
Lake trout	*Salvelinus namaycush*			X
Lake whitefish	*Coregonus clupeaformis*			X
Logperch	*Percina caprodes*	X	X	X
Longnose sucker	*Catostomus catostomus*		X	X
Mimic shiner	*Notropis volucellus*	X	X	X
Mottled sculpin	*Cottus bairdi*		X	X
Muskellunge	*Esox masquinongy*			X
Ninespine stickleback	*Pungitius pungitius*			X
Northern pike	*Esox lucius*		X	X
Pumpkinseed	*Lepomis gibbosus*	X	X	X
Rainbow smelt	*Osmerus mordax*	X	X	X
Rainbow trout	*Oncorhynchus mykiss*			X
Rockbass	*Ambloplites rupestris*	X	X	X
Round whitefish	*Prosopium cylindraceum*			X
Sea lamprey	*Petromyzon marinus*			X
Shorthead redhorse	*Moxostoma breviceps*		X	X
Silver redhorse	*Moxostoma anisurum*		X	X
Slimy sculpin	*Cottus cognatus*	X	X	X
Smallmouth bass	*Micropterus dolomieui*	X	X	X
Splake	*brook trout/lake trout hybrid*			X
Spoonhead sculpin	*Cottus ricei*			X
Spottail shiner	*Notropis hudsonius*	X	X	X
Trout-perch	*Percopsis omiscomaycus*	X	X	X
Walleye	*Stizostedion vitreum*	X	X	X
White perch	*Morone americanus*			X
White sucker	*Catostomus commersoni*		X	X
Yellow perch	*Perca flavescens*	X	X	X

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Table 7 Comparison of Sediment Probable Effects Benchmarks

		Dry Weight Values						Normalized to Organic Carbon Values:			
		1988 Barrick AET-H (mg/kg)	1996 Smith FQAV PEL (mg/kg)	1996 HA-28 ERM (mg/kg)	1996 HA-28 PEL (mg/kg)	1997 ORNL PRGs (mg/kg)	2000 MacD CBSQG PEC (mg/kg)	1996 HA-28 ERM (ug/g TOC)	1996 HA-28 PEL (ug/g TOC)	1997 EPA SQAL (ug/g TOC)	2002 WDNR Guidance PEC (ug/g TOC)
PAHs											
	Acenapthene	2	NSE	NSE	NSE	0.089	NSE	*0.885*	*1.33*	*130*	NSE
	Acenapthylene	1.3	NSE	NSE	NSE	0.13	NSE	*1*	*2.755*	NSE	NSE
	Anthracene	2	NSE	0.14	0.167	0.25	0.845	*4.545*	*5.741*	NSE	84.5
	Benzo(a)anthracene	5.1	0.385	0.3	0.285	0.69	1.05	*14.091*	*16.461*	NSE	105
	Benzo(a)pyrene	3.6	0.782	0.465	0.319	0.394	1.45	*11.216*	*13.185*	NSE	145
	Benzo(b)flouranthene	9.9	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE
	Benzo (ghi) perylene	2.6	NSE	0.275	0.252	6.3	NSE	*10.621*	*11.9*	NSE	NSE
	Chrysene	9.2	0.862	0.5	0.406	0.85	1.29	*16.757*	*20.262*	NSE	129
	Dibenzo(a,h) anthracene	0.97	NSE	0.015	0.028	0.028	NSE	*1.125*	*1.936*	NSE	NSE
	Flouranthene	30	2.355	0.175	0.319	0.834	2.23	*7.619*	*17.118*	*620*	223
	Fluorene	3.6	NSE	0.14	0.149	0.14	0.536	*3.286*	*5.636*	*54*	53.6
	Indeno(123-cd)pyrene	2.6	NSE	0.25	0.239	0.837	NSE	*9.054*	*8.801*	NSE	NSE
	2-Methylnaphthalene	1.9	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE
	Naphthalene	2.7	NSE	0.098	0.139	0.39	0.561	*3.636*	*5.134*	*47*	56.1
	Phenanthrene	6.9	0.515	0.345	0.409	0.54	1.17	*13.848*	*23.309*	*180*	117
	Pyrene	16	0.875	0.348	0.493	1.4	1.52	*18.333*	*31.643*	NSE	152
	Total PAHs	NSE	NSE	2.227	13.66	13.66	22.8	*105.2*	*207.877*	NSE	2280
	LPAHs	24	NSE	0.653	1.177	3.369	NSE	*31.095*	*54.731*	NSE	NSE
	HPAHs	64	NSE	1.746	2.338	4.354	NSE	*96.167*	*149.272*	NSE	NSE
VOCs	Benzene	NSE	NSE	NSE	NSE	*0.16*	NSE	NSE	NSE	*5.7*	11
	Ethylbenzene	0.037	NSE	NSE	NSE	*5.4*	NSE	NSE	NSE	*480*	NSE
	Toluene	NSE	NSE	NSE	NSE	*0.05*	NSE	NSE	NSE	*89*	180
	Xylenes	0.12	NSE	NSE	NSE	*0.16*	NSE	NSE	NSE	*2.5*	5
Misc Organics	Dibenzofuran	1.7	NSE	NSE	NSE	0.42	NSE	NSE	NSE	200	58
	4-Methylphenol	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE	NSE	670
	Phenol	1.2	NSE	NSE	NSE	0.032	NSE	NSE	NSE	NSE	1200
Quantity of stations where values were exceeded for at least one chemical											
2001 Bioactive Zone, 0-0.5' (6 stations w/ detects):		not eval	not eval	not eval	not eval	4	4	5	not eval	4	4
% (stations w/detects) that exceed values:						67%	67%	83%		67%	67%
1998 Bioactive Zone, 0-0.5' (10 stations w/ detects):		5	7	8	8	9		10	10	2	
% (stations w/detects) that exceed values:		50%	70%	80%	80%	90%		100%	100%	20%	
1996 Shallow Sediments, 0 - 4' (31 stations w/ detects):		17	23	31	30	29		31	30		
% (stations w/detects) that exceed values:		55%	74%	100%	97%	94%		100%	97%		
1996 Deep Sediments, 4-10' (15 stations w/ detects):		8	9	14	14	13		14	14		
% (stations w/detects) that exceed values:		53%	60%	93%	93%	87%		93%	93%		

NSE = No Standard Established for the Chemical

Table 8
1998 Surface Water Chemical Data

Analytical Parameters	NR 140 Standards				Sample No./Grid Location/Sampling Date												
					Winter 1998 Samples												Spring 1998
	NAWQC		Tier II		SW-1	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	SW-9	EB-W	EB-E	WB-3	CW
					2800N 2100E	2900N 1800E	2800N 1400E	2600N 2100E	2700N 1800E	2600N 1400E	2400N 2100E	2500N 1800E	2400N 1400E	2430E 2630E	2420N 2780E	2100N 900E	2400N 1400E
	Acute Value	Chronic Value	Acute Value	Chronic Value	1/14/98	1/14/98	1/14/98	1/15/98	1/15/98	1/15/98	1/15/98	1/15/98	1/15/98	1/14/98	1/14/98	1/15/98	5/14/98
Ammonia Nitrogen (mg/l)	--	--	--	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--
Sulfide (mg/l)	--	--	--	--	0.67	0.93	0.53	0.40	0.27	0.80	0.80	0.93	0.40	0.8	0.8	0.93	--
PAHs[1] (μg/l)																	
Anthracene	NSE	NSE	13	0.73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.10
Benzo(a)Anthracene	NSE	NSE	0.49	0.027	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.29
Benzo(a)Pyrene	NSE	NSE	0.24	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.33**
Benzo(b)Fluoranthene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
Benzo(k)Fluoranthene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.095
Benzo(g,h,i)Perylene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.22
Chrysene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.27
Dibenzo(a,h)Anthracene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
Fluoranthene	33.6	6.16	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.46
Indeno(1,2,3-cd)Pyrene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.42
Phenanthrene	30	6.3	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.66
Pyrene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.70
VOCs[2] (μg/l)																	
Benzene	NSE	NSE	NSE	NSE	ND	0.88	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.28
Ethylbenzene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.32
Toluene	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.36
Total Xylenes	NSE	NSE	NSE	NSE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.54

NAWQC = National Ambient Water Quality Criteria
NSE = No standard established
ND = Not detected
-- = Not analyzed for
0.29 = Chronic value exceeded
0.33 = Acute value exceeded
[1] = PAH list is not complete; PAHs not listed were ND
[2] = VOC list is not complete; VOCs not listed were ND
Compiled by: JEG Checked by: DRR

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Table 9: Contaminant Dispersion / Sediment Settling Study Results

	Initial Composite Sediment	Settled Sand after Initial Mix	After Floc Fine Slurry 17.1% Solids
%Gravel	4.4	6	0
%Sand	65.5	75.2	0
%Fines	30.1	18.8	100
PAHs	(ug/kg)	(ug/kg)	(ug/kg)
Acenapthene	86,000	17,000	470,000
Acenapthylene	<2800	<1000	43,000
Anthracene	43,000	7,100	310,000
Benzo(a)anthracene	16,000	3,500	140,000
Benzo(a)pyrene	12,000	1,700	150,000
Benzo(b)flouranthene	6,200	<1000	93,000
Benzo (ghi) perylene	4,800	<1100	68,000
Benzo (k) flouranthene	6,000	<1000	79,000
Chrysene	15,000	2,800	130,000
Dibenzo(a,h) anthracene	<2900	<1100	19,000
Flouranthene	38,000	8,900	300,000
Fluorene	46,000	8,300	300,000
Indeno(123-cd)pyrene	3,700	<1100	53,000
1-Methylnaphthalene	90,000	21,000	390,000
2-Methylnaphthalene	150,000	36,000	590,000
Naphthalene	240,000	60,000	480,000
Phenanthrene	120,000	25,000	890,000
Pyrene	56,000	13,000	510,000
Total PAHs	932,700	204,300	5,015,000
VOCs			
Benzene	2,700	380	not analyzed
n-Butylbenzene	2,000		
Ethylbenzene	19,000	3,600	
Isopropylbenzene	2,100		
p-Isopropylbenzene	2,000	350	
Toluene	7,800	930	
1,2,4 -Trimethylbenzene	12,000	1,900	
1,3,5 -Trimethylbenzene	3,500	630	
Xylenes -m,-p	12,000	2,100	
Xylenes -o	6,500	1,000	
Total VOCs	**69,600**	**10,890**	

	3/31 Initial Sediment Slurry	4/2/98 Mixture after 2 days settling	4/11/98 Mixture after 11 days settling	Clear Water After Floc	Compared to Water Quality Criteria: NAWQ Acute Value (ug/l)	NAWQ Chronic Value (ug/l)	Tier II Acute Value (ug/l)	Tier II Chronic Value (ug/l)
TSS (g/l)	4.6	1.8	1.4	0.03				
PAHs	(ug/l)	(ug/l)	(ug/l)	(ug/l)				
Acenapthene	460	370	420	30	80	23		
Acenapthylene	<210	35	46	< 8.2				
Anthracene	240	82	88	15			13	0.73
Benzo(a)anthracene	61	23	25	7			0.49	0.027
Benzo(a)pyrene	64	33	35	6			0.24	0.014
Benzo(b)flouranthene	37	15	15	4				
Benzo (ghi) perylene	32	<10	11	3				
Benzo (k) flouranthene	21	8	9	2				
Chrysene	59	23	24	6				
Dibenzo(a,h) anthracene	28	20	24	4				
Flouranthene	170	71	75	20	33.6	6.16		
Fluorene	140	78	96	13			70	3.9
Indeno(123-cd)pyrene	84	27	29	7				
1-Methylnaphthalene	540	450	570	<7.2			37	2.1
2-Methylnaphthalene	810	480	740	<7.2				
Naphthalene	1,800	450	1,600	<8.4			190	12
Phenanthrene	720	210	310	27	30	6.3		
Pyrene	270	120	120	30				
Total PAHs	**5,536**	**2,495**	**4,237**	**174**				
VOCs								
Benzene	230	97	73	not analyzed			2300	130
n-Butylbenzene	<14	<14	9					
Ethylbenzene	810	280	210				130	7.3
Isopropylbenzene	36	24	18					
p-Isopropylbenzene	16	17	<6					
Methylene Chloride	24	31	<9				26000	2200
Toluene	410	190	130				120	9.8
1,2,4 -Trimethylbenzene	220	160	130					
1,3,5 -Trimethylbenzene	61	45	35					
Xylenes -m,-p	500	260	200				32	1.8
Xylenes -o	270	140	110					
Total VOCs	**2,577**	**1,244**	**915**					

Table 10
Comparison to PAH Levels Associated with Tumors in Fish at Other Sites

Analytical Parameters	Average and Range for Maximum Concentration of PAH Compounds Found at Sites with Tumors in Fish[1]			Sample No./Grid Location/Depth (in.)/Date																	
				Winter 1998 Samples									Spring 1998 Samples				2001 Samples				
				SD-3	SD-4	SD-6	SD-7	SD-8	SD-9	EB-W	EB-E	WB-E	Cont. Wood	Cont. Sand	Ref. Wood	Ref Sand.	Ref. Sand	Cont. Sand #1	Cont. Sand #2	Ref. Wood	Cont. Wood #1	Cont. Wood #2
				2800N 1400E	2600N 2100E	2600N 1400E	2400N 2100E	2500N 1800E	2400N 1400E	2430N 2630E	2420N 2780E	2100N 900E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E	3100N 2300E	2500N 1700E	2500N 1600E	3100N 1500E	2400N 1400E	2400N 1700E
				0-6	0-6	0-6	0-6	0-6	0-9	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6	0-6
	Low End Max.	Average Max. Concentration	High End Max.	1/14/98	1/15/98	1/15/98	1/15/98	1/15/98	2/23/98	1/14/98	1/14/98	1/15/98	5/22/98	5/2/98	5/14/98	5/14/98	4/30/01	4/30/01	4/30/01	4/30/01	4/30/01	4/30/01
PAHs[2] (µg/kg)																						
Benzo(a)Anthracene	830	8,400	51,000	4,000*	54	9,200	6,700*	550	45,000	ND	ND	2,300*	24,000	59	450	51	280	18,000	5,300*	1,100*	44,000	5,600*
Benzo(a)Pyrene	360	6,800	43,000	5,500*	ND	10,000	8,200	540*	35,000	ND	ND	2,700*	28,000	73	540*	62	350	14,000	4,100*	1,400*	36,000	4,600*
Fluoranthene	1,800	35,000	220,000	2,900*	93	10,000*	6,800*	550	97,000	ND	ND	3,700*	36,000	97	910	39	260	51,000	15,000*	1,100	87,000	9,800*
Phenanthrene	1,000	43,000	390,000	1,600*	71	8,600*	ND	650	340,000	ND	ND	3,200*	46,000	270	690	23	120	120,000	38,000*	520	120,000	12,000*
Pyrene	1,700	25,000	140,000	5,200*	140	20,000*	9,800*	1,100	140,000	ND	ND	4,500*	68,000	190	940	58	400	72,000	22,000*	1,600	130,000	12,000*

-- = Not analyzed for
ND = Not detected
NSE = No standard established
140,000 = Above high end concentration of PAHs associated with tumors in fish
9,200 = Above average maximum concentration of PAHs associated with tumors in fish
* = Above low end maximum concentration of PAHs associated with tumors in fish
[1] = Tumor data from Internal WDNR memo, March 6, 1997, from Tom Janisch to Jim Reyburn regarding WPSC MGP sites. Table 8 of memo summarized data from Paul Baumann, National Fisheries Contaminated Research Center, 1990.
[2] = PAH list is not complete; PAHs only shown for PAHs with chemical specific values
All sediment samples were collected from the 0 to 15 cm sediment depth interval, except for sample SD-9, which was collected from the 0 to 22 cm depth interval
Compiled by: MJB Checked by: GPW

P:\proj\wdnr\9401\misc\10-comp to PAH levels-fish.xls

Table 11: 1998 Benthic Community Survey Indices

MEAN RESULTS	*Richness Indices*		*Abundance Indices*		*Relative Indices*			
	Average Total Taxa Richness	Average Midge Richness	Total Abundance	Midge Abundance	Relative Midge Abundance	Ratio Avg Mid / Avg Olig	Number of Indices w/ > 30% difference	
CW	5.7	0.3	2,282	22	0.08	0.17		
RW	13.2	5.0	1,285	287	0.26	0.86		
CS	21.2	8.7	9,459	2,541	0.30	1.80		
RS	30.8	8.7	40,498	13,169	0.32	1.86		
Comparisons of Indices (% difference)								
Reference Site Comparisons								
CW:RW	57%	93%	-78%	93%	68%	80%	5	of 6
CS:RS	31%	0%	77%	81%	6%	3%	3	of 6
Comparisons to Cleanest Sample RS:								
CW:RS	82%	96%	94%	100%	74%	91%	6	of 6
RW:RS	57%	42%	97%	98%	19%	54%	5	of 6
CS:RS	31%	0%	77%	81%	6%	3%	3	of 6

COMPOSITE RESULTS	*Richness Indices*		*Abundance Indices*		*Relative Indices*			
	Composite Total Taxa Richness	Composite Midge Richness	Total Abundance	Midge Abundance	Relative Comp Mid Abundance	Ratio Comp Mid/ Comp Olig	Number of Indices w/ > 30% difference	
CW	11	2	2,282	22	0.01	0.01		
RW	33	15	1,285	287	0.22	0.78		
CS	36	17	9,459	2,541	0.27	1.54		
RS	59	25	40,498	13,169	0.33	1.62		
Comparisons of Indices (% difference)								
Comparisons to Reference Substrates								
CW:RW	67%	87%	-78%	93%	96%	98%	5	of 6
CS:RS	39%	32%	77%	81%	17%	5%	4	of 6
Comparisons to Cleanest Sample RS:								
CW:RS	81%	92%	94%	100%	97%	99%	6	of 6
RW:RS	44%	40%	97%	98%	31%	51%	6	of 6
CS:RS	39%	32%	77%	81%	17%	5%	4	of 6

Compiled by: MJB
Checked by: GPW

Table 12: 1998 Biossay Toxicity Test Results

Sample	Test Organism	Duration	Test Type	Survival Ratio	Final Weight (mg)
Contaminated Wood (CW)	*Hyalella azteca*	10 day	Sediment Exposure	0.26	0.050
Contaminated Sand (CS)	HA	10d	Sed Exp	0.89	0.115
Reference Wood (RW)	HA	10d	Sed Exp	0.96	0.128
Reference Sand (RS)	HA	10d	Sed Exp	0.95	0.182
Control	HA	10d	Sed Exp	0.90	0.173
CW	*Chironomus tentans*	10 day	Sediment Exposure	0.68	1.050
CS	CT	10d	Sed Exp	0.80	1.860
RW	CT	10d	Sed Exp	0.94	1.420
RS	CT	10d	Sed Exp	0.93	1.830
Control	CT	10d	Sed Exp	0.95	0.890
Highly Contaminated	CT	10d	Sed Exp	0.00	0.000
CW	*Lumbriculus variegatus*	10 day	Sediment Exposure	0.25	0.500
CS	LV	10d	Sed Exp	0.96	1.070
RW	LV	10d	Sed Exp	1.70	1.140
RS	LV	10d	Sed Exp	1.32	2.060
Control	LV	10d	Sed Exp	1.24	1.160
CW	*Lumbriculus variegatus*	2 hours	UV Light after 13d Sed Exp	0.00	nm
CS	LV -UV	2hr	UV Light after 13d Sed Exp	0.00	nm
RW	LV -UV	2hr	UV Light after 13d Sed Exp	0.00	nm
RS	LV -UV	2hr	UV Light after 13d Sed Exp	0.40	nm
Control	LV -UV	2hr	UV Light after 13d Sed Exp	1.00	nm
CW	*Daphnia magna*	48 hours	Elutriate Exposure - Test 1	1.00	nm
CS	DM #1	48hr	Elutriate	1.00	nm
RW	DM #1	48hr	Elutriate	0.92	nm
RS	DM #1	48hr	Elutriate	1.00	nm
Control	DM #1	48hr	Elutriate	1.00	nm
CW	*Daphnia magna*	48 hours	Elutriate Exposure - Test 2	0.72	nm
CS	DM #2	48hr	Elutriate	1.00	nm
RW	DM #2	48hr	Elutriate	1.00	nm
RS	DM #2	48hr	Elutriate	0.96	nm
Control	DM #2	48hr	Elutriate	1.00	nm
CW	*Daphnia magna*	2 hours	UV Light after 48hr Elutriate	0.00	nm
CS	DM #2 - UV	2hr	UV Light after 48hr Elutriate	0.00	nm
RW	DM #2 - UV	2hr	UV Light after 48hr Elutriate	0.08	nm
RS	DM #2 - UV	2hr	UV Light after 48hr Elutriate	1.00	nm
Control	DM #2 - UV	2hr	UV Light after 48hr Elutriate	1.00	nm
CW	*Pimephales promelas (fry)*	7 days	Elutriate Exposure	0.00	0.000
CS	PP	7d	Elutriate	0.05	0.130
RW	PP	7d	Elutriate	0.83	0.382
RS	PP	7d	Elutriate	0.93	0.404
Control	PP	7d	Elutriate	1.00	0.406
CW - 50%	*Pimephales promelas (fry)*	7 days	Elutriate Exposure @ Dilutions	0.00	0.000
CW - 25%	PP	7d	Elutriate Dilution	0.00	0.000
CW - 12.5%	PP	7d	Elutriate Dilution	0.00	0.000
CW - 6.25%	PP	7d	Elutriate Dilution	0.18	0.130
CS - 50%	PP	7d	Elutriate Dilution	0.38	0.300
CS - 25%	PP	7d	Elutriate Dilution	0.78	0.220
CS - 12.5%	PP	7d	Elutriate Dilution	0.85	0.340
CS - 6.25%	PP	7d	Elutriate Dilution	0.95	0.450
Control	PP	7d	Elutriate Dilution	1.00	0.520
CW - 25%	*Pimephales promelas (fry)*	24 hours	Elutriate Exposure @ Dilutions	0.90	nm
CW - 6.25%	PP	24 hr	Elutriate Dilution	1.00	nm
CS - 25%	PP	24 hr	Elutriate Dilution	1.00	nm
CS - 6.25%	PP	24 hr	Elutriate Dilution	1.00	nm
Control	PP	24 hr	Elutriate Dilution	0.95	nm
CW - 25%	*Pimephales promelas (fry)*	4 hours	UV exposure after 24 hr Elutriate	0.00	nm
CW - 6.25%	PP - UV	4 hr	UV exposure after 24 hr Elutriate	0.75	nm
CS - 25%	PP - UV	4 hr	UV exposure after 24 hr Elutriate	0.90	nm
CS - 6.25%	PP - UV	4 hr	UV exposure after 24 hr Elutriate	1.00	nm
Control	PP - UV	4 hr	UV exposure after 24 hr Elutriate	0.95	nm

compiled by: MJB
checked by: DC

Table 13 1998 Sediment Quality Triad Analysis

Chemistry Data (1, 5)	Toxicity Studies (2)	Benthos Survey (3)	Station	Associated Conclusions (4)
+	-	-	Ref Sand 1998	Contaminants are not bioavailable
+	+	+	Cont Sand 1998	Strong evidence for contaminant induced degradation
+	+	+	Ref Wood 1998	Strong evidence for contaminant induced degradation
+	+	+	Cont Wood 1998	Strong evidence for contaminant induced degradation

1. Plus for Chemistry indicates the sum of HA-28 toxic units was greater than 1.

2. Plus for Toxicity Studies indicates that at least two sets of test results (survival, weight) showed ecological response compared to results for cleanest station CS, or Lab Control

3. Plus for Benthos Survey indicates greater than 30% difference when compared to reference sand station for more than half of the indices.

4. Possible conclusions taken from Sediment Methods Compendium, Chapter 10: Sediment Quality Triad Approach (USEPA, 1993)

5. Chemistry Data for PAH data also exceeds ESG TU of 1 for each station (2002 evaluation).

Table 14 1998 Fish Tissue Chemical Data

Results of PAH Analysis Of Fish Tissue Collected 05/18/98 and 10/14/98 From Harbor Area Off the Ashland Lakefront Property

PAHs				Fish Tissue Concentration of PAHs (ug / kg) - Harbor Off Lakefront Property								
				9812	9810	9811	9813	98AS01	98AS02	9805	9809	98AS05
Low Mol Wt.	No. Rings	Kow	Solubility mg/l	Fillet	Whole Fish	Fillet	Fillet	Fillet	Fillet	Whole Fish	Whole Fish	Fillet
Naphthalene	2	3.36	31.7	(19)1.	110		-35-2.	-34-	93	34	71	-38-
Acenaphthylene	3	4.07	3.93	(21)								
Acenaphthene	3	3.92	3.47	(17)	200	-17-	-53-		120		83	-48-
Anthracene	3	4.54	0.073	(7.1)	-21-				-7.6-			
Fluorene	3	4.38	1.98	(58)	73							
Phenanthrene	3	4.57	1.29	(19)	79		-17-	-17-	-47-			
High Mol Wt.	Total LMW Concen.→			• 0	483	17	105	51	318.6		154	86
Fluoranthene	4	5.22	0.26	(29)								
Pyrene	4	5.18	0.135	(12)								
Chrysene	4	5.79	0.014	(7.4)								
Benzol(a)anthracene	4	5.91	0.014	(19)								
Benzol(a)pyrene	5	6.42	0.0038	(23)								
Benzol(b)fluoranthene	5	6.60	0.0012	(32)								
Benzol(k)fluoranthene	5	6.85	0.0006	(21)								
Dibenzo(a,h)anthracene	5	6.50	0.0005	(8)								
Indeno(1,2,3-c,d)pyrene	6	7.66	0.062	(34)								
Benzol(g,h,i)perylene	6	7.05	0.0003	(22)								
% Lipids	-----		-----	2.8	7.5	1.3	1.3	3.7	10	3.3	0.8	2.9

1. Value in parenthesis is the reported level of detection (LOD) for the compound. The LODs for sample 9810 are the same for the other samples that have no values placed in the columns under that sample.
2. A value with a hypen on either side, e.g. -19-, indicates that the value reported is between the LOD and LOQ.

Fish species and characteristics

Fish Where PAHs Detected In Tissue (% lipids given in the table above)
9810 - Shorthead redhorse, 18.4 in., 1.08 kg, whole fish
9811 - Smallmouth bass, 9.8 in., 022 kg, skin on fillet
9813 - Northern Pike - 22.5 in., 1.21, skin on fillet
98AS01 - Brown Trout, 21.25 in., 1.69 kg, skin on fillet
98AS02 - Rainbow Trout, 20.5 in., 2.02 kg, skin on fillet
98AS05 - White sucker, 17.5 in., 0.86 kg, skin on fillet
9805 - Pumpkinseed, 5.0 in. 0.04 kg, whole fish
9809 - Shorthead redhorse, 18.2 kg, whole fish

Fish Were PAHs Not Detected In Tissue
98AS04 - Largemouth Bass, 10.0 in., 28 kg, skin on fillet, 0.8% lipids
98AS03 - White Sucker, 17.75 in., 0.91 kg, skin on fillet, 1.0% lipids
9812 - Walleye, 17.8 in., 0.77 kg, skin on fillet, 2.8% lipids (listed in table above for indication of LODs
9801 - Rock Bass, 6 in, 0.07 kg, skin on fillet, 0.7% lipids
9802 - Rock Bass, 5.9 in., 0.08 kg, skin on fillet, 1.0% lipids
9803 - Rock Bass, 7.8 in., 0.17 kg, skin on fillet, 0.9% lipids
9804 - Rock Bass, 9.8 in., 0.36 kg, skin on fillet, 0.7% lipids
9806 - White Sucker, 15.9 in., 0.69 kg, skin on fillet, 2.4%
9807 - White Sucker, 16.5 in., 0.68 kg, skin on fillet, 1.7%
9808 - White Sucker, 18.2 in., 1.02 kg, skin on fillet, 2.5%

(EXCERPTED FROM WDNR JUNE 1999 COMMENTS - ATTACHMENT A)

Table 15 2001 Sediment Bioassay Toxicity Test Chemical Data - Dry Weight

Chem Lab ID:	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	*2400N/1700E Duplicate*
Sediment Depth (ft)	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	*0-0.5*
LSRI Lab ID:	Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2	Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	*100% Wood #2 Dup.*
Date Homogenized:	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001
Total Organic Carbon (mg/kg)	21,000	22000	20000	25000	170000	36,000	1,900	190,000	140000	53000	230000	230000	480,000	260,000	*190,000*
TOC (%)	2	2	2	3	17	4	0	19	14	5	23	23	48	26	*19*
Polycyclic Aromatic Hydrocarbons (ug/kg)															
Benzo(e)Pyrene	250	460	1100	3200	12000	9,100	2,400	990	1100	3200	9400	18000	21,000	2,900	*3,300*
Acenaphthene	16	1300	7800	27000	75000	88,000	28,000	100	640	6600	18000	45000	48,000	7,500	*7,400*
Acenaphthylene	96	180	580	1700	3900	5,200	1,400	410	360	1300	3500	7600	8,800	1,200	*1,300*
Anthracene	52	410	2300	7300	20000	23,000	7,900	220	540	4200	12000	28000	34,000	3,300	*3,700*
Benzo(a)Anthracene	280	670	2200	6300	23000	18,000	5,300	1,100	1300	6100	19000	38000	44,000	5,600	*6,500*
Benzo(a)Pyrene	350	660	1900	5300	19000	14,000	4,100	1,400	1600	5300	16000	32000	36,000	4,600	*5,100*
Benzo(b)Fluoranthene	210	420	1000	2500	13000	8,300	1,900	860	950	2800	8000	16000	18,000	3,300	*3,400*
Benzo(ghi)Perylene	270	450	1100	3000	12000	8,500	2,300	940	1100	3100	8700	17000	18,000	2,800	*3,000*
Benzo(k)Fluoranthene	230	420	1300	3900	17000	11,000	3,000	910	1000	3400	9800	20000	22,000	3,300	*3,800*
Chrysene	230	500	1700	5700	21000	18,000	4,900	910	1100	4600	14000	28000	32,000	4,300	*4,800*
Dibenzo(a,h)Anthracene	58	84	190	540	2800	1,500	380	240	250	650	1800	3300	3,500	710	*780*
Fluoranthene	260	1100	5100	16000	55000	51,000	15,000	1,100	2200	11000	33000	75000	87,000	9,800	*10,000*
Fluorene	14	510	3000	10000	26000	30,000	9,700	77	320	3100	8800	21000	23,000	3,100	*3,400*
Indeno(1,2,3-cd)Pyrene	180	310	740	2000	9400	5,700	1,500	740	800	2200	6400	12000	13,000	2,200	*2,400*
1-Methyl Naphthalene	25	1100	6600	20000	67000	73,000	20,000	110	470	4200	11000	27000	29,000	7,900	*7,700*
2-Methyl Naphthalene	38	1700	11000	33000	110000	120,000	34,000	180	650	5800	15000	36000	41,000	8,100	*8,600*
Naphthalene	31	2200	14000	39000	170000	160,000	33,000	190	600	4500	11000	27000	31,000	9,200	*9,400*
Phenanthrene	120	2000	11000	39000	100000	120,000	38,000	520	1700	15000	42000	100000	120,000	12,000	*14,000*
Pyrene	400	1700	7300	24000	67000	72,000	22,000	1,600	3400	17000	54000	110000	130,000	12,000	*13,000*
Total PAHs (ug/kg)	**3,110**	**16,174**	**79,910**	**249,440**	**823,100**	**836,300**	**234,780**	**12,597**	**20,080**	**104,050**	**301,400**	**660,900**	**759,300**	**103,810**	**111,580**
Heterocyclic Aromatic Hydrocarbons (ug/kg)															
Dibenzothiophene	<590	<590	850	1500	3500	5,100	1900	<870	<800	<1000	1900	5300	12,000	1,500	*980*
Carbazole	<68	<67	120	150	430	2200	210	<99	<91	<120	<110	<420	<680	580	*490*
Dibenzofuran	<23	49	380	700	1800	3000	830	52	71	310	640	1800	3700	980	*600*
Total HAHs (ug/kg)	**ND**	**49**	**1,350**	**2,350**	**5,730**	**10,300**	**2,940**	**52**	**71**	**310**	**2,540**	**7,100**	**15,700**	**3,060**	***2,070***
Phenolic Compounds (ug/kg)															
2-Fluorobiphenyl	77	69	74	69	78	73	69	75	68	74	74	77	77	74	*72*
4-Methylphenol	<77	180	160	89	<230	<310	<58	690	560	660	530	500	<780	350	*200*
Phenol	93	83	<41	87	<130	<180	<34	980	830	1400	1200	1600	1900	450	*250*
Total Phenolics (ug/kg)	**170**	**332**	**234**	**245**	**78**	**73**	**69**	**1,745**	**1,458**	**2,134**	**1,804**	**2,177**	**1,977**	**874**	**522**
Volatile Organic Compounds (ug/kg)															
Benzene	<25	<25	<50	<100	<250	<310	<250	<25	<25	52	140	290	530	150	*140*
Ethylbenzene	<25	29	410	580	1,800	2,800	990	<25	<25	44	110	310	450	180	*180*
Isopropylbenzene	<25	<25	70	<100	250	390	<250	<25	<25	<25	37	59	76	38	*40*
p-Isopropyltoluene	<25	<25	68	100	280	470	380	<25	<25	<25	<25	26	36	<25	*<25*
Methylene Chloride	<25	<25	57	<100	<250	360	<250	<25	<25	<25	<25	<25	<25	<25	*<25*
Toluene	<25	<25	<50	<100	<250	<310	<250	28	26	<25	<25	<25	28	41	*41*
1,2,4-Trimethylbenzene	<25	34	400	580	1,600	2,700	1,800	<25	<25	44	86	230	350	140	*160*
1,3,5-Trimethylbenzene	<25	<25	130	180	540	790	570	<25	<25	<25	26	78	110	50	*54*
Xylenes, -m, -p	<50	<50	240	350	1,100	1,600	560	<50	<50	<50	68	180	280	95	*94*
Xylene, -o	<25	<25	160	220	680	990	400	<25	<25	28	62	160	250	85	*90*
Total VOCs (ug/kg)	**ND**	**63**	**1,535**	**1,910**	**6,250**	**10,100**	**4,700**	**28**	**26**	**168**	**529**	**1,333**	**2,110**	**779**	***799***
Total BETX (ug/kg)	ND	29	810	1,150	3,580	5,390	1,950	28	26	124	380	940	1,538	551	545

Table 16 2001 Sediment Bioassay Toxicity Test Chemical Data - Normalized to Organic Carbon

Chem Lab ID:	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	*2400N/1700E Duplicate*
Sediment Depth (ft)	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	*0-0.5*
LSRI Lab ID:	Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2	Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	*100% Wood #2 Dup.*
Date Homogenized:	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001	4/30/2001
Total Organic Carbon (mg/kg)	21000	22000	20000	25000	170000	36000	1900	190000	140000	53000	230000	230000	480000	260000	*190000*
TOC (%)	2	2	2	3	17	4	0	19	14	5	23	23	48	26	*19*
Polycyclic Aromatic Hydrocarbons (ug/g OC)															
Benzo(e)Pyrene	12	21	55	128	71	253	1,263	5	8	60	41	78	44	11	*17*
Acenaphthene	1	59	390	1,080	441	2,444	14,737	1	5	125	78	196	100	29	*39*
Acenaphthylene	5	8	29	68	23	144	737	2	3	25	15	33	18	5	*7*
Anthracene	2	19	115	292	118	639	4,158	1	4	79	52	122	71	13	*19*
Benzo(a)Anthracene	13	30	110	252	135	500	2,789	6	9	115	83	165	92	22	*34*
Benzo(a)Pyrene	17	30	95	212	112	389	2,158	7	11	100	70	139	75	18	*27*
Benzo(b)Fluoranthene	10	19	50	100	76	231	1,000	5	7	53	35	70	38	13	*18*
Benzo(ghi)Perylene	13	20	55	120	71	236	1,211	5	8	58	38	74	38	11	*16*
Benzo(k)Fluoranthene	11	19	65	156	100	306	1,579	5	7	64	43	87	46	13	*20*
Chrysene	11	23	85	228	124	500	2,579	5	8	87	61	122	67	17	*25*
Dibenzo(a,h)Anthracene	3	4	10	22	16	42	200	1	2	12	8	14	7	3	*4*
Fluoranthene	12	50	255	640	324	1,417	7,895	6	16	208	143	326	181	38	*53*
Fluorene	1	23	150	400	153	833	5,105	0	2	58	38	91	48	12	*18*
Indeno(1,2,3-cd)Pyrene	9	14	37	80	55	158	789	4	6	42	28	52	27	8	*13*
1-Methyl Naphthalene	1	50	330	800	394	2,028	10,526	1	3	79	48	117	60	30	*41*
2-Methyl Naphthalene	2	77	550	1,320	647	3,333	17,895	1	5	109	65	157	85	31	*45*
Naphthalene	1	100	700	1,560	1,000	4,444	17,368	1	4	85	48	117	65	35	*49*
Phenanthrene	6	91	550	1,560	588	3,333	20,000	3	12	283	183	435	250	46	*74*
Pyrene	19	77	365	960	394	2,000	11,579	8	24	321	235	478	271	46	*68*
Total PAHs (ug/g OC)	**148**	**735**	**3,996**	**9,978**	**4,842**	**23,231**	**123,568**	**66**	**143**	**1,963**	**1,310**	**2,873**	**1,582**	**399**	*587*
Heterocyclic Aromatic Hydrocarbons (ug/g OC)															
Dibenzothiophene			43	60	21	142	1,000				8	23	25	6	*5*
Carbazole			6	6	3	61	111							2	*3*
Dibenzofuran		2	19	28	11	83	437	0.3	0.5	6	3	8	8	4	*3*
Total HAHs (ug/g OC)	**ND**	**2**	**68**	**94**	**34**	**286**	**1,547**	**0.3**	**0.5**	**6**	**11**	**31**	**33**	**12**	*11*
Phenolic Compounds (ug/g OC)															
2-Fluorobiphenyl	4	3	4	3	0.5	2	36	0.4	0.5	1.4	0.3	0.3	0.2	0.3	*0.4*
4-Methylphenol		8	8	4				4	4	12	2	2		1	*1*
Phenol	4	4		3				5	6	26	5	7	4	2	*1*
Total Phenolics (ug/g OC)	**8**	**15**	**12**	**10**	**0.5**	**2**	**36**	**9**	**10**	**40**	**8**	**9**	**4**	**3**	*3*
Volatile Organic Compounds (ug/g OC)															
Benzene										1.0	0.6	1.3	1.1	0.6	*1*
Ethylbenzene		1	21	23	11	78	521			0.8	0.5	1.3	0.9	0.7	*1*
Isopropylbenzene			4		1	11					0.2	0.3	0.2	0.1	*0.2*
p-Isopropyltoluene			3	4	2	13	200					0.1	0.1		
Methylene Chloride			3			10									
Toluene								0.1	0.2				0.1	0.2	*0.2*
1,2,4-Trimethylbenzene		2	20	23	9	75	947			0.8	0.4	1.0	0.7	0.5	*1*
1,3,5-Trimethylbenzene			7	7	3	22	300				0.1	0.3	0.2	0.2	*0.3*
Xylenes, -m, -p			12	14	6	44	295				0.3	0.8	0.6	0.4	*0.5*
Xylene, -o			8	9	4	28	211			0.5	0.3	0.7	0.5	0.3	*0.5*
Total VOCs (ug/g OC)	**ND**	**3**	**77**	**76**	**37**	**281**	**2,474**	**0.1**	**0.2**	**3**	**2**	**6**	**4**	**3**	*4*
Total BETX (ug/g OC)	ND	1	41	46	21	150	1,026	0.1	0.2	2	2	4	3	2	*3*

Table 17 Summary of Bioassay Toxicity Test Results

	2001 Lab Controls			2001 Contaminated Sand Series							2001 Contaminated Wood Series							1998 Series				
Sampling Location:	LSRI	LSRI	LSRI	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	LSRI	2600N/2500E	2550N/1450E	2600N/2100E	2400N/1400E
	Silica Sand Control 2001	Formulated Sediment 2001	W Bearskin Lake Sed. 2001	Ref Sand 2001	1% Cont Sand#1 2001	10% Cont Sand#1 2001	25% Cont Sand#1 2001	50% Cont Sand#1 2001	Cont. Sand#1 2001	Cont. Sand#2 2001	Ref Wood 2001	1% Cont Wood#1 2001	10% Cont Wood#1 2001	25% Cont Wood#1 2001	50% Cont Wood#1 2001	Cont. Wood#1 2001	Cont. wood#2 2001	Lab Control Sand 1998	Ref Sand 1998	Cont Sand 1998	Ref Wood 1998	Cont Wood 1998
				0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5
	Apr-01	Apr-01	Apr-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	May-98	May-98	May-98	May-98	May-98
Chemical Data																						
Dry Weight Values (ug/kg)																						
Total PAHs (19 chemicals) DW				3,110	16,174	79,910	249,440	823,100	836,300	234,780	12,597	20,080	104,050	301,400	660,900	759,300	103,810		424	1,459	6,543	370,200
Total VOCs (9 chemicals) DW				ND	63	1,535	1,910	6,250	10,100	4,700	28	26	168	529	1,333	2,110	779		44	49	395	1,257
Total HAHs (3 chemicals) DW				ND	49	1,350	2,350	5,730	10,300	2,940	52	71	310	2,540	7,100	15,700	3,060					
Total Phenolics (3 chemicals) DW				170	332	234	245	78	73	69	1,745	1,458	2,134	1,804	2,177	1,977	874					
Concentrations Normalized to Organic Carbon (ug/g OC)																						
% Total Organic Carbon				2.1	2.2	2.0	2.5	17.0	3.6	0.2	19.0	14.0	5.3	23.0	23.0	48.0	26.0		0.46	0.25	5.7	1.7
Total PAHs (19 chemicals) NOC				148	735	3,996	9,978	4,842	23,231	123,568	66	143	1,963	1,310	2,873	1,582	399		92	584	115	21,778
Total VOCs (9 chemicals) NOC				ND	3	77	76	37	281	2,474	0.1	0.2	3	2	6	4	3		10	20	7	74
Total HAHs (3 chemicals) NOC				ND	2	68	94	34	286	1,547	0.3	0.5	6	11	31	33	12					
Total Phenolics (3 chemicals) NOC				8	15	12	10	0	2	36	9	10	40	8	9	4	3					
Chem Data Relative to Sediment Benchmarks:																						
Dry Weight Benchmark Ratios																						
MacDonald CBSQG PEC-Q for Sum of 13 PAHs				0.09	0.6	3	9	30	32	9	0.4	0.6	4	11	24	28	4		0.01	0.06	0.2	13
ORNL PRG TU's for BTEX				0.00	0.01	3	4	11	17	6	0.6	0.5	0.5	2	4	7	3		0.9	0.00	6	6
ORNL PRG TU's for Dibenzofuran				0.00	0.1	0.9	2	4	7	2	0.1	0.2	0.7	2	4	9	2					
ORNL PRG TU's for Phenol				3	3	0.00	3	0.00	0.00	0.00	31	26	44	38	50	59	14					
Normalized to Organic Carbon Benchmark Ratios																						
Total ESG TU's for 13 NOC PAHs (EPA 2001 - Draft EQP)				1.7	11	62	156	76	369	1,908	0.8	2	26	19	42	23	6		1.1	9	2	323
Total HA-28 NOC ERM TU's for PAHs (EPA 1996)				19	161	968	2,499	1,152	5,849	31,911	9	22	370	239	555	297	61		7	119	14	3,728
WDNR Guidance - CBSQG PEC-Q for Sum of 13 PAHs normalized to 1% OC				0.04	0.3	1.5	4	2	9	47	0.02	0.05	0.7	0.5	1.1	0.6	0.1		0.03	0.2	0.04	8
WDNR Draft guidance TU's for BTEX				0.00	0.00	4	5	2	14	101	0.00	0.00	0.2	0.2	0.4	0.3	0.2		0.05	0.00	0.03	6
WDNR Draft guidance TU's for Dibenzofuran				0.00	0.04	0.3	0.5	0.2	1.4	8	0.00	0.01	0.1	0.06	0.1	0.1	0.1					
WDNR Draft guidance TU's for Phenol				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00					
EPA SQAL TU's for BTEX				0.00	0.00	8	9	4	29	203	0.00	0.00	0.4	0.3	0.8	0.6	0.4		0.11	0.00	0.06	11
EPA SQAL TU's for Dibenzofuran				0.00	0.01	0.1	0.1	0.1	0.4	2	0.00	0.00	0.03	0.01	0.04	0.04	0.02					
Toxicity Test Results (* indicates stat significant reduction in survival or weight relative to a reference site)																						
HA-28 Non UV (2001) or HA-10 Non UV (1998)																						
Survival (%)	78%	93%	98%	86%	98%	95%	84%	46% *	0% *	5% *	98%	95%	90%	88%	86%	3% *		90%	95%	89%	96%	26% *
Weight	0.19	0.56	0.18	0.27	0.22	0.21	0.26	0.43	0.00	0.57	0.24	0.22	0.25	0.24	0.26	0.42						
HA-28 with UV (2001)																						
Survival (%)	95%	70% *	98%	93%	99%	69% *	14% *	0% *	0% *	0% *	99%	95%	83% *	33% *	0% *	0% *	36% *					
Weight	0.17	0.49	0.18	0.21	0.19	0.29	0.50	0.00	0.00	0.00	0.24	0.23	0.29	0.50	0.00	0.00	0.49					
CT-10 (2001) or CT-10 (1998)																						
Survival (%)	83%	90%	96%	95%	98%	73% *	23% *	0% *	0% *	0% *	85%	93%	93%	88% *	48% *	5% *	95%	95%	93%	80% *	94%	68% *
Weight	0.65	0.72	0.81	0.83	0.75	0.80	0.58	0.00	0.00	0.00	0.91	0.83	0.71	0.63	0.55	0.35	0.67					
PP-7 Bulk Sediment (2001)																						
Survival (%)	100%	100%	94%	92%	96%	92%	90%	12% *	0% *	0% *	98%	92%	96%	98%	88% *	18% *	96%					
Weight	1.04	0.98	0.95	0.91	0.90	0.84	0.61	0.29	0.00	0.00	0.95	0.96	0.94	0.87	0.65	0.28	0.78					
Other 1998 Toxicity Test Results																						
PP-7 elutriate Survival (%)																		100%	93%	5% *	83%	0% *
LV-10 Survival (%)																		124%	132%	96%	170%	25% *
LV-10 UV Survival (%)																		100%	40% *	0% *	0% *	0% *
DM - 48 hr Survival (%)																		100%	100%	100%	92%	100%
DM - 48 hr UV Survival (%)																		100%	100%	0% *	8% *	0% *
Percent of Toxicity Test Results with Statistically Significant Reductions (*):																						
2001 Toxicity Tests (4 tests)	0%	25%	0%	0%	0%	50%	75%	100%	100%	100%	0%	0%	25%	50%	75%	100%	50%					
1998 Toxicity Tests (6 tests)																		0%	14%	57%	29%	86%

Table 18 Bioassay Toxicity Test Results - Sorted by DW PAH Concentrations

Sampling Location:	LSW	LSN	LSN	LSN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Silica Sand Control 2001	Formulated Sediment 2001	W Bearskin Lake Sed. 2001	Lab Control Sand 1998	Ref Sand 1998	Cont Sand 1998	Ref Sand 2001	Ref Wood 1998	Ref Wood 2001	1% Cont Sand#1 2001	1% Cont Wood#1 2001	10% Cont Sand#1 2001	Cont. wood#2 2001	10% Cont Wood#1 2001	Cont. Sand#2 2001	25% Cont Sand#1 2001	25% Cont Wood#1 2001	Cont Wood 1998	50% Cont Wood#1 2001	Cont. Wood#1 2001	50% Cont Sand#1 2001	Cont. Sand#1 2001
					0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
	Apr-01	Apr-01	Apr-01	May-98	May-98	May-98	Mar-01	May-98	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	May-98	Mar-01	Mar-01	Mar-01	Mar-01
Chemical Data																						
Dry Weight Values (ug/kg)																						
Total PAHs (19 chemicals) DW					424	1,459	3,110	6,543	12,597	16,174	20,080	79,910	103,810	104,050	234,780	249,440	301,400	370,200	660,900	759,300	823,100	836,300
Total VOCs (9 chemicals) DW					44	49	ND	395	28	63	26	1,535	779	168	4,700	1,910	529	1,257	1,333	2,110	6,250	10,100
Total HAHs (3 chemicals) DW							ND		52	49	71	1,350	3,060	310	2,940	2,350	2,540		7,100	15,700	5,730	10,300
Total Phenolics (3 chemicals) DW							170		1,745	332	1,458	234	874	2,134	69	245	1,804		2,177	1,977	78	73
Concentrations Normalized to Organic Carbon (ug/g OC)																						
% Total Organic Carbon					0.5	0.3	2	6	19	2.2	14	2	26	5	0.2	2.5	23	1.7	23	48	17	4
Total PAHs (19 chemicals) NOC					92	584	148	115	66	735	143	3,996	399	1,963	123,568	9,978	1,310	21,776	2,873	1,582	4,842	23,231
Total VOCs (9 chemicals) NOC					10	20	ND	7	0.1	3	0.2	77	3	3	2,474	76	2	74	6	4	37	281
Total HAHs (3 chemicals) NOC							ND		0.3	2	0.5	68	12	6	1,547	94	11		31	33	34	286
Total Phenolics (3 chemicals) NOC							8		9	15	10	12	3	40	36	10	8		9	4	0	2
Chem Data Relative to Sediment Benchmarks:																						
Dry Weight Benchmark Ratios																						
MacDonald CBSQG PEC-Q for Sum of 13 PAHs					0.01	0.06	0.09	0.2	0.4	0.6	0.6	3	4	4	9	9	11	13	24	28	30	32
ORNL PRG TU's for BTEX					0.9	0.00	0.00	6	0.6	0.01	0.5	3	3	0.5	6	4	2	6	4	7	11	17
ORNL PRG TU's for Dibenzofuran							0.00		0.12	0.12	0.17	0.9	2	0.7	2	2	2		4	9	4	7
ORNL PRG TU's for Phenol							3		31	3	26	0.00	14	44	0.00	3	38		50	59	0.00	0.00
Normalized to Organic Carbon Benchmark Ratios																						
Total ESG TU's for 13 NOC PAHs (EPA 2001 - Draft EQP)					1.1	9	2	2	0.8	11	2	62	6	28	1,908	156	19	323	42	23	76	369
Total HA-28 NOC ERM TU's for PAHs (EPA 1996)					7	119	19	14	9	161	22	968	81	370	31,911	2,499	239	3,728	555	297	1,152	5,849
WDNR Guidance - CBSQG PEC-Q for Sum of 13 PAHs normalized to 1% OC					0.03	0.2	0.04	0.04	0.02	0.3	0.05	1.5	0.1	0.7	47	4	0.5	8	1.1	0.6	2	9
WDNR Draft guidance TU's for BTEX					0.05	0.00	0.00	0.03	0.00	0.00	0.00	4	0.2	0.2	101	5	0.2	6	0.4	0.3	2	14
WDNR Draft guidance TU's for Dibenzofuran							0.00		0.00	0.04	0.01	0.3	0.1	0.1	5	0.48	0.05		0.13	0.13	0.2	1.4
WDNR Draft guidance TU's for Phenol							0.00		0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00		0.01	0.00	0.00	0.00
EPA SQAL TU's for BTEX					0.11	0.00	0.00	0.06	0.00	0.00	0.00	8	0.4	0.4	203	9	0.3	11	0.8	0.6	4	29
EPA SQAL TU's for Dibenzofuran							0.00		0.00	0.01	0.00	0.10	0.02	0.03	2	0.14	0.01		0.04	0.04	0.1	0.4
Toxicity Test Results (* indicates stat significant reduction in survival or weight relative to a reference site)																						
HA-28 Non UV (2001) or HA-10 Non UV (1998)																						
Survival (%)	78%	93%	98%	90%	95%	89%	86%	96%	98%	98%	95%	95%		90%	5%	84%	88%	26%	86%	3%	46%	0%
Weight	0.2	0.6	0.2				0.3		0.2	0.2	0.2	0.2		0.2	0.6	0.3	0.2		0.3	0.4	0.4	0.0
HA-28 with UV (2001)																						
Survival (%)	95%	70%	98%				93%		99%	99%	95%	69%	36%	83%	0%	14%	33%		0%	0%	0%	0%
Weight	0.2	0.5	0.2				0.2		0.2	0.2	0.2	0.3	0.5	0.3	0.0	0.5	0.5		0.0	0.0	0.0	0.0
CT-10 (2001) or CT-10 (1998)																						
Survival (%)	83%	90%	96%	95%	93%	80%	95%	94%	85%	98%	93%	73%	95%	93%	0%	23%	88%	68%	48%	5%	0%	0%
Weight	0.7	0.7	0.8				0.8		0.9	0.7	0.8	0.8	0.7	0.7	0.0	0.6	0.6		0.5	0.3	0.0	0.0
PP-7 Bulk Sediment (2001)																						
Survival (%)	100%	100%	94%				92%		98%	96%	92%	92%	98%	96%	0%	90%	98%		88%	18%	12%	0%
Weight	1.0	1.0	1.0				0.9		1.0	0.9	1.0	0.8	0.8	0.9	0.0	0.6	0.9		0.7	0.3	0.3	0.0
Other 1998 Toxicity Test Results																						
PP-7 elutriate	Survival (%)			100%	93%	5%		83%										0%				
LV-10	Survival (%)			124%	132%	96%		170%										25%				
LV-10 UV	Survival (%)			100%	40%	0%		0%										0%				
DM - 48 hr	Survival (%)			100%	100%	100%		92%										100%				
DM - 48 hr UV	Survival (%)			100%	100%	0%		8%										0%				
Percent of Toxicity Test Results with Statistically Significant Reductions (*):																						
2001 Toxicity Tests (4 tests)	0%	25%	0%				0%		0%	0%	0%	50%	50%	25%	100%	75%	100%		75%	100%	100%	100%
1998 Toxicity Tests (6 tests)				0%	14%	57%		29%										86%				

Table 19 - Bioassay Toxicity Test Results - Sorted by NOC PAH Concentrations

Sampling Location:	LSRI	LSRI	LSRI	LSRI	3100N/1500E	2000N/2500E	2000N/2100E	3100N/1500E 99%	3100N/2300E	2400N/1700E	2500N/1400E	3100N/2300E 99%	3100N/1500E 75%	3400N/1400E	3100N/1500E 99%	3100N/1500E 50%	3100N/2300E 99%	3100N/2300E 50%	3100N/2300E 75%	3400N/1400E	2500N/1700E	2000N/1600E
	Silica Sand Control 2001	Formulated Sediment 2001	W Bearskin Lake Sed. 2001	Lab Control Sand 1998	Ref Wood 2001	Ref Sand 1998	Ref Wood 1998	1% Cont Wood01 2001	Ref Sand 2001	Cont. wood02 2001	Cont Sand 1998	1% Cont Sand01 2001	25% Cont Wood01 2001	Cont. Wood01 2001	10% Cont Wood01 2001	50% Cont Wood01 2001	10% Cont Sand01 2001	50% Cont Sand01 2001	25% Cont Sand01 2001	Cont Wood 1998	Cont. Sand01 2001	Cont. Sand02 2001
					0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
	Apr-01	Apr-01	Apr-01	May-98	Mar-01	May-98	May-98	Mar-01	Mar-01	Mar-01	May-98	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	Mar-01	May-98	Mar-01	Mar-01
Chemical Data																						
Dry Weight Values (ug/kg)																						
Total PAHs (19 chemicals) DW					12,597	424	6,543	20,080	3,110	103,810	1,459	16,174	301,400	759,300	104,050	660,900	79,910	823,100	249,440	370,200	836,300	234,780
Total VOCs (9 chemicals) DW					28	44	395	26	ND	779	49	63	529	2,110	168	1,333	1,535	6,250	1,910	1,257	10,100	4,700
Total HAHs (3 chemicals) DW					52			71	ND	3,060		49	2,540	15,700	310	7,100	1,350	5,730	2,350		10,300	2,940
Total Phenolics (3 chemicals) DW					1,745			1,458	170	874		332	1,804	1,977	2,134	2,177	234	78	245		73	69
Concentrations Normalized to Organic Carbon (ug/g OC)																						
% Total Organic Carbon					19	0	6	14	2.1	26	0	2	23	48	5	23	2	17	3	2	3.6	0.2
Total PAHs (19 chemicals) NOC					**66**	**92**	**115**	**143**	**148**	**399**	**584**	**735**	**1,310**	**1,582**	**1,963**	**2,873**	**3,996**	**4,842**	**9,978**	**21,776**	**23,231**	**123,568**
Total VOCs (9 chemicals) NOC					0.1	10	7	0.2	ND	3	20	3	2	4	3	6	77	37	76	74	281	2,474
Total HAHs (3 chemicals) NOC					0.3			0.5	ND	12		2	11	33	6	31	68	34	94		286	1,547
Total Phenolics (3 chemicals) NOC					9			10	8	3		15	8	4	40	9	12	0	10		2	36
Chem Data Relative to Sediment Benchmarks:																						
Dry Weight Benchmark Ratios																						
MacDonald CBSQG PEC-Q for Sum of 13 PAHs					0.4	0.01	0.2	0.6	0.09	3.6	0.06	0.6	10.9	28.0	3.7	24	3	30	9	13	32	9
ORNL PRG TU's for BTEX					0.6	0.9	6.4	0.5	0.00	2.9	0.00	0.0	1.7	7.3	0.5	4	3	11	4	6	17	6
ORNL PRG TU's for Dibenzofuran					0			0.2	0.00	2.3		0.1	1.5	8.8	0.7	4	0.9	4	2		7	2
ORNL PRG TU's for Phenol					31			25.9	2.9	14.1		2.6	37.5	59.4	43.8	50	0.00	0.00	3		0.00	0.00
Normalized to Organic Carbon Benchmark Ratios																						
Total ESG TU's for 13 NOC PAHs (EPA 2001 - Draft EQP)					**0.8**	**1**	**2**	**2**	**2**	**6**	**9**	**11**	**19**	**23**	**28**	**42**	**62**	**76**	**156**	**323**	**369**	**1,908**
Total HA-28 NOC ERM TU's for PAHs (EPA 1996)					9	7	14	22	19	81	119	161	239	297	370	555	968	1,152	2,499	3,728	5,849	31,911
WDNR Guidance - CBSQG PEC-Q for Sum of 13 PAHs normalized to 1% OC					0.02	0.03	0.04	0.05	0.04	0.1	0.2	0.3	0.5	0.6	0.7	1.1	1.5	2	4	8	9	47
WDNR Draft guidance TU's for BTEX					0.00	0.05	0.03	0.00	0.00	0.2	0.00	0.00	0.2	0.3	0.2	0.4	4	2	5	6	14	101
WDNR Draft guidance TU's for Dibenzofuran					0.00			0.01	0.00	0.1		0.04	0.05	0.1	0.1	0.1	0.3	0.2	0.5		1.4	8
WDNR Draft guidance TU's for Phenol					0.00			0.00	0.00	0.00		0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00		0.00	0.00
EPA SQAL TU's for BTEX					0.00	0.11	0.06	0.00	0.00	0.4	0.00	0.00	0.3	0.6	0.4	0.8	8	4	9	11	29	203
EPA SQAL TU's for Dibenzofuran					0.00			0.00	0.00	0.02		0.01	0.01	0.04	0.03	0.04	0.10	0.1	0.1		0.4	2
Toxicity Test Results (* indicates stat significant reduction in survival or weight relative to a reference site)																						
HA-28 Non UV (2001) or HA-10 Non UV (1998) Survival (%)	78%	93%	98%	90%	98%	95%	96%	95%	86%		89%	98%	88%	3%	90%	86%	95%	46%	84%	26%	0%	5%
Weight	0.2	0.6	0.2		0.2			0.2	0.3			0.2	0.2	0.4	0.2	0.3	0.2	0.4	0.3		0.0	0.6
HA-28 with UV (2001) Survival (%)	95%	70%	98%		99%			95%	93%	36%		99%	33%	0%	83%	0%	69%	0%	14%		0%	0%
Weight	0.2	0.5	0.2		0.2			0.2	0.2	0.5		0.2	0.5	0.0	0.3	0.0	0.3	0.0	0.5		0.0	0.0
CT-10 (2001) or CT-10 (1998) Survival (%)	83%	90%	96%	95%	85%	93%	94%	93%	95%	95%	80%	98%	88%	5%	93%	48%	73%	0%	23%	68%	0%	0%
Weight	0.7	0.7	0.8		0.9			0.8	0.8	0.7		0.7	0.6	0.3	0.7	0.5	0.8	0.0	0.6		0.0	0.0
PP-7 Bulk Sediment (2001) Survival (%)	100%	100%	94%		98%			92%	92%	98%		96%	98%	18%	96%	88%	92%	12%	90%		0%	0%
Weight	1.0	1.0	1.0		1.0			1.0	0.9	0.8		0.9	0.9	0.3	0.9	0.7	0.8	0.3	0.8		0.0	0.0
Other 1998 Toxicity Test Results																						
PP-7 elutriate Survival (%)				100%		93%	83%				5%									0%		
LV-10 Survival (%)				124%		132%	170%				96%									25%		
LV-10 UV Survival (%)				100%		40%	0%				0%									0%		
DM - 48 hr Survival (%)				100%		100%	92%				100%									100%		
DM - 48 hr UV Survival (%)				100%		100%	8%				0%									0%		
Percent of Toxicity Test Results with Statistically Significant Reductions (*):																						
2001 Toxicity Tests (4 tests)	0%	25%	0%		0%			0%	0%	50%		0%	50%	100%	25%	75%	50%	100%	75%		100%	100%
1998 Toxicity Tests (6 tests)				0%		14%	29%				57%									86%		

Table 20 - Summary of Ecological Risk Assessment Weight of Evidence

Benthic Community

1. Adsorbed PAH, VOC, HAH, and Phenolic compounds in sediment bioactive zone
2. Exceedance of several different sediment effects benchmarks and SQGs for PAHs, VOCs, HAHs, and Phenols in sediments
3. Impacted Benthic Community per Spring 1998 Survey
4. Toxicity Study results indicate PAH contaminated sediments are toxic to benthic organisms
5. UV light exposure results indicate the toxicity of PAH contaminated sediments to benthic and water column organisms
6. Degradation of lower order foodchain microorganism populations based on microbial enumeration bioassays

Aquatic Community

1. Adsorbed PAH, VOC, HAH, and Phenolic compounds in sediment bioactive zone
2. Exceedance of several different sediment effects benchmarks and SQGs for PAHs, VOCs, HAHs, and Phenols in sediments
3. PAH concentrations in sediments at levels comparable to those associated with tumors in fish at other sites
4. PAHs detected in fish tissues collected from site
5. Exceedance of acute and chronic criteria for water quality during wave action
6. Reports of sheen and odors in surface waters above contaminated sediments
7. Potential for release of more heavily contaminated deeper sediments due to natural or anthropogenic disturbances.
8. Toxicity Study results indicate PAH contaminated sediments are toxic to fish fry
9. UV light exposure results indicate the toxicity of PAH contaminated sediments to fish fry and Daphnia magna

Terrestial Community

1. HHRA indicated risk of cancer to humans from exposure to sediments or contaminated water
2. Lower order food chain impacted - decreases quantity and quality of fish and other food sources
3. Potential for uptake of PAH contaminants by terrestial organisms feeding on lower order aquatic or benthic organisms that may have bioaccumulated contaminants.

Table 21 Preliminary Remediation Goals for Sediments

	Sandy Sediments				Wood Chip Sediments			
	PAH	VOC	PAH	VOC	PAH	VOC	PAH	VOC
	Dry Weight Concentration (ug/kg)	Dry Weight Concentration (ug/kg)	Normalized to OC Concentration (ug/g OC)	Normalized to OC Concentration (ug/g OC)	Dry Weight Concentration (ug/kg)	Dry Weight Concentration (ug/kg)	Normalized to OC Concentration (ug/g OC)	Normalized to OC Concentration (ug/g OC)
Background Concentrations								
Reference Locations (avg 1998 & 2001)	1,767	44	120	5	9,750	212	91	4
Bioassay Toxicity Test Results								
LC50's for 2001 Sediment Dilution Bioassays								
CT-10	111,258	1,311	3,144	36	373,105	1,033	777	2
PP-7	296,060	3,551	8,264	99	570,160	1,583	1,165	3
HA-28	353,716	4,250	9,861	118	459,648	1,274	947	2
HA-28 w/UV	94,178	1,104	2,671	31	134,832	369	307	1
10% of LC50's for 2001 Sediment Dilution Bioassays								
CT-10	11,126	131	314	4	37,311	103	78	0.2
PP-7	29,606	355	826	10	57,016	158	117	0.3
HA-28	35,372	425	986	12	45,965	127	95	0.2
HA-28 w/UV	9,418	110	267	3	13,483	37	31	0.1
Lowest Observed Adverse Effect Concentrtions (LOAEC's) for 2001 Bioassays (reduced growth or mortality >20%)								
CT-10	79,910	1,535	3,996	77	301,400	529	1,310	2
PP-7	249,440	1,910	9,978	76	103,810	779	388	3
HA-28	823,100	6,250	4,842	37	759,300	2,110	1,538	4
HA-28 w/UV	79,910	1,535	3,996	77	103,810	779	388	3
No Observed Adverse Effect Concentrations (NOAEC's) for 2001 Bioassays								
CT-10	16,174	63	735	3	103,810	779	388	3
PP-7	79,910	1,535	3,996	77	20,080	26	143	0.2
HA-28	249,440	1,910	9,978	76	660,900	1,333	2,873	6
HA-28 w/UV	16,174	63	735	3	20,080	26	143	0.2
LOAEC's for 1998 Bioassays (reduced growth or mortality >20%)								
CT-10	1,459	49	584	20	370,200	1,257	21,776	74
HA-10	no adverse effect	no adverse effect	no adverse effect	no adverse effect	370,200	1,257	21,776	74
LV-10	no adverse effect	no adverse effect	no adverse effect	no adverse effect	370,200	1,257	21,776	74
LV-10 w/UV	424	44	92	10	6543	395	115	7
DM-48	no adverse effect	no adverse effect	no adverse effect	no adverse effect	no adverse effect	no adverse effect	no adverse effect	no adverse effect
DM-48 w/UV	1,459	49	584	20	6543	395	115	7
PP-7 Elutriate	1,459	49	584	20	370,200	1,257	21,776	74
PP-7 Elutriate Dilutions	365	12	146	5	23,138	79	1,361	5
NOAEC's for 1998 Bioassays								
CT-10	424	44	92	10	6543	395	115	7
HA-10	1,459	49	584	20	6543	395	115	7
LV-10	1,459	49	584	20	6543	395	115	7
LV-10 w/UV	adverse effects for all	adverse effects for all	adverse effects for a	adverse effects for all	adverse effects for all	adverse effects for all	adverse effects for all	adverse effects for all
DM-48	1,459	49	584	20	370,200	1,257	21,776	74
DM-48 w/UV	424	44	92	10	adverse effects for all	adverse effects for all	adverse effects for all	adverse effects for all
PP-7 Elutriate	424	44	92	10	6543	395	115	7
PP-7 Elutriate Dilutions	182	6	73	3	adverse effects for all	adverse effects for all	adverse effects for all	adverse effects for all
LOAEC's for 1998 Benthic Survey	1,459	49	584	20	370,200	1,257	21,776	74
PRG Evaluation and Comparison to Benchmark Values:								
	PAH (ug/kg)	VOC (ug/kg)	PAH (ug/g OC)	VOC (ug/g OC)	PAH (ug/kg)	VOC (ug/kg)	PAH (ug/g OC)	VOC (ug/g OC)
Lowest LOAEC:	365	12	146	5	6543	395	115	7
Lowest NOAEC:	182	6	73	3	6543	395	115	7
Mean of LOAEC and NOAEC:	274	9	110	4	6,543	395	115	7
Background Concentration	1,767	44	120	5	9,750	212	91	4
WDNR PAH TEC (@1%TOC)	1,610		161		1,610		161	
WDNR BETX TEC (@1% TOC)		972		97		972		97
Preliminary Remediation Goal:	**1,767**	**972**	**161**	**97**	**9,750**	**972**	**161**	**97**
Corresponding MacD CBSQG PAH PEC-Q (unitless)	0.05				0.3			
Corresponding PAH ESG TU's (unitless)			1.4				1.4	

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ASHLAND LAKEFRONT PROPERTY CONTAMINATED SEDIMENTS ECOLOGICAL RISK ASSESSMENT

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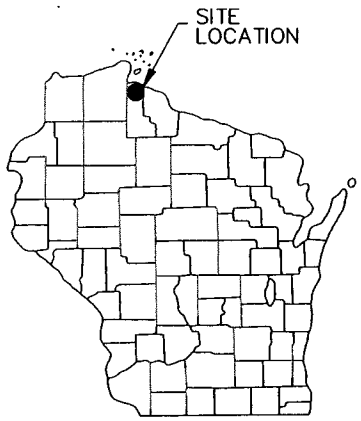

COUNTY LOCATION MAP

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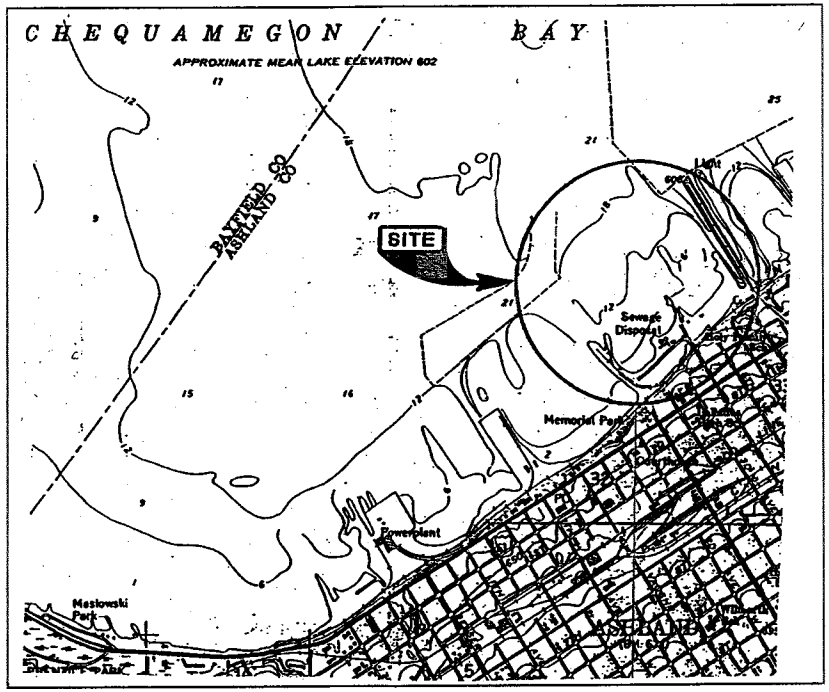

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PREPARED BY:

SHORT ELLIOTT HENDRICKSON, INC.
WASTE MANAGEMENT SERVICE AREA
CHIPPEWA FALLS, WISCONSIN

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ASHLAND LAKEFRONT PROPERTY CONTAMINATED SEDIMENTS ECOLOGICAL RISK ASSESSMENT

FIGURE 1
SITE LOCATION

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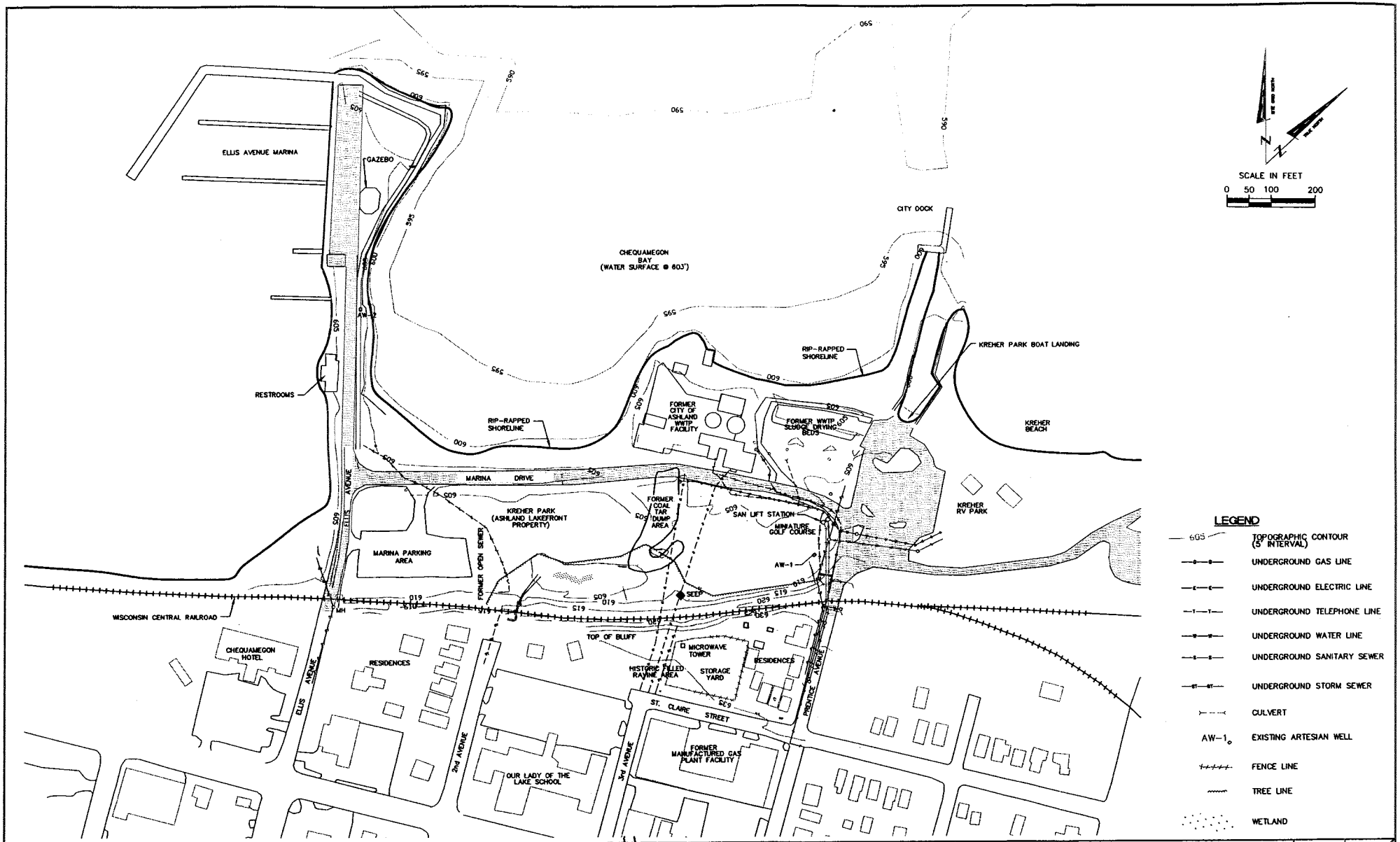

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ASHLAND LAKEFRONT PROPERTY
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FIGURE 2
SITE VICINITY

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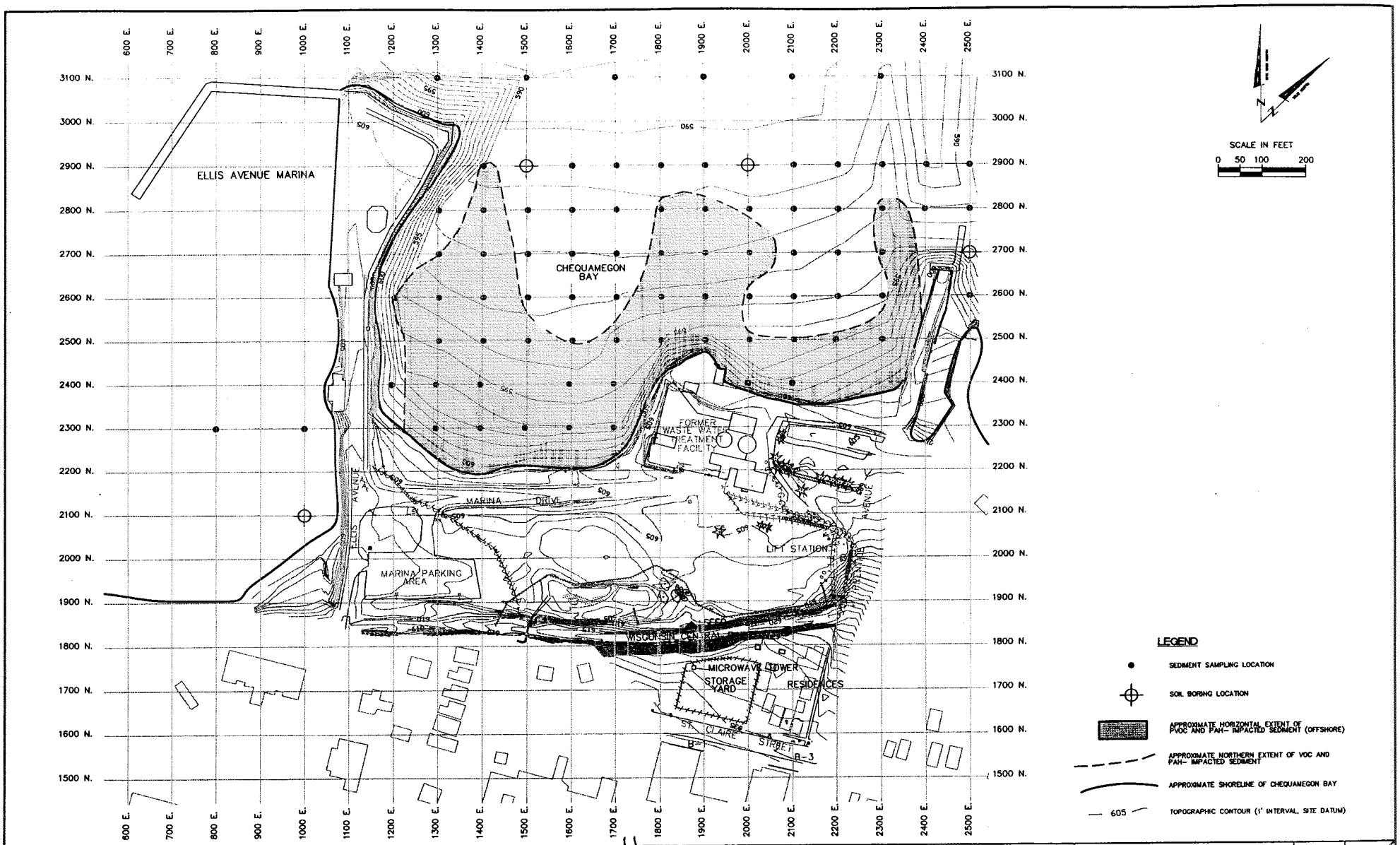

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FIGURE 3
1996 EXTENT OF VOC AND PAH SEDIMENT CONTAMINATION

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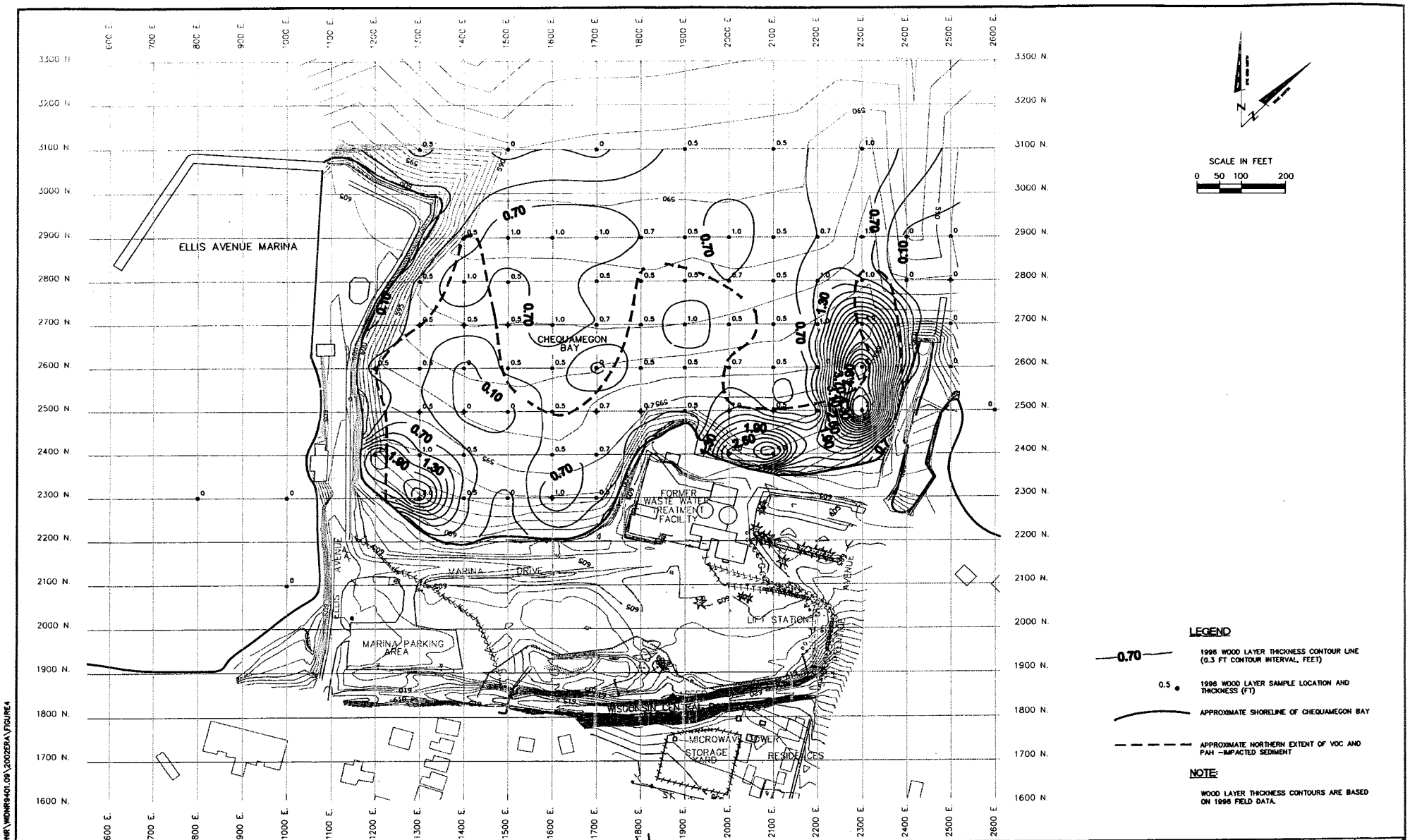

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FIGURE 4
OFFSHORE
WOOD LAYER THICKNESS

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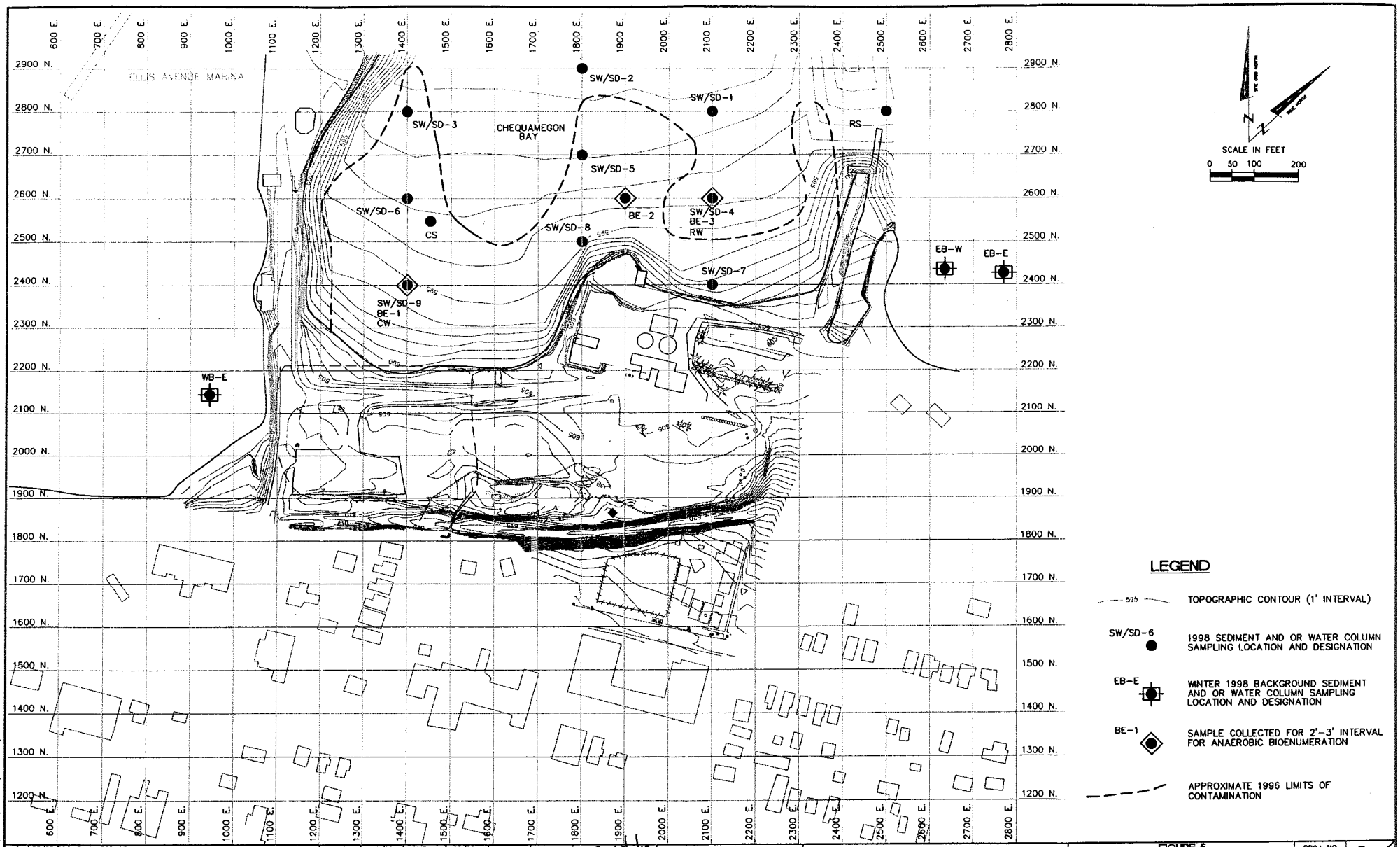

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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
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FIGURE 5
1998 SEDIMENT BIOACTIVE ZONE SAMPLING LOCATIONS

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DATE 02/19/02

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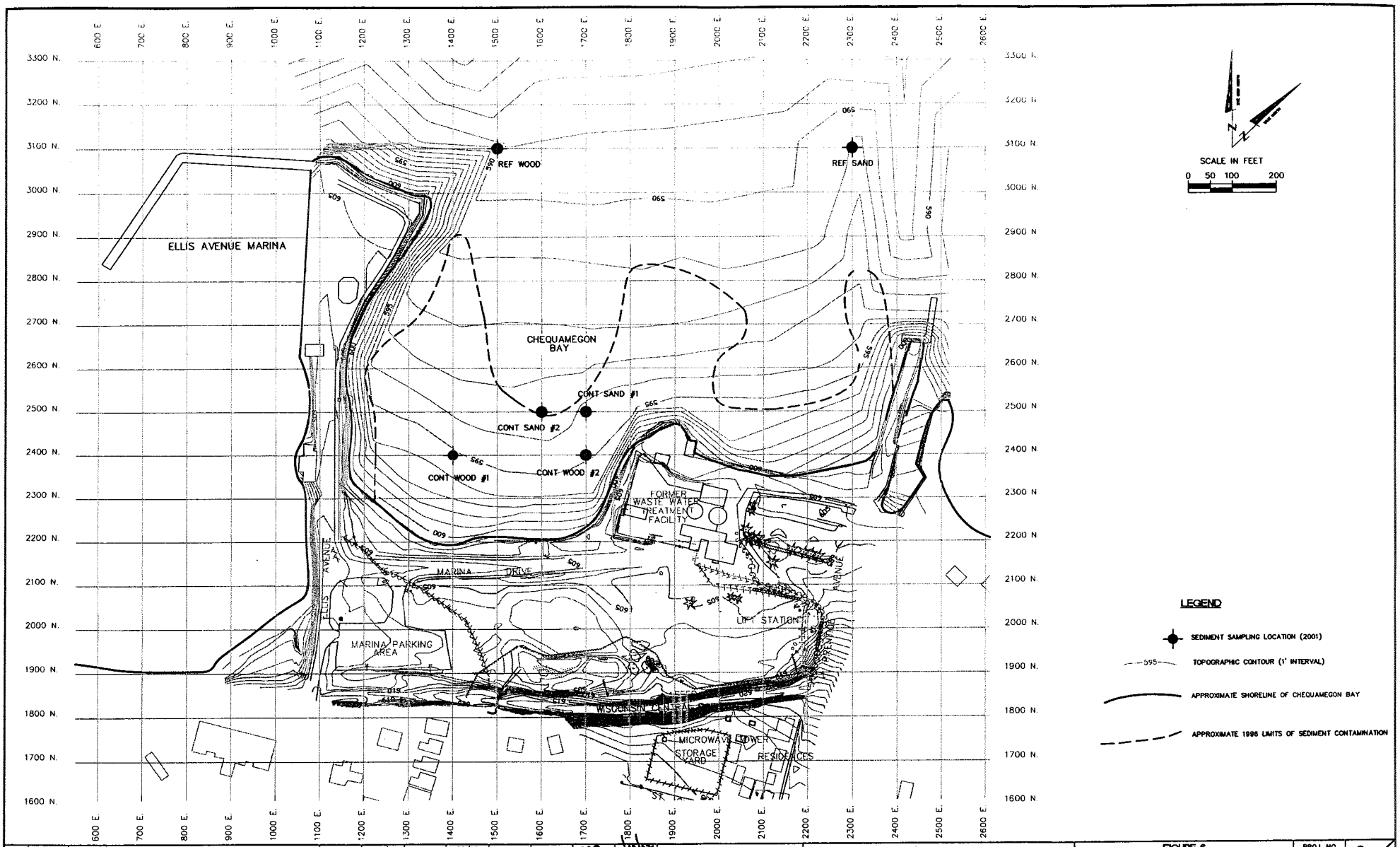

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ASHLAND/NSP LAKEFRONT CONTAMINATED SEDIMENTS ECOLOGICAL RISK ASSESSMENT

FIGURE 6
2001 SEDIMENT BIOACTIVE ZONE SAMPLING LOCATIONS

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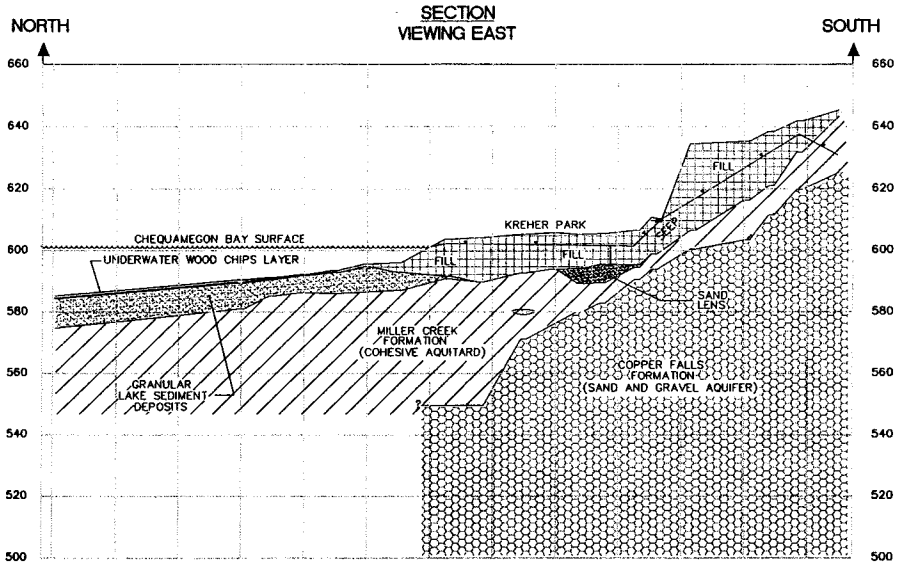
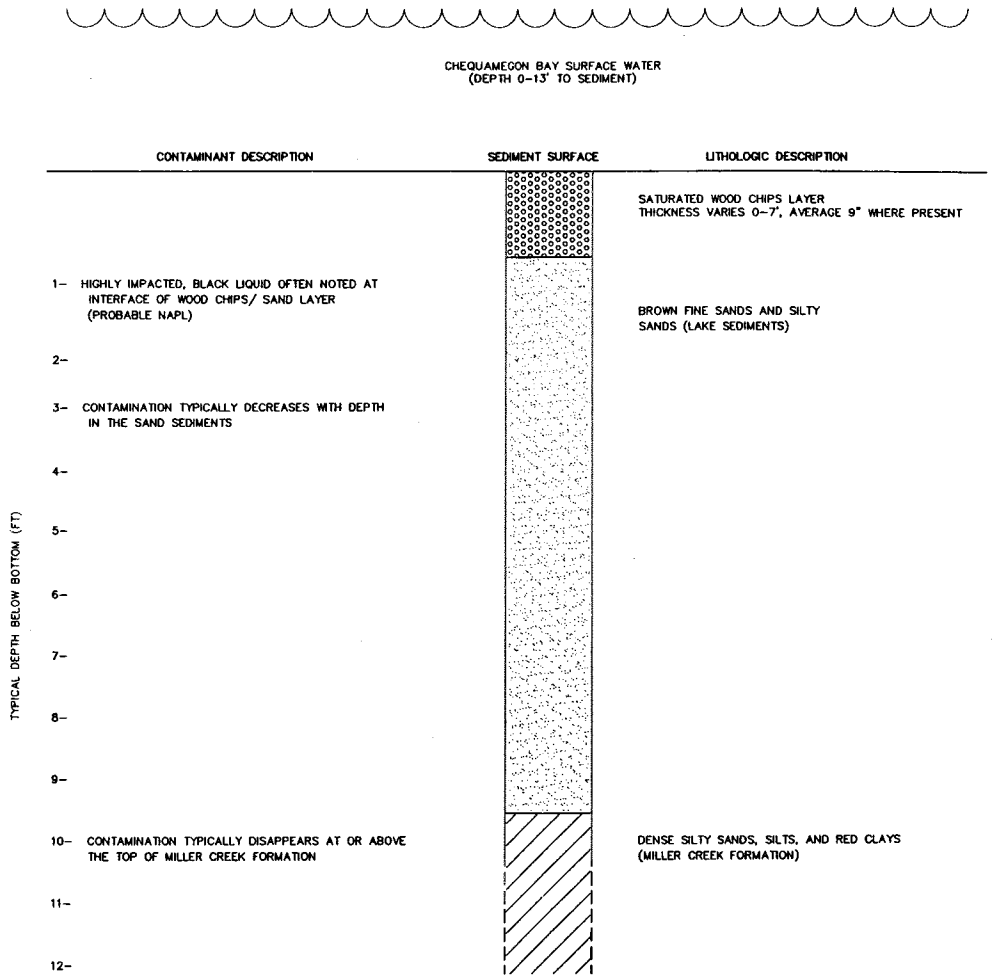


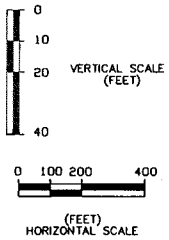
CONCEPTUAL GEOLOGIC CROSS SECTION



CONTAMINATED SEDIMENT PROFILE

NOTES:

1. ELEVATIONS ARE SHOWN IN REFERENCE TO SITE DATUM.
2. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS, REFER TO SOIL BORING LOGS IN PREVIOUS REPORTS.



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 7
TYPICAL CONTAMINATED SEDIMENT PROFILE AND GEOLOGIC CROSS SECTION

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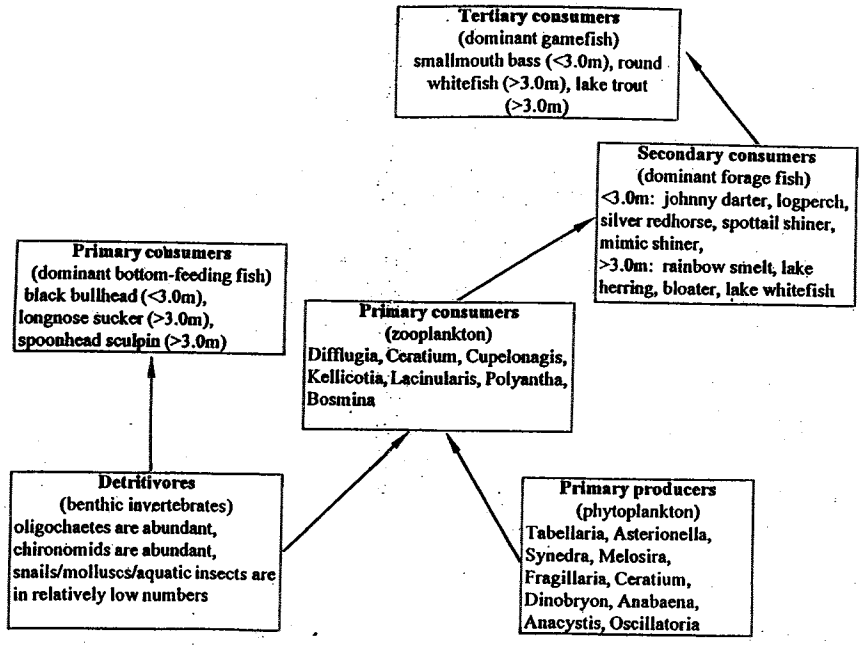
E:\WASTE\WDNR\9401.09\2002ERA\FIGURE7

Exposure Pathway Model Based on Trophic Levels at the Study Site



Trophic levels are separated into boxes and list species identified in surveys of the Ashland Harbor and Chequamegon Bay except for the benthic organisms surveyed as a part of this study. Data are from Dickas et al., 1973 and Hoff and Bronte, 1996.

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ASHLAND LAKEFRONT PROPERTY
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FIGURE 8
EXPOSURE PATHWAY MODEL BASED ON TROPHIC LEVELS AT THE SITE

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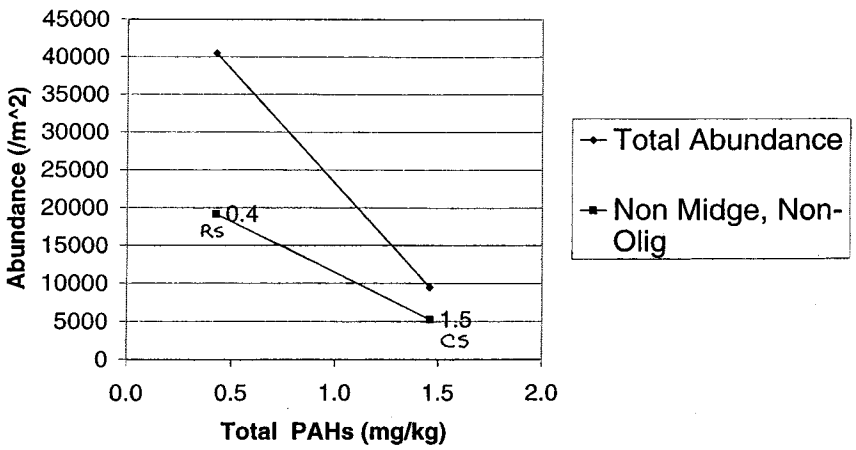
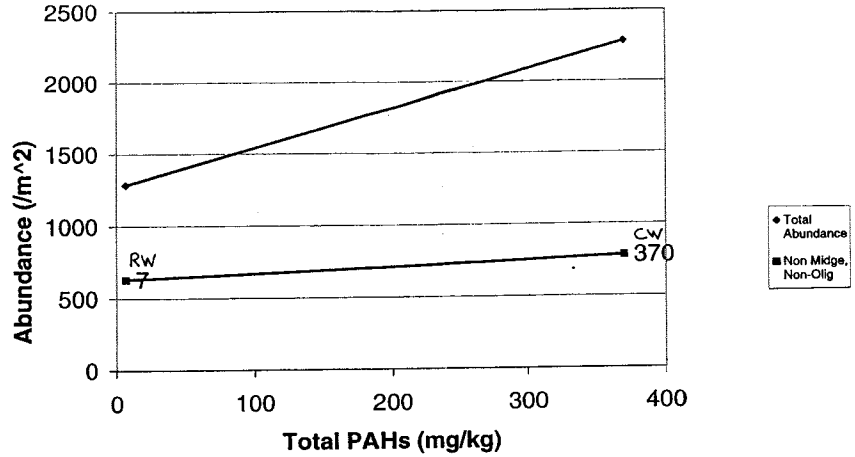
E:\WASTE\WDNR\9401.09\2002ERA\FIGURE8

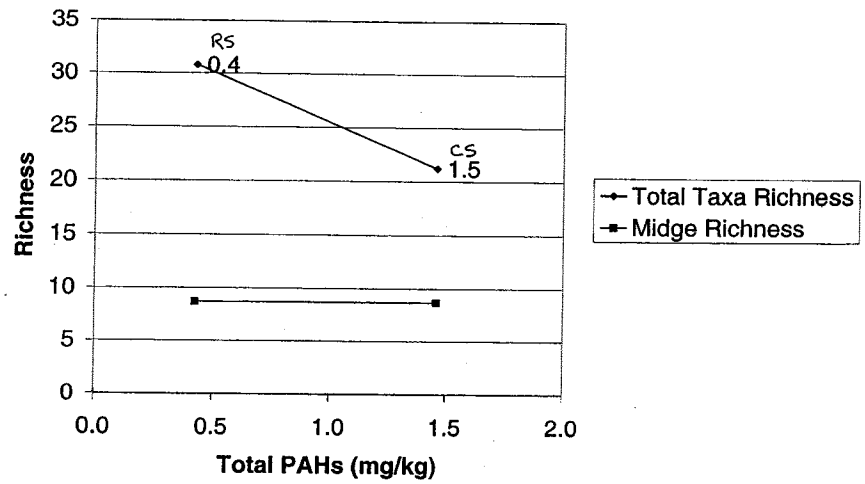
Abundance Indices vs TPAH Sand Substrate



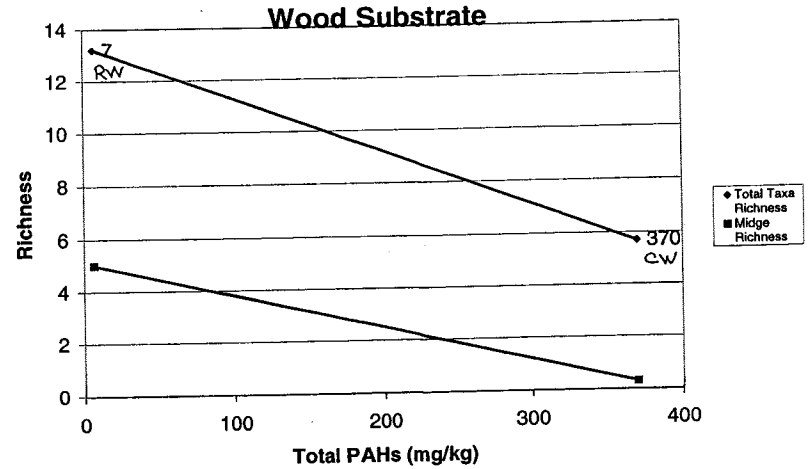
Abundance Indices vs. TPAH Wood Substrate



Richness Indices vs TPAH Sand Substrate



Richness Indices vs. TPAH Wood Substrate



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 9
1998 BENTHIC COMMUNITY SURVEY
INDICES vs. PAH

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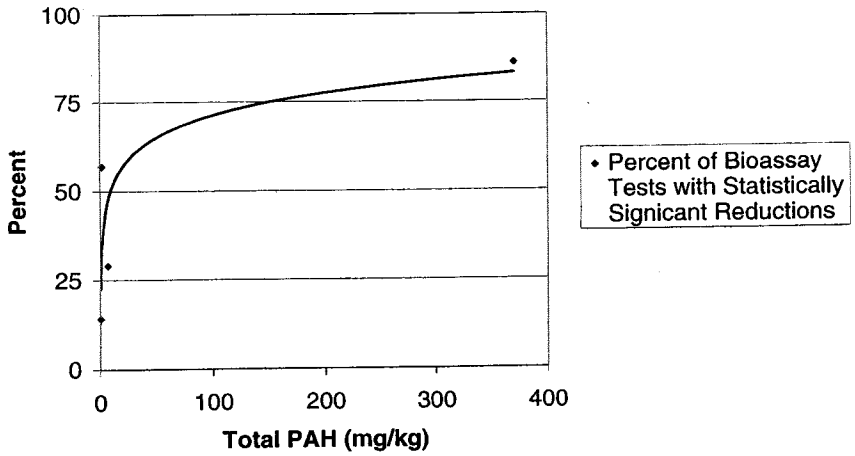
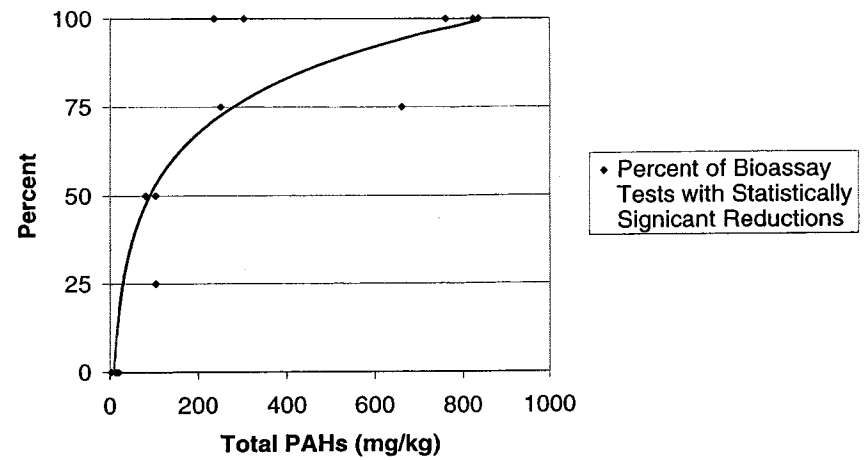
E:\WASTE\WDNR\9401.09\2002ERA\FIGURES

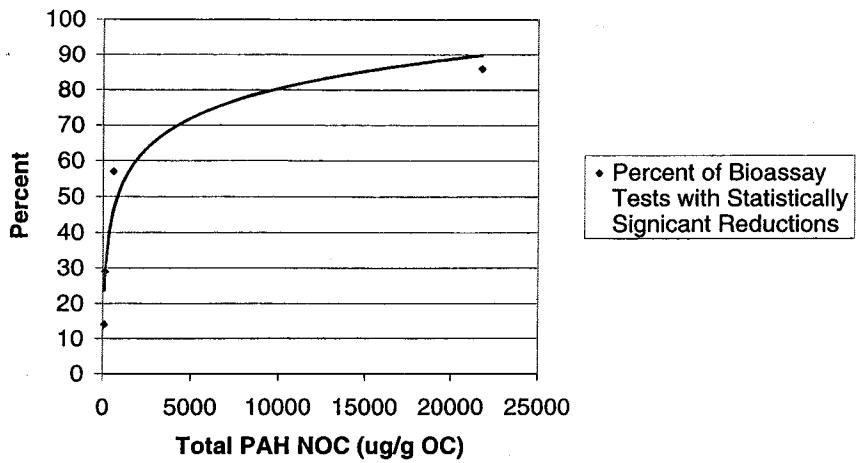
1998 Bioassay Tests Results vs
Total PAH DW (mg/kg)



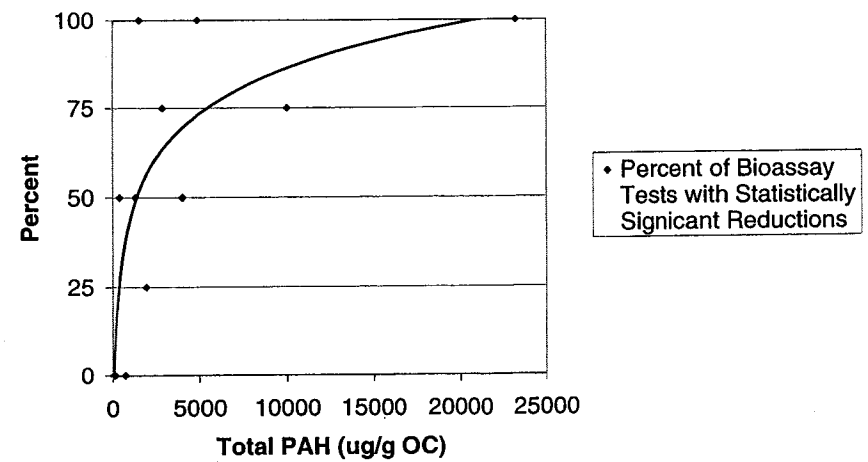
2001 BioassayToxicity Test Results vs
Total PAHs DW (mg/kg)



1998 Bioassay Toxicity Test Results vs
Total PAH NOC (ug/g OC)



2001 Bioassay Toxicity Test Results vs
Total PAH NOC (ug/g OC)



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 10
BIOASSAY TOXICITY TEST
RESULTS - MULTIPLE SPECIES

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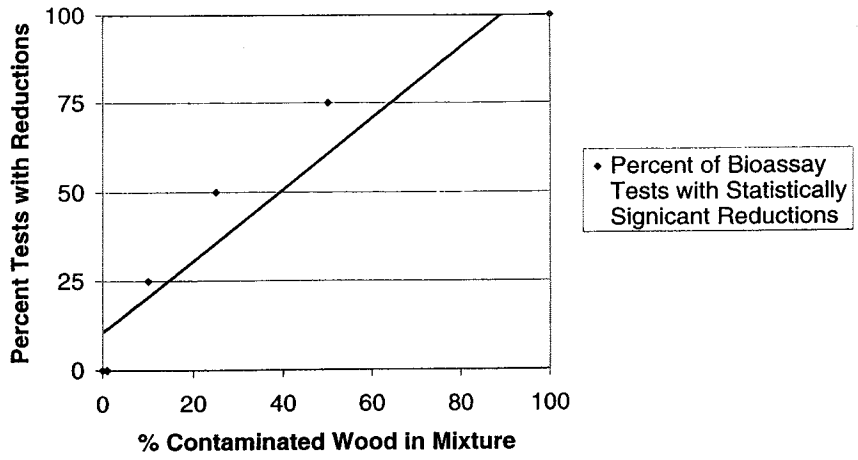
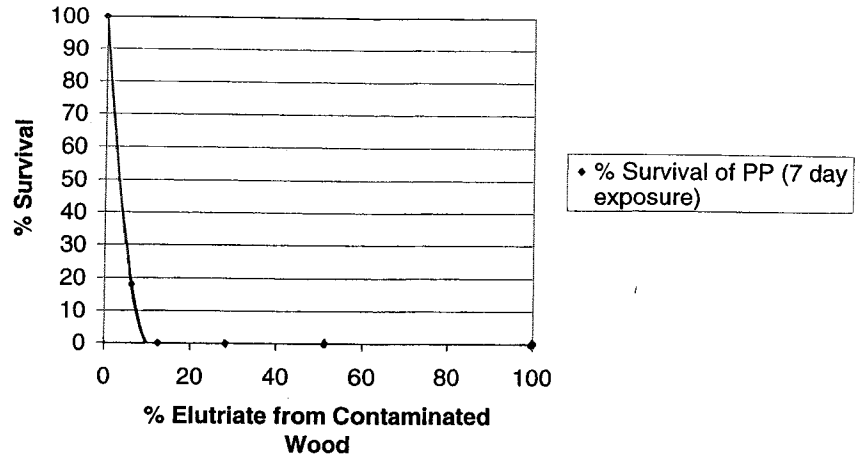
E:\WASTE\WDNR\9401.09\2002ERA\FIGURE10

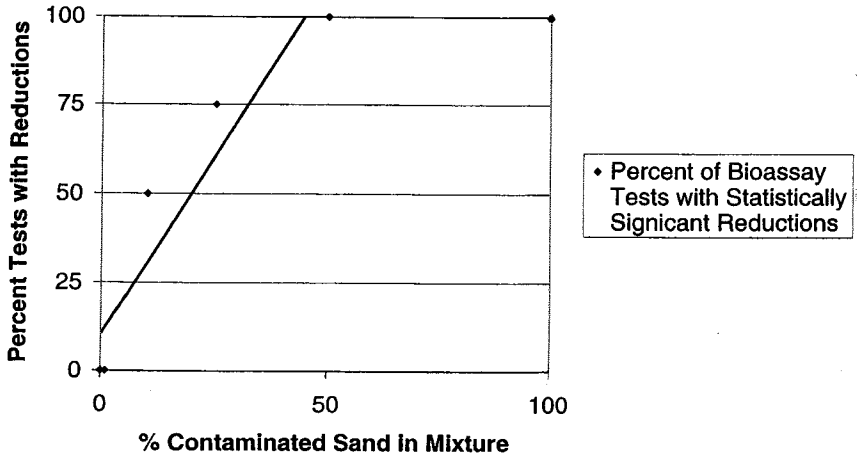
2001 Contaminated Wood Dilution Series Test Results vs.
% Contaminated Wood in Mixture



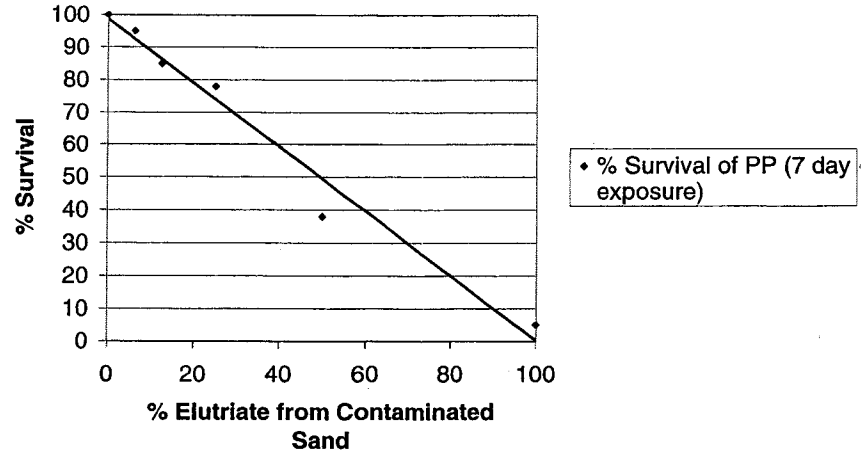
1998 CW Elutriate Dilution Series:
% PP Survival vs % Elutriate from CW



2001 Contaminated Sand Dilution Series Test Results vs.
% Contaminated Sand in Mixture



1998 CW Elutriate Dilution Series:
% PP Survival vs % Elutriate from CS



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 11
BIOASSAY TOXICITY TEST RESULTS
- DILUTIONS

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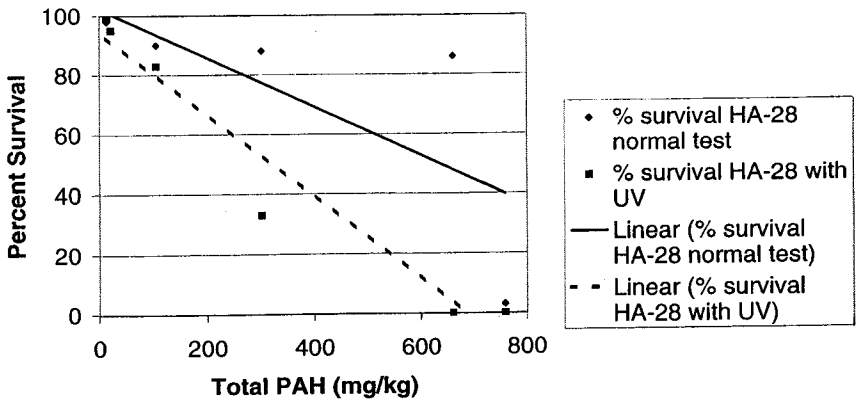
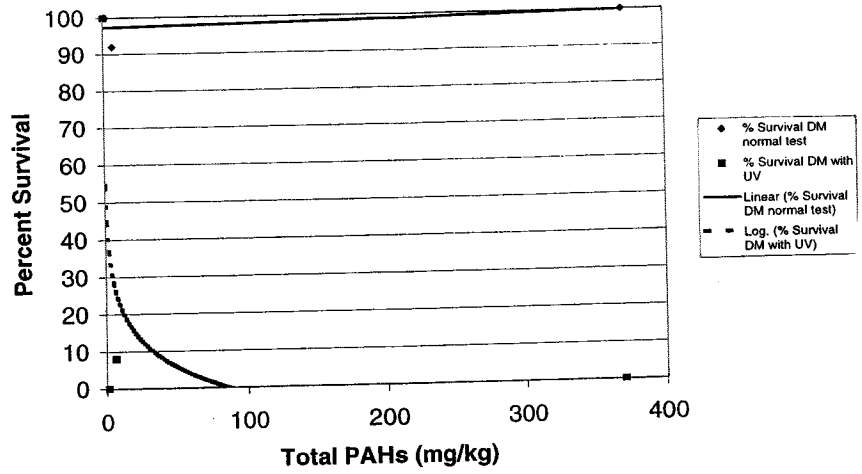
E:\WASTE\WDNR\9401.09\2002ERA\FIGURE 11

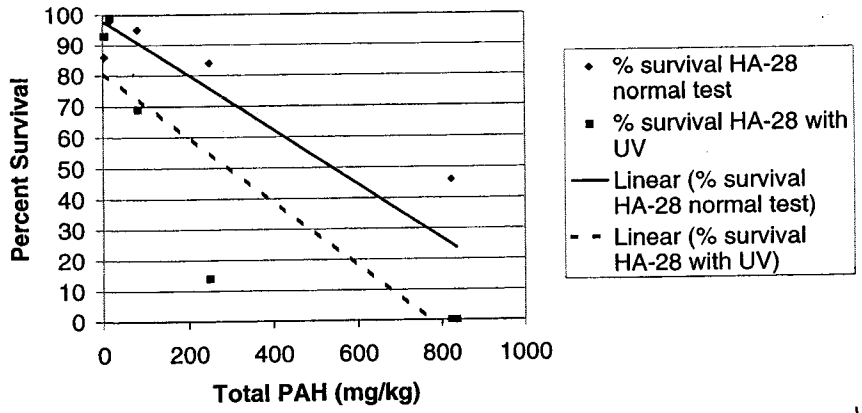
Comparison of 2001 Hyallela azteca Toxicity Test Results for CW Dilution Series - UV and Non-UV



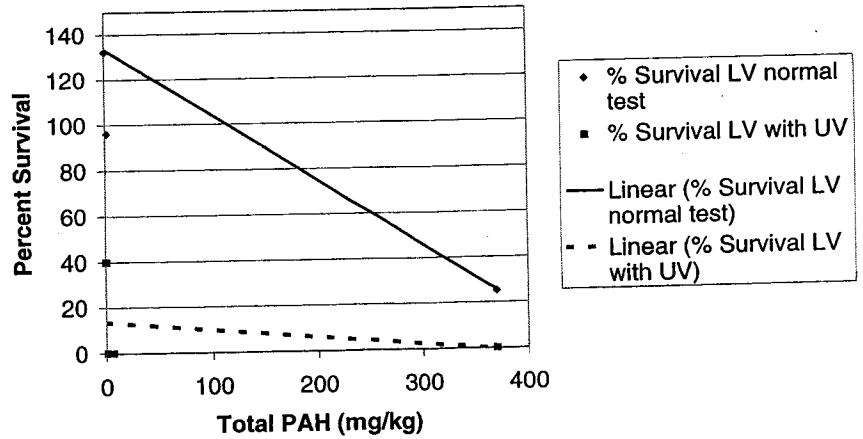
Comparison of 1998 Daphnia magna Toxicity Test Results - UV and Non-UV



Comparison of 2001 Hyallela azteca Toxicity Test Results for the CS Dilution Series- UV and Non-UV



Comparison of 1998 Lumbricus variegatus Toxicity Test Results - UV and Non-UV



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
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FIGURE 12
BIOASSAY TOXICITY TEST RESULTS
- UV EXPOSURES

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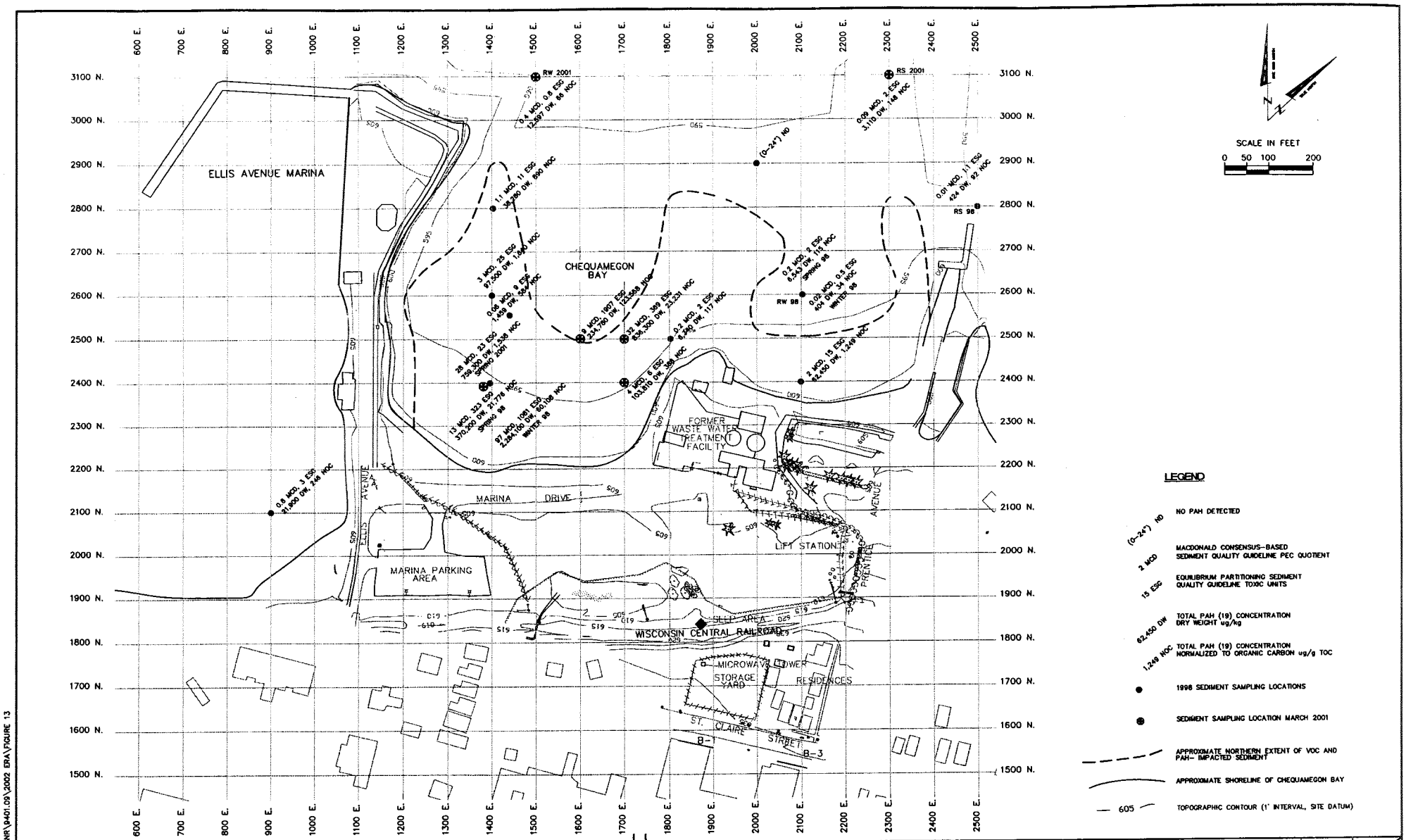
E:\WASTE\WDNR\9401.09\2002ERA\FIGURE12



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 13
PAH TOXIC UNITS IN
SEDIMENT 0-6" BIOACTIVE ZONE

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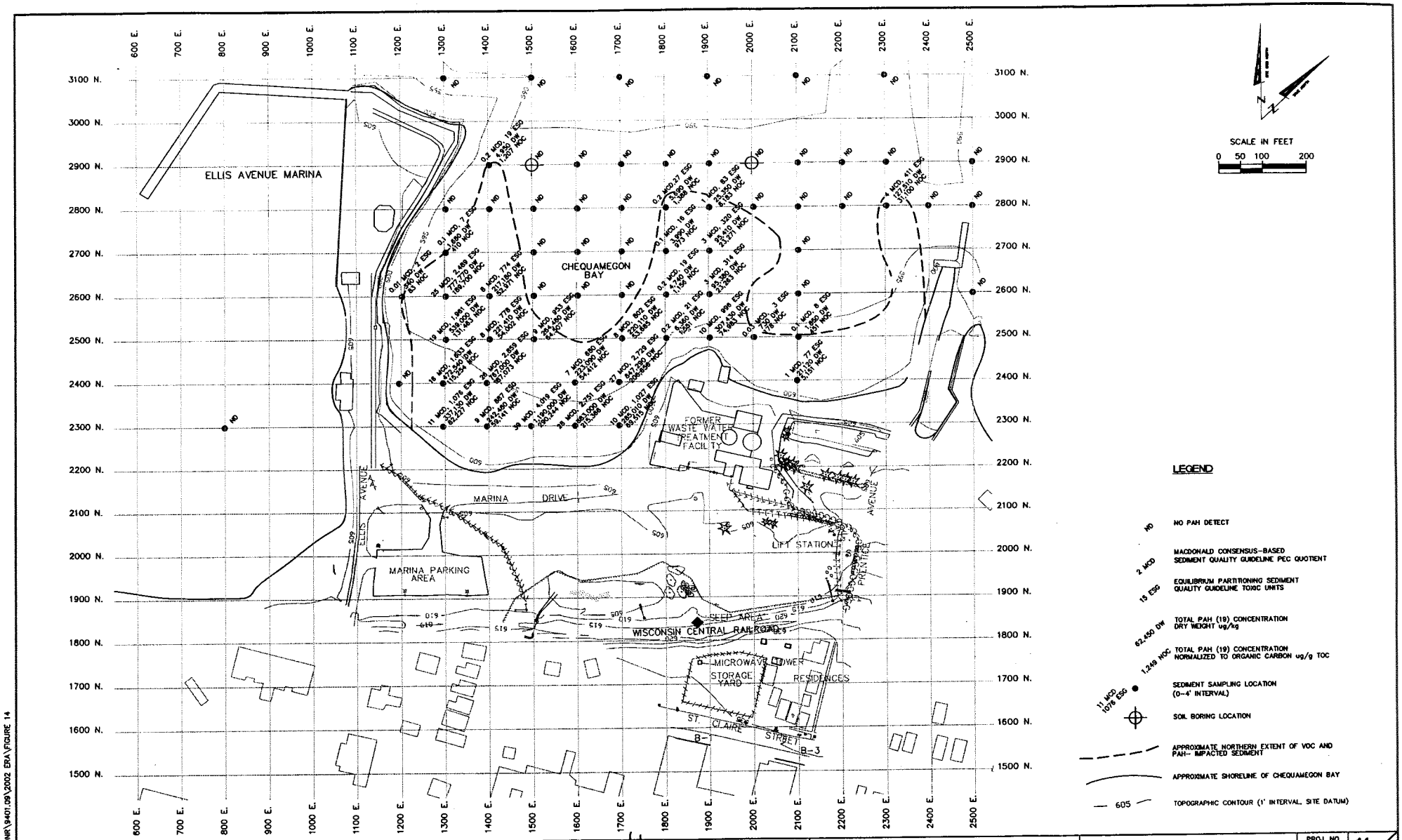
E:\WASTE\WIDNR\9401.09\2002 ERA\FIGURE 13



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ASHLAND LAKEFRONT PROPERTY
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FIGURE 14
PAH TOXIC UNITS
IN SEDIMENT 0'-4' INTERVAL

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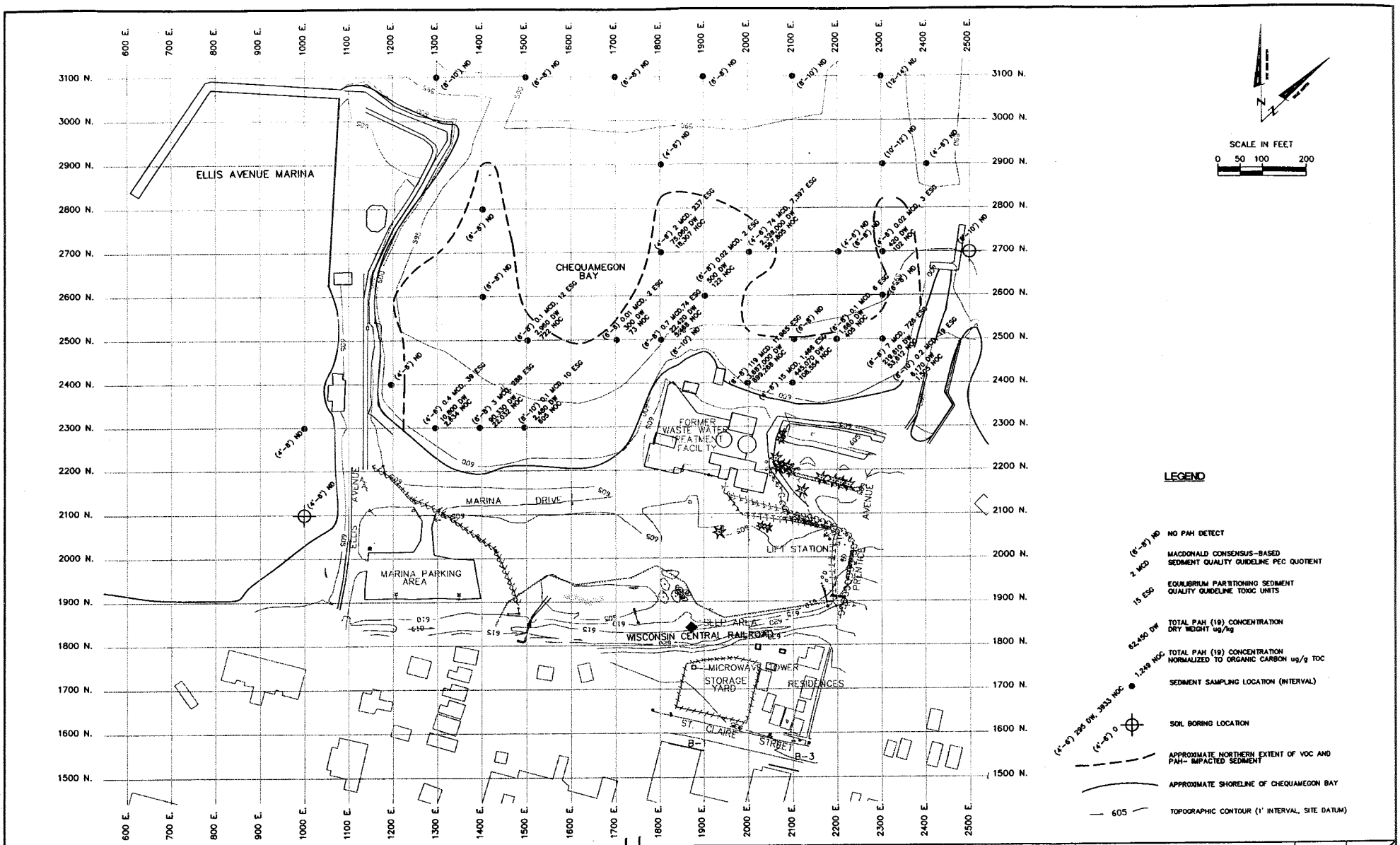
E:\WASTE\WDNR\9401.09\2002 ERA\FIGURE 14



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ASHLAND LAKEFRONT PROPERTY CONTAMINATED SEDIMENTS ECOLOGICAL RISK ASSESSMENT

FIGURE 15
PAH TOXIC UNITS IN SEDIMENT 4'-10' INTERVAL

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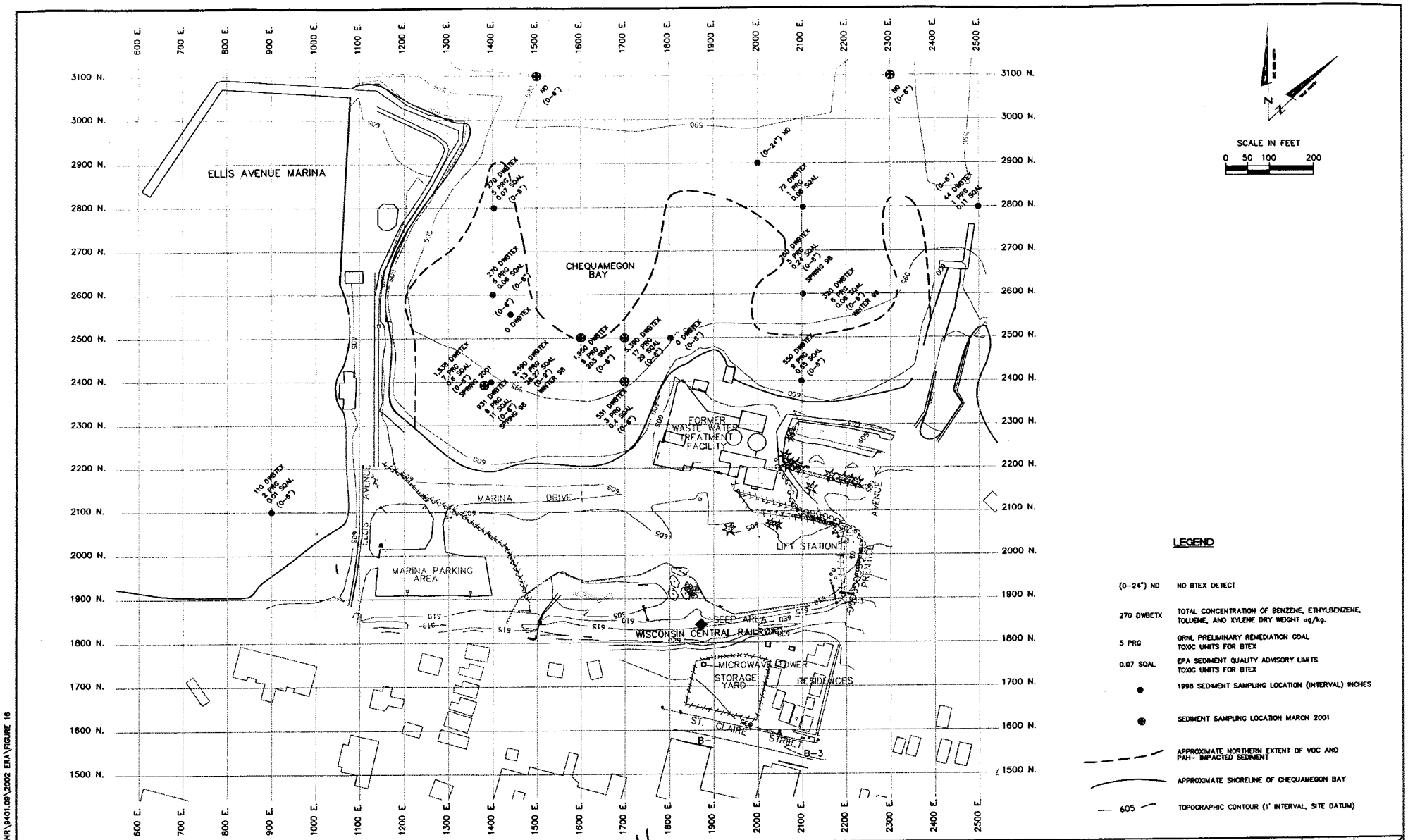
E:\WASTE\WDNR\9401.09\2002 ERA\FIGURE 15



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 16
BTEX TOXIC UNITS IN
SEDIMENT 0-6" BIOACTIVE ZONE

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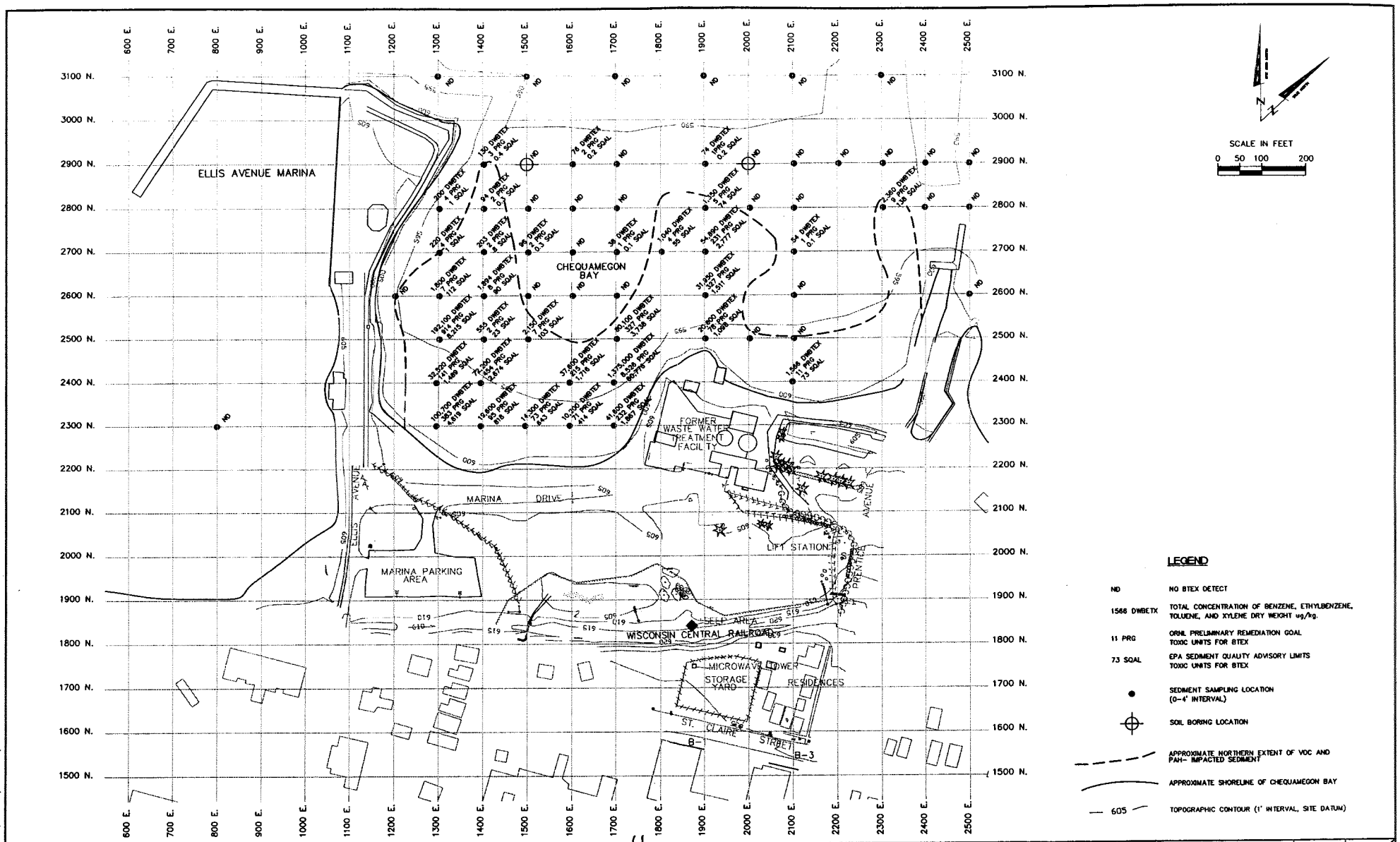
E:\WASTE\WIONR\9401.09\2002 ERA\FIGURE 16



NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK
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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 17
BTEX TOXIC
UNITS IN SEDIMENT 0'-4' INTERVAL

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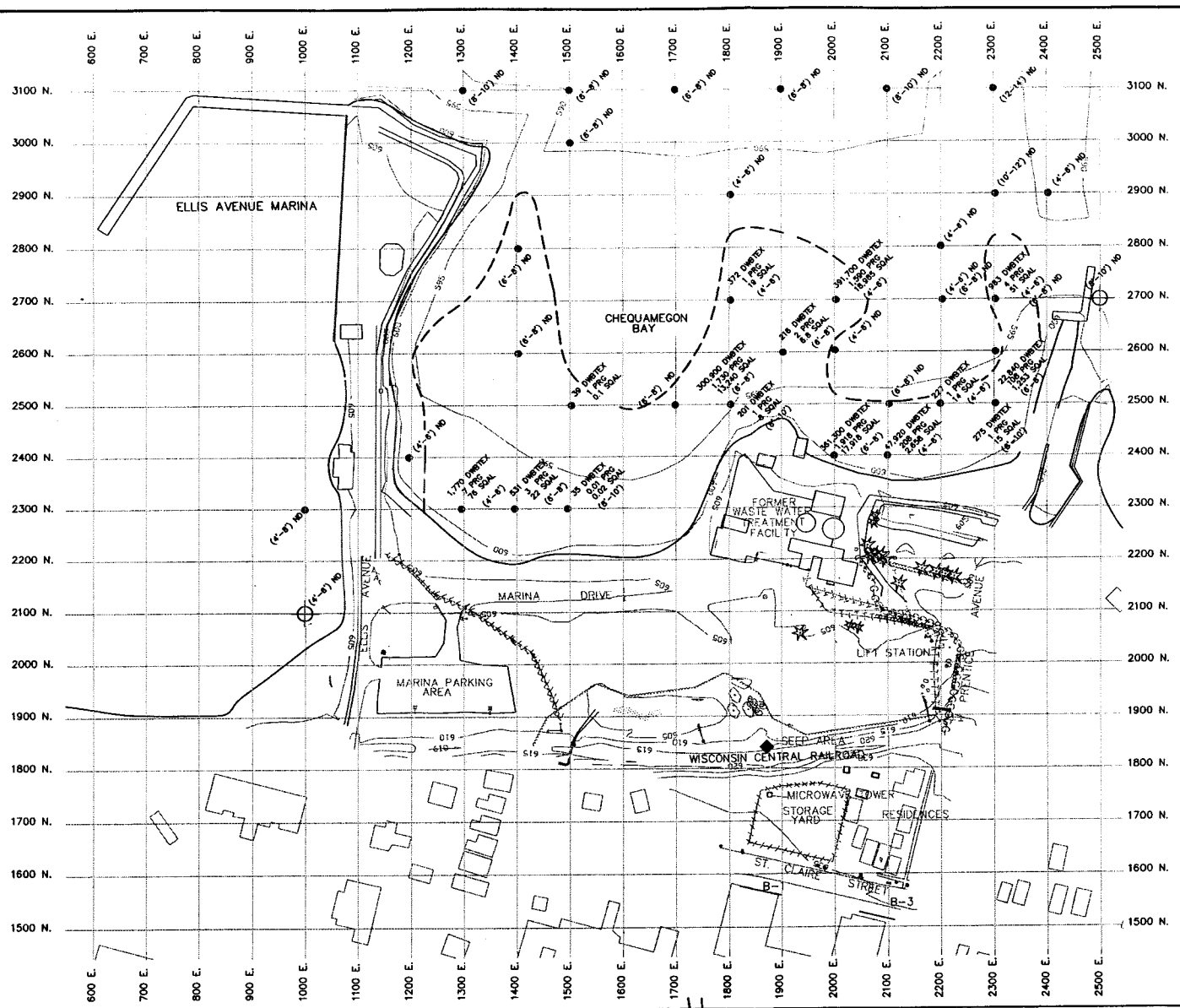
E:\WASTE\WDNR\9401.09\2002 ERA\FIGURE 17



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ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 18
BTEX TOXIC
UNITS IN SEDIMENT 4'-10' INTERVAL

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E:\WASTE\WDNR\9401.09\2002 ERA\FIGURE 18

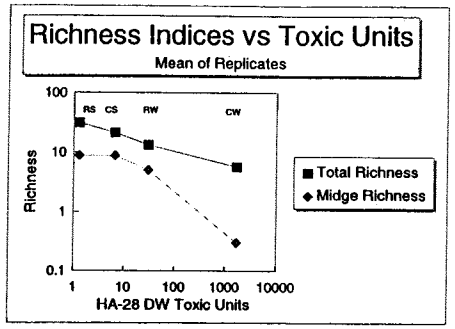
Appendix A

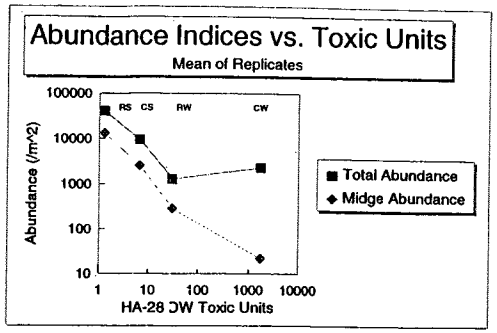
Excerpts from 1998 SEH ERA

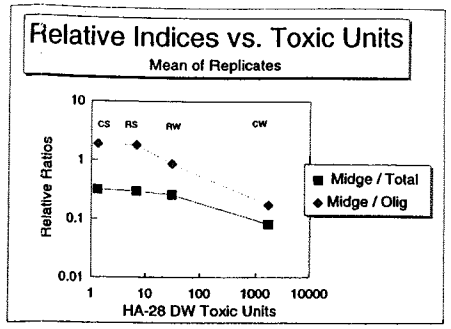
ASHLAND HARBOR SITE
1998 MACROINVERTEBRATE SURVEY
(NUMBER PER SQUARE METER)

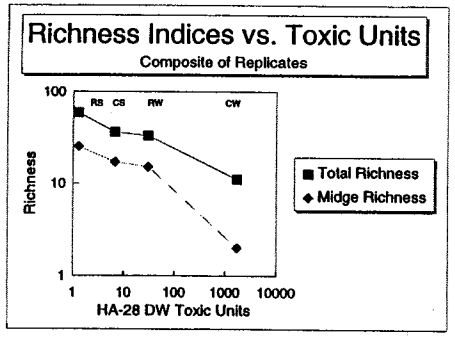
TAXON	2400N 1400E						2600N 2100E						2550N 1450E						2800N 2500E					
	CONTAMINATED WOOD						REFERENCE WOOD						CONTAMINATED SAND						REFERENCE SAND					
Reps	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Pisidium							43					86	431	947	1033	431	1464	1120	129	1077	904	2411	86	1033
Musculum/Sphaerium													86	172	172	86	258		43					43
Amnicola limosa															86		86	86	86	86	43	86		86
Valvata tricarinata																				86	43			
TOTAL MOLLUSCA							43					86	517	1120	1292	517	1809	1206	258	1249	990	2497	86	1163
HYDRACHNIDA (mites)															86			86		215	172	344		
Cancidotes racovitzei (sowbugs)	431	43		2928		172			43	43		129	689	5081	2670	517	4048	1550						
Crangonyx sp. (scuds)	86	43		775																	86			
Osmarus pseudolimnaeus (scuds)				86			215	43	258	904	86	474	86	172	603	86	603	517				43		
TOTAL CRUSTACEA	517	86		3789		172	215	43	301	947	86	603	775	5253	3273	603	4650	2067			86	43		
Mystacides sepulchralis																					43			
Oecetis																			86	86	172			43
Parenyctiophylax								43																
Phylocentropus		43													344	86			43	86	43	86		
Polycentropus										43														
TOTAL TRICHOPTERA (caddisfly)		43						43		43					344	86			129	172	258	86		43
Caenis sp.												43										86	86	
Hexagenia sp.																				172	86		43	
TOTAL EPHEMEROPTERA (mayfly)												43								172	86	86	129	
CERATOPOGONIDAE (Diptera)														86					172	388	172	172	172	861
CHIRONOMIDAE																								
Cryptochironomus							43			43		43		517	86	258	258	258	474	258	603	1077	1033	689
Cryptotendipes									43			43	86	258	344	517	344		344	1206	689	1378	1206	1206
Demicryptochironomus																								172
Dicrotendipes neomodestus								172	43			43												
Glyptotendipes sp. grp. A								43		43		43									43			
Harnischia curtilamellata																				344				172
Nilothauma																	86						172	
Pagastiella													172					86			172	172		
Parachironomus arcuatus grp.														86							43	172		
Paralauterborniella nigrohalteralе																			344	1033	1722	172	172	689
Polypedilum halterale grp.								43					344	258	86	258	86	86	344	689	689	861	172	172
Polypedilum scalenum grp.												86		344	86			172		215		172		172
Pseudochironomus																			388	388		86		172
Stictochironomus									43					258	172	172						43		172
Tribelos jucundum													86	172	344	172	86	86	43	43	172	43		
TOTAL CHIRONOMINI							43	258	129	86		258	689	1895	1120	1378	861	689	1938	4177	4134	4177	2756	3617
Cladotanytarsus sp. grp. A							43	43		43	43		86			172	86	86	172	172		517	344	1378
Cladotanytarsus mancus grp.					43										86					172		172	689	1722
Cladotanytarsus vanderwulpi grp.															86									
Stempellina															86					86				
Stempellinella												43												
Tanytarsus							43	172			43	86	431	689	86	1033	1033	517	1895	7320	2411	6890	7406	14640
TOTAL TANYTARSINI					43		86	215		43	86	129	517	689	344	1206	1120	603	2067	7751	2411	7579	8440	17741
Ablabesmyia mallochi							43	43				43					86			172				
Ablabesmyia monilis																			172			172		172
Procladius													775	775	517	517	1033	344	517	3531	2584	1033	689	1722
TOTAL TANYPODINAE							43	43				43	775	775	517	517	1120	344	689	3703	2584	1206	689	1893
Porthastia longimana (Diamesinae)																						43		
Cricotopus/Orthocladius								43																
Heterotrissocladius marcidus grp.																							43	
Limnophyes								43																
Nanocladius balticus grp.													86									172		
Parakiefferiella sp. A (Epler)				86				86		43											344	172	344	344
Parametriocnemus											43													
TOTAL ORTHOCLADIINAE				86				172		43	43		86								344	344	388	344
TOTAL CHIRONOMIDAE				86	43		172	689	129	172	129	431	2067	3359	1981	3100	3100	1636	4694	13651	9475	13549	12272	23597
NEMATODA									86	172		86		172		86	86		7062	3703	7751	9129	2239	2756
Dugesia tigrina (flatworm)							43	43		172	86											43		
Moorsobdella microstoma (leech)				86																				
Manayunkia speciosa (Polychaeta)							215	172		86			689	3962	431	517	775	1120	8612	12789	6717	19291	8268	16535
OLIGOCHAETA																								
Amphichaeta leydigi									43										172			172		172
Arcteonais lomondi																		86			172	172		344
Chaetogaster diastrophus								86	43			43										689		172
Nais variabilis										43		86												
Nais simplex				172			43	43	43	258		86										172		
Pristina leidyi												301		86			86		172			172		
Pristina sequiseta									43															
Ripistes parasita								43																
Slavina appendiculata																86		86						
Specaria josinae																							172	
Uncinais uncinata																						172	344	172
TOTAL NAIDIDAE				172			43	172	172	301		517		86		86	86	172	344		172	1550	517	861
immature tubificids			517	603		517																		
immature tubificids w/o hairs	603	43	689	2842		258	129					86	258	1636	947	603	1033	861	4306	3273	3100	6890	1722	4134
immature tubificids with hairs	172	86	172	86		86	129	86	86	43		301	86	344		86	172	172				215	517	344
Aulodrilus americanus																			1206	689			172	
Aulodrilus limnobius																				517				
Aulodrilus pigueti																	86		344	1206		172		172
Aulodrilus pluriseta																				344				
Limnodrilus hoffmeisteri	172			603	43	172								172		258	86	86						172
Limnodrilus claparedianus				603																				
Quistadrilus multisetosus	86			258		86							258	517			517	172		172				
Spirosperma ferox													86	172	172	86	172	172	818	1507	2067	3703	344	2756
TOTAL TUBIFICIDAE	1033	129	1378	4993	43	1120	258	86	86	43		388	689	2842	1120	1033	2067	1464	6454	7708	5167	10990	2756	7579
Eclipidrilus																			172		172			
Lumbriculus																	86		43	43	474	43	172	
Stylodrilus heringianus																						172		
TOTAL LUMBRICULIDAE																	86		215	43	646	215	172	
ENCHYTRAEIDAE								43				86				86	86				1722	1378		172
TOTAL OLIGOCHAETA	1033	129	1378	5167	43	1120	301	301	258	344		990	689	2928	1120	1206	2323	1636	7234	7751	7708	14124	3443	8612
fish fry												172												
TOTAL ORGANISMS	1550	258	1378	9129	86	1292	990	1292	773	1938	301	2411	4737	16080	8326	6115	12746	7751	28161	42070	33415	39164	28611	53567
TAXA RICHNESS	6	5	3	12	2	6	11	18	11	13	5	20	17	22	21	21	25	21	26	32	29	41	25	32

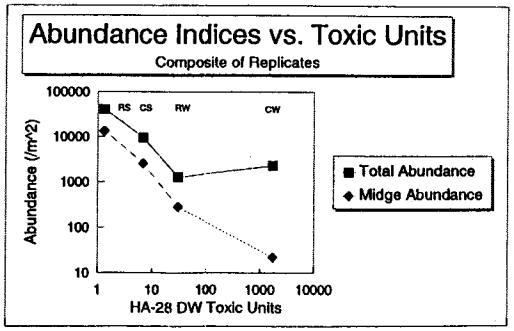
Lake Superior Research Institute – Kurt L. Schmude, Ph.D.

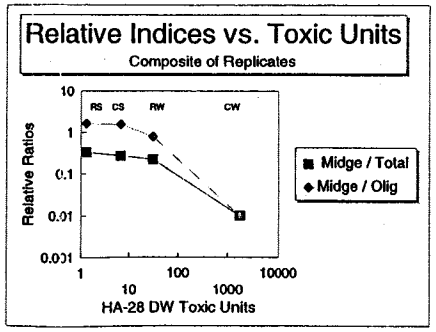












E:\WASTE\WDNR\9401.02\DRA\FIG-14

NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK
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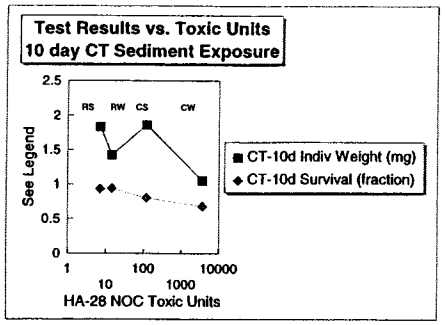
1	09/15/98	DRAFT ISSUED TO CLIENT FOR REVIEW	JLE 09/98	MJB 09/98		

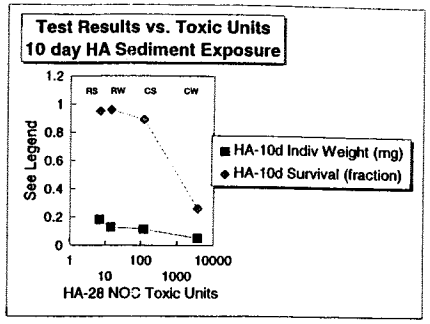
SEH

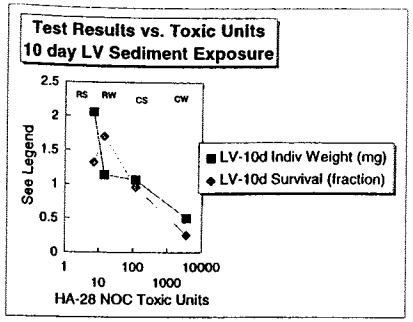
ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

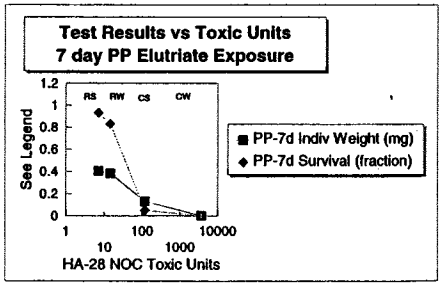
FIGURE 14
COMPARISON OF BENTHIC COMMUNITY SURVEY INDICES TO HA-28 DW TOXIC UNITS

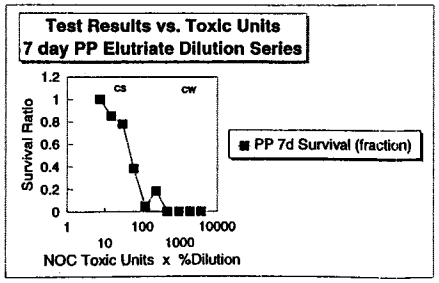
PROJ. NO. WDNR9401.02
DATE 10/07/98











E:\WASTE\WONR\P401.02\ERA\FIG-15

NO.	DATE	ISSUE/REVISIONS	DRAWN BY	DESIGN	FIELD REVIEW	QC CHECK
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1	09/15/98	DRAFT ISSUED TO CLIENT FOR REVIEW	JLE 09/98	MJB 09/98		

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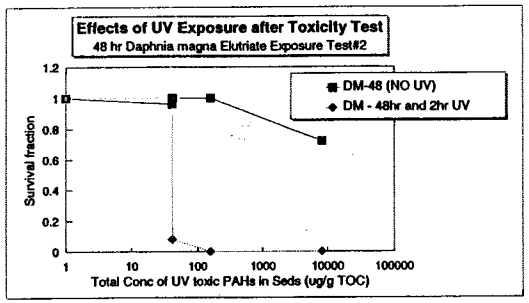
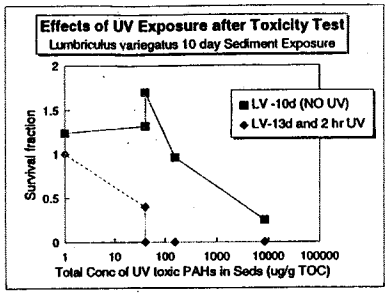
ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

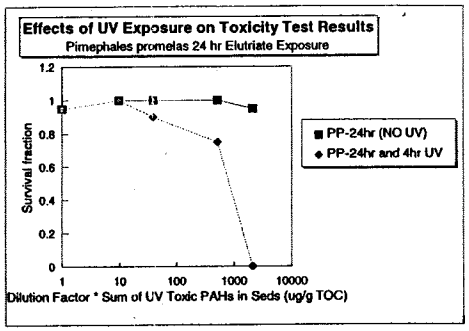
FIGURE 15
COMPARISON OF TOXICITY TEST RESULTS TO HA-28 NOC TOXIC UNITS

PROJ. NO. WONRS401.02
DATE 10/07/98

15/17







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1	09/15/98	DRAFT ISSUED TO CLIENT FOR REVIEW	JLE	09/98	MJB	09/98				

SEH

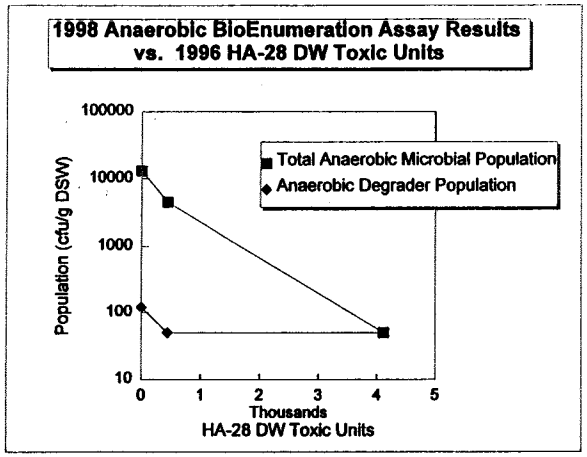
ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

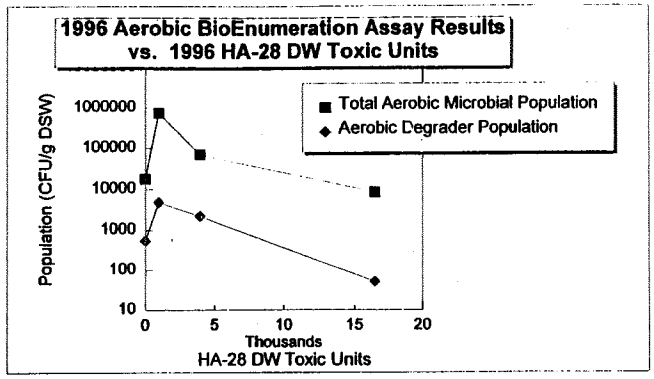
FIGURE 16
COMPARISON OF UV EXPOSED TOXICITY TEST RESULTS TO UV-TOXIC PAH CONCENTRATIONS

PROJ. NO. WDNR9401.02
DATE 10/07/98

16 / 17

E:\WASTE\WDNR\9401.02\ERA\FIG-16





NO.	DATE	ISSUE/REVISIONS	DRAWN BY		DESIGN		FIELD REVIEW		QC CHECK	
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1	09/15/98	DRAFT ISSUED TO CLIENT FOR REVIEW	JLE	09/98	MJB	09/98				

SEH

ASHLAND LAKEFRONT PROPERTY
CONTAMINATED SEDIMENTS
ECOLOGICAL RISK ASSESSMENT

FIGURE 17
COMPARISON OF BIO ENUMERATION ASSAY RESULTS TO HA-28 DW TOXIC UNITS

PROJ. NO. WDNR9401.02
DATE 10/07/98

17/17

E:\WASTE\WDNR\9401.02\ERA\FIG-17

Appendix B

Excerpts from 1999 – 2001 WDNR Comments on ERA

B-1 – WDNR (Tom Janisch) Summary of WDNR Fish Tissue Results

B-2 – WDNR (Tom Janisch) Evaluation of Benthic Survey Results

B-3 – WDNR (Tom Janisch) Comments Regarding D&M Comments on UV Light

B-1 – WDNR (Tom Janisch) Summary of WDNR Fish Tissue Results

(B-1) EXCERPTED FROM WDNR JUNE 1999 COMMENTS TO THE D&M MARCH 1999 DRAFT ERA.

Attachment A

Results of the WDNR PAH Analysis of Fillets and Whole Fish Collected In the Harbor Offshore of the Ashland Lakefront Property On 05/18/98 and 10/14/98

Comments On the Results of the PAH Analysis In Fillets and A Whole Fish Collected In the Harbor Offshore of the Ashland Lakefront Property 05/18/98 and 10/14/98

1) The analytical results are summarized in Table 1 below. In the table, the 16 PAHs are arranged in order of increasing number of benzene rings and thus molecular weights. Two columns in the table indicate the number of rings and the molecular weight associated with each PAH. The dividing line between low and high molecular weight PAHs is put between the 3-ring and 4-ring groups and each weight group listing is headed appropriately. The ring groupings and molecular weight determine such characteristics as the water solubility and octanol-water partitioning coefficient(Kow) of the individual PAH compounds (both of which are shown in Table 1) which are important for determining their fate and behavior in the water and in aquatic organisms. The mode of toxicity is related to the individual PAH characteristics and its metabolized or photoactivated product.

2) Table 1 across the top contains the individual field sample number (e.g. 9812) for the fish analyzed and whether fillets or the whole fish were analyzed. At the bottom of the table, the lipid content of the fillets or whole fish, as applicable, is given. On the page after Table 1, the fish species and size and weight metrics of the fish for each field sample number is given. The fish are broken into two groups, one where PAHs were detected in the tissues (Table 1 fish) and the other where no PAHs were detected in the tissue.

3) In Table 1, the reported LODs (values in parenthesis) for all the compounds were listed only for sample 9812. These LODs which apply to the results for all the other samples were left blank in the columns under those samples. Values reported as being between the LOD and LOQ are shown with hyphens on either side of the concentration values in the table.

4) In looking at Table 1 it is noted that all of the PAH compounds detected or where between the LOD and LOQ were all lower molecular weight (LMW) compounds with 2 to 3 benzene rings. No high molecular weight (HMW) PAH compounds were detected in any of the samples, either fillets or whole fish, at levels greater than the reported LODs. The three whole fish analyzed had total LMW PAH concentrations of 34, 154, and 483 ug/kg in the tissue. The five fillets had LMW PAH concentrations 17, 51, 86, 105, and 319 ug/kg.

5) There may be a number of reasons why the HMW PAH compounds are not being detected in the tissues:

a. They may be present in the tissues but at levels below the reported LODs achievedunder the analytical method. Analysis for PAHs in whole fish tissues for a sampling project on the Lower Fox River done by another laboratory detected 6 of the 10 listed highermolecular weight PAHs at concentrations just below the LOD values reported in Table 1 below (ThermoRetec, 1999).

b. In general, the HMW unsubstituted PAHs (4 to 5 rings) tend to have a faster rate ofmetabolism than the LMW PAH compounds (2 to 3 rings). The metabolism may occur fasterif the MFO enzyme system that metabolizes PAHs has been previously induced by exposures of the fish to PAHs. Induction of the MFO enzyme system varies between fish species. Higher activity of the MFO system increases biotransformation in fish. The metabolism can lead to biotransformation to

reactive intermediates that are toxic, mutagenic, or carcinogenic or to the detoxification of the PAH compounds and excretion from the body. Also, short exposures of fish whose MFO systems were active could result in low levels of PAHs in tissues and low estimates of PAHs in the water. No data exists as to the health implications to humans who consume fish tissue that contain reactive metabolites of the biotransformed PAHs.

Based on the ability of PAHs to exert their toxicity following biotransformtion to toxic metabolites, an assessment based on parent PAH compounds in tissues is insufficient. Tissue levels of parent PAH compounds are not a real biological indication of possible effects of exposure of fish to PAHs from a contaminated site over time. To determine PAH exposure in fish, the fate of PAH metabolites should be investigated to quantify the PAH flux in the fish. With fish, the metabolite:aromatic hydrocarbon ratio generally increases after hydrocarbon exposure.

c. If the primary mode of uptake of the contaminant is across the gill surfaces during respiration, the HMW compounds with their lower water solubilities will be less available for uptake compared to the more soluble LMW PAHs. Given the increased hydrophobicity of the HMW PAHs due to their higher octanol-water partitioning coefficients, they would have a tendency to be more adsorbed to suspended particulate matter, colloidal matter, and dissolved organic carbon and to be less available in the be freely dissolved form for uptake by the respiratory pathway in fish but would be ingested and available in the gut.

d. In the fish analyzed as fillets, HMW PAHs maybe present in the gut from ingestion of contaminated food and would not show up in the fillet analysis. Accumulation of HMW parent PAHs in tissue through contaminated food would take place only after a continuous period of exposure and then it may occur slowly and be at low levels. Dietary uptake of HMW PAHs may have a minimal effect on tissue-PAH levels due to low or slow uptake from the digestive system. PAHs ingested in food by fish can be largely metabolized by the MFO enzymes in the gut epithelium and may not be absorbed efficiently across the gut wall. However, there are large interspecific differences in fish in their ability to metabolize, absorb, and/or assimilate PAHs. Exposure of fish to highly contaminated sites over a period of time may not follow the above behavior of any PAHs as discussed above. See comments in this regard made in the coments of the main text.

e. While not analyzed for, there is demonstrated strong tendency for some fish species to accumulate alkyl-substituted aromatic hydrocarbons in preference to unsubstituted parent PAH compounds.

f. The relative availability of the PAHs for uptake may be determined both by their solubilities and relative concentrations in the contaminated sediments that act as source of PAHs to the water column. In general, the relative concentrations of some or most of the LMW PAHs are greater in the sediments at the Ashland site compared to the HMW PAHs (see discussion below).

6) The dominance of the accumulated LMW PAHs in tissues is most likely due to exposure and uptake of the PAHs dissolved in the water column over the gill surfaces of the fish during respiration. All of the PAHs detected are more water soluble and have lower particulate affinities than the HMW PAHs. The aqueous solubility of the LMW PAHs is several orders of magnitude higher than that of HMW PAHs. The fraction of freely dissolved PAHs is usually assumed to be readily available for uptake by fish and other aquatic organisms and accumulated directly from the water phase. The fish accumulate the LMW PAHs in their soft tissues from the water in which they

reside in proportion to the concentration of the PAHs in solution in the water and the concentration of total lipids in their tissues. If the fish are continuously exposed to a contaminated site over time, the concentration of PAHs in the tissues can reach a steady state or equilibrium (equilibrium partitioning theory). Due to the mobility of most fish species, steady state conditions are not likely tc be achieved. PAH levels in tissues and their trends with time can be adequately explained and are probably controlled by equilibrium partitioning from the surrounding water which is much faster for the LMW PAHs than uptake from food. This bioconcentration represents a direct transfer of the PAHs from water, across the gill surfaces, and through the bloodstream to tissues. The results from the Ashland fish are similar to the results from other heavily contaminated PAH sediment sites where LMW PAHs are found in fish tissues while the HMW PAHs were at very low levels or undetectable. In Table 1 the redhorse with the whole body analysis (9810) had a total PAH concentration of 483 ug/kg, all of which was due to LMW PAHs.
Redhorses usually occupy the habitat at the bottom of the water column above the sediment. In this zone, they may be exposed to greater concentrations of the LMW PAHs that are being released from the sediments or coal tar oils to the water column by partitioning and diffusion than they would if they spent their time higher in the water column or were more pelagic. The whole fish analysis of a pumpkinseed sunfish, a more pleagic fish, showed naphthalene levels of 34 ug/kg.

7) Given the concentrations of LMW PAHs found in the whole fish analyzed (9810 in Table 1), we estimate that the fish received some term of exposure to high levels of PAHs in the water column that was associated with a site highly contaminated with these compounds in the sediments.
The fish whose tissue were analyzed are mobile and have various home ranges during which they would use the area of the coal tar contaminated sediments for various periods depending on the time of the year and the fish species. We would contend that to achieve the levels of LMW PAHs found in sample 9810, it would have been exposed to a highly contaminated PAH site and not a harbor site where typical ubiquitous or low PAH levels are found in sediments. Uptake in the fish has to be associated with a site highly contaminated with LMW PAHs. Unless it can be demonstrated that there is another site either distal or proximal within the home ranges of the species of fish involved where they could possibly pick up the tissue levels measured, the primary site for exposure and uptake has to be considered the harbor site off the Ashland Lakefront property.

The table below shows the concentrations of PAHs in a composited sediment sample of the Ashland site that SEH used in their dispersion and settling study for the FS.

Low Mol. Wt. PAH	ug/kg *	Comments
Naphthalene	240,000 +	Concentrations followed by "+" are LMW compounds bioaccumulated in fish sample 9810 The methylated naphthalene compounds were not analyzed for in fish
1-Methylnaphthalene	90.000	
2-Methlynaphthalene	150,000	
Acenaphthylene	< 2,800	
Acenaphthene	86,000 +	
Anthracene	43,000 +	Total Concentration of LMW PAHs
Fluorene	46,000 +	
Phenanthrene	120,000 +	778,800 ug/kg
High Mol. Wt. PAH		
Fluoranthene	38,000	
Pyrene	56,000	
Chrysene	15,000	
Benz(a)Anthracene	16,000	Total Concentration of HMW PAHs
Benzo(a)pyrene	12,000	
Benzo(b)fluoranthene	6,200	160,600 ug/kg
Benzo(k)fluoranthene	6,000	
Dibenzo(a,h) anthracene	< 2,900	
Indeno(1,2,3-c,d)pyrene	3,700	
Benzo(g,h,i)perylene	4,800	
Total PAHs	932,700	

* The sediment sample in the above table represents a composite sample from several locations over the Ashland harbor site. A fish utilizing the site would be exposed to the "average" concentrations related to the sediment. It is noted that the LMW compounds predominate in the sediments and they are the PAHs accumulated and measured in the fish collected from the site. This would indicate that the LMW PAHs associated with the sediment are partitioning and diffusing to the water column in a freely dissolved form to be taken up by fish during respiration of perfusing the contaminated water over the gill surfaces.

8) Based on the literature, the concentration of total parent PAH compounds in fish from unpolluted surface waters or where only ubiquitous levels of PAHs are present in sediments are generally non-detectable and if detected generally do not exceed 50 ug/kg. Not a lot of sampling information is available on total PAH levels in whole bodies of fish of various species from studies. PAH levels reported from large bodies of water are generally below ug/kg concentrations (e.g. Gossett et al., 1983; Lawrence and Weber, 1984). Some data is available from the studies conducted in regard to

the Exxon oil spill in Alaska (Saxton et al. 1993 and Neff et al. 1996) and the series of Baumann studies (e.g. Baumann et al. 1982) that established PAH levels in fish from reference sites. PAH levels can attain mg/kg concentrations in fish collected from waters where sediment levels exceed 100 mg/kg. In some localized situations, mg/kg PAH levels can be obtained in demersal species like bullheads.

9) Toxicity has been attributed to exposure to and accumulation of naphthalene in fish tissues (DiMichele et al. 1978; Russel et al. 1984). Exposure to high levels of naphthalene as a water soluble fraction can lead to accumulation of high levels in the brains of fish which affect breathing rates and brain dopamine levels. Major effects have been found in the brain, liver, and pancreas. The toxicity of naphthalene in fish was found to be due primarily to its effect on blood components in lethal acute situations. Evidence of neurosensory damage has been found. Serum glucose, protein, and cortisol were found to be elevated in fish exposed to low levels of naphthalene in water indicating metabolic stress. In sublethal exposures, there is evidence of neurosensory damage and metabolic stress which may affect fishes overall ability to survive in aquatic systems. Exposure concentrations of naphthalene in water related to effects ranged from 20 ug/l (degeneration of neurosensory organs) to 2,000 ug/l (generalized blood stasis-slowing or stoppage of the normal flow of blood). The fish in the study were exposed for 15 days. It was noted that the naphthalene concentration in the dispersion test that SEH performed on the Ashland sediments was 1,800 ug/l at the start and 1,600 ug/l eleven days later.

10) General observations from literature:

a. Concentrations of parent PAH compounds in different tissue types is generally related to the lipid content of the tissues. The whole body lipid content can be as much as twice the lipid concentration in muscle tissue. The lipid content of the viscera of some fish is 3 to 7 times that of the whole body. From Table 1 it can be seen that generally whole body tissue concentrations of the LMW PAHs are greater than the fillet concentrations. This may be due in part to the differences in lipid content between the whole body and fillets.

b. Uptake of PAHs in fish is influenced to some extent by the gill perfusion rate, feeding , temperature, and duration of exposure. Fathead minnows and green sunfish show an increase in BCF for PAHs of about a factor of 4 from 5 to 15^0 C.

c. In one study using radio-tagged naphthalene, equilibrium levels were reached in fish tissue in 1 hour. After 24 hours in clean water, most of the radioactivity due to the radio-tagged naphthalene had been lost from fish tissue. The visceral fat contained the highest levels of the accumulated naphthalene. If the fish were exposed to higher concentrations of naphthalene for a longer period of time, the naphthtalene was released much more slowly than following a short term exposure. Half-lives for the naphthalene and its metabolites ranged from 341 h for liver and 909 h for muscle.

d. There are large interspecific differences in fish ability to absorb and assimilate PAHs into tissues. Several endogenous biological factors such as size, nutritional status, body composition, age, and sex as well as exogenous physical factors such as temperature and the physical

characteristics of the individual PAHs affect the patterns of uptake and release of PAHs by aquatic organisms. Temperature of the ambient medium may have a profound effect on many physiological functions in aquatic organisms. Temperature will affect solubility of the PAH compounds, absorption-desorption kinetics, and the octanol-water partitioning of PAHs in water.

e. PAHs that become associated with stable lipid pools within the organism such as depot lipids and gonadal lipid stores may be retained until the organism mobilizes lipids for nutritional purposes. PAHs that become associated with more labile hydrophilic compartments such as membrane lipids and cellular macromolecules may be released more rapidly when ambient levels of PAHs in the water decrease.

11) While the tissue levels of early life stages of fish were not done in the Ashland study, recent papers (Heintz et al. 1999 and Carls et al., 1999) published in regard to studies done on the lingering effects of the Exxon Valdez oil spill in Alaska in 1989 on fish eggs, embryos, and larvae using the impacted portions of streams in the intertidal zone shows impacts to salmon and herring at very low concentrations of total PAHs in the water column and over the stream bottoms. The commonality of contaminants between the oil impacted sites of Alaska and the coal tar contaminated sediments off the Lakefront property of the Ashland Harbor are the LMW and HMW PAH compounds. Understandably, there are be differences in the fish species involved between the two sites and the use of the Lakefront Property harbor by the fish life stages of egg, embryos and adult is not fully known. However, it is interesting to take a look at what inferences can be drawn between the results of the Alaska studies and what may be potentially happening at the Ashland site due to the exposures from PAHs in the surface waters, sediments,.and residual coal tars. Some of the findings of the two above cited studies are as follows:

a. Comparison of tissue-total PAH (TPAH) uptake rates demonstrated that the larger PAHs that predominate in more weathered oil require more time to reach maximum tissue concentrations, attain lower concentration maxima, and persist in tissues longer compared with the smaller PAH that predominate in less-weathered oil.

b. Aqueous-TPAH concentrations as low as 1 ug/L derived from weathered oil can kill salmon embryos located downstream from oil sources. This value is one tenth the current water quality standard for TPAH in Alaska. Dissolved PAHs may damage or kill developing fish embryos and that embryo contact with oiled substrate is not a necessary exposure condition. Accumulation of PAHs by embryos is determined by passive uptake from water and depuration kinetics.

c. In the herring study, total aqueous PAH concentrations as low as 0.4 ug/l caused sublethal responses such as yolk sac edema and immaturity consistent with premature hatching. Responses to less weathered oil which had relatively lower portions of HMW PAHs, generally paralleled those of more weathered oil, but lowest observed effective concentrations (LOECs) were higher (9.1 ug/l) demonstrating the importance of the LMW and HMW PAH composition. The LOEC of 0.4 ug/l for herring was similar to that observed in salmon (1.0 ug/l), a species of very different development rate; by inference, the embryos of other fish species may be similarly sensitive to exposure to low level PAH exposures from dissolved PAHs in the water column. The total PAH concentration in the

water column in the SEH sample collected from the Lakefront harbor during the spring 1998 high energy event was 3.89 ug/l. The total PAH concentration in the water column 11 days after the initiation of their March 1998 dispersion and settling study conducted on the harbor sediments was 4,237 ug/l. Somewhere between these values the actual near bottom water concentration conditions for dissolved PAHs at the Lakefront range. Actual near bottom water concentrations likely vary over the site and are affected by seasonal conditions including temperatures, the previous and ongoing wind and wave conditions occurring in the harbor that result in disturbance and suspension of contaminated sediments and coal tar oils, possible on-land inflows of coal tar oils to the harbor, and weathered state of the coal tars.tar oils.

d. Fish embryos were susceptible to low concentrations of the least labile PAHs. The toxicity of the PAHs increases with the molecular size.

e. The sublethal effects observed among the exposed embryos were characteristic of chemical teratogenesis and included altered development of bony parts such as increased frequencies of opercular hypoplasia and of spinal deformities. Also noted were possible effects on circulation manifested as increased frequency of ascites (edema) and possible cytogenic effects demonstrated by reductions in the frequency of conjoined twinning. Under normal hatchery conditions, conjoined twinning is typically seen at low frequencies. The observation was that the reduced frequency of the conjoined twinning lesion suggested that some developmental abnormalities manifested under normal circumstances may interact with the oil effects to preclude survival.

f. Lipid rich embryos can effectively scavenge PAHs dissolved from the oiled substrate to toxic internal concentrations, despite the low solubilities of the larger PAHs.

g. A consequence of PAH uptake mediated by transport kinetics is that PAHs are accumulated more rapidly by smaller embryos based on the absolute uptake rate of PAHs being directly proportional with the ratio of surface area to volume so smaller eggs accumulate all PAHs more rapidly than larger eggs.

h. The adverse effects found for embryos exposed to low part-per-billion TPAH concentrations from the study suggests that restoration of habitats chronically polluted with PAHs may be even more difficult than previously appreciated. The larger and more toxic PAHs will most likely persist longest at locations where PAHs are continually leached into receiving aquatic habitats. The effects of these PAHs on organisms in these habitats may be sublethal at early life stages but may lead to mortality later in life by increasing the vulnerability of these organisms to disease, parasitism, or predation. In the studies, the embryos exposed to PAHs exhibited a variety of adverse effects, and although the frequencies of the effects were often low, the cumulative impact on the exposed populations may be substantial. Concentrations of aqueous-TPAH above 1 ug/l may be readily attained in surface waters of urbanized drainages, so cumulative impacts on fish populations attempting to reproduce in PAH-contaminated surface waters of these drainages may be greater than currently recognized. Reduction of PAH inputs to safe levels for restoration and maintenance

of healthy, self-sustaining fish populations may therefore require much more restrictive regulation of anthropogenic PAH sources,

Table 1. Results of PAH Analysis Of Fish Tissue Collected 05/18/98 and 10/14/98 From Harbor Area Off the Ashland Lakefront Property

PAHs				Fish Tissue Concentration of PAHs (ug / kg) - Harbor Off Lakefront Property								
				9812	9810	9811	9813	98AS01	98AS02	9805	9809	98AS05
Low Mol. Wt.	No. Rings	Kow	Solubility mg/l	Fillet	Whole Fish	Fillet	Fillet	Fillet	Fillet	Whole Fish	Whole Fish	Fillet
Naphthalene	2	3.36	31.7	(19)1.	110		-35-2.	-34-	93	34	71	-38-
Acenaphthylene	3	4.07	3.93	(21)								
Acenaphthene	3	3.92	3.47	(17)	200	-17-	-53-		120		83	-48-
Anthracene	3	4.54	0.073	(7.1)	-21-				-7.6-			
Fluorene	3	4.38	1.98	(58)	73							
Phenanthrene	3	4.57	1.29	(19)	79		-17-	-17-	-47-			
High Mol. Wt. ↓	Total LMW Concen.→			0	483	17	105	51	318.6		154	86
Fluoranthene	4	5.22	0.26	(29)								
Pyrene	4	5.18	0.135	(12)								
Chrysene	4	5.79	0.014	(7.4)								
Benzol(a)anthracene	4	5.91	0.014	(19)								
Benzol(a)pyrene	5	6.42	0.0038	(23)								
Benzol(b)fluoranthene	5	6.60	0.0012	(32)								
Benzol(k)fluoranthene	5	6.85	0.0006	(21)								
Dibenzo(a,h)anthracene	5	6.50	0.0005	(8)								
Indeno(1,2,3-c,d)pyrene	6	7.66	0.062	(34)								
Benzol(g,h,i)perylene	6	7.05	0.0003	(22)								
% Lipids	-----		-----	2.8	7.5	1.3	1.3	3.7	10	3.3	0.8	2.9

1. Value in parenthesis is the reported level of detection (LOD) for the compound. The LODs for sample 9810 are the same for the other samples that have no values placed in the columns under that sample.
2. A value with a hypen on either side, e.g. -19-, indicates that the value reported is between the LOD and LOQ.
3. See next page for species analyzed and characteristics.

Fish species and characteristics

Fish Where PAHs Detected In Tissue (% lipids given in the table above)
9810 - Shorthead redhorse, 18.4 in., 1.08 kg, whole fish
9811 - Smallmouth bass, 9.8 in., 022 kg, skin on fillet
9813 - Northern Pike - 22.5 in., 1.21, skin on fillet
98AS01 - Brown Trout, 21.25 in., 1.69 kg, skin on fillet
98AS02 - Rainbow Trout, 20.5 in., 2.02 kg, skin on fillet
98AS05 - White sucker, 17.5 in., 0.86 kg, skin on fillet
9805 - Pumpkinseed, 5.0 in. 0.04 kg, whole fish
9809 - Shorthead redhorse, 18.2 kg, whole fish

Fish Were PAHs Not Detected In Tissue
98AS04 - Largemouth Bass, 10.0 in., 28 kg, skin on fillet, 0.8% lipids
98AS03 - White Sucker, 17.75 in., 0.91 kg, skin on fillet, 1.0% lipids
9812 - Walleye, 17.8 in., 0.77 kg, skin on fillet, 2.8% lipids (listed in table above for indication of LODs
9801 - Rock Bass, 6 in, 0.07 kg, skin on fillet, 0.7% lipids
9802 - Rock Bass, 5.9 in., 0.08 kg, skin on fillet, 1.0% lipids
9803 - Rock Bass, 7.8 in., 0.17 kg, skin on fillet, 0.9% lipids
9804 - Rock Bass, 9.8 in., 0.36 kg, skin on fillet, 0.7% lipids
9806 - White Sucker, 15.9 in., 0.69 kg, skin on fillet, 2.4%
9807 - White Sucker, 16.5 in., 0.68 kg, skin on fillet, 1.7%
9808 - White Sucker, 18.2 in., 1.02 kg, skin on fillet, 2.5%

B-2 – WDNR (Tom Janisch) Evaluation of Benthic Survey Results

(B-2) EXCERPTED FROM WDNR JUNE 1997 COMMENTS TO THE D&M MARCH 1999 ERA

In addition to the exposure of waterborne xenobiotics, early life stages of fish may be exposed to PAHs by a transfer from parental fish to the developing gametes. Some studies have shown relatively high percentages of unmetabolized naphthalene and benzo(a)pyrene in fish ovaries compared to other tissues. This may indicate that the deposition of lipid in the oocyte strongly favors accumulation of lipophilic parent compounds. The transfer of xenobiotics from parental fish to developing gametes may represent an important role in the exposure of early life stages to xenobiotics.

Based on Table 13 of the SEH ERA, 20 species of fish spawn in the Ashland Harbor and 29 species use the harbor for rearing purposes. The shallow water habitat of the bay off the Lakefront Property is likely used by a number of these fish species and invertebrate species during various stages of reproduction and development. The habitat preference of some of these organisms predisposes them to exposure both to PAHs and UV light.

The results of the WDNR fish collections in the harbor off the Lakefront property and analyses for PAHs in the fillets and whole fish collected are shown in Attachment A below. A discussion of the results is included in the attachment.

22. Risk Characterization (Section 4, page 15)

Due to the D & M inappropriate calculation steps related to the Swartz Σ PAH Toxicity Model, further complicated by calculation errors as identified in the above comments, the discussions and conclusions in this section of the D & M ERA and the referenced D & M Table 2 HQ EC25 values are invalid and unusable and will not be commented on further. Any attempts to link the HQ EC25 values to the results of the bioassays and macroinvertebrate studies conducted during the SEH ERA are also invalid and unusable.

23. Benthic Studies (Section 5.1,pages 17-18)

The CW location is within about 200 feet of the shoreline, while the CS location is 300 feet offshore. The reference locations are removed from the plant area.

The distance offshore to the CS location is 400 feet, not 300 as stated. What is the "plant area" referenced in the above statement?

Results from the benthic surveys were evaluated by D & M using the **"Community Loss Index"** that measures the loss of benthic taxa between a reference station and the station of comparison. D & M indicate that the Community Loss Index is an index of compositional dissimilarity, with values increasing as the degree od dissimilarity with the reference station increases.

What is the reference source and the equation for deriving a Community Loss Index value? Were mean taxa richness and mean number of taxa-in-common between the reference and study site used in the formula to derive the Community Loss Index between RS:CS and RW:CW? We would like to see the two values for the mean number in taxa in common between the applicable reference and study sites that was used in the calculation.

We assume the value is calculated as per the Coefficient of Community Loss of Courtemanch et al. (1987) or Klemm (1990). In Courtemanch, it appears the community loss index was primarily derived to evaluate the effects of wastewater discharges on surface water communities and is a

measure of water quality impacts. The coefficient of community loss is a ratio of the number of taxa assumed lost due the pollution source to the number of taxa remaining, including any new taxa. If the Courtemanch formula for calculating the coefficient of community loss is the same as used by D & M, then it is difficult to reconcile the index values of 0.235 and 0.067 as calculated by D & M with the Courtemanch classification which potentially places these values for both paired sites into a pristine site classification. The other possible alternative is that the paired sites could be classified as "enriched" that in Courtemanch's classification is due to sites being influenced by the discharge of sewage or other organically rich effluent. It would appear that the only way a higher index value is achievable is when all or most of the taxa at the reference site are eliminated from the contaminated site and new tolerant taxa appear at the contaminated site. The situation where the number of reference site taxa and total number of organisms are reduced at the contaminated site (both situations that are present in the CS:RS and CW:CW relationship) which is indicative of potential impacts to the community are not addressed in the Community Loss Index. The Index would only appear to be important from the aspect of compositional changes due to the large scale elimination of reference site taxa and establishment of new taxa at the study sites. The community loss index needs to be interpreted very closely in this regard. It can be misleading.

Courtemanch et al.(1987) identify the following limitations about the Community Loss Index value:

a. It should be noted that the Index only looks at taxonomic composition. Other unbalancing effects to the community could be occurring that are not measured by the Index.

b. No single measure of community structure is sufficient to fully asses environmental impacts. The Index needs to be interpreted along with other measures.

c. Measures of richness or similarity alone may be insufficient to document important changes to water quality (if we are to assume the Index applies to benthic communities, it may likewise be insufficient to document important changes in sediment quality).

Similarity indices such as the Community Loss Index have been used extensively in terrestrial ecology and have been used in water pollution work where point source input is suspected but the metric does not appear to have been extended to aquatic ecology (Washington, 1984).

The analysis suggests that factors other than PAHs (e.g., wood chips) contribute to the differences in measured metrics. The most obvious explanation for this difference in populations is the different substrate (page 18).

We are not sure why D & M is making an argument that the different types of bottom substrates are likely causing differences in the makeup of the benthic communities between the wood and sand substrates. This goes without saying and that is the reason for establishing the paired sampling sites on the two different types of substrates present. Benthic invertebrates will colonize largely on their preferred substrates and habitats. The important point in any comparison of the benthic communities is to compare the contaminated sand study site with the reference sand site and the contaminated wood study site with the reference wood site. Cross substrate comparisons of benthic communities cannot be used to make conclusions about any probable impacts for the site. In Table 3 of the D & M ERA, the results of the benthic organism metrics from both the sand and wood substrates are compared relative to the reference sand results. This comparison is inappropriate in assessing the differences and contamination impacts on the benthic communities. Communities on the contaminated sand can only be compared to communities on the reference sand and

communities on the contaminated wood can only be compared to the communities on the reference wood.

Figure 9 in the D & M ERA which is the graphed index of the midge-oligochaete ratios calculated for the 4 sites are all incorrect based on the calculated ratios in Appendix A of the SEH ERA (1998) and therefore the graph cannot be used.

In rebuttal comment 17, D & M makes the following statement: **"The lack of sufficient biomass of benthic invertebrates at the reference sand site suggests that other, possibly physical, factors may play an important role in the bioassay results and the population dynamics of the site."** What is the point of reference for saying there was a lack of sufficient biomass of invertebrates at the reference sand site ? Lack of sufficient biomass compared to what ? The total number of organisms (40,498 / $m^{2)}$, the total number of midge (13,169 m^2), and the total number of oligochaetes (8,146 m^2) at the reference sand site are comparable to the numbers found at other Great Lakes harbor sites (Canfield et al.1996). The lack of biomass was perceived by SEH and LSRI on site because of the small size of the organisms and not because the lack of abiundance. The vast majority of specimens at the references sand site were quite small, which was verified in the laboratory during the processing of the samples. Trying to obtain a sufficient, live mass of these organisms for each taxon while in the field would have been highly impractical. The collectors perception of lack of biomass was in relation to obtaining enough mass to do chemical anayses for body burdens of contaminants. What specific role does the D & M perceived lack of biomass play in the bioassay results ? What is the relationship ? The comment on lack of sufficient biomass is not understandable and needs elaboration.

Based on page 17 of the D & M ERA, the table below summarizes the qualitative assessment of the benthic macroinvertebrate results from the SEH ERA by comparing the ranges (means, maximum, and minimum) of the indices for each station. The following metrics were identified by D & M as giving "conclusive indications of probable impacts" based principally on no overlaps in the minimum and maximum ranges of the replicates from the contaminated and references sites:

a. Midge taxa richness - CW compared to RW
b. Total abundance - CS compared to RS
c. Midge abundance - CS compared to RS
d. Oligochaete abundance - CS compared to RS

The shaded indices in the following table represent the D & M interpretation of "probable impacts" due to the decrease in the index when the reference site results are compared to the study site results.

Indices	Reference Wood		Contaminated Wood		Reference Sand		Contaminated Sand	
	Mean	std. dev.	Mean	std dev.	Mean	std.dev.	Mean	std. dev.
Total Taxa Richness	***13.2***	***5.4***	***5.7***	***3.5***	**30.8**	**5.8**	**21.2**	**2.6**
Midge Taxa Richness	5.2	2.8	0.3	0.5	**13.2**	**3.1**	**8.8**	**1.2**
Total Abundance (m2)	1285	776	2282	3410	40,498	13,542	9459	4542
Midge Abundance (m2)	**287**	**228**	**21.5**	**36**	13,169	6342	2541	728
Oligochaete Abundance (m2)	366	330	1478	1888	8146	3442	1651	836
Relative Midge Abundance	0.26	.18	0.08	0.20	0.32	0.12	0.30	0.13
Midge / Oligochaete Ratio	0.86	0.80	0.17	0.41	1.86	1.13	1.80	0.81

Shaded indices represent D & M interpretation of "probable impacts.
Indices in bold and larger font appear to meet the criteria of no overlap or single point overlap in ranges but were not included by D & M as "probable impacts".
The index in italic and in bold and larger font represents where the range as determined by the standard deviation did not overlap between the RW and CW sites and therefore the index is interpreted as showing probable impacts.

Based on the above D & M qualitative methods, it also appears that the a.) midge abundance (contaminated wood compared to reference wood with no overlap) , b.) total taxa richness (contaminated sand compared to reference sand with one point of overlap), and c.) midge taxa richness (contaminated sand compared to reference sand with one point of overlap based on a revision to the SEH ERA Appendix A calculation tables) also could be considered "probable impacts". It is uncertain why D & M omitted these three indices (or at least the one index with no overlap) for the sites along with the other four they have identified. If the criteria was the range of the standard deviation from mean rather than maximum and minimum values, the total taxa richness index for contaminated wood compared to reference wood would also show probable impacts. The above represents four additional indices to make a total of eight that show that there are impacts between the contaminated sites and the reference sites based on qualitative comparisons.

D & M states that **"statistical evaluations afforded by the existing data are limited because of small sample sizes and large resulting variances."** (p. 17)

We do not agree with this. Given the background discussion on statistics and the need to apply the correct interpretive terminology to the results of statistical evaluations as reflected in the D & M rebuttal comment 2, it is not understandable how statistical evaluations are limited based on the available data (see comment 42 below).

A statistical analyses was done on the paired sampling results from each substrate to determine if the results were significantly different. Separate t-tests (alpha less than or equal to 0.05) were run to compare the raw data from the two sand sites and the two wood sites. Data were transformed when necessary to achieve normality and equal variance by using natural log or natural log (x + 1) (if zero values were present in the data). Normality was tested using the Kolmogorov-Smirnov Test (with Lilliefors' correction), while equal variance was tested using the Levene Medial Test. If normality or equal variance could not be achieved, a Mann-Whitney Rank Sum Test was used. All tests were done using SigmaStat (Jandel Scientific, San Rafael, CA.). The paired results that were shown to be statistically different and the level of significance are shown in the table below. The eight indices that are significantly different in the table below are the same eight identified in the table above through qualitative means that were related to probable impacts from the coal tar contamination.. The statistical analyses confirms the conclusions reached through the qualitative evaluation of the data.

Indices	Comparison of RW:CW Index Means Level of Significance		Comparison of RS:CS Index Means Level of Significance	
Total Taxa Richness	Significant	p = 0.019	Significant	p = 0.004
Midge Taxa Richness	Significant	p = 0.002	Significant	p = 0.007
Total Abundance (m2)	Not significantly different	p = 0.838	Significant	p < 0.001
Midge Abundance (m2)	Significant	p = 0.002	Significant	p < 0.001
Oligochaete Abundance (m2)	Not significantly different due to high variability at contaminated site	p = 0.294	Significant	p < 0.001

The end results of the above comparisons is the identification of four additional indices from the four identified by D & M which show probable impacts when the reference site results are compared to the contaminated site results on a qualitative and quantitative statistical basis.. The above results also generally coincide with the SEH ERA qualitative analysis of the macroinvertebrate data as shown in Table 15 of the ERA.

Given that both the indices of relative midge abundance and the midge / oligochaete ratio are reduced between the contaminated wood site and the reference wood site with only one point of overlap in the ranges, these indices may also possibly be used as indicators of probable impact.

D & M makes the statement **"Four of the six metrics show large changes between the RS and CS locations, followed by an equal change between the CS and RW location."** (page 18)

From the above, D & M originally indicated that only three of the six metrics were different between RS and CS rather than four. The end result of the above considerations is that five of the seven metrics are significantly different between RS and CS.

The second part of the above D & M statement is confusing. Why are changes between the CS and RW sites being compared ? It is inappropriate to be doing comparison of results across substrate types as above between the CS or contaminated sand location with the RW or reference wood location. (See comment above).

D & M also makes the statement that **"...the bioassay results in which midge (C. tentens [tentans]) survival was reduced to only 68% in the highest PAH concentration location (CW), but midge abundance was reduced to 23% in the CS location that caused no toxicity to C. tentens [tentans]."** (page 18)

There are a number of facts in error or in confusion in the above statement or other considerations also need to be made as follows:
a.) Survival of *C tentans* at CW was 68% relative to RW and 80% at CS relative to the RS (the latter while indicating a reduced survival relative to the control but was not significantly different)
b.) Midge abundance was reduced 93% at CW compared to RW and 80% at CS (not 23% as stated above) compared to RS.
c.) As to toxicity to *C. tentans* at CS, it was indicated in point a.above that survival was reduced and growth as mean dry total biomass / replicate was reduced by 23% relative to RS (CS significantly different than RS).

Given the above, it is uncertain exactly what point D & M is trying to make in the above statement.

Additional Observations From the Benthic Community Composition Studies

The studies available on the near shore and deep water benthic communities of Lake Superior are somewhat limited and include Reynoldson et al. (1995), Freitag et al. (1976), Thomas (1966), and the studies conducted to establish the data base for the Ontario Sediment Quality Guidelines. (Ontario MOE, 1993). The composition of the benthic communities will be determined by a number of environmental variables including water depth, water flow conditions, oxygen state, substrate type, substrate stability, sediment and water chemistries, and the feeding habits and habitat preferences of each benthic species. Animals found in or on the vaious bottom substrates will be adapted to the physical conditions present. The benthic community in fine particulate sediment typically includes oligochaete worms and chironomid larvae. Sand, gravel, and cobble substrates provide habitats for a more diverse benthic community including a wide variety of aquatic insects, crustaceans, and molluscs (Swift et al. 1996). These substrate differences are reflected in the reference sand site at Ashland that had an average total taxa richness of 30.8 versus 13.2 at the reference wood site.

Organic pollution from nonpoint and point sources in harbors and bays near urban areas in the Great Lakes is common and may be the case with the Lakefront Harbor at Ashland. In common to the areas of sandy substrate and the wood-related substrates in the harbor may be additional organic enrichment from the above sources that could modify the biodiversity of the benthic community in the harbor compared to harbor or embayment not subject to urban area influences. The presence of the wood related materials and the coal tar source inputs further impacts what may already be a benthic community somewhat influenced by organic enrichment. Due to the proximal location of the reference sand site to the wood covered bay area, fractions of the wood material may have migrated to the reference sand area and contributed to the organic enrichment that may be present.

Mollusca

Substrate preferences likely determined the presence of the two species of gastropods and three genera of bivalves on the paired sand substrates in the Ashland Harbor. The presence of no mollusca except for a few *Pisidium* at the paired wood sites would indicate the wood is not a

preferred substrate. Bivalves prefer stable sand and gravel substrates that can be mixed with other materials. They are not found on unstable bottoms with high turbidities which may be found in association with the wood substrates. Comparable numbers of mollusca were found at the reference sand site and the contaminated sand site and there was no significant differences between the two sites. The majority (approximately 88%) of the mollusca from both paired sand sites was made up of the bivalve *Pisidium* which filter feeds microscopic particles from the water column. They also move through the bottom sediments and filter organic detritus and bacteria through their gills. Species of *Pisidium* are usually the most abundant mollusk in the deeper portions of lakes. Comparable population levels at the paired sand sites would appear to indicate that exposures to PAHs or other coal tar compounds, at least at the concentration levels present (1,459 ug/kg TPAHs) at the CS site, was not impacting the suspension feeding mollusca as it was the deposit feeding infaunal chironomids and oligochaetes . Amounts of bioaccumulation of PAHs into tissues or measurements of sublethal effects to the exposed molluscs were not measured. Most members of the phylum Mollusca studied to date lack the ability to metabolize PAHs to more polar metabolites (Neff, 1979).

Crustacea

In regard to crustacea, a situation appears where there are greater numbers of crustacea at both the contaminated wood site and the contaminated sand site compared to their respective reference site. The numbers are greater at the contaminated sand (CS) site (an average of 2,756 organisms / m^2) compared to the contaminated wood (CW) site (an average of 775 organisms /m^2). The relative percent contribution to the total crustacea at the CS site (88%) and the CW (78%) is from the sow bug (Isopoda), *Caecidotea racovitzai.* Sowbugs crawl on the bottom, they do not move by swimming. Sowbugs are omnivores and they ingest dead or decaying vegetative matter. They may be consuming some selective portion of the woody material at the wood sites While they may not be consuming enough contaminated material to reach toxic body burdens of the coal tar compounds, they may be bioaccumulating the compounds for transfer to higher trophic levels. Isopods represent an important food source for predatory invertebrates, fish, and waterfowl (van Hattum et al. 1998). van Hattum et al. (1998) concluded that isopods have a marked ability to accumulate PAHs because of low biotransformation abilities and that their tissue residues tend to reflect spatial and temporal variations in the bioavailability of PAHs in littoral freshwater environments. PAH concentrations ranges in the isopods and sediments found in the van Hattum study are shown in the table below. The concentration range in parenthesis beneath the PAH wet weight concentration in the isopod tissues is the dry weight concentration assuming the isopods are 90% water. As noted in comment 6 above the scud *Gammarus pseudolimnaeus* was found at the CS and RW site in low numbers. The other scud, *Crangonyx sp.*, was found in low numbers in one of the CW replicates and not at any of the other sites. As mentioned in comment 6 above, the amphipod, *Diporeia hoyi,* which along with the mysid, *Mysis relicta*, which make up the major proportion of the benthic biomass in the deeper areas of the lake, were not found in the Ashland site benthic samples.

Compound	Sediment mg/kg - dry wt.	Isopod Tissue ug/kg - wet wt. (dry wt.)	Compound	Sediment mg/kg - dry wt.	Isopod Tissue ug/kg - wet wt. (dry wt.)
Naphthalene	0.001 - 6	11 - 360 (110 -3600)	Benzo(b)fluoranthene	0.03 - 110 (0.3 - 1110)	1 - 2,000 (10 - 20,000)
Phenanthrene	0.03 - 300	4 - 4,100 (40 - 41,000)	Benzo(k)fluoranthene	0.006 - 48 (0.006 - 480)	0.4 - 710 (4 - 7,100)
Anthracene	0.009 - 130	1 - 630 (10 - 630)	Benzo(a)pyrene	0.006 - 91 (0.006 - 910)	1 - 1,300 (10 - 13,000)
Fluoranthene	0.12 - 660	32 - 26,000 (320 - 260,000)	Dibenzo(a,h)anthracene	0.02 - 11 0.2 - 110)	4 - 270 (40 - 2,700)
Pyrene	0.12 - 510	19 - 10,000 (190 - 100,000)	Benzo(g,h,i)perylene	0.01 - 48 (0.1 - 480)	3 - 520 (30 -5,200)
Benzo(a)anthracene	0.03 - 14	1 - 2,200 (10 - 22,000)	Indeno(1,2,3-c,d)pyrene	0.03 - 61 (0.3 - 610)	1 - 360 (10 - 3,600)
Chrysene	0.04 - 130	9 - 3,500 (90 - 35,000)			

Based on Hilsenhoff (1987), the amphipod *Gammarus pseudolimnaeus*, which was found in low numbers largely at the CS and RW sites is indicative of some organic pollution and good water quality.

Probably the main component of a habitat that sowbugs prefer is to have various types of cover as provided by debris and particles that sowbugs can hide and secrete themselves under. Initially it would appear that various types of cover for the sowbugs might not be present at the CS site but would be present at the CW. However, personnel doing the field collections noted pockets of sand substrate and wood debris mixed at the CS site which may have provided the needed habitat component for sow bugs to be present at the CS site. It is assumed that the differences in the total number of crustacea between the CS site and the CW site is due to more suitable types of cover at the CS compared to the CW site and not to the different levels of TPAH concentrations found between the two sites (370 mg/kg at CW and 1.46 mg/kg as CS). Given the predominant wood substrate at CW with likely more possibilities for preferred cover, the expectation would be for more sowbugs to be found at the CW site unless the TPAH levels are playing some role. Replicate number 4 from the CW site had an exceptional number of crustacea in it compared to the other replicates from this site. This may either indicate that the quality of the characteristics of the woody debris is different at this replicate site compared to the others or that due to the heterogeneity of contaminant distributions in a small area, concentrations of PAH were less in the area of replicate number 4 compared to the others. Replicate number 4 also had the highest number of oligochaetes compared to the other replicates from the CW site.

Substrate stability may be a factor in the determination of what organisms may be found in or on particular substrates. The crustaceas that are active swimmers and/or are mobile are not

influenced to a large degree whether a substrate remains stable and undisturbed. The wood debris substrate may be variously unstable and disturbed by the currents and wave actions in the bay. This may have an influence on the total numbers and taxa of infaunal organisms that are found associated with the wood related substrates. The presence of more oligochaetes at the CW site compared to the RW site may be related to substrate stability or to differences in the quality of the wood material between the sites or for other reasons as explored below.

Oligochaetes

The use of indicator species or communities to attempt to identify the degree of organic enrichment or eutrophication in aquatic systems have been used for many years (Mozley and Howmiller, 1978; Howmiller, 1977; Nalepa, 1976; and Barton, 1989). Oligochaetes are considered one of the best groups to use as indicators of organic pollution or trophic status of a body of water (Lauritsen et al. 1985). Bioturbation of contaminated sediments by oligochaetes can be responsible increased fluxes of sediment PAHs to the overlying water column. In one study (Reible et al. 1996), the estimated flux from bioturbated sediment after 10 years would be 370 times greater than the flux from a non-bioturbated sediment exhibiting only diffusional release to the overlying water column.

The following are the oligochaetes found in the benthic communities in the sediments off of the Lakefront Property and how they have been used as indicators of trophic status indication:

1. *Limnodrilus hoffmeisteri* - *L. hoffmeisteri* is a common and abundant aquatic oligochaete and shows great adaptability (Fisher et al. 1975). It is assumed that all of the immature tubificids without hair setae found at all the Lakefront sampling sites were *L. hoffmeisteri* (Nalepa et al. 1976 ; Lauritsen et al. 1985 and Barton, 1989). It is possible that the immature forms without hair setae may include other species of tubificid. With the immature forms included, *L. hoffmeisteri* makes up approximately 50 - 60% of the total number of oligochaetes at all of the sites (except RW which has low total numbers of oligochaetes). *L. hoffmeisteri* is found in a wide variety of habitats and reaches its maximum densities in organically enriched areas. Recent studies indicate that an important factor in the distribution of this species is the fraction of sediment able to support bacterial colonies and interrelationships of species in utililizing this food source (Nalepa et al. 1976). *L. hoffmeisteri* is tolerant of and an indicator of eutrophic conditions based on the above studies. In one classification, it is placed in a group of macroinvertebrates that are tolerant of extreme enrichment or organic pollution. The relative percentage of *L. hoffmeisteri* to all the other oligochaetes is also used as an indicator of pollution. A 50% or greater level is used as an indicator of eutrophic conditions. Sampling in May and June might tend to overestimate the importance of *L. hoffmeisteri* to the overall benthic populations (Barton, 1989).

2. *Limnodrilus claparedianus* - Only found at CW but in lower numbers compared to *L. hoffmeisteri*. *L. claparedianus* is also a species tolerant of and an indicator of eutrophic conditions.

3. *Quistadrilus multisetosus* - *Q. multisetosus* was found in low numbers mostly at CS and CW. It, like *L. hoffmeisteri* is an indicator of eutrophic conditions.

4. *Spirosperma ferox* - A species relatively intolerant to organic pollution and where present indicates mesotrophic conditions. *S. ferox* was found predominantly at RS, in lesser numbers at CS which is possibly related to the elevated levels of TPAH at CS. It was not found at either CW or RW which may be related to its intolerence to the organic pollution represented by the wood materials or substrate incompatibility represented by the wood substrate materials.

5. *Aulodrilus americanus, Aulodrilus limnobius, and Aulodrilus pluriseta* - Like *S. ferox*, the Aulodrilus spp. are characteristic of areas which are mesotrophic or only slightly organically enriched. The three *Aulodrilus* spp. were only found at the RS site in relatively low numbers and only minimally present at the CS site. They were not found either at the CW or RW site. Their lower numbers at the CS site was likely related to the TPAH levels and covarying coal tar contaminants. Absence from either the CW or RW sites was probably due to unsuitable substrates.

6.. *Stylodrilus heringianus* - Found in low numbers in one replicate sample at RS, *S heringianus* is an indicator of oligotrophic conditions and is a species intolerant of organic pollution (Canfield et al. 1996).

See comment 39 below for the discussion of a study (Kukkonen et al. 1994) where the uptake and bioaccumulatiom of a PAH was measured in the oligochaete worm *Lumbriculus variegatus.* Lumbriculus had a body burden of pyrene of 35 to 40 times the sediment concentration on a dry weight basis at steady state conditions.

Chironomids

Chironomid communities have also been used as indicators of water quality and organic enrichment (Saether, 1979; Weidweholm, 1980; Aagaard, 1986; Waterhouse et al. 1985; Winnell et al. 1985; and Hilsenhoff, 1987). The degree of organic enrichment and water quality indicator from Hilsenhoff (1987) assigned to the predominant chironomidae genera found in their greatest numbers at RS, reduced at CS, very low numbers at RW and virtually absent from CW are in the following table. The species are listed in order of their abundance as found at RS.

Chironomidae Genera	No. / Meter^2	Degree of Organic Enrichment	Water Quality
Tanytarsus spp.	6,760	Fairly significant organic pollution	Fair
Procladius spp.	1,679	Severe organic pollution	Very poor
Cryptotendipes spp.	1,005	Fairly significant organic pollution	Fair
Cryptochironomus spp.	689	Very significant organic pollution	Poor
Polypedium spp.	581	Fairly significant organic pollution	Fair

Normally in Great Lakes Harbors and Bays that have received organic inputs, the number of oligochaetes per square meter is usually greater than the number of chiromomids (Canfield et al. 1996).. This is not the case at the RS and CS sites where the number of chironomids is greater than the number of oligochaetes (as reflected in the midge/oligochaete ratios of 1.86 and 1.80, respectively).

Using sediments spiked with a range of concentrations, Clements et al. (1994) measured the bioaccumulation of fluoranthene and benzo(a)pyrene in the midge *Chironomus riparius.* Sediment concentrations of fluoranthene ranged from ranged 47 to 4,040 ug/kg and concentrations in the midge ranged from 400 to 181,000 ug/kg (d.w) and increased significantly with sediment concentrations.. Sediment concentrations of benzo(a)pyrene ranged from 1.1 to 2,740 ug/kg and

concentrations in the midge ranged from 2,000 to 6,030 ug/kg (d.w.) and increased significantly with sediment levels. Visual inspection of the midges in the test beakers during the study indicated considerable reworking of sediments by the midge which was related to increased turbidity in the overlying water. The concentration of benzo(a)pyrene in water increased with midge density and was highly correlated with turbidity. Levels of benzo(a)pyrene in the midge increased significantly as the density of the midge in the treatments increased. Fluoranthene levels in fish in the study that were fed the midges that had accumulated fluoranthene ranged from 80 - 500 ug/kg in the gut tissue. No benzo(a)pyrene was detected in bluegills fed the midges that had accumulated this compound. Conclusions of the Clements et al. (1994) study were a) that the bluegill accumulated PAHs from both food and water, and b) that bioturbation and food chain transfer as mediated by benthic invertebrates, increased availability of sediment-associated PAHs. The pathway of contaminant transfer from sediments to midges to bluegills is realistic as chironomids comprise a significant portion of the diet of juvenile bluegill. While bluegills are not an indigenous fish species to the Ashland harbor based on Table 13 of the SEH ERA, the results are applicable to other species that are indigenous to the harbor that utilize midge larvae in their food base. Emerging adult midges carrying body burdens of PAHs accumulated in their tissues during the larval stage in the sediments could serve as a biotic pathway making the PAHs available to upper trophic level organisms. As adult midges emerge from the water column they can become a significant portion of the diet of swallows, terns, redwing blackbirds, bats, adult and immature ducks, and amphibians. Many species of birds time their breeding cycles to take advantage of the seasonally abundant supply of emerging insects.

Nematodes

Nematodes are found at large numbers at RS (average of 5,426 organisms / m^2 and contribute approximately 30% of the total number of organisms at the RS site), much reduced numbers at the CS site (56 / m^2) , a similar low organism number at RW, and none at CW. Difference in nematode numbers between the RS and CS site are likely due to the TPAH levels at the CS site. It is assumed that the absence or low numbers of nematodes at the CW and RW sites is due to the type of wood substrate or instability of the wood substrate. Nematodes are usually found on any collection of sand, mud, debris or vegetation making up the bottom substrate (Pennak, 1989).

Polychaeta

Manayunkia speciosa - High numbers of *M. speciosa* (an average of 12,057 organisms / m^2) were found at RS, with a lesser number at CS (1,248 organisms / m^2), and minimal numbers at RW and CW. Again differences between RS and CS are likely due to the TPAH levels as the CS site. It is assumed the almost absence of *M. speciosa* at CW and RW is due to the unsuitability of the wood substrate.

M. speciosa is one of a limited number of polychaete species found in fresh water as they are almost exclusively marine annelids. Little is known about the present distribution and occurrence of this species (Pennak, 1989). The mature worm is 3 to 5 mm. long and inhabits a tube built of sand, silt, debris and mucus. It extrudes about 18 ciliated tentacles that are on its head end out of their tubes to filter feed from the water. It can be found in colonies and seems to prefer deeper water. It seem to prefer areas with good water quality but is has been found in organically enriched sediments in the Duluth-Superior harbor (Schmude, 1999).

Trichoptera, Ephemeroptera, and Diptera other than Chironomidae

Five genera of Trichoptera (caddisflies) and two of Ephemeroptera (mayflies) were found in low numbers at the RS site, even lower numbers at the CS site, and virtually absent from the RW and CW sites. The pattern was the same for dipterans (Ceratopogonidae). Trichopterans and ephemeropterans are usually found in low numbers and frequency in Great Lakes sediments (Canfield et al. 1996 and Reynoldson et al. 1995). Based on Hilsenhoff (1987), all of the trichopteran and ephemopteran genera that were found in the Ashland sediments are indicators of various degrees of organic enrichment.

Tolerances of Oligochaetes To Organically Enriched Sediments and To Sediments Containing Elevated Concentrations of Xenobiotic Organic Compounds

It is unknown if those benthic organisms found to be tolerant to enriched organic conditions in sediment are also tolerant to and can be used characterize chemical pollution (e.g. heavy metals, pesticides, and PAHs) based on the presence ar absence of particular species in relation to the rest of the benthos. There is some evidence that tubificid oligochaetes exhibit a high tolerance for hydrophobic organic contaminants and can be used to characterize chemical pollution (Chapman et al 1982; Chapman, P.M. et al. 1993) Wildhaber et al.(1998) found correlations between toxic units (as defined by the ratio of the estimated pore water concentrations of contaminants to their chronic toxicity values) and benthic organisms used as indices of organic enrichment (Hilsenhoff, 1987; Lenat, 1993). Chapman et al. (1982) showed that in sediment exposures to five pollutants (Cd, Hg, PCP, pulp mill effluent, and sewage sludge, the rank order of oligochaete species tolerance followed the associations established for increasing eutrophic conditions. In regard to studies conducted on benthic community exposures to oil spills (Rosenberg et al. 1976; Tubb and Doris, 1965; Cushman et al. 1984; and Mozley et al. 1978) with their attendant PAHs and hydrocarbon compounds, the studies have showed that the populations certain oligochaete species persisted and in cases were stimulated to produce greater numbers when compared to the unimpacted substrates. The increased food supply from carbon in the crude oil may be related to the oligochaete presence. The chemical components of crude oils and oils from coal tars are different but it is interesting to speculate that the presence of the greater number eutrophic-condition indicating tubificid oligochaetes at the CW site compared to the RW site may be related to their tolerance and possible stimulation by the coal tar oils at this site. Based on the numbers of oligochaetes found on the RS site compared to the RW site, it would appear that the oligochaetes prefer the sand substrate and the numbers are influenced by the TPAHs at the CS site. The population of oligochaetes present at the CW site may possibly be somewhat tolerant of the TPAH levels present but they also may be bioaccumulating PAHs that are transferred to higher trophic level organisms.

It should be noted that the statistical analysis (see table on page 24 above) showed that there was no significant difference between the abundance of oligochaetes at the contaminated wood site compared to the reference wood site due to the variability in the replicates at the contaminated wood site so what qualitatively appears to be a larger number of oligochaetes at CW may in fact not the case when compared to RW on a statistical basis.

June 1999 references

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B-3 – WDNR (Tom Janisch) Comments Regarding D&M Comments on UV Light

(B-3) EXCERPTED FROM WDNR JANUARY 2000 COMMENTS TOM JANISCH. (p. 54 - 77)

General Comments

Site Specific Water Quality Conditions in Lake Superior and the Bay Off of the Lakefront Property In Ashland

Based on Figure 6/17 of the SEH Sediment Investigation Report (1996), the maximum water depth over the area of contaminated sediments off the Lakefront Property is approximately 10 ft. The water depth over approximately 50% of the contaminated area is 6 ft. or less with the remainder between the 6 and 10 ft. depth contours. According to U.S. Army Corps of Engineers forecasts, Great Lakes water levels are projected to continue dropping which includes the levels on Lake Superior. Water levels on Lake Superior are currently 6 to 8 inches below the long term (1918-1998) monthly mean. Lake Superior water levels have not been recorded as low as they currently are since 1927. Below normal snowfall amounts for this time of year in the Lake Superior Basin may result in less runoff to the lake in the spring. As water levels decline, the amount of bottom area of the Lakefront Property sediments within shallower depth contours will increase compared to the above based on 1996 water depth measurements. Shallower depths have implications for ultraviolet light penetrating and impinging on more bottom areas at the sediment-water interface where benthic organisms and various life stages of aquatic organisms reside.

The concentrations of dissolved organic carbon (DOC) in Lake Superior's surface waters (Baker and Eisenreich, 1989) averaged 1.63 ± 0.50 mg C / L (it was noted that the authors referred to the preceding values as "total organic carbon" in their text, but their table designated the values as "dissolved organic carbon"). Concentrations of DOC in the lake bottom areas in the benthic nephloid zone had similar concentrations to those in the surface waters except for one bottom sample.

The concentrations of total suspended matter (TSM or TSS) in the surface waters of Lake Superior (Baker and Eisenreich, 1989) averaged 0.41 mg/L (range 0.21 to 0.72 mg / L, n = 7). The TSM in the benthic nephloid layer on the bottom averaged 1.21 ± 0.93 mg / L. These low levels are typical of the open water regions of oligotrophic Lake Superior. By comparison, TSM concentrations range from 0.5 to 2 mg / L in Lake Michigan and from 0.04 to 0.25 mg / L in the open oceans. An observation that the Baker and Eisenreich made in dives to the bottom of Lake Superior was the unexpectedly high level of biological activity in the benthic nephloid layer with a high proportion of the particles being identifiable organisms (e.g. mysids and *Diporeia*).

The relative ranges of DOC in the water column in natural waters (Leavitt et al. 1997; Smith et al. 1999) and their corresponding potential to attenuate the penetration of the ultraviolet wavelengths in the water column are:

1. < 2.0 mg C / L - Low DOC content
2. 2.0 - 4.0 mg C / L - Low to Moderate DOC content
3. 4.0 - 6.0 mg C / L - Moderate to High DOC content
4. > 6.0 mg C / L - High DOC content

Schertzer et al. (1978) considered the relative extinction of light flux with depth for the photosynthetically active wavelength band of 400 - 500 nm on a temporal and spatial basis in Lake Superior. The photic zone depth defines the portion of the water column in which the greater proportion of primary production occurs The attenuation of photosynthetically active radiation can be

correlated with the attenuation of the ultraviolet wavelength spectrum (Smith et al. 1999). The mean potential photic depth for the central area of the lake was from 25 to 30 m (81 to 98 ft.). The mean vertical extinction coefficient (MVEC) (the greater the extinction coefficient the greater the attenuation of the photosynthetically active radiation in the water column) for the central areas of the lake was approximately 0.17 and ranged from 0.14 to 0.23. The mean potential photic depth for coastal regions of the western end of the lake that includes Chequamegon Bay (does not include the region off Duluth) was 15 to 20 m (49 to 65 ft.) with an average MVEC of 0.28 and a seasonal range of 0.24 to 0.38. The larger MVEC values and somewhat shallower photic zone depths for the coastal regions in the proximity of the southwest 'red clay' portions of the lake and Apostle Islands is attributable to seasonal disturbances of bottom sediments in shallow nearshore areas or associated sediments in water discharged as runoff from the surrounding basin. The nearshore coastal area off of Duluth represents the highest MVEC values for the lake and shallowest photic zone. The MVEC for the Duluth area was 0.66 with a range of 0.37 to 1.02. The mean potential photic zone depth for this area was less than 10 m (< 33 ft.).

The nearshore coastal area as represented by the bay off of the Lakefront Property will be subject to a range of seasonal and yearly water quality conditions related to and induced by the substrate types and the variable mechanical factors associated with wind and wave forces (Bedford et al. 1987). At its simplest sediments will be disturbed and suspended into the water column followed by periods of no wave and wind forces when the suspended sediments that have not been transported off site, will undergo resettling and sedimentation at the site. The period of bottom disturbance and sediment suspension will be associated with the release of coal tar oils and coal tar-related contaminants into the water column in the freely dissolved forms or associated with colloidal particles, microparticles, larger particles or in various oil components. At the same time, wave and current actions may be shifting the overlying wood layer around and exposing coal tars at and in the mineral sediment surface or coal tar contaminated sediments. All of the exposed coal tar contaminants will potentially be available for uptake by aquatic organisms depending on their feeding habits, exposure routes, and the habitats they occupy. The period of settling can be followed by periods of increased water clarity and associated increase of depth of penetration of ultraviolet solar wavelengths in the water column. The disturbed bottom conditions, release and availability of coal tar contaminants, uptake of contaminants by site organisms, followed by increased water clarity and penetration of ultraviolet light represents a realistic exposure scenario for the site

Exposure of Aquatic Biota to Ultraviolet Light Based on Life Stage and Habitat Occupied

Generally, the sensitivity of organisms to phototoxicity induced by ultraviolet photoactivation of PAHs within tissues will be greatest in the egg, larvae, and immature stages of aquatic organisms compared to adult stages. Species-specific behavioral traits and habitats normally occupied by the species determines how much the organisms will be effected by photo-induced toxicity. For the enhanced toxicity to occur, PAHs accumulated in lipid tissues and UV light must be present simultaneously. Although the photoactivation of PAHs can take place in external media such as water, the toxicity to organisms is likely due to internal mechanisms and not due to externally formed photoproducts (Hatch et al. 1999: Ankley et al. 1995).

The general ordering of increased chances of exposures to PAHs and ultraviolet light based on habitat occupied would be in the general order of:

1.Pelagic or water column organisms especially those that occupy the lower portion of the water column over the contaminated sediment (e.g. fish, phytoplankton, zooplankton)

2. Organisms associated with the sediment surface (e.g. eggs of organisms layed on sediment surface or on detritus)
3. Epibenthic organisms living on and in the sediment (scuds and sowbugs) and
4.Infaunal organisms living below the sediment surface by burrowing or within tubes (the polychaete, *Manayunkia speciosa*) but may be found partially out of the sediment or on the sediment surface for various periods.

Not all infaunal organisms are strictly confined below the sediment-water interface at all times. Depending in the infaunal species, many, such as the annelids move around by crawling in or on the surficial layers of substrate; some naiads (family Naididae) are effective swimmers that move along just above the substrate; most tubificids build tubes and project the posterior end of the animal out into the overlying water; some dipteran larvae swim by rapid wriggling movements of the body or by creeping on the surface of the substrate by forelegs; and the locomotion of some Tendipedidae consists of a series of creeping or looping movements, although some species are active swimmers. Some benthic organisms will show avoidance reactions to contaminants in the sediment and may attempt to leave the localized contaminated area thus becoming exposed on the sediment surface. The oligochaete *Lumbriculus variegatus* showed an avoidance reaction to elevated concentrations of a PAH in sediment (Kukkonen and Landrum, 1994). The ability of oligochaetes to detect contaminants and show avoidance reactions has been observed for *Stylodrilus heringianus* and *Limnodrilus hoffmeisteri* with an organic contaminant at concentrations 50 to 150 times lower than the 96-h LC50 concentration (Keilty et al. 1988). This avoidance response was suggested as a potential subacute toxicity end point. The amphipod *Diporeia* spp. shows avoidance behavior to PAH-contaminated sediment at toxic concentrations (Landrum et al. 1991).

Hatch et al. (1999) were the first to demonstrate the effects of species-specific behavior in attenuating photo-induced toxicity experimentally. Their results suggested that if the epi-benthic amphipod *Hyalella* had refugia available, it exhibited a behavioral response specific to its epibenthic life habits. The effects of photo-induced toxicity was reduced. Where no refugia were available, survival was significantly reduced in the presence of PAHs and ultraviolet light. In their testing, *Chironomus tentans* did not exhibit any significant behavioral adaptation to the photo-induced toxicity of fluoranthene. The overall response to photo-induced toxicity is affected by the presence and intensity of UV light, the type of substrate available, and species-specific life history and behavior patterns (Hatch et al. 1999). All must be taken into account in extrapolating the results of laboratory toxicity testing to the contaminated field site. The life history and behavioral patterns of the surrogate infaunal laboratory test organism must be looked at in terms of how representative these characteristics are to the endemic infaunal organisms at the field site.

Depth of Penetration of the Ultraviolet Solar Spectrum into the Water Column

◎ From Zepp (19980):
-- Most of what is known about the characteristics of solar light penetration and UV light attenuation in the water column has been gained through studies conducted in the oceans. Lesser number of studies have been conducted in inland water bodies. Differences in the qualities of water including dissolved organic matter content, total suspended solids, chlorophyll a, and other factors will result in different depths of ultraviolet light penetration in the oceans compared to inland waters. In ocean habitats, UV-B wavelengths penetrate to 30 m (98 ft.) and close to 100 m (325 ft,) for wavelengths in the UV-A spectral region. Coastal and upwelling regions of the ocean are considerably more productive, and because microorganisms absorb light, sunlight does not penetrate as deeply into these waters. The depth of penetration of the 350 to 500 nm spectrum (UV-A into blue spectrum) is

5 to 10 times shallower (33 - 65 ft.) in coastal than open sea water. The depth of ultraviolet light penetration in inland waters is quite variable and depends on the influencing factors discussed above.

◎ From Morris et al (1995):
-- Reductions in stratospheric ozone may substantially increase fluxes of the most energetic and potentially damaging radiation at the surface of the earth (UV-B, 280 - 320 nm).
-- Freshwater ecosystems, especially those at mid- to low latitudes, may be affected to a much higher degree by *existing* fluxes of UV radiation. Shallow water depths, seasonal stratification patterns, high and seasonally variable fluxes of solar UV radiation potentially expose plankton and benthos to harsh UV environments.
-- In clear natural waters, the attenuation of across the UVR solar spectrum is exceedingly low.
-- The attenuation of the UVR solar spectrum can be dependent on the dissolved organic carbon and chlorophyll a content of the water which can vary between lakes and within a lake on a seasonal, locational, and yearly basis. Differences in chemical and optical properties of the DOC variably influence its UV attenuation characteristics. Few studies have measured optical properties of natural freshwaters in situ for the UV range.
-- The study lakes showed a large variability with respect to penetration of UVR. In low DOC lakes (< 2.0 mg C / L), substantial fluxes of the shortest, most energetic wavelengths of UV-B radiation can occur to depths of excess of 10 m (33 ft.). In shallow, transparent, low DOC lakes, the entire water column and sediment-water interface may be exposed to a substantial fraction of incident solar UVR. The Morris study makes a case for high altitude lakes for the latter type of situation but it also could be applied to lakes of lower altitude although the UVR flux will not be as great at the lower altitudes.
-- Absorption coefficients of common classes of DOC compounds (fulvic acids, tannic acids, and lignins) can vary by an order of magnitude across the solar UV spectrum. Lake DOC tends to be a complex association of compounds with markedly different chemical and optical properties.
-- Diffuse attenuation coefficients are determined by the interaction of a number of factors, including absorbance by dissolved materials, absorbance by particulate materials, molecular particle scattering, and the angular distribution of the light field.

◎ From Kuhn et al. (1999):
-- Recent ozone losses and concurrent increases in ultraviolet-B (UV-B, 280-320 nm), the shortest and most damaging wavelengths) radiation by 7% in summer have been reported in temperate latitude regions. A growing number of studies indicate that UVB radiation is harmful to aquatic organisms; reductions in productivity have been reported for phytoplankton and zooplankton.
-- As cited from Kouwenberg et al. (1999) experiments on a cod and planktonic copepod from the Gulf of St. Lawrence found that egg mortality was strongly affected by exposure to UV-B radiation.
-- The 10% depths (depth to which 10% of wavelengths just below the water surface penetrates) in the study ranged up to 4 m (13 ft.) for the shortwave UV-B wavelengths (320 nm) and up to 65 feet for the longer UV-A wavelengths (400 nm). The 10% depths, under ambient conditions, penetrate a substantial portion of the water column and therefore the early life stages of the crustacean and fish species present in the layer may be affected by UV radiation.

◎ From Jerome et al. (1998):
-- UV absorption for a given DOC concentration varied from water body to water body.
-- Phytoplankton photosynthesis inhibition by UV-A significantly exceeds inhibition by UV-B.
-- The transmission of UV-B across the air-water interface is unaffected by surface waves.
-- The dispersal of ultraviolet radiation in the water column is controlled by the wavelength-

dependent specific absorption and scattering properties of the organic and inorganic matter indigenous to the water column.
-- Water displays a reasonably high transmission (> 87% per meter for wavelengths > 300 nm) in the UV-B and UV-A regions of the electromagnetic spectrum.
-- The nature of the DOM indigenous to each North American water body reflects the geographic and hydrologic diversity of the North American ecozones. Consequently, the DOC absorption spectra will also reflect this diversity.
-- An example of different types of DOC at the same concentrations (2 mg C/L) resulting in different UV-B light attenuations is shown by the depth of the 1% penetration level. It was 4.6 m (15 ft.) for DOC from one source and 2.2 m (7.2 ft.) for DOC from another source.
-- The actual irradiance measured at a specified depth is a function of the global location, calendar day, atmospheric conditions, solar time, and aquatic environment.
-- Jerome et al. state that from their work it is possible to reach the unintended and erroneous impression that the presence of dissolved organic matter removes the vulnerability of pelagic inland water ecosystems to possible impacts of stratospheric ozone thinning. They indicate that ultraviolet radiation, in addition to being an agent of photobiological change, is also an agent of photochemical change. The presence of dissolved organic matter, while it can act as a UV protective screen for aquatic organisms, might also, through the chemically active role of dissolved organic matter with ultraviolet radiation, offset some of its own value as a screening agent. (When natural waters are irradiated with ultraviolet radiation (280 nm to 400 nm) the indigenous dissolved organic matter (DOM) may be bleached and degraded resulting in the generation of a variety of free radicals (Mill et al. 1980; Jerome and Bukata, 1998). The complex interactive chemical and biological impacts of ultraviolet radiation , dissolved organic matter, aquatic biota (and the presence of PAHs in a system) considered within the context of a suite of atmospheric stressors, emphasizes the need to assess ecosystem response in terms looking at the interactions and relationships of all the components.

◎ Holst and Geisy (1989):
-- The ecologically relevant UVR intensities used in the study were comparable to intensities that routinely penetrate to depths of 10 to 12 m (33 - 39 ft.).in Lake Michigan. The UV-A light intensities used in the study was up to 117 uW/cm^2. Exposure of *Daphnia magna* to 7.2 ug/L anthracene and 117 uW/cm^2 UV-A resulted in 70% mortality or a 69% reduction in fecundity of the *D. magna* that survived.
-- Solar wavelengths necessary to mediate the phototoxicity of anthracene penetrate to depths of 10 to 12 meters in Lake Michigan.
-- Based on the dispersion/settling tests conducted on the sediments from the Lakefront Property (SEH, 1998) the anthracene concentration in the water column 11 days after to allow settling of the initial slurry was 88 ug/L.

◎ From Smith et al. (1999):
-- In a study conducted on mesotrophic Lake Erie, UVR attenuation varied positively and significantly with the attenuation coefficient for photosynthetically active radiation (k_{dl}PAR).
-- Total suspended solids (TSS) concentration was the single most useful water quality characteristic for predicting broadband UV-B (305 - 320 nm) and UVA (320 - 400) attenuation.
Dissolved organic carbon (DOC)was much less important than TSS in predicting UVR attenuation over the typical range of water clarity. Particles are the dominant agents of variable UVR attenuation in Lake Erie.
-- The attenuation of UVR in natural waters is due to both scattering and absorption processes. Scattering by itself does not in itself extinguish radiation, it effectively increases the path length that the average photon must travel.

-- Freshwater ecosystems, like other parts of the biosphere, are subject to increasing UV-B radiation (UV-B, 290 - 320 nm) consequent to diminished concentrations of ozone in the stratosphere.
-- The dominance of DOC-mediated absorption in variable UVR attenuation is not universal among natural waters.
-- Lake Erie is the most sediment influenced of the Laurentian Great Lakes with the range of TSS concentration approximately 20 times the DOC. Despite the abundance of particles in Lake Erie's water column, the median values for the attenuation coefficients for UV-A and UV-B were comparable with those for lakes of low to moderate DOC (i.e., 2 - 4 mg C/L). Organisms in Lake Erie may therefore be exposed to considerable amounts of UVR, by freshwater standards, even though the lake is relatively turbid to photosynthetically active radiation.
-- The corresponding range in the 1% depth for integrated UVB was approximately from 1 to 3 m (3.3 to 9.8 ft.) which is a considerable range in the volume of lake exposed to potential UV effects.
-- There was substantial variation in spectral absorption properties of natural DOC and of narrower classes such as humic and fulvic acids. The light absorbing organic content of particles in Lake Erie was generally low.

◎ From Leavitt et al. (1997):
-- Pigments specific to the presence of UV radiation acting on benthic algae were most abundant in shallow lake (mean depth < 5 m (16.3 ft.) with low concentrations of DOC (< 2 mg/L).
-- In a lake where the DOC content was reduced from ~ 7 to ~ 1.5 mg/L, the maximum depth of UV-B penetration increased eight-fold.

◎ From Scully and Lean (1994):
-- Since increases of UV radiation caused by ozone depletion will be limited to UV-B, it is important to consider UV-B attenuation separate from that for UV-A. Both UV-B and UV-A are damaging to aquatic organisms and both contribute to photochemical reactions. Action spectra that have been developed show that the shorter wavelengths are more reactive.
-- The role of chlorophyll a and particulate organic carbon were unimportant in the attenuation of UV-B and UV-A wavelengths based on weak correlations.

◎ From Williamson et al. (1996):
-- At DOC concentrations of less than 1 - 2 mg/L, UV light can penetrate a substantial portion of the depth of lakes and may approach 20 m (65 ft.).

◎ From Wiegman et al. (1999):
-- The ratio of UV-B, UV-A, and visible light of sunlight varies with the thickness of the ozone layer, cloud cover, zenith angle, attenuation in water, and season. In spring and summer, UV-A and UV-B are clearly present in surface waters. UV-A constitutes a larger fraction of sunlight at the earth surface and in the water column than UV-B. Since photolysis of PAHs by UV-A increases toxicity, the contribution of UV-A to degradation and toxicity deserves particular attention in the risk evaluation of polycyclic aromatic compounds,
-- DOC presence can enhance photolysis of PAHs by acting as a photosensitizer thereby increasing their toxicity.
-- UV-A radiation increased the hazard of azaarenes (nitrogen-containing PAHs) due to formed phototransformation products in combination with or without parent azaarenes. It is assumed that plants and algae are more tolerant to PAHs than vertebrates, but recent observations showed that photomodified PAHs have an unique mechanism of toxicity to photosynthesis of plants and consequently of algae, which makes them very sensitive to modified PAHs and Nitrogen PAHs.

Specific Responses to D&M Comments

The above comments serve as a response to many of D&M comments on pages 9 to 11 and will not be repeated. Some specific responses to the D&M comments on pages 9 to 11 are below.

1. Page 9 . Laboratory Conditions vs. Field Effects

■ D&M states that the **"apparent increase in the toxicity of certain PAHs in the laboratory due to UVB light has never been convincingly shown in the field"** and **" Monson et al.(1995) appear to be the only authors that have conducted both laboratory and field experiments with PAHs in sediments and organisms exposed to UVB light".**

WDNR Response

-- In addition to the Monson et al. (1995), other studies that relate laboratory photoinduced toxicity of PAHs to *in situ* studies in some cases where sediments were involved include Ireland et al. (1996), Sasson-Brickson and Burton (1991), Hatch and Burton (1998), Spehar et al. (1999), and Skalski, 1991 (as cited in Ireland et al. 1996). We have no idea how D&M is defining "never been convincingly shown" ? Is D&M suggesting that even if Monson et al.may be the only ones to date to demonstrate duplicated in situ effects to a benthic infaunal organism from likely photoactivated unsubstituted or substituted (Kosian et al. 1998) PAHs that the results are somehow invalid or unusable ? The literature as reviewed above appears to be overwhelming in direct or indirect support in regard to UV light penetration and effects. D&M has presented absolutely nothing to support their claims for no effects other than some irrelevant comment about what they perceive happens in **"real life !"** (page 10 of their September 14 comments).

■ **They** (Monson) **found that UVB light increased the toxicity of PAHs in both the laboratory and the field. However, they also found that laboratory exposures were much more toxic than field exposures and their field exposures were conducted at a depth of only 12 to 17 cm in clean (i.e. clear) flowing stream, not in deep or turbid lake bottom sediments as is found at the site. Monson et al. (1995) concluded that mortality in *Lumbriculus* exposed in the laboratory was significantly greater than that found *in situ*."**

WDNR Response

-- The "clean" and "clear" descriptors that D&M is using for the stream involved in the Monson et al. (1995) study is hardly the case. The particular stream in which Monson et al. conducted their in situ studies is in the city of Superior and is a channel in a ravine that has been down cut into the lacustrine clays and is subject to channel bed and bank erosion. Furthermore, 99% of the flow in the creek is due to the discharge from a petroleum refinery. The average and range of DOC concentrations monitored (WDNR, 1994) in the creek during two baseline and one storm-related flow event in 1993 at the time of the Monson et al. (1995) study at the upper end and downstream end of the creek were 57 mg/L (16.7 - 138 mg C /L) and 49 mg/L (26.3 - 85.2 mg C/L), respectively. As discussed above, these values are well above the high end DOC concentrations (~ 6 mg C / L) potentially associated with some degree Ultraviolet light attenuation. That the Monson et al. study

showed 40% and 53% mortality to the *Lumbriculus* exposed *in situ* to sunlight is significant given the high DOC concentrations in the water column of the creek.

-- Some of the conclusions of the Monson et al. study were:
- Based on laboratory determinations and structure-activity models, a number of the PAHs measured in the sediment samples from the study site would be predicted to be phototoxic.
- Relatively low levels of UV light consistently affected survival at the contaminated site. The concurrence of the laboratory and field test results underscores this observation.
- Although the laboratory light intensity was greater than concurrent measurements in the field, the laboratory light regime was not unrealistic relative to levels potentially encountered in the field.
- The results suggest that sediment toxicity tests and sediment-quality criteria should consider the significance of phototoxicity of PAHs under ecologically relevant conditions. To disregard this phenomenon may provide values that are substantially underprotective of benthic communities.

-- See additional comments below where D&M's comparisons of the Monson et al. (1995) study with the LSRI Ashland study in regard to ultraviolet light intensity are invalid and unusable.

2. Page 9 and 10. Effects of Habitat and Suspended Material on Transmitted Light

Benthic organisms such as *Hyalella* and more representative amphipods which might inhabit these areas both feed and seek shelter beneath organic detritus, and organisms such as *Lumbriculus* and *Chironomus* that live in the sediment would be exposed to even higher levels of DOC in sediment pore water. In fact, *Chironomus* in their constant re-working of sediments, increases the turbidity in their local micro-environment (Clements et al. 1994).

WDNR Response

-- For the discussion on *Hyalella* exposures to ultraviolet light, see the discussion above that involves Hatch and Burton (1999).
-- We are not sure what the high levels of DOC in the pore water of sediments has to do with ultraviolet light exposures to *Lumbriculus* and *Chironomus* as stated above. Ultraviolet light cannot penetrate through the sediments to reach the pore waters. The only relationship the DOC in pore water can have to the effects of ultraviolet light exposure to these two organisms is the ingestion of PAH contaminated sediment on POC or DOC and the movement of the organisms to the sediment surface where impinging ultraviolet light on the organisms will photoactivate the PAHs in the tissues.
-- The species of *Chironomus* used in the above referenced Clement et al. (1994) study was *Chironomus riparius*. This particular species or any other *Chironomus* species were not found in either the Contaminated Wood or Contaminated Sand sediment samples collected from the Lakefront Property sediments. Other members of the subfamily Chironomini in which *Chironomus* is a member were found at the contaminated sand site (average of 1,105 organisms / sq. m.) but were absent at the contaminated wood site. The total number of Chironomidae at the Contaminated Sand site was an average of 2,541 organisms / sq. m. Only 22 total Chironomidae / sq. m. were found at the Contaminated Wood site. It is unknown how many of these chironomid species found in the Contaminated Sand sediments have the behavioral characteristics of *Chironomus riparius* associated with bioturbation of surface sediments that increases turbidity and release PAHs to the overlying surface water. Biological sediment mixing in lakes is species specific. In many places the most abundant species in a benthic community may not be the most important in terms of sediment mixing (Matisoff et al. 1999). Due to the virtual absence of chironomids from the Contaminated Wood

sediments at the Ashland site, bioturbation is not a factor for release in this sediment type at the site.
-- The Clement et al. laboratory setup was the placement of 0, 20, 40, 80, 120, and 200 *Chironomus riparius* organisms in a series 1 liter beakers with PAH-spiked sediments and overlying water. The overlying water was monitored for PAH releases and turbidity. How relevant what takes place in the small closed system represented by the 1 liter beakers with a few inches of water over the sediments to the open system dynamics present in the Lakefront Property bay waters needs to be looked at closely. Due to bottom currents, the water volume involved, and mixing, it would seem any turbidity over the bottom area caused by bioturbation of the chironomids would be diminished over time.
-- Clement et al. indicate that increased turbidity was associated with the high chironomid density treatment. The high density treatment in the study was 80 organisms per beaker or 8,000 organisms / sq. m. (the study did not use the 120 and 200 organisms per beaker because the chironomids remained clumped at the surface and did not burrow). As noted above the mean number of chironomids in the Contaminated Sand sediments off the Lakefront Property was approximately 2,500 organisms / sq. m. This density is less than that projected in the Clement study associated with bioturbation related effects.
-- It is interesting to note that in the two highest density treatments (120 and 200 organisms per beaker) in the Clement et al. study, the chironomids remained clumped at the surface and did not burrow into the sediments. It is not known if this is an artifact of the experiment or if the surface clumping take place under natural conditions where high organism density is involved.
-- The Clement et al. study noted that *C. riparius* activities, such as feeding, tube building, and burrowing, disturbed the upper 10 - 15 cm of the sediment profile. This is deeper than D&M was previously trying to attribute as the depth of the bioactive layer.
-- Other findings of the Clement et al. study to be noted are:
- The mean concentration of fluoranthene in the sediments and the tissues of chironmids exposed to the sediments was 4,040 ug/kg (d.w.) and 181,000 ug/kg (d.w.), respectively. The mean concentration of benzo(a)pyrene in sediments and chironomids was 2,740 ug/kg and 6030 ug/kg, respectively.
- Bioturbation of sediments by chironomids released sediment associated benzo(a)pyrene to the overlying water.
- Levels of benzo(a)pyrene accumulated in chironomids was greater in beakers with the higher densities.
- Bioturbation and food chain transfer as mediated by benthic invertebrates, increased availability of sediment-associated PAHs. The pathway of contaminant transfer established in the study (sediments to chironomids to bluegill) is realistic.

-- Karickhoff and Morris (1985) noted that tubificid oligochaetes burrowing in surficial sediments ingest sediment fines (silt and clay particles) and egest them at the sediment water interface as sand-sized fecal pellets. They do not mention any increased turbidities in the water over the sediment surface due to the oligochaete activities, only the deposition of sand-sized sediment fecal pellets at the sediment surface.

Page 9. **Additionally, since most aquatic organisms avoid high intensity daylight (negatively phototropic) and approach the surface for only short periods of time during the day, or only at dawn, dusk, and night, this further decreases the likelihood that a significant amount of UVB (sic) light would reach the area where benthic organisms actually live[8].**

WDNR Response

Is the reference to "surface" in the above statement apply to the water surface or the sediment surface ? If it applies to pelagic organisms and their response to light at the water surface, it is

unclear how these behavioral traits are related to the amount of UV-B light that reaches the sediments where benthic organisms reside.

The above D&M statement is an overly broad generalization that is not true for all species of aquatic organisms. If D&M feels the statement is an accurate characterization than they need to support it. Some zooplankton do undergo vertical migrations in response to light conditions.
In some species, a reverse migration occurs with a single maximum in numbers near the water surface during the daylight period (Wetzel, 1983). Birge (Frey, 1963) in his studies of planktonic crustacea of Wisconsin lakes, especially Lake Mendota, found no diel migrations (migrate close to water surface at night and deeper waters in daylight) but distributions were dictated primarily by seasonal water temperatures with peak numbers of zooplankton in surface waters or the epilimnion on a daily basis during the summer. Warmer surface temperatures are sought as they affect the cycles of growth and reproduction and the magnitude of peaks of the food supply, Birge found that during July, 50% of the copepods and Cladocera were found in the upper 3 m (9.8 ft.) of the water column. Where Birge did find a diel migration, it was confined to the uppermost 1 or 1 1/2 m below the water surface rather than extending over the entire depth of the lake (Frey, 1966). Phytoplankton are positively phototropic with the responses to light intensity being species specific. Ultraviolet light is particularly harmful to planktonic algae (Wetzel, 1983; Smith et al. 1998)). Fish reaction to light is species specific. Sight feeding fish such as northern pike need light conditions to find their prey. Other fish species while not avoiding light will seek out hiding places in the habitat such as stands of emergents to avoid predators. Eggs, larva, and immature fish are susceptible from effects of exposure to ultraviolet light and these life stages are generally associated with the lower portions of the water column or substrate surface.. Baker and Ball (1995) found that light level did not affect the positioning of *Chironomus tentans* that began experimental exposure with tubes. When the organisms began exposure without tubes, they chose dark areas to avoid predation and not necessarily to avoid light.

From Welch (1935):
-- Nature and extent of diurnal movements of plankton:
- Diurnal movements differ greatly under the various environmental conditions and with the various species involved. The following statements indicate in part, the reasons for the lack of uniformity in diurnal movements:
    1. Lakes differ widely in their inherent environmental conditions.
    2. The various plankters are not equally affected by factors which stimulate and govern these migrations.
    3. Close kinship of plankters does not insure similarity of performance.
    4. Representatives of any one species do not necessarily behave in the same way in different waters.
    5. Nauplii and other juvenile stages may exhibit behavior distinctly different from that of adults of the same species.
    6. When a species is involved in vertical diurnal movement, the movement can vary greatly in extent between species. Certain plankters may exhibit a movement of only a fraction of a meter. Other plankters in the same lake and same season may perform a migrations to various deeper depths.
    7. Some species occupy the surface waters in the afternoon but show a distinct downward movement at night.
    8. The adults of certain plankters remain near the surface both day and night or occupy the surface during the day and migrate downward at night, but the juvenile stages migrate to lower depths at dawn in both cases.

-- The effects of ultraviolet light on aquatic organisms was recognized as early as the 1930s (Klugh, 1930 as cited in Welch, 1935). Klugh found that short-length ultraviolet radiation was deadly to planktonic crustaceans. Various surface-inhabiting marine species when exposed to ultraviolet light were killed (e.g. young eels died in 18 to 24 hours; amphipods died in 2 to 4 days; and animals that lived at depth that came to the surface only under weak illumination died when exposed to ultraviolet light.

-- Responses of aquatic organisms are often due to, or conditioned by light. For some organisms, day is the period of general activity and night the period of quiescence; for other organisms, the reverse is true.

Page 9, bottom footnote. **This is particularly true given the elevated levels of suspended solids (TSS), that results from the erosion of the fine-grained clays, near Ashland. These very high levels remain for sustained periods subsequent to significant rainfall events.**

WDNR Response

The phenomenon that is occurring is taking place principally in the western arm of the lake and along the southwest shore and has little impact in the waters off Ashland. See the comment above where the Schertzer et al. (1978) study is discussed in regard to the water transparency of areas of Lake Superior. The principal source of eroded glaciolacustrine clays in the western end of the lake is from the Nemadji River. The Nemadji River is the principal source of sediment load to Lake Superior, contributing 89% of the eroded material from streams in Douglas and Bayfield Counties (Bahnick et al. 1979). The St. Louis River to the west of the Nemadji River also carries a suspended sediment load consisting of eroded soil, resuspended sediments, and biological material. Both rivers enter the Superior-Duluth Harbor behind the sand bar that stretches entirely along the outer harbor with openings in it for the Superior and Duluth ship entryways. Most of the sediment load settles within the harbor, although a portion is discharged into Lake Superior (Bahnick and Markee, 1985). The portion of the sediment load that passes through the entryways creates visible turbidity plumes out into the western end of the lake. The location and direction of the turbidity plume depends principally on wind direction (Sydor et al. 1979). Modeling and interpretation of Landstat photo imagery indicates that westerly winds carry the turbidity plume up along the southwest shore with the farthest extent of the plume being to the west of the Apostle Islands. Most of the sediment load is deposited along the area of the plume. At times, under certain conditions, it was estimated that approximately 3% of the material per year would disperse outside of this area with some of the plume extending past the Apostle Islands. The transport patterns for the two wind directions modeled predicted the outer boundary of the turbidity plume of fine red clay particles in detectable concentrations (1 mg/L TSS) would reach up to 50 miles from the Duluth-Superior entryways. Again, this material would have little to no effect on the water quality conditions off Ashland.

In regard to impacts of any increased turbidity on western Lake Superior from a biological perspective, the following was extracted from a summary report (Andrews et al. 1979) on the red clay project conducted in the 1970's:

> The glacial lake deposits of the Nemadji River system are highly erodible even under strictly natural conditions. Aquatic problems attributed to red clay turbidity have included the substitution of undesirable fish species for more desirable ones, negative effects on spawning runs, decreased oxygen levels and increased nutrients as well as general observations on

"adverse effects on biological life processes." None of these statements can be supported by the findings from this research in the Nemadji River Basin.

Analysis of areas of Lake Superior and the Nemadji River system which are turbid throughout the year due to erosion of unconsolidated glacial lake deposits indicated that any direct, physical effects of this turbidity and resultant low level of sedimentation are minimal. The changes induced in the behavioral patterns of aquatic life by any turbidity were for the most part considered to be beneficial rather than detrimental to the survival of native species. A positive balance seems to have been struck between present levels of turbidity and sedimentation and existing aquatic life. The finding of the research are that:

1. Red clay does not contribute significant quantities of nutrients to Lake Superior.
2. Oxygen levels are not significantly affected by red clay.
3. Primary production does not appear to be significantly affected by turbidity within the range of depths at which most production occurs in the streams.
4. Number of macroinvertebrates per unit area, total number of taxa, diversity, and biomass are not significantly affected by clay turbidity and siltation within the Nemadji River system.
5. All genera of insects which occurred in clear streams also occurred in turbid streams.
6. Walleye in the lower Nemadji River, the Duluth-Superior Harbor, and Lake Superior benefit from red clay turbidity as it enables them to inhabit the shallow more productive areas.
7. In the Nemadji River, high turbidity levels decreased egg survival of walleye and rainbow smelt based on bioassays. However, levels of turbidity in the bioassays were much higher than in the natural system, probably resulting in higher egg mortality than would naturally occur.

Fish Creek that enters Chequamegon Bay just to the west of Ashland represents the largest tributary to the bay that flows through the red clay areas of Bayfield county. The annual sediment loading contributed by Fish Creek is much lower than that contributed by the Nemadji River (Rose and Graczyk, 1996; Sydor et al. 1979). Another major difference is that the majority (approximately 67%) of the total annual sediment load as measured near Ashland is made up of sand sized particles (Rose and Graczyk, 1996) which would settle out of the water column and not remain in suspension for any period of time A lot of the remainder appears to be made up of silt sized particles with clays only making up a minor contribution.. Bluff erosion along the upper main stem of North Fish Creek accounts for most of the sediment source that is transported to Lake Superior (Fitzpatrick et al. 1999). On the whole, the bluffs are sources for substantial amounts of sand. The eroding bluffs along North Fish Creek expose varied sedimentary beds, ranging from clayey tills and boulders deposited in former glacial ice-contact settings to sand and silt deposited by former glacial-meltwater runoff and ponding. Individual beds range from nearly all silt to nearly all sand (Fitzpatrick et al. 1999). The streambed of the lower 9 miles of North Fish Creek is underlain by 2 to 3 feet of sand (Rose and Graczyk, 1996). Site vists by this commentator to two other tributaries (Boyd Creek and Whittlesey Creek) that enter the west side of Chequamegon Bay also showed sand dominance in the sediments of the creek bed and offshore deposits from the mouths.

Page 10, 2nd paragraph. **In another study of the effects of UV radiation, Swartz et al. (1997) in their paper on UVB-induced toxicity of PAHs concluded that, "Our results may be toxicologically correct, but ecologically irrelevant because infaunal burrowing amphipods such as our test species are rarely, if ever exposed to UV radiation". This would certainly be true of organisms that live in the nepheloid layer or hide underneath organic detritus such as leaves, wood chips etc.**

WDNR Response

Swartz et al. (1997) in the above D&M citation also states that the importance of phototoxicity in the derivation of sediment quality guidelines for PAHs will ultimately be determined by the photoecology of benthic organisms in the ecosystem. The above Swartz statement in regard to the particular marine amphipod species involved is irrelevant to the freshwater amphipod species and their behavioral traits that are found in Wisconsin freshwaters and that are found at the site. As discussed in one of the comments above, the Swartz studies all involve marine amphipods that appear to occupy different habitats (largely burrow into the sediments) and have different behavioral traits than freshwater amphipod species. They also appear to be less sensitive to PAHs than freshwater amphipods (see the discussion in one of the comments above). We are not about to research what the characteristics of the marine amphipod species are then try to extrapolate these characteristics to freshwater responses and introduce a lot of uncertainties into the assessment. We know what the behavioral traits of freshwater amphipods are. The amphipod taxa found at the site were *Crangonyx* sp. and *Gammarus pseudolimnaeus*. The amphipod species that resides off shore of the site in adjacent deeper waters is *Diporeia* sp. The amphipod used as a surrogate in toxicity testing to develop the Ingersoll et al. (1996) Sediment Quality Guidelines and the toxicity testing conducted on the site sediments was the surrogate test organism, *Hyalella azteca*.

Freshwater amphipods generally show free-swimming and epi-benthic behavioral traits. Flexing and extending of the entire body aids in walking or crawling over the sediment surface. They swim above the substrate by undulatory motions. *Diporeia* sp. has been described as both a benthic and plankton organism (Pennak, 1989). *Diporeia* sp. can burrow through the upper 2 cm of substrate to feed (Landrum and Nalepa, 1998). These amphipod species may have the ability to lower the effects of photo-induced toxicity of PAHs during the time they are hiding under detritus when it is available. *Gammarus pseudolimnaeus* when in lotic environments typically drifts in the current 150 to 200 ft. before returning to the substrate (Waters, 1965). It may also follow this trait in near bottom lake currents at the site.

Boese et al. (1997) (that has Swartz as a co-author) showed the importance of not making judgements of the effects of photoinduced toxicity of PAHs on benthic organisms by using
only species with certain behavioral traits. Dependence on the results using only these species would underestimate the exposure risks to other members of the invertebrate community.
Boese et al. (1997) exposed seven marine crustaceans (5 amphipods and 2 non-amphipod) to fluoranthene using normal laboratory lighting and ultraviolet light. Based on their behavioral traits, the seven crustaceans had various degrees of potential to be exposed to sunlight reaching bottom areas in their natural habitats. LC50 (concentration of fluoranthene lethal to 50% of the test organisms) and EC50 (survivors' ability to rebury in the sediments after exposure to laboratory or ultraviolet lights) values were calculated. The results of the Boese et al. (1997) study are summarized in Table 13 below. Some of the pertinent findings and conclusions from the Boese et al (1997) findings were:
-- The test organisms were initially exposed to five concentrations of fluoranthene for 4 days and the survivors were exposed to UV light for one hour. UV light exposure enhanced fluoranthene toxicity by as much as tenfold in five of the seven species tested.
-- The enhanced toxicity was likely due to the photoactivation of bioaccumulated fluoranthene.
-- Species having the greatest potential for natural exposure to sunlight (the crab and isopod) were the least sensitive to photoinduced fluoranthene toxicity. These organisms may have evolved mechanisms such as pigmentation to absorb UV radiation or enhanced DNA repair abilities to protect themselves from UV radiation and from photoinduced toxicity. Absence of photoinduced toxicity in these species may have been due to lower fluoranthene tissue residues relative to the other five species. Also, the intensity of the UV light exposures were only about 10% of what these species would experience in their natural setting. More realistic exposures in terms of duration and intensity may change the results.

-- Toxicity tests conducted under normal laboratory lighting do not indicate the potential for photoinduced toxicity and, therefore, may underestimate environmental risks. Similarly, sediment quality criteria, such as the proposed criterion for fluoranthene (EPA, 1993), that are based on toxicity conducted without UV radiation may also underestimate the risks associated with photoactivated compounds.
-- Use of certain organisms like the burrowing marine amphipod, *R. abronius*, that are very sensitive to photoinduced toxicity, but are also unlikely to be exposed to sunlight in their natural habitat, could overestimate environmental risks. However, Boese et al (1997) notes that in laboratory toxicity tests, burrowing amphipods may not burrow and bury themselves in toxic sediments or may emerge soon after burial and remain on the sediment surface. Under these conditions, the burrowing amphipods may have bioaccumulated PAHs when in close association with the sediment and sediment pore water and then become exposed to ultraviolet light when they emerge from the sediments in showing avoidance reactions to the contaminated sediments.

Swartz makes additional comments in regard to the role of photoactivation of PAHs in his other studies for sediment quality guidelines for PAHs. Swartz et al. (1995) indicates that their summed PAH toxicity model (as discussed in comments above) to predict the toxicity of PAH-contaminated sediment does not account for the potential enhancement of toxicity caused by photoactivation of some PAH compounds. Swartz (1999) also notes that his consensus sediment quality guidelines for PAHs (discussed in the comments below) do not take into account the photoactivation of PAH compounds and thus the effects may be greater than predicted from the guidelines.

Table 12. Results of Exposure of Ultraviolet Light to Seven Marine Crustacean Species that Are Have Epi-Benthic or Burrowing Behavioral Traits (Taken from Boese et al. 1997).

Saltwater Species	Sunlight Exposure Potential	Behavioral Trait / Taxa	LC50 Concentrations ug/L with 95% confidence intervals in parenthesis		EC50 Concentrations < ug/L with 95% confidence intervals in parenthesis	
			Initial LC50 Values Under Laboratory Lighting	LC50 Values Under Ultraviolet Exposures	Initial EC50 Values Under Laboratory Lighting	EC50 Values Under Ultraviolet Light Exposures
Rhepoxynius abronius	O	Burrowing Amphipod	> 70	14 (11-16)*	63 (60-66)	< 5*
Eohaustorius estuarius	O	Burrowing Amphipod	> 70	66 (61-73)*	> 70	7 (6-7)*
Leptocheirus plumulosus	+	Epi-benthic Amphipod	> 98	69 (51-93)*	51 (42-61)	20 (19-21)*
Grandidierella japonica	+	Epi-benthic Amphipod	36 (30-43)	26 (23-38)	27 (21-33)	19 (16-21)*
Corophium insidosum	+	Epi-benthic Amphipod	85 (73-100)	32 (27-38)*	54 (43-66)	20 (18-22)*
Excirolana vancouverensis	+ +	Substrate surface Isopod	> 70	> 70	> 70	> 70
Emerita analoga	+ +	Substrate surface crab	74 (73-75)	74 (73-75)	74 (72-74)	73 (72-74)

O = not exposed ; + = occasionally exposed; + + = often exposed
* denotes post-UV exposure LC50 or EC50 concentrations were different than corresponding initial values under laboratory light exposures.

Another study that compared the toxicity of fluoranthene to freshwater and saltwater species (Spehar et al. 1999) under fluorescent and ultraviolet light had the following pertinent findings and conclusions:

-- Acute tests with the 21 species demonstrated that fluoranthene was not lethal within its water solubility limit to most species tested under fluorescent light, but was lethal well below this limit to nearly all of the species tested under UV light.

-- In general, the acute sensitivity of freshwater and saltwater species from the same class was similar, although UV light exposure changed the relative sensitivity of some species. Crustaceans were the most sensitive to fluoranthene, but in the presence of UV light, an oligochaete and a fish were the most sensitive.

-- Overall, the UV light increased acute fluoranthene toxicity approximately one to three orders of magnitude. The greater increases of two to three orders of magnitude were observed for the oligochaete and winter flounder (the most sensitive freshwater and saltwater species tested under UV light).

-- In chronic tests, sublethal concentration of fluoranthene were toxic under both fluorescent and UV light, but as in most acute tests, UV light increased chronic toxicity approximately an order of magnitude. There is little information in the literature on the effects of UV light on chronic endpoints.

-- Comparison of data from tests conducted in the laboratory and outdoors demonstrated that acute toxicity increased with increased UV light intensity.

-- UV light changed the relative acute sensitivity of some species to fluoranthene. In the presence of UV light, the sensitivity of lower invertebrate forms and fish approached or was below that of some sensitive crustaceans. Organisms such as the oligochaete and winter flounder became extremely sensitive to fluoranthene under UV light because they probably lack well developed defense mechanisms due to their normal association with bottom sediments, where they can be shielded from UV exposure.

-- The similarity in organism sensitivity observed from the laboratory and outdoor exposures suggests that laboratory tests may be useful in predicting field effects that are attributable to solar radiation. The greater effects observed for two species tested under natural sunlight suggests that higher natural light intensities compared to those used in the laboratory can increase phototoxicity.

-- Although many organisms have developed protective mechanisms against UV light, behavioral, morphological, or biochemical responses may not afford enough protection when organisms contaminated with fluoranthene and other phototoxic PAHs cannot avoid UV light.

-- The outdoor experiments conducted in this study and previous studies by Ankley et al. (1995, 1997) and Monson et al. (1999) suggest that organisms may be more at risks when exposed to phototoxic compounds at higher UV light intensities.

-- Further studies are needed to determine the effects of UV light intensity in long-term exposures with a wide variety of species and phototoxic compounds. At the present time, it is not clear if the determined linear relationships between toxicological effects versus light intensity can be extrapolated for long-term exposures of such compounds.

22. Page 10. **Unnatural Exposure Conditions of LSRI Bioassays**

WDNR claims LSRI conducted bioassays with sediment elutriates and UV light to mimic conditions of the littoral zone during heavy wave periods. However, elutriate bioassays were designed to mimic conditions during dredging and the conditions in these bioassays have little relationship to what really happens in sediments or at the sediment-water interface over natural sediments under natural conditions.

WDNR Response

We have already responded to the issue of the use of elutriate testing in comment 33 of the June 7, 1999 comments. The use of the elutriate testing has applications above and beyond mimicking dredging activities and open water disposal of dredged materials. D&M continues to indicate that the elutriate testing "has little relationship to what really happens" in sediments or at the sediment-water interface, but in no fashion do they present in either a quantitative or qualitative manner any data or information as to describe "what really happens". We have ask D&M in the past for recommendations for an alternative testing method that would simulate various conditions in the near bottom and lower water column area for toxicity testing. However, this was not responded to. Until D&M can fully describe in a useable and detailed manner "what really happens" in the near bottom area when sediments are disturbed by waves and current actions especially under severe weather and from any boat traffic in the bay, we will continue to use the results of the elutriate testing, as appropriately interpreted taking into account any uncertainties, as relevant and applicable for assessing the site. Elutriate testing represents our best estimate of to simulate the dynamic conditions that occur at the site where bottom disturbance, mixing, resuspension, release of coal tar contaminants from residuals and free oils and solubilization, redeposition, etc. occur.

It should be understood that elutriate is prepared by mixing a 1:4 volume ratio of sediment to test water by mixing for a period of time. After settling, the supernatant was decanted off and the supernatant centrifuged for 45 minutes to precipitate suspended solids. The supernatant was then used in the exposure tests. This preparation may not represent a worst case situation when suspension of contamimated bottom substrates into the water column occurs at the site and exposure to organisms occurs. Total PAHs in the water column 11 days after the initiation of the SEH (1998) sediment dispersion and settling study was 4,237 ug / L. The concentration in the elutriate supernatant was likely much less than this. When the supernatant derived from the Contaminated Wood site is in turn diluted down to 50%, 25%, and 12.5% strength and 100% mortality to fathead minnows was still experienced along with 82% mortality at 6.25%, this has to raise serious concerns. Likewise, when 62% mortality at 50% strength and 22% mortality to fathead minnows at 25% strength occurred in elutriate derived from the Contaminated Sand sediments which had much lower total PAHs associated with them, this has to raise additional concerns. Overlain on this is the enhanced toxicity under ultraviolet light exposures in the most diluted elutriates.

23. Page 10. 4th paragraph. **Unnatural Exposure Conditions of LSRI Bioassays**

However it should be noted that even Monson et al's (1995) open water samples measured at the sediment-water interface at 10 to 17 cm was 1.3 to 5.4 uW UVB/cm^2. Therefore even in shallow clear water, field UVB intensity was 18 to 76 times lower than the 20% air UVB intensity used in the LSRI experiment. This failure to duplicate representative conditions where the receptors lives negates the use of these experiments as a scientific basis for evaluating photo-induced toxicity in the field.

WDNR Response

D&M has failed to consider two key factors in making the above comparisons between the Monson et al. (1995) study and the LSRI Ashland sediment study in regard to the ultraviolet light intensities associated with the specific studies. Considerations of these factors renders the above D&M comparisons invalid and erroneous. The factors for consideration involve temporal and spatial

differences that apply to the seasonal timing when the ultraviolet light intensities were applied and measured and water quality characteristics specific to each location

The temporal factor relates to when the ultraviolet light intensities where measured or seasonally simulated. Table 14 below summarizes some of the basic information from both studies that will be discussed below relating to the study-specific ultraviolet light intensities

Table 14. Comparison of the Ultraviolet Light Intensities Used in the Monson et al. (1995) and LSRI (1998) Studies.

Study		Ultraviolet Light Intensities at the Point of Measurement			Ultraviolet Wavelength Intensities In Air On a Sunny Day In the Month Indicated		Percent of Ultraviolet Light In Air Used In the Study	
LSRI (1998)	Lab measurement made at the surface of shelf on which test beakers were placed to simulate 20% of mid-day, mid-July sunlight intensity at Duluth	UV-A	521 uW/cm^2		2,330 uW/cm^2 †		22.4 %	
		UV-B	98.4 uW/cm^2		860 uW/cm^2 † † Values from Ankley et al. (1994). Measurements made in air on a sunny day at noon on July 15, 1993 in Duluth.		11.4 %	
Monson et al. (1995)	Field Measurement at sed.-water interface (10 cm depth) in Oct.	UV-A	Ref. Site	Study Site	580 uW/cm^2 ‡		Ref. Site	Study Site
			56 uW/cm2	47 uW/cm2			9.7%	8.1%
		UV-B	1.3 uW/cm2	5.4 uW/cm2	64 uW/cm^2 ‡		2%	8.4%
					‡ Values from Monson et al. (1995). Measurements made in air on a sunny day at noon at the end of Oct. 1993 in Duluth.			
	Laboratory Testing	UV-A	532 uW/cm^2		----		----	
		UV-B	93.1 uW/cm^2		----		-----	
			% Reduction of Ultraviolet Light Intensities From July to Oct.		UV-A	75%	----	
					UV-B	93%	----	

Some of the things to note from Table 14 above that render the D&M comparisons of the two studies inappropriate are:

-- The significant decreases in seasonal ultraviolet light intensities when July levels are compared to

October levels. From July to October, UV-A and UV-B wavelength intensities are reduced by approximately 75% and 93%, respectively.
-- LSRI indicates that the ultraviolet light intensity they used represented approximately 20% of the mid-day, mid-July intensity measured in the air. Since the 20% value was measured on the bench surface in the laboratory and not at the sediment water surface in the test beakers, the actual percentage may have been lower than 20%. Additionally, using the above figures, the actual percentages of ultraviolet light LSRI used in the laboratory was approximately 22% and 11% for UV-A and UV-B, respectively, of the intensity of these wavelengths in air which accounts for a significant amount of simulated attenuation in the water column at the site.
-- The measurements of ultraviolet light intensities made in the field at the sediment-water surface in the Monson et al. study were made in late October, a time when seasonal conditions had greatly reduced the intensity of ultraviolet light in solar radiation even before attenuation occurred in the water column. On an absolute basis, the ultraviolet light intensities measured by Monson et al. were less than LSRI used in the laboratory, but on a relative basis, the percentage reduction based on the seasonal ultraviolet light present was similar between the two studies.
-- The Monson et al. laboratory light intensities were similar to the LSRI intensities and would simulate mid-July conditions. Under these conditions, the *Lumbriculus* test organism experienced 100% mortality. In the field under the reduced October ultraviolet light intensities, *Lumbriculus* experienced 40% and 63% mortality.
-- The bottom line is that LSRI simulated mid-July ultraviolet light conditions and the Monson et al. field light measurements were made in late October. These facts have to be considered in making any comparisons.

The specific water quality conditions encountered in the creek in the Monson et al. (1995) study are discussed in one of the comments above. The descriptor used by D&M of "clear" to characterize the creek is inappropriate. The flow in the creek involved is made up of 99% of effluent from a petroleum refinery. Dissolved organic carbon concentrations can range up to 85 to 138 mg/L. Any attempts to extrapolate comparisons of the light measurements made in the creek under these continuous high DOC conditions with the variable conditions that are found at the nearshore bay site off the Lakefront property is inappropriate.

The significant thing to take away from the results of the Monson et al. (1995) study was that even under the high DOC conditions and late October reduced ultraviolet light intensity, *Lumbriculus* still showed 40% and 63% mortality. If these conditions are present at the Lakefront Property site, they may not represent worse case conditions. Worse case conditions would be a period of rough weather where waves and currents would disturb bottom substrates and release coal tar contaminated sediments and oils. The contaminants would be made available and bioaccumulated by various aquatic organisms. The rough weather would be followed by a period of calm weather allowing for settling and clearing in the water column, followed by deeper penetrations of ultraviolet light. The ultraviolet light would impinge on the various aquatic organisms that had bioaccumulated the PAH compounds, thereby inducing phototoxicity.

24. Page 10. Last paragraph. **Unnatural Exposure Conditions of LSRI Bioassays**

LSRI conducted bioassays on phototoxicity with the benthic worm, *Lumbriculus variegatus* (sic) **that were first exposed to PAH contaminated sediments and then exposed to UV light. The laboratory UVA/UVB exposures to PAH-loaded *Lumbriculus* were made under unnatural conditions. *Lumbriculus* is an organism that normally lives beneath the sediment surface and are likely to be unusually sensitive to UV exposure. Boese et al. (1995) concluded that**

organisms that are not normally exposed to UV light are the most sensitive. Only when BOD is high does this species live on the sediment surface. However, LSRI exposed *Lumbriculus* to contaminated sediments and then placed them in clear, water for their exposures.

WDNR Response

There are no direct studies that demonstrate that *Lumbriculus* is unusually sensitive to UV light exposure as D&M speculates. *Lumbriculus* locomotion is by a crawling movement on or in the superficial layers of the substrate (Pennak, 1989). It may be associated with the sediment surface at times other than just when the sediment oxygen demand of the sediments is high. Kukkonen and Landrum (1994) showed that the worms avoided PAH contaminated sediment by moving to the sediment surface. Disturbance of the bottom substrates may for a time result in the Lumbriculidae being present on the sediment surface. What D&M describes as unnatural exposure conditions as represented by the regime of sediment exposure and then UV light exposure in clear water may be more the natural exposure conditions for the site as discussed elsewhere in these comments. The LSRI test results showed that the few *Lumbriculus* survivors that were exposed for 13 days to sediments from the contaminated wood site died within 15 minutes when exposed to ultraviolet light. It is interesting to note that although it took longer, complete mortality also occurred for the survivors from the Contaminated Sand site and Reference Wood site when exposed to ultraviolet light. These latter are significant because of the relatively low PAH concentrations in these sediments. High mortality (60%) was experienced for the survivors from the Reference Sand site that were exposed to ultraviolet light. This latter site had the lowest sediment PAH concentration of all the sites. Because the *Lumbriculus* from the sand control sediments did not experience any mortality when exposed to ultraviolet light, the ultraviolet light by itself is not responsible for the mortality experienced in animals from the four site locations but must be due to photoactivation of bioaccumulated compounds from the site sediments.

In the above D&M statement, Boese et a.l (1995) is cited. However their is no Boese et al. (1995) in the D&M reference listing. We are familiar with Boese et al. 1997 and 1999 papers but not the cited 1995 paper.

25. Page 11. 1st paragraph. **Unnatural Exposure Conditions of LSRI Bioassays**

LSRI also conducted bioassays with the pelagic invertebrate *Daphnia magna* exposed to PAHs derived from sediments, and UV light. These laboratory UVA/UVB tests with *Daphnia* also were made under unnatural conditions. LSRI first exposed *Daphnia* to sediment elutriate water containing PAHs and then transferred them in clear water for the UV exposure. *Daphnia* is an organisms that lives in the water column of relatively still waters, and in nature, *Daphnia* is not exposed to sediment elutriates. Furthermore, *Daphnia* is negatively phototropic and actively avoids high intensity UV light. Finally, dissolved and particulate organic carbon that would normally be present in the water column and scatter light, thus reducing toxicity were absent in these experiments[9]. The absence of dissolved and suspended organic carbon in the LSRI laboratory bioassays invalidates their use as a scientific basis for evaluating photo-induced PAH toxicity to pelagic invertebrates in the field under normal field conditions.

WDNR Response

The *Daphnia magna* used in the laboratory testing serves as a surrogate for the zooplankton species that utilize the nearshore areas of Lake Superior that includes the bay off the Lakefront property and

adjacent offshore areas. *Daphnia* is routinely used in assessments of PAH exposure and toxicity and photo-induced toxicity (Oris et al. 1990; Davenport and Spacie, 1991; Holst and Giesy, 1989; and Sasson-Brickson and Allen, 1991).

To better understand the makeup and characteristics zooplankton populations of Lake Superior and its nearshore areas, a review which includes Watson and Wilson, 1978; Basch et al. 1980; Patalas, 1972; Watson, 1974; Munawar and Wilson, 1978; and Selgeby, 1975 needs to be done. A review of these journal articles indicates that the behavior of the zooplankton community is much more diverse and complex than D&M's simplistic portrayal as attributed singularly to *Daphnia magna*. Not all zooplankton species are as negatively phototropic as D&M is attributing to *Daphnia magna*, and based on the studies of Birge (Frey, 1963), *Daphnia* and other cladocerans respond differently to light depending on the species and the location. The bottom line is that zooplankton utilize the nearshore areas of the lake under various conditions from still to agitated water column conditions that may be related to bottom substrate disturbances and associated resuspension of bottom contaminants, hence the applicability of the elutriate testing; they will ingest algae, detritus, bacteria, other particulate matter, and dissolved and particulate organic carbon contaminated with coal tar contaminants from filter feeding, integument diffusion, and respiration. While Cladocerans ingest algae and protozoa, it is well known that organic detritus of all kinds, as well as bacteria, are very important and commonly form the great bulk of the material ingested. It has been demonstrated that the feeding movements of the legs of plankton species are so efficient that they separate colloidal organic particles from the water. It is generally believed that all organic particles of suitable size are ingested without any selective mechanisms (Pennak, 1989). Davenport and Spacie (1991) attribute part of the feeding and exposure to PAHs comes from *Daphnia* feeding at the sediment surface where they would ingest contaminated particulates. Depending on the clarity of water conditions, they will become exposed to ultraviolet light at various depths in the water column which will photoactivate the accumulated PAHs and cause enhanced toxicity.

Depending on conditions, the presence of dissolved and particulate organic carbon may attenuate ultraviolet light penetration at various depths, but it will not render 100% protection via attenuation at all times but may reduce toxicity as D&M recognizes. That DOC and POC were not present in the water column during the LSRI ultraviolet light exposures does not render their laboratory bioassays invalid as D&M claims. Absence of DOC and POC may represent a worst case scenario where periods of storms may be followed by periods of calm water and increased clarity as discussed above where DOC levels may approach the < 2 mg C / L lake norm. Dissolved organic carbon and dissolved humic materials as in comments discussed above are of different characteristics and qualities that result in different attenuation characteristics. There may be selective attenuation with more in the UV-A solar spectrum and less in the UV-B spectrum. Organic carbon in the form of humic and fulvic acids can have variable characteristics as can organic carbon derived from lignocellulose (wood-derived organic matter)(Gauthier et al. 1987; McCarthy et al. 1989; Chiou et al. 1987; Morgan and Hodson, 1989; Visser, 1983; Khan, 1980; Haitzer et al. 1998:Haitzer et al. 1999a; Haitzer et al. 1999b; and Carter and Suffet, 1983). Organic matter of terrestrial origin has different characteristics than organic matter of aquatic origin (Chiou et al. 1986). The laboratory testing cannot recreate all the variables involved. The standard procedure is to carry out the experiment with the variables controlled and extrapolate the results to the field setting identifying the uncertainties involved in this process. The only reason to invalidate the experiment is if the controlled factors in the laboratory cannot be extrapolated to the field setting with a reasonable degree of certainty. The *Daphnia* in the LSRI test which were exposed to the elutriates from the contaminated wood and contaminated sand had 72% and 100% survival after 48 hours of exposure. These surviving organisms when placed under ultraviolet light exposure did not survive 15 minutes.

A summary review of the zooplankton community that is found in the nearshore areas of Lake Superior derived from some of the above listed journal articles is as follows to put some perspective on the on zooplankton populations in the lake ecosystem,:
From Watson and Wilson, 1978:
-- The dominant zooplankters of Lake Superior as classified by percentage of total numbers and percent of total biomass is shown in Table 12 below.

Table 15. The Dominant Zooplankters of Lake Superior as Classified by % of total numbers and % of total biomass.

Taxa Group	% Total Numbers	% Total Biomass
Calanoid Copepods	81.6	83.5
Cyclopoid Copepods	12.5	3.5
Cladocerans (Includes 3 species of *Daphnia*)	4.4	8.4
Others - Mysis (opossum Shrimp) Rotifers	----	----

-- Little variation was seen in total numbers / m^3 through the sampling season but total biomass increased five-fold between May and September.
-- The lake appeared to support a permanent year-round lake-wide community which was augmented annually by a succession of summer forms which developed initially inshore and then spread to various degrees into the offshore waters.
-- The zooplankton community was quite heterogeneous with greatest abundance being found in the inshore zones.
-- There was a strong correlation between zooplankton biomass and surface water temperature. Temperature of the surface waters was the single parameter most strongly associated with the distribution of zooplankton concentrations and standing stocks.
-- An analysis of the zooplankton standing stock and the heat content of the upper waters of Lake Superior suggested that the zooplankton biomass was exponentially related to the average temperature in the top 10 m of the water column, especially within the period from May to September during which the zooplankton biomass was increasing. It would appear that both the magnitude and timing of zooplankton biomass maxima in the lake was influenced by the differential heating of the surface waters which was in turn affected by lake morphometry and the movement of water masses as well as the restrictions to movement caused by thermal bars and alongshore currents.
-- The cladocerans all developed during the summer in the inshore regions, probably from overwintering eggs.
-- Inshore populations composed largely of the cladocerans species and the smaller diaptomids were most abundant in the major embayments and along the southern and eastern shorelines. These species gradually extended their ranges into the offshore waters during the late summer and early fall.
-- A strong possibility exists that the large numbers of smaller zooplankters in the warmer shallow bays and shoreline areas arises at least in part from the selective predation on the larger zooplankters by the extensive populations of the rainbow trout (*Osmerus mordax*) that utilize these

areas.
-- In the nearshore areas represented by Chequamegon Bay, seasonal zooplankton concentrations average 35,000 animals / m^3 with a maximum value of 60,000 animals / m^3 (contrasted with an open lake maxima of 3,000 / m^3.
-- Inshore biomass pulses tended to precede adjacent offshore pulses by approximately one month, and zone mean biomass values along the entire southern shoreline exceeded the lakewide averages by a factor of two.

From Munawar and Wilson (1978):
-- The crustacean zooplankton as secondary producers feature a variety of feeding strategies. They are detrivores, bacteriovores, carnivores, and herbivores. The Cladocera are known to be filter feeders, with algae and possibly bacteria, constituting the bulk of the food source. The Calanoid copepods are capable of some degree of visual shape and size discrimination in their food selection and feed on large particles. They are primarily herbivorous filter feeders. The Cyclopoid copepods depend on a variety of food sources, preying on other crustaceans, rotifers, and ciliates, as well as on algae.

26. Page 11. 2nd paragraph. **Unnatural Exposure Conditions of LSRI Bioassays**

As with *Daphnia*, LSRI exposed fathead minnow larvae to PAHs derived from sediments, and UV light. The laboratory UVA/UVB tests with fathead minnows were made under unnatural conditions. LSRI first exposed fathead minnows to sediment elutriate water and then transferred them to clear water for the UV exposure. However, fish such as the fathead minnows live in the water column, not in sediment elutriate water. Furthermore, juvenile fish are negatively phototropic and avoid high intensity light. As with the organisms discussed above the fathead minnow lives in an environment where there are substantial amounts of dissolved organic carbon and suspended particulate matter. In nature, the dissolved organic carbon and particulate matter bind PAHs and scatter light, thus reducing toxicity. Therefore, juvenile fish are unlikely to be adversely affected by photo-activated PAHs under normal field conditions.

WDNR Comments

Many of the comments made in regard to *Daphnia* above apply to the fathead minnow. Again, there appears to be broad-based, unsupported opinions on the part of D&M as to what is "likely" or "unlikely" to happen. Fathead minnow larvae are surrogate organisms for the immature forms of fish species that may utilize the Lakefront Property bay. Based on Table 13 and the discussions in Section 3.4.2.1 of the SEH ERA (1998), 29 species of fish either spawn or rear their young in Ashland Harbor. Some portion of these may utilize the Lakefront Property bay. Fish at early life stages of development are particularly vulnerable to pollutants over short periods and may be sensitive to brief exposures. Exposure will vary depending on the horizontal distribution of the larvae in the water column and their feeding habits. . Fish species will spend critical portions of their life cycles in near shore during early development (Kingsford and Gray, 1996). The immature forms of the various fish species will be present under variable water quality conditions in the water column related to still, calm, clear waters and conditions under which bottom materials will be suspended in the water column. It is not understandable when D&M states that fathead minnows can live in an environment where there is substantial dissolved and particulate matter but cannot be found in sediment elutriate which in fact simulates these conditions. As discussed above, elutriates may not simulate worst case exposure conditions as would exposure ti suspended contaminated sediments

and oils in the water column. How would D&M propose simulating the conditions of high dissolved and particulate matter in the water column ? Again, as above, conditions in the water column will be variable and dissolved and suspended particulate matter will not be present at all times to bind PAHs and scatter light. The quality and quantity of these materials, when present, will determine their attenuating abilities. Again, D&M acknowledges that these factors when present will reduce phototoxicity but not completely eliminate it.

In the LSRI testing, fathead minnow survivors that had been exposed to 24 hours to a 25% dilution of the elutriate water from the contaminated wood site, showed effects within 15 minutes of being exposed to the to ultraviolet light. The effects took the form of limited movement. By 30 minutes, half were dead and by 60 minutes all were dead. 25% mortality was experienced in the 6.25% dilution of the contaminated wood sediment elutriate after being exposed to ultraviolet light.

27. Page 11. 3rd paragraph. **Unnatural Exposure Conditions of LSRI Bioassays**

Thus, none of these studies of photo-toxicity add any weight-of-evidence in support of the inappropriately conservative assumptions used by WDNR to establish proposed remediation areas.

WDNR Response

Given a thorough review of all the issues involved with phototoxicity of PAHs to the various aquatic organisms as contained in all of the WDNR response comments in the past and above, we have not changed our original conclusions that due consideration needs to be given to the phototoxicity component in assessing the ecological risks posed by the coal tar contamination at the site. All of the information presented, put in context and weighing the uncertainties, provides lines of evidence to the weight-of-evidence to support the estimated overall ecological risks judged to be associated with the site. While D&M appears to admit phototoxicity can be present, albeit reduced phototoxicity, they cannot seem to make the transition to using this information in any fashion for use as a piece of the weight-of-evidence for evaluating the risks of the site. D&M has presented their versions of "likely" scenarios in the natural system that are overly broad, simplistic, unsupported, and simply wrong in cases to adequately account for the site variables and interactions of these variables that will effect aquatic life associated with the site. The uncertainty in regard to phototoxicity for the site are is not indeterminable and as such needs to be weighed into overall decision making for the site. The uncertainties need to be dealt with in an open minded manner with careful and thorough review of the results of all site studies and related studies in the literature. Based on any uncertainties, the lines of evidence from these sources are weighed appropriately for use in the overall weight-of-evidence in assessing the site. The lines of evidence can neither be discarded out-of-hand because there may be various degrees of uncertainty associated with them nor can full relative weight be given to each of the lines of evidence in the overall assessment because of these uncertainties.

As to the D&M comment about the "inappropriately conservative assumptions used by WDNR", we of course do not agree and have commented on this elsewhere. Given some of the uncertainties, current state of the science, complexities of the interactions of chemical, biological, and physical factors, and uniqueness of the associated Lake Superior ecosystem, we believe the assumptions we have made are reasonably cautious and conservative.

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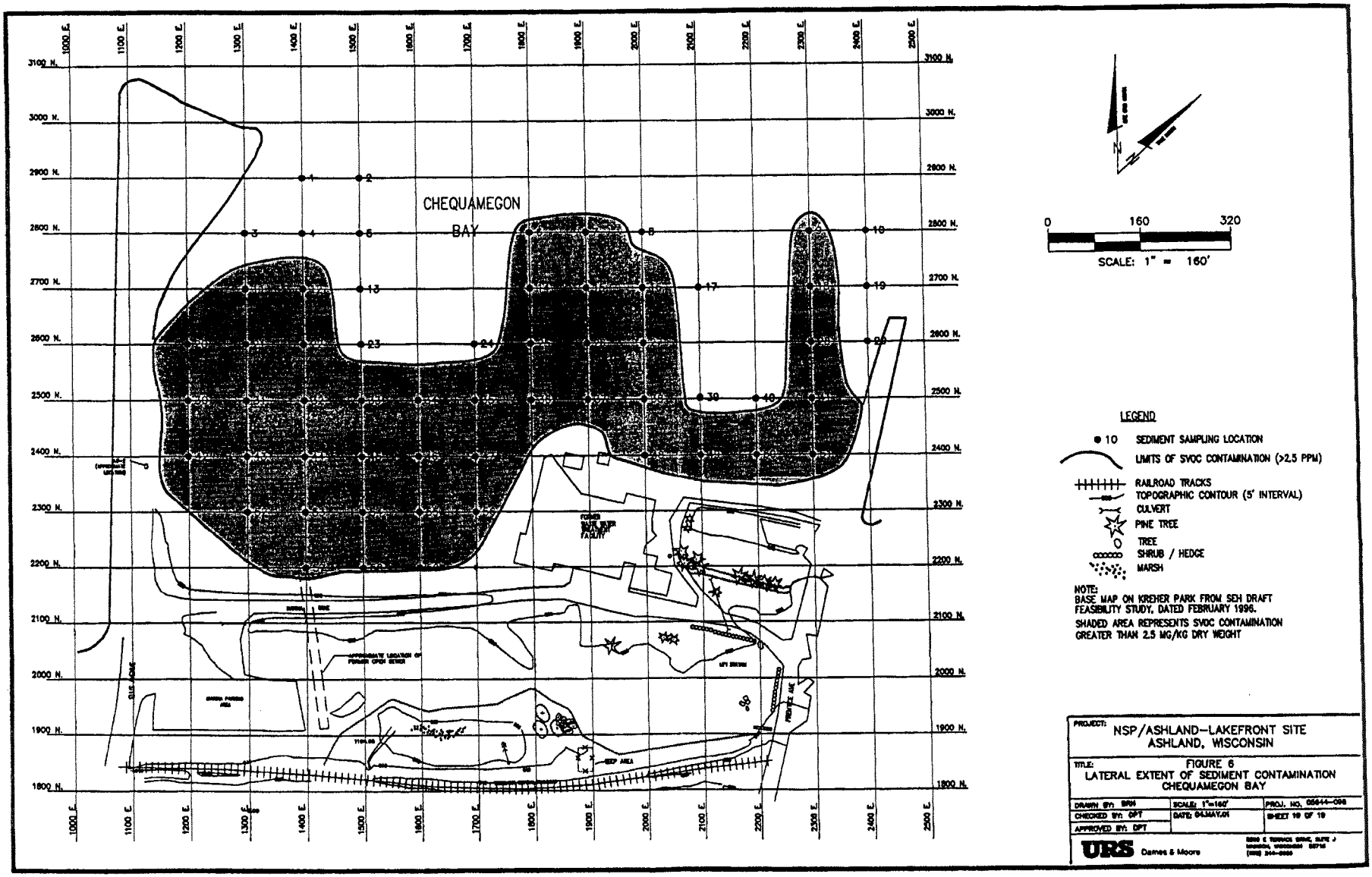
Appendix C

Excerpts from 2001 URS Sediment Sampling Report



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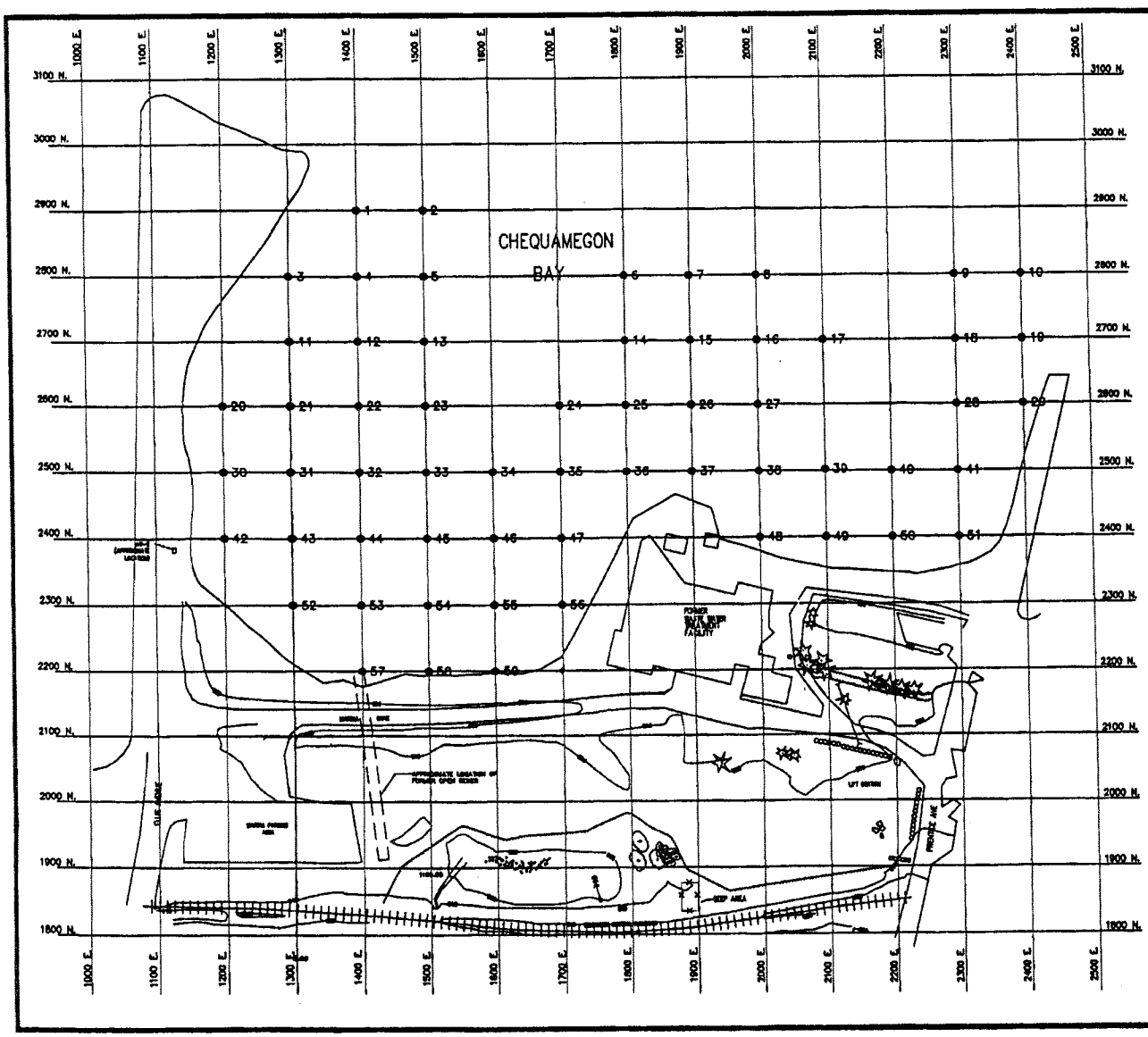
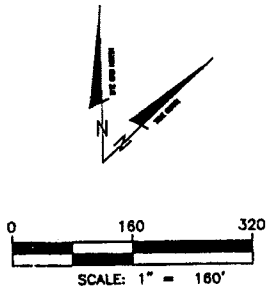




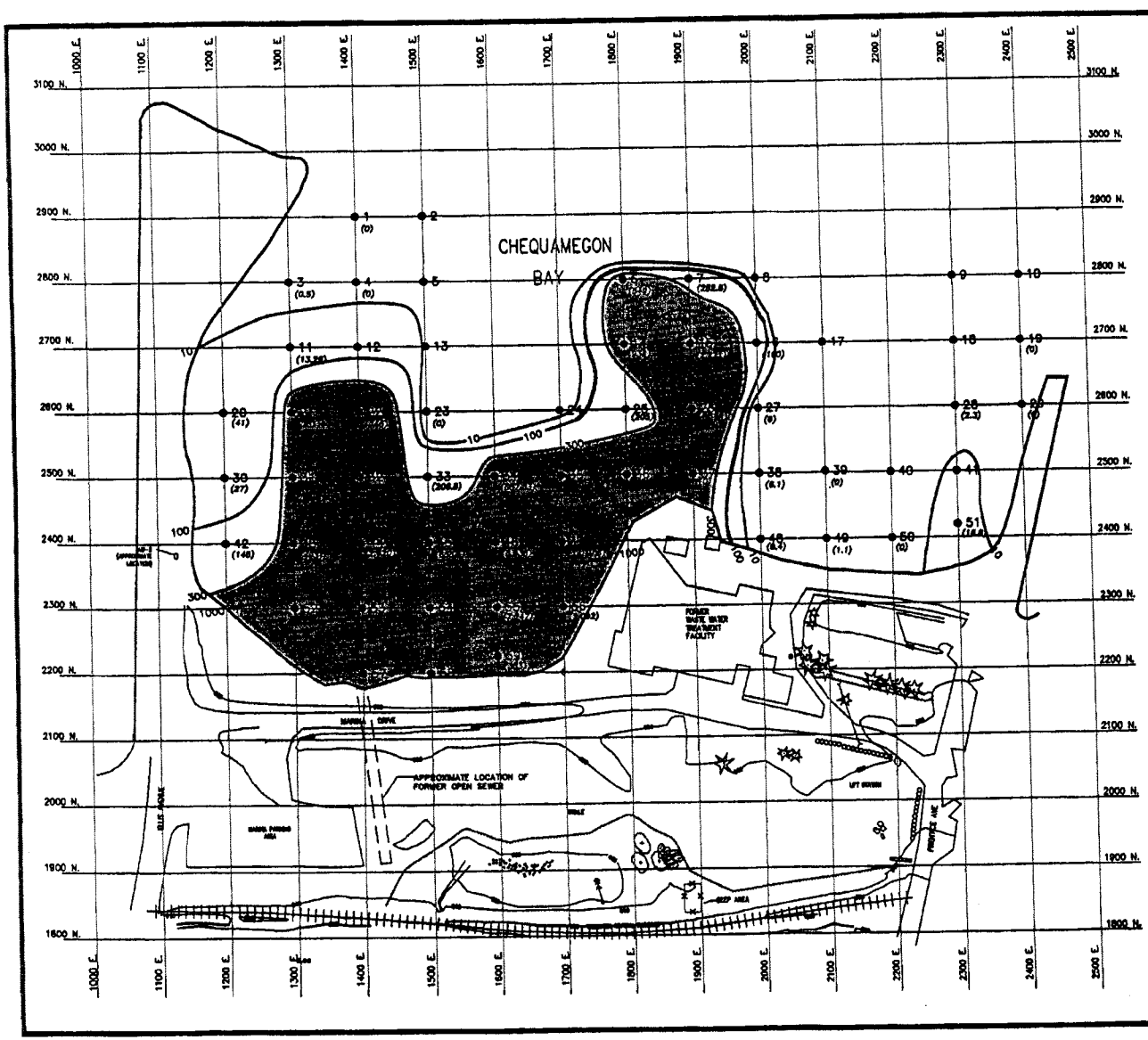
LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.

PROJECT:	NSP/ASHLAND–LAKEFRONT SITE ASHLAND, WISCONSIN
TITLE:	FIGURE 2 SEDIMENT SAMPLING LOCATIONS CHEQUAMEGON BAY
DRAWN BY: SRN	SCALE: 1"=160' / PROJ. NO. 05644-098
CHECKED BY: DPT	DATE: 04-MAY-97 / SHEET 2 OF 19
APPROVED BY: DPT	
URS Dames & Moore	5500 E. TENNYSON DRIVE, SUITE J MADISON, WISCONSIN 53718 (608) 244-5666

FILE: S:\CADFILES\NSP\05644098\0501_FIGURE_2



0 160 320

SCALE: 1" = 160'

LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 SVOC ISOCONCENTRATION CONTOUR (MG/KG)
- (1.1) SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.

SVOC UNITS ARE REPORTED IN MG/KG DRY WEIGHT

AREA OF TOTAL SVOCs > 300 MG/KG = 5.51 ACRES
AREA OF TOTAL SVOCs > 1000 MG/KG = 2.50 ACRES

PROJECT: NSP/ASHLAND-LAKEFRONT SITE
ASHLAND, WISCONSIN

TITLE: FIGURE 3A
TOTAL SVOCs AT 0-2 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: BRN	SCALE: 1"=160'	PROJ. NO. 05844-098
CHECKED BY: DPT	DATE: 02.MAY.01	SHEET 3 OF 10
APPROVED BY: DPT		

URS Dames & Moore

5500 E TWENTY NINE, SUITE J
SPOKANE, WASHINGTON 99212
(509) 344-5600

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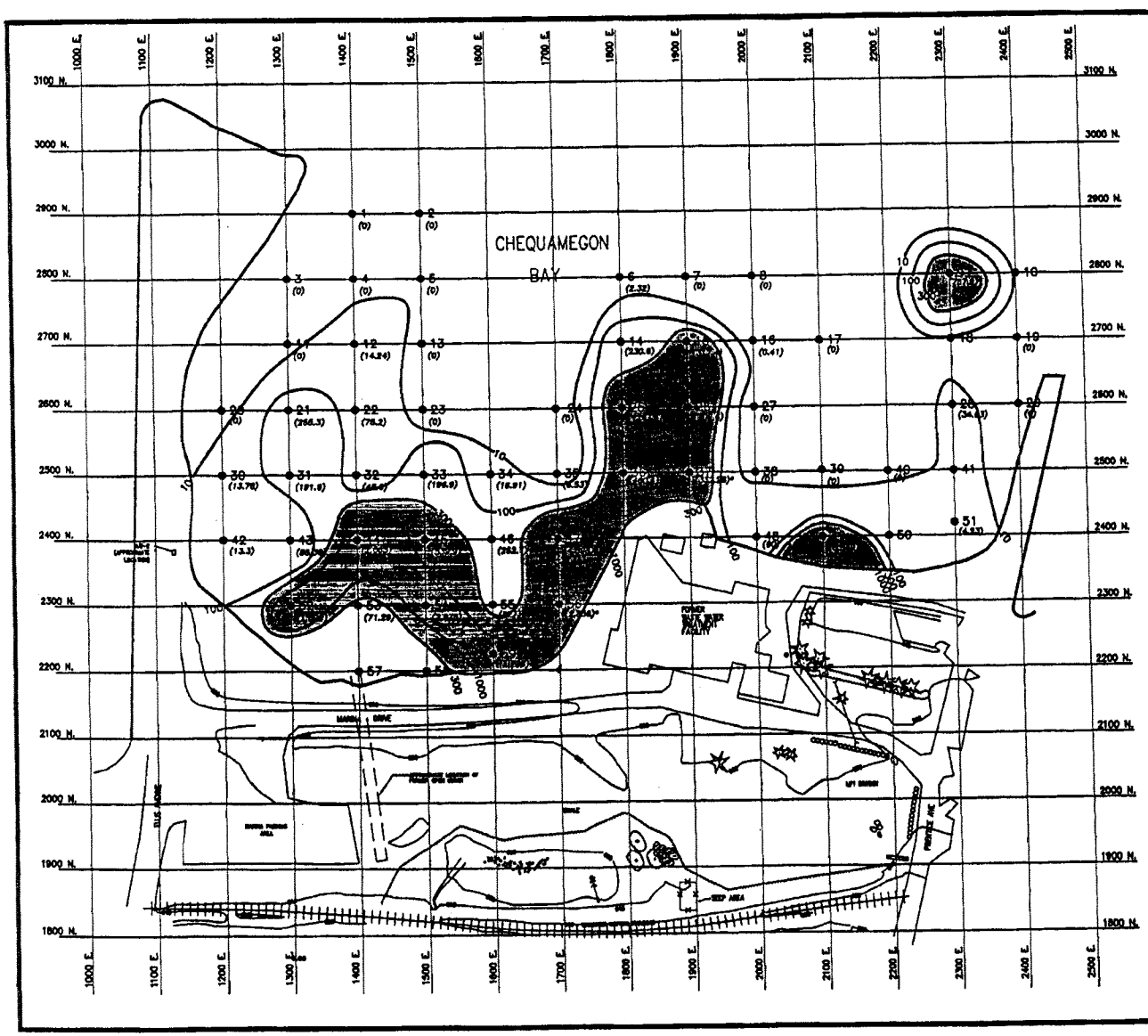

0 160 320

SCALE: 1" = 160'

LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 SVOC ISOCONCENTRATION CONTOUR (MG/KG)
- (1.1) SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.

SVOC UNITS ARE REPORTED IN MG/KG DRY WEIGHT

AREA OF TOTAL SVOCs > 300 MG/KG = 3.10 ACRES
AREA OF TOTAL SVOCs > 1000 MG/KG = 1.30 ACRES

PROJECT: NSP/ASHLAND-LAKEFRONT SITE
ASHLAND, WISCONSIN

TITLE: FIGURE 3B
TOTAL SVOCs AT 2-4 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: BRN	SCALE: 1"=160'	PROJ. NO. 05444-068
CHECKED BY: DPT	DATE: 08.MAY.01	SHEET 4 OF 19
APPROVED BY: DPT		

URS Dames & Moore

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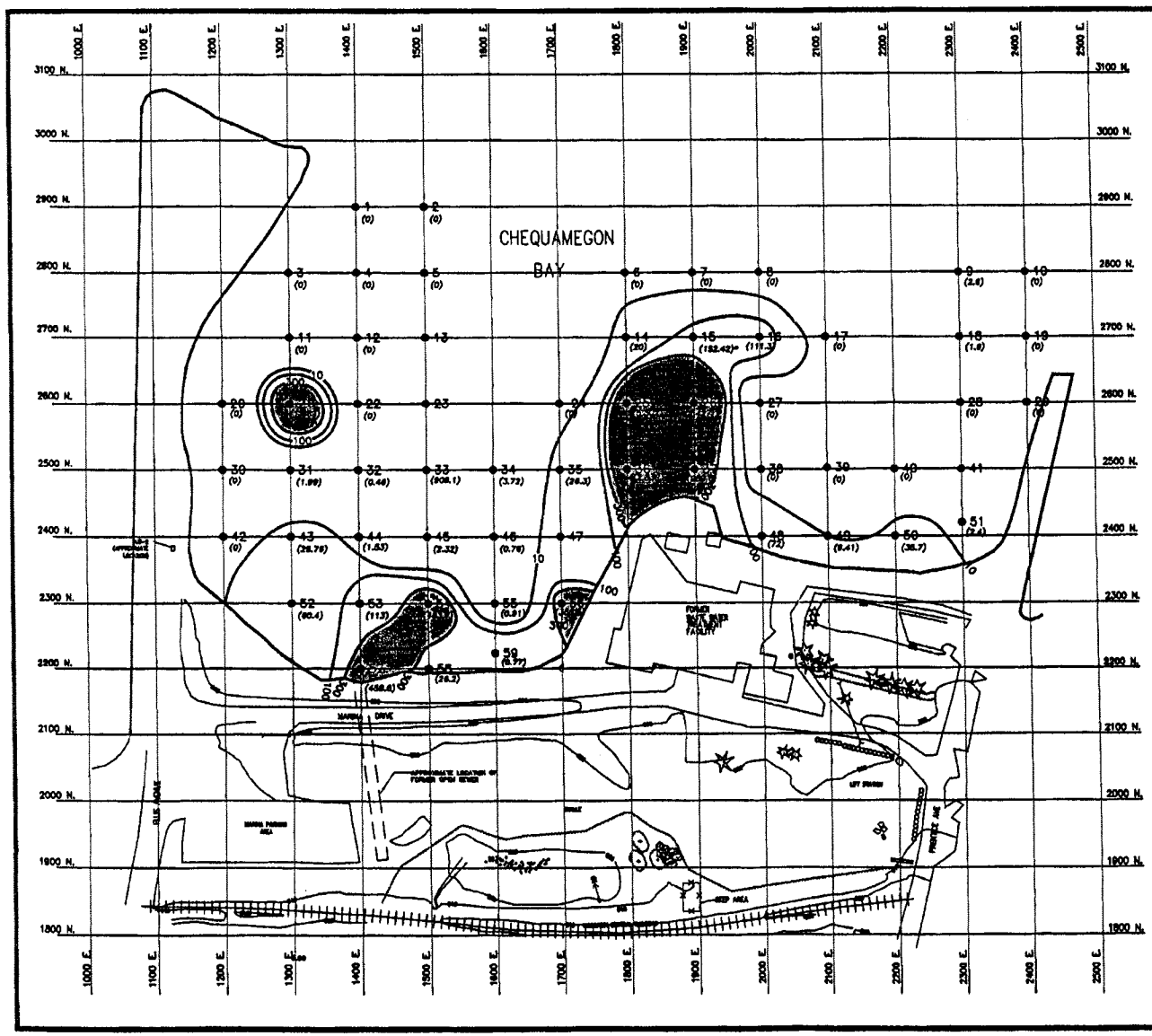

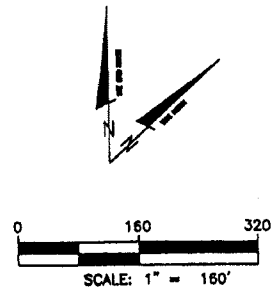

LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 SVOC ISOCONCENTRATION CONTOUR (MG/KG)
- (1.1) SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
SVOC UNITS ARE REPORTED IN MG/KG DRY WEIGHT
AREA OF TOTAL SVOCs > 300 MG/KG = 1.16 ACRES
AREA OF TOTAL SVOCs > 1000 MG/KG = 0.54 ACRES

PROJECT: NSP/ASHLAND-LAKEFRONT SITE
ASHLAND, WISCONSIN

TITLE: FIGURE 3C
TOTAL SVOCs AT 4-6 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: BRN	SCALE: 1"=160'	PROJ. NO. 05644-098
CHECKED BY: DPT	DATE: 03.MAR.01	SHEET 6 OF 10
APPROVED BY: DPT		

URS Dames & Moore

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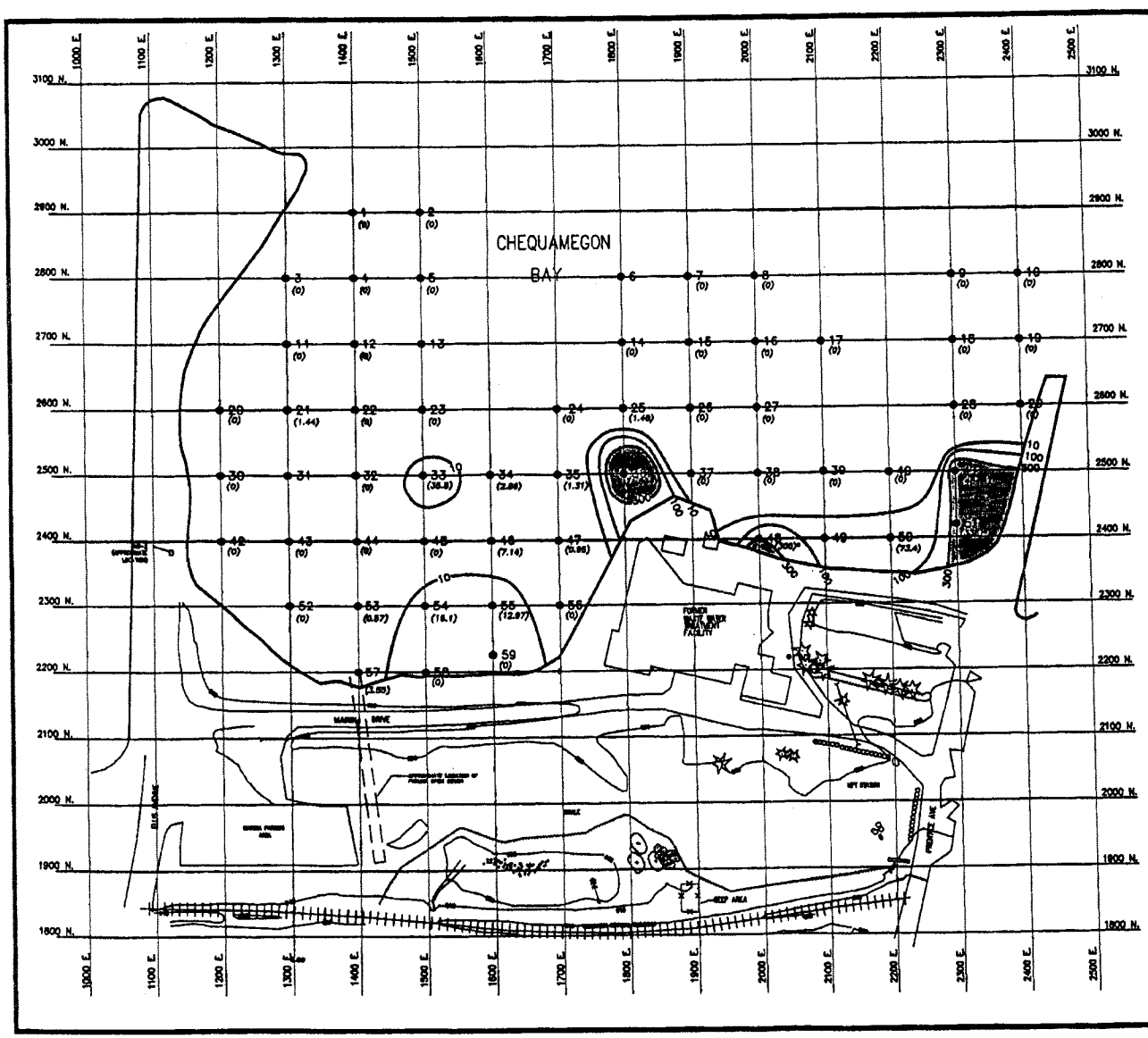

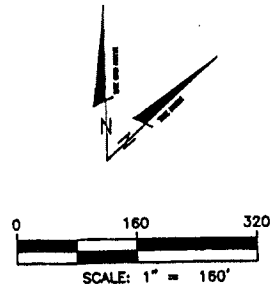

LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 SVOC ISOCONCENTRATION CONTOUR (MG/KG)
- (1.1) SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
SVOC UNITS ARE REPORTED IN MG/KG DRY WEIGHT
AREA OF TOTAL SVOCs > 300 MG/KG = 0.43 ACRES
AREA OF TOTAL SVOCs > 1000 MG/KG = 0.05 ACRES

PROJECT: NSP/ASHLAND–LAKEFRONT SITE
ASHLAND, WISCONSIN

TITLE: FIGURE 3D
TOTAL SVOCs AT 6–8 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: BRM	SCALE: 1"=160'	PROJ. NO. 05644-058
CHECKED BY: DPT	DATE: 02.MAY.01	SHEET 6 OF 10
APPROVED BY: DPT		

URS Dames & Moore

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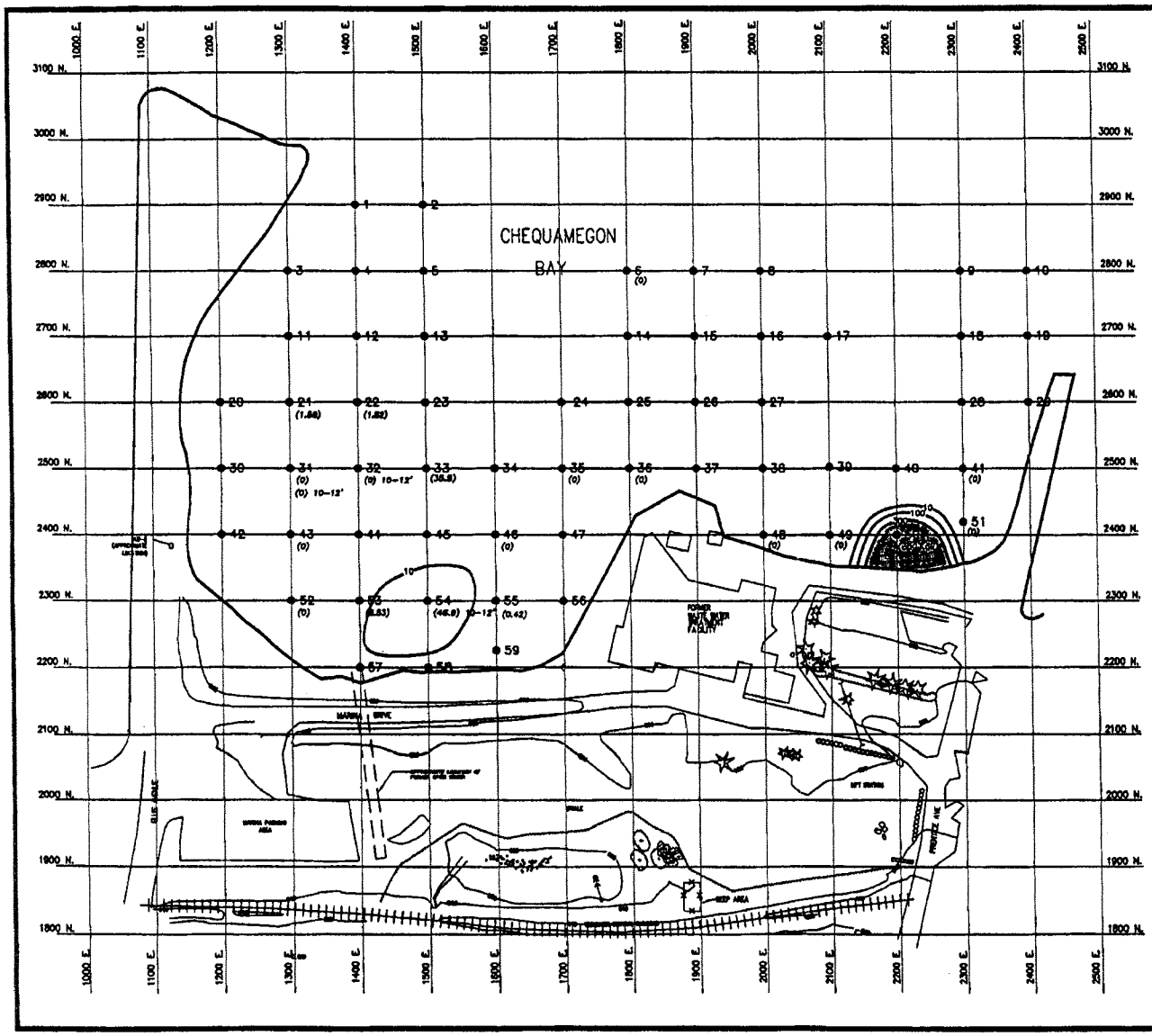

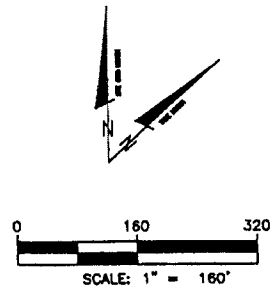

LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 SVOC ISOCONCENTRATION CONTOUR (MG/KG)
- (1.1) SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* SVOC CONCENTRATION (MG/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.

SVOC UNITS ARE REPORTED IN MG/KG DRY WEIGHT

AREA OF TOTAL SVOCs > 300 MG/KG = 0.17 ACRES
AREA OF TOTAL SVOCs > 1000 MG/KG = 0.05 ACRES

PROJECT: NSP/ASHLAND-LAKEFRONT SITE
ASHLAND, WISCONSIN

TITLE: FIGURE 3E
TOTAL SVOCs AT 8-10 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: BRH	SCALE: 1"=160'	PROJ. NO. 05644-088
CHECKED BY: DPT	DATE: 02.MAY.01	SHEET 7 OF 10
APPROVED BY: DPT		

URS Dames & Moore

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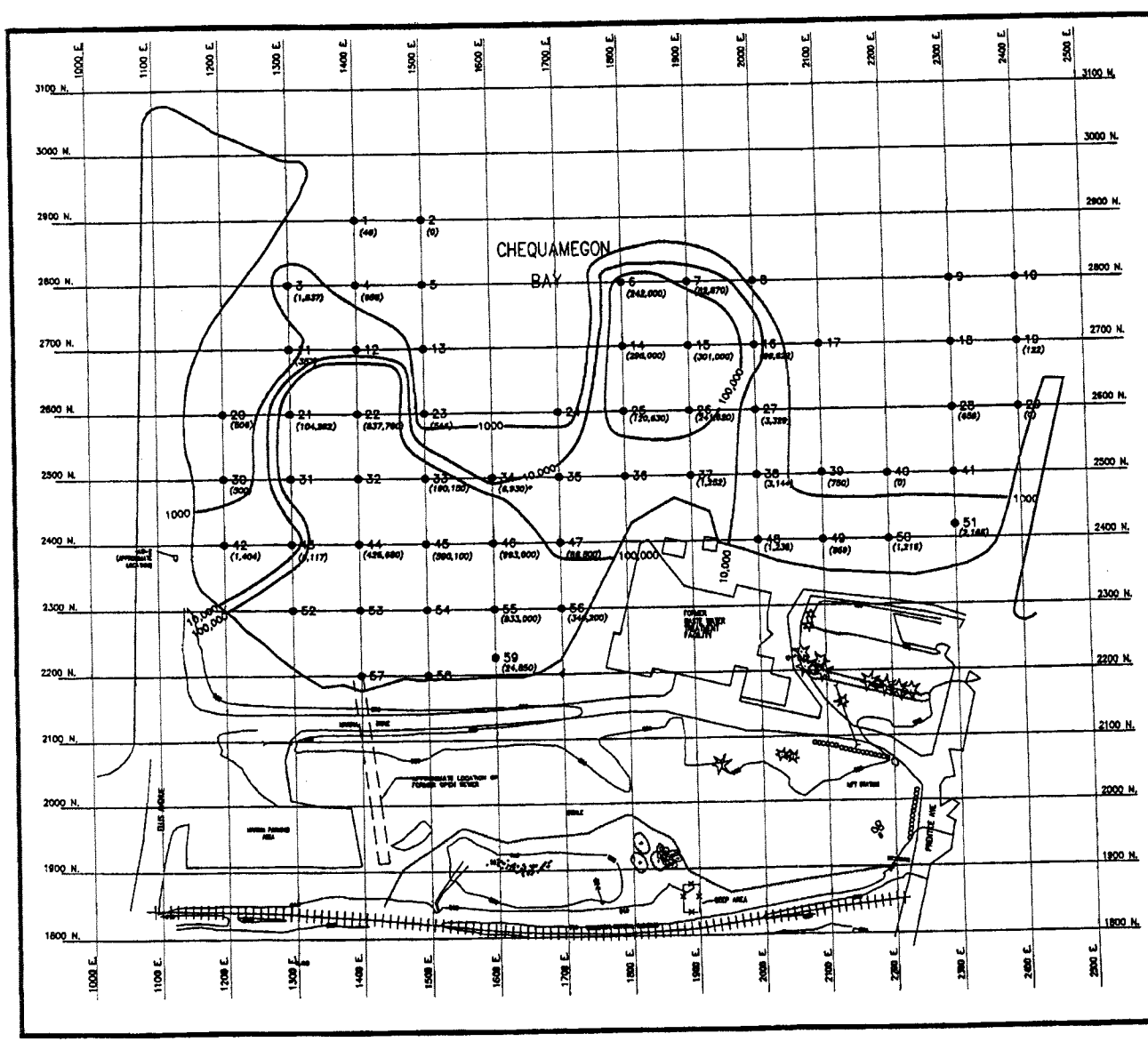
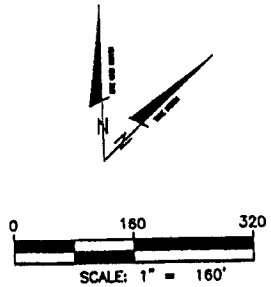




LEGEND

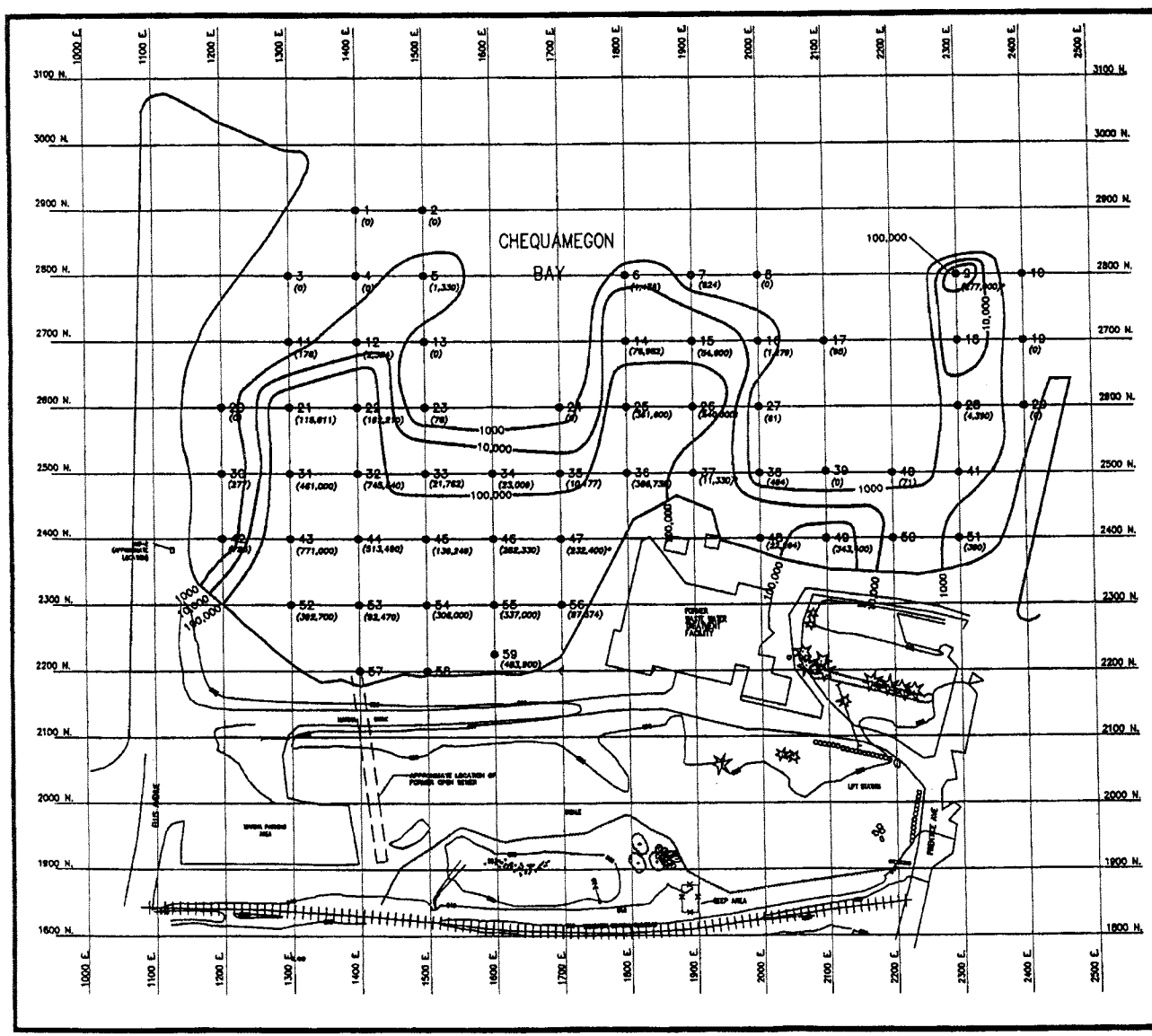
- ● 10 SEDIMENT SAMPLING LOCATION
- 10 VOC ISOCONCENTRATION CONTOUR (ug/KG)
- (1.1) VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

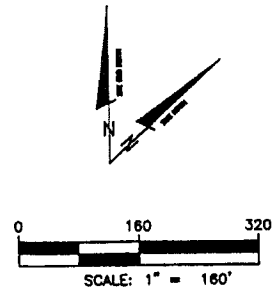
NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
VOC UNITS ARE REPORTED IN ug/KG DRY WEIGHT

PROJECT:	NSP/ASHLAND-LAKEFRONT SITE ASHLAND, WISCONSIN
TITLE:	FIGURE 4A TOTAL VOCs AT 0-2 FT. INTERVAL CHEQUAMEGON BAY
DRAWN BY: AMS	SCALE: 1"=160'
CHECKED BY: DPT	DATE: 08JAN97
APPROVED BY: DPT	
PROJ. NO. 05644-098	SHEET 8 OF 10

URS Dames & Moore

FILE: S:\CADFILES\WSP\05644098\050_FIGURE_4A





LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 VOC ISOCONCENTRATION CONTOUR (ug/KG)
- (1.1) VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1998.
VOC UNITS ARE REPORTED IN ug/KG DRY WEIGHT

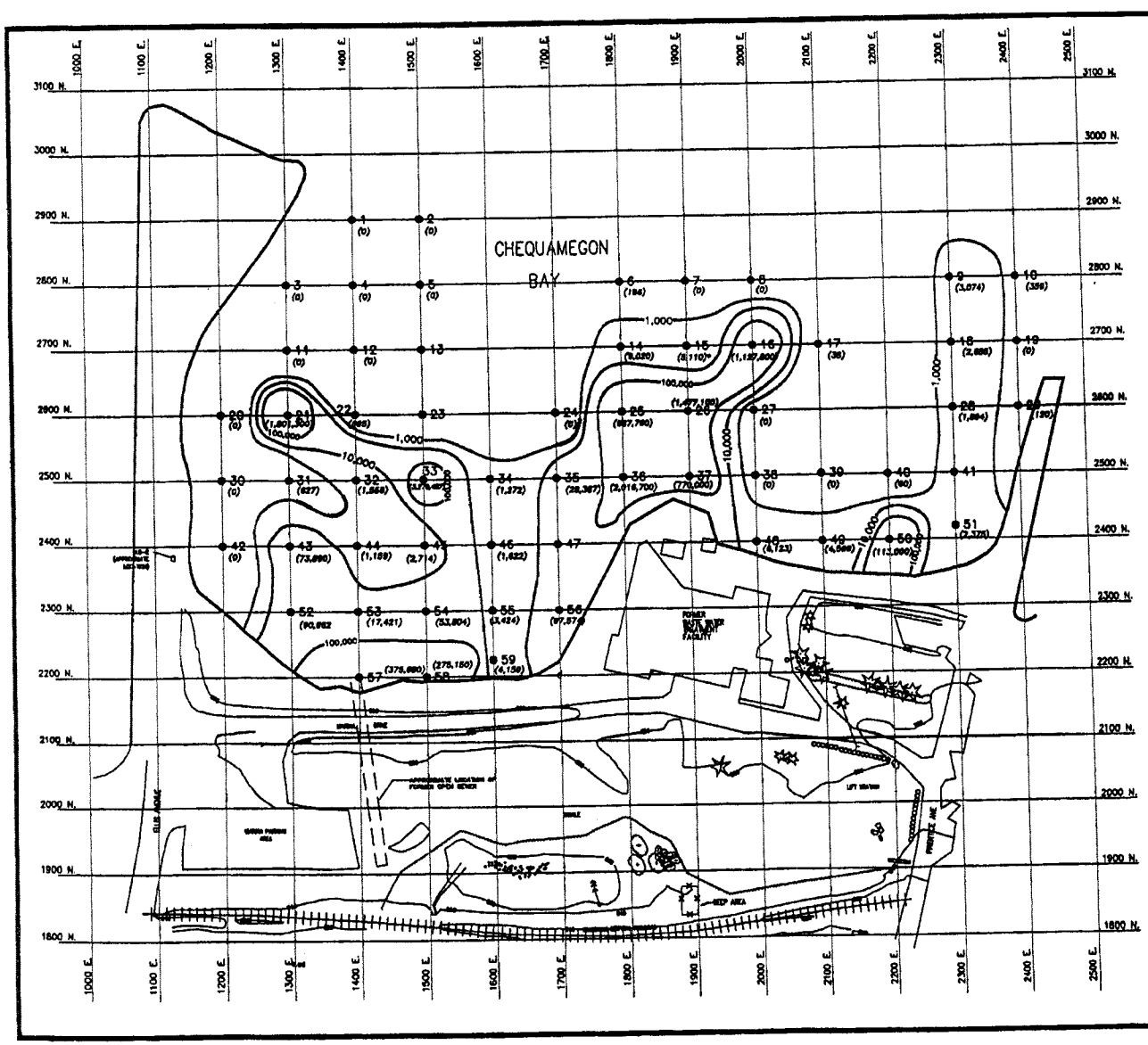
PROJECT: NSP/ASHLAND–LAKEFRONT SITE
ASHLAND, WISCONSIN

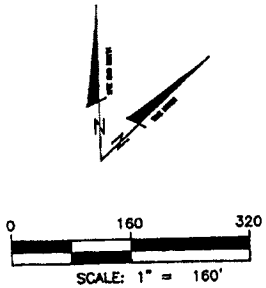
TITLE: FIGURE 4B
TOTAL VOCs AT 2–4 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: AMS	SCALE: 1"=160'	PROJ. NO. 05644-098
CHECKED BY: DPT	DATE: 02.MAY.01	SHEET 9 OF 19
APPROVED BY: DPT		

URS Dames & Moore

FILE: S:\CADFILES\NSP\05644098\0501_FIGURE_4B





LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 VOC ISOCONCENTRATION CONTOUR (ug/KG)
- (1.1) VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
VOC UNITS ARE REPORTED IN ug/KG DRY WEIGHT

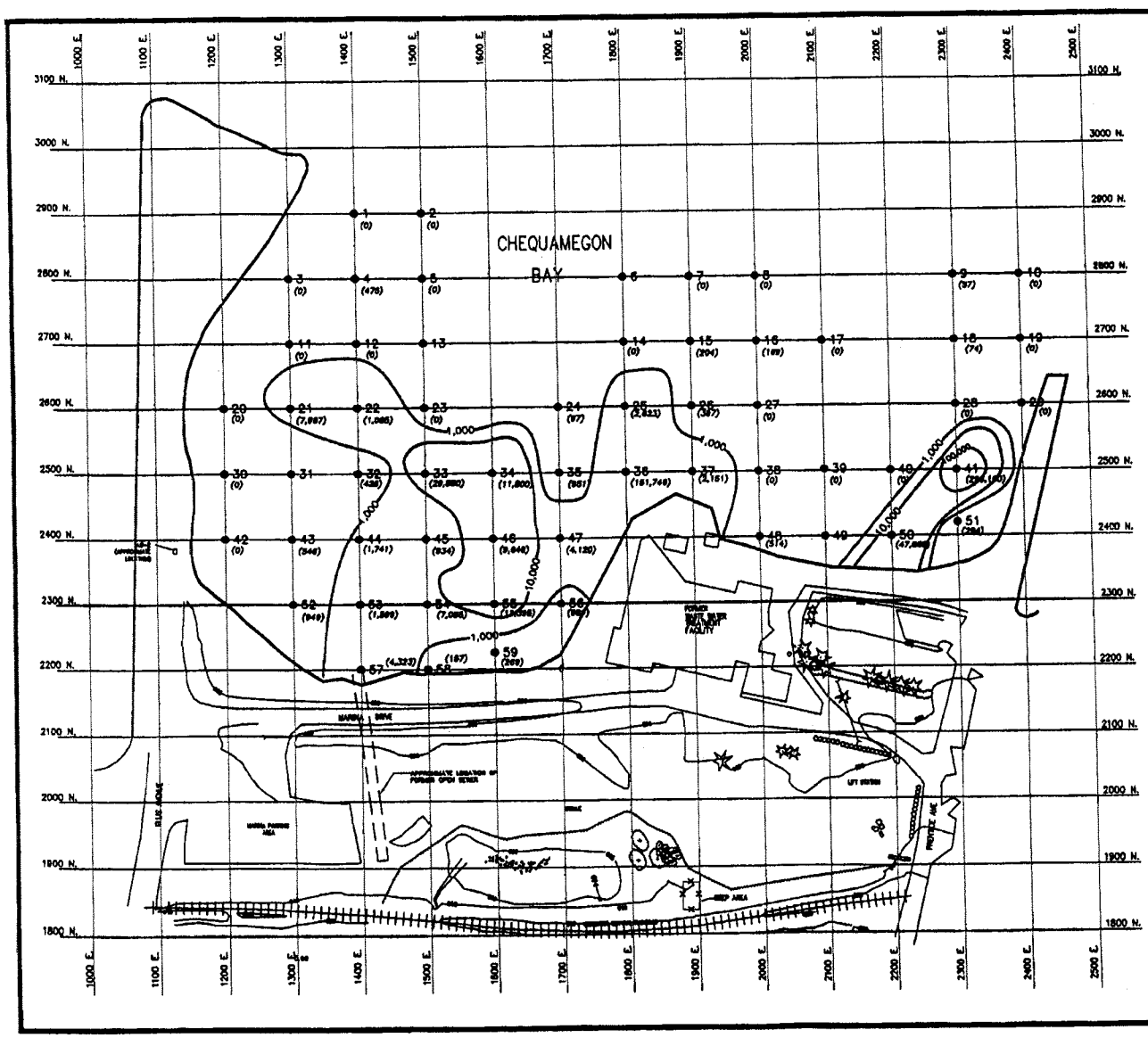
PROJECT: NSP/ASHLAND-LAKEFRONT SITE
ASHLAND, WISCONSIN

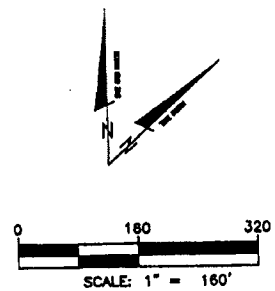
TITLE: FIGURE 4C
TOTAL VOCs AT 4-6 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: AMS	SCALE: 1"=160'	PROJ. NO. 05644-098
CHECKED BY: DPT	DATE: 08.MAY.01	SHEET 10 OF 19
APPROVED BY: DPT		

URS Dames & Moore

FILE: S:\CADDFILES\NSP\05644098\0501_FIGURE_4C





LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 VOC ISOCONCENTRATION CONTOUR (ug/KG)
- (1.1) VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
VOC UNITS ARE REPORTED IN ug/KG DRY WEIGHT

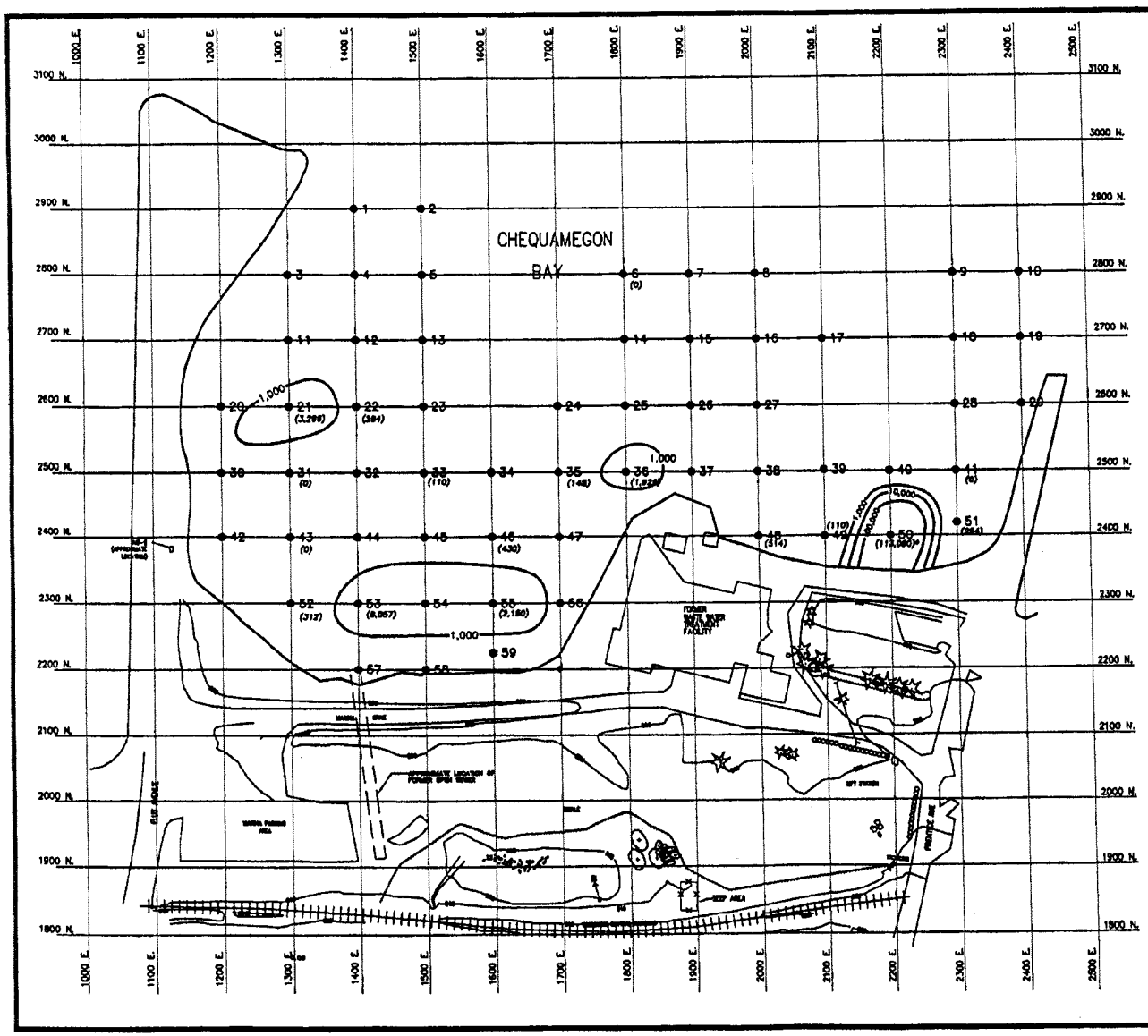
PROJECT: NSP/ASHLAND–LAKEFRONT SITE
ASHLAND, WISCONSIN

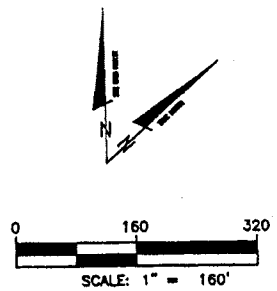
TITLE: FIGURE 4D
TOTAL VOCs AT 6–8 FT. INTERVAL
CHEQUAMEGON BAY

DRAWN BY: AMS	SCALE: 1"=160'	PROJ. NO. 05844-098
CHECKED BY: DPT	DATE: 03.MAY.01	SHEET 11 OF 19
APPROVED BY: DPT		

URS Dames & Moore

FILE: S:\CADFILES\NSP\05844098\0501_FIGURE_4D





LEGEND

- ● 10 SEDIMENT SAMPLING LOCATION
- 10 VOC ISOCONCENTRATION CONTOUR (ug/KG)
- (1.1) VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY TEST AMERICA
- (1.1)* VOC CONCENTRATION (ug/KG) SAMPLE ANALYZED BY META ENVIRONMENTAL
- RAILROAD TRACKS
- TOPOGRAPHIC CONTOUR (5' INTERVAL)
- CULVERT
- PINE TREE
- TREE
- SHRUB / HEDGE
- MARSH

NOTE:
BASE MAP ON KREHER PARK FROM SEH DRAFT FEASIBILITY STUDY, DATED FEBRUARY 1996.
VOC UNITS ARE REPORTED IN ug/KG DRY WEIGHT

PROJECT:	NSP/ASHLAND–LAKEFRONT SITE ASHLAND, WISCONSIN
TITLE:	FIGURE 4E TOTAL VOCs AT 8–10 FT. INTERVAL CHEQUAMEGON BAY
DRAWN BY: AMS	SCALE: 1"=160' / PROJ. NO. 05644-098
CHECKED BY: DPT	DATE: 02.MAY.01 / SHEET 12 OF 18
APPROVED BY: DPT	

URS Dames & Moore

FILE: S:\CADDFILES\NSP\05644098\0501_FIGURE_4D

Appendix D

Chemical Analysis Laboratory Reports

EN CHEM INC.
1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
FAX: 920-469-8827

- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Client: SEH

WI DNR LAB ID : 405132750

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
811297-001	3100N / 2300E	3/29/01			
811297-002	3100N / 1500E	3/29/01			
811297-003	2400N / 1700E	3/29/01			
811297-004	2400N / 1400E	3/29/01			
811297-005	2500N / 1700E	3/29/01			
811297-006	2500N / 1600E	3/29/01			

Please visit our Internet homepage at: www.enchem.com

The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.

Approval Signature

4/18/01
Date

PRELIMINARY SAMPLES (BEFORE DILUTIONS).

Documentation of Subcontracted Analysis

Listed below are the labs used for subcontracted analysis and associated FID number.

Code	Laboratory	Wisconsin FID Number
*MD	En Chem Madison	113172950
*GB	En Chem Green Bay	405132750
*SP	En Chem Superior	816079330
*RL	Robert E. Lee	405043870
*NL	Northern Lakes Service	721026460
*SF	Sommer - Frey	241249360
*CT	Commonwealth Tech.	157066030
*QO	Quanterrra - North Canton, OH	999518190
*QP	Quanterra - Pittsburgh, PA	998027800
*KM	Kemron - Merietta, OH	998202040

*SUB Indicates analysis that requires no certification

EN CHEM - GREEN BAY **COOLER RECEIPT LOG**

Batch No. 811297 Project Name or ID WIDNR 9401.00 No. of Coolers: 1

Temps: / / 1.5 °C WI only(circle): ROI

A. Receipt Phase: Date cooler was opened: 4/3/01 By: ARO

				Initals/Date
1: Were temperture blanks present? ..(record temperatures above)	YES	NO		ARO 4/3/01
2: Were custody seals present? (Also record on COC)	YES	NO		
3: Are COC documents present?	YES	NO[2]		
4: Were all sample containers for tests requested on the COC received?	YES	NO[2]		
5: Do sample labels match the COC?	YES	NO[2]		
6: Are there any short holdtime tests?	YES[1]	NO		
7: Are sample volumes adequate for tests requested?	YES	NO[2]		
8: Are VOC samples free of bubbles >6mm	YES	NO[2]	NA	
9: Are dissolved parameters field filtered?	YES	NO[2]	NA	
10: Check sample pH of preserved samples. (not VOCs) Completed	YES	NO	NA	
11: Are samples preserved properly?	YES	NO[2]		
12: Started nonconformance/phone log record if applicable. Completed	YES	NO	NA	
13: Enter samples into Project Logbook. Completed	YES	NO		
14: Place laboratory sample number on all containers Completed	YES	NO		NJ
15: Check laboratory sample number on all containers and COC Completed	YES	NO		ARO

B. Log-In Phase: Date samples were logged-in: 4-3-01 By: BB

1: Were samples received on ice? (Must be ≤ 4 C)	YES	NO[2]		4-3-01 BB
2: Is the COC signed as received by En Chem ?	YES	NO		
3: Is this Project a Quick Turn Project?	YES	NO		
4: Is there any sub-work?	YES	NO		
5: Are any samples nearing expiration of hold-time? (Within 2 days)	YES[1]	NO	Contacted	
6: Initiate Subcontracting procedure, SOP 1-REC-4, if applicable. Completed	YES	NO	NA	

Short Hold-time tests:

48 Hours or less	7 days	Footnotes
Coliform (6 hrs)	Flashpoint	1 Notify proper lab group immediately.
Hexavalent Chromium (24 Hrs)	TSS	2 Complete phone log.
BOD	Total Solids	
Nitrite	TDS	
Ortho Phosphorus	Sulfide	
Turbidity	Free Liquids	
Surfactants	Total Volatile Solids	
Sulfite	Aqueous Extractable Organics- ALL	
En Core Preservation	Unpreserved VOC's	
Color	Ash	

Rev. 12/15/99, Attachment to 1-REC-5. *Subject to QA Audit.

I have reviewed Log-in sheets, resolved all nonconformance issues,corrected and properly documented these actions

Project Mgmt reviewed by/date CW 4/4/01

F:\SOP\FORMS\GBCRL_04.DOC

April 24, 2000

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

Lab#:	TestGroupID:	Comment:
811297-001 3100N / 2300E	8260+-S-ME	Sample was prepared under the assumption that the sample was received with 20g soil to 20 ml methanol. Later it was discovered that 25g of soil was used. Final ratio after assuming 25g of soil was 25g to 34.1 ml methanol.
811297-002 3100N / 1500E	8260+-S-ME	Sample was prepared under the assumption that the sample was received with 20g soil to 20 ml methanol. Later it was discovered that 25g of soil was used. Final ratio after assuming 25g of soil was 25g to 33.8 ml methanol.
	8260+-S-ME	Surrogate failure low. This was due to the fact that the surrogate was added assuming 20g of soil while the actual sample weight was 25g. The extra methanol addition biased the surrogate recoveries low.
811297-003 2400N / 1700E	8260+-S-ME	Sample was received with 49.9 ml of Methanol assuming the soil weight was 25 grams.
	8260+-S-ME	Surrogate failure low. This was due to the fact that the surrogate was added assuming 20g of soil while the actual sample weight was 25g. The extra methanol addition biased the surrogate recoveries low.
811297-004 2400N / 1400E	8260+-S-ME	Sample was prepared under the assumption that the sample was received with 20g soil to 20 ml methanol. Later it was discovered that 25g of soil was used. Final ratio after assuming 25g of soil was 25g to 35.5 ml methanol.
	8260+-S-ME	Surrogate failure low. This was due to the fact that the surrogate was added assuming 20g of soil while the actual sample weight was 25g. The extra methanol addition biased the surrogate recoveries low.
811297-005 2500N / 1700E	8260+-S-ME	Sample was prepared under the assumption that the sample was received with 20g soil to 20 ml methanol. Later it was discovered that 25g of soil was used. Final ratio after assuming 25g of soil was 25g to 34.2 ml methanol.
	8260+-S-ME	Surrogate failure low. This was due to the fact that the surrogate was added assuming 20g of soil while the actual sample weight was 25g. The extra methanol addition biased the surrogate recoveries low.
811297-006 2500N / 1600E	8260+-S-ME	Sample was prepared under the assumption that the sample was received with 20g soil to 20 ml methanol. Later it was discovered that 25g of soil was used. Final ratio after assuming 25g of soil was 25g to 34.7 ml methanol.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 | **Client :** SEH

Field ID : 3100N / 2300E | **Report Date :** 4/16/01

Lab Sample Number : 811297-001 | **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 | **Matrix Type :** SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	22000	1700	5400		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	60.0				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromoform	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloroform	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 34	34	82		ug/kg		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 3100N / 2300E **Report Date :** 4/16/01

Lab Sample Number : 811297-001 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
trans-1,2-Dichloroethene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,2-Dichloropropane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1-Dichloroethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,3-Dichloropropane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
2,2-Dichloropropane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1-Dichloropropene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
cis-1,3-Dichloropropene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
trans-1,3-Dichloropropene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Diisopropyl ether	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Ethylbenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Fluorotrichloromethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Hexachlorobutadiene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Isopropylbenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
p-Isopropyltoluene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Methylene chloride	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Naphthalene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
n-Propylbenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Styrene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Tetrachloroethene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Toluene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,1-Trichloroethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,2-Trichloroethane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,4-Trimethylbenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Trichloroethene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,3-Trichloropropane	<	34	34	82	ug/kg	4/4/01	SW846 8260B
1,3,5-Trimethylbenzene	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Vinyl chloride	<	34	34	82	ug/kg	4/4/01	SW846 8260B
Xylenes, -m, -p	<	68	68	160	ug/kg	4/4/01	SW846 8260B
Xylene, -o	<	34	34	82	ug/kg	4/4/01	SW846 8260B
4-Bromofluorobenzene		70			%Recov	4/4/01	SW846 8260B
Dibromofluoromethane		70			%Recov	4/4/01	SW846 8260B
Toluene-d8		76			%Recov	4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 3100N / 2300E

Lab Sample Number : 811297-001

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW/846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	< 23	23	73		ug/kg		4/5/01	SW846 8270
Acenaphthylene	32	32	100		ug/kg	Q	4/5/01	SW846 8270
Anthracene	21	18	57		ug/kg	Q	4/5/01	SW846 8270
Benzo(a)anthracene	78	23	73		ug/kg		4/5/01	SW846 8270
Benzo(a)pyrene	120	27	86		ug/kg		4/5/01	SW846 8270
Benzo(b)fluoranthene	78	22	70		ug/kg		4/5/01	SW846 8270
Benzo(g,h,i)perylene	76	28	89		ug/kg	Q	4/5/01	SW846 8270
Benzo(k)fluoranthene	100	22	70		ug/kg		4/5/01	SW846 8270
Chrysene	88	23	73		ug/kg		4/5/01	SW846 8270
Dibenzo(a,h)anthracene	< 27	27	86		ug/kg		4/5/01	SW846 8270
Fluoranthene	110	25	80		ug/kg		4/5/01	SW846 8270
Fluorene	< 17	17	54		ug/kg		4/5/01	SW846 8270
Indeno(1,2,3-cd)pyrene	52	27	86		ug/kg	Q	4/5/01	SW846 8270
1-Methylnaphthalene	< 23	23	73		ug/kg		4/5/01	SW846 8270
2-Methylnaphthalene	26	22	70		ug/kg	Q	4/5/01	SW846 8270
Naphthalene	32	23	73		ug/kg	Q	4/5/01	SW846 8270
Phenanthrene	78	23	73		ug/kg		4/5/01	SW846 8270
Pyrene	120	22	70		ug/kg		4/5/01	SW846 8270
Nitrobenzene-d5	53				%Recov		4/5/01	SW846 8270
2-Fluorobiphenyl	68				%Recov		4/5/01	SW846 8270
Terphenyl-d14	107				%Recov		4/5/01	SW846 8270

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 3100N / 1500E

Lab Sample Number : 811297-002

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	46000	340	1100		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	44.0				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromoform	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloroform	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 34	34	82		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 34	34	82		ug/kg		4/4/01	SW846 8260B

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 3100N / 1500E **Report Date :** 4/16/01

Lab Sample Number : 811297-002 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
trans-1,2-Dichloroethene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,2-Dichloropropane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1-Dichloroethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,3-Dichloropropane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
2,2-Dichloropropane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1-Dichloropropene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
cis-1,3-Dichloropropene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
trans-1,3-Dichloropropene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Diisopropyl ether	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Ethylbenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Fluorotrichloromethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Hexachlorobutadiene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Isopropylbenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
p-Isopropyltoluene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Methylene chloride	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Naphthalene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
n-Propylbenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Styrene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Tetrachloroethene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Toluene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,1-Trichloroethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,1,2-Trichloroethane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,4-Trimethylbenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Trichloroethene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,2,3-Trichloropropane	< 34	34	82	ug/kg	4/4/01	SW846 8260B
1,3,5-Trimethylbenzene	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Vinyl chloride	< 34	34	82	ug/kg	4/4/01	SW846 8260B
Xylenes, -m, -p	< 68	68	160	ug/kg	4/4/01	SW846 8260B
Xylene, -o	< 34	34	82	ug/kg	4/4/01	SW846 8260B
4-Bromofluorobenzene	62			%Recov	4/4/01	SW846 8260B
Dibromofluoromethane	63			%Recov	4/4/01	SW846 8260B
Toluene-d8	66			%Recov	4/4/01	SW846 8260B

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 3100N / 1500E

Lab Sample Number : 811297-002

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	32	32	100		ug/kg	Q	4/5/01	SW846 8270
Acenaphthylene	74	43	140		ug/kg	Q	4/5/01	SW846 8270
Anthracene	51	25	80		ug/kg	Q	4/5/01	SW846 8270
Benzo(a)anthracene	200	32	100		ug/kg		4/5/01	SW846 8270
Benzo(a)pyrene	290	36	110		ug/kg		4/5/01	SW846 8270
Benzo(b)fluoranthene	150	30	96		ug/kg		4/5/01	SW846 8270
Benzo(g,h,i)perylene	160	39	120		ug/kg		4/5/01	SW846 8270
Benzo(k)fluoranthene	240	30	96		ug/kg		4/5/01	SW846 8270
Chrysene	200	32	100		ug/kg		4/5/01	SW846 8270
Dibenzo(a,h)anthracene	< 36	36	110		ug/kg		4/5/01	SW846 8270
Fluoranthene	240	34	110		ug/kg		4/5/01	SW846 8270
Fluorene	30	23	73		ug/kg	Q	4/5/01	SW846 8270
Indeno(1,2,3-cd)pyrene	110	36	110		ug/kg		4/5/01	SW846 8270
1-Methylnaphthalene	55	32	100		ug/kg	Q	4/5/01	SW846 8270
2-Methylnaphthalene	120	30	96		ug/kg		4/5/01	SW846 8270
Naphthalene	170	32	100		ug/kg		4/5/01	SW846 8270
Phenanthrene	160	32	100		ug/kg		4/5/01	SW846 8270
Pyrene	260	30	96		ug/kg		4/5/01	SW846 8270
Nitrobenzene-d5	58				%Recov		4/5/01	SW846 8270
2-Fluorobiphenyl	76				%Recov		4/5/01	SW846 8270
Terphenyl-d14	102				%Recov		4/5/01	SW846 8270

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 — **Client :** SEH

Field ID : 2400N / 1700E — **Report Date :** 4/16/01

Lab Sample Number : 811297-003 — **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 — **Matrix Type :** SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	250000	1700	5400		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	27.6				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL — **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	630	180	430		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Bromoform	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Chloroform	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 50	50	120		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 50	50	120		ug/kg		4/4/01	SW846 8260B

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 2400N / 1700E **Report Date :** 4/16/01

Lab Sample Number : 811297-003 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
trans-1,2-Dichloroethene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,2-Dichloropropane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,3-Dichloropropane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
2,2-Dichloropropane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1-Dichloropropene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
cis-1,3-Dichloropropene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
trans-1,3-Dichloropropene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Diisopropyl ether	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Ethylbenzene		910	180	430	ug/kg		4/4/01	SW846 8260B
Fluorotrichloromethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Hexachlorobutadiene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Isopropylbenzene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
p-Isopropyltoluene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Methylene chloride		180	180	430	ug/kg	Q	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Naphthalene		11000	180	430	ug/kg		4/4/01	SW846 8260B
n-Propylbenzene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Styrene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Tetrachloroethene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Toluene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1,1-Trichloroethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,1,2-Trichloroethane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,2,4-Trimethylbenzene		760	180	430	ug/kg		4/4/01	SW846 8260B
Trichloroethene	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichloropropane	<	50	50	120	ug/kg		4/4/01	SW846 8260B
1,3,5-Trimethylbenzene		260	180	430	ug/kg	Q	4/4/01	SW846 8260B
Vinyl chloride	<	50	50	120	ug/kg		4/4/01	SW846 8260B
Xylenes, -m, -p		450	360	860	ug/kg	Q	4/4/01	SW846 8260B
Xylene, -o		400	180	430	ug/kg	Q	4/4/01	SW846 8260B
4-Bromofluorobenzene		45			%Recov		4/4/01	SW846 8260B
Dibromofluoromethane		54			%Recov		4/4/01	SW846 8260B
Toluene-d8		55			%Recov		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 | **Client :** SEH

Field ID : 2400N / 1700E | **Report Date :** 4/16/01

Lab Sample Number : 811297-003 | **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 | **Matrix Type :** SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	3000	100	320		ug/kg		4/5/01	SW846 8270
Acenaphthylene	550	140	450		ug/kg		4/5/01	SW846 8270
Anthracene	1600	80	250		ug/kg		4/5/01	SW846 8270
Benzo(a)anthracene	2200	100	320		ug/kg		4/5/01	SW846 8270
Benzo(a)pyrene	2600	120	380		ug/kg		4/5/01	SW846 8270
Benzo(b)fluoranthene	1400	94	300		ug/kg		4/5/01	SW846 8270
Benzo(g,h,i)perylene	1300	120	380		ug/kg		4/5/01	SW846 8270
Benzo(k)fluoranthene	2000	94	300		ug/kg		4/5/01	SW846 8270
Chrysene	2000	100	320		ug/kg		4/5/01	SW846 8270
Dibenzo(a,h)anthracene	280	120	380		ug/kg	Q	4/5/01	SW846 8270
Fluoranthene	3300	110	350		ug/kg		4/5/01	SW846 8270
Fluorene	1300	72	230		ug/kg		4/5/01	SW846 8270
Indeno(1,2,3-cd)pyrene	930	120	380		ug/kg		4/5/01	SW846 8270
1-Methylnaphthalene	3400	100	320		ug/kg		4/5/01	SW846 8270
2-Methylnaphthalene	4000	94	300		ug/kg		4/5/01	SW846 8270
Naphthalene	6100	100	320		ug/kg		4/5/01	SW846 8270
Phenanthrene	4900	100	320		ug/kg		4/5/01	SW846 8270
Pyrene	3800	94	300		ug/kg		4/5/01	SW846 8270
Nitrobenzene-d5	56				%Recov		4/5/01	SW846 8270
2-Fluorobiphenyl	76				%Recov		4/5/01	SW846 8270
Terphenyl-d14	95				%Recov		4/5/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 2400N / 1400E

Lab Sample Number : 811297-004

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	280000	1700	5400		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	41.5				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	2000	86	210		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Bromoform	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Chloroform	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 36	36	86		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 36	36	86		ug/kg		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 2400N / 1400E **Report Date :** 4/16/01

Lab Sample Number : 811297-004 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
trans-1,2-Dichloroethene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,2-Dichloropropane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,3-Dichloropropane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
2,2-Dichloropropane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1-Dichloropropene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
cis-1,3-Dichloropropene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
trans-1,3-Dichloropropene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Diisopropyl ether	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Ethylbenzene		1400	86	210	ug/kg		4/4/01	SW846 8260B
Fluorotrichloromethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Hexachlorobutadiene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Isopropylbenzene		220	86	210	ug/kg		4/4/01	SW846 8260B
p-Isopropyltoluene		110	86	210	ug/kg	Q	4/4/01	SW846 8260B
Methylene chloride		94	86	210	ug/kg	Q	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Naphthalene		24000	86	210	ug/kg		4/4/01	SW846 8260B
n-Propylbenzene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Styrene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Tetrachloroethene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Toluene		100	86	210	ug/kg	Q	4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1,1-Trichloroethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,1,2-Trichloroethane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,2,4-Trimethylbenzene		1100	86	210	ug/kg		4/4/01	SW846 8260B
Trichloroethene	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichloropropane	<	36	36	86	ug/kg		4/4/01	SW846 8260B
1,3,5-Trimethylbenzene		350	86	210	ug/kg		4/4/01	SW846 8260B
Vinyl chloride	<	36	36	86	ug/kg		4/4/01	SW846 8260B
Xylenes, -m, -p		870	170	410	ug/kg		4/4/01	SW846 8260B
Xylene, -o		770	86	210	ug/kg		4/4/01	SW846 8260B
4-Bromofluorobenzene		60			%Recov		4/4/01	SW846 8260B
Dibromofluoromethane		61			%Recov		4/4/01	SW846 8260B
Toluene-d8		64			%Recov		4/4/01	SW846 8260B

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 2400N / 1400E

Lab Sample Number : 811297-004

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW/846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	22000	670	2100		ug/kg		4/3/01	SW846 8270
Acenaphthylene	4100	920	2900		ug/kg		4/3/01	SW846 8270
Anthracene	18000	530	1700		ug/kg		4/3/01	SW846 8270
Benzo(a)anthracene	18000	670	2100		ug/kg		4/3/01	SW846 8270
Benzo(a)pyrene	20000	770	2500		ug/kg		4/3/01	SW846 8270
Benzo(b)fluoranthene	7000	630	2000		ug/kg		4/3/01	SW846 8270
Benzo(g,h,i)perylene	8200	820	2600		ug/kg		4/3/01	SW846 8270
Benzo(k)fluoranthene	15000	630	2000		ug/kg		4/3/01	SW846 8270
Chrysene	16000	670	2100		ug/kg		4/3/01	SW846 8270
Dibenzo(a,h)anthracene	1600	770	2500		ug/kg	Q	4/3/01	SW846 8270
Fluoranthene	34000	720	2300		ug/kg		4/3/01	SW846 8270
Fluorene	12000	480	1500		ug/kg		4/3/01	SW846 8270
Indeno(1,2,3-cd)pyrene	5700	770	2500		ug/kg		4/3/01	SW846 8270
1-Methylnaphthalene	15000	670	2100		ug/kg		4/3/01	SW846 8270
2-Methylnaphthalene	22000	630	2000		ug/kg		4/3/01	SW846 8270
Naphthalene	21000	670	2100		ug/kg		4/3/01	SW846 8270
Phenanthrene	51000	670	2100		ug/kg		4/3/01	SW846 8270
Pyrene	46000	630	2000		ug/kg		4/3/01	SW846 8270
Nitrobenzene-d5	48				%Recov		4/3/01	SW846 8270
2-Fluorobiphenyl	63				%Recov		4/3/01	SW846 8270
Terphenyl-d14	101				%Recov		4/3/01	SW846 8270

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 — **Client :** SEH

Field ID : 2500N / 1700E — **Report Date :** 4/16/01

Lab Sample Number : 811297-005 — **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 — **Matrix Type :** SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	18000	170	540		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	67.6				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL — **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Bromoform	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Chloroform	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 680	680	1600		ug/kg		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 2500N / 1700E **Report Date :** 4/16/01

Lab Sample Number : 811297-005 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
trans-1,2-Dichloroethene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,2-Dichloropropane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,3-Dichloropropane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
2,2-Dichloropropane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1-Dichloropropene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
cis-1,3-Dichloropropene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
trans-1,3-Dichloropropene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Diisopropyl ether	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Ethylbenzene		5300	1000	2400	ug/kg		4/4/01	SW846 8260B
Fluorotrichloromethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Hexachlorobutadiene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Isopropylbenzene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
p-Isopropyltoluene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Methylene chloride		1100	1000	2400	ug/kg	Q	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Naphthalene		240000	1000	2400	ug/kg		4/4/01	SW846 8260B
n-Propylbenzene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Styrene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Tetrachloroethene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Toluene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1,1-Trichloroethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,1,2-Trichloroethane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,2,4-Trimethylbenzene		4500	1000	2400	ug/kg		4/4/01	SW846 8260B
Trichloroethene	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichloropropane	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
1,3,5-Trimethylbenzene		1500	1000	2400	ug/kg	Q	4/4/01	SW846 8260B
Vinyl chloride	<	680	680	1600	ug/kg		4/4/01	SW846 8260B
Xylenes, -m, -p		3300	2000	4800	ug/kg	Q	4/4/01	SW846 8260B
Xylene, -o		1900	1000	2400	ug/kg	Q	4/4/01	SW846 8260B
4-Bromofluorobenzene		64			%Recov		4/4/01	SW846 8260B
Dibromofluoromethane		67			%Recov		4/4/01	SW846 8260B
Toluene-d8		70			%Recov		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 | **Client :** SEH

Field ID : 2500N / 1700E | **Report Date :** 4/16/01

Lab Sample Number : 811297-005 | **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 | **Matrix Type :** SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW/846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	30000	1200	3800		ug/kg		4/5/01	SW846 8270
Acenaphthylene	2000	1700	5400		ug/kg	Q	4/5/01	SW846 8270
Anthracene	16000	980	3100		ug/kg		4/5/01	SW846 8270
Benzo(a)anthracene	6600	1200	3800		ug/kg		4/5/01	SW846 8270
Benzo(a)pyrene	6200	1400	4500		ug/kg		4/5/01	SW846 8270
Benzo(b)fluoranthene	2700	1200	3800		ug/kg	Q	4/5/01	SW846 8270
Benzo(g,h,i)perylene	2900	1500	4800		ug/kg	Q	4/5/01	SW846 8270
Benzo(k)fluoranthene	6700	1200	3800		ug/kg		4/5/01	SW846 8270
Chrysene	7500	1200	3800		ug/kg		4/5/01	SW846 8270
Dibenzo(a,h)anthracene	< 1400	1400	4500		ug/kg		4/5/01	SW846 8270
Fluoranthene	18000	1300	4100		ug/kg		4/5/01	SW846 8270
Fluorene	13000	890	2800		ug/kg		4/5/01	SW846 8270
Indeno(1,2,3-cd)pyrene	1600	1400	4500		ug/kg	Q	4/5/01	SW846 8270
1-Methylnaphthalene	34000	1200	3800		ug/kg		4/5/01	SW846 8270
2-Methylnaphthalene	51000	1200	3800		ug/kg		4/5/01	SW846 8270
Naphthalene	85000	1200	3800		ug/kg		4/5/01	SW846 8270
Phenanthrene	45000	1200	3800		ug/kg		4/5/01	SW846 8270
Pyrene	25000	1200	3800		ug/kg		4/5/01	SW846 8270
Nitrobenzene-d5	46				%Recov		4/5/01	SW846 8270
2-Fluorobiphenyl	54				%Recov		4/5/01	SW846 8270
Terphenyl-d14	62				%Recov		4/5/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 2500N / 1600E **Report Date :** 4/16/01

Lab Sample Number : 811297-006 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
TOC as NPOC	1600	170	540		mg/kg		4/5/01	SW846 9060M	SW846 9060M	*MD
Solids, percent	77.0				%		4/4/01	SM2540G	SM2540G	NJS

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 4/4/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Bromobenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Bromochloromethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Bromodichloromethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Bromoform	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Bromomethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
s-Butylbenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
t-Butylbenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
n-Butylbenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Carbon tetrachloride	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Chloroform	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Chlorobenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Chlorodibromomethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Chloroethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Chloromethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
2-Chlorotoluene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
4-Chlorotoluene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,2-Dibromoethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
Dibromomethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,3-Dichlorobenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,4-Dichlorobenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,2-Dichloroethane	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,2-Dichlorobenzene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethene	< 350	350	840		ug/kg		4/4/01	SW846 8260B
cis-1,2-Dichloroethene	< 350	350	840		ug/kg		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00 **Client :** SEH

Field ID : 2500N / 1600E **Report Date :** 4/16/01

Lab Sample Number : 811297-006 **Collection Date :** 3/29/01

WI DNR LAB ID : 405132750 **Matrix Type :** SOIL

Dichlorodifluoromethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
trans-1,2-Dichloroethene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,2-Dichloropropane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1-Dichloroethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,3-Dichloropropane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
2,2-Dichloropropane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1-Dichloropropene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
cis-1,3-Dichloropropene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
trans-1,3-Dichloropropene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Diisopropyl ether	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Ethylbenzene		1600	450	1100	ug/kg		4/4/01	SW846 8260B
Fluorotrichloromethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Hexachlorobutadiene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Isopropylbenzene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
p-Isopropyltoluene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Methylene chloride		590	450	1100	ug/kg	Q	4/4/01	SW846 8260B
Methyl-tert-butyl-ether	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Naphthalene		98000	450	1100	ug/kg		4/4/01	SW846 8260B
n-Propylbenzene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Styrene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Tetrachloroethene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Toluene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichlorobenzene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,2,4-Trichlorobenzene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1,1-Trichloroethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,1,2-Trichloroethane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,2,4-Trimethylbenzene		2600	450	1100	ug/kg		4/4/01	SW846 8260B
Trichloroethene	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,2,3-Trichloropropane	<	350	350	840	ug/kg		4/4/01	SW846 8260B
1,3,5-Trimethylbenzene		840	450	1100	ug/kg	Q	4/4/01	SW846 8260B
Vinyl chloride	<	350	350	840	ug/kg		4/4/01	SW846 8260B
Xylenes, -m, -p		1200	900	2200	ug/kg	Q	4/4/01	SW846 8260B
Xylene, -o		700	450	1100	ug/kg	Q	4/4/01	SW846 8260B
4-Bromofluorobenzene		66			%Recov		4/4/01	SW846 8260B
Dibromofluoromethane		64			%Recov		4/4/01	SW846 8260B
Toluene-d8		68			%Recov		4/4/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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Fax: 920-469-8827

- Analytical Report -

Project Name :

Project Number : WIDNR 9401.00

Field ID : 2500N / 1600E

Lab Sample Number : 811297-006

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 4/16/01

Collection Date : 3/29/01

Matrix Type : SOIL

Organic Results

PAH - SEMIVOLATILES **Prep Method:** SW/846 3545 **Prep Date:** 4/3/01 **Analyst:** AVS

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene	11000	360	1100		ug/kg		4/3/01	SW846 8270
Acenaphthylene	650	490	1600		ug/kg	Q	4/3/01	SW846 8270
Anthracene	5100	290	920		ug/kg		4/3/01	SW846 8270
Benzo(a)anthracene	2400	360	1100		ug/kg		4/3/01	SW846 8270
Benzo(a)pyrene	2400	420	1300		ug/kg		4/3/01	SW846 8270
Benzo(b)fluoranthene	860	340	1100		ug/kg	Q	4/3/01	SW846 8270
Benzo(g,h,i)perylene	1000	440	1400		ug/kg	Q	4/3/01	SW846 8270
Benzo(k)fluoranthene	2300	340	1100		ug/kg		4/3/01	SW846 8270
Chrysene	2500	360	1100		ug/kg		4/3/01	SW846 8270
Dibenzo(a,h)anthracene	< 420	420	1300		ug/kg		4/3/01	SW846 8270
Fluoranthene	6300	390	1200		ug/kg		4/3/01	SW846 8270
Fluorene	4200	260	830		ug/kg		4/3/01	SW846 8270
Indeno(1,2,3-cd)pyrene	650	420	1300		ug/kg	Q	4/3/01	SW846 8270
1-Methylnaphthalene	9500	360	1100		ug/kg		4/3/01	SW846 8270
2-Methylnaphthalene	15000	340	1100		ug/kg		4/3/01	SW846 8270
Naphthalene	17000	360	1100		ug/kg		4/3/01	SW846 8270
Phenanthrene	18000	360	1100		ug/kg		4/3/01	SW846 8270
Pyrene	8500	340	1100		ug/kg		4/3/01	SW846 8270
Nitrobenzene-d5	54				%Recov		4/3/01	SW846 8270
2-Fluorobiphenyl	58				%Recov		4/3/01	SW846 8270
Terphenyl-d14	90				%Recov		4/3/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

(Please Print Legibly)

Company Name: SEH Inc

Branch or Location: CF

Project Contact: Mark Broses

Telephone: 715 720 6234

Project Number: WIDNR 9401.00

Project Name:

Project State: WI

Sampled By (Print): CEH/MB

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300
FAX: 608-233-0502

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61182

Page ____ of ____

P.O. # ____ Quote # ____

Mail Report To:

Company:

Address:

Invoice To:

Company:

Address:

Mail Invoice To:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=EnCore F=Methanol G=NaOH
H = Sodium Bisulfate Solution I = Other

Data Package Options
(please circle if requested)
Results Only
EnChem Level III (Subject to Surcharge)
EnChem Level IV (Subject to Surcharge)

Regulatory Program	Matrix Codes
UST	W=Water
RCRA	S=Soil
SDWA	A=Air
NPDES	C=Charcoal
CERCLA	B=Biota
	SI=Sludge

LABORATORY ID (Lab Use Only)	FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	PAH	TOC	VOC					TOTAL # OF BOTTLES SENT	CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)
FILTERED? (YES/NO)					N	N	N							
PRESERVATION (CODE)*					A	A	F							
001	3100N/2300E	3/29/01	1:01pm	SI	X	X	X					3	Good	please call 1-800 1-5 unless notified
002	3100N/1500E		1:40pm		X	X	X					3		
003	2400N/1700E				X	X	X					3		
004	2400N/1400E				X	X	X					3		
005	2500N/1700E				X	X	X					3		
006	2500N/1600E				X	X	X					3		

Rush Turnaround Time Requested (TAT) - Prelim
(Rush TAT subject to approval/surcharge)
Date Needed: 4-9-01
Transmit Prelim Rush Results by (circle):
Phone Fax E-Mail
Phone #: 715 720-6234
Fax #:
E-Mail Address:

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
[signature]	3/29/01 2:00pm		
[signature]	4/2/01 16:00	[signature]	4-2-01 10:10
[signature]	4-2-01 14:00	Dunham	4-2-01 14:00
Dunham	4/3/01 0820	[signature]	4/3/01 0820

En Chem Project No. 811297

Sample Receipt Temp. 4°C

Sample Receipt pH (Wet/Metals)

Cooler Custody Seal

Present / Not Present

Intact / Not Intact

EN CHEM INC.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09 **Client:** SEH

WI DNR LAB ID : 405132750

Sample No.	Field ID	Collection Date	Sample No.	Field ID	Collection Date
811774-001	31N/23E	4/30/2001			
811774-004	31N/15E	4/30/2001			
811774-005	24N/17E	4/30/2001			
811774-006	24N/17E-FD	4/30/2001			
811774-007	24N/14E	4/30/2001			
811774-008	25N/17E	4/30/2001			
811774-009	25N/16E	4/30/2001			
811774-010	99%(31N/23E)	4/30/2001			
811774-011	90%(31N/23E)	4/30/2001			
811774-012	75%(31N/23E)	4/30/2001			
811774-013	50%(31N/23E)	4/30/2001			
811774-014	99%(31N/15E)	4/30/2001			
811774-015	90%(31N/15E)	4/30/2001			
811774-016	75%(31N/15E)	4/30/2001			
811774-017	50%(31N/15E)	4/30/2001			
811774-018	MEOH BLANK	4/30/2001			

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The "Q" flag is present when a parameter has been detected below the LOQ. This indicates the results are qualified due to the uncertainty of the parameter concentration between the LOD and the LOQ.

Soil VOC detects are corrected for the total solids, unless otherwise noted.

I certify that the data contained in this Final Report has been generated and reviewed in accordance with approved methods and Laboratory Standard Operating Procedure. Exceptions, if any, are discussed in the accompanying sample comments. Release of this final report is authorized by Laboratory management, as is verified by the following signature. Reported results shall not be reproduced, except in full, without the written approval of the lab. The sample results relate only to the analytes of interest tested.

Nathan Melkey 6/01/01

Approval Signature Date

AFTER DILUTIONS

EN CHEM
SAMPLE NARRATIVE

PROJECT NAME : SEH
WORKORDER NUMBER : 811774
DATE : 05/31/2001

:

VOLATILE ORGANICS: The project specific MS/MSD samples provided by the client were inadvertently prepared without the MS/MSD spike solution. The samples were post spiked. Matrix spike recoveries failed accuracy criteria (75% of the compounds failed approximately 5% below the lower control limits). Data reported based on acceptable BS/BSD data showing the instrument was in control.
811774-006 and –007: Surrogate failure low. This was confirmed by a second analysis on 05/09/2001.

EN CHEM
SAMPLE NARRATIVE

PROJECT NAME : SEH
WORKORDER NUMBER : 911304/811774
DATE : 5/21/2001

SEMIVOLATILE GC/MS-SIM: Both of the associated method blanks contain compounds above their respective MDL's. The samples however have these compounds at concentrations well above 20 times the blank level therefore samples were not flagged. The MS/MSD have several compounds which fail to meet their % recovery criteria. The parent and MS/MSD were analyzed at a 1:10 dilution and parent contained the failed spike compounds at concentrations at least 2 times the spiked level. The MS/MSD and parent are flagged accordingly.

SEMIVOLATILE GC/MS-Full Scan: Furan and Thiophene were too volatile to be seen during a semivolatile scan and therefore, not reported. Benzothiophene and methyl-benzofuran were not observed in the TIC search performed on the samples. Since there is no MDL for Dibenzothiophene, concentrations found below the reporting limit were flagged with a "J". Samples 911304-007, -008, -013, and -017 were analyzed at a dilution due to background interferences. The reporting limits for these samples will be elevated accordingly.

Organic Data Qualifiers

F	Surrogate results outside control criteria or not available due to sample dilution.
N	Spiked sample recovery not within control limits.
Q	The analyte has been detected between the limit of detection (LOD) and limit of quantitation (LOQ). The results are qualified due to the uncertainty of analyte concentrations within this range.
U	The analyte was not detected above the reporting limit.

Inorganic Data Qualifier

*	Duplicate not within control limits.

En Chem Inc.

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920-469-2436
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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E

Lab Sample Number : 811774-001

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	56.1				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	21000	170	540		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg	N	5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E

Lab Sample Number : 811774-001

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
Toluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,2,4-Trimethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
Xylenes, -m, -p	<	50	50	120	ug/kg	N	5/8/01	SW846 8260B
Xylene, -o	<	25	25	60	ug/kg	N	5/8/01	SW846 8260B
4-Bromofluorobenzene		79			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		80			%Recov		5/8/01	SW846 8260B
Toluene-d8		82			%Recov		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E

Lab Sample Number : 811774-001

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	60				%Recov		5/12/01	SW846 8270C
Acenaphthene-d10	72				%Recov		5/12/01	SW846 8270C
Benzo(a)pyrene-d12	76				%Recov		5/12/01	SW846 8270C
Benzo(e)pyrene	250	9.5	30		ug/kg	N	5/12/01	SW846 8270C
Acenaphthene	16	5.7	18		ug/kg	QN	5/12/01	SW846 8270C
Acenaphthylene	96	7.4	24		ug/kg		5/12/01	SW846 8270C
Anthracene	52	8.5	27		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)anthracene	280	9.9	32		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)pyrene	350	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Benzo(b)fluoranthene	210	6.6	21		ug/kg	N	5/12/01	SW846 8270C
Benzo(g,h,i)perylene	270	6.9	22		ug/kg	N	5/12/01	SW846 8270C
Benzo(k)fluoranthene	230	12	38		ug/kg	N	5/12/01	SW846 8270C
Chrysene	230	7.8	25		ug/kg	N	5/12/01	SW846 8270C
Dibenzo(a,h)anthracene	58	6.0	19		ug/kg		5/12/01	SW846 8270C
Fluoranthene	260	8.2	26		ug/kg	N	5/12/01	SW846 8270C
Fluorene	14	6.3	20		ug/kg	Q	5/12/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	180	6.1	19		ug/kg	N	5/12/01	SW846 8270C
1-Methylnaphthalene	25	7.3	23		ug/kg		5/12/01	SW846 8270C
2-Methylnaphthalene	38	8.7	28		ug/kg		5/12/01	SW846 8270C
Naphthalene	31	7.8	25		ug/kg		5/12/01	SW846 8270C
Phenanthrene	120	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Pyrene	400	9.3	30		ug/kg	N	5/12/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	77				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 68	68	220		ug/kg		5/14/01	SW846 8270
4-Methylphenol	< 77	77	250		ug/kg		5/14/01	SW846 8270
Acridine	< 590	590	1900		ug/kg		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E

Lab Sample Number : 811774-001

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Dibenzothiophene	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Quinoline	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Indole	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Xanthene	<	590	590	1900	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	23	23	73	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	23	23	73	ug/kg		5/14/01	SW846 8270
Carbazole	<	68	68	220	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	190	190	610	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
Dibenzofuran	<	23	23	73	ug/kg		5/14/01	SW846 8270
2-Nitrophenol	<	17	17	54	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	130	130	410	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	390	390	1200	ug/kg		5/14/01	SW846 8270
Phenol		93	45	140	ug/kg	Q	5/14/01	SW846 8270
Pyridine	<	100	100	320	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	46	46	150	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		94			%Recov		5/14/01	SW846 8270
Phenol-d5		90			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		86			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		80			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		82			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		82			%Recov		5/14/01	SW846 8270
Terphenyl-d14		88			%Recov		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E-MS

Lab Sample Number : 811774-002

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	59.8				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	27000	170	540		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

SPECIAL PAH LIST **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene-d10	74				%Recov		5/12/01	SW846 8270C
Benzo(a)pyrene-d12	83				%Recov		5/12/01	SW846 8270C
Benzo(e)pyrene	280	9.5	30		ug/kg	N	5/12/01	SW846 8270C
Fluoranthene-d10	55				%Recov		5/12/01	SW846 8270C
Acenaphthene	62	5.7	18		ug/kg	N	5/12/01	SW846 8270C
Acenaphthylene	150	7.4	24		ug/kg		5/12/01	SW846 8270C
Anthracene	97	8.5	27		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)anthracene	310	9.9	32		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)pyrene	360	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Benzo(b)fluoranthene	260	6.6	21		ug/kg	N	5/12/01	SW846 8270C
Benzo(g,h,i)perylene	290	6.9	22		ug/kg	N	5/12/01	SW846 8270C
Benzo(k)fluoranthene	250	12	38		ug/kg	N	5/12/01	SW846 8270C
Chrysene	250	7.8	25		ug/kg	N	5/12/01	SW846 8270C
Dibenzo(a,h)anthracene	130	6.0	19		ug/kg		5/12/01	SW846 8270C
Fluoranthene	250	8.2	26		ug/kg	N	5/12/01	SW846 8270C
Fluorene	70	6.3	20		ug/kg		5/12/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	220	6.1	19		ug/kg	N	5/12/01	SW846 8270C
1-Methylnaphthalene	75	7.3	23		ug/kg		5/12/01	SW846 8270C
2-Methylnaphthalene	88	8.7	28		ug/kg		5/12/01	SW846 8270C
Naphthalene	78	7.8	25		ug/kg		5/12/01	SW846 8270C
Phenanthrene	140	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Pyrene	370	9.3	30		ug/kg	N	5/12/01	SW846 8270C

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E-MS

Lab Sample Number : 811774-002

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL SEMI-VOLATILE LIST **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
4-Methylphenol	6000	77	250		ug/kg		5/14/01	SW846 8270
Isoquinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Quinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Xanthene	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	86				%Recov		5/14/01	SW846 8270
Indole	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Methylphenol	5500	68	220		ug/kg		5/14/01	SW846 8270
Acridine	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Benzofuran	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Dibenzothiophene	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Chlorophenol	5400	23	73		ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	5300	23	73		ug/kg		5/14/01	SW846 8270
Carbazole	5200	68	220		ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	5300	26	83		ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	4400	190	610		ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	4900	26	83		ug/kg		5/14/01	SW846 8270
Dibenzofuran	4900	23	73		ug/kg		5/14/01	SW846 8270
2-Nitrophenol	5100	17	54		ug/kg		5/14/01	SW846 8270
4-Nitrophenol	5500	130	410		ug/kg		5/14/01	SW846 8270
Pentachlorophenol	5600	390	1200		ug/kg		5/14/01	SW846 8270
Phenol	5600	45	140		ug/kg		5/14/01	SW846 8270
Pyridine	4400	100	320		ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	5300	26	83		ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	5300	46	150		ug/kg		5/14/01	SW846 8270
2-Fluorophenol	99				%Recov		5/14/01	SW846 8270
Phenol-d5	95				%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4	90				%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4	81				%Recov		5/14/01	SW846 8270
Nitrobenzene-d5	87				%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol	94				%Recov		5/14/01	SW846 8270
Terphenyl-d14	105				%Recov		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E-MSD

Lab Sample Number : 811774-003

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	57.4				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	28000	340	1100		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

SPECIAL PAH LIST **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Acenaphthene-d10	71				%Recov		5/12/01	SW846 8270C
Benzo(a)pyrene-d12	74				%Recov		5/12/01	SW846 8270C
Benzo(e)pyrene	240	9.5	30		ug/kg	N	5/12/01	SW846 8270C
Fluoranthene-d10	55				%Recov		5/12/01	SW846 8270C
Acenaphthene	59	5.7	18		ug/kg	N	5/12/01	SW846 8270C
Acenaphthylene	130	7.4	24		ug/kg		5/12/01	SW846 8270C
Anthracene	86	8.5	27		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)anthracene	270	9.9	32		ug/kg	N	5/12/01	SW846 8270C
Benzo(a)pyrene	300	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Benzo(b)fluoranthene	220	6.6	21		ug/kg	N	5/12/01	SW846 8270C
Benzo(g,h,i)perylene	260	6.9	22		ug/kg	N	5/12/01	SW846 8270C
Benzo(k)fluoranthene	220	12	38		ug/kg	N	5/12/01	SW846 8270C
Chrysene	210	7.8	25		ug/kg	N	5/12/01	SW846 8270C
Dibenzo(a,h)anthracene	110	6.0	19		ug/kg		5/12/01	SW846 8270C
Fluoranthene	220	8.2	26		ug/kg	N	5/12/01	SW846 8270C
Fluorene	64	6.3	20		ug/kg		5/12/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	190	6.1	19		ug/kg	N	5/12/01	SW846 8270C
1-Methylnaphthalene	72	7.3	23		ug/kg		5/12/01	SW846 8270C
2-Methylnaphthalene	84	8.7	28		ug/kg		5/12/01	SW846 8270C
Naphthalene	78	7.8	25		ug/kg		5/12/01	SW846 8270C
Phenanthrene	130	8.1	26		ug/kg	N	5/12/01	SW846 8270C
Pyrene	320	9.3	30		ug/kg	N	5/12/01	SW846 8270C

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/23E-MSD

Lab Sample Number : 811774-003

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL SEMI-VOLATILE LIST **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
4-Methylphenol	5800	77	250		ug/kg		5/14/01	SW846 8270
Isoquinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Quinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Xanthene	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	80				%Recov		5/14/01	SW846 8270
Indole	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Methylphenol	5200	68	220		ug/kg		5/14/01	SW846 8270
Acridine	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Benzofuran	< 590	590	1900		ug/kg		5/14/01	SW846 8270
Dibenzothiophene	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Chlorophenol	5200	23	73		ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	5000	23	73		ug/kg		5/14/01	SW846 8270
Carbazole	4900	68	220		ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	5000	26	83		ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	4500	190	610		ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	4600	26	83		ug/kg		5/14/01	SW846 8270
Dibenzofuran	4600	23	73		ug/kg		5/14/01	SW846 8270
2-Nitrophenol	4800	17	54		ug/kg		5/14/01	SW846 8270
4-Nitrophenol	4800	130	410		ug/kg		5/14/01	SW846 8270
Pentachlorophenol	4900	390	1200		ug/kg		5/14/01	SW846 8270
Phenol	5500	45	140		ug/kg		5/14/01	SW846 8270
Pyridine	4200	100	320		ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	4900	26	83		ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	4800	46	150		ug/kg		5/14/01	SW846 8270
2-Fluorophenol	98				%Recov		5/14/01	SW846 8270
Phenol-d5	91				%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4	88				%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4	80				%Recov		5/14/01	SW846 8270
Nitrobenzene-d5	81				%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol	85				%Recov		5/14/01	SW846 8270
Terphenyl-d14	92				%Recov		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 31N/15E
Lab Sample Number : 811774-004
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	38.4				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	190000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/15E

Lab Sample Number : 811774-004

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene		28	25	60	ug/kg	Q	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Xylene, -o	<	25	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		66			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		71			%Recov		5/8/01	SW846 8260B
Toluene-d8		70			%Recov		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 31N/15E
Lab Sample Number : 811774-004
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	92				%Recov		5/11/01	SW846 8270C
Acenaphthene-d10	86				%Recov		5/11/01	SW846 8270C
Benzo(a)pyrene-d12	93				%Recov		5/11/01	SW846 8270C
Benzo(e)pyrene	990	14	45		ug/kg		5/11/01	SW846 8270C
Acenaphthene	100	8.3	26		ug/kg		5/11/01	SW846 8270C
Acenaphthylene	410	11	35		ug/kg		5/11/01	SW846 8270C
Anthracene	220	12	38		ug/kg		5/11/01	SW846 8270C
Benzo(a)anthracene	1100	14	45		ug/kg		5/11/01	SW846 8270C
Benzo(a)pyrene	1400	12	38		ug/kg		5/11/01	SW846 8270C
Benzo(b)fluoranthene	860	9.7	31		ug/kg		5/11/01	SW846 8270C
Benzo(g,h,i)perylene	940	10	32		ug/kg		5/11/01	SW846 8270C
Benzo(k)fluoranthene	910	17	54		ug/kg		5/11/01	SW846 8270C
Chrysene	910	11	35		ug/kg		5/11/01	SW846 8270C
Dibenzo(a,h)anthracene	240	8.7	28		ug/kg		5/11/01	SW846 8270C
Fluoranthene	1100	12	38		ug/kg		5/11/01	SW846 8270C
Fluorene	77	9.2	29		ug/kg		5/11/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	740	8.9	28		ug/kg		5/11/01	SW846 8270C
1-Methylnaphthalene	110	11	35		ug/kg		5/11/01	SW846 8270C
2-Methylnaphthalene	180	13	41		ug/kg		5/11/01	SW846 8270C
Naphthalene	190	11	35		ug/kg		5/11/01	SW846 8270C
Phenanthrene	520	12	38		ug/kg		5/11/01	SW846 8270C
Pyrene	1600	14	45		ug/kg		5/11/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 870	870	2800		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	75				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 99	99	320		ug/kg		5/14/01	SW846 8270
4-Methylphenol	690	110	350		ug/kg		5/14/01	SW846 8270
Acridine	< 870	870	2800		ug/kg		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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Green Bay, WI 54302
920-469-2436
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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 31N/15E

Lab Sample Number : 811774-004

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	870	870	2800	ug/kg		5/14/01	SW846 8270
Dibenzothiophene	<	870	870	2800	ug/kg		5/14/01	SW846 8270
Quinoline	<	870	870	2800	ug/kg		5/14/01	SW846 8270
Indole	<	870	870	2800	ug/kg		5/14/01	SW846 8270
Xanthene	<	870	870	2800	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	34	34	110	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	33	33	110	ug/kg		5/14/01	SW846 8270
Carbazole	<	99	99	320	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	38	38	120	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	270	270	860	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	38	38	120	ug/kg		5/14/01	SW846 8270
Dibenzofuran		52	34	110	ug/kg	Q	5/14/01	SW846 8270
2-Nitrophenol	<	25	25	80	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	190	190	610	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	570	570	1800	ug/kg		5/14/01	SW846 8270
Phenol		980	65	210	ug/kg		5/14/01	SW846 8270
Pyridine	<	150	150	480	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	38	38	120	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	66	66	210	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		92			%Recov		5/14/01	SW846 8270
Phenol-d5		86			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		84			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		78			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		75			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		79			%Recov		5/14/01	SW846 8270
Terphenyl-d14		97			%Recov		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/17E

Lab Sample Number : 811774-005

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	27.0				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	260000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	150	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/17E

Lab Sample Number : 811774-005

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		180	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		38	25	60	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		1900	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene		41	25	60	ug/kg	Q	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		140	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		50	25	60	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		95	50	120	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		85	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		59			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		64			%Recov		5/8/01	SW846 8260B
Toluene-d8		63			%Recov		5/8/01	SW846 8260B

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800-7-ENCHEM
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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/17E

Lab Sample Number : 811774-005

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(e)pyrene	2900	200	640		ug/kg		5/11/01	SW846 8270C
Acenaphthene	7500	120	380		ug/kg		5/11/01	SW846 8270C
Acenaphthylene	1200	150	480		ug/kg		5/11/01	SW846 8270C
Anthracene	3300	180	570		ug/kg		5/11/01	SW846 8270C
Benzo(a)anthracene	5600	210	670		ug/kg		5/11/01	SW846 8270C
Benzo(a)pyrene	4600	170	540		ug/kg		5/11/01	SW846 8270C
Benzo(b)fluoranthene	3300	140	450		ug/kg		5/11/01	SW846 8270C
Benzo(g,h,i)perylene	2800	140	450		ug/kg		5/11/01	SW846 8270C
Benzo(k)fluoranthene	3300	240	760		ug/kg		5/11/01	SW846 8270C
Chrysene	4300	160	510		ug/kg		5/11/01	SW846 8270C
Dibenzo(a,h)anthracene	710	120	380		ug/kg		5/11/01	SW846 8270C
Fluoranthene	9800	170	540		ug/kg		5/11/01	SW846 8270C
Fluorene	3100	130	410		ug/kg		5/11/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	2200	130	410		ug/kg		5/11/01	SW846 8270C
1-Methylnaphthalene	7900	150	480		ug/kg		5/11/01	SW846 8270C
2-Methylnaphthalene	8100	180	570		ug/kg		5/11/01	SW846 8270C
Naphthalene	9200	160	510		ug/kg		5/11/01	SW846 8270C
Phenanthrene	12000	170	540		ug/kg		5/11/01	SW846 8270C
Pyrene	12000	190	610		ug/kg		5/11/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 1200	1200	3800		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	74				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 140	140	450		ug/kg		5/14/01	SW846 8270
4-Methylphenol	350	160	510		ug/kg	Q	5/14/01	SW846 8270
Acridine	< 1200	1200	3800		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Client : SEH

Field ID : 24N/17E

Report Date : 6/1/01

Lab Sample Number : 811774-005

Collection Date : 4/30/01

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Benzofuran	<	1200	1200	3800	ug/kg		5/14/01	SW846 8270
Dibenzothiophene		1500	1200	3800	ug/kg	Q	5/14/01	SW846 8270
Quinoline	<	1200	1200	3800	ug/kg		5/14/01	SW846 8270
Indole	<	1200	1200	3800	ug/kg		5/14/01	SW846 8270
Xanthene	<	1200	1200	3800	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	49	49	160	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	47	47	150	ug/kg		5/14/01	SW846 8270
Carbazole		580	140	450	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	54	54	170	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	390	390	1200	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	54	54	170	ug/kg		5/14/01	SW846 8270
Dibenzofuran		980	49	160	ug/kg		5/14/01	SW846 8270
2-Nitrophenol	<	35	35	110	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	270	270	860	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	810	810	2600	ug/kg		5/14/01	SW846 8270
Phenol		450	93	300	ug/kg		5/14/01	SW846 8270
Pyridine	<	210	210	670	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	55	55	180	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	95	95	300	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		89			%Recov		5/14/01	SW846 8270
Phenol-d5		82			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		82			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		77			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		74			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		77			%Recov		5/14/01	SW846 8270
Terphenyl-d14		95			%Recov		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/17E-FD

Lab Sample Number : 811774-006

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	43.1				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	190000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	140	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Client : SEH

Field ID : 24N/17E-FD

Report Date : 6/1/01

Lab Sample Number : 811774-006

Collection Date : 4/30/01

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		180	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		40	25	60	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		2100	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene		41	25	60	ug/kg	Q	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		160	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		54	25	60	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		94	50	120	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		90	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		54			%Recov	F	5/8/01	SW846 8260B
Dibromofluoromethane		60			%Recov		5/8/01	SW846 8260B
Toluene-d8		59			%Recov		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

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800-7-ENCHEM
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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 24N/17E-FD
Lab Sample Number : 811774-006
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(e)pyrene	3300	120	380		ug/kg		5/11/01	SW846 8270C
Acenaphthene	7400	74	240		ug/kg		5/11/01	SW846 8270C
Acenaphthylene	1300	96	310		ug/kg		5/11/01	SW846 8270C
Anthracene	3700	110	350		ug/kg		5/11/01	SW846 8270C
Benzo(a)anthracene	6500	130	410		ug/kg		5/11/01	SW846 8270C
Benzo(a)pyrene	5100	110	350		ug/kg		5/11/01	SW846 8270C
Benzo(b)fluoranthene	3400	86	270		ug/kg		5/11/01	SW846 8270C
Benzo(g,h,i)perylene	3000	89	280		ug/kg		5/11/01	SW846 8270C
Benzo(k)fluoranthene	3800	150	480		ug/kg		5/11/01	SW846 8270C
Chrysene	4800	100	320		ug/kg		5/11/01	SW846 8270C
Dibenzo(a,h)anthracene	780	78	250		ug/kg		5/11/01	SW846 8270C
Fluoranthene	10000	110	350		ug/kg		5/11/01	SW846 8270C
Fluorene	3400	82	260		ug/kg		5/11/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	2400	80	250		ug/kg		5/11/01	SW846 8270C
1-Methylnaphthalene	7700	95	300		ug/kg		5/11/01	SW846 8270C
2-Methylnaphthalene	8600	110	350		ug/kg		5/11/01	SW846 8270C
Naphthalene	9400	100	320		ug/kg		5/11/01	SW846 8270C
Phenanthrene	14000	110	350		ug/kg		5/11/01	SW846 8270C
Pyrene	13000	120	380		ug/kg		5/11/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 770	770	2500		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	72				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 89	89	280		ug/kg		5/14/01	SW846 8270
4-Methylphenol	200	100	320		ug/kg	Q	5/14/01	SW846 8270
Acridine	< 770	770	2500		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/17E-FD

Lab Sample Number : 811774-006

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	770	770	2500	ug/kg		5/14/01	SW846 8270
Dibenzothiophene		980	770	2500	ug/kg	Q	5/14/01	SW846 8270
Quinoline	<	770	770	2500	ug/kg		5/14/01	SW846 8270
Indole	<	770	770	2500	ug/kg		5/14/01	SW846 8270
Xanthene	<	770	770	2500	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	30	30	96	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	29	29	92	ug/kg		5/14/01	SW846 8270
Carbazole		490	88	280	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	34	34	110	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	240	240	760	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	34	34	110	ug/kg		5/14/01	SW846 8270
Dibenzofuran		600	31	99	ug/kg		5/14/01	SW846 8270
2-Nitrophenol	<	22	22	70	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	170	170	540	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	510	510	1600	ug/kg		5/14/01	SW846 8270
Phenol		250	58	180	ug/kg		5/14/01	SW846 8270
Pyridine	<	130	130	410	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	34	34	110	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	59	59	190	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		82			%Recov		5/14/01	SW846 8270
Phenol-d5		76			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		75			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		70			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		68			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		76			%Recov		5/14/01	SW846 8270
Terphenyl-d14		91			%Recov		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/14E

Lab Sample Number : 811774-007

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	27.8				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	480000	3400	11000		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	530	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/14E

Lab Sample Number : 811774-007

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		450	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		76	25	60	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene		36	25	60	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		8400	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene		28	25	60	ug/kg	Q	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		350	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		110	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		280	50	120	ug/kg		5/8/01	SW846 8260B
Xylene, -o		250	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		48			%Recov	F	5/8/01	SW846 8260B
Dibromofluoromethane		56			%Recov		5/8/01	SW846 8260B
Toluene-d8		54			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 24N/14E

Lab Sample Number : 811774-007

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/11/01	SW846 8270C
Benzo(e)pyrene	21000	960	3100		ug/kg		5/11/01	SW846 8270C
Acenaphthene	48000	580	1800		ug/kg		5/11/01	SW846 8270C
Acenaphthylene	8800	740	2400		ug/kg		5/11/01	SW846 8270C
Anthracene	34000	860	2700		ug/kg		5/11/01	SW846 8270C
Benzo(a)anthracene	44000	1000	3200		ug/kg		5/11/01	SW846 8270C
Benzo(a)pyrene	36000	820	2600		ug/kg		5/11/01	SW846 8270C
Benzo(b)fluoranthene	18000	670	2100		ug/kg		5/11/01	SW846 8270C
Benzo(g,h,i)perylene	18000	690	2200		ug/kg		5/11/01	SW846 8270C
Benzo(k)fluoranthene	22000	1200	3800		ug/kg		5/11/01	SW846 8270C
Chrysene	32000	790	2500		ug/kg		5/11/01	SW846 8270C
Dibenzo(a,h)anthracene	3500	600	1900		ug/kg		5/11/01	SW846 8270C
Fluoranthene	87000	830	2600		ug/kg		5/11/01	SW846 8270C
Fluorene	23000	630	2000		ug/kg		5/11/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	13000	620	2000		ug/kg		5/11/01	SW846 8270C
1-Methylnaphthalene	29000	740	2400		ug/kg		5/11/01	SW846 8270C
2-Methylnaphthalene	41000	880	2800		ug/kg		5/11/01	SW846 8270C
Naphthalene	31000	790	2500		ug/kg		5/11/01	SW846 8270C
Phenanthrene	120000	820	2600		ug/kg		5/11/01	SW846 8270C
Pyrene	130000	940	3000		ug/kg		5/11/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 6000	6000	19000		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	77				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 690	690	2200		ug/kg		5/15/01	SW846 8270
4-Methylphenol	< 780	780	2500		ug/kg		5/15/01	SW846 8270
Acridine	< 6000	6000	19000		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Client : SEH

Field ID : 24N/14E

Report Date : 6/1/01

Lab Sample Number : 811774-007

Collection Date : 4/30/01

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Benzofuran	<	6000	6000	19000	ug/kg		5/15/01	SW846 8270
Dibenzothiophene		12000	6000	19000	ug/kg	Q	5/15/01	SW846 8270
Quinoline	<	6000	6000	19000	ug/kg		5/15/01	SW846 8270
Indole	<	6000	6000	19000	ug/kg		5/15/01	SW846 8270
Xanthene	<	6000	6000	19000	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	240	240	760	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	230	230	730	ug/kg		5/15/01	SW846 8270
Carbazole	<	680	680	2200	ug/kg		5/15/01	SW846 8270
2,4-Dichlorophenol	<	260	260	830	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	1900	1900	6100	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	260	260	830	ug/kg		5/15/01	SW846 8270
Dibenzofuran		3700	240	760	ug/kg		5/15/01	SW846 8270
2-Nitrophenol	<	170	170	540	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	1300	1300	4100	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	3900	3900	12000	ug/kg		5/15/01	SW846 8270
Phenol		1900	450	1400	ug/kg		5/15/01	SW846 8270
Pyridine	<	1000	1000	3200	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	270	270	860	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	460	460	1500	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		79			%Recov		5/15/01	SW846 8270
Phenol-d5		72			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		75			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		73			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		67			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		74			%Recov		5/15/01	SW846 8270
Terphenyl-d14		91			%Recov		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/17E

Lab Sample Number : 811774-008

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	69.4				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	36000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Bromoform	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Chloroform	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 310	310	740		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 310	310	740		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/17E

Lab Sample Number : 811774-008

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		2800	310	740	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		390	310	740	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene		470	310	740	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride		360	310	740	ug/kg	Q	5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Naphthalene		110000	310	740	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Styrene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Toluene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		2700	310	740	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	310	310	740	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		790	310	740	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	310	310	740	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		1600	630	1500	ug/kg		5/8/01	SW846 8260B
Xylene, -o		990	310	740	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		79			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		75			%Recov		5/8/01	SW846 8260B
Toluene-d8		77			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 25N/17E
Lab Sample Number : 811774-008
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	9100	1500	4800		ug/kg		5/14/01	SW846 8270C
Acenaphthene	88000	920	2900		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	5200	1200	3800		ug/kg		5/14/01	SW846 8270C
Anthracene	23000	1400	4500		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	18000	1600	5100		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	14000	1300	4100		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	8300	1100	3500		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	8500	1100	3500		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	11000	1900	6100		ug/kg		5/14/01	SW846 8270C
Chrysene	18000	1300	4100		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	1500	970	3100		ug/kg	Q	5/14/01	SW846 8270C
Fluoranthene	51000	1300	4100		ug/kg		5/14/01	SW846 8270C
Fluorene	30000	1000	3200		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	5700	990	3200		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	73000	1200	3800		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	120000	1400	4500		ug/kg		5/14/01	SW846 8270C
Naphthalene	160000	1300	4100		ug/kg		5/14/01	SW846 8270C
Phenanthrene	120000	1300	4100		ug/kg		5/14/01	SW846 8270C
Pyrene	72000	1500	4800		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 2400	2400	7600		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	73				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 270	270	860		ug/kg		5/15/01	SW846 8270
4-Methylphenol	< 310	310	990		ug/kg		5/15/01	SW846 8270
Acridine	< 2400	2400	7600		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/17E

Lab Sample Number : 811774-008

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	2400	2400	7600	ug/kg		5/15/01	SW846 8270
Dibenzothiophene		5100	2400	7600	ug/kg	Q	5/15/01	SW846 8270
Quinoline	<	2400	2400	7600	ug/kg		5/15/01	SW846 8270
Indole	<	2400	2400	7600	ug/kg		5/15/01	SW846 8270
Xanthene	<	2400	2400	7600	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	94	94	300	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	91	91	290	ug/kg		5/15/01	SW846 8270
Carbazole		2200	270	860	ug/kg		5/15/01	SW846 8270
2,4-Dichlorophenol	<	100	100	320	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	750	750	2400	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	110	110	350	ug/kg		5/15/01	SW846 8270
Dibenzofuran		3000	95	300	ug/kg		5/15/01	SW846 8270
2-Nitrophenol	<	68	68	220	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	530	530	1700	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	1600	1600	5100	ug/kg		5/15/01	SW846 8270
Phenol	<	180	180	570	ug/kg		5/15/01	SW846 8270
Pyridine	<	410	410	1300	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	110	110	350	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	180	180	570	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		78			%Recov		5/15/01	SW846 8270
Phenol-d5		70			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		74			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		74			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		63			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		66			%Recov		5/15/01	SW846 8270
Terphenyl-d14		84			%Recov		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/16E

Lab Sample Number : 811774-009

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	74.2				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	1900	340	1100		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromoform	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloroform	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 250	250	600		ug/kg		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/16E

Lab Sample Number : 811774-009

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		990	250	600	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene		380	250	600	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Naphthalene		77000	250	600	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Styrene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Toluene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		1800	250	600	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		570	250	600	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		560	500	1200	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		400	250	600	ug/kg	Q	5/8/01	SW846 8260B
4-Bromofluorobenzene		88			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		80			%Recov		5/8/01	SW846 8260B
Toluene-d8		87			%Recov		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/16E

Lab Sample Number : 811774-009

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	2400	360	1100		ug/kg		5/14/01	SW846 8270C
Acenaphthene	28000	220	700		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	1400	280	890		ug/kg		5/14/01	SW846 8270C
Anthracene	7900	320	1000		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	5300	370	1200		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	4100	310	990		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	1900	250	800		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	2300	260	830		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	3000	440	1400		ug/kg		5/14/01	SW846 8270C
Chrysene	4900	300	960		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	380	230	730		ug/kg	Q	5/14/01	SW846 8270C
Fluoranthene	15000	310	990		ug/kg		5/14/01	SW846 8270C
Fluorene	9700	240	760		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	1500	230	730		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	20000	280	890		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	34000	330	1100		ug/kg		5/14/01	SW846 8270C
Naphthalene	33000	300	960		ug/kg		5/14/01	SW846 8270C
Phenanthrene	38000	310	990		ug/kg		5/14/01	SW846 8270C
Pyrene	22000	350	1100		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 450	450	1400		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	69				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 51	51	160		ug/kg		5/14/01	SW846 8270
4-Methylphenol	< 58	58	180		ug/kg		5/14/01	SW846 8270
Acridine	< 450	450	1400		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 25N/16E

Lab Sample Number : 811774-009

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	450	450	1400	ug/kg	5/14/01	SW846 8270
Dibenzothiophene		1900	450	1400	ug/kg	5/14/01	SW846 8270
Quinoline	<	450	450	1400	ug/kg	5/14/01	SW846 8270
Indole	<	450	450	1400	ug/kg	5/14/01	SW846 8270
Xanthene	<	450	450	1400	ug/kg	5/14/01	SW846 8270
2-Chlorophenol	<	18	18	57	ug/kg	5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	17	17	54	ug/kg	5/14/01	SW846 8270
Carbazole		210	51	160	ug/kg	5/14/01	SW846 8270
2,4-Dichlorophenol	<	20	20	64	ug/kg	5/14/01	SW846 8270
2,4-Dinitrophenol	<	140	140	450	ug/kg	5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	20	20	64	ug/kg	5/14/01	SW846 8270
Dibenzofuran		830	18	57	ug/kg	5/14/01	SW846 8270
2-Nitrophenol	<	13	13	41	ug/kg	5/14/01	SW846 8270
4-Nitrophenol	<	100	100	320	ug/kg	5/14/01	SW846 8270
Pentachlorophenol	<	290	290	920	ug/kg	5/14/01	SW846 8270
Phenol	<	34	34	110	ug/kg	5/14/01	SW846 8270
Pyridine	<	77	77	250	ug/kg	5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	20	20	64	ug/kg	5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	34	34	110	ug/kg	5/14/01	SW846 8270
2-Fluorophenol		80			%Recov	5/14/01	SW846 8270
Phenol-d5		76			%Recov	5/14/01	SW846 8270
2-Chlorophenol-d4		76			%Recov	5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		71			%Recov	5/14/01	SW846 8270
Nitrobenzene-d5		70			%Recov	5/14/01	SW846 8270
2,4,6-Tribromophenol		70			%Recov	5/14/01	SW846 8270
Terphenyl-d14		87			%Recov	5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/23E)

Lab Sample Number : 811774-010

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	56.4				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	22000	340	1100		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/23E)

Lab Sample Number : 811774-010

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		29	25	60	ug/kg	Q	5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		1300	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		34	25	60	ug/kg	Q	5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Xylene, -o	<	25	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		79			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		74			%Recov		5/8/01	SW846 8260B
Toluene-d8		80			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/23E)

Lab Sample Number : 811774-010

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	96				%Recov		5/14/01	SW846 8270C
Acenaphthene-d10	94				%Recov		5/14/01	SW846 8270C
Benzo(a)pyrene-d12	95				%Recov		5/14/01	SW846 8270C
Benzo(e)pyrene	460	19	61		ug/kg		5/14/01	SW846 8270C
Acenaphthene	1300	11	35		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	180	15	48		ug/kg		5/14/01	SW846 8270C
Anthracene	410	17	54		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	670	20	64		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	660	16	51		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	420	13	41		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	450	14	45		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	420	23	73		ug/kg		5/14/01	SW846 8270C
Chrysene	500	16	51		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	84	12	38		ug/kg		5/14/01	SW846 8270C
Fluoranthene	1100	16	51		ug/kg		5/14/01	SW846 8270C
Fluorene	510	12	38		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	310	12	38		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	1100	15	48		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	1700	17	54		ug/kg		5/14/01	SW846 8270C
Naphthalene	2200	16	51		ug/kg		5/14/01	SW846 8270C
Phenanthrene	2000	16	51		ug/kg		5/14/01	SW846 8270C
Pyrene	1700	19	61		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 590	590	1900		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	69				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 68	68	220		ug/kg		5/14/01	SW846 8270
4-Methylphenol	180	76	240		ug/kg	Q	5/14/01	SW846 8270
Acridine	< 590	590	1900		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/23E)

Lab Sample Number : 811774-010

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Dibenzothiophene	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Quinoline	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Indole	<	590	590	1900	ug/kg		5/14/01	SW846 8270
Xanthene	<	590	590	1900	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	23	23	73	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	23	23	73	ug/kg		5/14/01	SW846 8270
Carbazole	<	67	67	210	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	180	180	570	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
Dibenzofuran		49	23	73	ug/kg	Q	5/14/01	SW846 8270
2-Nitrophenol	<	17	17	54	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	130	130	410	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	390	390	1200	ug/kg		5/14/01	SW846 8270
Phenol		83	44	140	ug/kg	Q	5/14/01	SW846 8270
Pyridine	<	100	100	320	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	45	45	140	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		80			%Recov		5/14/01	SW846 8270
Phenol-d5		73			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		74			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		70			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		65			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		78			%Recov		5/14/01	SW846 8270
Terphenyl-d14		81			%Recov		5/14/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/23E)

Lab Sample Number : 811774-011

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	60.5				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	20000	170	540		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Bromoform	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Chloroform	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 50	50	120		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 50	50	120		ug/kg		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/23E)

Lab Sample Number : 811774-011

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		410	50	120	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		70	50	120	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene		68	50	120	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride		57	50	120	ug/kg	Q	5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Naphthalene		16000	50	120	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Styrene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Toluene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		400	50	120	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	50	50	120	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		130	50	120	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	50	50	120	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		240	100	240	ug/kg		5/8/01	SW846 8260B
Xylene, -o		160	50	120	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		76			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		72			%Recov		5/8/01	SW846 8260B
Toluene-d8		80			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/23E)

Lab Sample Number : 811774-011

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	1100	88	280		ug/kg		5/14/01	SW846 8270C
Acenaphthene	7800	53	170		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	580	68	220		ug/kg		5/14/01	SW846 8270C
Anthracene	2300	79	250		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	2200	92	290		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	1900	75	240		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	1000	62	200		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	1100	64	200		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	1300	110	350		ug/kg		5/14/01	SW846 8270C
Chrysene	1700	72	230		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	190	55	180		ug/kg		5/14/01	SW846 8270C
Fluoranthene	5100	76	240		ug/kg		5/14/01	SW846 8270C
Fluorene	3000	58	180		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	740	57	180		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	6600	68	220		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	11000	80	250		ug/kg		5/14/01	SW846 8270C
Naphthalene	14000	73	230		ug/kg		5/14/01	SW846 8270C
Phenanthrene	11000	75	240		ug/kg		5/14/01	SW846 8270C
Pyrene	7300	87	280		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 550	550	1800		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	74				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 63	63	200		ug/kg		5/15/01	SW846 8270
4-Methylphenol	160	71	230		ug/kg	Q	5/15/01	SW846 8270
Acridine	< 550	550	1800		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/23E)

Lab Sample Number : 811774-011

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	550	550	1800	ug/kg		5/15/01	SW846 8270
Dibenzothiophene		850	550	1800	ug/kg	Q	5/15/01	SW846 8270
Quinoline	<	550	550	1800	ug/kg		5/15/01	SW846 8270
Indole	<	550	550	1800	ug/kg		5/15/01	SW846 8270
Xanthene	<	550	550	1800	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	22	22	70	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	21	21	67	ug/kg		5/15/01	SW846 8270
Carbazole		120	63	200	ug/kg	Q	5/15/01	SW846 8270
2,4-Dichlorophenol	<	24	24	76	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	170	170	540	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	24	24	76	ug/kg		5/15/01	SW846 8270
Dibenzofuran		380	22	70	ug/kg		5/15/01	SW846 8270
2-Nitrophenol	<	16	16	51	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	120	120	380	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	360	360	1100	ug/kg		5/15/01	SW846 8270
Phenol	<	41	41	130	ug/kg		5/15/01	SW846 8270
Pyridine	<	95	95	300	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	24	24	76	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	42	42	130	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		86			%Recov		5/15/01	SW846 8270
Phenol-d5		77			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		80			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		77			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		70			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		78			%Recov		5/15/01	SW846 8270
Terphenyl-d14		90			%Recov		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 75%(31N/23E)
Lab Sample Number : 811774-012
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	60.9				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	25000	170	540		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Bromoform	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Chloroform	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 100	100	240		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 100	100	240		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 75%(31N/23E)

Lab Sample Number : 811774-012

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		580	100	240	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene		100	100	240	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Naphthalene		26000	100	240	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Styrene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Toluene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		580	100	240	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	100	100	240	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		180	100	240	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	100	100	240	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		350	200	480	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		220	100	240	ug/kg	Q	5/8/01	SW846 8260B
4-Bromofluorobenzene		75			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		70			%Recov		5/8/01	SW846 8260B
Toluene-d8		77			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 75%(31N/23E)

Lab Sample Number : 811774-012

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/15/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/15/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/15/01	SW846 8270C
Benzo(e)pyrene	3200	440	1400		ug/kg		5/15/01	SW846 8270C
Acenaphthene	27000	260	830		ug/kg		5/15/01	SW846 8270C
Acenaphthylene	1700	340	1100		ug/kg		5/15/01	SW846 8270C
Anthracene	7300	390	1200		ug/kg		5/15/01	SW846 8270C
Benzo(a)anthracene	6300	460	1500		ug/kg		5/15/01	SW846 8270C
Benzo(a)pyrene	5300	370	1200		ug/kg		5/15/01	SW846 8270C
Benzo(b)fluoranthene	2500	310	990		ug/kg		5/15/01	SW846 8270C
Benzo(g,h,i)perylene	3000	320	1000		ug/kg		5/15/01	SW846 8270C
Benzo(k)fluoranthene	3900	540	1700		ug/kg		5/15/01	SW846 8270C
Chrysene	5700	360	1100		ug/kg		5/15/01	SW846 8270C
Dibenzo(a,h)anthracene	540	280	890		ug/kg	Q	5/15/01	SW846 8270C
Fluoranthene	16000	380	1200		ug/kg		5/15/01	SW846 8270C
Fluorene	10000	290	920		ug/kg		5/15/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	2000	280	890		ug/kg		5/15/01	SW846 8270C
1-Methylnaphthalene	20000	340	1100		ug/kg		5/15/01	SW846 8270C
2-Methylnaphthalene	33000	400	1300		ug/kg		5/15/01	SW846 8270C
Naphthalene	39000	360	1100		ug/kg		5/15/01	SW846 8270C
Phenanthrene	39000	370	1200		ug/kg		5/15/01	SW846 8270C
Pyrene	24000	430	1400		ug/kg		5/15/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 550	550	1800		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	69				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 63	63	200		ug/kg		5/14/01	SW846 8270
4-Methylphenol	89	71	230		ug/kg	Q	5/14/01	SW846 8270
Acridine	< 550	550	1800		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 75%(31N/23E)

Lab Sample Number : 811774-012

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	550	550	1800	ug/kg		5/14/01	SW846 8270
Dibenzothiophene		1500	550	1800	ug/kg	Q	5/14/01	SW846 8270
Quinoline	<	550	550	1800	ug/kg		5/14/01	SW846 8270
Indole	<	550	550	1800	ug/kg		5/14/01	SW846 8270
Xanthene	<	550	550	1800	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	22	22	70	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	21	21	67	ug/kg		5/14/01	SW846 8270
Carbazole		150	62	200	ug/kg	Q	5/14/01	SW846 8270
2,4-Dichlorophenol	<	24	24	76	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	170	170	540	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	24	24	76	ug/kg		5/14/01	SW846 8270
Dibenzofuran		700	22	70	ug/kg		5/14/01	SW846 8270
2-Nitrophenol	<	15	15	48	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	120	120	380	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	360	360	1100	ug/kg		5/14/01	SW846 8270
Phenol		87	41	130	ug/kg	Q	5/14/01	SW846 8270
Pyridine	<	94	94	300	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	24	24	76	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	42	42	130	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		82			%Recov		5/14/01	SW846 8270
Phenol-d5		75			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		75			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		73			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		67			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		70			%Recov		5/14/01	SW846 8270
Terphenyl-d14		85			%Recov		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 50%(31N/23E)
Lab Sample Number : 811774-013
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	56.2				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	170000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromoform	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloroform	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 250	250	600		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 250	250	600		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/23E)

Lab Sample Number : 811774-013

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		1800	250	600	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		250	250	600	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene		280	250	600	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Naphthalene		70000	250	600	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Styrene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Toluene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		1600	250	600	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	250	250	600	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		540	250	600	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	250	250	600	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		1100	500	1200	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		680	250	600	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		68			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		67			%Recov		5/8/01	SW846 8260B
Toluene-d8		70			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 50%(31N/23E)
Lab Sample Number : 811774-013
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	12000	1900	6100		ug/kg		5/14/01	SW846 8270C
Acenaphthene	75000	1100	3500		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	3900	1500	4800		ug/kg	Q	5/14/01	SW846 8270C
Anthracene	20000	1700	5400		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	23000	2000	6400		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	19000	1600	5100		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	13000	1300	4100		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	12000	1400	4500		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	17000	2300	7300		ug/kg		5/14/01	SW846 8270C
Chrysene	21000	1600	5100		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	2800	1200	3800		ug/kg	Q	5/14/01	SW846 8270C
Fluoranthene	55000	1600	5100		ug/kg		5/14/01	SW846 8270C
Fluorene	26000	1300	4100		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	9400	1200	3800		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	67000	1500	4800		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	110000	1700	5400		ug/kg		5/14/01	SW846 8270C
Naphthalene	170000	1600	5100		ug/kg		5/14/01	SW846 8270C
Phenanthrene	100000	1600	5100		ug/kg		5/14/01	SW846 8270C
Pyrene	67000	1900	6100		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 1800	1800	5700		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	78				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 200	200	640		ug/kg		5/15/01	SW846 8270
4-Methylphenol	< 230	230	730		ug/kg		5/15/01	SW846 8270
Acridine	< 1800	1800	5700		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/23E)

Lab Sample Number : 811774-013

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	1800	1800	5700	ug/kg		5/15/01	SW846 8270
Dibenzothiophene		3500	1800	5700	ug/kg	Q	5/15/01	SW846 8270
Quinoline	<	1800	1800	5700	ug/kg		5/15/01	SW846 8270
Indole	<	1800	1800	5700	ug/kg		5/15/01	SW846 8270
Xanthene	<	1800	1800	5700	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	70	70	220	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	68	68	220	ug/kg		5/15/01	SW846 8270
Carbazole		430	200	640	ug/kg	Q	5/15/01	SW846 8270
2,4-Dichlorophenol	<	78	78	250	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	560	560	1800	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	78	78	250	ug/kg		5/15/01	SW846 8270
Dibenzofuran		1800	70	220	ug/kg		5/15/01	SW846 8270
2-Nitrophenol	<	50	50	160	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	390	390	1200	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	1200	1200	3800	ug/kg		5/15/01	SW846 8270
Phenol	<	130	130	410	ug/kg		5/15/01	SW846 8270
Pyridine	<	310	310	990	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	79	79	250	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	140	140	450	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		82			%Recov		5/15/01	SW846 8270
Phenol-d5		74			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		77			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		74			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		66			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		75			%Recov		5/15/01	SW846 8270
Terphenyl-d14		88			%Recov		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/15E)

Lab Sample Number : 811774-014

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	41.6				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	140000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/15E)

Lab Sample Number : 811774-014

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
p-Isopropyltoluene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene	350	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene	26	25	60	ug/kg	Q	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	< 25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	< 25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p	< 50	50	120	ug/kg		5/8/01	SW846 8260B
Xylene, -o	< 25	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene	62			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane	66			%Recov		5/8/01	SW846 8260B
Toluene-d8	65			%Recov		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 99%(31N/15E)
Lab Sample Number : 811774-014
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	73				%Recov		5/14/01	SW846 8270C
Acenaphthene-d10	78				%Recov		5/14/01	SW846 8270C
Benzo(a)pyrene-d12	82				%Recov		5/14/01	SW846 8270C
Benzo(e)pyrene	1100	26	83		ug/kg		5/14/01	SW846 8270C
Acenaphthene	640	15	48		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	360	20	64		ug/kg		5/14/01	SW846 8270C
Anthracene	540	23	73		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	1300	27	86		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	1600	22	70		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	950	18	57		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	1100	19	61		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	1000	32	100		ug/kg		5/14/01	SW846 8270C
Chrysene	1100	21	67		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	250	16	51		ug/kg		5/14/01	SW846 8270C
Fluoranthene	2200	22	70		ug/kg		5/14/01	SW846 8270C
Fluorene	320	17	54		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	800	16	51		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	470	20	64		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	650	23	73		ug/kg		5/14/01	SW846 8270C
Naphthalene	600	21	67		ug/kg		5/14/01	SW846 8270C
Phenanthrene	1700	22	70		ug/kg		5/14/01	SW846 8270C
Pyrene	3400	25	80		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 800	800	2500		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	68				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 92	92	290		ug/kg		5/15/01	SW846 8270
4-Methylphenol	560	100	320		ug/kg		5/15/01	SW846 8270
Acridine	< 800	800	2500		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 99%(31N/15E)

Lab Sample Number : 811774-014

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	800	800	2500	ug/kg		5/15/01	SW846 8270
Dibenzothiophene	<	800	800	2500	ug/kg		5/15/01	SW846 8270
Quinoline	<	800	800	2500	ug/kg		5/15/01	SW846 8270
Indole	<	800	800	2500	ug/kg		5/15/01	SW846 8270
Xanthene	<	800	800	2500	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	31	31	99	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	31	31	99	ug/kg		5/15/01	SW846 8270
Carbazole	<	91	91	290	ug/kg		5/15/01	SW846 8270
2,4-Dichlorophenol	<	35	35	110	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	250	250	800	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	35	35	110	ug/kg		5/15/01	SW846 8270
Dibenzofuran		71	32	100	ug/kg	Q	5/15/01	SW846 8270
2-Nitrophenol	<	23	23	73	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	180	180	570	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	530	530	1700	ug/kg		5/15/01	SW846 8270
Phenol		830	60	190	ug/kg		5/15/01	SW846 8270
Pyridine	<	140	140	450	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	35	35	110	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	61	61	190	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		78			%Recov		5/15/01	SW846 8270
Phenol-d5		71			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		73			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		67			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		61			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		75			%Recov		5/15/01	SW846 8270
Terphenyl-d14		87			%Recov		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/15E)

Lab Sample Number : 811774-015

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/2001

Collection Date : 4/30/2001

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	32.6				%		5/4/2001	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	53000	340	1100		mg/kg		5/10/2001	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/2001 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	52	25	60		ug/kg	Q	5/8/2001	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/2001	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Client : SEH

Field ID : 90%(31N/15E)

Report Date : 6/1/2001

Lab Sample Number : 811774-015

Collection Date : 4/30/2001

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Ethylbenzene		44	25	60	ug/kg	Q	5/8/2001	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Isopropylbenzene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Naphthalene		910	25	60	ug/kg		5/8/2001	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Toluene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,2,4-Trimethylbenzene		44	25	60	ug/kg	Q	5/8/2001	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
1,3,5-Trimethylbenzene	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/2001	SW846 8260B
Xylenes, -m, -p	<	50	50	120	ug/kg		5/8/2001	SW846 8260B
Xylene, -o		28	25	60	ug/kg	Q	5/8/2001	SW846 8260B
4-Bromofluorobenzene		61			%Recov		5/8/2001	SW846 8260B
Dibromofluoromethane		63			%Recov		5/8/2001	SW846 8260B
Toluene-d8		64			%Recov		5/8/2001	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/15E)

Lab Sample Number : 811774-015

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/2001

Collection Date : 4/30/2001

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — Prep Method: SW846 3550B — Prep Date: — Analyst: *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/11/2001	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/11/2001	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/11/2001	SW846 8270C
Benzo(e)pyrene	3200	160	510		ug/kg		5/11/2001	SW846 8270C
Acenaphthene	6600	98	310		ug/kg		5/11/2001	SW846 8270C
Acenaphthylene	1300	130	410		ug/kg		5/11/2001	SW846 8270C
Anthracene	4200	150	480		ug/kg		5/11/2001	SW846 8270C
Benzo(a)anthracene	6100	170	540		ug/kg		5/11/2001	SW846 8270C
Benzo(a)pyrene	5300	140	450		ug/kg		5/11/2001	SW846 8270C
Benzo(b)fluoranthene	2800	110	350		ug/kg	Q	5/11/2001	SW846 8270C
Benzo(g,h,i)perylene	3100	120	380		ug/kg		5/11/2001	SW846 8270C
Benzo(k)fluoranthene	3400	200	640		ug/kg		5/11/2001	SW846 8270C
Chrysene	4600	130	410		ug/kg		5/11/2001	SW846 8270C
Dibenzo(a,h)anthracene	650	100	320		ug/kg		5/11/2001	SW846 8270C
Fluoranthene	11000	140	450		ug/kg		5/11/2001	SW846 8270C
Fluorene	3100	110	350		ug/kg		5/11/2001	SW846 8270C
Indeno(1,2,3-cd)pyrene	2200	110	350		ug/kg		5/11/2001	SW846 8270C
1-Methylnaphthalene	4200	130	410		ug/kg		5/11/2001	SW846 8270C
2-Methylnaphthalene	5800	150	480		ug/kg		5/11/2001	SW846 8270C
Naphthalene	4500	130	410		ug/kg		5/11/2001	SW846 8270C
Phenanthrene	15000	140	450		ug/kg		5/11/2001	SW846 8270C
Pyrene	17000	160	510		ug/kg		5/11/2001	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — Prep Method: SW846 3550 — Prep Date: — Analyst: *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 1000	1000	3200		ug/kg		5/14/2001	SW846 8270
2-Fluorobiphenyl	74				%Recov		5/14/2001	SW846 8270
2-Methylphenol	< 120	120	380		ug/kg		5/14/2001	SW846 8270
4-Methylphenol	660	130	410		ug/kg		5/14/2001	SW846 8270
Acridine	< 1000	1000	3200		ug/kg		5/14/2001	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 90%(31N/15E)

Lab Sample Number : 811774-015

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/2001

Collection Date : 4/30/2001

Matrix Type : SOIL

Benzofuran	<	1000	1000	3200	ug/kg	5/14/2001	SW846 8270
Dibenzothiophene	<	1000	1000	3200	ug/kg	5/14/2001	SW846 8270
Quinoline	<	1000	1000	3200	ug/kg	5/14/2001	SW846 8270
Indole	<	1000	1000	3200	ug/kg	5/14/2001	SW846 8270
Xanthene	<	1000	1000	3200	ug/kg	5/14/2001	SW846 8270
2-Chlorophenol	<	40	40	130	ug/kg	5/14/2001	SW846 8270
4-Chloro-3-methylphenol	<	39	39	120	ug/kg	5/14/2001	SW846 8270
Carbazole	<	120	120	380	ug/kg	5/14/2001	SW846 8270
2,4-Dichlorophenol	<	45	45	140	ug/kg	5/14/2001	SW846 8270
2,4-Dinitrophenol	<	320	320	1000	ug/kg	5/14/2001	SW846 8270
4,6-Dinitro-2-methylphenol	<	45	45	140	ug/kg	5/14/2001	SW846 8270
Dibenzofuran		310	40	130	ug/kg	5/14/2001	SW846 8270
2-Nitrophenol	<	29	29	92	ug/kg	5/14/2001	SW846 8270
4-Nitrophenol	<	230	230	730	ug/kg	5/14/2001	SW846 8270
Pentachlorophenol	<	670	670	2100	ug/kg	5/14/2001	SW846 8270
Phenol		1400	77	250	ug/kg	5/14/2001	SW846 8270
Pyridine	<	180	180	570	ug/kg	5/14/2001	SW846 8270
2,4,5-Trichlorophenol	<	45	45	140	ug/kg	5/14/2001	SW846 8270
2,4,6-Trichlorophenol	<	78	78	250	ug/kg	5/14/2001	SW846 8270
2-Fluorophenol		86			%Recov	5/14/2001	SW846 8270
Phenol-d5		77			%Recov	5/14/2001	SW846 8270
2-Chlorophenol-d4		80			%Recov	5/14/2001	SW846 8270
1,2-Dichlorobenzene-d4		76			%Recov	5/14/2001	SW846 8270
Nitrobenzene-d5		69			%Recov	5/14/2001	SW846 8270
2,4,6-Tribromophenol		78			%Recov	5/14/2001	SW846 8270
Terphenyl-d14		92			%Recov	5/14/2001	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 75%(31N/15E)

Lab Sample Number : 811774-016

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	36.1				%		5/4/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	230000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	140	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

All soil results are reported on a dry weight basis unless otherwise noted.

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 75%(31N/15E)

Lab Sample Number : 811774-016

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		110	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		37	25	60	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		2100	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		86	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		26	25	60	ug/kg	Q	5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		68	50	120	ug/kg	Q	5/8/01	SW846 8260B
Xylene, -o		62	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		60			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		64			%Recov		5/8/01	SW846 8260B
Toluene-d8		64			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : 75%(31N/15E)
Lab Sample Number : 811774-016
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	9400	440	1400		ug/kg		5/14/01	SW846 8270C
Acenaphthene	18000	270	860		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	3500	340	1100		ug/kg		5/14/01	SW846 8270C
Anthracene	12000	400	1300		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	19000	460	1500		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	16000	380	1200		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	8000	310	990		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	8700	320	1000		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	9800	550	1800		ug/kg		5/14/01	SW846 8270C
Chrysene	14000	360	1100		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	1800	280	890		ug/kg		5/14/01	SW846 8270C
Fluoranthene	33000	380	1200		ug/kg		5/14/01	SW846 8270C
Fluorene	8800	290	920		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	6400	280	890		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	11000	340	1100		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	15000	400	1300		ug/kg		5/14/01	SW846 8270C
Naphthalene	11000	370	1200		ug/kg		5/14/01	SW846 8270C
Phenanthrene	42000	380	1200		ug/kg		5/14/01	SW846 8270C
Pyrene	54000	430	1400		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 920	920	2900		ug/kg		5/14/01	SW846 8270
2-Fluorobiphenyl	74				%Recov		5/14/01	SW846 8270
2-Methylphenol	< 110	110	350		ug/kg		5/14/01	SW846 8270
4-Methylphenol	530	120	380		ug/kg		5/14/01	SW846 8270
Acridine	< 920	920	2900		ug/kg		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Client : SEH

Field ID : 75%(31N/15E)

Report Date : 6/1/01

Lab Sample Number : 811774-016

Collection Date : 4/30/01

WI DNR LAB ID : 405132750

Matrix Type : SOIL

Benzofuran	<	920	920	2900	ug/kg		5/14/01	SW846 8270
Dibenzothiophene		1900	920	2900	ug/kg	Q	5/14/01	SW846 8270
Quinoline	<	920	920	2900	ug/kg		5/14/01	SW846 8270
Indole	<	920	920	2900	ug/kg		5/14/01	SW846 8270
Xanthene	<	920	920	2900	ug/kg		5/14/01	SW846 8270
2-Chlorophenol	<	36	36	110	ug/kg		5/14/01	SW846 8270
4-Chloro-3-methylphenol	<	35	35	110	ug/kg		5/14/01	SW846 8270
Carbazole	<	110	110	350	ug/kg		5/14/01	SW846 8270
2,4-Dichlorophenol	<	40	40	130	ug/kg		5/14/01	SW846 8270
2,4-Dinitrophenol	<	290	290	920	ug/kg		5/14/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	41	41	130	ug/kg		5/14/01	SW846 8270
Dibenzofuran		640	36	110	ug/kg		5/14/01	SW846 8270
2-Nitrophenol	<	26	26	83	ug/kg		5/14/01	SW846 8270
4-Nitrophenol	<	200	200	640	ug/kg		5/14/01	SW846 8270
Pentachlorophenol	<	610	610	1900	ug/kg		5/14/01	SW846 8270
Phenol		1200	69	220	ug/kg		5/14/01	SW846 8270
Pyridine	<	160	160	510	ug/kg		5/14/01	SW846 8270
2,4,5-Trichlorophenol	<	41	41	130	ug/kg		5/14/01	SW846 8270
2,4,6-Trichlorophenol	<	71	71	230	ug/kg		5/14/01	SW846 8270
2-Fluorophenol		84			%Recov		5/14/01	SW846 8270
Phenol-d5		77			%Recov		5/14/01	SW846 8270
2-Chlorophenol-d4		78			%Recov		5/14/01	SW846 8270
1,2-Dichlorobenzene-d4		74			%Recov		5/14/01	SW846 8270
Nitrobenzene-d5		68			%Recov		5/14/01	SW846 8270
2,4,6-Tribromophenol		78			%Recov		5/14/01	SW846 8270
Terphenyl-d14		97			%Recov		5/14/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/15E)

Lab Sample Number : 811774-017

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Inorganic Results

Test	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Prep Method	Analysis Method	Analyst
Solids, percent	27.1				%	*	5/7/01	SM 2540G M	SM 2540G M	*MD
TOC as NPOC	230000	1700	5400		mg/kg		5/10/01	SW846 9060M	SW846 9060M	*MD

Organic Results

EPA 8260 VOLATILE LIST - SOIL/METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	290	25	60		ug/kg		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/kg		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/15E)

Lab Sample Number : 811774-017

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Dichlorodifluoromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
2,2-Dichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Ethylbenzene		310	25	60	ug/kg		5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Isopropylbenzene		59	25	60	ug/kg	Q	5/8/01	SW846 8260B
p-Isopropyltoluene		26	25	60	ug/kg	Q	5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Naphthalene		5600	25	60	ug/kg		5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Toluene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,4-Trimethylbenzene		230	25	60	ug/kg		5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/kg		5/8/01	SW846 8260B
1,3,5-Trimethylbenzene		78	25	60	ug/kg		5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/kg		5/8/01	SW846 8260B
Xylenes, -m, -p		180	50	120	ug/kg		5/8/01	SW846 8260B
Xylene, -o		160	25	60	ug/kg		5/8/01	SW846 8260B
4-Bromofluorobenzene		60			%Recov		5/8/01	SW846 8260B
Dibromofluoromethane		61			%Recov		5/8/01	SW846 8260B
Toluene-d8		64			%Recov		5/8/01	SW846 8260B

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/15E)

Lab Sample Number : 811774-017

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Organic Results

SPECIAL PAH LIST — **Prep Method:** SW846 3550B **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Fluoranthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Acenaphthene-d10	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(a)pyrene-d12	< NA				%Recov	F	5/14/01	SW846 8270C
Benzo(e)pyrene	18000	990	3200		ug/kg		5/14/01	SW846 8270C
Acenaphthene	45000	590	1900		ug/kg		5/14/01	SW846 8270C
Acenaphthylene	7600	760	2400		ug/kg		5/14/01	SW846 8270C
Anthracene	28000	880	2800		ug/kg		5/14/01	SW846 8270C
Benzo(a)anthracene	38000	1000	3200		ug/kg		5/14/01	SW846 8270C
Benzo(a)pyrene	32000	840	2700		ug/kg		5/14/01	SW846 8270C
Benzo(b)fluoranthene	16000	690	2200		ug/kg		5/14/01	SW846 8270C
Benzo(g,h,i)perylene	17000	710	2300		ug/kg		5/14/01	SW846 8270C
Benzo(k)fluoranthene	20000	1200	3800		ug/kg		5/14/01	SW846 8270C
Chrysene	28000	810	2600		ug/kg		5/14/01	SW846 8270C
Dibenzo(a,h)anthracene	3300	620	2000		ug/kg		5/14/01	SW846 8270C
Fluoranthene	75000	850	2700		ug/kg		5/14/01	SW846 8270C
Fluorene	21000	650	2100		ug/kg		5/14/01	SW846 8270C
Indeno(1,2,3-cd)pyrene	12000	630	2000		ug/kg		5/14/01	SW846 8270C
1-Methylnaphthalene	27000	760	2400		ug/kg		5/14/01	SW846 8270C
2-Methylnaphthalene	36000	900	2900		ug/kg		5/14/01	SW846 8270C
Naphthalene	27000	810	2600		ug/kg		5/14/01	SW846 8270C
Phenanthrene	100000	840	2700		ug/kg		5/14/01	SW846 8270C
Pyrene	110000	970	3100		ug/kg		5/14/01	SW846 8270C

Organic Results

SPECIAL SEMI-VOLATILE LIST — **Prep Method:** SW846 3550 **Prep Date:** **Analyst:** *MD

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Isoquinoline	< 3700	3700	12000		ug/kg		5/15/01	SW846 8270
2-Fluorobiphenyl	77				%Recov		5/15/01	SW846 8270
2-Methylphenol	< 420	420	1300		ug/kg		5/15/01	SW846 8270
4-Methylphenol	500	480	1500		ug/kg	Q	5/15/01	SW846 8270
Acridine	< 3700	3700	12000		ug/kg		5/15/01	SW846 8270

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- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : 50%(31N/15E)

Lab Sample Number : 811774-017

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : SOIL

Benzofuran	<	3700	3700	12000	ug/kg		5/15/01	SW846 8270
Dibenzothiophene		5300	3700	12000	ug/kg	Q	5/15/01	SW846 8270
Quinoline	<	3700	3700	12000	ug/kg		5/15/01	SW846 8270
Indole	<	3700	3700	12000	ug/kg		5/15/01	SW846 8270
Xanthene	<	3700	3700	12000	ug/kg		5/15/01	SW846 8270
2-Chlorophenol	<	150	150	480	ug/kg		5/15/01	SW846 8270
4-Chloro-3-methylphenol	<	140	140	450	ug/kg		5/15/01	SW846 8270
Carbazole	<	420	420	1300	ug/kg		5/15/01	SW846 8270
2,4-Dichlorophenol	<	160	160	510	ug/kg		5/15/01	SW846 8270
2,4-Dinitrophenol	<	1200	1200	3800	ug/kg		5/15/01	SW846 8270
4,6-Dinitro-2-methylphenol	<	160	160	510	ug/kg		5/15/01	SW846 8270
Dibenzofuran		1800	150	480	ug/kg		5/15/01	SW846 8270
2-Nitrophenol	<	100	100	320	ug/kg		5/15/01	SW846 8270
4-Nitrophenol	<	820	820	2600	ug/kg		5/15/01	SW846 8270
Pentachlorophenol	<	2400	2400	7600	ug/kg		5/15/01	SW846 8270
Phenol		1600	280	890	ug/kg		5/15/01	SW846 8270
Pyridine	<	630	630	2000	ug/kg		5/15/01	SW846 8270
2,4,5-Trichlorophenol	<	160	160	510	ug/kg		5/15/01	SW846 8270
2,4,6-Trichlorophenol	<	280	280	890	ug/kg		5/15/01	SW846 8270
2-Fluorophenol		82			%Recov		5/15/01	SW846 8270
Phenol-d5		74			%Recov		5/15/01	SW846 8270
2-Chlorophenol-d4		79			%Recov		5/15/01	SW846 8270
1,2-Dichlorobenzene-d4		76			%Recov		5/15/01	SW846 8270
Nitrobenzene-d5		66			%Recov		5/15/01	SW846 8270
2,4,6-Tribromophenol		77			%Recov		5/15/01	SW846 8270
Terphenyl-d14		91			%Recov		5/15/01	SW846 8270

All soil results are reported on a dry weight basis unless otherwise noted.

En Chem Inc.

1795 Industrial Drive
Green Bay, WI 54302
920-469-2436
800-7-ENCHEM
Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001
Project Number : WIDNR 9401.09
Field ID : MEOH BLANK
Lab Sample Number : 811774-018
WI DNR LAB ID : 405132750

Client : SEH
Report Date : 6/1/01
Collection Date : 4/30/01
Matrix Type : METHANOL

Organic Results

EPA 8260 VOLATILE LIST - METHANOL **Prep Method:** SW846 5030B **Prep Date:** 5/7/01 **Analyst:** TLT

Analyte	Result	LOD	LOQ	EQL	Units	Code	Analysis Date	Analysis Method
Benzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
Bromobenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
Bromochloromethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
Bromodichloromethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
Bromoform	< 25	25	60		ug/L		5/8/01	SW846 8260B
Bromomethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
s-Butylbenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
t-Butylbenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
n-Butylbenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
Carbon tetrachloride	< 25	25	60		ug/L		5/8/01	SW846 8260B
Chloroform	< 25	25	60		ug/L		5/8/01	SW846 8260B
Chlorobenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
Chlorodibromomethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
Chloroethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
Chloromethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
2-Chlorotoluene	< 25	25	60		ug/L		5/8/01	SW846 8260B
4-Chlorotoluene	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,2-Dibromo-3-chloropropane	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,2-Dibromoethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
Dibromomethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,3-Dichlorobenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,4-Dichlorobenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,2-Dichloroethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,2-Dichlorobenzene	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,1-Dichloroethene	< 25	25	60		ug/L		5/8/01	SW846 8260B
cis-1,2-Dichloroethene	< 25	25	60		ug/L		5/8/01	SW846 8260B
Dichlorodifluoromethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
trans-1,2-Dichloroethene	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,2-Dichloropropane	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,1-Dichloroethane	< 25	25	60		ug/L		5/8/01	SW846 8260B
1,3-Dichloropropane	< 25	25	60		ug/L		5/8/01	SW846 8260B
2,2-Dichloropropane	< 25	25	60		ug/L		5/8/01	SW846 8260B

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1795 Industrial Drive
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Fax: 920-469-8827

- Analytical Report -

Project Name : ASHLAND ERA 2001

Project Number : WIDNR 9401.09

Field ID : MEOH BLANK

Lab Sample Number : 811774-018

WI DNR LAB ID : 405132750

Client : SEH

Report Date : 6/1/01

Collection Date : 4/30/01

Matrix Type : METHANOL

1,1-Dichloropropene	<	25	25	60	ug/L	5/8/01	SW846 8260B
cis-1,3-Dichloropropene	<	25	25	60	ug/L	5/8/01	SW846 8260B
trans-1,3-Dichloropropene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Diisopropyl ether	<	25	25	60	ug/L	5/8/01	SW846 8260B
Ethylbenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Fluorotrichloromethane	<	25	25	60	ug/L	5/8/01	SW846 8260B
Hexachlorobutadiene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Isopropylbenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
p-Isopropyltoluene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Methylene chloride	<	25	25	60	ug/L	5/8/01	SW846 8260B
Methyl-tert-butyl-ether	<	25	25	60	ug/L	5/8/01	SW846 8260B
Naphthalene	<	25	25	60	ug/L	5/8/01	SW846 8260B
n-Propylbenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Styrene	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,1,2,2-Tetrachloroethane	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,1,1,2-Tetrachloroethane	<	25	25	60	ug/L	5/8/01	SW846 8260B
Tetrachloroethene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Toluene	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,2,3-Trichlorobenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,2,4-Trichlorobenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,1,1-Trichloroethane	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,1,2-Trichloroethane	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,2,4-Trimethylbenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Trichloroethene	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,2,3-Trichloropropane	<	25	25	60	ug/L	5/8/01	SW846 8260B
1,3,5-Trimethylbenzene	<	25	25	60	ug/L	5/8/01	SW846 8260B
Vinyl chloride	<	25	25	60	ug/L	5/8/01	SW846 8260B
Xylenes, -m, -p	<	50	50	120	ug/L	5/8/01	SW846 8260B
Xylene, -o	<	25	25	60	ug/L	5/8/01	SW846 8260B
4-Bromofluorobenzene		93			%Recov	5/8/01	SW846 8260B
Dibromofluoromethane		96			%Recov	5/8/01	SW846 8260B
Toluene-d8		90			%Recov	5/8/01	SW846 8260B

Documentation of Subcontracted Analysis

Listed below are the labs used for subcontracted analysis and associated FID number.

Code	Laboratory	Wisconsin FID Number
*MD	En Chem Madison	113172950
*GB	En Chem Green Bay	405132750
*SP	En Chem Superior	816079330
*RL	Robert E. Lee	405043870
*NL	Northern Lakes Service	721026460
*SF	Sommer - Frey	241249360
*CT	Commonwealth Tech.	157066030
*QO	Quanterrra - North Canton, OH	999518190
*QP	Quanterra - Pittsburgh, PA	998027800
*KM	Kemron - Merietta, OH	998202040

*SUB Indicates analysis that requires no certification

(Please Print Legibly)
Company Name: SEH
Branch or Location: C. Falls
Project Contact: M. Broses
Telephone: 720-6200
Project Number: WIANR 9401.09
Project Name: Ashland/NSP Lakefront ERA 2001
Project State: WI
Sampled By (Print):

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300
FAX: 608-233-0502

CHAIN OF CUSTODY

65245

Page 2 of 3
P.O. # _____ Quote # _____
Mail Report To: M. Broses
Company: SEH
Address: 421 Frenette Dr.
C. Falls, WI
Invoice To:
Company:
Address:
Mail Invoice To:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=EnCore F=Methanol G=NaOH
H = Sodium Bisulfate Solution I = Other

FILTERED? (YES/NO) N N N N N
PRESERVATION (CODE)* A F A A A

Data Package Options
(please circle if requested)
Results Only
EnChem Level III (Subject to Surcharge)
EnChem Level IV (Subject to Surcharge)

Regulatory Program: UST, RCRA, SDWA, NPDES, CERCLA

Matrix Codes: W=Water, S=Soil, A=Air, C=Charcoal, B=Biota, SI=Sludge

ANALYSES REQUESTED: TSC/TOC; VOCs; PAHs (include Benzo(e) pyrene); SVOCs (include phenols + cresols); HAHs (see attached list)

TOTAL # OF BOTTLES SENT

LABORATORY ID (Lab Use Only)	FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	TSC/TOC	VOCs	PAHs	SVOCs	HAHs			TOTAL # OF BOTTLES SENT	CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)
011 One sample	90% (3100N/2300E) 10% (2500N/1700E)	4/30/01	2:15	S	✓	✓	✓	✓	✓			5		
012 " "	75% (3100N/2300E) 25% (2500N/1700E)	4/30/01	2:30		✓	✓	✓	✓	✓					
013 " "	50% (3100N/2300E) 50% (2500N/1700E)	4/30/01	2:45		✓	✓	✓	✓	✓					
014 " "	99% (3100N/1500E) 1% (2400N/1400E)	4/30/01	2:05		✓	✓	✓	✓	✓					
015 " "	90% (3100N/1500E) 10% (2400N/1400E)	4/30/01	2:20		✓	✓	✓	✓	✓					
016 " "	75% (3100N/1500E) 25% (2400N/1400E)	4/30/01	2:10		✓	✓	✓	✓	✓					

Rush Turnaround Time Requested (TAT) - Prelim
(Rush TAT subject to approval/surcharge)
Date Needed:
Transmit Prelim Rush Results by (circle):
Phone Fax E-Mail
Phone #:
Fax #:
E-Mail Address:

Relinquished By:	Date/Time:	Received By:	Date/Time:
[signature]	4/30/01 3:30	[signature]	4-30-01 3:30
[signature]	5-1-01 14:00	[signature]	5-1-01 14:00
[signature]	5/2/01 15:45	[signature]	5/2/01 1545

En Chem Project No. 811774
Sample Receipt Temp. 3.3°C ROI (in Mag.)
Sample Receipt pH (Wet/Metals) NA
Cooler Custody Seal Present / Not Present
Not

Sampl[illegible] HOLD [illegible] bject [illegible] special pricing and release of liability

(Please Print Legibly)
Company Name: SEH
Branch or Location: C. Falls
Project Contact: M. Broses
Telephone: 720-6200
Project Number: WIDNR 9401.09
Project Name: Ashland/NSP Lakefront ERA 2001
Project State: WI
Sampled By (Print):

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300
FAX: 608-233-0502

CHAIN OF CUSTODY

65244

Page 1 of 3
P.O. # _____ Quote # _____
Mail Report To: M. Broses
Company: SEH
Address: 421 Frenette Dr.
Chippewa Falls, WI
Invoice To:
Company:
Address:
Mail Invoice To:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=EnCore F=Methanol G=NaOH
H = Sodium Bisulfate Solution I = Other

FILTERED? (YES/NO) N N N N N
PRESERVATION (CODE)* A F A A A

Data Package Options
(please circle if requested)
Results Only
EnChem Level III (Subject to Surcharge)
EnChem Level IV (Subject to Surcharge)

Regulatory Program: UST, RCRA, SDWA, NPDES, CERCLA

Matrix Codes: W=Water, S=Soil, A=Air, C=Charcoal, B=Biota, SI=Sludge

ANALYSES REQUESTED: TSC / TOC; VOCs; PAH (include benzo(e)pyrene); SVOCs (include phenols + cresols); HAHs (see attached list)

TOTAL # OF BOTTLES SENT

LABORATORY ID (Lab Use Only)	FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	TSC / TOC	VOCs	PAH (include benzo(e)pyrene)	SVOCs (include phenols + cresols)	HAHs (see attached list)			TOTAL # OF BOTTLES SENT	CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)
001	3100N/2300E	4/30/01	1:20	S	✓	✓	✓	✓	✓			5		
002	3100N/2300E-MS	4/30/01	1:30		✓	✓	✓	✓	✓					
003	3100N/2300E-MSD	4/30/01	1:40		✓	✓	✓	✓	✓					
004	3100N/1500E	4/30/01	1:55		✓	✓	✓	✓	✓					
005	2400N/1700E	4/30/01	2:35		✓	✓	✓	✓	✓					
006	2400N/1700E-FD	4/30/01	2:40		✓	✓	✓	✓	✓					
007	2400N/1400E	4/30/01	2:55		✓	✓	✓	✓	✓					
008	2500N/1700E	4/30/01	3:00		✓	✓	✓	✓	✓					
009	2500N/1600E	4/30/01	2:50		✓	✓	✓	✓	✓					
010 one sample	99% (3100N/2300E 1% (2500N/1700E	4/30/01	2:00		✓	✓	✓	✓	✓					

Rush Turnaround Time Requested (TAT) - Prelim
(Rush TAT subject to approval/surcharge)
Date Needed:
Transmit Prelim Rush Results by (circle):
Phone Fax E-Mail
Phone #:
Fax #:
E-Mail Address:

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
[signature]	4/30/01 3:30	[signature]	4-30-01 3:30
[signature]	5-1-01 14:00	Dunham	5-1-01 14:00
Dunham	5/2/01 15:45	[signature]	5/2/01 1545

En Chem Project No. 811774
Sample Receipt Temp. 3.3°C ROI (in mid.)
Sample Receipt pH (Wet/Metals) NA
Cooler Custody Seal
Present / Not Present
Intact / Not Intact

(Please Print Legibly)
Company Name: SEH
Branch or Location: C. Falls
Project Contact: M. Brooks
Telephone: 720-6200
Project Number: WIDNR 9401.09
Project Name: Ashland/NSP Lakefront ERA 2001
Project State: WI
Sampled By (Print):

EN CHEM INC.

1241 Bellevue St., Suite 9
Green Bay, WI 54302
920-469-2436
FAX 920-469-8827

525 Science Drive
Madison, WI 53711
608-232-3300
FAX: 608-233-0502

CHAIN OF CUSTODY

65919

Page 3 of 3
P.O. #: Quote #:
Mail Report To: M. Brooks
Company: SEH
Address: 421 Frenette Dr. C. Falls, WI
Invoice To:
Company:
Address:
Mail Invoice To:

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=EnCore F=Methanol G=NaOH
H = Sodium Bisulfate Solution I = Other

Data Package Options
(please circle if requested)
Results Only
EnChem Level III (Subject to Surcharge)
EnChem Level IV (Subject to Surcharge)

Regulatory Program	Matrix Codes
UST	W=Water
RCRA	S=Soil
SDWA	A=Air
NPDES	C=Charcoal
CERCLA	B=Biota
	Sl=Sludge

LABORATORY ID (Lab Use Only)	FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	TSC/TOC	VOCs	PAHs (In-house Energy(s) Dynamics)	SVOCs (In-house Energy(s) Dynamics)	HAH (Sr. attached (3))			TOTAL # OF BOTTLES SENT	CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)
one 017	502 (3100N/1500E)	4/30/01	2:25	S	✓	✓	✓	✓	✓			5		
Simple	502 (2400N/1400E)			1	✓	~~✓~~	~~✓~~	~~✓~~	~~✓~~					
018	Meoh Blank													

Rush Turnaround Time Requested (TAT) - Prelim
(Rush TAT subject to approval/surcharge)
Date Needed:
Transmit Prelim Rush Results by (circle):
Phone Fax E-Mail
Phone #:
Fax #:
E-Mail Address:

Sample[illegible] HOLD [illegible] subject t[illegible] special pricing and release of liab[illegible]

Relinquished By:	Date/Time:	Received By:	Date/Time:
[signature]	4/30/01 3:40	[signature]	4-30-01 3:40
[signature]	5-1-01 14:00	Dunham	5-1-01 14:00
Dunham	5/2/01 1545	[signature]	5/2/01 1545

En Chem Project No. 811774
Sample Receipt Temp: 3.3°C RAT (6 Mat.)
Sample Receipt pH (Water/Media): N/A
Cooler Custody Seal: Present / Not Present
Intact / Not Intact

Appendix E

Calculations

Calculation of LC50 Chemical Concentrations

	Sandy Sediments				Wood Chips and Sandy Sediments			
	PAH DW Conc (ug/kg)	**VOC DW Conc (ug/kg)**	**PAH NOC Conc (ug/g OC)**	**VOC NOC Conc (ug/g OC)**	**PAH DW Conc (ug/kg)**	**VOC DW Conc (ug/g OC)**	**PAH NOC Conc (ug/g OC)**	**VOC NOC Conc (ug/g OC)**
100% Cont#1	836,300	10,100	23,231	281	759,300	2,110	1,538	4
100% Ref	3,110	-	148	-	12,597	28	66	0.1
LC50 Concentration Calculations								
CT								
%Cont	13%	13%	13%	13%	48%	48%	48%	48%
%Ref	87%	87%	87%	87%	52%	52%	52%	52%
LC50 Conc	**111,258**	**1,311**	**3,144**	**36**	**373,105**	**1,033**	**777**	**2.0**
PP								
%Cont	35%	35%	35%	35%	75%	75%	75%	75%
%Ref	65%	65%	65%	65%	25%	25%	25%	25%
LC50 Conc	**296,060**	**3,551**	**8,264**	**99**	**570,160**	**1,583**	**1,165**	**3.0**
HA								
%Cont	42%	42%	42%	42%	60%	60%	60%	60%
%Ref	58%	58%	58%	58%	40%	40%	40%	40%
LC50 Conc	**353,716**	**4,250**	**9,861**	**118**	**459,648**	**1,274**	**947**	**2.4**
HA UV								
%Cont	11%	11%	11%	11%	16%	16%	16%	16%
%Ref	89%	89%	89%	89%	84%	84%	84%	84%
LC50 Conc	**94,178**	**1,104**	**2,671**	**31**	**134,832**	**369**	**307**	**0.7**

Table I-1. Original Approach Recommended by NSI Workshop (April 1994)

Category of Sampling Station Classifications	Data Used to Determine Classifications				
	Sediment Chemistry (sampling station is identified by any one of the following characteristics)		Tissue Residue/ Histopathology		Toxicity
* High Probability of Adverse Effects to Aquatic Life or Human Health	Sediment chemistry values exceed sediment draft quality criteria for any one of the five chemicals for which criteria have been developed by EPA (based on measured TOC)	OR	Human health thresholds for dioxin or PCBs are exceeded in resident species (not a consensus agreement—participants evenly divided on this issue)	OR	Toxicity demonstrated by two or more acute toxicity tests (one of which must be a solid-phase nonmicrobial test)
	OR Sediment chemistry values exceed all relevant AETs (high), ERMs, PELs, and SQALs for any one chemical (can use default TOC)				
	OR Sediment chemistry values >50 ppm for PCBs				
	OR Sediment chemistry TBP exceeds FDA action levels, EPA risk levels, or wildlife criteria	AND	Tissue levels in resident species exceed FDA action levels or EPA risk levels, or wildlife criteria	—	—
	OR Elevated sediment chemistry concentrations of PAHs	AND	Presence of fish tumors	—	—
Medium-High Probability of Adverse Effects to Aquatic Life or Human Health	Sediment chemistry values exceed at least two of the sediment upper screening values (i.e., ERM, SQAL, PEL, high AET) (can use default TOC)	OR	Tissue levels in resident species exceed FDA action levels or wildlife criteria	OR	Toxicity demonstrated by a single-species toxicity test (solid-phase, nonmicrobial)
	OR Sediment chemistry TBP exceeds FDA action levels or wildlife criteria				
Medium-Low Probability of Adverse Effects to Aquatic Life	Sediment chemistry values exceed one of the lower screening values (ERL, SQAL, TEL, lower AET) (can use default TOC and AVS)	OR	—	—	Toxicity demonstrated by a single species toxicity test (elutriate-phase, nonmicrobial)
Low Probability of Adverse Effects to Aquatic Life or Human Health	No exceedance of lower screening values AND No sediment chemistry TBP exceedances of FDA action levels or wildlife criteria	AND	Tissue levels in resident species are lower than FDA action levels or wildlife criteria	AND	No toxicity demonstrated in tests using at least two species and at least one solid-phase test using amphipods
Unknown	Not enough data to place a site in any of the other categories.				

(USEPA, 1997b)

CALCULATION OF MACDONALD CBSQG PECs.

Analytical		Boring No./Depth (ft)/Date																		
		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref Sand	1% Cont Sand#1	10% Cont Sand#1	25% Cont Sand#1	50% Cont Sand#1	Cont. Sand #1	Cont. Sand #2	Ref Wood	1% Cont Wood#1	10% Cont Wood#1	25% Cont Wood#1	50% Cont Wood#1	Cont. Wood #1	Cont. wood #2	CW-98	CS-98	RW-98	RS-98
		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
TOC (mg/kg)		21,000	22000	20000	25000	170,000	36,000	1,900	190,000	140000	53,000	230000	230000	480,000	260,000	17,000	2,500	57,000	4,600
TOC (%)		2.10	2.20	2.00	2.50	17.00	3.60	0.19	19.00	14.00	5.30	23.00	23.00	48.00	26.00	1.70	0.25	5.70	0.46
foc		0.021000	0.022000	0.020000	0.025000	0.170000	0.036000	0.001900	0.190000	0.140000	0.053000	0.230000	0.230000	0.480000	0.260000	0.017000	0.002500	0.057000	0.004600
PAHs (ug/kg)																			
Acenaphthene	0.001	16	1300	7800	27000	75000	88,000	28,000	100	640	6600	18000	45000	48,000	7,500	17,000	110	48	ND
Acenaphthylene		96	180	580	1700	3900	5,200	1,400	410	360	1300	3500	7600	8,800	1,200	3,800	ND	85	ND
Anthracene		52	410	2300	7300	20000	23,000	7,900	220	540	4200	12000	28000	34,000	3,300	15,000	81	130	ND
Benzo(a)Anthracene		280	670	2200	6300	23000	18,000	5,300	1,100	1300	6100	19000	38000	44,000	5,600	24,000	59	450	51
Benzo(a)Pyrene		350	660	1900	5300	19000	14,000	4,100	1,400	1600	5300	16000	32000	36,000	4,600	28,000	73	540	62
Chrysene		230	500	1700	5700	21000	18,000	4,900	910	1100	4600	14000	28000	32,000	4,300	21,000	54	470	46
Dibenzo(a,h)Anthracene		58	84	190	540	2800	1,500	380	240	250	650	1800	3300	3,500	710	3,000	ND	85	ND
Fluoranthene		260	1100	5100	16000	55000	51,000	15,000	1,100	2200	11000	33000	75000	87,000	9,800	36,000	97	910	39
Fluorene		14	510	3000	10000	26000	30,000	9,700	77	320	3100	8800	21000	23,000	3,100	10,000	62	85	ND
2-Methyl Naphthalene		38	1700	11000	33000	110000	120,000	34,000	180	650	5800	15000	36000	41,000	8,100	15,000	120	240	ND
Naphthalene		31	2200	14000	39000	170000	160,000	33,000	190	600	4500	11000	27000	31,000	9,200	19,000	160	230	ND
Phenanthrene		120	2000	11000	39000	100000	120,000	38,000	520	1700	15000	42000	100000	120,000	12,000	46,000	270	690	23
Pyrene		400	1700	7300	24000	67000	72,000	22,000	1,600	3400	17000	54000	110000	130,000	12,000	68,000	190	940	58
Total 13 PEC-DW PAHs	(ug/kg)	1,945	13,014	68,070	209,540	692,700	720,700	203,680	8,047	14,660	85,150	248,100	550,900	638,300	81,410	305,800	1,276	4,903	279

McDonald DW		Boring No./Depth (ft)/Date																	
PEC-Q	PEC (DW) ug/kg	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref Sand	1% Cont Sand#1	10% Cont Sand#1	25% Cont Sand#1	50% Cont Sand#1	Cont. Sand #1	Cont. Sand #2	Ref Wood	1% Cont Wood#1	10% Cont Wood#1	25% Cont Wood#1	50% Cont Wood#1	Cont. Wood #1	Cont. wood #2	CW-98	CS-98	RW-98	RS-98
		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/98	5/98	5/98	5/98
Special PAHs (ug/kg)																			
Acenaphthene																			
Acenaphthylene																			
Anthracene	845	0.062	0.485	2.722	8.639	23.669	27.219	9.349	0.260	0.639	4.970	14.201	33.136	40.237	3.905	17.751	0.096	0.154	0.000
Benzo(a)Anthracene	1050	0.267	0.638	2.095	6.000	21.905	17.143	5.048	1.048	1.238	5.810	18.095	36.190	41.905	5.333	22.857	0.056	0.429	0.049
Benzo(a)Pyrene	1450	0.241	0.455	1.310	3.655	13.103	9.655	2.828	0.966	1.103	3.655	11.034	22.069	24.828	3.172	19.310	0.050	0.372	0.043
Chrysene	1290	0.178	0.388	1.318	4.419	16.279	13.953	3.798	0.705	0.853	3.566	10.853	21.705	24.806	3.333	16.279	0.042	0.364	0.036
Dibenzo(a,h)Anthracene																			
Fluoranthene	2230	0.117	0.493	2.287	7.175	24.664	22.870	6.726	0.493	0.987	4.933	14.798	33.632	39.013	4.395	16.143	0.043	0.408	0.017
Fluorene	536	0.026	0.951	5.597	18.657	48.507	55.970	18.097	0.144	0.597	5.784	16.418	39.179	42.910	5.784	18.657	0.116	0.159	0.000
2-Methyl Naphthalene																			
Naphthalene	561	0.055	3.922	24.955	69.519	303.030	285.205	58.824	0.339	1.070	8.021	19.608	48.128	55.258	16.399	33.868	0.285	0.410	0.000
Phenanthrene	1170	0.103	1.709	9.402	33.333	85.470	102.564	32.479	0.444	1.453	12.821	35.897	85.470	102.564	10.256	39.316	0.231	0.590	0.020
Pyrene	1520	0.263	1.118	4.803	15.789	44.079	47.368	14.474	1.053	2.237	11.184	35.526	72.368	85.526	7.895	44.737	0.125	0.618	0.038
Total PAH TUs	22,800																		
Total PAH TU (13 PEC) PEC-Q		**0.09**	**0.57**	**2.99**	**9.19**	**30.38**	**31.61**	**8.93**	**0.35**	**0.64**	**3.73**	**10.88**	**24.16**	**28.00**	**3.57**	**13.41**	**0.06**	**0.22**	**0.01**
Total Individual PAH Q's		1.3	10.2	54.5	167.2	580.7	581.9	151.6	5.5	10.2	60.7	176.4	391.9	457.0	60.5	228.9	1.0	3.5	0.2
Total PAH (13) PEC-Q if DW values normalized to 1% (per WDNR draft guidance - Dec 2001)																			
divide total PAH Tus by %TOC:		2.10	2.20	2.00	2.50	17.00	3.60	0.19	19.00	14.00	5.30	23.00	23.00	48.00	26.00	1.70	0.25	5.70	0.46
normalized total PAH PEC-Q		**0.04**	**0.26**	**1.49**	**3.68**	**1.79**	**8.78**	**47.02**	**0.02**	**0.05**	**0.70**	**0.47**	**1.05**	**0.58**	**0.14**	**7.89**	**0.22**	**0.04**	**0.03**

EXAMPLE (USING 3100/2300 DATA)

13 PAH PEC-Q

TOTAL PAH = 13,014 ug/kg

PEC = 22,800

$$\frac{13,014}{22,800} = \boxed{0.57}$$

CALCULATION OF ESG TU's.

Calculation of ESG Tus

Coc	Boring No./Depth (ft)/Date	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E
		Ref Sand	1% Cont Sand#1	10% Cont Sand#1	25% Cont Sand#1	50% Cont Sand#1	Cont. Sand #1	Cont. Sand #2	Ref Wood	1% Cont Wood#1	10% Cont Wood#1	25% Cont Wood#1	50% Cont Wood#1	Cont. Wood #1	Cont. wood #2
		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001
Special PAHs (ug/g)															
Acenaphthene		0.762	59.091	390.000	1080.000	441.176	2444.444	14736.842	0.526	4.571	124.528	78.261	195.652	100.000	28.846
Acenaphthylene		4.571	8.182	29.000	68.000	22.941	144.444	736.842	2.158	2.571	24.528	15.217	33.043	18.333	4.615
Anthracene		2.476	18.636	115.000	292.000	117.647	638.889	4157.895	1.158	3.857	79.245	52.174	121.739	70.833	12.692
Benzo(a)Anthracene		13.333	30.455	110.000	252.000	135.294	500.000	2789.474	5.789	9.286	115.094	82.609	165.217	91.667	21.538
Benzo(a)Pyrene		16.667	30.000	95.000	212.000	111.765	388.889	2157.895	7.368	11.429	100.000	69.565	139.130	75.000	17.692
Benzo(e)pyrene		11.905	20.909	55.000	128.000	70.588	252.778	1263.158	5.211	7.857	60.377	40.870	78.261	43.750	11.154
Benzo(b)Fluoranthene		10.000	19.091	50.000	100.000	76.471	230.556	1000.000	4.526	6.786	52.830	34.783	69.565	37.500	12.692
Benzo(ghi)Perylene		12.857	20.455	55.000	120.000	70.588	236.111	1210.526	4.947	7.857	58.491	37.826	73.913	37.500	10.769
Benzo(k)Fluoranthene		10.952	19.091	65.000	156.000	100.000	305.556	1578.947	4.789	7.143	64.151	42.609	86.957	45.833	12.692
Chrysene		10.952	22.727	85.000	228.000	123.529	500.000	2578.947	4.789	7.857	86.792	60.870	121.739	66.667	16.538
Dibenzo(a,h)Anthracene		2.762	3.818	9.500	21.600	16.471	41.667	200.000	1.263	1.786	12.264	7.826	14.348	7.292	2.731
Fluoranthene		12.381	50.000	255.000	640.000	323.529	1416.667	7894.737	5.789	15.714	207.547	143.478	326.087	181.250	37.692
Fluorene		0.667	23.182	150.000	400.000	152.941	833.333	5105.263	0.405	2.286	58.491	38.261	91.304	47.917	11.923
Indeno(1,2,3-cd)Pyrene		8.571	14.091	37.000	80.000	55.294	158.333	789.474	3.895	5.714	41.509	27.826	52.174	27.083	8.462
Naphthalene		1.476	100.000	700.000	1560.000	1000.000	4444.444	17368.421	1.000	4.286	84.906	47.826	117.391	64.583	35.385
Perylene		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Phenanthrene		5.714	90.909	550.000	1560.000	588.235	3333.333	20000.000	2.737	12.143	283.019	182.609	434.783	250.000	46.154
Pyrene		19.048	77.273	365.000	960.000	394.118	2000.000	11578.947	8.421	24.286	320.755	234.783	478.261	270.833	46.154

2800N 2500E	2550N 1450E	2600N 2100E	2400N 1400E
RS-98	CS-98	RW-98	CW-98
0-0.5	0-0.5	0-0.5	0-0.5
5/14/1998	5/22/1998	5/14/1998	5/22/1998
0.000	44.000	0.842	1000.000
0.000	0.000	1.491	223.529
0.000	32.400	2.281	882.353
11.087	23.600	7.895	1411.765
13.478	29.200	9.474	1647.059
0.000	0.000	0.000	0.000
10.870	15.200	9.825	941.176
6.739	0.000	4.912	647.059
8.043	18.400	6.491	941.176
10.000	21.600	8.246	1235.294
0.000	0.000	1.491	176.471
8.478	38.800	15.965	2117.647
0.000	24.800	1.491	588.235
5.870	0.000	4.561	552.941
0.000	64.000	4.035	1117.647
0.000	0.000	0.000	0.000
5.000	108.000	12.105	2705.882
12.609	76.000	16.491	4000.000

$ESGTU_{fcv}$		$C_{oc,pah,fcv}$	3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E	3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E
			Ref Sand	1% Cont Sand#1	10% Cont Sand#1	25% Cont Sand#1	50% Cont Sand#1	Cont. Sand #1	Cont. Sand #2	Ref Wood	1% Cont Wood#1	10% Cont Wood#1	25% Cont Wood#1	50% Cont Wood#1	Cont. Wood #1	Cont. wood #2
			0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
			3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001
Special PAHs																
Acenaphthene		491	0.002	0.120	0.794	2.200	0.899	4.979	30.014	0.001	0.009	0.254	0.159	0.398	0.204	0.059
Acenaphthylene		452	0.010	0.018	0.064	0.150	0.051	0.320	1.630	0.005	0.006	0.054	0.034	0.073	0.041	0.010
Anthracene		594	0.004	0.031	0.194	0.492	0.198	1.076	7.000	0.002	0.006	0.133	0.088	0.205	0.119	0.021
Benzo(a)Anthracene		841	0.016	0.036	0.131	0.300	0.161	0.595	3.317	0.007	0.011	0.137	0.098	0.196	0.109	0.026
Benzo(a)Pyrene		965	0.017	0.031	0.098	0.220	0.116	0.403	2.236	0.008	0.012	0.104	0.072	0.144	0.078	0.018
Benzo(e)pyrene		967														
Benzo(b)Fluoranthene		979	0.010	0.020	0.051	0.102	0.078	0.236	1.021	0.005	0.007	0.054	0.036	0.071	0.038	0.013
Benzo(ghi)Perylene		1095														
Benzo(k)Fluoranthene		981	0.011	0.019	0.066	0.159	0.102	0.311	1.610	0.005	0.007	0.065	0.043	0.089	0.047	0.013
Chrysene		844	0.013	0.027	0.101	0.270	0.146	0.592	3.056	0.006	0.009	0.103	0.072	0.144	0.079	0.020
Dibenzo(a,h)Anthracene		1123														
Fluoranthene		707	0.018	0.071	0.361	0.905	0.458	2.004	11.167	0.008	0.022	0.294	0.203	0.461	0.256	0.053
Fluorene		538	0.001	0.043	0.279	0.743	0.284	1.549	9.489	0.001	0.004	0.109	0.071	0.170	0.089	0.022
Indeno(1,2,3-cd)Pyrene		1115														
Naphthalene		385	0.004	0.260	1.818	4.052	2.597	11.544	45.113	0.003	0.011	0.221	0.124	0.305	0.168	0.092
Perylene		967														
Phenanthrene		596	0.010	0.153	0.923	2.617	0.987	5.593	33.557	0.005	0.020	0.475	0.306	0.730	0.419	0.077
Pyrene		697	0.027	0.111	0.524	1.377	0.565	2.869	16.613	0.012	0.035	0.460	0.337	0.686	0.389	0.066
TOTAL ESGTUs			**0.14**	**0.94**	**5.40**	**13.59**	**6.64**	**32.07**	**165.82**	**0.07**	**0.16**	**2.46**	**1.64**	**3.67**	**2.04**	**0.49**
UF_{13}	**11.5**		**1.64**	**10.81**	**62.14**	**156.26**	**76.38**	**368.80**	**1906.95**	**0.76**	**1.85**	**28.31**	**18.90**	**42.24**	**23.41**	**5.64**

2800N 2500E	2550N 1450E	2600N 2100E	2400N 1400E
RS-98	CS-98	RW-98	CW-98
0-0.5	0-0.5	0-0.5	0-0.5
5/14/1998	5/22/1998	5/14/1998	5/22/1998
0.000	0.090	0.002	2.037
0.000	0.000	0.003	0.495
0.000	0.055	0.004	1.485
0.013	0.028	0.009	1.679
0.014	0.030	0.010	1.707
0.011	0.016	0.010	0.961
0.008	0.019	0.007	0.959
0.012	0.026	0.010	1.464
0.012	0.055	0.023	2.995
0.000	0.046	0.003	1.093
0.000	0.166	0.010	2.903
0.008	0.181	0.020	4.540
0.018	0.109	0.024	5.739
0.10	**0.82**	**0.13**	**28.06**
1.11	**9.43**	**1.54**	**322.66**

Sum of column

Acenapthene conc = 0.762 ug/g / 491 = 0.00155

Acenapthene $C_{oc,pah,fcv}$ = 491

11.5 × 0.14 = 1.6 ESG TU's

Analytical	Boring No./Depth (ft)/Date																			
		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E		3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2		Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	CW-98	CS-98	RW-98	RS-98
		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
TOC (mg/kg)		21000	22000	20000	25000	170,000	36,000	1,900		190,000	140000	53,000	230000	230000	480,000	260,000	17,000	2,500	57,000	4,600
TOC (%)		2.10000	2.2000	2.0000	2.5000	17.0000	3.6000	0.1900		19.0000	14.0000	5.3000	23.0000	23.0000	48.0000	26.0000	1.70	0.25	5.70	0.46
foc		0.02100	0.022000	0.020000	0.025000	0.170000	0.036000	0.001900		0.190000	0.140000	0.053000	0.230000	0.230000	0.480000	0.260000	0.017000	0.002500	0.057000	0.004600
Misc Organics (ug/kg)																				
Benzene												52	140	290	530	150	540			
Ethylbenzene			29	410	580	1800	2800	990				44	110	310	450	180	85			
Toluene										28	26				28	41	76		320	44
Xylenes				400	570	1780	2590	960				28	130	340	530	180	230			
BTEX		0	29	810	1150	3580	5390	1950		28	26	124	380	940	1538	551	931	0	320	44
Dibenzofuran			49	380	700	1800	3,000	830		52	71	310	640	1800	3,700	980				
Phenol		93	83		87					980	830	1400	1200	1600	1,900	450				

Coc	Boring No./Depth (ft)/Date																			
		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E		3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2		Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	CW-98	CS-98	RW-98	RS-98
		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
Misc Organics (ug/g OC)																				
Benzene		0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.981	0.609	1.261	1.104	0.577	31.8	0.0	0.0	0.0
Ethylbenzene		0.000	1.318	20.500	23.200	10.588	77.778	521.053		0.000	0.000	0.830	0.478	1.348	0.938	0.692	5.0	0.0	0.0	0.0
Toluene		0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.147	0.186	0.000	0.000	0.000	0.058	0.158	4.5	0.0	5.6	9.6
Xylenes		0.000	0.000	20.000	22.800	10.471	71.944	505.263		0.000	0.000	0.528	0.565	1.478	1.104	0.692	13.5	0.0	0.0	0.0
Dibenzofuran		0.000	2.227	19.000	28.000	10.588	83.333	436.842		0.274	0.507	5.849	2.783	7.826	7.708	3.769				
Phenol		4.429	3.773	0.000	3.480	0.000	0.000	0.000		5.158	5.929	26.415	5.217	6.957	3.958	1.731				

EPA SQAL		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E		3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2		Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	CW-98	CS-98	RW-98	RS-98
	SQALs	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
	ug/g OC	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
Misc organics compared to EPA OC SQAL																				
Benzene	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.17	0.11	0.22	0.19	0.10	5.57	0.00	0.00	0.00
Ethylbenzene	480.00	0.00	0.00	0.04	0.05	0.02	0.16	1.09		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Toluene	89.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.06	0.11
Xylenes	2.50	0.00	0.00	8.00	9.12	4.19	28.78	202.11		0.00	0.00	0.21	0.23	0.59	0.44	0.28	5.41	0.00	0.00	0.00
Total BETX SQAL TUs (NOC)		0.00	0.00	8.04	9.17	4.21	28.94	203.19		0.00	0.00	0.39	0.33	0.82	0.64	0.38	11.05	0.00	0.06	0.11
Dibenzofuran	200.00	0.00	0.01	0.10	0.14	0.05	0.42	2.18		0.00	0.00	0.03	0.01	0.04	0.04	0.02				
Phenol	na																			

ORNL PRGs	Boring No./Depth (ft)/Date																			
		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E		3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2		Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	CW-98	CS-98	RW-98	RS-98
	PRGs	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
	ug/kg	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
Misc organics compared to ORNL PRG																				
Benzene	160	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.33	0.88	1.81	3.31	0.94	3.38	0.00	0.00	0.00
Ethylbenzene	5400	0.00	0.01	0.08	0.11	0.33	0.52	0.18		0.00	0.00	0.01	0.02	0.06	0.08	0.03	0.02	0.00	0.00	0.00
Toluene	50	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.56	0.52	0.00	0.00	0.00	0.56	0.82	1.52	0.00	6.40	0.88
Xylenes	160	0.00	0.00	2.50	3.56	11.13	16.19	6.00		0.00	0.00	0.18	0.81	2.13	3.31	1.13	1.44	0.00	0.00	0.00
Total BETX ORNL TUs		0.00	0.01	2.58	3.67	11.46	16.71	6.18		0.56	0.52	0.51	1.71	3.99	7.27	2.92	6.35	0.00	6.40	0.88
Dibenzofuran	420	0.00	0.12	0.90	1.67	4.29	7.14	1.98		0.12	0.17	0.74	1.52	4.29	8.81	2.33				
Phenol	32	2.91	2.59	0.00	2.72	0.00	0.00	0.00		30.63	25.94	43.75	37.50	50.00	59.38	14.06				

WDNR	Boring No./Depth (ft)/Date																			
		3100N/2300E	3100N/2300E 99%	3100N/2300E 90%	3100N/2300E 75%	3100N/2300E 50%	2500N/1700E	2500N/1600E		3100N/1500E	3100N/1500E 99%	3100N/1500E 90%	3100N/1500E 75%	3100N/1500E 50%	2400N/1400E	2400N/1700E	2400N 1400E	2550N 1450E	2600N 2100E	2800N 2500E
		Ref. Sand	1% Sand #1	10% Sand #1	25% Sand #1	50% Sand #1	100% Sand #1	100% Sand #2		Ref. Wood	1% Wood #1	10% Wood #1	25% Wood #1	50% Wood #1	100% Wood #1	100% Wood #2	CW-98	CS-98	RW-98	RS-98
	PEC	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5		0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5
	@1%OC	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001		3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	3/29/2001	5/22/1998	5/22/1998	5/14/1998	5/14/1998
Misc organics compared to WDNR Guidelines																				
Benzene	110	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.09	0.06	0.11	0.10	0.05	2.89	0.00	0.00	0.00
Ethylbenzene	na																			
Toluene	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.05
Xylenes	50	0.00	0.00	4.00	4.56	2.09	14.39	101.05		0.00	0.00	0.11	0.11	0.30	0.22	0.14	2.71	0.00	0.00	0.00
Total BETX WDNR TUs		0.00	0.00	4.00	4.56	2.09	14.39	101.05		0.00	0.00	0.19	0.17	0.41	0.32	0.19	5.62	0.00	0.03	0.05
Dibenzofuran	580	0.00	0.04	0.33	0.48	0.18	1.44	7.53		0.00	0.01	0.10	0.05	0.13	0.13	0.06				
Phenol	12000	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.02	0.00	0.01	0.00	0.00				

CALCULATION OF TU's for MISC ORGANICS.

EXAMPLE CALCS

USING 3100N/2300E DATA

NORMALIZATION TO OC calc.

TOC = 22,000 mg/kg

DW Ethylbenzene = 29 ug/kg

NOC Ethylbenzene = $\frac{29\ ug/kg}{22{,}000\ mg/kg} = 0.0132\ \frac{ug}{mg\ OC} = \boxed{1.32\ \frac{ug}{g\ OC}}$

1) EPA SQAL TU's calc

NOC Dibenzofuran = 2.227 ug/gOC $\quad \frac{2.227}{200} = \boxed{0.01}$ SQAL TU's

SQAL Dibenzofuran = 200 ug/g OC

2) ORNL TU's

DW Dibenzofuran = 49 ug/kg $\quad \frac{49}{420} = \boxed{0.116}$ ORNL PRG TU's

PRG = 420 ug/kg

3) WDNR PEC-Q

DW Dibenzofuran = 49 ug/kg

TOC = 2.2%

DW Dibenzofuran normalized to 1%TOC = $49 \cdot \frac{1}{2.2} = 22.3$

WDNR PEC (@1%OC) = 580 ug/kg $\quad \frac{22.3}{580} = \boxed{0.038}$

OR WDNR PEC NORMALIZED TO OC

$\frac{580\ ug/kg}{10{,}000\ \frac{mg}{kg}} = .058\ \frac{ug}{mg} = 58\ ug/g\ OC$

NOC Dibenzofuran = 2.227 ug/g OC

$\frac{2.227}{58} = \boxed{0.038}$

Appendix F

Lake Superior Research Institute Bioassay Report

EVALUATION OF AQUATIC SEDIMENTS FROM THE ASHLAND HARBOR NSP LAKEFRONT SITE FOR TOXICITY TO *CHIRONOMUS TENTANS, PIMEPHALES PROMELAS, AND HYALELLA AZTECA*

By

Mary Balcer, Matt TenEyck, Thomas Markee,
and Dianne L. Brooke

Lake Superior Research Institute
University of Wisconsin-Superior
Superior, WI

FINAL REPORT

To

Short Elliott Hendrickson Inc.
421 Frenette Drive
Chippewa Falls, WI 54729-3374
Mark Broses (Project Officer)

December, 2001

INTRODUCTION

The University of Wisconsin-Superior's Lake Superior Research Institute (LSRI) contracted with Short Elliott Hendrickson Inc. (SEH) to evaluate sediments from the Ashland NSP Lakefront Site for toxicity toward two species of benthic invertebrates and one species of fish. Sediment samples were collected from six sites (two reference and four non-reference). The contaminated sediments from two of the sites were mixed with reference sediment to obtain concentrations of 1%, 10%, 25%, and 50% contaminated test sediment. A ten-day exposure was conducted with larvae of the insect, *Chironomus tentans* while larval fathead minnows, *Pimephales promelas*, were exposed to solid phase sediment for 7 days. Two 28-day exposures were performed with the crustacean amphipod, *Hyalella azteca.* One of the tests was conducted under normal laboratory lighting, while the other utilized UV light levels comparable to those seen in the Ashland Harbor. The endpoints of survival and growth were determined for all experiments.

METHODS

Sediment Collection and Preparation

Sediment was collected by staff from SEH on March 27 and 28, 2001 and placed in 30-gallon plastic drums. Six drums of sediment were delivered to the Lake Superior Research Institute on March 29. The samples were designated as having been collected from either a reference site (Reference Sand or Reference Wood) or a non-reference site (Contaminated Sand 1, Contaminated Sand 2, Contaminated Wood 1 and Contaminated Wood 2). The "wood" sediment samples contained sandy sediment with varying amounts of woody debris, primarily wood chips. The GPS coordinates for each sample were recorded (Table 1.) Upon arrival at LSRI, the containers were opened and immediately homogenized under a fume hood. Excess water was siphoned from each drum until only 1 inch of overlying water was left. Initial homogenization was for 15 minutes using a commercial drill equipped with a stainless steel mortar paddle. At 5 minute intervals, the sediment was mixed manually with a stainless steel spoon to further ensure homogeneity. Subsamples of homogenized sediment from each site were collected for chemical analysis before the samples were split and placed in two to four 3.5-gallon plastic buckets which were sealed and refrigerated at 4°C until needed.

On April 22, 2001 all sediment samples were removed from the refrigerators and each sample was again mixed for 5 minutes. Subsamples of Contaminated Sand 1 were mixed volumetrically with the reference sand sediment to obtain concentrations of 1%, 10%, 25% and 50% contaminated sand. Subsamples from the Contaminated Wood Sediment 1 were similarly mixed with the reference wood sediment to make samples with 1%, 10%, 25% and 50% contaminated sediment. A portion of each of the diluted sediments was removed for chemical analysis. The sediments were then assigned to treatments as indicated in Table 1 and refrigerated again until used for the solid phase toxicity tests. It was noted that the reference wood sediment (Treatment E) had a very inconsistent texture, with chunks of woody material in a more watery matrix than

the other sediments. The second contaminated sand sediment (Treatment O) was a fine grained sand that tended to pack tightly in the bottom of the bucket.

Three laboratory control sediments were used in these studies. Our lab traditionally uses silica sand as a performance control to assess survival of the test organisms. For this experiment we also used a 19% sand and 2% organic carbon formulated sediment (Kemble et al 1999) that is recommended by EPA (2000) for use as a control sediment. In addition, we used sediment from West Bearskin Lake, near Grand Marais, MN which has been routinely used as a control sediment at EPA-Duluth.

At the beginning of each toxicity test, the sediment samples were removed from the refrigerator and homogenized for 5 minutes with the mortar paddle immediately prior to placement of the sediment in the test chambers. All tests were completed within 11 weeks of sample receipt.

Solid Phase Sediment Toxicity Tests

Chironomus tentans Toxicity Test. A 10-day solid phase sediment toxicity test was performed with *C. tentans* following EPA's Test Method 100.2 "*Chironomus tentans* 10-d Survival and Growth Test for Sediments" (EPA 2000). Eight replicates of each of the 12 test sediments, 2 reference sediments, and 3 control sediments were used for this experiment. One day prior to test initiation, approximately 100 mL of sediment was placed into each 300-mL screened test beaker using a clean plastic measuring scoop. The eight filled replicate beakers for each sediment were covered with glass plates and placed into a single aquarium which received the renewal water. The 17 aquaria in turn, were randomly assigned to locations within large, shallow water baths set to maintain the desired test temperature of 23°C. A 16L:8D photoperiod was maintained in the test system throughout the exposure period.

The test beakers contained two screened holes about two-thirds of the distance up the beaker walls to allow for exchange of overlying water between the beaker and the aquarium in which it was placed. The water was regularly and automatically renewed throughout the test using dechlorinated municipal water from the City of Superior, WI, which had passed through an ion exchange resin to remove trace metals. The source of this water supply is a series of shallow wells located in the strata underlying the western tip of Lake Superior, resulting in a soft water with hardness, alkalinity and pH similar to the water of Lake Superior. The water in each aquarium was aerated, and was renewed twice daily at a flow rate of 32 mL/minute for 1.25 hours that resulted in two volume renewals per day in the test beakers.

The *C. tentans* test was initiated on April 29, 2001 with chironomid larvae from the LSRI culturing laboratory that were 12 days old. Ten larvae were randomly distributed to each replicate beaker at the start of the test. Based on measurements of four replicates of 10 animals each, the mean (± s.d.) individual dry weight of the animals was 0.132 ± 0.023 mg at the start of the test. Measurements of head capsule width revealed that 87% of the larvae were in the third instar (0.32 to 0.44 mm) at the start of the test. A 48-hr reference toxicant toxicity test with KCl

was initiated on the same day using a subset of the same batch of organisms. The calculated LC50 value of 3533 mg/L for these larvae is within the normal range of LC50 values for our laboratory (3176 to 7763 mg/L), as determined from a control chart containing reference toxicant tests performed over several years.

During the exposure, the test beakers were provided with equal volumes of food daily, consisting of 1.5 mL of a 4 g/L suspension of Tetrafin® goldfish food. Twice daily measurements of dissolved oxygen and temperature were made prior to the water renewal periods. Alkalinity, hardness, pH, conductivity, and ammonia were measured at the beginning and end of the test.

At the end of the 10-day exposure period, sediment from each beaker was sieved through a No. 40 (425 *um* mesh opening) sieve and rinsed into a clean glass pan. The pan was placed over a light table and the surviving organisms were gently retrieved. The survivors from each replicate beaker were cleaned of debris and combined in a single pre-weighed aluminum pan which was then oven-dried at 60°C for 24 hr. Dry weights were measured to 0.01 mg for each replicate following the cooling of dried animals in a desiccator. The test organisms were then ashed at 550°C for an additional 2 hours and weighed again for determination of ash-free dry weight.

Pimephales promelas Toxicity Test. A 7-day solid phase sediment toxicity test was performed with larval fathead minnows using a combination of three EPA test procedures; Method 1000.0 for a 7-day water-only test entitled "Fathead Minnow, *Pimephales Promelas*, Larval Survival and Growth Test" (EPA 1994), EPA Method 8.2 for a 4-d acute toxicity test using elutriate water from dredged sediments (Call et. Al. 1994) and EPA Method 100.2 for solid phase toxicity tests with chironomids (EPA 2000). These modifications are summarized in the UWS Standard Operating Procedure AT/33 "Conducting a 7-d sediment renewal toxicity test with *Pimephales Promelas*".

The modified procedure is essentially a static renewal test with a layer of sediment in the bottom of each test chamber. Test chambers consisted of 1 L glass beakers with an inner diameter of 10 cm. One day prior to starting the test, approximately 250 mL of homogenized test sediment was added to each beaker using a plastic scoop. The sediment layer was 2 to 3 cm deep depending on the consistency of the test sediment. Approximately 750 mL of water was added to each beaker to bring the level up to the 1L mark. Water was gently added by using airline tubing to siphon clean water from a large reservoir. The water was allowed to flow over the back of the bowl of a stainless steel spoon which was held just below the water surface in each beaker. Five replicate beakers were used for each of the control, reference, and test sediments. After filling, the beakers were randomly assigned to water baths set to maintain a temperature of 25°C. The beakers were covered with glass plates and fine-tipped glass pasteur pipettes connected to airlines were inserted into holes in the covers to provide aeration.

On day 0, daily water renewals were begun by carefully siphoning 600 mL of water out of each beaker (to the 400 mL mark on the beaker). Uneaten food and fecal materials were also removed

by the siphon.

Water temperature and dissolved oxygen levels were measured in at least one replicate test beaker for each treatment prior to the daily renewal. Similar measurements were made to ensure that the renewal water was at the proper temperature and contained adequate oxygen concentrations prior to addition. Water quality measurements were repeated approximately 4 hours after renewal. Hardness alkalinity, and conductivity measurements were taken at beginning and end of the test. The pH and ammonia levels were measured on days 0, 1, 2, 4, and 7.

On May 14, 2001 larval fathead minnows, less than 24 hours old, were obtained from Environmental Consulting and Testing (ECT) in Superior, WI. Dry weight of the larvae was determined by drying three replicate groups of 10 organisms at 60°C for 24 hours. The mean (± s.d.) individual dry weight per larva was 0.118 ± 0.008 mg at the start of the test. Reference toxicity tests conducted by ECT with KCl determined a LC50 value of 4.87 g/L, which was within their control chart limits.

Ten *P. promelas* fry were randomly added to each replicate test beaker after the renewal on day 0. Each beaker of fish was fed approximately 0.15 g of newly hatched (<24-h old brine shrimp nauplii) twice daily. Approximately 6 hours were allowed between feedings. Larvae were not fed during the final 12 h of the test. The brine shrimp nauplii were obtained by turning off the air in the culture flasks and allowing the nauplii to concentrate at the bottom of the flasks. Approximately 125 mL of concentrated nauplii was collected on a fine mesh screen, rinsed with lab water, and then diluted to 15 ml. A 0.15 mL alliquot of this concentrate contained approximately 0.15 g of nauplii (Call et al. 1994).

On day 7, the test was ended by siphoning surviving larvae out of each beaker. If 10 larvae were not recovered from the overlying water in each beaker, the sediment was then gently sieved through a 425 um mesh to recover remaining organisms. Surviving fish were rinsed, and then placed in pre-weighed pans. Dry weights were determined to the nearest 0.01 mg after drying for 24 hours at 60°C.

<u>*Hyalella azteca* Toxicity Test - Regular Lab Lighting</u> A 28-day solid phase sediment toxicity test was performed with *H. azteca* according to a modification of method 100.4 "*Hyalella azteca* 42-d Test for Measuring the Effects of Sediment-associated Contaminants on Survival, Growth, and Reproduction" described in EPA 2000. The test was reduced to 28 days with survival and growth as endpoints. The exposures were performed in screened 300-mL beakers contained within aquaria set in a water bath at 23°C, as described above for *C. tentans*. The exposures were of the flow-through type, with intermittent renewal of the overlying water to provide approximately two volume exchanges daily. The water in the aquaria housing the exposure beakers was aerated. Eight replicate beakers were used for each of the control, reference, and test sediments listed in Table 1. The sediments were added to the beakers on day -1 and allowed

to settle for 24 hours prior to the addition of animals.

A 16L:8D photoperiod was provided using regular lab lighting at an intensity of 25 to 90 foot candles. The wide spectrum light bulbs used in this experiment provide 2 to 5 *u*watts/cm2 UVA (315-400 nm) in the aquaria which held the test beakers. These measurements were made when no beakers or glass covers were present which have further reduced UV intensity.

This experiment was started on May 27, 2001. Ten juvenile *H. azteca* (7-8 days old) were randomly distributed to each replicate beaker at the start of the test. The individual dry weight (± s.d.) of a subsample of 4 groups of 40 organisms averaged 0.038 (± 0.011) mg. A 48-hr reference toxicity test with KCl was performed on May 27, 2001 with 7 to 14 d old *Hyalella* from the laboratory culture. The LC50 value of 400 mg/L is within the normal range of LC50 values for our laboratory (356 to 442 mg/L).

Each test beaker received 1.0 mL of a 1,800 mg/L YCT (yeast, Cerophyll®, trout chow) mixture daily. Daily measurements were made of dissolved oxygen and temperature prior to the renewal period and again later in the afternoon. Alkalinity, hardness, and ammonia were measured at the beginning and end of the exposure while pH was measured three times per week and conductivity was measured once per week.

On May 31, the aquarium housing Treatment N, 100% contaminated wood 2, overflowed due to a clogged drain line. Animals escaped from several of the test beakers and ended up in other beakers or in the holding tank. This treatment was repeated with a second set of test organisms between June 12 to July 10, while the UV tests described below were being conducted. Treatment H, 10% contaminated sand 1 and treatment I, 10% contaminated wood 1, were also repeated in order to check for differences between batches of test organisms.

At the end of the 28-day exposure periods, the sediments were sieved as described above for the chironomid test. Survivors were rinsed in lab water then oven-dried for 24 hr at 60° C in pre-weighed aluminum weighing pans. The animals within a given replicate were weighed collectively to obtain a single dry weight for each replicate.

Hyalella azteca Toxicity Test - Ultraviolet Lighting

This experimental methods for this test were identical to those used in the experiment described above except that ultraaviolet lights (UVA-340 bulbs from Q-Panel Co.) were used in addition to the normal wide spectrum light bulbs in order to mimic natural ultraviolet light levels at the test site. The ultraviolet light levels in Ashland Harbor were measured on June 8, 2001 a mildly overcast day (Table 3). UVA levels (315-400 nm) ranged from 19 to 76 *u*watts/cm2 at the shallow test site while UVB levels (280 to 315nm) varied from nondetectable (ND) to 18 *u*watts/cm2. Our laboratory conditions were set to approximate intensities found between 0.5 and 1.0 m. To decrease light intensity, pieces of window screen were positioned between the light bulbs and the test chambers. These filters were removed for approximately four hours

between 11am and 3 pm to mimic the increased light intensity present at midday. The total light intensity at the surface of the test beakers ranged from 45-75 foot candles. UVA intensity averaged 69.5 +/- 16.9 *u*watts/cm2 in the middle of the glass covered test beakers when the filters were removed and 45.9 +/- 10.1 *u*watts/cm2 with filters in place (Table 3). The UVB levels were 3.99 +/- 0.9 *u*watts/cm2 without filters and 2.52 +/- 0.5 *u*watts/cm2 with filters.

The experiment was started with 7 to 8-d old Hyalella azteca on June 12, 2001. The test organisms had an average initial dry weight of 0.029 +/- 0.0011 mg. A reference toxicity test was begun on the same date using 7 to 14-d old organisms from the culture unit. The LC50 of 424 mg/L KCl is within the range of our laboratory control chart (356 to 442 mg/L).

STATISTICAL ANALYSIS

Toxicity test data were analyzed using a SYSTAT® statistical software package (SPSS, Inc., 1997) that included a one-way analysis of variance and a suite of tests for comparison of treatment group means. Survival data transformed (Arc sine-square root transformation, Section 16 U.S. EPA 2000) to normalize data Mean survival and mean dry weight values for each of the test sites were compared to the corresponding mean values for the laboratory control sediments and the appropriate reference sediment using the Bonferroni t-test, with statistical significance set at a probability level of 0.05 and below.

The trimmed Spearmann-Karber test (Section 16, U.S. EPA 2000) was also used to determine an LC50 value for the sediments that were used in the dilution series. Survival was examined for the reference sand and wood sediments along with the 1%, 10%, 25%, 50% and 100% concentrations of contaminated sand 1 and contaminated wood 1.

RESULTS

Chironomus tentans Toxicity Test.

Survival was high for *C. tentans* larvae exposed to the laboratory control and field reference sediments (Table 4) and above the test acceptability criterion of 70.0% survival (U.S. EPA 2000). The Sand Performance Control animals had a mean (± s.d.) survival of 82.5, while survival in the formulated and West Bearskin control sediments averaged 90.0 and 96.2% resepectively. Survival of larval chironomids in the 10% concentration of contaminated sand 1 (72.5%) was significantly reduced relative to the West Bearskin sediment and a concentration of 25% contaminated sand 1 significantly reduced survival (22.5%) relative to all of the control sediments and to the reference sand sediment (95% survival). The second contaminated sand sediment and concentrations of contaminated sand 1 of 50% and 100% were lethal to the test animals. The first contaminated wood sediment demonstrated toxicity at concentrations of 50 and 100% (survival reduced to 47.5 and 5% respectively), but no adverse effects were observed

with the second contaminated wood sediment. The calculated LC50 value (with 95% confidence intervals) for the first contaminated sand sediment was 12.98% contaminated sediment (10.90 - 15.46%) while the first contaminated wood sediment had an LC50 concentration of 48.28% contaminated sediment (43.45 to 53.64%). Raw data for survival in each replicate are presented in Appendix Table 1.

Mean ash-free dry weight in the control and reference sediments ranged from 0.652 mg/animal in the silica sand control to 0.905 mg/animal in the reference wood sediment (Table 2). These values are above the minimum mean weight of 0.48 mg recommended for test acceptability (U.S. EPA, 2000). Growth was significantly reduced relative to the reference wood sediment at concentrations of contaminated wood 1 equal to or greater than 25%. Dry weight data for each replicate are presented in Table 1 of the Appendix.

Measurements of water quality parameters that accompanied this test are presented in Tables 2 to 4 of the Appendix. Average water temperatures for the various test sediments ranged from 22.8 to 23.0° C with instantaneous values ranging from 21.5 to 23.9°C. These values are within EPA guidelines for average temperatures of 22 to 24°C and instantaneous temperatures of 20 to 26°C, Average dissolved oxygen values during the test ranged from 4.8 to 6.0 ppm in the different treatments, occassionally oxygen levels dropped below the recommended level of 2.5 ppm but were soon adjusted by increasing aeration to the aquaria that housed the test beakers.

During the 10-d exposure pH values ranged from 6.71 to 8.23 in the test beakers (Appendix Table 4). The lowest pH readings were observed in the formulated sediment. Average conductivity values ranged from 149 to 159 umhos/cm2. Ammonia values were generally quite low. A maximum concentration of 1.99 ppm was measured in the 50% concentration of contaminated sand 1 at the end of the test. The average hardness values for the treatments ranged from 52 to 105 ppm CaCO3 while average alkalinites varied from 41 to 52 ppm CaCO3.

Pimephales promelas Toxicity test

Survival in the control and reference sediments were quite high, ranging from 92% in the reference sand to 100% in the silica sand and formulated sediments (Table 5). These values are well above the required test criterion of 80% survival. A significant decrease in survival (12%) was noted in the 50% concentration of contaminated sand 1. The 100% concentrations of contaminated sand 1 and contaminated sand 2 were lethal to larval fathead minnows in only 2 days. The 100% contaminated wood sample reduced survival to 18%. The calculated LC50 concentrations of contaminated sediment were 35.16% (31.35 to 39.43%) for contaminated sand 1 and 74.67% (69.83 to 79.85%) for contaminated wood sediment 1.

Growth effects were noticed at slightly lower concentrations. The fish in the control and reference sediments had average dry weights of 0.91 to 1.04 mg each. Significant reductions were seen in the 25% sand 1 (0.612 mg), 50% sand 1 (0.291 mg), 50% wood 1 (0.654 mg), and 100% wood 1 (0.282mg) treatments relative to the control and reference sediments. Exposure to

the 100%concentration of wood sediment 2 resulted in a smaller reduction in weight (0.783 mg) which was only significantly reduced relative to the silica sand control (1.04mg). Values of survival and dry weight for each treatment are listed in appendix table 5.

Water temperatures averaged 24.7 to 25.0°C for the treatments over the 7-day test period (Appendix table 6). Instantaneous temperatures ranged from 23.3 to 26.1°C, well within the recommended range of of 22 to 28°C. Oxygen values averaged 5.73 to 6.47 ppm (Appendix table 7). The lowest recorded value of 4.1 ppm was still above the recommended level of 4.0 ppm or 49% saturation. Appendix table 8 summarizes the pH, conductivity, ammonia, hardness and alkalinity measurements. The pH ranged from 7.28 to 8.17 in the test beakers. The average treatment values for conductivity were 141 to 183 umho/cm2, while the averages for hardness and alkalinity were 49.8 to 55.5 and 42.8 to 52.1 ppm CaCO3, respectively. Most test sediments had fairly low ammonia concentrations, with treatment averages below 0.5 ppm. The 10% concentration of sand sediment 1 had a maximum ammonia concentration of 2.77 ppm.

Hyalella azteca Toxicity Test - Laboratory light

Survival of *H. azteca* in the reference sediments (86.2 and 97.5%) , the formulated sediment (92.5%), and the West Bearskin control sediment (97.5%) met the U.S. EPA (2000) criteria of 80% or greater survival (Table 6). Survival in the silica sand control (77.5%) was significantly lower than the West Bearskin control and did not meet the test criteria. A significant reduction in survival was observed in the 50% concentration of contaminated sand 1 (11.9% survival), and the 100% contaminated sand 2 treatment (5% survival). The 100% concentration of contaminated sand 1 was lethal to *Hyalella* in the 28-d exposure. Only the 100% concentration of woody sediment 1 significantly affected survival (2.5%). The initial results from the exposure with 100% wood sediment 2 were not used because the test system had flooded. When the test was repeated with this sediment, survival was found to be quite high (91.3%). The results from the repeated exposures with the 10% concentrations of sand 1 and wood 1 were almost identical to those obtained from the initial exposure, indicating that the test organisms used for both exposures had similar tolerances to the sediments. LC50 values were determined to be 42.08% (37.52 to 47.19%) of contaminated sand sediment 1 and 59.87% (49.68 to 65.10%) of contaminated wood sediment 1.

The average dry weights of animals exposed to the reference sediments (0.236 and 0.270 mg), the silica sand control (0.189 mg), and the West Bearskin Lake control sediment (0.183 mg) were significantly less than those obtained from animals in the formulated sediment (0.558 mg). This may have been because the *Hyalella* fed on the thick mat of fungus that grew in the beakers containing the formulated sediment. No significant reductions in growth were attributed to exposure to the contaminated sediments. The raw data on survival and growth are contained in Table 9 in the appendix.

During the 28-d test water temperatures ranged from 22.0 to 24.2°C and averaged 22.9 to 23.1°C in the various treatments (Appendix Table 10). Dissolved oxygen levels were generally well

above the required value of 2.5 ppm with average concentration of 5.5 to 7.1 ppm (Appendix Table 11). The lowest oxygen levels were observed in the formulated sediments that contained large amounts of fungus. Oxygen levels were improved by increasing the amount of aeration to the aquaria that housed the test beakers. The pH levels in the beakers ranged from 6.69 to 8.42 (Appendix Table 12). Average conductivity values were 162 to 173 umho/cm2 while average hardness and alkalinity values from the treatments were 57.9 to 66.0 and 46.9 to 51.0 pppm CaCO3, respectively.

Hyalella azteca Toxicity Test -UV Light

During the UV light exposure, survival of Hyalella in the reference sediments (92.5 and 98.7%), the silica sand (95%), and the West Bearskin sediment (97.5%) met the U.S. EPA test criteria of 80% survival. The survival in the formulated sediment (70%) was not acceptable. The UV exposure led to significant reductions in survival occurring at lower concentrations of the contaminated sediments than was observed under regular laboratory lighting (Table 7). Survival in the 10% concentration of contaminated sand 1 was reduced to 68.7%, while the 50% and 100% concentrations of contaminated sand 1 and 100% sand 2 were lethal. Under the UV light levels used in this experiment, the LC50 concentrations for contaminated sand 1 and contaminated wood 1 were 10.93% (9.17 to 13.04%) and 16.37% (13.83 to 19.38%), resepectively. These values are approximately 1/4 of those obtained under laboratory lighting.

Growth in the formulated sediment was again greater than in the other control and reference sediments (Table 7). No significant reductions in growth were observed in any of the test sediments. The raw data for survival and growth are contained in Appendix Table 13.

During this 28-d exposure, the temperatures ranged from 21.1 to 24.0°C (Appendix Table 14). Average temperatures for the various treatments were quite similar, 22.8 to 23.0°C. The dissolved oxygen levels ranged from 1.7 to 8.3 ppm, with treatment averages between 5.2 and 7.0 ppm (Appendix Table 15). Lowest values were observed in the formulated sediment and in the 100% concentrations of contaminated sand 1 and contaminated wood 1. The pH values during the test ranged from 6.66 to 8.20. Conductivity, hardness, and alkalinity averaged 147 to 164 umho/cm2, 58.3 to 63.2 ppm CaCO3, and 46.1 to 52.2 ppm CaCO3, respectively (Appendix Table 16). The maximum observed concentrtion of ammonia in the test beakers was 0.586 ppm.

Summary/Discussion

The survival and growth of all test organisms in the West Bearskin control sediment and in the two reference sediments were high and met EPA criteria for test acceptability. Some problems were encountered with the silica sand and the formulated sediment that were also included as optional laboratory controls. Growth and survival of some organisms was reduced in silica sand due to limited food availability. The formulated sediment tended to have a very high oxygen demand and supported excessive growth of fungus. We have noticed this in some of our previous tests and our laboratory will be exploring other types of formulated sediment for future use. For this experiment, results from the test sediments are compared primarily to data from the West Bearskin control and the reference sediments.

The contaminated wood sediment #2 (2400N 1700E) did not exhibit any toxicity to the test organisms under ambient laboratory light conditions at 100% strength. However, under increased UV light intensity, *Hyalella* showed a significant decline in survival (36%) in this sediment. Contaminated wood sediment #1 (2400N 1400E) affected survival of all of the test species with calculated LC50s of 75% contaminant sediment for fathead minnows, 48% for chironomids, 60% for *Hyalella* under ambient light and only 16% for *Hyalella* under UV light.

Contaminated sand sediment #2 (2500N 1600E) was only tested at the 100% concentration and was found to be lethal for all test organisms except 5% of the *Hyalella* which were able to survive under ambient light conditions. The other contaminated sand sediment (2500N 1700E) was slightly more toxic than the woody sediments with calculated LC50s of 35% contaminated sediment for fathead minnows, 13% for chironomids, 42% for *Hyalella* under ambient light and only 11% for *Hyalella* under UV light.

The addition of UV light at levels comparable to those found in the Ashland harbor increased the toxicity of the test sediments to *Hyalella* which spend time out of the sediment and exposed to the light. Additional work needs to be done to determine if ambient UV light levels would also increase the toxicity of sediments to organisms such as chironomids or oligochaetes which spend more time buried in the sediment.

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Table 1. Treatment codes associated with test sediments from the Ashland/NSP Lakefront Sites16901t3b0s12.00v1P

Sediment Type	Sediment Description	GPS coordinates of sediment source	Treatment code
Laboratory Control Sediments	silica sand	----	A
	formulated sediment	----	B
	West Bearskin Lake sediment	North of Grand Marais, Minnesota	C
Ashland Harbor Test Sediments	reference sand	3100 N 2300 E	D
	1% sand 1	1% of 2500 N 1700 E and 99% 3100 N 2300 E	F
	10% sand 1	10% of 2500 N 1700 E and 90% 3100 N 2300 E	H
	25% sand 1	25% of 2500 N 1700 E and 75% 3100 N 2300 E	J
	50% sand 1	50% of 2500 N 1700 E and 50% 3100 N 2300 E	L
	100% sand 1	100% of 2500 N 1700 E	P
	100% sand 2	2500 N 1600 E	O
	reference wood	3100 N 1500 E	E
	1% wood 1	1% of 2400N 1400E and 99% 3100 N 1500 E	G
	10% wood 1	10% of 2400N 1400E and 90% 3100 N 1500 E	I
	25% wood 1	25% of 2400N 1400E and 75% 3100 N 1500 E	K
	50% wood 1	50% of 2400N 1400E and 50% 3100 N 1500 E	M
	100% wood 1	100% of 2400N 1400E	Q
	100% wood 2	2400 N 1700 E	N

Table 2. Ultraviolet light levels in the Ashland Harbor on June 8, 2001. Multiple readings were made as cloud conditions varied. Values are uwatts/cm^2 UVA (315-400 nm), UVB (280-315 nm), and UVC (100-280 nm).

Depth	UVA	UVB	UVC
Air	370 , 620, 1100	210, 330, 310	160, 170, 120
0.25 to 0.3 m	71	9	16
0.5 m	76	18	12
0.7 to 0.76 m	35	1	0.3
0.9 m		0.85	
1.1 m	30		1.9
1.4 to 1.6 m	19	ND*	0.016

* ND = Not detectable, less than 0.01 uwatts/cm^2.

Table 3. Ultraviolet Light Levels (uwatts/cm2) in test chambers during the Hyalella azteca experiment June 12 to July 10, 2001 Readings were made at the front, middle, and back of each tank. The experiment was conducted in glass covered beakers, with screen filters that were removed at midday to increase light intensity.

Treatment	UV A No Filter	Treatment Average	UVA W/ Filters	Treatment Average	UV B No Filter	Treatment Average	UV B W/ Filters	Treatment Average
Silica Sand	100		64.3		4.7		2.5	
	55	83	40.4	54	3	3.9	1.5	2.2
	93.6		58.6		4		2.6	
West Bearskin	91.3		56.4		5		3.1	
	46.5	76	29.3	46	2.6	4.1	2.0	2.6
	90.5		52.0		4.6		2.8	
Formulated Sediment	71.8		50.0		4.3		2.3	
	51.4	59	42.1	43	3.8	3.7	2.0	2.1
	54.9		35.4		3.1		2.1	
Reference Sand	93.4		58.4		3.7		2.0	
	45.8	74	34.3	42	2.5	3.3	1.9	2.2
	82		33.9		3.7		2.7	
1% Sand 1	92.4		63.0		4.8		3.1	
	58.7	77	42.2	54	3.5	4.1	2.1	2.6
	79.5		56.8		3.9		2.6	
10% Sand 1	92.6		62.3		5		3.0	
	65.3	79	45.7	54	2.9	4.1	3.1	2.9
	78.8		55.3		4.4		2.7	
25% Sand 1	60		41.2		3.6		2.1	
	55.1	66	39.7	44	3.2	3.8	2.8	2.6
	82.9		52.3		4.6		2.8	
50% Sand 1	61.9		50.2		4.8		2.9	
	59.5	67	43.9	46	3.2	4.1	3.8	3.1
	80.3		42.6		4.3		2.6	
100% Sand 1	91.4		58.1		4.2		3.0	
	52.7	73	32.9	47	2.4	3.5	2.5	2.4
	74.1		48.5		3.8		1.8	

Table 3. continued.

Treatment	UV A No Filter	Treatment Average	UVA W/ Filters	Treatment Average	UV B No Filter	Treatment Average	UV B W/ Filters	Treatment Average
100% Sand 2	89.6		58.9		6.4		3.5	
	59.7	77	41.3	50	6.1	5.6	3.3	3.2
	82.5		50.0		4.3		2.7	
Reference Wood	75.5		51.1		4.3		2.7	
	60	73	38.2	48	4.9	4.5	1.8	2.4
	84.9		53.4		4.4		2.6	
1% Wood 1	31.4		36.4		3.2		1.8	
	60	45	25.2	29	2.6	3.4	1.7	2.0
	42.6		26.0		4.3		2.6	
10% Wood 1	88.8		56.0		5.3		3.2	
	42.2	66	29.9	46	3	4.3	1.9	2.7
	67.4		51.5		4.5		2.9	
25% Wood 1	90.9		59.1		5.4		3.1	
	55.7	74	39.3	50	3.4	4.4	2.9	2.9
	76.6		51.1		4.3		2.6	
50% Wood 1	56.2		45.7		4		2.8	
	51.6	61	40.2	46	3.3	4.0	2.9	2.8
	75.2		50.7		4.6		2.7	
100% Wood 1	72.8		46.7		3.4		2.1	
	44.2	63	29.9	41	2.2	2.9	1.3	1.7
	72.9		45.9		3		1.8	
100% Wood 2	58.9		39.3		3.5		2.5	
	61.6	67	35.8	42	4.9	4.3	2.1	2.4
	80.4		51.3		4.5		2.7	
Average	69.5		45.9		4.0		2.5	
Minimum	31.4		25.2		2.2		1.3	
Maximum	100.0		64.3		6.4		3.8	
Standard Deviation	16.9		10.1		0.9		0.5	

Table 4. Average survival and ashfree dry weight of *Chironomus tentans* following 10 days of exposure to sediments from Ashland Harbor, April 29 to May 9, 2001. Standard deviations are in ( ).

Treatment	Average percent survival	Average ashfree dry weight (mg)
Silica sand control	82.5 (10.4)	0.652 (0.130)
Formulated Sediment	90.0 (14.1)	0.721 (0.215)
West Bearskin Lake	96.2 (7.4)	0.810 (0.095)
reference sand	95.0 (5.3)	0.832 (0.086)
1% sand 1	97.5 (4.6)	0.745 (0.74)
10% sand 1	72.5 (16.7)[c]	0.800 (0.155)
25% sand 1	22.5 (21.2)[abcd]	0.579 (0.276)
50% sand 1	0 (0)[abcd]	----
100% sand 1	0 (0)[abcd]	----
100% sand 2	0 (0)[abcd]	----
reference wood	85.0 (20.7)	0.905 (0.119)
1% wood 1	92.5 (10.4)	0.831 (0.188)
10% wood 1	92.5 (13.9)	0.706 (0.116)
25% wood 1	87.5 (10.4)	0.629 (0.055)[e]
50% wood 1	47.5 (23.8)[abce]	0.547 (0.179)[e]
100% wood 1	5.0 (5.3)[abce]	0.345 (0.089)[bce]
100% wood 2	95.0 (7.6)	0.665 (0.112)

[a] Significantly reduced relative to the silica sand control by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced relative to the formulated sediment control by one-way ANOVA and the Bonferroni T-test

[c] Significantly reduced relative to the West Bearskin Lake control by one-way ANOVA and the Bonferroni T-test

[d] Significantly reduced relative to the sand reference sediment by one-way ANOVA and the Bonferroni T-test

[e] Significantly reduced relative to the wood reference sediment by one-way ANOVA and the Bonferroni T-test

Table 5. Average survival and dry weight of *Pimephales promelas* following 7 days of exposure to sediments from Ashland Harbor, May 14 to 21, 2001. Standard deviations are in ( ).

Treatment	Average percent survival	Average dry weight (mg)
Silica sand control	100 (0)	1.042 (0.173)
Formulated Sediment	100 (0)	0.976 (0.085)
West Bearskin Lake	94.0 (5.5)	0.953 (0.063)
reference sand	92.0 (4.5)	0.912 (0.094)
1% sand 1	96.0 (5.5)	0.897 (0.072)
10% sand 1	92.0 (11.0)	0.842 (0.110)
25% sand 1	90.0 (7.1)	0.612 (0.092)[abcd]
50% sand 1	12.0 (13.0)[abcd]	0.291 (0.069)[abcd]
100% sand 1	0 (0)[abcd]	----
100% sand 2	0 (0)[abcd]	----
reference wood	98.0 (4.5)	0.954 (0.123)
1% wood 1	92.0 (8.4)	0.959 (0.127)
10% wood 1	96.0 (5.5)	0.937 (0.052)
25% wood 1	98.0 (4.5)	0.872 (0.075)
50% wood 1	88.0 (11.0)	0.654 (0.161)[abce]
100% wood 1	18.0 (16.4)[abce]	0.282 (0.065)[abce]
100% wood 2	98.0 (4.5)	0.783 (0.066)[a]

[a] Significantly reduced relative to the silica sand control by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced relative to the formulated sediment control by one-way ANOVA and the Bonferroni T-test

[c] Significantly reduced relative to the West Bearskin Lake control by one-way ANOVA and the Bonferroni T-test

[d] Significantly reduced relative to the sand reference sediment by one-way ANOVA and the Bonferroni T-test

[e] Significantly reduced relative to the wood reference sediment by one-way ANOVA and the Bonferroni T-test

Table 6. Average survival and dry weight of *Hyalella azteca* following 28 days of exposure to sediments from Ashland Harbor under laboratory lighting, May 27 to June 24, 2001. Three of the exposures were repeated from June 12 to July 10. Standard deviations are in ( ).

Treatment	Average percent survival	Average dry weight (mg)
Silica sand control	77.5 (15.8)[ce]	0.189 (0.030)[b]
Formulated Sediment	92.5 (10.4)	0.558 (0.082)
West Bearskin Lake	97.5 (4.6)	0.183 (0.027)[b]
reference sand	86.2 (20.0)	0.270 (0.092)[b]
1% sand 1	97.5 (4.6)	0.220 (0.030)[b]
10% sand 1	95.0 (7.6)	0.209 (0.054)[b]
25% sand 1	83.7 (16.9)	0.259 (0.055)[b]
50% sand 1	46.2 (11.9)[abcd]	0.430 (0.066)[b]
100% sand 1	0 (0)[abcd]	----
100% sand 2	5.0 (5.3)[abcd]	0.573 (0.051)
reference wood	97.5 (7.1)	0.236 (0.025)[b]
1% wood 1	95.0 (5.3)	0.218 (0.025)[b]
10% wood 1	90.0 (17.7)	0.245 (0.071)[b]
25% wood 1	87.5 (10.4)	0.241 (0.053)[b]
50% wood 1	86.2 (10.6)	0.256 (0.029)[b]
100% wood 1	2.5 (4.6)[abce]	0.415 (0.276)
100% wood 2	----	----
repeat - 10% sand	92.5 (8.9)	0.205 (0.029)
repeat - 10% wood	92.5 (8.9)	0.232 (0.021)
repeat - 100% wood	91.3 (8.3)	0.227 (0.028)

[a] Significantly reduced relative to the silica sand control by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced relative to the formulated sediment control by one-way ANOVA and the Bonferroni T-test

[c] Significantly reduced relative to the West Bearskin Lake control by one-way ANOVA and the Bonferroni T-test

[d] Significantly reduced relative to the sand reference sediment by one-way ANOVA and the Bonferroni T-test

[e] Significantly reduced relative to the wood reference sediment by one-way ANOVA and the Bonferroni T-test

Table 7. Average survival and dry weight of *Hyalella azteca* following 28 days of exposure to sediments from Ashland Harbor under ultraviolet lighting, June 12 to July 10, 2001. Standard deviations are in ( ).

Treatment	Average percent survival	Average dry weight (mg)
Silica sand control	95.0 (5.3)	0.171 (0.010)[b]
Formulated Sediment	70.0 (15.1)[acde]	0.494 (0.077)
West Bearskin Lake	97.5 (4.6)	0.178 (0.014)[b]
reference sand	92.5 (7.1)	0.211 (0.040)[b]
1% sand 1	98.7 (3.5)	0.190 (0.041)[b]
10% sand 1	68.7 (9.9)[acd]	0.289 (0.043)[b]
25% sand 1	13.8 (9.2)[abcd]	0.497 (0.080)
50% sand 1	0 (0)[abcd]	----
100% sand 1	0 (0)[abcd]	----
100% sand 2	0 (0)[abcd]	----
reference wood	98.7 (3.5)	0.242 (0.023)[b]
1% wood 1	95.0 (5.3)	0.226 (0.032)[b]
10% wood 1	82.5 (20.5)[ce]	0.292 (0.100) [b]
25% wood 1	32.5 (12.8)[abce]	0.495 (0.127)
50% wood 1	0 (0)[abce]	----
100% wood 1	0 (0)[abce]	----
100% wood 2	36.2 (20.7)[abce]	0.485 (0.141)

[a] Significantly reduced relative to the silica sand control by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced relative to the formulated sediment control by one-way ANOVA and the Bonferroni T-test

[c] Significantly reduced relative to the West Bearskin Lake control by one-way ANOVA and the Bonferroni T-test

[d] Significantly reduced relative to the sand reference sediment by one-way ANOVA and the Bonferroni T-test

[e] Significantly reduced relative to the wood reference sediment by one-way ANOVA and the Bonferroni T-test

Appendix Table 1. Survival and growth of ***Chironomus tentans***

Treatment	Test Sediment	Rep	Number of survivors	individual dry weight (ug)	ash free dry weight (ug)
a	Sand	1	9	0.590	0.533
a	Sand	2	10	0.987	0.766
a	Sand	3	8	0.799	0.694
a	Sand	4	7	0.904	0.801
a	Sand	5	7	0.813	0.744
a	Sand	6	8	0.782	0.708
a	Sand	7	8	0.534	0.505
a	Sand	8	9	0.502	0.466
b	Formu	1	9	0.930	0.651
b	Formu	2	10	1.129	0.921
b	Formu	3	6	0.923	0.658
b	Formu	4	9	1.252	0.872
b	Formu	5	10	1.063	0.689
b	Formu	6	10	0.627	0.462
b	Formu	7	8	1.947	1.060
b	Formu	8	10	0.588	0.456
c	W. Bear	1	10	1.322	0.687
c	W. Bear	2	10	1.600	0.870
c	W. Bear	3	11	1.306	0.767
c	W. Bear	4	9	1.794	0.911
c	W. Bear	5	10	1.256	0.664
c	W. Bear	6	10	1.482	0.871
c	W. Bear	7	8	1.613	0.812
c	W. Bear	8	10	1.702	0.899
d	ref sand	1	9	1.219	0.862
d	ref sand	2	9	1.142	0.804
d	ref sand	3	10	1.199	0.838
d	ref sand	4	10	1.055	0.745
d	ref sand	5	9	1.188	0.861
d	ref sand	6	11	1.397	0.993
d	ref sand	7	9	1.231	0.842
d	ref sand	8	10	1.022	0.707
e	ref wood	1	10	1.115	0.849
e	ref wood	2	8	1.305	1.021
e	ref wood	3	10	1.110	0.840
e	ref wood	4	10	1.031	0.766
e	ref wood	5	8	1.180	0.886
e	ref wood	6	10	1.101	0.821
e	ref wood	7	4	1.430	1.130
e	ref wood	8	8	1.253	0.926

Appendix Table 1 (continued) Survival and growth of Chironomus tentans.

Treatment	Test Sediment	Rep	Number of survivors	individual dry weight (ug)	ash free dry weight (ug)
f	1%cont sand	1	10	1.087	0.753
f	1%cont sand	2	9	1.082	0.802
f	1%cont sand	3	9	1.096	0.783
f	1%cont sand	4	10	1.132	0.857
f	1%cont sand	5	10	1.002	0.751
f	1%cont sand	6	10	1.031	0.728
f	1%cont sand	7	10	0.911	0.653
f	1%cont sand	8	10	0.931	0.633
g	1% cont wood	1	10	0.966	0.650
g	1% cont wood	2	9	1.252	0.900
g	1% cont wood	3	10	1.199	0.889
g	1% cont wood	4	10	1.166	1.147
g	1% cont wood	5	9	1.320	1.013
g	1% cont wood	6	9	0.996	0.664
g	1% cont wood	7	7	0.899	0.749
g	1% cont wood	8	10	0.930	0.635
h	10%cont Sand	1	5	0.764	0.648
h	10%cont Sand	2	9	0.946	0.714
h	10%cont Sand	3	9	0.943	0.740
h	10%cont Sand	4	5	1.378	1.078
h	10%cont Sand	5	6	1.288	1.002
h	10%cont Sand	6	8	1.011	0.741
h	10%cont Sand	7	8	0.954	0.784
h	10%cont Sand	8	8	0.834	0.690
i	10%cont Wood	1	10	0.893	0.717
i	10%cont Wood	2	10	0.798	0.606
i	10%cont Wood	3	12	0.847	0.658
i	10%cont Wood	4	6	1.182	0.932
i	10%cont Wood	5	11	0.887	0.734
i	10%cont Wood	6	9	0.626	0.539
i	10%cont Wood	7	9	0.951	0.743
i	10%cont Wood	8	10	0.845	0.715

Appendix Table 1 (continued) Survival and growth of Chironomus tentans.

Treatment	Test Sediment	Rep	Number of survivors	individual dry weight (ug)	ash free dry weight (ug)
j	25%cont Sand	1	2	0.555	0.515
j	25%cont Sand	2	0		
j	25%cont Sand	3	1	0.300	0.160
j	25%cont Sand	4	1	1.030	0.920
j	25%cont Sand	5	0		
j	25%cont Sand	6	5	0.812	0.586
j	25%cont Sand	7	4	0.975	0.842
j	25%cont Sand	8	5	0.558	0.450
k	25%cont Wood	1	8	0.886	0.704
k	25%cont Wood	2	7	0.821	0.636
k	25%cont Wood	3	8	0.824	0.646
k	25%cont Wood	4	9	0.814	0.642
k	25%cont Wood	5	9	0.641	0.531
k	25%cont Wood	6	9	0.830	0.672
k	25%cont Wood	7	10	0.686	0.571
k	25%cont Wood	8	10	0.809	0.632
l	50% cont Sand	1	0		
l	50% cont Sand	2	0		
l	50% cont Sand	3	0		
l	50% cont Sand	4	0		
l	50% cont Sand	5	0		
l	50% cont Sand	6	0		
l	50% cont Sand	7	0		
l	50% cont Sand	8	0		
m	50%cont Wood	1	0		
m	50%cont Wood	2	4	0.968	0.817
m	50%cont Wood	3	5	0.630	0.548
m	50%cont Wood	4	8	0.433	0.344
m	50%cont Wood	5	7	0.906	0.723
m	50%cont Wood	6	4	0.498	0.470
m	50%cont Wood	7	5	0.730	0.580
m	50%cont Wood	8	5	0.384	0.346

Appendix Table 1 (continued) Survival and growth of Chironomus tentans.

Treatment	Test Sediment	Rep	Number of survivors	individual dry weight (ug)	ash free dry weight (ug)
n	cont Wood #2	1	8	0.886	0.755
n	cont Wood #2	2	10	0.808	0.679
n	cont Wood #2	3	10	0.802	0.699
n	cont Wood #2	4	9	0.532	0.486
n	cont Wood #2	5	9	0.576	0.514
n	cont Wood #2	6	10	0.956	0.806
n	cont Wood #2	7	10	0.802	0.659
n	cont Wood #2	8	10	0.606	0.720
o	cont sand #2	1	0		
o	cont sand #2	2	0		
o	cont sand #2	3	0		
o	cont sand #2	4	0		
o	cont sand #2	5	0		
o	cont sand #2	6	0		
o	cont sand #2	7	0		
o	cont sand #2	8	0		
p	cont Sand #1	1	0		
p	cont Sand #1	2	0		
p	cont Sand #1	3	0		
p	cont Sand #1	4	0		
p	cont Sand #1	5	0		
p	cont Sand #1	6	0		
p	cont Sand #1	7	0		
p	cont Sand #1	8	0		
q	cont Wood #1	1	1	0.270	0.260
q	cont Wood #1	2	1	0.440	0.400
q	cont Wood #1	3	1	0.500	0.440
q	cont Wood #1	4	0		
q	cont Wood #1	5	0		
q	cont Wood #1	6	0		
q	cont Wood #1	7	1	3.400	0.280
q	cont Wood #1	8	0		

Appendix Table 2. Water Temperatures (C) for 10 day *Chironomus tentans test*

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
29-Apr-01	0	9:30-12:00	1	22.4	22.3	22.7	22.6	22.6	22.8	22.7	22.9	22.9
29-Apr-01	0	9:30-12:00	2	22.4	22.4	22.6	22.5	22.6	22.4	22.8	22.9	22.9
29-Apr-01	0	9:30-12:00	3	22.4	22.3	22.6	22.4	22.6	22.4	22.7	22.9	22.9
29-Apr-01	0	9:30-12:00	4	22.4	22.3	22.6	22.3	22.6	22.3	22.8	22.8	22.9
29-Apr-01	0	9:30-12:00	5	22.4	22.3	22.6	22.4	22.6	22.3	22.7	22.9	22.9
29-Apr-01	0	9:30-12:00	6	22.4	22.3	22.6	22.4	22.6	22.3	22.8	22.9	22.9
29-Apr-01	0	9:30-12:00	7	22.4	22.3	22.6	22.4	22.6	22.3	22.7	22.9	22.9
29-Apr-01	0	9:30-12:00	8	22.4	22.3	22.6	22.4	22.6	22.3	22.8	22.9	22.9
29-Apr-01	0	21:00	1	23.2	23.3	23.3	23.3	23.2	23.1	23.3	23.5	23.3
29-Apr-01	0	21:00	4	23.3	23.3	23.3	23.2	23.2	23.1	23.3	23.4	23.3
30-Apr-01	1	8:30-10:00	4	23.4	23.4	23.6	23.4	23.4	23.3	23.5	23.7	23.6
30-Apr-01	1	8:30-10:00	6	23.5	23.4	23.6	23.4	23.4	23.3	23.5	23.7	23.6
30-Apr-01	1	16:30-17:00	4	23.5	23.5	23.6	23.6	23.6	23	23.6	23.6	23.4
30-Apr-01	1	16:30-17:00	8	23.5	23.5	23.6	23.6	23.6	23.1	23.6	23.6	23.6
1-May-01	2	7:30-10:00	4	22.8	22.9	23	22.9	22.9	22.9	23.1	23.3	23.1
1-May-01	2	7:30-10:00	5	22.8	22.9	23	22.9	22.9	22.9	23.1	23.3	22.9
1-May-01	2	15:30-15:45	2	23.6	23.9	23.6	23.7	23.8	23.4	23.7	23.6	23.5
1-May-01	2	15:30-15:45	4	23.6	23.9	23.7	23.8	23.8	23.3	23.7	23.6	23.5
2-May-01	3	7:25-9:30	4	21.6	21.5	21.8	21.8	21.9	21.8	22.3	22.2	22.3
2-May-01	3	7:25-9:30	7	21.6	21.5	21.9	21.8	21.9	21.8	22.3	22.2	22.3
2-May-01	3	15:30-15.45	3	23.2	23.6	23.4	23.6	23.6	23.3	23.6	23.2	23.2
2-May-01	3	15:30-15.45	4	23.3	23.6	23.4	23.6	23.6	23.3	23.7	23.2	23.2
3-May-01	4	7:30-8:00	1	23	22.4	23.3	22.5	22.4	23.2	22.6	22.9	23
3-May-01	4	7:30-8:00	4	23	22.4	23.3	22.5	22.4	23.2	22.6	22.9	23.1
3-May-01	4	15:00-15:30	3	23.1	23.1	23.2	23	22.9	23	23	22.8	22.9
3-May-01	4	15:00-15:30	4	23.1	23	23.2	23.1	22.9	23.1	23	22.8	22.9
4-May-01	5	7:45-8:15	4	22.8	22.9	23	22.9	22.8	22.9	22.8	22.6	22.8
4-May-01	5	7:45-8:15	6	22.8	22.9	23	22.9	22.9	22.9	22.8	22.7	22.8
4-May-01	5	14:30-15:00	4	22.8	22.9	23.1	23	22.9	22.7	22.8	22.7	22.7
4-May-01	5	14:30-15:00	8	22.8	22.9	23	23	22.9	22.7	22.8	22.7	22.7
5-May-01	6	9:00-9:30	4	22.4	22.9	23.1	22.9	22.8	22.9	22.8	22.7	22.7

Appendix Table 2 (continued). Water Temperatures (C) for 10 day *Chironomus tentans test*

Date	Day	Time	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
29-Apr-01	0	9:30-12:00	22.9	22.8	23.2	23	22.9	22.9	22.9	23
29-Apr-01	0	9:30-12:00	23.2	22.8	23.2	23	22.9	22.9	22.9	23.1
29-Apr-01	0	9:30-12:00	23.2	22.8	23.2	23	22.9	22.9	22.9	23
29-Apr-01	0	9:30-12:00	23.1	22.7	23.2	22.9	22.9	22.9	22.9	23.1
29-Apr-01	0	9:30-12:00	23.1	22.7	23.2	23	22.9	22.9	22.9	23.1
29-Apr-01	0	9:30-12:00	23.1	22.7	23.2	23.1	22.9	22.9	22.9	23.1
29-Apr-01	0	9:30-12:00	23.1	22.7	23.2	23.1	22.9	22.8	22.9	23
29-Apr-01	0	9:30-12:00	23.1	22.8	23.2	23	22.9	22.9	22.9	23
29-Apr-01	0	21:00	23.4	23.1	23.3	23.2	23.2	23	23.1	23.1
29-Apr-01	0	21:00	23.4	23.2	23.3	23.2	23.2	23	23.1	23.1
30-Apr-01	1	8:30-10:00	23.7	23.4	23.8	23.6	23.5	23.4	23.4	23.6
30-Apr-01	1	8:30-10:00	23.7	23.4	23.8	23.6	23.5	23.4	23.4	23.6
30-Apr-01	1	16:30-17:00	23.2	23.2	23.6	23.6	23.4	23.1	23.2	23.4
30-Apr-01	1	16:30-17:00	23.2	23.2	23.6	23.6	23.4	23.1	23.1	23.4
1-May-01	2	7:30-10:00	23.4	23.2	23.4	23.3	23.3	23.2	23.2	23.2
1-May-01	2	7:30-10:00	23.4	23.2	23.4	23.3	23.3	23.2	23.2	23.2
1-May-01	2	15:30-15:45	23.6	23.4	23.5	23.8	23.3	23.3	23.3	23.4
1-May-01	2	15:30-15:45	23.6	23.4	23.5	23.8	23.3	23.3	23.3	23.5
2-May-01	3	7:25-9:30	22.6	22.7	22.6	22.9	23	22.9	23.1	22.9
2-May-01	3	7:25-9:30	22.6	22.6	22.7	22.9	23.1	23	22.9	22.9
2-May-01	3	15:30-15.45	23.3	23.4	23.2	23.6	23.3	23.3	23.3	23.6
2-May-01	3	15:30-15.45	23.3	23.4	23.3	23.7	23.3	23.3	23.4	23.5
3-May-01	4	7:30-8:00	23.3	23.3	23.3	22.6	23.2	23.3	23.3	22.4
3-May-01	4	7:30-8:00	23.3	23.3	23.3	22.6	23.3	23.3	23.3	22.4
3-May-01	4	15:00-15:30	22.9	23.1	22.9	23	22.9	23.1	23.1	22.8
3-May-01	4	15:00-15:30	22.9	23.1	22.9	23	23	23.1	23.1	22.8
4-May-01	5	7:45-8:15	22.8	22.9	22.8	22.9	22.8	22.8	22.8	22.8
4-May-01	5	7:45-8:15	22.8	22.9	22.8	22.9	22.8	22.8	22.8	22.8
4-May-01	5	14:30-15:00	22.8	22.9	22.9	22.9	22.9	22.8	22.9	22.8
4-May-01	5	14:30-15:00	22.8	22.9	22.9	22.9	22.9	22.7	22.9	22.9
5-May-01	6	9:00-9:30	22.9	22.9	22.9	22.9	22.8	22.8	22.9	22.7

Appendix Table 2 (continued). Water Temperatures (C) for 10 day *Chironomus tentans test*

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
5-May-01	6	9:00-9:30	5	22.4	22.9	23.1	22.9	22.8	22.9	22.8	22.7	22.7
5-May-01	6	17:30-17:45	2	23.8	22.9	23.9	22.8	22.9	22.9	22.7	23.7	23.7
5-May-01	6	17:30-17:45	4	23.8	22.9	23.9	22.8	22.9	22.9	22.7	23.7	23.7
6-May-01	7	9:15-9:45	4	22.9	23	23.1	22.9	22.9	22.9	22.9	22.8	22.8
6-May-01	7	9:15-9:45	7	22.8	23	23.1	22.9	22.9	22.9	22.9	22.8	22.9
6-May-01	7	17:00-17:45	3	23.1	23.1	23.1	22.8	22.9	22.4	22.7	22.7	22.9
6-May-01	7	17:00-17:45	4	23.1	23.1	23.1	22.8	22.9	22.4	22.6	22.8	22.9
7-May-01	8	7:00-9:15	4	22.9	22.9	23	23.1	22.8	23	22.8	22.8	23
7-May-01	8	7:00-9:15	6	22.8	22.9	23.1	23.1	22.9	23	22.8	22.8	23
7-May-01	8	15:10-16:45	4	23.2	23.1	23.3	23.1	23.1	23.1	22.9	22.9	23.1
7-May-01	8	15:10-16:45	8	23.2	23.1	23.3	23.1	23.1	23.1	22.9	22.9	23.1
8-May-01	9	7:30-8:30	4	22.8	22.7	22.9	22.7	22.7	22.7	22.4	22.6	22.7
8-May-01	9	7:30-8:30	6	22.8	22.7	22.9	22.7	22.7	22.8	22.3	22.6	22.4
8-May-01	9	15:30-16:00	4	22.8	22.8	22.9	22.8	22.7	22.8	22.6	22.8	22.8
8-May-01	9	15:30-16:00	8	22.8	22.8	22.9	22.8	22.8	22.8	22.6	22.8	22.8
9-May-01	10	7:30	1	22	22.6	22.2	22.6	22.7	22.7	22.4	22	22.1
9-May-01	10	7:30	2	22.1	22.7	22.3	22.7	22.6	22.8	22.4	22.1	22.1
9-May-01	10	7:30	3	22.1	22.7	22.3	22.6	22.7	22.7	22.4	22	22.1
9-May-01	10	7:30	4	22.2	22.7	22.3	22.7	22.7	22.7	22.4	22.1	22.2
9-May-01	10	7:30	5	22.2	22.7	22.3	22.6	22.6	22.7	22.3	22.1	22.1
9-May-01	10	7:30	6	22.2	22.7	22.3	22.7	22.7	22.8	22.4	22.1	22.1
9-May-01	10	7:30	7	22.2	22.7	22.3	22.6	22.6	22.8	22.3	21.7	22.1
9-May-01	10	7:30	8	22.2	22	22.3	22.6	22.7	22.8	22.4	22	22.1
		Average		**22.8**	**22.8**	**23.0**	**22.9**	**22.9**	**22.8**	**22.8**	**22.8**	**22.9**
		Minimum		21.6	21.5	21.8	21.8	21.9	21.8	22.3	21.7	22.1
		Maximum		23.8	23.9	23.9	23.8	23.8	23.4	23.7	23.7	23.7

Appendix Table 2 (continued). Water Temperatures (C) for 10 day *Chironomus tentans test*

Date	Day	Time	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
5-May-01	6	9:00-9:30	22.9	22.9	22.9	22.8	22.8	22.8	22.8	22.7
5-May-01	6	17:30-17:45	23.7	23.1	23.7	23	23	22.9	23.1	22.7
5-May-01	6	17:30-17:45	23.7	23.1	23.7	23	23	22.9	22.9	22.7
6-May-01	7	9:15-9:45	22.9	23.1	22.9	23.1	22.9	22.9	23.1	22.7
6-May-01	7	9:15-9:45	22.9	23.1	22.9	23	22.9	22.9	23.1	22.7
6-May-01	7	17:00-17:45	22.8	22.6	22.6	22.9	22.4	22.6	22.6	22.6
6-May-01	7	17:00-17:45	22.8	22.6	22.6	22.9	22.4	22.6	22.6	22.6
7-May-01	8	7:00-9:15	22.9	23.1	22.9	23.1	23.1	23.1	23	22.9
7-May-01	8	7:00-9:15	22.9	23.1	22.9	23.1	23.1	23.1	23.1	22.9
7-May-01	8	15:10-16:45	23.1	23.2	23.1	23.1	23.1	23	23.1	23.1
7-May-01	8	15:10-16:45	23.1	23.2	23.1	23.1	23.1	23	23.1	23.1
8-May-01	9	7:30-8:30	22.6	22.7	22.6	22.7	22.7	22.7	22.7	22.5
8-May-01	9	7:30-8:30	22.6	22.8	22.6	22.6	22.7	22.7	22.7	22.4
8-May-01	9	15:30-16:00	22.8	22.9	22.8	22.8	23	22.8	22.9	22.6
8-May-01	9	15:30-16:00	22.8	22.9	22.8	22.8	22.9	22.8	22.9	22.6
9-May-01	10	7:30	22.1	22.7	22.1	22.6	22.6	22.7	22.6	22.6
9-May-01	10	7:30	22.1	22.7	22.2	22.6	22.7	22.7	22.8	22.6
9-May-01	10	7:30	22	22.7	22.1	22.6	22.6	22.7	22.6	22.6
9-May-01	10	7:30	22	22.7	22.1	22.6	22.7	22.7	22.7	22.6
9-May-01	10	7:30	22.1	22.7	22.1	22.6	22.7	22.7	22.7	22.6
9-May-01	10	7:30	22.1	22.7	22.1	22.6	22.7	22.7	22.8	22.6
9-May-01	10	7:30	22	22.6	22.1	22.6	22.7	22.6	22.7	22.5
9-May-01	10	7:30	22.1	22.7	22.1	22.6	22.8	22.7	22.8	22.5
		Average	**22.9**	**23.0**	**23.0**	**23.0**	**23.0**	**22.9**	**23.0**	**22.9**
		Minimum	22	22.6	22.1	22.6	22.4	22.6	22.6	22.4
		Maximum	23.7	23.4	23.8	23.8	23.5	23.4	23.4	23.6

Appendix Table 3. Dissolved Oxygen Levels (ppm) for 10 day *Chironomus tentans* test

Day	Time	Rep	A	B	C	D	E	F	G	H	I
0	9:30-12:00		Sand	Form Sed	West Bear	Ref Sand	Ref Wood	1% Sand	1% Wood	10% Sand	10% Wood
0	9:30-12:00	1	7.6	7.5	6.2	4.2	6	5.1	4.2	5.1	4.3
0	9:30-12:00	2	7.6	7.6	6.1	3.8	5.2	5	4.2	5.9	4.1
0	9:30-12:00	3	7.7	7.5	5.8	3.8	5	5.4	4.7	5.4	4.4
0	9:30-12:00	4	7.6	7.5	6.1	3.4	7.2	5.3	7.1	6.2	4.4
0	9:30-12:00	5	7.6	7.5	7.2	4.2	5	5.2	4.5	5.3	4.1
0	9:30-12:00	6	7.7	7.5	6.1	3.7	5	5.3	6.2	5.1	4.8
0	9:30-12:00	7	7.6	7.5	6.2	5.8	5.2	5.8	4.1	5.4	4.3
0	9:30-12:00	8	7.6	7.5	6	5.6	6.7	5.6	7	4.9	4
0	21:00	1	7.4	7.4	6.4	6.4	6.5	7.3	6.4	6.2	6.9
0	21:00	4	7.4	7.2	7	7.2	7	7.2	6.9	6.9	5
1	8:30-10:00	4	6.5	6.4	5.3	6.2	7	5.6	7.3	7	3.8
1	8:30-10:00	6	6.2	5.6	5	4.2	4.4	6.9	6.2	5.2	3.2
1	16:30-17:00	4	6	7.2	7.2	6.8	6.4	6	6.8	5.8	6.9
1	16:30-17:00	8	6.9	5.9	7.6	6.6	6.2	6.5	7	6.4	4.5
2	7:30-10:00	4	3.4	5.9	6.8	4.6	6.6	6.2	6.4	6.6	5.9
2	7:30-10:00	5	6.2	5.6	7	6	4.4	4.6	4.6	6.4	6.6
2	15:30-15:45	2	3	4.6	5.1	6.5	4.2	3.9	4.3	4.9	6.5
2	15:30-15:45	4	2.4	5	4.4	4.6	6	4.3	5.8	5.9	6.4
3	7:25-9:30	4	6.2	6.2	6.6	5.2	6.4	5.6	7	6.4	6.8
3	7:25-9:30	7	7	5.4	6.8	4.8	5	6.2	5	6.4	4.7
3	15:30-15.45	3	7	6.4	5.8	5.9	6.4	5	6.2	6.2	6.4
3	15:30-15.45	4	6.2	6.3	6.2	5.5	6.6	5.1	6.3	6.8	6.1
4	7:30-8:00	1	7	4.2	5.4	3.2	5	5.2	6.3	3	6.3
4	7:30-8:00	4	4	4.8	5.1	4.4	5.7	3.3	5.9	6.8	6.2
4	15:00-15:30	3	5.5	3.5	4.2	4.8	5.5	3.8	3.8	4.2	6
4	15:00-15:30	4	4.8	4.9	4.7	5	6.6	4	4.2	5.4	5.3
5	7:45-8:15	4	4.8	6.2	4	4.4	5.6	3.7	4.4	5.9	5.6
5	7:45-8:15	6	6.2	4.6	3.6	3.4	5.4	4.6	6.6	6.4	6.5
5	14:30-15:00	4	6.1	5.4	6.1	5.9	6.3	4.1	5.5	6.1	6.9
5	14:30-15:00	8	6.1	4.9	5.2	3.8	6.2	5.7	6.2	6.4	7
6	9:00-9:30	4	6.9	6.2	5.8	6.3	6.3	2.5	3.9	6.6	6.7

Appendix Table 3 (continued). Dissolved Oxygen Levels (ppm) for 10 day *Chironomus tentans* test

Day	Time	Rep	J	K	L	M	N	O	P	Q
0	9:30-12:00		25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
0	9:30-12:00	1	4.3	3.5	4.4	2.8	7	6.2	3.8	3.9
0	9:30-12:00	2	4.1	3.1	4.8	2.8	7.2	7	4.2	4.1
0	9:30-12:00	3	4.4	5.8	5	2	5.1	4.4	4	3.5
0	9:30-12:00	4	4.4	3	4	3.3	4.5	4.1	3.4	4.2
0	9:30-12:00	5	3.3	2.9	7	5.4	4.7	6	3.4	4
0	9:30-12:00	6	3.9	6.8	4.6	7	7.1	4.6	3.6	4
0	9:30-12:00	7	4.1	3.4	4.1	4.2	7.2	4	4.4	4.2
0	9:30-12:00	8	3.9	6.8	4.5	4	7.2	6.1	4	4.2
0	21:00	1	7	6.2	6.2	7.4	6.4	6.8	5.4	6
0	21:00	4	6.3	7.2	6.2	6.7	6.4	7	3.9	6
1	8:30-10:00	4	5.6	6.4	4.9	5.6	4.8	5.7	6.1	5.2
1	8:30-10:00	6	4.6	7	4.7	7	6.4	7.2	3	3.8
1	16:30-17:00	4	6.6	6.9	5.4	6.4	6.4	6.6	6	6.4
1	16:30-17:00	8	6.3	6.9	6.4	6.5	6.8	6.6	4	6
2	7:30-10:00	4	6.6	6	5.5	5.8	4.9	6.2	6.2	6.2
2	7:30-10:00	5	5.6	4	6.8	6.9	4.4	6.2	6.1	5.9
2	15:30-15:45	2	5.2	4.6	3	5.9	6.2	6.1	6.6	4.3
2	15:30-15:45	4	5.4	5.7	4.5	5.6	3.5	6.3	6.5	4.6
3	7:25-9:30	4	6.8	7	6.9	7	4.8	7.2	6.6	7.2
3	7:25-9:30	7	6.8	6.2	7	7	7	7	6.6	7.2
3	15:30-15.45	3	6.2	6.3	5.8	6	6.2	6.5	6.4	6.8
3	15:30-15.45	4	6.2	6.5	5.9	6.2	6.1	6.3	6.7	6.6
4	7:30-8:00	1	4.7	3.9	4.1	4.7	4.7	5.7	5.4	6.4
4	7:30-8:00	4	6	4.8	3.9	4.5	4.4	4.4	5.2	4.9
4	15:00-15:30	3	6	6.1	5	4.4	3.6	5.8	4.9	5.2
4	15:00-15:30	4	6.6	5.6	5.2	4.3	3.9	5.8	4.6	4.6
5	7:45-8:15	4	5.7	4.6	4.8	5.6	3.4	6.6	6.5	5.2
5	7:45-8:15	6	6	4.4	5.7	4	3.4	5.6	4	5.6
5	14:30-15:00	4	5.7	6.2	6	6.4	5.1	6	5.9	5.7
5	14:30-15:00	8	5.7	6	6.1	3.3	5.6	6.3	6.6	6.4
6	9:00-9:30	4	6	4.7	6.2	5.8	3.6	6.4	6.4	4.8

Appendix Table 3 (continued). Dissolved Oxygen Levels (ppm) for 10 day *Chironomus tentans* test

Day	Time	Rep	A	B	C	D	E	F	G	H	I
0	9:30-12:00		Sand	Form Sed	West Bear	Ref Sand	Ref Wood	1% Sand	1% Wood	10% Sand	10% Wood
6	9:00-9:30	5	6.4	6.7	7	3.3	4.6	3.6	6.6	6.9	6.5
6	17:30-17:45	2	3	2	4.4	4	4.2	5.1	4.1	4.3	6.2
6	17:30-17:45	4	4.3	4.2	4.6	4.9	5.8	3.6	5.8	4.9	6.1
7	9:15-9:45	4	5.1	4.3	4	3.5	7	7.2	4.5	6.6	4.8
7	9:15-9:45	7	6.4	6.7	6.4	4.3	6.5	4.4	2.4	6.1	5.4
7	17:00-17:45	3	3.6	2.2	5.8	3.7	4.7	5.7	6.5	3.4	5.9
7	17:00-17:45	4	4.3	6.2	3.9	5	5	4.5	5.5	5	5
8	7:00-9:15	4	6.4	1.4	4.4	4.4	6.6	4	5.4	6.2	6.3
8	7:00-9:15	6	6.8	3.2	5.4	2.9	7.2	4.4	6.9	7.3	3.8
8	15:10-16:45	4	5.2	2.4	4.3	5.1	6.9	4.4	5.3	6.4	5
8	15:10-16:45	8	6.3	1.8	4.6	3.1	5	5.8	6.9	4.7	3
9	7:30-8:30	4	5	5	5.4	6	6.8	6	5.5	4.4	6.8
9	7:30-8:30	6	7.2	3.6	3.6	6	6.2	5.6	4.9	5.8	2.8
9	15:30-16:00	4	6.8	6.2	4.3	6.5	6.7	5.4	5.4	3	6.8
9	15:30-16:00	8	6.9	6.3	4.8	3.1	4.5	5.8	6.6	2.4	4.9
10	7:30	1	5	2	6	3.4	4.8	6.2	6.6	5	6.2
10	7:30	2	4.8	2.1	2.6	4.6	4.4	5.4	5	6.3	5.8
10	7:30	3	3.6	2.4	4.2	4.8	6.5	3.4	4.3	2.5	7
10	7:30	4	5.6	1.3	2.6	6	6.7	3.8	5.8	5.8	6.8
10	7:30	5	5.2	3.2	5.7	4.6	3	3.7	6.3	7.2	6
10	7:30	6	6.5	3.4	3.4	5.7	6.8	7.3	6.9	5.4	6.2
10	7:30	7	6.8	3.9	3.8	4.9	5	4	3.5	6	5.4
10	7:30	8	6.7	2.7	2.6	4.8	3.8	6.4	6.7	3	5.8
	Average		**6.0**	**5.1**	**5.3**	**4.8**	**5.7**	**5.1**	**5.6**	**5.6**	**5.5**
	Minimum		2.4	1.3	2.6	2.9	3	2.5	2.4	2.4	2.8
	Maximum		7.7	7.6	7.6	7.2	7.2	7.3	7.3	7.3	7

Appendix Table 3 (continued). Dissolved Oxygen Levels (ppm) for 10 day *Chironomus tentans* test

Day	Time	Rep	J	K	L	M	N	O	P	Q
0	9:30-12:00		25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
6	9:00-9:30	5	4.9	4.2	6.8	6.6	3.2	6.7	6.6	5.7
6	17:30-17:45	2	5.3	3.7	4.4	4.6	5.8	6.1	6.4	5.6
6	17:30-17:45	4	5.2	4	5.2	5.9	3.6	5.6	6	5.6
7	9:15-9:45	4	6	4.2	5.9	4.1	3.4	6.2	6.4	6.2
7	9:15-9:45	7	3.6	5.8	6.2	5.3	4	5	4.6	6.7
7	17:00-17:45	3	3.6	5.3	3.8	4.7	3.6	6.5	3	5.9
7	17:00-17:45	4	3.8	4.8	4	5.4	2.9	4.7	6.4	6.4
8	7:00-9:15	4	6.8	2.9	6.8	5.2	2.6	6.4	5.4	6
8	7:00-9:15	6	7.4	5.2	7	4.4	5.8	6.8	6.4	5.8
8	15:10-16:45	4	4.6	3.3	5.5	6.2	3	5.2	5.4	6.3
8	15:10-16:45	8	4.5	5	4.7	3.6	4.2	5.9	6.7	6.2
9	7:30-8:30	4	4	4.2	3.6	6.8	2	4.2	6.6	6.9
9	7:30-8:30	6	6.6	5.6	6.2	2	4.2	6.4	6.2	6.3
9	15:30-16:00	4	3.9	3.9	4	6.3	2.8	3.4	6.8	6.2
9	15:30-16:00	8	4.2	4.1	4.8	2.6	4.8	4.6	4.2	4.7
10	7:30	1	5.7	5.4	4.4	3.6	2.6	4.4	5.2	6.6
10	7:30	2	3.4	2.8	3.4	2.2	6.2	4.1	6.4	6
10	7:30	3	3	6.8	5.2	4	2.8	5.4	6.4	7
10	7:30	4	3.8	3	3	5.3	1.5	3.5	5.8	6.6
10	7:30	5	7.2	4	3.9	5.4	6.6	6.6	6.8	5.6
10	7:30	6	6.8	6	6.1	5.3	4.1	5	6.8	5.8
10	7:30	7	3.6	2.9	5.9	3.2	5.8	6	6.8	5.2
10	7:30	8	5	6.4	4.4	5.6	5.7	5.6	7	6.2
	Average		**5.2**	**5.0**	**5.2**	**5.1**	**4.8**	**5.8**	**5.5**	**5.6**
	Minimum		3	2.8	3	2	1.5	3.4	3	3.5
	Maximum		7.4	7.2	7	7.4	7.2	7.2	7	7.2

Appendix Table 4. Water quality parameters for 10 day *Chironomus tentans* test

pH

Day	Time	Rep	Treatment A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
0	9:30-12:00	1	8.21	7.95	7.64	7.28	7.5	7.43	7.28	7.42	7.26
0	9:30-12:00	4	8.23	7.89	7.48	7.23	8.05	7.42	8.03	7.58	7.25
0	9:30-12:00	8	8.22	7.63	7.47	7.53	7.53	7.71	8.02	7.42	7.22
10	7:30	1	7.43	6.71	7.53	7.24	7.46	7.55	7.87	7.51	7.77
10	7:30	4	7.62	6.84	7.21	7.73	7.8	7.3	7.77	7.64	7.86
10	7:30	5	7.55	6.76	7.53	7.38	7.22	7.33	7.96	7.93	7.63
10	7:30	8	7.85	6.85	7.16	7.41	7.3	7.85	7.95	7.24	7.54
	average		**7.87**	**7.23**	**7.43**	**7.40**	**7.55**	**7.51**	**7.84**	**7.53**	**7.50**
	minimum		7.43	6.71	7.16	7.23	7.22	7.3	7.28	7.24	7.22
	maximum		8.23	7.95	7.64	7.73	8.05	7.85	8.03	7.93	7.86

Conductivity (uhmo/cm2)

Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
0	9:30-12:00	1	145	151	146	164	148	153	153	156	151
0	9:30-12:00	8	142	152	148	152	149	151	147	155	151
10	7:30	1	165	164	153	161	156	157	157	159	156
10	7:30	8	153	158	156	159	158	157	157	165	157
	average		**151**	**156**	**151**	**159**	**153**	**155**	**154**	**159**	**154**
	minimum		142	151	146	152	148	151	147	155	151
	maximum		165	164	156	164	158	157	157	165	157

Appendix Table 4 (continued). Water quality parameters for 10 day *Chironomus tentans* test

pH

Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
0	9:30-12:00	1	7.31	7.14	7.34	7.08	7.98	7.67	7.31	7.02
0	9:30-12:00	4	7.32	7.18	7.3	7.1	7.2	7.34	7.23	7.06
0	9:30-12:00	8	7.27	7.92	7.35	7.12	8.09	7.69	7.28	7.03
10	7:30	1	7.6	7.5	7.4	7.26	7.16	7.36	7.5	7.87
10	7:30	4	7.35	7.2	7.23	7.61	7.16	7.31	7.66	7.76
10	7:30	5	7.95	7.29	7.4	7.54	7.69	7.83	7.84	7.57
10	7:30	8	7.42	7.62	7.4	7.52	7.59	7.51	7.92	7.38
	average		**7.46**	**7.41**	**7.35**	**7.32**	**7.55**	**7.53**	**7.53**	**7.38**
	minimum		7.27	7.14	7.23	7.08	7.16	7.31	7.23	7.02
	maximum		7.95	7.92	7.4	7.61	8.09	7.83	7.92	7.87

Conductivity (uhmo/cm2)

Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
0	9:30-12:00	1	157	151	154	144	153	147	154	141
0	9:30-12:00	8	156	147	153	145	153	146	157	142
10	7:30	1	158	156	158	163	164	163	157	156
10	7:30	8	159	156	160	158	158	158	156	158
	average		**158**	**153**	**156**	**153**	**157**	**154**	**156**	**149**
	minimum		156	147	153	144	153	146	154	141
	maximum		159	156	160	163	164	163	157	158

Appendix Table 4 (continued). Water quality parameters for 10 day *Chironomus tentans* test

Ammonia (ppm)

Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
0	9:30-12:00	1	<0.063	<0.063	0.187	0.91	0.292	0.35	0.182	0.441	0.166
0	9:30-12:00	8	<0.063	<0.063	0.257	0.545	0.363	0.133	<0.063	0.774	0.154
10	7:30	1	0.904	<0.063	0.3425	0.465	0.441	0.52	0.302	0.774	0.405
10	7:30	8	0.433	<0.063	0.496	1.009	0.5485	0.431	0.272	1.125	0.384
	average		**0.350**	**<0.063**	**0.321**	**0.732**	**0.411**	**0.359**	**0.197**	**0.779**	**0.277**
	minimum		<0.063	<0.063	0.187	0.465	0.292	0.133	<0.063	0.441	0.154
	maximum		0.904	<0.063	0.496	1.009	0.5485	0.52	0.302	1.125	0.405

Hardness (ppm CaCO3)

Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
0	9:30-12:00	3	64.4	52.4	66	80.8	76	67	74	78	82.8
10	7:30	3	51.6	52	50.4	52.6	49.2	51.6	51.8	55.2	48.8
	average		**58**	**52.2**	**58.2**	**66.7**	**62.6**	**59.3**	**62.9**	**66.6**	**65.8**

Alkalinity (ppm CaCO3)

Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
0	9:30-12:00	2	44	40.8	51.2	64	52	56	54	52	51.8
10	7:30	2	41.2	41.8	40.8	44.4	43.8	47.6	44.4	43.2	41.2
	average		**42.6**	**41.3**	**46**	**54.2**	**47.9**	**51.8**	**49.2**	**47.6**	**46.5**

Appendix Table 4 (continued). Water quality parameters for 10 day *Chironomus tentans* test

Ammonia (ppm)

Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
0	9:30-12:00	1	0.391	0.523	0.547	0.103	0.607	0.111	0.907	0.083
0	9:30-12:00	8	0.396	0.223	1.07	0.225	0.225	0.135	1.27	0.078
10	7:30	1	0.378	0.731	1.993	0.482	0.365	0.9545	0.894	0.232
10	7:30	8	0.646	0.864	1.442	0.45	0.174	0.772	0.583	0.207
	average		**0.453**	**0.585**	**1.263**	**0.315**	**0.343**	**0.493**	**0.914**	**0.150**
	minimum		0.378	0.223	0.547	0.103	0.174	0.111	0.583	0.078
	maximum		0.646	0.864	1.993	0.482	0.607	0.9545	1.27	0.232

Hardness (ppm CaCO3)

Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
0	9:30-12:00	3	67.2	76	76	124	90	67	160	78
10	7:30	3	53.6	49.6	52.8	51.2	64	49.6	49.2	51.2
	average		**60.4**	**62.8**	**64.4**	**87.6**	**77**	**58.3**	**104.6**	**64.6**

Alkalinity (ppm CaCO3)

Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
0	9:30-12:00	2	54.8	47.6	48.4	44	44.4	45.8	44	44.4
10	7:30	2	44.4	47.2	46.8	45.2	45.6	46	44.4	44.4
	average		**49.6**	**47.4**	**47.6**	**44.6**	**45**	**45.9**	**44.2**	**44.4**

Appendix Table 5. Survival and Growth of ***Pimephales promelas***

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
a	Si Sand	1	10	0.9420
a	Si Sand	2	10	0.9820
a	Si Sand	3	10	1.3480
a	Si Sand	4	10	0.9980
a	Si Sand	5	10	0.9390
b	Formu	1	10	0.9900
b	Formu	2	10	0.9180
b	Formu	3	10	0.8780
b	Formu	4	10	0.9950
b	Formu	5	10	1.1000
c	W Bear	1	9	0.8789
c	W Bear	2	9	1.0389
c	W Bear	3	10	0.9540
c	W Bear	4	9	0.9856
c	W Bear	5	10	0.9090
d	Ref Sand	1	9	0.8633
d	Ref Sand	2	9	0.8244
d	Ref Sand	3	10	0.9700
d	Ref Sand	4	9	1.0489
d	Ref Sand	5	9	0.8550
e	Ref Wood	1	10	1.0390
e	Ref Wood	2	10	0.9470
e	Ref Wood	3	10	0.7550
e	Ref Wood	4	10	1.0700
e	Ref Wood	5	9	0.9575
f	1%cont Sand	1	9	0.9400
f	1%cont Sand	2	10	0.8440
f	1%cont Sand	3	9	1.0011
f	1%cont Sand	4	10	0.8730
f	1%cont Sand	5	10	0.8282

Appendix Table 5 (continued). Survival and Growth of ***Pimephales promelas***

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
g	1%cont Wood	1	9	0.9478
g	1%cont Wood	2	9	0.8256
g	1%cont Wood	3	10	0.9240
g	1%cont Wood	4	8	1.1688
g	1%cont Wood	5	10	0.9280
h	10%cont Sand	1	11	0.8536
h	10%cont Sand	2	8	0.7638
h	10%cont Sand	3	10	0.9070
h	10%cont Sand	4	10	0.9800
h	10%cont Sand	5	8	0.7050
i	10%cont Wood	1	9	0.9611
i	10%cont Wood	2	9	0.9500
i	10%cont Wood	3	10	0.9180
i	10%cont Wood	4	10	0.9967
i	10%cont Wood	5	10	0.8580
j	25%cont Sand	1	8	0.5325
j	25%cont Sand	2	9	0.5525
j	25%cont Sand	3	9	0.7256
j	25%cont Sand	4	10	0.6970
j	25%cont Sand	5	9	0.5525
k	25%cont Wood	1	10	0.7780
k	25%cont Wood	2	9	0.9411
k	25%cont Wood	3	10	0.8660
k	25%cont Wood	4	10	0.9530
k	25%cont Wood	5	10	0.8240
l	50%cont Sand	1	0	
l	50%cont Sand	2	3	0.0004
l	50%cont Sand	3	0	
l	50%cont Sand	4	2	0.0031
l	50%cont Sand	5	1	0.0002

Appendix Table 5 (continued). Survival and Growth of ***Pimephales promelas***

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
m	50% cont Wood	1	9	0.4067
m	50% cont Wood	2	7	0.6400
m	50% cont Wood	3	10	0.6350
m	50% cont Wood	4	9	0.8300
m	50% cont Wood	5	9	0.7578
n	Mod. Cont Wood	1	10	0.7120
n	Mod. Cont Wood	2	9	0.8011
n	Mod. Cont Wood	3	10	0.8710
n	Mod. Cont Wood	4	10	0.8100
n	Mod. Cont Wood	5	10	0.7220
o	Mod. Cont Sand	1	0	
o	Mod. Cont Sand	2	0	
o	Mod. Cont Sand	3	0	
o	Mod. Cont Sand	4	0	
o	Mod. Cont Sand	5	0	
p	very cont Sand	1	0	
p	very cont Sand	2	0	
p	very cont Sand	3	0	
p	very cont Sand	4	0	
p	very cont Sand	5	0	
q	very cont Wood	1	1	0.0003
q	very cont Wood	2	1	0.0002
q	very cont Wood	3	4	0.0003
q	very cont Wood	4	0	
q	very cont Wood	5	3	0.2200

Appendix Table 6. Water Temperatures (C) for 7 day *Pimephales promelas* test

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
14-May-01	0	15:00-16:20	1	24.6	25.0	24.4	24.2	23.9	23.9	24.4	24.2	24.4
14-May-01	0	15:00-16:20	2	24.3	24.4	24.2	23.3	24.4	24.3	24.2	24.4	24.7
14-May-01	0	15:00-16:20	3	24.6	24.2	24.4	23.7	23.8	24.0	24.1	23.9	24.5
14-May-01	0	15:00-16:20	4	24.2	24.9	24.1	23.8	24.1	23.8	24.4	24.3	24.9
14-May-01	0	15:00-16:20	5	24.6	24.7	24.1	23.9	24.3	24.3	24.6	24.3	24.3
15-May-01	1	9:00-10:15	1	25.8	25.6	25.6	24.9	26.0	25.8	24.8	25.2	25.9
15-May-01	1	9:00-10:15	4	25.9	25.3	25.3	25.7	25.9	24.9	25.4	25.9	25.4
15-May-01	1	19:00-19:38	1	25.8	25.5	25.8	25.3	25.7	25.3	25.2	25.8	25.6
15-May-01	1	19:00-19:38	5	25.9	25.6	25.7	25.5	25.3	25.9	25.7	25.6	25.8
16-May-01	2	8:00-10:30	1	25.2	25.5	24.9	24.7	25.1	25.2	24.8	24.5	25.1
16-May-01	2	8:00-10:30	2	24.9	25.1	24.6	25.8	25.2	25.1	24.9	25.3	25.1
16-May-01	2	18:15-18:35	1	24.8	25.7	24.7	25.4	24.8	24.7	25.6	24.4	24.8
16-May-01	2	18:15-18:35	3	25.2	24.7	24.7	24.5	24.1	24.7	24.6	24.7	25.7
17-May-01	3	6:30-7:00	1	25.3	25.0	24.9	23.8	24.9	24.9	24.7	24.9	25.0
17-May-01	3	6:30-7:00	4	25.1	24.8	25.1	24.9	25.1	24.2	24.9	25.2	24.8
17-May-01	3	18:35-19:00	1	24.8	24.9	24.8	24.7	24.9	24.8	24.7	24.7	24.8
17-May-01	3	18:35-19:00	5	24.8	24.9	24.8	24.7	24.8	24.7	24.8	24.8	24.7
18-May-01	4	8:30-9:00	1	24.8	25.0	25.0	24.6	24.7	24.8	24.8	24.7	24.7
18-May-01	4	8:30-9:00	3	24.8	24.7	24.9	24.8	24.5	24.5	24.7	24.7	24.6
18-May-01	4	17:20-18:00	1	25.2	24.9	24.9	24.6	24.5	24.6	24.8	25.2	24.5
18-May-01	4	17:20-18:00	4	24.7	24.8	24.9	24.4	24.4	25.0	25.2	24.5	24.7
19-May-01	5	11:05-11:40	1	24.9	25.0	24.8	24.5	24.5	24.6	24.5	24.6	24.6
19-May-01	5	11:05-11:40	5	24.7	25.0	24.8	24.4	24.6	24.8	24.8	24.7	24.6
19-May-01	5	16:45-17:25	1	26.0	26.0	25.8	25.8	26.1	25.9	25.7	25.8	25.9
19-May-01	5	16:45-17:25	2	25.1	25.9	25.8	25.5	25.9	25.8	25.6	26.1	25.8
20-May-01	6	9:45	1	25.5	25.5	25.1	24.9	25.3	25.1	25.1	25.2	25.1
20-May-01	6	9:45	3	25.2	25.4	25.4	25.2	25.3	25.0	25.2	25.0	25.3
20-May-01	6	17:05-17:28	1	25.2	25.2	25.3	24.5	24.7	24.7	24.7	25.0	24.7
20-May-01	6	17:05-17:28	4	24.7	25.0	25.1	24.7	24.8	24.8	25.0	24.8	24.9
21-May-01	7	9:35	1	24.5	25.0	24.7	23.9	24.5	24.5	24.4	24.2	24.3
21-May-01	7	9:35	2	24.3	24.3	24.2	23.7	24.3	24.5	24.2	24.7	24.5
21-May-01	7	9:35	3	24.2	24.4	24.5	24.0	24.0	24.5	24.1	24.5	24.5
21-May-01	7	9:35	4	24.6	24.8	24.5	24.2	24.5	23.8	24.3	24.7	24.5
21-May-01	7	9:35	5	24.6	24.9	24.3	24.4	24.0	24.5	24.6	24.0	24.4
		Average		**25.0**	**25.0**	**24.9**	**24.6**	**24.8**	**24.8**	**24.8**	**24.8**	**24.9**
		Minimum		24.2	24.2	24.1	23.3	23.8	23.8	24.1	23.9	24.3
		Maximum		26.0	26.0	25.8	25.8	26.1	25.9	25.7	26.1	25.9

Appendix Table 6 (continued). Water Temperatures (C) for 7 day *Pimephales promelas* test

Date	Day	Time	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
14-May-01	0	15:00-16:20	24.5	24.9	24.8	24.6	24.0	24.8	24.8	24.3
14-May-01	0	15:00-16:20	24.6	24.9	24.6	24.4	24.1	24.9	25.1	24.5
14-May-01	0	15:00-16:20	24.4	24.4	24.5	24.7	24.5	25.0	24.8	25.0
14-May-01	0	15:00-16:20	24.2	24.6	24.9	24.6	24.1	24.8	24.6	24.9
14-May-01	0	15:00-16:20	24.2	24.7	24.8	24.7	24.6	24.7	24.4	24.7
15-May-01	1	9:00-10:15	25.9	25.2	25.1	24.8	24.8	25.8	25.1	25.4
15-May-01	1	9:00-10:15	25.6	25.6	25.2	26.0	25.7	25.2	25.0	26.1
15-May-01	1	19:00-19:38	25.5	25.3	25.4	25.0	25.6	25.6	25.5	25.4
15-May-01	1	19:00-19:38	25.7	25.8	25.8	25.4	25.8	25.6	25.8	25.3
16-May-01	2	8:00-10:30	24.6	25.0	25.1	24.7	24.4	25.2	25.1	24.9
16-May-01	2	8:00-10:30	25.2	25.1	25.1	25.5	24.5	25.2	24.8	25.1
16-May-01	2	18:15-18:35	24.6	25.6	25.7	25.5	24.2		25.6	24.6
16-May-01	2	18:15-18:35	24.8	25.6	24.7	25.3	25.4	24.8	25.6	24.9
17-May-01	3	6:30-7:00	24.5	24.6	24.6	23.9	24.3		24.7	24.5
17-May-01	3	6:30-7:00	24.9	25.0	25.1	25.1	24.7	25.0	24.3	24.9
17-May-01	3	18:35-19:00	24.1	24.9	24.8	24.7	24.5		24.9	24.8
17-May-01	3	18:35-19:00	24.7	24.8	24.9	24.9	24.8	24.9	24.5	24.8
18-May-01	4	8:30-9:00	24.7	24.8	24.9	24.7	24.4		24.7	24.8
18-May-01	4	8:30-9:00	24.8	24.7	24.5	24.5	24.8	24.7	24.7	24.7
18-May-01	4	17:20-18:00	24.4	24.9	24.7	24.7	24.9		24.8	24.5
18-May-01	4	17:20-18:00	24.7	24.5	24.8	24.7	24.4	24.9	24.8	24.5
19-May-01	5	11:05-11:40	24.4	24.8	24.7	24.7	24.3		24.9	24.5
19-May-01	5	11:05-11:40	24.4	24.9	24.8	24.8	24.8	24.7	24.5	24.5
19-May-01	5	16:45-17:25	26.0	25.9	26.0	25.8	25.8	26.2	26.0	25.8
19-May-01	5	16:45-17:25	26.2	26.1	25.8	25.8	25.7	26.0	25.8	25.8
20-May-01	6	9:45	25.2	25.3	25.2	24.9	25.2		25.2	24.9
20-May-01	6	9:45	25.4	25.5	25.1	25.0	25.3	25.3	25.2	25.2
20-May-01	6	17:05-17:28	24.5	24.9	24.5	24.6	24.8		24.9	24.6
20-May-01	6	17:05-17:28	24.7	24.8	24.9	24.8	24.5	24.9	24.5	24.8
21-May-01	7	9:35	24.2	24.8	24.2	24.3	23.7		24.5	24.4
21-May-01	7	9:35	24.5	24.5	24.7	23.6	24.2	24.3	24.3	24.4
21-May-01	7	9:35	24.5	24.3	24.5	24.2	24.7	24.3	24.6	24.6
21-May-01	7	9:35	24.5	24.8	24.5	24.6	24.2	24.5	24.1	24.5
21-May-01	7	9:35	24.0	24.5	24.5	24.6	24.4	24.0	24.2	24.0
		Average	**24.8**	**25.0**	**24.9**	**24.8**	**24.7**	**25.0**	**24.9**	**24.8**
		Minimum	24.0	24.3	24.2	23.6	23.7	24.0	24.1	24.0
		Maximum	26.2	26.1	26.0	26.0	25.8	26.2	26.0	26.1

Appendix Table 7. Dissolved oxygen (ppm) for 7 day *Pimephales promelas* test

Date	Day	Time	Rep	A	B	C	D	E	F	G	H	I
14-May-01				Sand	Form Sed	West Bear	Ref Sand	Ref Wood	1% Sand	1% Wood	10% Sand	10% Wood
14-May-01	0	15:00-16:20	1	7.8	7.4	6.6	6.7	6.4	6.5	6.5	6.4	6.4
14-May-01	0	15:00-16:20	2	7.5	7.2	6.7	6.8	6.6	6.7	6.6	6.1	6.3
14-May-01	0	15:00-16:20	3	7.6	7.4	6.5	6.9	6.7	6.7	6.5	6.3	6.4
14-May-01	0	15:00-16:20	4	7.5	7.3	6.6	6.7	6.4	6.8	6.5	6.2	6.4
14-May-01	0	15:00-16:20	5	8.1	7.4	6.5	6.7	6.5	6.6	6.5	6.4	6.5
15-May-01	1	9:00-10:15	1	7.5	6.6	6.6	6.3	6.5	6.2	6.4	6.2	6.2
15-May-01	1	9:00-10:15	4	6.5	6.3	6.6	6.2	6.5	5.6	6.2	6.5	6.3
15-May-01	1	19:00-19:38	1	6.1	6.0	6.7	5.6	6.3	6.3	5.9	6.2	6.1
15-May-01	1	19:00-19:38	5	6.5	6.1	5.9	6.0	6.1	6.2	6.3	5.6	6.4
16-May-01	2	8:00-10:30	1	6.1	6.2	6.4	6.5	6.5	6.5	6.3	6.3	6.5
16-May-01	2	8:00-10:30	2	6.5	5.8	6.6	6.7	6.2	6.9	6.2	6.1	6.3
16-May-01	2	18:15-18:35	1	6.4	5.7	6.3	6.2	5.9	6.0	6.4	6.3	5.8
16-May-01	2	18:15-18:35	3	6.3	6.0	6.4	6.5	6.3	6.3	6.5	6.5	6.2
17-May-01	3	6:30-7:00	1	5.4	6.1	6.6	6.7	6.5	6.4	6.4	6.3	6.1
17-May-01	3	6:30-7:00	4	6.4	6.5	6.7	6.3	6.0	6.8	5.5	6.3	6.4
17-May-01	3	18:35-19:00	1	6.3	5.8	6.0	6.1	6.4	6.3	5.9	6.0	6.3
17-May-01	3	18:35-19:00	5	6.2	6.1	5.9	5.9	6.2	6.9	6.3	6.0	6.0
18-May-01	4	8:30-9:00	1	6.4	6.2	6.5	5.6	6.1	6.3	6.3	6.5	6.0
18-May-01	4	8:30-9:00	3	6.2	6.5	6.3	6.2	6.6	6.2	6.0	6.4	6.4
18-May-01	4	17:20-18:00	1	6.6	5.7	6.6	6.2	5.8	6.1	6.2	6.5	5.8
18-May-01	4	17:20-18:00	4	6.4	5.6	6.5	6.1	5.9	6.5	6.5	5.9	6.2
19-May-01	5	11:05-11:40	1	6.7	6.5	6.6	5.8	6.1	6.2	6.5	6.7	5.9
19-May-01	5	11:05-11:40	5	6.7	6.3	5.8	6.1	6.2	6.7	6.2	6.5	6.9
19-May-01	5	16:45-17:25	1	6.3	6.2	6.3	6.0	6.4	6.6	6.3	6.0	6.7
19-May-01	5	16:45-17:25	2	6.3	5.7	6.3	6.5	6.2	6.4	6.2	6.2	6.2
20-May-01	6	9:45	1	6.5	6.2	5.8	6.1	5.5	5.8	6.3	6.3	5.3
20-May-01	6	9:45	3	5.4	5.0	6.3	6.0	6.5	6.0	5.5	6.0	5.9
20-May-01	6	17:05-17:28	1	6.3	5.7	5.7	5.9	5.8	6.0	5.8	5.8	5.7
20-May-01	6	17:05-17:28	4	6.1	5.1	5.8	5.8	6.0	6.1	5.8	5.6	5.8
21-May-01	7	9:35	1	6.2	5.0	5.9	5.8	5.4	5.5	5.8	6.0	4.5
21-May-01	7	9:35	2	5.5	5.2	5.0	6.2	5.5	6.1	6.1	5.1	5.5
21-May-01	7	9:35	3	5.8	5.4	6.0	5.9	6.3	5.6	5.5	5.7	5.7
21-May-01	7	9:35	4	5.8	5.6	5.6	4.9	5.7	6.4	4.9	5.8	5.8
21-May-01	7	9:35	5	6.2	5.6	5.7	5.8	5.6	5.9	5.5	5.8	6.2
		Average		**6.47**	**6.10**	**6.24**	**6.17**	**6.16**	**6.30**	**6.13**	**6.13**	**6.09**
		Minimum		5.40	5.00	5.00	4.90	5.40	5.50	4.90	5.10	4.50
		Maximum		8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10

Appendix Table 7 (continued). Dissolved oxygen (ppm) for 7 day *Pimephales promelas* test

Date	Day	Time	Rep	J	K	L	M	N	O	P	Q
14-May-01				25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	15:00-16:20	1	6.2	6.0	5.1	5.7	6.2	4.2	4.8	4.8
14-May-01	0	15:00-16:20	2	5.8	5.9	5.5	5.8	6.1	4.3	4.5	4.9
14-May-01	0	15:00-16:20	3	5.9	6.0	5.3	6.0	6.0	4.1	4.9	5.1
14-May-01	0	15:00-16:20	4	5.9	5.9	5.2	5.8	6.0	4.1	4.8	4.9
14-May-01	0	15:00-16:20	5	6.1	6.1	5.5	5.8	6.1	4.6	5.2	4.9
15-May-01	1	9:00-10:15	1	6.2	6.3	5.1	5.6	5.1	5.7	5.4	5.6
15-May-01	1	9:00-10:15	4	6.3	5.8	6.1	6.4	6.0	5.2	5.5	6.3
15-May-01	1	19:00-19:38	1	6.0	6.4	5.7	5.5	5.8	5.8	5.5	6.1
15-May-01	1	19:00-19:38	5	5.9	5.8	6.5	5.9	5.9	5.4	5.1	5.7
16-May-01	2	8:00-10:30	1	5.8	4.7	5.6	4.7	5.6	5.8	6.0	6.0
16-May-01	2	8:00-10:30	2	6.1	6.1	6.0	6.3	6.2	6.0	6.4	6.2
16-May-01	2	18:15-18:35	1	5.7	6.3	5.7	5.8	6.1		6.2	5.9
16-May-01	2	18:15-18:35	3	6.3	6.6	5.9	5.9	6.6	5.1	5.0	6.0
17-May-01	3	6:30-7:00	1	6.5	6.6	5.6	6.1	6.3		6.5	6.1
17-May-01	3	6:30-7:00	4	6.4	6.1	6.3	6.0	6.3	6.2	6.5	6.3
17-May-01	3	18:35-19:00	1	6.3	6.3	5.8	5.8	5.8		5.8	6.2
17-May-01	3	18:35-19:00	5	5.8	5.8	5.8	6.2	5.9	5.5	5.2	5.8
18-May-01	4	8:30-9:00	1	6.3	6.4	6.2	6.1	6.2		6.3	5.7
18-May-01	4	8:30-9:00	3	6.5	6.3	6.1	5.2	5.8	5.6	6.4	6.1
18-May-01	4	17:20-18:00	1	6.0	6.1	6.1	6.0	6.9		5.7	5.6
18-May-01	4	17:20-18:00	4	5.7	5.8	6.1	5.3	6.1	6.2	5.7	5.6
19-May-01	5	11:05-11:40	1	6.4	6.4	6.3	6.2	6.7		5.2	6.0
19-May-01	5	11:05-11:40	5	6.8	6.4	6.7	6.2	6.5	6.7	5.6	6.2
19-May-01	5	16:45-17:25	1	6.6	6.0	6.3	5.8	6.0		5.3	6.3
19-May-01	5	16:45-17:25	2	6.2	5.9	5.7	6.7	6.3	6.1	6.7	6.1
20-May-01	6	9:45	1	6.2	5.7	6.0	5.7	6.3		5.9	5.9
20-May-01	6	9:45	3	6.4	6.3	5.8	5.7	6.4	4.9	6.3	5.9
20-May-01	6	17:05-17:28	1	5.9	5.9	5.7	5.7	5.8		5.6	6.0
20-May-01	6	17:05-17:28	4	6.0	5.7	5.6	5.6	5.8	5.5	5.7	5.9
21-May-01	7	9:35	1	5.8	5.8	5.0	5.5	6.1		5.8	5.7
21-May-01	7	9:35	2	5.4	5.2	5.3	5.5	5.8	5.4	5.3	4.7
21-May-01	7	9:35	3	6.1	5.9	5.6	5.2	5.6	5.0	5.2	5.5
21-May-01	7	9:35	4	5.4	4.9	5.5	5.2	5.6	5.7	5.0	5.1
21-May-01	7	9:35	5	6.0	5.4	4.2	5.4	6.0	6.0	5.1	5.5
		Average		**6.09**	**5.96**	**5.73**	**5.77**	**6.06**	**5.38**	**5.59**	**5.72**
		Minimum		5.40	4.70	4.20	4.70	5.10	4.10	4.50	4.70
		Maximum		8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10

Appendix Table 8. Water quality for 7 day *Pimephales promelas* test

pH

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand
14-May-01	0	15:00-16:20	2	8.16	7.53	7.68	7.72	7.69	7.73	7.68	7.61
14-May-01	0	15:00-16:20	5	8.17	7.47	7.66	7.69	7.68	7.73	7.67	7.68
15-May-01	1	9:00-10:15	1	8.13	7.46	7.83	7.75	7.97	7.83	7.81	7.75
15-May-01	1	9:00-10:15	4	7.91	7.28	7.83	7.74	7.99	7.56	7.77	7.96
16-May-01	2	18:15-18:35	1	8.15	7.63	7.90	8.00	7.89	7.94	7.86	7.82
16-May-01	2	18:15-18:35	2	7.97	7.47	7.95	8.02	7.73	8.03	7.78	7.81
18-May-01	4	8:30-9:00	1	7.85	7.55	7.78	7.54	7.71	7.72	7.75	7.85
18-May-01	4	8:30-9:00	3	7.76	7.71	7.68	7.74	8.08	7.71	7.70	7.78
21-May-01	7	9:35	2	7.72	7.50	7.49	7.91	7.71	7.96	7.89	7.64
21-May-01	7	9:35	5	8.00	7.76	7.68	7.80	7.73	7.84	7.73	7.74
		Average		**7.98**	**7.54**	**7.75**	**7.79**	**7.82**	**7.81**	**7.76**	**7.76**
		Minimum		7.72	7.28	7.49	7.54	7.68	7.56	7.67	7.61
		Maximum		8.17	7.76	7.95	8.02	8.08	8.03	7.89	7.96

Conductivity (umho/cm)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand
14-May-01	0	15:00-16:20	2	150	151	140	137	140	143	141	145
14-May-01	0	15:00-16:20	5	158	156	139	141	140	142	144	142
21-May-01	7	9:35	2	148	152	308	157	147	149	148	148
21-May-01	7	9:35	5	154	149	144	148	147	150	145	149
		Average		**153**	**152**	**183**	**146**	**144**	**146**	**145**	**146**
		Minimum		148	149	139	137	140	142	141	142
		Maximum		158	156	308	157	147	150	148	149

Appendix Table 8 (continued). Water quality for 7 day *Pimephales promelas* test

pH

Date	Day	Rep	Time	I	J	K	L	M	N	O	P	Q
				10% Wood	25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	2	15:00-16:20	7.62	7.55	7.54	7.55	7.44	7.55	7.39	7.45	7.30
14-May-01	0	5	15:00-16:20	7.63	7.60	7.54	7.49	7.43	7.58	7.40	7.54	7.29
15-May-01	1	1	9:00-10:15	7.85	7.86	7.79	7.47	7.49	7.45	7.68	7.57	7.49
15-May-01	1	4	9:00-10:15	7.80	7.91	7.61	7.76	7.89	7.75	7.54	7.57	7.69
16-May-01	2	1	18:15-18:35	7.84	7.69	7.42	7.60	7.46	7.77	7.74	7.70	7.61
16-May-01	2	2	18:15-18:35	7.85	7.79	7.75	7.74	7.78	7.66	7.65	7.61	7.69
18-May-01	4	1	8:30-9:00	7.62	7.74	7.74	7.72	7.63	7.68		7.65	7.52
18-May-01	4	3	8:30-9:00	7.75	7.82	7.74	7.66	7.49	7.61	7.55	7.70	7.67
21-May-01	7	2	9:35	7.73	7.70	7.61	7.68	7.62	7.79	7.69	7.66	7.48
21-May-01	7	5	9:35	7.93	7.83	7.61	7.46	7.64	7.87	7.90	7.53	7.66
			Average	**7.76**	**7.75**	**7.64**	**7.61**	**7.59**	**7.67**	**7.62**	**7.60**	**7.54**
			Minimum	7.62	7.55	7.42	7.46	7.43	7.45	7.39	7.45	7.29
			Maximum	7.93	7.91	7.79	7.76	7.89	7.87	7.90	7.70	7.69

Conductivity (umho/cm)

Date	Day	Rep	Time	I	J	K	L	M	N	O	P	Q
				10% Wood	25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	2	15:00-16:20	144	143	138	141	138	145	142	142	139
14-May-01	0	5	15:00-16:20	140	139	136	141	144	150	141	137	133
21-May-01	7	2	9:35	145	148	147	150	148	146	146	144	149
21-May-01	7	5	9:35	146	150	147	150	146	148	149	149	144
			Average	**144**	**145**	**142**	**146**	**144**	**147**	**145**	**143**	**141**
			Minimum	140	139	136	141	138	145	141	137	133
			Maximum	146	150	147	150	148	150	149	149	149

Appendix Table 8 (continued). Water quality for 7 day *Pimephales promelas* test

Ammonia (ppm)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand
14-May-01	0	15:00-16:20	2	<0.063	<0.063	0.121	0.112	0.075	0.141	0.092	0.170
14-May-01	0	15:00-16:20	5	<0.063	<0.063	0.226	0.150	0.091	0.158	0.110	0.440
15-May-01	1	9:00-10:15	1	0.096	<0.063	0.282	0.277	0.135	0.561	0.248	0.671
15-May-01	1	9:00-10:15	4	0.116	0.041	0.312	0.244	0.108	0.498	0.225	0.588
16-May-01	2	18:15-18:35	1	0.245	0.072	0.249	0.296	0.122	0.692	0.698	2.768
16-May-01	2	18:15-18:35	2	0.233	<0.063	0.239	0.248	0.152	0.566	0.258	0.685
18-May-01	4	8:30-9:00	1	0.388	0.182	0.348	0.557	0.206	0.611	0.335	0.779
18-May-01	4	8:30-9:00	3	0.504	0.123	0.379	0.436	0.207	0.346	0.274	0.860
21-May-01	7	9:35	2	0.276	<0.063	0.082	<0.063	0.095	<0.063	0.071	0.121
21-May-01	7	9:35	5	0.264	0.109	0.077	<0.063	0.113	<0.063	0.085	0.068
		Average		**0.218**	**0.068**	**0.232**	**0.238**	**0.130**	**0.364**	**0.240**	**0.715**
		Minimum		<0.063	<0.063	0.077	<0.063	0.075	<0.063	0.071	0.068
		Maximum		0.504	0.182	0.379	0.557	0.207	0.692	0.698	2.768

Hardness (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand
14-May-01	0	15:00-16:20	2	42.8	46.8	48.0	48.8	52.4	52.4	50.4	54.4
14-May-01	0	15:00-16:20	5	48.8	45.2	50.8	52.4	52.0	54.8	54.8	50.8
21-May-01	7	9:35	2	54.0	54.4	53.6	55.6	54.4	55.2	56.4	52.8
21-May-01	7	9:35	5	53.6	53.2	51.2	58.4	53.2	53.2	54.4	56.4
		Average		**49.8**	**49.9**	**50.9**	**53.8**	**53.0**	**53.9**	**54.0**	**53.6**

Alkalinity (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand
14-May-01	0	15:00-16:20	2	47.2	40.0	44.4	46.4	47.2	46.8	46.8	48.4
14-May-01	0	15:00-16:20	5	44.4	38.2	43.6	46.8	47.2	46.0	48.4	47.2
21-May-01	7	9:35	2	50.4	46.0	44.4	50.4	46.4	45.6	45.2	46.4
21-May-01	7	9:35	5	47.2	46.8	41.2	46.4	46.0	46.8	45.2	46.0
		Average		**47.3**	**42.8**	**43.4**	**47.5**	**46.7**	**46.3**	**46.4**	**47.0**

Appendix Table 8 (continued). Water quality for 7 day *Pimephales promelas* test

Ammonia (ppm)

Date	Day	Rep	Time	I	J	K	L	M	N	O	P	Q
				10% Wood	25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	2	15:00-16:20	0.082	0.167	<0.063	0.314	<0.063	0.217	<0.063	0.393	<0.063
14-May-01	0	5	15:00-16:20	0.076	0.105	<0.063	0.299	<0.063	0.213	<0.063	0.364	<0.063
15-May-01	1	1	9:00-10:15	0.233	0.439	0.166	0.596	<0.063	0.503	0.073	0.264	<0.063
15-May-01	1	4	9:00-10:15	0.269	0.408	0.117	0.570	<0.063	0.590	<0.063	0.207	<0.063
16-May-01	2	1	18:15-18:35	0.151	0.464	0.131	0.517	0.119	0.450	<0.063	0.140	<0.063
16-May-01	2	2	18:15-18:35	0.149	0.438	0.114	0.518	0.101	0.500	<0.063	0.092	0.066
18-May-01	4	1	8:30-9:00	0.223	0.623	0.340	1.012	0.182	1.599	0.315	0.315	0.179
18-May-01	4	3	8:30-9:00	0.252	0.654	0.332	0.802	0.204	0.575	0.065	0.227	0.114
21-May-01	7	2	9:35	0.091	0.638	0.182	0.480	0.168	0.089	0.174	0.223	0.144
21-May-01	7	5	9:35	0.068	0.360	0.123	0.440	0.295	<0.063	0.160	0.118	0.121
			Average	**0.159**	**0.430**	**0.157**	**0.555**	**0.132**	**0.521**	**0.094**	**0.234**	**0.078**
			Minimum	0.068	0.105	<0.063	0.299	<0.063	<0.063	<0.063	0.092	<0.063
			Maximum	0.269	0.654	0.340	1.012	0.295	1.599	0.315	0.393	0.179

Hardness (ppm CaCO3)

Date	Day	Rep	Time	I	J	K	L	M	N	O	P	Q
				10% Wood	25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	2	15:00-16:20	52.8	54.8	60.0	54.4	56.0	58.0	56.4	55.2	60.0
14-May-01	0	5	15:00-16:20	55.6	50.0	55.2	52.0	53.6	55.6	48.4	54.0	52.0
21-May-01	7	2	9:35	52.8	56.8	52.4	53.6	54.4	54.8	54.8	52.0	54.6
21-May-01	7	5	9:35	55.6	54.8	54.0	58.4	53.0	53.6	54.8	55.6	52.4
			Average	**54.2**	**54.1**	**55.4**	**54.6**	**54.3**	**55.5**	**53.6**	**54.2**	**54.8**

Alkalinity (ppm CaCO3)

Date	Day	Rep	Time	I	J	K	L	M	N	O	P	Q
				10% Wood	25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
14-May-01	0	2	15:00-16:20	47.6	48.0	44.0	50.0	46.0	52.0	66.0	44.0	40.0
14-May-01	0	5	15:00-16:20	47.2	47.2	36.8	49.6	49.2	32.0	45.2	44.0	46.0
21-May-01	7	2	9:35	46.8	48.0	53.2	48.4	46.8	46.8	47.0	46.0	49.2
21-May-01	7	5	9:35	48.0	47.4	47.2	47.6	46.0	46.4	50.0	47.2	50.4
			Average	**47.4**	**47.7**	**45.3**	**48.9**	**47.0**	**44.3**	**52.1**	**45.3**	**46.4**

Appendix Table 9. Survival and growth of ***Hyalella azteca*** under regular laboratory lights

Treatment	Sediment	Rep	Number of survivors	individual dry weight (ug)
a	Sand	1	5	0.192
a	Sand	2	10	0.206
a	Sand	3	8	0.177
a	Sand	4	9	0.194
a	Sand	5	8	0.161
a	Sand	6	8	0.139
a	Sand	7	6	0.205
a	Sand	8	8	0.239
b	Formu	1	7	0.566
b	Formu	2	10	0.567
b	Formu	3	9	0.579
b	Formu	4	9	0.549
b	Formu	5	10	0.431
b	Formu	6	9	0.509
b	Formu	7	10	0.724
b	Formu	8	10	0.543
c	W Bear	1	9	0.202
c	W Bear	2	10	0.186
c	W Bear	3	10	0.231
c	W Bear	4	9	0.196
c	W Bear	5	10	0.144
c	W Bear	6	10	0.163
c	W Bear	7	10	0.171
c	W Bear	8	10	0.174
d	Ref Sand	1	10	0.153
d	Ref Sand	2	10	0.230
d	Ref Sand	3	5	0.414
d	Ref Sand	4	9	0.197
d	Ref Sand	5	9	0.306
d	Ref Sand	6	10	0.228
d	Ref Sand	7	10	0.247
d	Ref Sand	8	6	0.388
e	Ref Wood	1	10	0.244
e	Ref Wood	2	10	0.258
e	Ref Wood	3	10	0.276
e	Ref Wood	4	10	0.217
e	Ref Wood	5	10	0.217
e	Ref Wood	6	10	0.242
e	Ref Wood	7	10	0.200
e	Ref Wood	8	8	0.230

Appendix Table 9 (continued). Survival and growth of ***Hyalella azteca*** under regular laboratory light

Treatment	Sediment	Rep	Number of survivors	individual dry weight (ug)
f	1% cont Sand	1	9	0.231
f	1% cont Sand	2	9	0.176
f	1% cont Sand	3	10	0.257
f	1% cont Sand	4	10	0.201
f	1% cont Sand	5	10	0.191
f	1% cont Sand	6	10	0.255
f	1% cont Sand	7	10	0.238
f	1% cont Sand	8	10	0.215
g	1% Cont Wood	1	10	0.199
g	1% Cont Wood	2	9	0.257
g	1% Cont Wood	3	9	0.241
g	1% Cont Wood	4	10	0.234
g	1% Cont Wood	5	10	0.195
g	1% Cont Wood	6	10	0.215
g	1% Cont Wood	7	9	0.217
g	1% Cont Wood	8	9	0.186
h	10%Cont Sand	1	10	0.183
h	10%Cont Sand	2	10	0.198
h	10%Cont Sand	3	11	0.152
h	10%Cont Sand	4	8	0.155
h	10%Cont Sand	5	9	0.269
h	10%Cont Sand	6	10	0.174
h	10%Cont Sand	7	10	0.293
h	10%Cont Sand	8	9	0.244
i	10%Cont Wood	1	8	0.210
i	10%Cont Wood	2	9	0.208
i	10%Cont Wood	3	13	0.233
i	10%Cont Wood	4	10	0.235
i	10%Cont Wood	5	10	0.204
i	10%Cont Wood	6	5	0.418
i	10%Cont Wood	7	10	0.235
i	10%Cont Wood	8	10	0.217
j	25%Cont Sand	1	8	0.205
j	25%Cont Sand	2	11	0.230
j	25%Cont Sand	3	9	0.277
j	25%Cont Sand	4	10	0.220
j	25%Cont Sand	5	9	0.213
j	25%Cont Sand	6	9	0.259
j	25%Cont Sand	7	7	0.303
j	25%Cont Sand	8	5	0.368

Appendix Table 9 (continued). Survival and growth of ***Hyalella azteca*** under regular laboratory light

Treatment	Sediment	Rep	Number of survivors	individual dry weight (ug)
k	25% Cont Wood	1	8	0.271
k	25% Cont Wood	2	8	0.326
k	25% Cont Wood	3	9	0.238
k	25% Cont Wood	4	7	0.293
k	25% Cont Wood	5	10	0.177
k	25% Cont Wood	6	9	0.180
k	25% Cont Wood	7	9	0.219
k	25% Cont Wood	8	10	0.221
l	50% Cont Sand	1	4	0.418
l	50% Cont Sand	2	4	0.410
l	50% Cont Sand	3	5	0.310
l	50% Cont Sand	4	4	0.465
l	50% Cont Sand	5	7	0.434
l	50% Cont Sand	6	5	0.460
l	50% Cont Sand	7	5	0.402
l	50% Cont Sand	8	3	0.543
m	50% Cont Wood	1	8	0.272
m	50% Cont Wood	2	10	0.226
m	50% Cont Wood	3	8	0.308
m	50% Cont Wood	4	7	0.281
m	50% Cont Wood	5	8	0.239
m	50% Cont Wood	6	9	0.249
m	50% Cont Wood	7	9	0.251
m	50% Cont Wood	8	10	0.225
n	Cont Wood # 2	1	5	0.548
n	Cont Wood # 2	2	7	0.166
n	Cont Wood # 2	3	3	0.727
n	Cont Wood # 2	4	0	
n	Cont Wood # 2	5	0	
n	Cont Wood # 2	6	9	0.342
n	Cont Wood # 2	7	18	0.158
n	Cont Wood # 2	8	3	0.833
o	Cont Sand # 2	1	1	0.580
o	Cont Sand # 2	2	1	0.640
o	Cont Sand # 2	3	1	0.520
o	Cont Sand # 2	4	0	
o	Cont Sand # 2	5	1	0.550
o	Cont Sand # 2	6	0	
o	Cont Sand # 2	7	0	
o	Cont Sand # 2	8	0	

Appendix Table 9 (continued). Survival and growth of ***Hyalella azteca*** under regular laboratory light

Treatment	Sediment	Rep	Number of survivors	individual dry weight (ug)
p	Cont Sand # 1	1	0	
p	Cont Sand # 1	2	0	
p	Cont Sand # 1	3	0	
p	Cont Sand # 1	4	0	
p	Cont Sand # 1	5	0	
p	Cont Sand # 1	6	0	
p	Cont Sand # 1	7	0	
p	Cont Sand # 1	8	0	
q	Cont Wood # 1	1	0	
q	Cont Wood # 1	2	1	0.610
q	Cont Wood # 1	3	0	
q	Cont Wood # 1	4	0	
q	Cont Wood # 1	5	0	
q	Cont Wood # 1	6	0	
q	Cont Wood # 1	7	1	0.220
q	Cont Wood # 1	8	0	

Appendix Table 10. Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	9:16-10:45	1	22.3	22.6	22.4	22.7	22.8	22.7	22.6	22.8	22.7
27-May-01	0	9:16-10:45	2	22.3	22.7	22.5	22.7	22.8	22.8	22.7	22.8	22.7
27-May-01	0	9:16-10:45	3	22.4	22.6	22.6	22.7	22.8	22.8	22.6	22.8	22.7
27-May-01	0	9:16-10:45	4	22.3	22.7	22.6	22.7	22.7	22.8	22.6	22.9	22.7
27-May-01	0	9:16-10:45	5	22.4	22.6	22.6	22.7	22.9	22.7	22.7	22.8	22.8
27-May-01	0	9:16-10:45	6	22.4	22.6	22.6	22.8	22.7	22.8	22.7	22.8	22.8
27-May-01	0	9:16-10:45	7	22.4	22.6	22.4	22.8	22.9	22.8	22.7	22.8	22.8
27-May-01	0	9:16-10:45	8	22.4	22.7	22.5	22.8	22.8	22.8	22.8	22.8	22.8
27-May-01	0	21:30	1	23.4	23.3	23.2	23.1	23.2	23.2	23.1	23.4	23.2
27-May-01	0	21:30	4	23.4	23.3	23.2	23.1	23.2	23.2	23.1	23.4	23.2
28-May-01	1	8:00-8:30	4	23.1	23	22.9	22.8	22.9	22.9	22.7	23	22.8
28-May-01	1	8:00-8:30	6	23.1	23	22.9	22.8	22.9	22.9	22.8	23	22.8
28-May-01	1	16:30-17:20	4	23.6	24.2	23.4	24.1	23.9	23.3	23.3	23.4	23.3
28-May-01	1	16:30-17:20	8	23.6	24.2	23.4	24.1	23.9	23.4	23.3	23.4	23.3
29-May-01	2	7:40-8:15	4	23.1	22.7	22.8	22.4	22.5	22.7	22.3	22.8	22.6
29-May-01	2	7:40-8:15	5	23.1	22.6	22.7	22.6	22.6	22.8	22.6	22.8	22.6
29-May-01	2	15:30-16:05	2	23	22.3	22.9	22.2	22.2	22.9	22.9	22.9	22.9
29-May-01	2	15:30-16:05	4	23.4	22.3	22.9	22.2	22.2	22.9	22.9	23	22.9
30-May-01	3	7:20-8:40	4	22.9	22.8	22.7	22.6	22.7	22.7	22.4	22.8	22.5
30-May-01	3	7:20-8:40	7	22.9	22.8	22.8	22.6	22.7	22.7	22.6	22.7	22.6
30-May-01	3	15:30-16:15	3	23.7	23.2	23.2	23.2	23.1	23.2	23.1	23.5	23.1
30-May-01	3	15:30-16:15	4	23.6	23.2	23.2	23.2	23.1	23.2	23.1	23.5	23.1
31-May-01	4	8:00-8:45	1	23	22.9	22.9	22.6	22.7	22.8	22.7	22.7	22.8
31-May-01	4	8:00-8:45	4	22.9	22.9	22.8	22.7	22.6	22.7	22.6	22.6	22.7
31-May-01	4	15:00-15:33	3	23	23	23	22.8	22.8	23	23	23	23.1
31-May-01	4	15:00-15:33	4	23	23	23	22.8	22.8	23	23	22.9	23.1
1-Jun-01	5	7:30-8:15	4	22.9	22.8	23	22.8	22.7	22.8	22.8	22.8	22.8
1-Jun-01	5	7:30-8:15	6	22.9	22.8	23	22.8	22.7	22.9	22.8	22.8	22.8
1-Jun-01	5	15:00-15:30	4	22.8	22.8	22.8	22.8	22.8	22.8	22.7	22.8	22.7
1-Jun-01	5	15:00-15:30	8	22.9	22.8	22.8	22.7	22.7	22.8	22.7	22.8	22.8
2-Jun-01	6	8:10-8:30	4	22.3	22.5	22.3	22.3	22.5	22.4	22.2	23.3	22.3
2-Jun-01	6	8:10-8:30	5	22.3	22.5	22.5	22.2	22.4	22.5	22.3	22.2	22.4
2-Jun-01	6	15:15-16:00	2	23.1	23.1	23.1	23	23	23	22.9	23.1	23.1
2-Jun-01	6	15:15-16:00	4	23.1	23.1	23	23	23	23	23	23.1	23

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	9:16-10:45	1	22.9	23	23	23.2	22.9	23.1	23.1	23.1
27-May-01	0	9:16-10:45	2	22.8	23	22.9	23.2	23	23.1	23.1	23.1
27-May-01	0	9:16-10:45	3	22.8	23	23.1	23.3	22.9	23.1	23.1	23.1
27-May-01	0	9:16-10:45	4	22.9	23	23	23.2	23	23.1	23.1	23.1
27-May-01	0	9:16-10:45	5	22.8	23	23.1	23.1	23	23.1	23.1	23.1
27-May-01	0	9:16-10:45	6	22.8	23	23	23.2	23	23.1	23.1	23.1
27-May-01	0	9:16-10:45	7	23	23	23.1	23.3	23.1	23.1	23.1	23.1
27-May-01	0	9:16-10:45	8	23	23.1	23.1	23.1	23.1	23.1	23.1	23.1
27-May-01	0	21:30	1	23.4	23.4	23.2	23.2	23.2	23.3	23.2	23.3
27-May-01	0	21:30	4	23.4	23.4	23.2	23.3	23.2	23.3	23.2	23.4
28-May-01	1	8:00-8:30	4	22.9	22.9	22.7	22.9	22.4	22.7	22.7	22.7
28-May-01	1	8:00-8:30	6	22.9	23	22.7	22.9	22.6	22.7	22.7	22.7
28-May-01	1	16:30-17:20	4	23.3	23.4	23.3	23.3	23.8	23.9	23.2	23.1
28-May-01	1	16:30-17:20	8	23.3	23.4	23.3	23.3	23.8	23.9	23.2	23.2
29-May-01	2	7:40-8:15	4	22.6	22.8	22.5	22.8	23.3	22.5	22.7	22.5
29-May-01	2	7:40-8:15	5	22.6	22.8	22.5	22.8	23.4	22.6	22.6	22.6
29-May-01	2	15:30-16:05	2	22.9	23	22.8	22.9	22.2	22.3	22.7	22.8
29-May-01	2	15:30-16:05	4	22.9	23	22.8	22.9	22.2	22.3	22.7	22.8
30-May-01	3	7:20-8:40	4	22.6	22.8	22.4	22.5	22.4	22.5	22.6	22.4
30-May-01	3	7:20-8:40	7	22.7	22.8	22.4	22.6	22.4	22.6	22.6	22.4
30-May-01	3	15:30-16:15	3	23.3	23.4	23.1	23.3	22.8	23	23.2	23
30-May-01	3	15:30-16:15	4	23.3	23.4	23.1	23.3	22.9	22.9	23.2	23
31-May-01	4	8:00-8:45	1	22.6	22.8	22.8	22.6	22.6	22.7	22.7	22.8
31-May-01	4	8:00-8:45	4	22.6	22.8	22.8	22.6	22.6	22.7	22.7	22.8
31-May-01	4	15:00-15:33	3	22.8	23	22.9	22.8	22.8	22.8	22.8	23
31-May-01	4	15:00-15:33	4	22.8	23	22.9	22.8	22.8	22.8	22.8	23
1-Jun-01	5	7:30-8:15	4	22.7	22.8	22.8	22.8	22.5	22.7	22.6	22.7
1-Jun-01	5	7:30-8:15	6	22.7	22.8	22.8	22.8	22.6	22.7	22.6	22.8
1-Jun-01	5	15:00-15:30	4	22.6	22.8	22.7	22.7	22.6	22.7	22.6	22.8
1-Jun-01	5	15:00-15:30	8	22.7	22.8	22.8	22.6	22.7	22.7	22.6	22.7
2-Jun-01	6	8:10-8:30	4	22.1	22.2	22.5	22.2	22.2	22.3	22	22.3
2-Jun-01	6	8:10-8:30	5	22.1	22.3	22.5	22.2	22.2	22.3	22	22.3
2-Jun-01	6	15:15-16:00	2	23	23.1	23.1	23.1	22.8	23	23	23.1
2-Jun-01	6	15:15-16:00	4	23	23.1	23.1	23.1	22.8	23	23	23.1

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
3-Jun-01	7	9:00	4	23	22.8	22.8	22.8	22.8	22.8	22.8	23	22.8
3-Jun-01	7	9:00	7	23	22.8	22.8	22.9	22.8	22.9	22.8	23	22.8
3-Jun-01	7	15:30	3	23.3	23.3	23.3	23.2	23.1	23.1	23.1	23.2	23.1
3-Jun-01	7	15:30	4	23.3	23.3	23.2	23.2	23.1	23.2	23.1	23.2	23.1
4-Jun-01	8	7:15-8:50	4	22.8	22.9	22.8	22.6	22.8	22.8	22.7	22.8	22.6
4-Jun-01	8	7:15-8:50	6	22.8	23	22.8	22.7	22.7	22.8	22.7	22.8	22.7
4-Jun-01	8	15:00-15:50	4	23.3	23.3	23.3	23.3	23.2	23.3	23.2	23.4	23.2
4-Jun-01	8	15:00-15:50	8	23.3	23.3	23.3	23.3	23.2	23.3	23.3	23.4	23.3
5-Jun-01	9	7:15-8:20	4	22.6	22.8	22.8	22.7	22.6	22.7	22.6	22.6	22.6
5-Jun-01	9	7:15-8:20	7	22.7	22.8	22.6	22.7	22.7	22.7	22.7	22.5	22.6
5-Jun-01	9	15:20-15:45	1	23.2	23.2	23.1	23	23.1	23	23	23.1	22.9
5-Jun-01	9	15:20-15:45	4	23.2	23.2	23.1	23	23.1	23	23	23.1	22.9
6-Jun-01	10	7:15-9:00	4	22.9	23.1	23.1	23.1	23	23.1	23	23	23
6-Jun-01	10	7:15-9:00	5	23	23.1	23.1	23.2	23	23.1	23	23	23
6-Jun-01	10	16:00	2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23.2
6-Jun-01	10	16:00	4	23.2	23.2	23.1	23.2	23.2	23.2	23.3	23.2	23.2
7-Jun-01	11	7:50-8:15	4	22.7	23	22.8	22.8	22.8	22.8	22.7	22.7	22.7
7-Jun-01	11	7:50-8:15	7	22.7	23	22.7	22.9	22.8	22.8	22.8	22.7	22.8
7-Jun-01	11	16:15-17:00	3	23.2	23.3	23.2	23.2	23.2	23.2	23.2	23.3	23.2
7-Jun-01	11	16:15-17:00	4	23.2	23.3	23.2	23.2	23.2	23.2	23.2	23.3	23.2
8-Jun-01	12	7:45-8:30	1	22.6	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
8-Jun-01	12	7:45-8:30	4	22.6	22.8	22.8	22.8	22.7	22.8	22.7	22.6	22.8
8-Jun-01	12	18:10-18:40	4	23.6	23.4	23.5	23.2	23.3	23.4	23.5	23.6	23.4
8-Jun-01	12	18:10-18:40	5	23.6	23.4	23.5	23.2	23.3	23.4	23.4	23.6	23.4
9-Jun-01	13	9:20-10:40	4	23.3	23.2	23.2	23	23.1	23.2	23.2	23.2	23.1
9-Jun-01	13	9:20-10:40	6	23.3	23.2	23.2	23	23.1	23.2	23.2	23.3	23.1
9-Jun-01	13	17:00	4	24.1	23.4	23.4	23.4	23.2	23.5	23.4	24.1	23.3
9-Jun-01	13	17:00	8	24.1	23.4	23.4	23.4	23.4	23.4	23.5	24.2	23.4
10-Jun-01	14	9:30	4	23.2	23.2	23.1	23	22.9	22.6	22.9	23.1	22.9
10-Jun-01	14	9:30	5	23.2	23.2	23	23.1	22.9	22.9	22.9	23.1	22.8
10-Jun-01	14	17:00	2	23.3	23.3	23.2	23.3	23.2	23.2	23.2	23.2	23.1
10-Jun-01	14	17:00	4	23.4	23.2	23.2	23	23.2	23.2	23.2	23.4	23.1
11-Jun-01	15	8:05-10:55	4	22.8	22.8	22.8	22.9	22.9	22.8	22.8	22.9	22.8
11-Jun-01	15	8:05-10:55	7	22.9	22.8	22.8	22.9	22.9	22.9	22.8	22.9	22.8

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
3-Jun-01	7	9:00	4	22.7	22.8	23	23	22.7	22.8	22.8	22.8
3-Jun-01	7	9:00	7	22.7	23	23	23	22.7	22.8	22.8	22.9
3-Jun-01	7	15:30	3	23.1	23.2	23.3	23.3	23.1	23.2	23.1	23.2
3-Jun-01	7	15:30	4	23.1	23.2	23.3	23.2	23	23.1	23.1	23.3
4-Jun-01	8	7:15-8:50	4	22.5	22.6	22.7	22.6	22.5	22.6	22.4	22.6
4-Jun-01	8	7:15-8:50	6	22.5	22.7	22.7	22.6	22.6	22.6	22.5	22.6
4-Jun-01	8	15:00-15:50	4	23.3	23.3	23.3	23.4	23.1	23.3	23.2	23.3
4-Jun-01	8	15:00-15:50	8	23.3	23.3	23.4	23.4	23.1	23.3	23.2	23.3
5-Jun-01	9	7:15-8:20	4	22.3	22.5	22.6	22.5	22.4	22.6	22.3	22.5
5-Jun-01	9	7:15-8:20	7	22.3	22.6	22.7	22.5	22.5	22.6	22.4	22.6
5-Jun-01	9	15:20-15:45	1	23	23.1	23	23	23	23	22.9	23
5-Jun-01	9	15:20-15:45	4	22.9	23.1	23	23	22.8	23.1	23	23
6-Jun-01	10	7:15-9:00	4	22.8	22.9	22.8	22.8	22.7	22.8	22.5	22.7
6-Jun-01	10	7:15-9:00	5	22.8	23	22.8	22.8	22.7	22.8	22.6	22.8
6-Jun-01	10	16:00	2	23.1	23.2	23.3	23.2	23.1	23.2	23.1	23.2
6-Jun-01	10	16:00	4	23.1	23.2	23.3	23.2	23.1	23.2	23.1	23.2
7-Jun-01	11	7:50-8:15	4	22.6	22.7	22.7	22.6	22.7	22.8	22.5	22.7
7-Jun-01	11	7:50-8:15	7	22.6	22.7	22.8	22.7	22.7	22.8	22.6	22.7
7-Jun-01	11	16:15-17:00	3	23.1	23.2	23.3	23.3	23.2	23.3	23.1	23.3
7-Jun-01	11	16:15-17:00	4	23.1	23.2	23.3	23.3	23.2	23.3	23.2	23.3
8-Jun-01	12	7:45-8:30	1	22.4	22.6	22.8	22.6	22.7	22.7	22.5	22.7
8-Jun-01	12	7:45-8:30	4	22.5	22.6	22.8	22.6	22.6	22.8	22.5	22.8
8-Jun-01	12	18:10-18:40	4	23.4	23.6	23.6	23.6	23.4	23.4	23.4	23.6
8-Jun-01	12	18:10-18:40	5	23.4	23.6	23.6	23.7	23.4	23.4	23.5	23.6
9-Jun-01	13	9:20-10:40	4	23.1	23.3	23.3	23.3	23	23.2	23.1	23.2
9-Jun-01	13	9:20-10:40	6	23.1	23.3	23.1	23.3	23	23.2	23.1	23.2
9-Jun-01	13	17:00	4	24.1	24.1	23.6	24.2	23.2	23.4	24	23.3
9-Jun-01	13	17:00	8	24.1	24.1	23.6	24.1	23.3	23.3	23.9	23.3
10-Jun-01	14	9:30	4	22.9	23.2	23	23.1	22.8	22.9	23	22.9
10-Jun-01	14	9:30	5	22.9	23.1	22.9	23.1	22.8	22.9	22.9	22.8
10-Jun-01	14	17:00	2	23.3	23.4	23.2	23.3	23.2	23.3	23.3	23.2
10-Jun-01	14	17:00	4	23.3	23.4	23.2	23.3	23.2	23.3	23.3	23.2
11-Jun-01	15	8:05-10:55	4	22.7	22.9	22.7	22.8	22.7	22.9	22.7	22.7
11-Jun-01	15	8:05-10:55	7	22.8	22.9	22.8	22.9	22.8	22.9	22.8	22.7

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
11-Jun-01	15	17:00-17:40	3	23.4	23.2	23.2	23.2	23.3	23.2	23.2	23.4	23.2
11-Jun-01	15	17:00-17:40	4	23.4	23.2	23.2	23.3	23.3	23.2	23.2	23.4	23.2
12-Jun-01	16	5:45-7:30	1	22.8	22.8	22.7	22.7	22.9	22.6	22.8	22.9	22.7
12-Jun-01	16	5:45-7:30	4	22.8	22.8	22.7	22.8	22.8	22.6	22.8	22.8	22.7
12-Jun-01	16	15;05-15:33	4	23.2	23.1	23.1	23.2	23.1	23.2	23.1	23.2	23.1
12-Jun-01	16	15;05-15:33	5	23.2	23.1	23.1	23.2	23.1	23.1	23.1	23.2	23.1
13-Jun-01	17	6;15-7:45	4	22.8	22.8	22.7	22.3	22.9	22.7	22.7	22.8	22.7
13-Jun-01	17	15:15-16:00	6	22.9	22.7	22.6	22.7	22.9	22.7	22.7	22.9	22.6
13-Jun-01	17	15:15-16:00	4	23.1	23.1	22.9	23	23	22.7	22.7	23.1	22.9
13-Jun-01	17	15:15-16:00	8	23.2	23.1	22.7	23	23	22.7	22.8	23.1	22.7
14-Jun-01	18	7:45-8:20	4	22.9	22.8	22.7	22.8	22.9	22.6	22.6	22.9	22.5
14-Jun-01	18	7:45-8:20	5	22.9	22.8	22.7	22.9	22.9	22.6	22.6	22.9	22.5
14-Jun-01	18	15:00-15:30	2	23.3	23.3	23.1	23.2	23.2	23.1	23.1	23.3	23.1
14-Jun-01	18	15:00-15:30	4	23.3	23.3	23.1	23.2	23.2	23.1	23.1	23.3	23.1
15-Jun-01	19	8:05-8:35	4	23.1	23.1	22.9	23	23	22.8	22.8	23	22.8
15-Jun-01	19	8:05-8:35	7	23.1	23.1	22.8	23	23	22.9	22.8	23	22.8
15-Jun-01	19	15:00-15:45	3	23.3	23.2	23.1	23.2	23.2	23.1	23	23.3	23
15-Jun-01	19	15:00-15:45	4	23.3	23.3	23.1	23.2	23.2	23.1	23	23.3	23
16-Jun-01	20	9:10-11:10	1	23.1	23.1	22.8	23	22.8	22.7	22.8	23	22.7
16-Jun-01	20	9:10-11:10	4	23.1	23.1	22.8	23	22.8	22.7	22.8	23	22.8
16-Jun-01	20	15:20-16:10	2	23.1	23.1	23	23.2	23	23	23	23.1	23
16-Jun-01	20	15:20-16:10	4	23.1	23.1	23	23.2	23	23	23	23.1	23
17-Jun-01	21	9:55-10:20	4	22.8	22.8	22.7	23	22.7	22.7	22.7	22.8	22.7
17-Jun-01	21	9:55-10:20	6	22.8	22.8	22.6	23	22.8	22.7	22.7	22.8	22.7
17-Jun-01	21	15:15-15:55	4	23.2	23.1	23.1	23.1	23.1	23.1	23.1	23.2	23.1
17-Jun-01	21	15:15-15:55	8	23.3	23.1	23	23.1	23.1	23	23.1	23.2	23
18-Jun-01	22	6:15-8:30	4	22.7	22.8	22.7	22.8	22.8	22.6	22.6	22.8	22.6
18-Jun-01	22	6:15-8:30	5	22.8	22.8	22.7	22.8	22.8	22.5	22.5	22.8	22.6
18-Jun-01	22	15:30-16:10	2	23.1	23.1	22.9	23.1	23.1	22.9	22.9	23.1	22.8
18-Jun-01	22	15:30-16:10	4	23.1	23.1	23	23.1	23.1	22.8	22.9	23.1	22.8
19-Jun-01	23	6:30-7:30	4	22.7	22.8	22.6	22.7	22.7	22.6	22.5	22.7	22.5
19-Jun-01	23	6:30-7:30	7	22.7	22.8	22.6	22.7	22.8	22.5	22.5	22.7	22.5
19-Jun-01	23	15:00-15:45	3	23.2	23.1	23	23.1	23.1	23	23	23.2	23
19-Jun-01	23	15:00-15:45	4	23.1	23.1	23.1	23.1	23.1	23	23	23.2	23

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J	K	L	M	N	O	P	Q
				25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
11-Jun-01	15	17:00-17:40	3	23.3	23.5	23.2	23.3	23.3	23.3	23.3	23.3
11-Jun-01	15	17:00-17:40	4	23.3	23.5	23.1	23.3	23.3	23.3	23.3	23.3
12-Jun-01	16	5:45-7:30	1	22.8	22.8	22.8	22.8	22.7	22.8	22.6	22.8
12-Jun-01	16	5:45-7:30	4	22.8	22.8	22.8	22.8	22.7	22.8	22.7	22.8
12-Jun-01	16	15;05-15:33	4	23.2	23.2	23.1	23.2	23	23.2	23.1	23.1
12-Jun-01	16	15;05-15:33	5	23.2	23.2	23.1	23.2	23.1	23.2	23.1	23.1
13-Jun-01	17	6;15-7:45	4	22.7	22.9	22.6	22.6	22.6	22.8	22.7	22.7
13-Jun-01	17	15:15-16:00	6	22.7	22.9	22.6	22.7	22.6	22.7	22.7	22.6
13-Jun-01	17	15:15-16:00	4	23	23.1	22.9	22.9	22.7	23	22.9	22.8
13-Jun-01	17	15:15-16:00	8	22.9	23.1	22.9	23	22.8	23	22.9	22.7
14-Jun-01	18	7:45-8:20	4	22.7	22.9	22.7	22.7	22.5	22.8	22.7	22.6
14-Jun-01	18	7:45-8:20	5	22.7	22.9	22.7	22.9	22.5	22.8	22.7	22.5
14-Jun-01	18	15:00-15:30	2	23.3	23.3	23.1	23.3	23.1	23.3	23.2	23.1
14-Jun-01	18	15:00-15:30	4	23.3	23.3	23.1	23.3	23.1	23.3	23.2	23.1
15-Jun-01	19	8:05-8:35	4	22.8	23.1	22.7	22.8	22.7	23	22.8	22.8
15-Jun-01	19	8:05-8:35	7	22.8	23.1	22.8	23	22.7	23	22.9	22.7
15-Jun-01	19	15:00-15:45	3	23.1	23.3	23	23.2	23	23.2	23.2	23.1
15-Jun-01	19	15:00-15:45	4	23.2	23.3	23.1	23.2	23	23.2	23.2	23.1
16-Jun-01	20	9:10-11:10	1	22.7	23	22.8	22.8	22.6	22.9	22.8	22.7
16-Jun-01	20	9:10-11:10	4	22.7	23	22.8	22.8	22.6	22.9	22.8	22.7
16-Jun-01	20	15:20-16:10	2	23	23.1	22.8	23	23	23.1	23	23
16-Jun-01	20	15:20-16:10	4	23	23.1	23	23	23	23.1	23	23
17-Jun-01	21	9:55-10:20	4	22.7	22.8	22.7	22.8	22.6	22.8	22.7	22.7
17-Jun-01	21	9:55-10:20	6	22.7	22.9	22.7	22.9	22.7	22.8	22.8	22.7
17-Jun-01	21	15:15-15:55	4	23.1	23.2	23	23.1	23	23	23.1	23
17-Jun-01	21	15:15-15:55	8	23.2	23.2	23	23.1	23	23.1	23.1	23
18-Jun-01	22	6:15-8:30	4	22.6	22.7	22.6	22.6	22.6	22.7	22.6	22.7
18-Jun-01	22	6:15-8:30	5	22.6	22.7	22.6	22.7	22.6	22.7	22.7	22.7
18-Jun-01	22	15:30-16:10	2	22.8	23.1	22.9	23	22.9	23.1	22.8	23
18-Jun-01	22	15:30-16:10	4	22.7	23.1	23	23	22.8	23	22.8	22.9
19-Jun-01	23	6:30-7:30	4	22.4	22.6	22.5	22.5	22.5	22.7	22.4	22.6
19-Jun-01	23	6:30-7:30	7	22.5	22.7	22.5	22.6	22.5	22.7	22.5	22.5
19-Jun-01	23	15:00-15:45	3	23	23.1	23.1	23.1	23.1	23.1	23	23
19-Jun-01	23	15:00-15:45	4	23	23.2	23.1	23.1	23	23.2	23	23.1

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
20-Jun-01	24	6:00-8:05	1	23.1	23	23.1	23	23.1	23	23	23.1	23
20-Jun-01	24	6:00-8:05	4	23	23.1	23	23	23.1	23	22.9	23.1	23
20-Jun-01	24	15:30-16:00	4	23.7	23.6	23.6	23.6	23.1	23.5	23.6	23.5	23.6
20-Jun-01	24	15:30-16:00	6	23.7	23.6	23.6	23.6	23.1	23.5	23.6	23.5	23.6
21-Jun-01	25	8:45-9:25	4	23	23	22.8	22.9	22.9	22.8	22.8	23	22.7
21-Jun-01	25	8:45-9:25	6	23	23	22.8	23	23	22.8	22.8	23	22.8
21-Jun-01	25	15:30-16:00	4	23.2	23.2	23.1	23.1	23.1	23.1	23	23.2	23
21-Jun-01	25	15:30-16:00	8	23.3	23.2	23.1	23.2	23.1	23.1	23.1	23.2	23
22-Jun-01	26	7:15-7:55	4	23.2	23.1	23	23.1	23.1	23.1	23.1	23.3	23
22-Jun-01	26	7:15-7:55	5	23.2	23.1	23.1	23.2	23.2	23.1	23.1	23.2	23
22-Jun-01	26	15:10-15:40	2	23.2	23.2	23	23.1	23.2	22.8	23	23.2	22.9
22-Jun-01	26	15:10-15:40	4	23.2	23.2	23	23.1	23.2	22.8	23	23.2	23
23-Jun-01	27	7:00-8:05	4	22.7	23	22.8	22.7	23	22.6	22.6	22.8	22.7
23-Jun-01	27	7:00-8:05	7	22.7	23	22.7	22.8	23	22.7	22.6	22.8	22.6
23-Jun-01	27	16:30-17:00	3	23.3	23.3	23.2	23.2	23.2	23.1	23.2	23.3	23.1
23-Jun-01	27	16:30-17:00	4	23.3	23.3	23.2	23.2	23.2	23.1	23.1	23.3	23.1
24-Jun-01	28	8:12	1	23.2	23.1	23.1	23.1	23.1	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	2	23.3	23.2	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	3	23.2	23.1	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	4	23.2	23.2	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	5	23.2	23.1	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	6	23.3	23.1	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	7	23.3	23.1	23.1	23.1	23.2	23.1	23.1	23.2	23.1
24-Jun-01	28	8:12	8	23.3	23.2	23.1	23.1	23.2	23.1	23.1	23.2	23.1
		Average		**23.1**	**23.0**	**23.0**	**23.0**	**23.0**	**22.9**	**22.9**	**23.1**	**22.9**
		Minimum		22.3	22.3	22.3	22.2	22.2	22.4	22.2	22.2	22.3
		Maximum		24.1	24.2	23.6	24.1	23.9	23.5	23.6	24.2	23.6

Appendix Table 10 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
20-Jun-01	24	6:00-8:05	1	23	23	23	22.9	23	23	22.8	22.9
20-Jun-01	24	6:00-8:05	4	23	23.1	23	22.9	22.9	23	22.9	23
20-Jun-01	24	15:30-16:00	4	23.6	23.6	23.6	23.6	23.7	23.6	23.5	23.6
20-Jun-01	24	15:30-16:00	6	23.6	23.6	23.6	23.6	23.7	23.6	23.6	23.6
21-Jun-01	25	8:45-9:25	4	22.9	23	23	22.9	22.8	23	22.9	22.8
21-Jun-01	25	8:45-9:25	6	22.9	23	22.9	23	22.8	23	22.9	22.8
21-Jun-01	25	15:30-16:00	4	23.1	23.2	23	23.1	22.9	23.2	23.2	23
21-Jun-01	25	15:30-16:00	8	23.1	23.2	23	23.1	23	23.1	23.2	23
22-Jun-01	26	7:15-7:55	4	23.1	23.3	23.1	23.1	23	23.2	23.1	23.1
22-Jun-01	26	7:15-7:55	5	23.1	23.2	23.1	23.1	23	23.2	23.2	23.1
22-Jun-01	26	15:10-15:40	2	23.1	23.2	22.8	23.1	23.1	23.2	23	23.1
22-Jun-01	26	15:10-15:40	4	23.1	23.2	22.9	23	23.1	23.1	23	23
23-Jun-01	27	7:00-8:05	4	22.5	22.7	22.7	22.7	22.7	22.9	22.5	22.6
23-Jun-01	27	7:00-8:05	7	22.5	22.7	22.8	22.7	22.7	23	22.5	22.6
23-Jun-01	27	16:30-17:00	3	23.1	23.2	23.1	23.1	23.1	23.2	23.2	23.2
23-Jun-01	27	16:30-17:00	4	23.1	23.2	23.2	23.1	23.2	23.2	23.2	23.2
24-Jun-01	28	8:12	1	23.1	23.1	23.1	23.1	23	23.2	23.2	23.1
24-Jun-01	28	8:12	2	23.1	23.2	23.1	23.1	23	23.2	23.2	23.1
24-Jun-01	28	8:12	3	23.1	23.1	23.2	23.1	23.1	23.3	23.2	23.1
24-Jun-01	28	8:12	4	23.2	23.2	23.1	23.1	23	23.2	23.2	23.1
24-Jun-01	28	8:12	5	23.1	23.2	23.1	23.1	23	23.2	23.2	23.1
24-Jun-01	28	8:12	6	23.2	23.2	23.1	23.1	23.1	23.2	23.2	23.1
24-Jun-01	28	8:12	7	23.1	23.2	23.1	23.1	23.1	23.2	23.2	23.1
24-Jun-01	28	8:12	8	23.1	23.2	23.1	23.1	23.1	23.2	23.2	23.1
		Average		**22.9**	**23.1**	**23.0**	**23.0**	**22.9**	**23.0**	**22.9**	**22.9**
		Minimum		22.1	22.2	22.4	22.2	22.2	22.3	22.0	22.3
		Maximum		24.1	24.1	23.6	24.2	23.8	23.9	24.0	23.6

Appendix Table 11. Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	1	7.7	7.5	7.5	6.3	5.9	7.3	7.2	5.5	4.4
27-May-01	0	10:45-13:31	2	7.8	7.5	6	6	5	7.4	4.8	4.9	4.3
27-May-01	0	10:45-13:32	3	7.7	7.5	7.4	5.1	5.7	7.4	6	7.1	5.4
27-May-01	0	10:45-13:33	4	7.7	7.5	6.4	5.1	4.8	7.4	4.8	7.3	4.4
27-May-01	0	10:45-13:34	5	7.7	7.5	7.4	5.6	6.9	5.3	7.2	6.4	6.6
27-May-01	0	10:45-13:35	6	7.7	7.5	7.4	5.4	4.8	5.9	7.4	5	7.3
27-May-01	0	10:45-13:36	7	7.7	7.5	6.4	6.8	7.2	5.9	5.7	4.4	7.4
27-May-01	0	10:45-13:37	8	7.7	7.6	7	5.9	6.4	7.2	7	5.9	7
28-May-01	1	8:00-8:30	4	8.3	7.9	7.8	7.7	5.8	7.7	4.8	7.7	5.4
28-May-01	1	8:00-8:30	6	8.1	7.5	7.9	7.7	7.6	7.7	7.7	7.7	7.6
28-May-01	1	8:00-8:30	4	7.6	6.5	6.8	7.4	6.2	6.8	4.9	7.1	6.1
28-May-01	1	8:00-8:30	8	6.9	6.2	7.5	6	7.1	7.5	6.8	7.1	6.8
29-May-01	2	07:40-08:15	4	7.7	7.2	7.3	7.3	7.3	7	6.9	7.2	7.2
29-May-01	2	07:40-08:15	5	7.5	7.3	7.3	7.2	7.3	7.1	7.1	7.2	7.2
29-May-01	2	15:30-16:05	2	7.6	6.9	7.2	7.2	7.3	7	6.8	7	7.2
29-May-01	2	15:30-16:05	4	7.2	6.9	7.1	7.3	7.3	6.9	6.1	7.2	7.1
30-May-01	3	07:20-08:40	4	7.7	7	7.4	7.4	7.4	7.2	7.1	7.4	7.2
30-May-01	3	07:20-08:40	7	7.5	7.5	7.5	7.3	7.4	7.4	7.2	7.4	7.3
30-May-01	3	15:30-16:15	3	7.5	6.9	6.8	7.1	7.1	6.9	7.1	7.2	7
30-May-01	3	15:30-16:15	4	7.2	7	6.9	6.7	7.4	7.1	6.8	7	7
31-May-01	4	08:00-08:45	1	7.8	7.5	7.6	7.2	7.2	7.6	7.5	7.5	7.2
31-May-01	4	08:00-08:45	4	7.8	6.9	7.5	7.5	7.6	7.3	7.1	7.5	6.9
31-May-01	4	15:00-15:33	3	7.8	7	7.2	7.2	7	7	7	7.3	6.8
31-May-01	4	15:00-15:33	4	7.8	6.9	6.6	7.1	7.2	7.1	6.8	7.1	6.6
1-Jun-01	5	07:30-08:15	4	7.4	6.6	7.3	7	7.2	7.2	7.1	7.4	6.8
1-Jun-01	5	07:30-08:15	6	7.5	6.4	7.4	6.7	7	7	7	7.3	6.9
1-Jun-01	5	15:00-15:33	4	7.3	6.7	7.1	7.1	7.2	6.9	6.8	7.2	6.8
1-Jun-01	5	15:00-15:33	8	7.4	6.7	7.1	6.9	7.2	6.9	6.9	7.1	7.1
2-Jun-01	6	08:10-09:30	4	7.5	7.1	7.3	7.4	7.4	7.4	7.2	7.3	7.3
2-Jun-01	6	08:10-09:30	5	7.6	7.3	7.5	6.9	7.3	7.4	7.3	7.1	7.2
2-Jun-01	6	15:15-16:00	2	7.5	6.6	7.2	6.9	7	6.4	7	6.9	7.3
2-Jun-01	6	15:15-16:00	4	7.2	6.6	7	7.2	6.8	7	7.5	7.5	6.9
3-Jun-01	7	9:05	4	7.6	7.2	6.6	6.8	6.8	5.9	6.6	6.8	6.6
3-Jun-01	7	9:05	7	7.9	7.6	6.7	6.7	6.9	6.6	6.5	6.5	6.8
3-Jun-01	7	15:30	3	6.1	5.2	6	5.2	6.2	6.2	5.6	6.2	6.2
3-Jun-01	7	15:30	4	6.3	5.2	6.1	5.8	6.2	5.7	5.4	6.2	5.4
4-Jun-01	8	07:15-08:30	4	6.2	6.1	6.2	6.1	6.2	6.1	6.1	6.2	6

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J	K	L	M	N	O	P	Q
				25% Sand	25% Wood	50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood
27-May-01	0	10:45-13:30	1	4	3.4	5.1	7	4.6	4.9	4.4	4.3
27-May-01	0	10:45-13:31	2	4	4.6	5.7	7.3	7.2	5.4	5.2	5.3
27-May-01	0	10:45-13:32	3	4.4	7.2	4.6	7.3	5.9	4.9	4.5	5
27-May-01	0	10:45-13:33	4	4.5	4.7	3.7	7.2	7.1	4.2	3.8	4.5
27-May-01	0	10:45-13:34	5	4	3.6	3.9	6.8	7.1	4.8	6.1	7.2
27-May-01	0	10:45-13:35	6	6.5	3.8	4	7	4.7	4.8	6	7.2
27-May-01	0	10:45-13:36	7	7.3	4.1	4.4	7.3	7.3	7.2	3.9	4.8
27-May-01	0	10:45-13:37	8	6.2	6.9	5	3.6	7.3	6.8	4.4	4.8
28-May-01	1	8:00-8:30	4	6	5.3	6.1	7.6	7.6	4.9	6.3	6.6
28-May-01	1	8:00-8:30	6	7.2	6.6	5.6	7.6	7.6	4.9	7	7.4
28-May-01	1	8:00-8:30	4	6	5	7	7.2	6.6	5.7	6.4	6.9
28-May-01	1	8:00-8:30	8	6.6	7.1	6.9	4.7	6.5	6.6	6.7	6.8
29-May-01	2	07:40-08:15	4	7.2	7.1	6.9	7.2	7	6.8	6.4	7.1
29-May-01	2	07:40-08:15	5	7.2	7.2	6.9	7.1	6.6	6	6.9	7.1
29-May-01	2	15:30-16:05	2	6.9	6.7	6.4	7.2	7.1	6.9	6.7	6.9
29-May-01	2	15:30-16:05	4	6.8	7.1	6.8	7.2	7	7.1	6.5	7
30-May-01	3	07:20-08:40	4	7.1	7.3	7.3	7.2	7.3	7.1	6.2	7.2
30-May-01	3	07:20-08:40	7	7.4	7.2	7.2	7.4	7.4	7.3	6.7	6.7
30-May-01	3	15:30-16:15	3	7	7.2	7.1	7.2	6.6	7.1	6.6	7
30-May-01	3	15:30-16:15	4	7	7	7.2	7.3	7.1	6.8	6.5	7
31-May-01	4	08:00-08:45	1	7.1	6.8	5.8	6.2	7.1	6.2	5.7	6.1
31-May-01	4	08:00-08:45	4	7.1	6.3	5.9	6.3	7.2	6.1	5.4	6.1
31-May-01	4	15:00-15:33	3	6.7	6.6	7.2	7	6.6	6.7	5.9	7.2
31-May-01	4	15:00-15:33	4	6.9	6.4	7	7	6.4	6.3	5.5	7.1
1-Jun-01	5	07:30-08:15	4	7.1	6.8	7.2	7.2	7.2	7	6.2	7.2
1-Jun-01	5	07:30-08:15	6	7.1	7.3	7.2	7.2	7.2	6.9	7.1	7.2
1-Jun-01	5	15:00-15:33	4	7	6.9	7	7.1	6.7	6.7	6.4	6.9
1-Jun-01	5	15:00-15:33	8	7.1	7	7.1	6.6	7.2	6.8	6.5	7
2-Jun-01	6	08:10-09:30	4	7.6	6.9	7.3	7.2	6.9	6.6	6.3	7.1
2-Jun-01	6	08:10-09:30	5	7.4	7.3	7.2	7.3	6.4	7	7.1	7.1
2-Jun-01	6	15:15-16:00	2	7.6	6.6	7	7.1	7.1	6.8	6.9	7.3
2-Jun-01	6	15:15-16:00	4	7.4	6.9	7.2	7.2	7	6.9	6.7	7.3
3-Jun-01	7	9:05	4	6.8	6	6.8	6.6	6.4	6.5	6	6.7
3-Jun-01	7	9:05	7	6.9	6.9	6.8	6.7	6.7	6.6	6.4	6.7
3-Jun-01	7	15:30	3	5.7	5.8	6.1	6.2	6	6.1	4.8	6.1
3-Jun-01	7	15:30	4	5.5	5.5	5.6	6.1	6	5.6	4.8	5.8
4-Jun-01	8	07:15-08:30	4	6	5.9	6	6.2	5.9	5.9	5.5	6

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
4-Jun-01	8	07:15-08:30	6	6.4	5.4	6.3	6	6.3	6.2	6.2	6.2	6.1
4-Jun-01	8	15:00-15:50	4	6.4	5.5	6.1	5.8	6.2	6	5.6	5.6	5.8
4-Jun-01	8	15:00-15:50	8	6.1	5.4	6.2	5.9	6	5.8	5.8	5.4	6.1
5-Jun-01	9	07:15-08:20	4	6.8	6.1	6.4	6.2	6.3	6.3	6.2	6.3	6.1
5-Jun-01	9	07:15-08:20	7	6.6	6.3	6.3	6.2	6.4	6.3	6.1	6.2	6.3
5-Jun-01	9	15:20-15:45	1	6	5.6	6	6.3	6.1	5.7	6.1	6.1	6.1
5-Jun-01	9	15:20-15:45	4	6.4	5.7	6.1	6	6.1	6.1	5.7	6.2	5.8
6-Jun-01	10	07:15-09:00	4	6.3	5.2	6	5.9	5.6	5.5	5.5	5.5	5.5
6-Jun-01	10	07:15-09:00	5	6.2	5.6	5.9	5.4	5.6	5.7	5.5	5.3	5.8
6-Jun-01	10	16:00	2	5.8	4.5	6	5.4	6	5.8	5.9	5.7	5.9
6-Jun-01	10	16:00	4	6	5.1	5.9	5.9	5.9	5.6	5.3	5.8	5.6
7-Jun-01	11	07:50-08:15	4	6.5	5.1	6	6.1	6.1	5.9	5.6	6	5.8
7-Jun-01	11	07:50-08:15	7	6.2	5.8	6	6	6.1	5.8	6	5.6	6.1
7-Jun-01	11	16:15-17:00	3	7.5	6.2	6.6	6.7	6.6	6.2	7	6.6	7
7-Jun-01	11	16:15-17:00	4	7.5	5.7	7	6.9	7	6.8	6.5	7	6
8-Jun-01	12	07:45-08:30	1	7.3	6.2	7.3	7.3	7.3	7.1	7.1	7.2	7.1
8-Jun-01	12	07:45-08:30	4	7.4	5.8	7.3	7.2	7.3	7.2	6.8	7.2	7.2
8-Jun-01	12	18:10-18:40	4	7.4	4.8	7.1	6.5	6.6	7	6.3	7	5.8
8-Jun-01	12	18:10-18:40	5	7.2	4.8	7.2	6.8	6.7	7.1	7.1	5.5	6.9
9-Jun-01	13	09:20-10:40	4	7.1	4.2	7	6.6	7	6.9	6.4	6.9	6.2
9-Jun-01	13	09:20-10:40	6	7.1	3.4	7.1	6.9	6.8	6.9	6.7	7	6.4
9-Jun-01	13	17:30	4									
9-Jun-01	13	17:30	8									
10-Jun-01	14	9:30	4	6.9	3.2	6.8	6.6	6.7	6.8	6	6.4	6.6
10-Jun-01	14	9:30	5	6.8	3.5	6.9	6.7	6.7	6.8	6.4	6.6	6.4
10-Jun-01	14	17:00	2	7	2.1	6.7	6.6	6	6.6	6.4	6.5	6.8
10-Jun-01	14	17:00	4	6.8	3	6.8	6.6	6.7	6.6	6	6.8	5
11-Jun-01	15	08:05-10:55	4	7	5.3	7	6.9	7	6.8	6.8	6.9	6.9
11-Jun-01	15	08:05-10:55	7	7	5.8	6.9	7	6.5	6.9	7	6.8	6.9
11-Jun-01	15	17:00-17:40	3	6.4	6.4	6.2	5.7	5.6	5	5.6	6.6	6.5
11-Jun-01	15	17:00-17:40	4	6.6	3	6.7	5.6	5.6	6.6	5.5	6.7	6.4
12-Jun-01	16	05:45-07:30	1	7.1	6.3	6.9	6.8	6.7	6.6	6.6	6.7	6.8
12-Jun-01	16	05:45-07:30	4	7	6.4	7	6.7	6.7	6.7	6.6	6.7	6.7
12-Jun-01	16	15:05-15:33	4	5.8	3.6	5.7	6.2	5.9	6.2	5.4	5.5	5.1
12-Jun-01	16	15:05-15:33	5	6.3	4	6.3	5.4	5.9	6.1	5.6	5.8	6.1
13-Jun-01	17	06:15-07:45	4	6.6	5.5	6.3	6.1	6.1	6.2	6.1	6.1	6
13-Jun-01	17	06:15-07:45	6	6.4	5.4	6.2	6	6.1	6	6.1	6.2	6

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
4-Jun-01	8	07:15-08:30	6	6.1	6.2	6	6.1	6.1	5.5	6.1	6.1
4-Jun-01	8	15:00-15:50	4	5.7	6	5.7	5.8	5.6	5.7	4.9	5.8
4-Jun-01	8	15:00-15:50	8	5.6	5.7	6.1	5.6	5.8	5	5.3	5.7
5-Jun-01	9	07:15-08:20	4	6.3	6	6.1	6.2	5.7	5.8	5.5	6.1
5-Jun-01	9	07:15-08:20	7	6.3	6.3	6.2	6.2	6.2	5.8	6.1	5.8
5-Jun-01	9	15:20-15:45	1	6.1	5.8	5.8	6	6	5.7	5.9	5.9
5-Jun-01	9	15:20-15:45	4	5.7	5.7	5.8	6	5.8	5.6	5.1	5.9
6-Jun-01	10	07:15-09:00	4	5.6	5.8	5.8	5.9	5.5	5.7	5.3	5.9
6-Jun-01	10	07:15-09:00	5	5.9	5.9	5.9	5.9	4.7	5.8	5.9	5.9
6-Jun-01	10	16:00	2	6	5.9	6	6	5.7	5.5	5.8	5.9
6-Jun-01	10	16:00	4	5.6	5.9	6	5.9	5	5.5	5.5	5.5
7-Jun-01	11	07:50-08:15	4	5.8	5.9	5.8	5.8	5.2	5.5	5.7	5.9
7-Jun-01	11	07:50-08:15	7	5.9	6	5.9	5.9	5.8	5.6	5.7	5.9
7-Jun-01	11	16:15-17:00	3	6.7	7.1	6.9	6.9	5.1	6.8	5.8	6.3
7-Jun-01	11	16:15-17:00	4	6.9	6.2	6.4	6.9	6.2	6.1	5.8	6.3
8-Jun-01	12	07:45-08:30	1	7.2	7.1	6.8	7	7.1	6.6	6.6	6.9
8-Jun-01	12	07:45-08:30	4	7.3	7.1	6.7	7	6.9	6.7	6.4	7
8-Jun-01	12	18:10-18:40	4	6.4	5.5	6.2	5.6	5.4	6.2	5	6
8-Jun-01	12	18:10-18:40	5	7.1	6.6	6.7	6.9	5.1	6	6.7	6.2
9-Jun-01	13	09:20-10:40	4	6.2	5.9	6.7	6.5	5.4	6	5.8	6.5
9-Jun-01	13	09:20-10:40	6	6.2	6.8	6.1	6.5	6	4.5	6.3	6.7
9-Jun-01	13	17:30	4								
9-Jun-01	13	17:30	8								
10-Jun-01	14	9:30	4	6.3	6	6.5	6.1	5.6	6	4.8	6.5
10-Jun-01	14	9:30	5	6.7	6.3	6.2	6.7	4.9	5.9	5.9	6.5
10-Jun-01	14	17:00	2	5.5	5.3	6.3	6.7	5.2	5.5	6.7	6.7
10-Jun-01	14	17:00	4	5.6	6.6	6.5	6.6	4.4	5.6	5.8	6.3
11-Jun-01	15	08:05-10:55	4	6.2	6.7	6.7	6.6	5.2	6.6	6.2	6.8
11-Jun-01	15	08:05-10:55	7	6.8	6.8	6.6	6.9	6.7	5.2	6.8	6.4
11-Jun-01	15	17:00-17:40	3	5.6	6.6	6	6.6	5	5.8	4.8	6.2
11-Jun-01	15	17:00-17:40	4	5.9	5.5	6.1	5.5	4.7	5.5	5.8	5.9
12-Jun-01	16	05:45-07:30	1	6.7	6.5	6	6.7	6.7	6.5	5.4	6.3
12-Jun-01	16	05:45-07:30	4	6.7	6.6	6.6	6.6	4.6	6.3	4.7	6.5
12-Jun-01	16	15:05-15:33	4	5.7	5.2	5.3	5.3	4.1	5.1	4.8	5.3
12-Jun-01	16	15:05-15:33	5	6.1	6.1	4.9	6	3.9	5.1	4.9	4.8
13-Jun-01	17	06:15-07:45	4	5.7	6	6.1	5.7	5.2	5.8	4.6	6
13-Jun-01	17	06:15-07:45	6	6.1	6.1	6.2	6.2	6.1	5	5.8	6

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
13-Jun-01	17	15:15-16:00	4	6	3.9	6	6	5.8	6	5.9	5.9	5.9
13-Jun-01	17	15:15-16:00	8	5.9	2	5.7	5.8	5.9	5.8	6	6	5.3
14-Jun-01	18	07:45-08:20	4	6.2	4.4	6.1	6	5.9	6	6.1	5.9	5.9
14-Jun-01	18	07:45-08:20	5	6.1	3.6	6.1	6.1	5.7	6.1	6.1	5.6	6
14-Jun-01	18	15:00-15:20	2	7.6	2.8	7.3	7.3	7	7.3	7.3	6.9	7.3
14-Jun-01	18	15:00-15:20	4	7.2	3.1	7.3	7.3	7.1	7.3	7.2	7.1	7.1
15-Jun-01	19	08:05-08:35	4	7.5	3.8	7.2	7	6.4	7	7	7.2	6.9
15-Jun-01	19	08:05-08:35	7	7.5	4.8	7.3	6.8	7	7.2	7.2	6.7	7
15-Jun-01	19	15:00-15:45	3	7	5.8	6.5	6.2	6.1	7	6.8	6.6	6.8
15-Jun-01	19	15:00-15:45	4	6.9	3.8	6.6	6	6.2	6.6	6.3	6.6	6
16-Jun-01	20	09:10-11:10	1	7.3	6.6	7.1	6.9	7	6.9	6.9	6.9	6.7
16-Jun-01	20	09:10-11:10	4	7.1	4	7.1	7.1	6.8	6.9	6.7	7	6.5
16-Jun-01	20	15:30-16:10	2	7.1	4.7	6.7	6.6	6.4	6.8	6.8	6.6	6.6
16-Jun-01	20	15:30-16:10	4	6.9	4.6	6.6	6.6	6.4	6.7	6.7	6.6	6.6
17-Jun-01	21	09:55-10:10	4	7.1	5.3	7	6.9	6.7	6.8	6.4	6.8	6.7
17-Jun-01	21	09:55-10:10	6	7.1	5.7	6.9	6.4	6.7	6.9	6.8	6.8	6.8
17-Jun-01	21	15:15-15:45	4	6.9	5.1	6.8	6.4	6.5	6.6	6.7	6.9	6.8
17-Jun-01	21	15:15-15:45	8	6.9	5.3	6.9	6.1	6.3	6.3	6.5	6.8	6.4
18-Jun-01	22	06:15-08:30	4	7.2	5.2	6.8	6.8	6.8	6.8	6.7	6.6	6.6
18-Jun-01	22	06:15-08:30	5	7	5	6.8	6.7	6.8	6.4	6.8	6.4	6.6
18-Jun-01	22	15:30-16:10	2	7.1	4.6	6.7	6.1	6.7	6.7	6.7	6.5	6.6
18-Jun-01	22	15:30-16:10	4	7	4.4	6.7	6.6	6.7	6.6	6.6	6.6	6.6
19-Jun-01	23	06:30-07:30	4	7.2	5	6.8	6.8	6.7	6.8	6.7	6.8	6.8
19-Jun-01	23	06:30-07:30	7	7	4.5	7	6.8	6.8	6.8	6.9	6.7	6.8
19-Jun-01	23	15:00-15:15	3	7	5.8	6.4	6.7	6.6	6.6	6.7	6.8	6.9
19-Jun-01	23	15:00-15:15	4	6.9	5	6.6	6.7	6.2	6.4	6.4	6.9	6.9
20-Jun-01	24	06:00-08:05	1	6.9	4.3	6.7	6.7	6.6	6.9	6.9	6.7	6.8
20-Jun-01	24	06:00-08:05	4	6.9	4.7	6.7	6.8	6.5	6.9	6.4	6.9	6.7
20-Jun-01	24	15:30-16:00	4	6.4	6.1	6.7	6.6	6.5	6.7	7	6.9	6.1
20-Jun-01	24	15:30-16:00	6	6.3	5.4	5.6	6.8	6.7	6.5	6.9	6.5	6.6
21-Jun-01	25	08:45-09:25	4	7.1	5.4	6.5	6.4	6.5	6.8	6.7	6.8	6.6
21-Jun-01	25	08:45-09:25	6	7	6.2	6.8	6.3	6.5	6.7	6.9	6.7	6.8
21-Jun-01	25	15:30-16:00	4	7.2	4.2	6.9	6.5	7	6.9	6.9	6.9	6.9
21-Jun-01	25	15:30-16:00	8	7.2	4.9	7	6.7	6.9	7	7	6.9	6.9
22-Jun-01	26	07:15-07:55	4	7.2	4.2	6.9	6.7	6.4	6.7	6.8	6.7	6.7
22-Jun-01	26	07:15-07:55	5	7.2	3.6	7	6.5	6.6	6.6	6.8	6.4	6.7
22-Jun-01	26	15:10-15:40	2	7.4	5.3	6.8	6.9	6.6	6.8	6.7	6.7	6.9

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
13-Jun-01	17	15:15-16:00	4	5.9	5.7	5.8	5.5	4.4	5	4.2	5.7
13-Jun-01	17	15:15-16:00	8	5.9	5.2	6.1	5.7	5.9	3.4	5.6	5.4
14-Jun-01	18	07:45-08:20	4	5.9	5.6	5.9	5.7	5.6	5.7	4.8	5.8
14-Jun-01	18	07:45-08:20	5	6	6	6	6	4.7	5.6	5.7	5.4
14-Jun-01	18	15:00-15:20	2	6.9	7.2	6.9	7	7.1	6.9	6.8	7
14-Jun-01	18	15:00-15:20	4	6.5	6.8	7.2	7.1	6.4	6.8	5.5	7
15-Jun-01	19	08:05-08:35	4	6.9	7.1	7.1	6.9	6.1	6.9	6	7
15-Jun-01	19	08:05-08:35	7	6.9	6.9	7	7.1	6.8	6.9	6.9	6.3
15-Jun-01	19	15:00-15:45	3	6.1	6.3	6.5	6.6	5.9	6.2	5.6	6.1
15-Jun-01	19	15:00-15:45	4	6.2	6.4	6.1	6.5	5.7	6	5.1	5.7
16-Jun-01	20	09:10-11:10	1	6.6	6.5	6.6	6.6	6.1	6.5	6.4	6.2
16-Jun-01	20	09:10-11:10	4	6.7	6.3	6.6	6.7	6.5	6.5	5.6	6.2
16-Jun-01	20	15:30-16:10	2	6.5	6.3	6.5	6.5	6.5	6.5	6.4	6.7
16-Jun-01	20	15:30-16:10	4	6.2	6.6	6.8	6.4	6.1	6.5	5.6	6.5
17-Jun-01	21	09:55-10:10	4	6.4	6.7	6.8	6.7	6.5	6.5	5.8	6.7
17-Jun-01	21	09:55-10:10	6	6.7	6.7	6.8	6.6	6.7	5.9	6.7	6.6
17-Jun-01	21	15:15-15:45	4	6	6.6	6.8	6.8	6	5.9	5.6	6.5
17-Jun-01	21	15:15-15:45	8	6.7	6.8	6.8	6.7	6.7	5.3	6.1	6.2
18-Jun-01	22	06:15-08:30	4	6.1	6.3	6.6	6.7	6.2	6.4	5.9	6.5
18-Jun-01	22	06:15-08:30	5	6.6	6.6	6.7	6.8	5.1	6.5	6.5	6.4
18-Jun-01	22	15:30-16:10	2	6.5	6.3	6.4	6.4	6.5	6.3	6.3	6.5
18-Jun-01	22	15:30-16:10	4	6.2	6.3	6.5	6.4	6.2	6.2	5.7	6.4
19-Jun-01	23	06:30-07:30	4	6.3	6.6	6.7	6.7	6.3	6.6	5.9	6.6
19-Jun-01	23	06:30-07:30	7	6.7	6.8	6.9	6.8	6.7	6.7	6.7	6.6
19-Jun-01	23	15:00-15:15	3	6.3	6.5	6.8	6.9	6.9	6.7	6.2	6.3
19-Jun-01	23	15:00-15:15	4	6.7	6.4	6.8	6.8	6.2	6.9	5.8	6.6
20-Jun-01	24	06:00-08:05	1	6.6	6.5	6.6	6.7	6.7	6.5	5.5	6.6
20-Jun-01	24	06:00-08:05	4	6.6	6.7	6.6	6.7	6.1	6.4	5.6	6.4
20-Jun-01	24	15:30-16:00	4	6.6	6.5	5.8	6.3	6.5	6.7	5.6	6.2
20-Jun-01	24	15:30-16:00	6	7.8	6.2	6.3	6.4	6.6	6.3	6.1	6
21-Jun-01	25	08:45-09:25	4	6.8	6.5	6.8	6.8	5.6	6.6	6	6.6
21-Jun-01	25	08:45-09:25	6	6.8	6.8	6.8	6.8	6.7	6.1	6	6.7
21-Jun-01	25	15:30-16:00	4	6.8	6.8	6.8	6.7	6	6.6	5.6	6.7
21-Jun-01	25	15:30-16:00	8	6.9	6.8	6.9	6.8	6.8	5.2	6.4	6.6
22-Jun-01	26	07:15-07:55	4	6.2	6.4	6.6	6.6	5.8	6.5	5.6	6.5
22-Jun-01	26	07:15-07:55	5	6.6	6.6	6.6	6.6	5.3	6.2	6.3	6.6
22-Jun-01	26	15:10-15:40	2	6.7	6.6	6.6	6.8	6.8	6.6	6.4	6.2

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
22-Jun-01	26	15:10-15:40	4	7.4	4.3	6.9	6.9	6.6	6.8	6.7	6.7	6.8
23-Jun-01	27	07:00-08:05	4	7.5	5.5	7.4	6.8	6.4	6.8	6.9	6.9	6.9
23-Jun-01	27	07:00-08:05	7	7.6	4.3	6.9	6.8	6.8	6.9	7	6.9	6.8
23-Jun-01	27	16:30-17:00	3	7.2	5.3	6.6	6.7					
23-Jun-01	27	16:30-17:00	4	7.3	5.2	6.9						
24-Jun-01	28	08:12-11:17	1	7.8	5.8	7.4	7.3	7.4	7.3	7.4	7.4	7.4
24-Jun-01	28	08:12-11:17	2	7.9	6.6	7.3	7.4	7.4	7.3	7.3	7.4	7.3
24-Jun-01	28	08:12-11:17	3	8	6.4	7.4	7.3	7.4	7.4	7.1	7.3	7.4
24-Jun-01	28	08:12-11:17	4	7.9	5.4	7.3	7.2	7.4	7.3	7.4	7.2	7.4
24-Jun-01	28	08:12-11:17	5	7.7	4.5	7.4	7.4	7.5	7.4	7.4	7.4	7.4
24-Jun-01	28	08:12-11:17	6	7.8	4.7	7.4	7.3	7.5	7.4	7.3	7.4	7.5
24-Jun-01	28	08:12-11:17	7	7.8	3.2	7.4	7.3	7.3	7.4	7.4	7.4	7.3
24-Jun-01	28	08:12-11:17	8	7.9	4	7.4	7.3	7	7.3	7.2	7.3	7.3
		Average		**7.1**	**5.5**	**6.8**	**6.6**	**6.6**	**6.7**	**6.6**	**6.7**	**6.6**
		Minimum		5.8	2.0	5.6	5.1	4.8	5.0	4.8	4.4	4.3
		Maximum		8.3	7.9	7.9	7.7	7.6	7.7	7.7	7.7	7.6

Appendix Table 11 (continued). Dissolved oxygen (ppm) for 28 day *Hyalella azteca* test (non-uv)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
22-Jun-01	26	15:10-15:40	4	6.6	6.7	6.7	6.7	5.5	6.6	6.4	6.4
23-Jun-01	27	07:00-08:05	4	6.8	6.9	6.8	6.9	5.3	6.7	5.8	6.5
23-Jun-01	27	07:00-08:05	7	6.8	6.9	6.7	6.9	6.6	6.9	6.8	6.6
23-Jun-01	27	16:30-17:00	3								
23-Jun-01	27	16:30-17:00	4								
24-Jun-01	28	08:12-11:17	1	7.4	7.1	7.2	6.6	7.1	7.1	6	7.2
24-Jun-01	28	08:12-11:17	2	7.4	7.3	7.1	6.9	6.2	7.1	6.4	7
24-Jun-01	28	08:12-11:17	3	7.4	7.1	7.3	7.1	7.1	7.1	5.8	7.2
24-Jun-01	28	08:12-11:17	4	7.3	7.1	6.9	6.8	5.6	6.9	5.4	7.2
24-Jun-01	28	08:12-11:17	5	7.4	7.3	7.1	7.1	6.5	7	6.7	7
24-Jun-01	28	08:12-11:17	6	7.3	7.3	7.2	7.2	7.2	6.3	6.1	7.1
24-Jun-01	28	08:12-11:17	7	7.3	7.2	7.2	7.3	7.2	7.1	6.9	7.2
24-Jun-01	28	08:12-11:17	8	7.2	7.2	7.1	7	7.2	5.7	6.6	7
		Average		**6.5**	**6.4**	**6.4**	**6.6**	**6.2**	**6.1**	**5.9**	**6.4**
		Minimum		4.0	3.4	3.7	3.6	3.9	3.4	3.8	4.3
		Maximum		7.8	7.3	7.3	7.6	7.6	7.3	7.1	7.4

Appendix Table 12. Water quality parameters for 28 day *Hyalella azteca* (non-uv)

pH

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	1	8.1	7.47	7.94	7.47	7.31	7.97	7.93	7.75	7.06
27-May-01	0	10:45-13:30	4	8.1	7.56	7.86	7.86	7.25	8.05	7.47	8.01	7.07
27-May-01	0	10:45-13:30	5	8.12	7.24	7.99	7.62	8.01	7.87	7.99	7.84	8.01
27-May-01	0	10:45-13:30	8	8.11	7.47	7.59	7.93	7.46	8.06	7.93	7.39	7.87
30-May-01	3	07:20-08:40	4	8.42	7.6	8	8.05	8.08	8.02	7.91	8.03	8
30-May-01	3	07:20-08:40	7	8.17	7.89	8.06	8.08	8.08	8.06	8.02	8.05	8.05
2-Jun-01	6	08:10-09:30	4	8.12	7.96	8.09	8.12	8.1	8.12	8.02	8.15	8.13
2-Jun-01	6	08:10-09:30	5	8.13	7.86	8.13	7.88	8.13	8.13	8.1	8.07	8.13
4-Jun-01	8	07:15-08:30	4	8.15	7.86	8.03	8.06	8.11	8.07	8.05	8.1	7.99
4-Jun-01	8	07:15-08:30	6	8.13	7.61	8.06	8.1	8.04	8.07	8.06	8.1	8.06
6-Jun-01	10	07:15-09:00	4	8.07	7.84	8	7.93	8.02	8.01	7.92	7.95	7.93
6-Jun-01	10	07:15-09:00	5	8.03	7.56	8.02	7.93	8.01	8.01	7.97	7.86	7.98
9-Jun-01	13	09:20-10:40	4	8.1	6.96	7.9	7.88	8.01	7.89	7.72	7.9	7.62
9-Jun-01	13	09:20-10:40	6	7.97	6.69	7.87	7.85	7.86	7.81	7.81	7.95	7.74
11-Jun-01	15	08:05-10:55	4	8.22	7.31	8.03	8.08	8.07	8.04	8.04	8.04	8.07
11-Jun-01	15	08:05-10:55	7	8.17	7.58	8	8.08	8.06	8.01	8.06	8.06	8.08
13-Jun-01	17	06:15-07:45	4	8.05	7.23	8.05	8.05	8.07	8.08	8.01	8.03	8
13-Jun-01	17	06:15-07:45	6	8.03	7.72	8.01	8.06	7.98	7.97	8.03	8.02	8.02
16-Jun-01	20	09:10-11:10	1	8.21	7.56	7.92	8.06	8.01	8	8.05	7.91	7.99
16-Jun-01	20	09:10-11:10	4	8.12	6.97	7.93	7.96	8.09	8.02	7.96	8.01	7.9
18-Jun-01	22	06:15-08:30	4	8.12	7.53	8.08	8.1	8.14	8.12	8.09	8.1	8.6
18-Jun-01	22	06:15-08:30	5	8.09	7.69	8.07	8.07	8.14	8	8.11	7.98	8.06
20-Jun-01	24	06:00-08:05	1	7.92	7.74	7.98	8.03	8.02	8.05	8.05	7.96	8.01
20-Jun-01	24	06:00-08:05	4	8.06	7.3	7.98	8.03	8.01	8.04	7.88	8.01	7.99
24-Jun-01	28	08:12-11:17	1	8.09	7.45	7.87	7.99	7.98	8	7.97	7.94	7.99
24-Jun-01	28	08:12-11:17	4	8.07	7.45	7.86	7.95	8.02	7.99	7.98	7.96	7.97
24-Jun-01	28	08:12-11:17	5	8.02	7.11	7.92	8	8.03	8	8	7.97	8
24-Jun-01	28	08:12-11:17	8	8.03	7.19	8	8.02	8	8.03	8	7.93	7.95
		Average		**8.10**	**7.48**	**7.97**	**7.97**	**7.97**	**8.02**	**7.97**	**7.97**	**7.94**
		Minimum		7.92	6.69	7.59	7.47	7.25	7.81	7.47	7.39	7.06
		Maximum		8.42	7.96	8.13	8.12	8.14	8.13	8.11	8.15	8.6

Appendix Table 12 (continued). Water quality parameters for 28 day *Hyalella azteca* (non-uv)

pH

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	10:45-13:30	1	7.17	7.21	7.69	7.84	7.09	7.5	7.22	7.17
27-May-01	0	10:45-13:30	4	7.25	7.19	7.4	8.05	7.88	7.01	7.26	6.93
27-May-01	0	10:45-13:30	5	7.65	7.61	7.47	7.93	7.93	7.24	7.97	7.97
27-May-01	0	10:45-13:30	8	7.94	7.7	8	7.09	8.01	7.62	7.12	7.03
30-May-01	3	07:20-08:40	4	7.98	8.05	8.07	8	8.08	8.01	7.7	8.05
30-May-01	3	07:20-08:40	7	8.09	8.05	8.07	8.05	8.07	8.06	7.8	7.86
2-Jun-01	6	08:10-09:30	4	8.16	7.91	8.12	8.15	7.9	7.81	7.68	8
2-Jun-01	6	08:10-09:30	5	8.14	8.13	8.13	8.09	7.7	8	7.96	7.99
4-Jun-01	8	07:15-08:30	4	8.02	7.9	8.09	8.06	8.02	7.94	7.71	7.92
4-Jun-01	8	07:15-08:30	6	8.08	8.1	8.06	8.08	8.05	7.82	8.06	8.02
6-Jun-01	10	07:15-09:00	4	7.99	8.01	7.94	7.97	7.73	7.87	7.65	7.91
6-Jun-01	10	07:15-09:00	5	8.03	8.01	7.97	7.96	7.45	7.94	7.92	7.95
9-Jun-01	13	09:20-10:40	4	7.67	7.55	7.81	7.71	7.4	7.8	7.48	7.77
9-Jun-01	13	09:20-10:40	6	7.64	7.85	7.61	7.76	7.53	7.39	7.71	7.75
11-Jun-01	15	08:05-10:55	4	7.75	8.04	7.9	7.89	7.46	7.93	7.9	7.87
11-Jun-01	15	08:05-10:55	7	8.06	8.05	8	8.03	7.92	7.62	7.98	7.87
13-Jun-01	17	06:15-07:45	4	7.84	7.99	7.99	7.78	7.61	7.94	7.49	7.94
13-Jun-01	17	06:15-07:45	6	8.02	8.02	8.07	7.99	8.02	7.58	7.83	7.91
16-Jun-01	20	09:10-11:10	1	7.84	7.94	7.87	7.8	7.72	7.8	7.65	7.63
16-Jun-01	20	09:10-11:10	4	7.84	7.99	7.9	7.96	7.69	7.76	7.56	7.7
18-Jun-01	22	06:15-08:30	4	8.05	7.98	8.07	8.06	7.83	7.96	7.79	8.02
18-Jun-01	22	06:15-08:30	5	8.04	8.05	8.06	8.07	7.58	8	7.98	7.95
20-Jun-01	24	06:00-08:05	1	7.96	7.99	7.95	7.98	7.97	7.9	7.58	7.93
20-Jun-01	24	06:00-08:05	4	7.95	8.01	7.97	7.96	7.73	7.7	7.61	7.91
24-Jun-01	28	08:12-11:17	1	7.91	7.97	7.97	7.73	7.92	7.9	7.55	7.92
24-Jun-01	28	08:12-11:17	4	7.96	7.99	7.86	7.79	7.42	7.77	7.43	7.87
24-Jun-01	28	08:12-11:17	5	7.94	8	7.92	7.92	7.69	7.87	7.79	7.91
24-Jun-01	28	08:12-11:17	8	7.95	7.95	7.93	7.87	7.97	7.51	7.66	7.86
		Average		**7.89**	**7.90**	**7.92**	**7.91**	**7.76**	**7.76**	**7.68**	**7.81**
		Minimum		7.17	7.19	7.4	7.09	7.09	7.01	7.12	6.93
		Maximum		8.16	8.13	8.13	8.15	8.08	8.06	8.06	8.05

Appendix Table 12 (continued). Water quality parameters for 28 day *Hyalella azteca* (non-uv)

Conductivity (umho/cm2)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	1	148	157	147	154	153	150	149	158	150
27-May-01	0	10:45-13:30	8	147	155	154	149	148	152	154	151	151
2-Jun-01	6	08:10-09:30	4	202	184	176	182	176	177	174	179	178
2-Jun-01	6	08:10-09:30	5	217	188	172	180	175	176	175	178	178
9-Jun-01	13	09:20-10:40	4	179	187	179	184	185	183	183	185	187
9-Jun-01	13	09:20-10:40	6	177	198	180	183	184	184	183	184	187
16-Jun-01	20	09:10-11:10	1	151	157	154	156	161	158	161	155	158
16-Jun-01	20	09:10-11:10	4	151	161	153	154	158	157	157	157	157
24-Jun-01	28	08:12-11:17	1	157	169	160	164	164	161	163	159	160
24-Jun-01	28	08:12-11:17	8	157	169	159	162	164	161	162	158	160
		Average		**169**	**173**	**163**	**167**	**167**	**166**	**166**	**166**	**167**
		Minimum		147	155	147	149	148	150	149	151	150
		Maximum		217	198	180	184	185	184	183	185	187

Ammonia (ppm)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	1	0.095	<.063	0.091	<.063	0.081	0.111	0.078	0.192	0.142
27-May-01	0	10:45-13:30	8	0.064	<.063	0.149	0.067	0.087	0.127	1.148	0.197	0.104
24-Jun-01	28	08:12-11:17	1	0.075	0.137	<.063	<.063	<.063	<.063	<.063	<.063	<.063
24-Jun-01	28	08:12-11:17	8	<.063	0.095	<.063	<.063	<.063	<.063	<.063	<.063	0.069
		Average		**0.066**	**0.074**	**0.076**	**<0.063**	**<.063**	**0.075**	**0.322**	**0.113**	**0.087**
		Minimum		<.063	<.063	<.063	<.063	<.063	<.063	<.063	<.063	<.063
		Maximum		0.095	0.137	0.149	0.067	0.087	0.127	1.148	0.197	0.142

Appendix Table 12 (continued). Water quality parameters for 28 day *Hyalella azteca* (non-uv)

Conductivity (umho/cm2)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	10:45-13:30	1	164	149	148	150	171	147	148	146
27-May-01	0	10:45-13:30	8	150	148	149	150	154	147	148	145
2-Jun-01	6	08:10-09:30	4	177	175	177	176	176	174	173	174
2-Jun-01	6	08:10-09:30	5	176	174	175	174	177	174	174	175
9-Jun-01	13	09:20-10:40	4	185	184	184	185	186	182	184	182
9-Jun-01	13	09:20-10:40	6	186	184	185	184	184	184	181	183
16-Jun-01	20	09:10-11:10	1	153	157	158	154	155	151	155	153
16-Jun-01	20	09:10-11:10	4	155	153	154	153	153	151	151	153
24-Jun-01	28	08:12-11:17	1	160	162	157	159	159	156	157	159
24-Jun-01	28	08:12-11:17	8	159	161	157	158	159	158	157	158
		Average		**167**	**165**	**164**	**164**	**167**	**162**	**163**	**163**
		Minimum		150	148	148	150	153	147	148	145
		Maximum		186	184	185	185	186	184	184	183

Ammonia (ppm)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	10:45-13:30	1	0.134	0.087	0.133	<.063	0.298	<.063	0.135	<.063
27-May-01	0	10:45-13:30	8	0.092	0.065	0.086	<.063	0.232	<.063	0.163	0.083
24-Jun-01	28	08:12-11:17	1	<.063	0.26	<.063	<.063	<.063	0.215	0.097	<.063
24-Jun-01	28	08:12-11:17	8	<.063	<.063	<.063	<.063	<.063	0.269	0.087	<.063
		Average		**0.072**	**0.111**	**0.071**	**<.063**	**0.148**	**0.137**	**0.121**	**<.063**
		Minimum		<.063	<.063	<.063	<.063	<.063	<.063	0.087	<.063
		Maximum		0.134	0.260	0.133	<.063	0.298	0.269	0.163	0.083

Appendix Table 12 (continued). Water quality parameters for 28 day *Hyalella azteca* (non-uv)

Hardness (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	3	58	52.4	60.4	60	60	61	62	61.6	61.2
27-May-01	0	10:45-13:30	7	64	55.6	67.6	60	60	64	60.4	62.4	64.8
24-Jun-01	28	08:12-11:17	3	58	61.6	57	58	56.8	52.4	64	59.6	60.8
24-Jun-01	28	08:12-11:17	7	56.4	62	58	60	63.2	55.6	56.8	56	59.2
		Average		**59.1**	**57.9**	**60.8**	**59.5**	**60.0**	**58.3**	**60.8**	**59.9**	**61.5**
		Minimum		56.4	52.4	57.0	58.0	56.8	52.4	56.8	56.0	59.2
		Maximum		64.0	62.0	67.6	60.0	63.2	64.0	64.0	62.4	64.8

Alkalinity (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood
27-May-01	0	10:45-13:30	2	44	38	41.6	43.6	44	44	47.6	44.4	48
27-May-01	0	10:45-13:30	6	44	38	42.8	44	48.4	47.6	48	43.6	42
24-Jun-01	28	08:12-11:17	2	52.8	56.2	43.2	51.6	51.6	48.4	53.6	52.4	50.4
24-Jun-01	28	08:12-11:17	6	50	55.2	55.6	49.2	52	48.2	52.8	50	50.8
		Average		**47.7**	**46.9**	**45.8**	**47.1**	**49.0**	**47.1**	**50.5**	**47.6**	**47.8**
		Minimum		44.0	38.0	41.6	43.6	44.0	44.0	47.6	43.6	42.0
		Maximum		52.8	56.2	55.6	51.6	52.0	48.4	53.6	52.4	50.8

Appendix Table 12 (continued). Water quality parameters for 28 day *Hyalella azteca* (non-uv)

Hardness (ppm CaCO3)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	10:45-13:30	3	58.4	68	60.8	63.6	67.2	60	63.2	70
27-May-01	0	10:45-13:30	7	63.6	58	63.2	61.2	67.6	60.4	60.4	74
24-Jun-01	28	08:12-11:17	3	56	59.6	57.8	59.6	51.6	60	54	58
24-Jun-01	28	08:12-11:17	7	60.4	58	56.8	60	56.4	56	58	62
		Average		**59.6**	**60.9**	**59.7**	**61.1**	**60.7**	**59.1**	**58.9**	**66.0**
		Minimum		56.0	58.0	56.8	59.6	51.6	56.0	54.0	58.0
		Maximum		63.6	68.0	63.2	63.6	67.6	60.4	63.2	74.0

Alkalinity (ppm CaCO3)

Date	Day	Time	Rep	J 25% Sand	K 25% Wood	L 50% Sand	M 50% Wood	N Wood #2	O Sand #2	P 100% Sand	Q 100% Wood
27-May-01	0	10:45-13:30	2	46	47.2	44.4	48	50	46	46	44
27-May-01	0	10:45-13:30	6	44	44.8	44	48	50	46	48	44
24-Jun-01	28	08:12-11:17	2	48.8	51.2	50.8	50.4	52	52.4	50.4	51
24-Jun-01	28	08:12-11:17	6	49.6	52.4	48.8	49.2	52	48.8	50.4	52
		Average		**47.1**	**48.9**	**47.0**	**48.9**	**51.0**	**48.3**	**48.7**	**47.8**
		Minimum		44.0	44.8	44.0	48.0	50.0	46.0	46.0	44.0
		Maximum		49.6	52.4	50.8	50.4	52.0	52.4	50.4	52.0

Appendix Table 13. Survival and growth of ***Hyalella azteca*** under UV light

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
a	Sand	1	10	0.169
a	Sand	2	9	0.177
a	Sand	3	10	0.157
a	Sand	4	9	0.177
a	Sand	5	9	0.176
a	Sand	6	10	0.182
a	Sand	7	9	0.157
a	Sand	8	10	0.177
b	Formu	1	6	0.443
b	Formu	2	7	0.500
b	Formu	3	8	0.639
b	Formu	4	9	0.516
b	Formu	5	4	0.427
b	Formu	6	7	0.471
b	Formu	7	8	0.556
b	Formu	8	7	0.401
c	W Bear	1	10	0.160
c	W Bear	2	10	0.176
c	W Bear	3	10	0.165
c	W Bear	4	10	0.179
c	W Bear	5	9	0.189
c	W Bear	6	10	0.185
c	W Bear	7	9	0.201
c	W Bear	8	10	0.165
d	Ref Sand	1	10	0.159
d	Ref Sand	2	9	0.183
d	Ref Sand	3	8	0.196
d	Ref Sand	4	10	0.184
d	Ref Sand	5	9	0.213
d	Ref Sand	6	9	0.222
d	Ref Sand	7	9	0.277
d	Ref Sand	8	10	0.257
e	Ref Wood	1	9	0.263
e	Ref Wood	2	10	0.274
e	Ref Wood	3	10	0.225
e	Ref Wood	4	10	0.244
e	Ref Wood	5	10	0.209
e	Ref Wood	6	10	0.228
e	Ref Wood	7	10	0.261
e	Ref Wood	8	10	0.228

Appendix Table 13(continued). Survival and growth of Hyalella azteca under UV light

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
f	1% cont Sand	1	10	0.158
f	1% cont Sand	2	10	0.160
f	1% cont Sand	3	10	0.274
f	1% cont Sand	4	9	0.236
f	1% cont Sand	5	10	0.192
f	1% cont Sand	6	10	0.201
f	1% cont Sand	7	10	0.130
f	1% cont Sand	8	10	0.166
g	1% Cont Wood	1	10	0.211
g	1% Cont Wood	2	10	0.256
g	1% Cont Wood	3	9	0.211
g	1% Cont Wood	4	9	0.190
g	1% Cont Wood	5	9	0.266
g	1% Cont Wood	6	9	0.269
g	1% Cont Wood	7	10	0.199
g	1% Cont Wood	8	10	0.210
h	10%Cont Sand	1	8	0.311
h	10%Cont Sand	2	6	0.302
h	10%Cont Sand	3	7	0.311
h	10%Cont Sand	4	7	0.216
h	10%Cont Sand	5	7	0.320
h	10%Cont Sand	6	5	0.340
h	10%Cont Sand	7	7	0.273
h	10%Cont Sand	8	8	0.236
i	10%Cont Wood	1	10	0.212
i	10%Cont Wood	2	9	0.290
i	10%Cont Wood	3	7	0.277
i	10%Cont Wood	4	10	0.218
i	10%Cont Wood	5	10	0.220
i	10%Cont Wood	6	8	0.295
i	10%Cont Wood	7	4	0.523
i	10%Cont Wood	8	8	0.299
j	25%Cont Sand	1	2	0.560
j	25%Cont Sand	2	2	0.545
j	25%Cont Sand	3	3	0.403
j	25%Cont Sand	4	1	0.500
j	25%Cont Sand	5	1	0.370
j	25%Cont Sand	6	1	0.580
j	25%Cont Sand	7	0	
j	25%Cont Sand	8	1	0.520

Appendix Table 13(continued). Survival and growth of Hyalella azteca under UV light

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
k	25% Cont Wood	1	5	0.380
k	25% Cont Wood	2	3	0.410
k	25% Cont Wood	3	4	0.523
k	25% Cont Wood	4	4	0.438
k	25% Cont Wood	5	2	0.610
k	25% Cont Wood	6	4	0.358
k	25% Cont Wood	7	1	0.730
k	25% Cont Wood	8	3	0.513
l	50% Cont Sand	1	0	
l	50% Cont Sand	2	0	
l	50% Cont Sand	3	0	
l	50% Cont Sand	4	0	
l	50% Cont Sand	5	0	
l	50% Cont Sand	6	0	
l	50% Cont Sand	7	0	
l	50% Cont Sand	8	0	
m	50% Cont Wood	1	0	
m	50% Cont Wood	2	0	
m	50% Cont Wood	3	0	
m	50% Cont Wood	4	0	
m	50% Cont Wood	5	0	
m	50% Cont Wood	6	0	
m	50% Cont Wood	7	0	
m	50% Cont Wood	8	0	
n	Cont Wood # 2	1	3	0.487
n	Cont Wood # 2	2	4	0.520
n	Cont Wood # 2	3	2	0.485
n	Cont Wood # 2	4	6	0.350
n	Cont Wood # 2	5	4	0.425
n	Cont Wood # 2	6	2	0.460
n	Cont Wood # 2	7	7	0.357
n	Cont Wood # 2	8	1	0.800
o	Cont Sand # 2	1	0	
o	Cont Sand # 2	2	0	
o	Cont Sand # 2	3	0	
o	Cont Sand # 2	4	0	
o	Cont Sand # 2	5	0	
o	Cont Sand # 2	6	0	
o	Cont Sand # 2	7	0	
o	Cont Sand # 2	8	0	

Appendix Table 13(continued). Survival and growth of Hyalella azteca under UV light

Treatment	Sediment	Rep	Number of survivors	Individual dry weight (ug)
p	Cont Sand # 1	1	0	
p	Cont Sand # 1	2	0	
p	Cont Sand # 1	3	0	
p	Cont Sand # 1	4	0	
p	Cont Sand # 1	5	0	
p	Cont Sand # 1	6	0	
p	Cont Sand # 1	7	0	
p	Cont Sand # 1	8	0	
q	Cont Wood # 1	1	0	
q	Cont Wood # 1	2	0	
q	Cont Wood # 1	3	0	
q	Cont Wood # 1	4	0	
q	Cont Wood # 1	5	0	
q	Cont Wood # 1	6	0	
q	Cont Wood # 1	7	0	
q	Cont Wood # 1	8	0	
hrh	10%Cont Sand	1	9	0.219
hrh	10%Cont Sand	2	10	0.177
hrh	10%Cont Sand	3	8	0.243
hrh	10%Cont Sand	4	8	0.169
hrh	10%Cont Sand	5	10	0.240
hrh	10%Cont Sand	6	10	0.213
hrh	10%Cont Sand	7	9	0.177
hrh	10%Cont Sand	8	10	0.214
hrl	10%Cont Wood	1	10	0.221
hrl	10%Cont Wood	2	9	0.219
hrl	10%Cont Wood	3	10	0.242
hrl	10%Cont Wood	4	10	0.223
hrl	10%Cont Wood	5	8	0.256
hrl	10%Cont Wood	6	9	0.221
hrl	10%Cont Wood	7	10	0.209
hrl	10%Cont Wood	8	8	0.269
hrn	Cont Wood # 2	1	10	0.185
hrn	Cont Wood # 2	2	10	0.246
hrn	Cont Wood # 2	3	10	0.197
hrn	Cont Wood # 2	4	8	0.265
hrn	Cont Wood # 2	5	9	0.237
hrn	Cont Wood # 2	6	9	0.208
hrn	Cont Wood # 2	7	9	0.248
hrn	Cont Wood # 2	8	8	0.230

Appendix Table 14. Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	9:00-11:30	1	23.4	23.4	23.3	23.3	23.2	23.2	23	23	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	2	23.4	23.4	23.3	23.4	23.3	23.2	23.1	23	23	23.1	23.1
12-Jun-01	0	9:00-11:30	3	23.4	23.4	23.3	23.4	23.3	23.2	23.1	23	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	4	23.4	23.4	23.3	23.4	23.3	23.2	23.1	23.1	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	5	23.4	23.4	23.3	23.4	23.3	23.2	23.1	23.1	23.1	23	23.1
12-Jun-01	0	9:00-11:30	6	23.4	23.4	23.3	23.4	23.3	23.2	23.1	23.1	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	7	23.4	23.4	23.4	23.4	23.3	22.9	23.1	23.1	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	8	23.4	23.4	23.4	23.4	23.3	22.9	23.1	23.1	23.1	23.1	23.1
12-Jun-01	0	15:40-16:04	1	23.5	23.5	23.6	23.5	23.5	23.5	23.5	23.5	23.6	23.5	23.5
12-Jun-01	0	15:40-16:04	4	23.5	23.5	23.6	23.5	23.6	23.5	23.5	23.5	23.6	23.5	23.5
13-Jun-01	1	07:55-08:50	4	23.2	23.1	23.1	23.1	22.9	22.9	23.1	23	23	23	23.1
13-Jun-01	1	07:55-08:50	6	23.1	23.1	23.1	23.1	22.9	22.9	23.1	22.9	23.1	23	23
13-Jun-01	1	16:20-17:00	4	23.4	23.4	23.3	23.2	23.1	22.9	23.4	23.1	23.1	23.2	23.1
13-Jun-01	1	16:20-17:00	8	23.2	23.3	23.3	23.2	23.1	23	23.4	23.1	23.1	23.2	23.2
14-Jun-01	2	08:20-0945	4	22.6	22.7	22.6	22.7	22.4	22.5	22.7	22.6	22.6	22.6	22.6
14-Jun-01	2	08:20-0945	5	22.7	22.7	22.6	22.7	22.5	22.5	22.7	22.6	22.6	22.6	22.6
14-Jun-01	2	15:20-15:55	2	23.3	23.3	23.3	23.2	23.2	23	23.3	23.2	23.3	23.2	23.2
14-Jun-01	2	15:20-15:55	4	23.3	23.3	23.3	23.2	23.1	22.9	23.3	23.2	23.3	23.2	23.2
15-Jun-01	3	08:35-09:45	4	22.8	22.9	22.8	22.8	22.6	22.6	22.9	23.8	22.8	22.8	22.8
15-Jun-01	3	08:35-09:45	7	22.8	22.9	22.8	22.9	22.7	22.7	22.9	22.8	22.8	22.8	22.8
15-Jun-01	3	15:50-16:25	3	23.1	23.2	23.2	23.2	23.2	23	23.2	23.1	23.2	23.1	23.2
15-Jun-01	3	15:50-16:25	4	23.1	23.2	23.2	23.2	22.9	23	23.2	23.2	23.2	23.1	23.2
16-Jun-01	4	09:45-10:30	1	23.1	23	22.9	23	22.9	22.5	23	22.9	22.8	23	22.8
16-Jun-01	4	09:45-10:30	4	23	23	22.9	23	22.7	22.6	23	23	22.8	23	22.9
16-Jun-01	4	16:10-16:40	3	23.5	23.5	23.4	23.5	23	23.2	23.5	23.3	23.3	23.5	23.4
16-Jun-01	4	16:10-16:40	4	23.5	23.5	23.4	23.5	23	23.2	23.5	23.3	23.4	23.5	23.5
17-Jun-01	5	10:20-10:40	4	23	23.1	23	23.1	22.7	23	23.1	23	23.1	23	23
17-Jun-01	5	10:20-10:40	6	23	23.1	23	23.1	22.7	23	23.1	23	23.1	23.1	23
17-Jun-01	5	15:55-16:25	4	23.5	23.5	23.5	23.5	23	23.3	23.4	23.5	23.5	23.5	23.5
17-Jun-01	5	15:55-16:25	8	23.5	23.5	23.5	23.5	23.2	23.5	23.5	23.5	23.5	23.5	23.5
18-Jun-01	6	06:15-09:30	4	22.8	22.8	22.8	22.8	22.4	22.8	22.8	22.8	22.8	22.8	22.8
18-Jun-01	6	06:15-09:30	5	22.8	22.8	22.8	22.8	22.4	22.8	22.8	22.8	22.8	22.8	22.8
18-Jun-01	6	16:10-16:45	2	23.2	23.2	23.2	23.3	22.8	23.1	23.2	23.2	23.2	23.2	23.2
18-Jun-01	6	16:10-16:45	4	23.2	23.2	23.2	23.3	22.6	23.1	23.3	23.2	23.2	23.2	23.2
19-Jun-01	7	08:15-09:05	4	22.7	22.6	22.5	22.6	21.9	22.6	22.6	22.5	22.5	22.5	22.5

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	9:00-11:30	1	23	23.1	23.2	23.1	23.1	23.2	23.2	23.1	23.1
12-Jun-01	0	9:00-11:30	2	23.1	23.2	23.1	23.1	23.1	23.2	23.2	23.9	23.1
12-Jun-01	0	9:00-11:30	3	23.1	23.1	23.2	23.1	23.1	23.2	23.1	23	23
12-Jun-01	0	9:00-11:30	4	23.1	23.1	23.2	23.1	23.1	23.2	23.1	23.1	23.1
12-Jun-01	0	9:00-11:30	5	23.1	23.2	23.2	23.1	23.1	23.2	23.1	23	23.1
12-Jun-01	0	9:00-11:30	6	23.1	23.2	23.2	23.1	23.1	23.2	23.1	22.9	23.1
12-Jun-01	0	9:00-11:30	7	23.1	23.2	23.2	23.1	23.2	23.2	23.1	22.9	23.1
12-Jun-01	0	9:00-11:30	8	23.1	23.2	23.2	23.1	23.2	23.2	23	22.9	23.1
12-Jun-01	0	15:40-16:04	1	23.5	23.5	23.5	23.5	23.5	23.5	23.2	23.1	23.2
12-Jun-01	0	15:40-16:04	4	23.5	23.5	23.5	23.5	23.5	23.5	23.2	23.1	23.2
13-Jun-01	1	07:55-08:50	4	22.9	23.1	23.1	23	23	23.1	22.9	22.6	23
13-Jun-01	1	07:55-08:50	6	22.9	23.1	23.1	23	23	23.1	22.8	22.6	22.9
13-Jun-01	1	16:20-17:00	4	23	23.2	23.2	23.1	23.1	23.1	22.9	22.5	23
13-Jun-01	1	16:20-17:00	8	23.1	23.2	23.2	23.2	23.1	23.1	23	22.5	23
14-Jun-01	2	08:20-0945	4	22.6	22.6	22.7	22.6	22.6	22.6	22.9	22.5	22.8
14-Jun-01	2	08:20-0945	5	22.6	22.6	22.7	22.6	22.6	22.7	22.9	22.6	22.9
14-Jun-01	2	15;20-15:55	2	23.1	23.2	23.3	23.2	23.2	23.2	23.2	23.2	23.3
14-Jun-01	2	15:20-15:55	4	23.1	23.2	23.3	23.2	23.2	23.2	23.2	23.2	23.3
15-Jun-01	3	08:35-09:45	4	22.7	22.8	22.9	22.8	22.7	23	23	22.7	23
15-Jun-01	3	08:35-09:45	7	22.8	22.8	22.9	22.8	22.7	23.1	23	22.7	23.1
15-Jun-01	3	15:50-16:25	3	23.1	23.2	23.2	23.2	23.1	23.1	23.2	23	23.3
15-Jun-01	3	15:50-16:25	4	23.1	23.2	23.2	23.2	23.1	23.1	23.3	23	23.3
16-Jun-01	4	09:45-10:30	1	22.9	22.7	22.9	22.8	22.8	22.8	22.8	22.9	23
16-Jun-01	4	09:45-10:30	4	22.9	22.7	22.9	22.9	22.8	22.8	23	22.8	23
16-Jun-01	4	16:10-16:40	3	23.4	23.5	23.5	23.3	23.3	23.5	23.1	23	23.2
16-Jun-01	4	16:10-16:40	4	23.4	23.5	23.5	23.4	23.4	23.5	23.1	23	23.2
17-Jun-01	5	10:20-10:40	4	23	23	23.1	23	22.9	23	22.9	22.7	23
17-Jun-01	5	10:20-10:40	6	23.1	23	23.1	23	22.9	23	22.8	22.8	23
17-Jun-01	5	15:55-16:25	4	23.5	23.5	23.5	23.5	23.3	23.4	23.2	23.1	23.2
17-Jun-01	5	15:55-16:25	8	23.5	23.5	23.5	23.5	23.4	23.5	23.2	23.1	23.2
18-Jun-01	6	06:15-09:30	4	22.8	22.8	22.8	22.8	22.6	22.8	22.8	22.5	22.8
18-Jun-01	6	06:15-09:30	5	22.8	22.8	22.8	22.8	22.6	22.8	22.7	22.5	22.8
18-Jun-01	6	16:10-16:45	2	23.2	23.2	23.2	23.1	23.1	23.2	23.1	22.8	23.1
18-Jun-01	6	16:10-16:45	4	23.2	23.2	23.3	23.2	23.1	23.2	23.1	22.8	23.1
19-Jun-01	7	08:15-09:05	4	22.6	22.5	22.5	22.6	22.4	22.5	22.8	22.5	22.8

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
19-Jun-01	7	08:15-09:05	7	22.7	22.6	22.5	22.7	22.1	22.6	22.5	22.6	22.5	22.6	22.6
19-Jun-01	7	15:25-15:55	3	23.3	23.3	23.3	23.3	22.8	23.2	23.2	23.2	23.3	23.2	23.2
19-Jun-01	7	15:25-15:55	4	23.3	23.3	23.3	23.3	22.9	23.2	23.2	23.2	23.3	23.5	23.3
20-Jun-01	8	08:05-09:30	4	23.4	23.4	23.3	23.3	23	23.3	23.2	23.2	23.3	23.2	23.2
20-Jun-01	8	08:05-09:30	6	23.4	23.4	23.3	23.3	23	23.3	23.2	23.2	23.3	23.2	23.2
20-Jun-01	8	15:00-15:30	4	23.5	23.3	23.3	23.5	23.3	23.2	23.3	23.5	23.5	23.3	23.5
20-Jun-01	8	15:00-15:30	8	23.5	23.3	23.3	23.5	23.3	23.2	23.3	23.5	23.5	23.3	23.5
21-Jun-01	9	08:00-8:40	4	23	23	22.8	23	22.5	22.9	22.9	22.9	22.8	23	22.8
21-Jun-01	9	08:00-8:40	7	23	23	22.8	23	22.7	23	22.9	22.8	22.8	23	22.8
21-Jun-01	9	16:00-16:45	1	23.3	23.2	23.2	23.3	22.8	23.2	23.3	23.2	23.2	23.2	23.2
21-Jun-01	9	16:00-16:45	4	23.3	23.2	23.2	23.2	22.7	23.1	23.3	23.2	23.2	23.2	23.2
22-Jun-01	10	8:00-09:30	4	23.2	23.3	23.3	23.2	22.8	23.2	23.3	23.2	23.3	23.1	23.2
22-Jun-01	10	8:00-09:30	5	23.3	23.3	23.3	23.3	22.7	23.2	23.3	23.2	23.3	23.2	23.2
22-Jun-01	10	15:40-16:10	2	23.2	23.3	23.3	23.2	22.9	23.2	23.2	23.2	23.3	23.2	23.3
22-Jun-01	10	15:40-16:10	4	23.2	23.4	23.3	23.3	22.8	23.2	23.2	23.3	23.4	23.2	23.3
23-Jun-01	11	08:05-08:45	4	22.5	22.5	22.4	22.5	22.1	22.6	22.5	22.5	22.6	22.5	22.5
23-Jun-01	11	08:05-08:45	7	22.6	22.5	22.4	22.6	22.2	22.5	22.5	22.5	22.6	22.5	22.5
23-Jun-01	11	15:45-16:15	3	23.6	23.5	23.5	23.5	23.1	23.5	23.6	23.5	23.5	23.5	23.5
23-Jun-01	11	15:45-16:15	4	23.6	23.5	23.5	23.5	23.1	23.5	23.6	23.5	23.5	23.5	23.5
24-Jun-01	12	10:10-10:40	1	23.3	23.3	23.3	23.3	22.9	23.3	23.2	23.2	23.3	23.2	23.3
24-Jun-01	12	10:10-10:40	4	23.3	23.3	23.3	23.3	22.8	23.3	23.2	23.3	23.3	23.2	23.3
24-Jun-01	12	16:00-16:40	4	23.9	23.8	23.9	23.9	23.6	23.8	23.9	23.8	23.8	23.8	23.7
24-Jun-01	12	16:00-16:40	5	23.9	23.8	23.9	23.8	23.5	23.8	23.9	23.8	23.9	23.8	23.7
25-Jun-01	13	07:35-09:15	4	23.4	23.2	23.3	23.3	23	23.2	23.2	23.2	23.3	23.2	23.3
25-Jun-01	13	07:35-09:15	6	23.4	23.3	23.2	23.3	23	23.2	23.2	23.3	23.3	23.2	23.3
25-Jun-01	13	15:00-15:40	4	23.7	23.6	23.7	23.7	23.3	23.6	23.6	23.6	23.7	23.7	23.6
25-Jun-01	13	15:00-15:40	8	23.7	23.6	23.7	23.7	23.5	23.6	23.6	23.6	23.7	23.6	23.7
26-Jun-01	14	07:15-08:20	4	23.6	23.5	23.5	23.5	23.1	23.5	23.5	23.5	23.5	23.5	23.5
26-Jun-01	14	07:15-08:20	5	23.6	23.5	23.5	23.6	23.1	23.5	23.5	23.5	23.6	23.5	23.5
26-Jun-01	14	15:00-15:50	2	23.5	23.3	23.5	23.5	23.4	23.4	23.5	23.5	23.5	23.5	23.4
26-Jun-01	14	15:00-15:50	4	23.5	23.3	23.5	23.5	23.3	23.4	23.5	23.8	23.5	23.4	23.4
27-Jun-01	15	07:30-09:15	4	22.7	22.7	22.7	22.6	22.6	22.6	22.6	22.6	22.7	22.5	22.6
27-Jun-01	15	07:30-09:15	7	22.7	22.6	22.8	22.6	22.6	22.6	22.5	22.6	22.7	22.5	22.6
27-Jun-01	15	15:05-15:40	3	23.1	22.9	23.1	23	22.6	22.7	23	23	23	23	23
27-Jun-01	15	15:05-15:40	4	23.1	23	23.1	23.1	22.7	22.7	23.1	23	23	23	23

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
19-Jun-01	7	08:15-09:05	7	22.6	22.5	22.6	22.6	22.4	22.5	22.8	22.5	22.8
19-Jun-01	7	15:25-15:55	3	23.3	23.2	23.3	23.2	22.1	23.2	23.1	22.8	23.2
19-Jun-01	7	15:25-15:55	4	23.3	23.3	23.3	23.3	23.2	23.2	23.2	22.8	23.2
20-Jun-01	8	08:05-09:30	4	23.2	23.2	23.1	23.1	23.1	23.1	23.2	22.9	23
20-Jun-01	8	08:05-09:30	6	23.2	23.2	23.2	23.1	23.1	23.1	23.2	22.9	23
20-Jun-01	8	15:00-15:30	4	23.3	23.4	23.3	23.4	23.3	23.3	23.3	23.2	23.5
20-Jun-01	8	15:00-15:30	8	23.3	23.5	23.3	23.4	23.4	23.3	23.4	23.3	23.5
21-Jun-01	9	08:00-8:40	4	23	22.9	23	22.9	22.7	22.8	23.1	22.9	23.1
21-Jun-01	9	08:00-8:40	7	23	22.9	23	22.9	22.8	22.8	23.1	22.9	23.1
21-Jun-01	9	16:00-16:45	1	23.1	23.2	23.2	23.2	23.2	23.2	23.1	23.1	23.2
21-Jun-01	9	16:00-16:45	4	23.2	23.2	23.3	23.2	23.2	23.2	23.2	23.1	23.2
22-Jun-01	10	8:00-09:30	4	23.2	23.2	23.2	23.2	23.1	23.2	23.2	23	23.2
22-Jun-01	10	8:00-09:30	5	23.2	23.2	23.2	23.2	23.2	23.2	23.2	23	23.2
22-Jun-01	10	15:40-16:10	2	23.2	23.2	23.2	23.2	23.1	23.2	23.2	22.8	23.1
22-Jun-01	10	15:40-16:10	4	23.3	23.2	23.3	23.3	23.1	23.2	23.2	22.8	23.1
23-Jun-01	11	08:05-08:45	4	22.4	22.5	22.5	22.5	22.3	22.4	23	22.5	22.8
23-Jun-01	11	08:05-08:45	7	22.5	22.5	22.5	22.6	22.4	22.4	23	22.5	22.8
23-Jun-01	11	15:45-16:15	3	23.5	23.5	23.5	23.5	23.5	23.5	23.3	23.3	23.3
23-Jun-01	11	15:45-16:15	4	23.5	23.5	23.5	23.5	23.5	23.5	23.3	23.3	23.3
24-Jun-01	12	10:10-10:40	1	23.3	23.2	23.2	23.3	23.2	23.2	23.2	23.1	23.2
24-Jun-01	12	10:10-10:40	4	23.3	23.3	23.2	23.3	23.2	23.2	23.2	23.1	23.2
24-Jun-01	12	16:00-16:40	4	23.7	23.8	23.7	23.7	23.7	23.8	23.7	23.8	23.8
24-Jun-01	12	16:00-16:40	5	23.7	23.8	23.8	23.8	23.7	23.8	23.7	23.8	23.8
25-Jun-01	13	07:35-09:15	4	23.2	23.3	23.2	23.2	23.2	23.2	22.8	22.9	22.9
25-Jun-01	13	07:35-09:15	6	23.2	23.3	23.2	23.2	23.2	23.2	22.8	23	23
25-Jun-01	13	15:00-15:40	4	23.6	23.7	23.7	23.6	23.7	23.7	23.4	23.3	23.5
25-Jun-01	13	15:00-15:40	8	23.6	23.7	23.7	23.6	23.7	23.7	23.4	23.3	23.5
26-Jun-01	14	07:15-08:20	4	23.5	23.6	23.6	23.5	23.6	23.6	23.1	23.3	23.2
26-Jun-01	14	07:15-08:20	5	23.5	23.6	23.6	23.5	23.6	23.6	23	23.4	23.2
26-Jun-01	14	15:00-15:50	2	23.3	23.5	23.5	23.5	23.6	23.5	23.1	23.2	23.2
26-Jun-01	14	15:00-15:50	4	23.3	23.5	23.5	23.4	23.6	23.5	23.1	23.2	23.2
27-Jun-01	15	07:30-09:15	4	22.6	22.6	22.6	22.6	22.6	22.6	22.1	22.1	22
27-Jun-01	15	07:30-09:15	7	22.6	22.6	22.5	22.6	22.6	22.6	22.1	22.1	22.1
27-Jun-01	15	15:05-15:40	3	22.7	23.1	23.1	23	23.1	23.1	22.2	22.5	22.3
27-Jun-01	15	15:05-15:40	4	22.7	23.1	23.1	23	23.1	23.1	22.2	22.5	22.3

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
28-Jun-01	16	07:30-08:40	1	21.6	21.5	21.5	21.5	21.3	21.4	21.6	21.5	21.5	21.5	21.5
28-Jun-01	16	07:30-08:40	4	21.6	21.5	21.5	21.5	21.2	21.4	21.6	21.5	21.5	21.5	21.5
28-Jun-01	16	15:00-15:40	4	22.2	22.1	22.2	22.2	21.8	22.1	22.4	22.2	22.2	22.1	22.2
28-Jun-01	16	15:00-15:40	8	22.3	22.1	22.3	22.2	22.1	22.1	22.2	22.2	22.2	22.1	22.2
29-Jun-01	17	07:45-09:30	4	21.5	21.3	21.5	21.3	21.1	21.3	21.4	21.4	21.4	21.3	21.3
29-Jun-01	17	07:45-09:30	6	21.5	21.4	21.5	21.3	21.1	21.3	21.5	21.4	21.4	21.3	21.3
29-Jun-01	17	14:50-15:35	4	24	23.9	24	23.9	23.7	23.9	23.8	23.9	24	23.9	23.9
29-Jun-01	17	14:50-15:35	8	24	23.9	24	23.9	23.8	23.9	23.8	23.9	24	23.9	23.9
30-Jun-01	18	08:45-09:30	4	23.5	23.4	23.6	23.5	23.3	23.4	23.3	23.4	23.5	23.4	23.5
30-Jun-01	18	08:45-09:30	5	23.5	23.4	23.6	23.5	23.4	23.4	23.3	23.4	23.5	23.4	23.4
30-Jun-01	18	14:30-15:00	2	23.6	23.5	23.5	23.5	23.4	23.4	23.4	23.4	23.5	23.5	23.4
30-Jun-01	18	14:30-15:00	4	23.6	23.5	23.5	23.5	23.3	23.4	23.4	23.4	23.5	23.5	23.4
1-Jul-01	19	08:30-09:15	4	22.5	22.4	21.8	22.4	21.9	22.1	22.4	22.2	22	22.5	22
1-Jul-01	19	08:30-09:15	7	22.6	22.4	21.8	22.4	22	22	22.4	22.3	22	22.5	22
1-Jul-01	19	14:30-15:10	3	23.3	23.2	23	23.2	22.8	22.9	23.2	23	23	23.2	23.1
1-Jul-01	19	14:30-15:10	4	23.3	23.2	23.1	23.2	22.7	22.9	23.2	23.1	23.1	23.2	23.1
2-Jul-01	20	07:00-08:30	1	22.6	22.5	22.7	22.7	22.3	22.5	22.3	22.5	22.3	22.4	22.5
2-Jul-01	20	07:00-08:30	4	22.6	22.5	22.7	22.6	22.3	22.5	22.4	22.6	22.5	22.4	22.3
2-Jul-01	20	14:30-15:10	2	22.7	22.8	22.9	22.7	22.8	22.9	22.4	22.9	22.9	22.4	22.9
2-Jul-01	20	14:30-15:10	4	22.8	22.8	22.9	22.6	22.7	22.8	22.4	22.9	22.9	22.4	22.9
3-Jul-01	21	07:00-08:05	4	23	23	22.9	22.8	23	23	22.8	23.1	23.1	22.7	23
3-Jul-01	21	07:00-08:05	6	23	23	23.1	22.8	22.9	23	22.8	23	23.1	22.8	23
3-Jul-01	21	15:15-16:15	4	23.2	23.1	23.4	23	23.2	23.2	23	23.3	23.3	22.9	23.3
3-Jul-01	21	15:15-16:15	8	23.2	23.1	23.3	23	23.2	23.2	23	23.2	23.4	23	23.3
4-Jul-01	22	06:55-08:40	4	22.8	22.8	23	22.7	22.9	23	22.7	23	23	22.4	23
4-Jul-01	22	06:55-08:40	5	22.8	22.8	23	22.7	22.9	22.9	22.7	23	22.9	22.8	23
4-Jul-01	22	15:10-16:00	2	23	23	23.2	22.9	23	23.2	23	23.2	23.2	22.9	23.2
4-Jul-01	22	15:10-16:00	4	23	23	23.2	22.9	23	23.2	23	23.2	23.2	22.9	23.2
5-Jul-01	23	07:00-08:00	4	23	23.3	23.4	22.9	22.9	23	22.9	23.1	23.3	22.7	23
5-Jul-01	23	07:00-08:00	7	23	23.3	23.3	22.9	22.9	23	22.9	23.1	23.3	22.8	23
5-Jul-01	23	15:00-15:37	3	22.4	22.2	22.4	22.3	23.2	22.3	22.4	22.4	22.5	22.5	22.4
5-Jul-01	23	15:00-15:37	4	22.4	22.2	22.3	22.3	22.2	22.4	22.4	22.5	22.5	22.5	22.5
6-Jul-01	24	07:45-09:00	1	22.7	22.6	22.8	22.6	22.6	22.7	22.7	22.7	22.7	22.7	22.7
6-Jul-01	24	07:45-09:00	4	22.7	22.6	22.8	22.6	22.6	22.7	22.7	22.7	22.8	22.7	22.7
6-Jul-01	24	15:20-16:05	4	22.7	22.5	22.7	22.6	22.5	22.6	22.6	22.7	22.7	22.7	22.7

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
28-Jun-01	16	07:30-08:40	1	21.5	21.6	21.6	21.6	21.6	21.6	21.2	21.2	21.2
28-Jun-01	16	07:30-08:40	4	21.5	21.6	21.6	21.6	21.6	21.6	21.2	21.2	21.2
28-Jun-01	16	15:00-15:40	4	22.1	22.2	22.2	22.2	22.1	22.1	21.8	21.7	21.8
28-Jun-01	16	15:00-15:40	8	22.1	22.2	22.2	22.2	22.1	22.2	21.8	21.7	21.9
29-Jun-01	17	07:45-09:30	4	21.3	21.5	21.5	21.4	21.4	21.5	21.2	21.1	21.1
29-Jun-01	17	07:45-09:30	6	21.3	21.5	21.5	21.6	21.5	21.5	21.2	21.2	21.1
29-Jun-01	17	14:50-15:35	4	23.9	23.9	23.9	23.9	24	24	22.5	23.4	23.5
29-Jun-01	17	14:50-15:35	8	23.9	23.9	23.9	23.9	24	23.9	22.5	23.4	23.5
30-Jun-01	18	08:45-09:30	4	23.4	23.5	23.4	23.4	23.5	23.5	23.3	23.2	23.2
30-Jun-01	18	08:45-09:30	5	23.4	23.4	23.4	23.4	23.5	23.5	23.3	23.3	23.2
30-Jun-01	18	14:30-15:00	2	23.4	23.6	23.6	23.4	23.5	23.5	23.2	23.2	23.3
30-Jun-01	18	14:30-15:00	4	23.4	23.6	23.5	23.4	23.5	23.5	23.3	23.2	23.3
1-Jul-01	19	08:30-09:15	4	22.3	22.5	22.5	22.3	22.5	22.5	22.9	22.7	22.9
1-Jul-01	19	08:30-09:15	7	22.4	22.5	22.5	22.3	22.5	22.4	22.9	22.7	22.8
1-Jul-01	19	14:30-15:10	3	23	23.2	23.2	23.1	23	23.2	22.7	22.5	22.7
1-Jul-01	19	14:30-15:10	4	23	23.2	23.2	23.1	23	23.2	22.7	22.6	22.7
2-Jul-01	20	07:00-08:30	1	22.4	22.5	22.4	22.4	22.4	22.4	22.2	22.2	22.2
2-Jul-01	20	07:00-08:30	4	22.4	22.5	22.4	22.4	22.4	22.5	22.2	22.2	22
2-Jul-01	20	14:30-15:10	2	22.8	22.5	22.3	22.7	22.5	22.4	22.9	22.7	22.9
2-Jul-01	20	14:30-15:10	4	22.8	22.5	22.3	22.7	22.5	22.4	22.9	22.7	22.9
3-Jul-01	21	07:00-08:05	4	23	22.9	22.7	22.8	22.5	22.5	22.9	22.9	22.9
3-Jul-01	21	07:00-08:05	6	23	22.8	22.7	22.8	22.5	22.6	23	22.9	22.9
3-Jul-01	21	15:15-16:15	4	23	22.9	22.9	23.1	22.8	22.8	23.2	23	23
3-Jul-01	21	15:15-16:15	8	23	22.9	22.9	23	22.9	22.9	23.2	23	23
4-Jul-01	22	06:55-08:40	4	22.9	22.5	22.7	22.9	22.5	22.5	22.6	22.5	22.5
4-Jul-01	22	06:55-08:40	5	22.9	22.7	22.6	22.9	22.5	22.5	22.7	22.6	22.5
4-Jul-01	22	15:10-16:00	2	23	22.9	22.9	23.1	22.8	22.8	22.8	22.7	22.8
4-Jul-01	22	15:10-16:00	4	23.1	22.9	22.9	23.2	22.8	22.8	22.8	22.7	22.8
5-Jul-01	23	07:00-08:00	4	23	22.8	22.8	23	22.8	22.5	22.9	22.7	22.8
5-Jul-01	23	07:00-08:00	7	23	22.8	22.8	23	22.8	22.6	22.9	22.7	22.8
5-Jul-01	23	15:00-15:37	3	22.3	22.3	22.3	22.3	22.1	22.2	22.2	22.1	22
5-Jul-01	23	15:00-15:37	4	22.3	22.4	22.4	22.3	22.1	22.2	22.2	22.1	22
6-Jul-01	24	07:45-09:00	1	22.6	22.6	22.6	22.6	22.5	22.5	22.4	22.4	22.3
6-Jul-01	24	07:45-09:00	4	22.6	22.6	22.6	22.7	22.5	22.6	22.4	22.4	22.3
6-Jul-01	24	15:20-16:05	4	22.6	22.7	22.7	22.6	22.5	22.6	22	22	21.9

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
6-Jul-01	24	15:20-16:05	6	22.7	22.5	22.7	22.6	22.5	22.6	22.7	22.7	22.7	22.7	22.7
7-Jul-01	25	08:30-09:05	4	22.8	22.5	22.7	22.7	22.6	22.7	22.7	22.7	22.7	22.7	22.7
7-Jul-01	25	08:30-09:05	6	22.8	22.5	22.7	22.7	22.6	22.7	22.7	22.7	22.7	22.7	22.7
7-Jul-01	25	15:30-16:00	4	22.8	22.8	22.9	22.8	22.6	22.7	22.8	22.8	22.8	22.8	22.8
7-Jul-01	25	15:30-16:00	8	22.9	22.8	22.9	22.8	22.7	22.8	22.8	22.8	22.8	22.9	22.8
8-Jul-01	26	08:30-09:25	4	22.3	22.3	22.4	22.2	22.2	22.3	22.1	22.4	22.5	22	22.5
8-Jul-01	26	08:30-09:25	5	22.3	22.3	22.5	22.1	22.2	22.3	21.8	22.4	22.5	22.1	22.5
8-Jul-01	26	14:30-15:45	2	22.6	22.8	22.8	22.7	22.9	22.8	22.6	22.9	22.9	22.6	22.9
8-Jul-01	26	14:30-15:45	4	22.6	22.8	22.8	22.7	22.8	22.8	22.6	22.9	22.9	22.5	22.9
9-Jul-01	27	06:45-07:30	4	22.6	22.7	22.7	22.4	22.5	22.6	22.4	22.7	22.7	22.4	22.7
9-Jul-01	27	06:45-07:30	7	22.6	22.7	22.7	22.4	22.5	22.6	22.4	22.7	22.7	22.4	22.6
9-Jul-01	27	14:40-15:30	3	23	23.1	23.1	22.9	23	23.1	22.9	23.1	23.1	23.1	23.1
9-Jul-01	27	14:40-15:30	4	23	23.1	23.1	22.9	23.1	23.1	22.9	23.1	23.1	22.8	23.1
10-Jul-01	28	06:30-08:30	1	22.4	22.7	22.7	22.2	22.6	22.6	22.2	22.7	22.7	22.3	22.8
10-Jul-01	28	06:30-08:30	2	22.3	22.7	22.7	22.3	22.6	22.7	22.2	22.8	22.7	22.4	22.8
10-Jul-01	28	06:30-08:30	3	22.4	22.7	22.7	22.2	22.6	22.7	22.3	22.8	22.8	22.4	22.8
10-Jul-01	28	06:30-08:30	4	22.3	22.7	22.7	22.2	22.6	22.7	22.3	22.8	22.7	22.3	22.8
10-Jul-01	28	06:30-08:30	5	22.4	22.7	22.7	22.2	22.5	22.7	22.2	22.7	22.8	22.4	22.8
10-Jul-01	28	06:30-08:30	6	22.3	22.7	22.7	22.3	22.6	22.7	22.2	22.8	22.8	22.4	22.8
10-Jul-01	28	06:30-08:30	7	22.4	22.7	22.7	22.2	22.6	22.7	22.3	22.8	22.8	22.3	22.8
10-Jul-01	28	06:30-08:30	8	22.4	22.7	22.7	22.2	22.6	22.7	22.3	22.8	22.8	22.4	22.9
		Average		**23.0**	**23.0**	**23.0**	**23.0**	**22.8**	**22.9**	**22.9**	**23.0**	**23.0**	**22.9**	**23.0**
		Minimum		21.5	21.3	21.5	21.3	21.1	21.3	21.4	21.4	21.4	21.3	21.3
		Maximum		24.0	23.9	24.0	23.9	23.8	23.9	23.9	23.9	24.0	23.9	23.9

Appendix Table 14 (continued). Water Temperatures (C) for 28 day *Hyalella azteca* test. (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
6-Jul-01	24	15:20-16:05	6	22.6	22.7	22.7	22.6	22.5	22.6	22.1	22.1	21.9
7-Jul-01	25	08:30-09:05	4	22.5	22.7	22.7	22.6	22.5	22.6	22.4	22.3	22.4
7-Jul-01	25	08:30-09:05	6	22.6	22.7	22.7	22.6	22.6	22.6	22.3	22.3	22.1
7-Jul-01	25	15:30-16:00	4	22.7	22.9	22.8	22.7	22.6	22.8	22.3	22.3	22.2
7-Jul-01	25	15:30-16:00	8	22.7	23	22.8	22.8	22.7	22.8	22.3	22.3	22.2
8-Jul-01	26	08:30-09:25	4	22.6	22.5	22.4	22.7	22.4	22.3	22.8	22.7	22.6
8-Jul-01	26	08:30-09:25	5	22.7	22.5	22.4	22.7	22.4	22.3	22.7	22.7	22.6
8-Jul-01	26	14:30-15:45	2	22.9	22.6	22.5	22.8	22.4	22.3	22.5	22.6	22.3
8-Jul-01	26	14:30-15:45	4	22.9	22.6	22.6	22.8	22.4	22.3	22.5	22.6	22.3
9-Jul-01	27	06:45-07:30	4	22.7	22.4	22.4	22.6	22.3	22.3	22.5	22.4	22.4
9-Jul-01	27	06:45-07:30	7	22.7	22.4	22.4	22.6	22.4	22.3	22.6	22.4	22.4
9-Jul-01	27	14:40-15:30	3	23.1	22.9	22.8	23.1	22.8	22.9	22.9	22.9	22.9
9-Jul-01	27	14:40-15:30	4	23.1	22.9	22.9	23.1	22.8	22.9	22.9	22.9	22.9
10-Jul-01	28	06:30-08:30	1	22.9	22.5	22.6	22.9	22.8	22.7	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	2	22.9	22.5	22.6	22.9	22.8	22.7	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	3	22.9	22.6	22.6	22.9	22.8	22.7	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	4	22.9	22.5	22.6	22.9	22.8	22.7	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	5	22.9	22.6	22.6	22.9	22.8	22.8	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	6	22.9	22.6	22.6	22.9	22.8	22.7	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	7	22.9	22.6	22.6	22.9	22.8	22.8	22.8	22.9	22.8
10-Jul-01	28	06:30-08:30	8	22.9	22.6	22.6	22.9	22.8	22.7	22.8	22.9	22.8
		Average		**23.0**	**22.9**	**22.9**	**23.0**	**22.9**	**22.9**	**22.8**	**22.8**	**22.8**
		Minimum		21.3	21.5	21.5	21.4	21.4	21.5	21.2	21.1	21.1
		Maximum		23.9	23.9	23.9	23.9	24.0	24.0	23.7	23.9	23.8

Appendix Table 15. Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	9:00-11:30	1	6.6	6.6	4.6	5.6	4.9	6.2	5.3	4.4	5.8	5.6	4.6
12-Jun-01	0	9:00-11:30	2	6.6	6.5	5.5	5.6	4.7	6.3	4.6	5.6	4.2	5	5.9
12-Jun-01	0	9:00-11:30	3	6.6	6.6	4.7	5.6	4.4	6.2	5.8	4.4	5.4	5.6	4.7
12-Jun-01	0	9:00-11:30	4	6.6	6.5	4.9	4.6	4.1	6.3	5.3	4.1	4.3	5.7	4.3
12-Jun-01	0	9:00-11:30	5	6.6	6.4	5.1	5.5	4.6	6	5.4	5.6	6.2	5.3	3.9
12-Jun-01	0	9:00-11:30	6	6.6	6.5	5.2	6.3	5	6.2	5	6.1	4.1	4.4	4
12-Jun-01	0	9:00-11:30	7	6.6	6.3	5.9	6.3	4.7	4.9	5.7	6.1	4.1	4.2	4
12-Jun-01	0	9:00-11:30	8	6.5	6.4	6.2	6.2	4.6	5.5	5.9	5.8	4	5.6	4.2
12-Jun-01	0	15:40-16:04	1	6.1	6	5.5	5.5	5	6.1	5	5.4	5.8	5.4	5.2
12-Jun-01	0	15:40-16:04	4	6.2	6	6	4.9	4.8	6.2	5.6	5	4.6	6	5.9
13-Jun-01	1	07:55-08:50	4	6.2	6.1	6	6.1	5.3	6.2	5.9	6.9	5.5	5.9	6.1
13-Jun-01	1	07:55-08:50	6	6.2	5.7	5.8	6.1	4.9	6.2	5.1	6.1	4.2	5.6	5.2
13-Jun-01	1	16:20-17:00	4	5.9	5.6	5.9	5.9	5.7	5.9	5.8	5.9	5.9	5.8	5.9
13-Jun-01	1	16:20-17:00	8	5.7	5.4	6	5.4	5.5	5.8	5.9	5.6	5.2	5.6	5.4
14-Jun-01	2	08:20-0945	4	6.1	6	6	6	5.9	6	6	6	5.8	6	6.1
14-Jun-01	2	08:20-0945	5	6.4	6	5.9	5.8	5.8	6.1	5.5	6	5.9	5	5.9
14-Jun-01	2	15:20-15:55	2	7.1	6.5	7.2	6.9	6.9	7.2	6.8	7	6.8	7	7.1
14-Jun-01	2	15:20-15:55	4	7.1	7	7	7.1	6.9	7	6.8	7	6.8	7	7.1
15-Jun-01	3	08:35-09:45	4	7.1	6.9	7.1	7.1	6.7	7	7	6.9	6.9	7	6.9
15-Jun-01	3	08:35-09:45	7	7.2	6.6	7	6.7	6.8	7.2	6.9	6.8	6.6	6.8	6.2
15-Jun-01	3	15:50-16:25	3	6.8	6.6	6.6	6.9	6.6	6.7	6.8	6.3	6.2	6.9	6.9
15-Jun-01	3	15:50-16:25	4	6.7	6.5	6.8	6.8	6.5	6.9	6.8	6.6	6.6	6.8	6.7
16-Jun-01	4	09:45-10:30	1	7.4	6.5	6.9	6.4	7.1	7.2	7.3	7.5	7.2	6.2	6.7
16-Jun-01	4	09:45-10:30	4	7.1	6.9	6.9	6.4	6.9	6.9	7.4	7	7.3	7.3	6.6
16-Jun-01	4	16:10-16:40	3	6.3	6.2	6.4	6.4	5.9	6.3	6.5	6.6	6.2	6.4	6.4
16-Jun-01	4	16:10-16:40	4	6	6.1	6.5	6.5	5.9	6	6.4	6.6	6.1	6.4	6.3
17-Jun-01	5	10:20-10:40	4	6.6	6.4	6.7	6.6	6.6	6.6	6.9	6.7	6.6	6.8	6.6
17-Jun-01	5	10:20-10:40	6	6.6	6.4	6.7	6.7	6.5	6.6	6.7	6.7	6.7	6.7	6.5
17-Jun-01	5	15:55-16:25	4	6.8	6.2	6.6	6.6	6.4	5.7	6.6	6.7	5.8	6.5	6.2
17-Jun-01	5	15:55-16:25	8	6.2	6.5	6.8	6.1	5.8	6.6	6.7	6.7	6.6	6.4	6
18-Jun-01	6	06:15-09:30	4	6.7	6.3	6.6	6.5	6.6	6.2	6.6	6.6	6.4	6.6	6.4
18-Jun-01	6	06:15-09:30	5	6.6	6.6	6.5	6.5	6.5	6.6	6.5	6.4	6.6	6.7	6.4
18-Jun-01	6	16:10-16:45	2	6.2	6	6.4	6.4	6.2	6.9	6.4	6.5	6	6.6	6.5
18-Jun-01	6	16:10-16:45	4	6	5.9	6.4	6.3	6.2	6.3	6.6	6.5	6.1	6.5	6.4
19-Jun-01	7	08:15-09:05	4	7.3	6	7	6.8	6.8	6.8	7	6.8	6.8	6.6	6.7

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	9:00-11:30	1	3.7	5.5	4.9	4.5	3.8	4.8	5.5	4.8	4.6
12-Jun-01	0	9:00-11:30	2	4.5	4.1	5	5.9	5.2	4.2	6	6.1	5.1
12-Jun-01	0	9:00-11:30	3	5.9	5.6	5.6	4.5	3.8	5.9	5.3	6.7	4.6
12-Jun-01	0	9:00-11:30	4	5.5	5.7	5.6	5.7	4.4	5.7	5	5.8	4.9
12-Jun-01	0	9:00-11:30	5	6.1	4	5.3	4.1	3.1	4.2	5.7	5	4.6
12-Jun-01	0	9:00-11:30	6	4	4	5.1	6.1	4.1	3.9	4.9	6	5.7
12-Jun-01	0	9:00-11:30	7	3.9	4.9	5	4.2	5.7	4.3	5.9	5.8	5
12-Jun-01	0	9:00-11:30	8	3.8	4.1	5.7	4.3	5.9	5.4	5.8	6	4.6
12-Jun-01	0	15:40-16:04	1	3.7	5.4	5.3	4.9	4.4	4.7	5.4	4.5	4.6
12-Jun-01	0	15:40-16:04	4	5.2	5	5.7	5.3	4.6	5.5	5.3	5	5
13-Jun-01	1	07:55-08:50	4	6	5.8	5.6	5.6	5.7	5.6	6.2	6.2	5.8
13-Jun-01	1	07:55-08:50	6	4.6	4.3	5.5	6.1	3.9	4.3	5.6	6.2	5.1
13-Jun-01	1	16:20-17:00	4	5.9	5.8	5.7	5.4	4.2	5.6	6	5.9	5.7
13-Jun-01	1	16:20-17:00	8	6	4.5	5.4	5.5	5.5	5.1	6	6	5.3
14-Jun-01	2	08:20-0945	4	6	5.9	6	6	5.3	5.8	6	5.9	5.9
14-Jun-01	2	08:20-0945	5	6	4.9	5.6	4.9	4.5	5.3	5.9	6.2	5.7
14-Jun-01	2	15:20-15:55	2	6.9	6.5	6.8	6.9	6.3	5.9	7.1	7.2	6.7
14-Jun-01	2	15:20-15:55	4	7.1	6.9	6.8	6.9	6.2	7	7.2	7.2	6.9
15-Jun-01	3	08:35-09:45	4	6.9	6.8	7.1	6.9	6.4	6.5	6.9	7	6.5
15-Jun-01	3	08:35-09:45	7	6.9	6.8	6.6	5.2	6.4	6.7	6.9	7.1	6.6
15-Jun-01	3	15:50-16:25	3	6.7	6.2	6.1	5.8	6	5.7	6.8	6.6	6.4
15-Jun-01	3	15:50-16:25	4	6.8	6.7	6.6	5.9	5.9	5.5	6.7	6.8	6.4
16-Jun-01	4	09:45-10:30	1	7.4	6.2	5.3	6.1	5.9	5.3	6.3	7.2	6.5
16-Jun-01	4	09:45-10:30	4	6.4	6.6	6.6	6.1	5.9	5.6	6.8	6.7	6.3
16-Jun-01	4	16:10-16:40	3	6.5	5.6	6.3	6	6.1	6.2	6.6	6.6	6.4
16-Jun-01	4	16:10-16:40	4	6.1	5.7	6	6.4	6.3	6.3	6.7	6.7	6.5
17-Jun-01	5	10:20-10:40	4	6.4	6.5	6.3	6	6.2	6.5	6.8	6.9	6.6
17-Jun-01	5	10:20-10:40	6	6.8	5.2	5.6	6.4	6.3	5.1	6.6	6.9	6.7
17-Jun-01	5	15:55-16:25	4	6.1	6.4	6.1	6.3	5.7	6.3	6.8	6.5	6.2
17-Jun-01	5	15:55-16:25	8	6.4	4.6	5.7	5.7	6.5	6.5	6.3	6.5	5.7
18-Jun-01	6	06:15-09:30	4	6.2	6.2	6.1	6.1	6.1	6.4	6.6	6.6	6.4
18-Jun-01	6	06:15-09:30	5	6.5	5.8	6.5	6.3	6.4	6.5	6.3	6.7	6.3
18-Jun-01	6	16:10-16:45	2	6.5	6.5	6.1	6.3	5.3	5.9	6.6	6.5	6.2
18-Jun-01	6	16:10-16:45	4	6.2	6.2	6.3	6.4	5.7	6	6.5	6.5	6.3
19-Jun-01	7	08:15-09:05	4	6.3	6.4	6.6	6.5	6	6.4	6.7	6.8	6.7

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
19-Jun-01	7	08:15-09:05	7	7.2	6.4	7	6.8	6.6	6.9	6.8	7	6.8	6.8	6.9
19-Jun-01	7	15:25-15:55	3	6.5	6.6	6.5	6.6	6.3	6.6	6.6	5.7	6.1	6.3	6.4
19-Jun-01	7	15:25-15:55	4	6.4	6.2	6.8	6.2	6.5	6.6	6.7	6	6.2	6.4	6.4
20-Jun-01	8	08:05-09:30	4	7.5	6.8	6.9	6.9	7.1	6.7	7.1	6.8	6.6	6.8	6.6
20-Jun-01	8	08:05-09:30	6	7	5	6.5	7.1	7.1	7.1	7.2	6.4	6.7	7	6.4
20-Jun-01	8	15:00-15:30	4	7.1	4.3	6.3	6.4	6.4	6.9	6.6	6.8	6.9	6.3	5.1
20-Jun-01	8	15:00-15:30	8	6.6	3.8	6.1	6.3	6.5	6	6.8	6.2	6.7	6.3	6.8
21-Jun-01	9	08:00-8:40	4	7.1	6.2	6.8	6.6	6.5	6.7	6.8	6.6	6	6.8	6.6
21-Jun-01	9	08:00-8:40	7	7.1	5.5	6.9	6.5	6.6	6.8	6.8	6.6	6.7	6.8	6.8
21-Jun-01	9	16:00-16:45	1	6.7	5.8	6.7	6.8	6.5	6.8	6.5	6.3	5.3	6.7	6.5
21-Jun-01	9	16:00-16:45	4	6.3	5.8	6.7	6.6	6.5	6.4	6.6	6.3	6.6	6.6	6.6
22-Jun-01	10	8:00-09:30	4	6.5	4.6	6.5	6.4	6.7	6.6	6.7	6.3	6.6	6.3	6.4
22-Jun-01	10	8:00-09:30	5	6.6	4.7	6.4	6.5	6.3	6.6	6.7	6	5.9	6.6	6.2
22-Jun-01	10	15:40-16:10	2	6.1	4.6	6.7	6.6	6.4	6.6	6.6	6.5	6.1	6.8	6.5
22-Jun-01	10	15:40-16:10	4	6.7	5.2	6.6	6.6	6.3	6.5	6.6	6.4	6.4	6.5	6.4
23-Jun-01	11	08:05-08:45	4	7	5.7	6.9	6.6	6.7	6.9	6.9	6.7	6.7	6.8	6.7
23-Jun-01	11	08:05-08:45	7	6.9	5.1	7	6.8	6.4	6.9	6.7	6.6	6.9	6.7	6.7
23-Jun-01	11	15:45-16:15	3	7.4	6.6	6.7	6.9	6.7	6.5	6.6	6.4	6.1	6.3	6.3
23-Jun-01	11	15:45-16:15	4	7	4.9	6.9	6.7	6.7	6.5	6.6	6.7	6.4	6.9	6.5
24-Jun-01	12	10:10-10:40	1	7.2	3.7	7.1	7	7.2	7.2	7.1	7.1	6.8	6.9	7.1
24-Jun-01	12	10:10-10:40	4	7.3	4.1	7.1	7.1	7.2	7.2	7.2	6.9	7.1	7	7.1
24-Jun-01	12	16:00-16:40	4	6.9	3.8	6.9	6.9	6.8	6	6.7	6.8	6.4	6.6	6.7
24-Jun-01	12	16:00-16:40	5	7.2	3.4	6.7	6.8	5.7	6.7	6.7	6.6	6.5	6.2	6.1
25-Jun-01	13	07:35-09:15	4	7.2	4.2	6.9	6.9	6.9	6.9	6.9	6.7	6.8	7	6.8
25-Jun-01	13	07:35-09:15	6	7.1	3.4	7	7	6.9	6.5	6.8	6.2	6.7	6.8	6.8
25-Jun-01	13	15:00-15:40	4	7.1	2.8	6.8	6.6	6.8	6.2	7	6.4	6.6	6.1	6.5
25-Jun-01	13	15:00-15:40	8	6.9	4.2	7.1	6.5	6.8	6.9	6.6	6.5	6.5	6.6	6.4
26-Jun-01	14	07:15-08:20	4	7.3	2.4	6.8	6.7	7	6.8	6.9	7	6.8	6.8	6.6
26-Jun-01	14	07:15-08:20	5	7.3	4.1	6.6	6.8	6.8	6.9	6.8	5.7	6.4	6.3	6.8
26-Jun-01	14	15:00-15:50	2	7	2.7	6.9	6.7	6.4	6.8	6.4	5.9	6.2	6	6.8
26-Jun-01	14	15:00-15:50	4	7	3.1	6.3	6.7	6.8	6.2	6.8	6.5	6.2	6.7	6.9
27-Jun-01	15	07:30-09:15	4	7.3	2.2	6.9	6.9	6.7	7	7	6.8	6.9	6.8	6.9
27-Jun-01	15	07:30-09:15	7	7.1	2.9	7	6.6	6.9	7	7	6.8	6.4	6.2	6.8
27-Jun-01	15	15:05-15:40	3	6.8	5.8	6.7	6.9	6.8	5.3	6.9	5.8	6.8	5.2	6.4
27-Jun-01	15	15:05-15:40	4	6.8	3	6.9	6.7	6.9	6.9	6.9	6.9	6.7	6	6.9

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
19-Jun-01	7	08:15-09:05	7	6.7	6.8	6.6	6.3	6	6.5	6.7	6.8	6.7
19-Jun-01	7	15:25-15:55	3	6.5	6.1	6.4	6.5	6	6.1	6.8	6.8	6.3
19-Jun-01	7	15:25-15:55	4	5.6	5.8	6.1	6.5	5.3	6.1	6.5	6.8	6.3
20-Jun-01	8	08:05-09:30	4	6.3	6	6.6	6.7	6.1	6.4	6.7	6.8	6.4
20-Jun-01	8	08:05-09:30	6	6.6	5.9	6.3	6.6	6.1	6.2	6.3	6.8	6.5
20-Jun-01	8	15:00-15:30	4	6.7	6.7	5.6	6.3	5.7	6.4	6.8	5.3	6.1
20-Jun-01	8	15:00-15:30	8	6.7	6.3	6.8	5.5	6.2	6.4	6.7	5.5	6.6
21-Jun-01	9	08:00-8:40	4	6.2	6.3	6.4	6.7	5.2	6.2	6.7	6.8	6.5
21-Jun-01	9	08:00-8:40	7	6.8	6.5	6.5	6.5	5.3	6.3	6.6	6.8	6.6
21-Jun-01	9	16:00-16:45	1	6.6	6.2	6.3	6.6	6	5.6	6.8	6.9	6.6
21-Jun-01	9	16:00-16:45	4	5.6	6.3	6.6	6.6	5.8	6.4	6.9	6.8	6.5
22-Jun-01	10	8:00-09:30	4	5.2	6.2	6.4	6.7	5.6	6.2	6.5	6.7	6.3
22-Jun-01	10	8:00-09:30	5	6.6	6.6	5.8	6.2	5.5	6.5	6.7	6.8	6.7
22-Jun-01	10	15:40-16:10	2	6.3	6.3	6.4	6	6.5	5.1	6.7	6.6	6.4
22-Jun-01	10	15:40-16:10	4	6	6.3	6.6	6	5.4	5.9	6.8	6.6	6.4
23-Jun-01	11	08:05-08:45	4	6.3	6.3	6.8	6.5	5.8	6.5	6.8	6.8	6.3
23-Jun-01	11	08:05-08:45	7	6.5	6.5	6.6	6.4	5.7	6.3	6.8	6.9	6.7
23-Jun-01	11	15:45-16:15	3	6	6.8	6.5	6.2	6.3	5.5	6.9	6.4	6.2
23-Jun-01	11	15:45-16:15	4	5.8	6.2	6.4	6.1	6.1	6.2	6.8	6.6	6.4
24-Jun-01	12	10:10-10:40	1	6.2	6.1	6.7	7	6.1	5	7.2	7.3	7.1
24-Jun-01	12	10:10-10:40	4	6.1	6.6	6.9	6.8	6.4	5.9	7.4	7.1	6.9
24-Jun-01	12	16:00-16:40	4	6.1	5.8	6.4	5.6	5.9	5.1	6.8	6.8	6.1
24-Jun-01	12	16:00-16:40	5	6.6	5.2	5.8	5.5	4.8	5.6	6.9	6.9	6.1
25-Jun-01	13	07:35-09:15	4	6.5	6.3	6.7	6.4	5.8	5.8	6.9	6.9	6.8
25-Jun-01	13	07:35-09:15	6	6.7	6.3	6.5	5.5	5.4	5.4	6.9	6.7	6.9
25-Jun-01	13	15:00-15:40	4	6.1	5.8	6.4	6.2	5.9	4.7	7.3	7.1	6.6
25-Jun-01	13	15:00-15:40	8	6.3	5.4	6.1	6.2	5.8	5.9	7.3	7.1	6.6
26-Jun-01	14	07:15-08:20	4	6.3	6.4	6.7	6.1	6.3	5.4	6.9	6.9	6.8
26-Jun-01	14	07:15-08:20	5	6.9	6	5.9	6	5.8	5.5	6.8	7.1	6.8
26-Jun-01	14	15:00-15:50	2	6.7	5.2	5.7	6	5.5	4	6.9	6.4	6.4
26-Jun-01	14	15:00-15:50	4	6.9	5.7	6.6	6.1	5.8	5.6	6.9	6.8	6.8
27-Jun-01	15	07:30-09:15	4	6.1	5.5	6.8	6.6	5.7	5.6	7.1	6.9	6.8
27-Jun-01	15	07:30-09:15	7	7	5.4	6.2	5.9	5.5	5.1	7.1	6.8	6.7
27-Jun-01	15	15:05-15:40	3	6.8	5.2	5.8	5.9	4.7	4.8	6.8	6.9	6.5
27-Jun-01	15	15:05-15:40	4	6	6.7	6.3	5.8	4.8	5.7	7	6.3	6.9

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
27-Jun-01	15	07:30-09:15	4	7.3	2.2	6.9	6.9	6.7	7	7	6.8	6.9	6.8	6.9
27-Jun-01	15	07:30-09:15	7	7.1	2.9	7	6.6	6.9	7	7	6.8	6.4	6.2	6.8
27-Jun-01	15	15:05-15:40	3	6.8	5.8	6.7	6.9	6.8	5.3	6.9	5.8	6.8	5.2	6.4
27-Jun-01	15	15:05-15:40	4	6.8	3	6.9	6.7	6.9	6.9	6.9	6.9	6.7	6	6.9
28-Jun-01	16	07:30-08:40	1	7.5	4.8	7.2	7.3	7	7.4	7	6.8	7.2	5.8	7
28-Jun-01	16	07:30-08:40	4	7.6	3.3	7.3	7.1	7	7.1	7.2	6.9	7.1	6.9	7.2
28-Jun-01	16	15:00-15:40	4	6.8	3.2	6.9	6.9	6.8	6.9	7	6.9	7	6	6.7
28-Jun-01	16	15:00-15:40	8	6.8	3.1	6.9	6.8	6.9	6.9	6.9	6.8	7	6.8	6.5
29-Jun-01	17	07:45-09:30	4	7.3	4.5	7	7	7	7.1	7.6	7.1	6.6	6.2	7
29-Jun-01	17	07:45-09:30	6	7.2	3.2	7.1	7.3	6.7	7.4	7.6	6.1	7.2	7.4	7.7
29-Jun-01	17	14:50-15:35	4	6.5	3.5	6.9	6.9	6.7	6.3	7	6.3	6.5	5.7	6.3
29-Jun-01	17	14:50-15:35	8	6.7	2.5	6.6	6.6	6.4	6.2	7	6.2	6.3	6.2	6.6
30-Jun-01	18	08:45-09:30	4	7.1	4.2	6.9	6.6	6.6	7	7.1	7	7	6	6.8
30-Jun-01	18	08:45-09:30	5	7.1	4.2	6.7	7.1	6.8	7	6.9	6.5	6.8	5.6	6.4
30-Jun-01	18	14:30-15:00	2	7	3.7	7.1	7.2	6.9	7.2	7.2	6.1	7.1	6.7	6.1
30-Jun-01	18	14:30-15:00	4	7.3	3.6	7.1	6.9	6.9	7.2	7.3	7	7.1	6.3	7.1
1-Jul-01	19	08:30-09:15	4	7.3	3.1	7.2	7.3	7.2	7.3	7.2	7.3	7.4	6.3	7.4
1-Jul-01	19	08:30-09:15	7	7.4	3.3	7.3	7.2	7.3	7.4	7.2	7.3	7.4	6.6	7.3
1-Jul-01	19	14:30-15:10	3	6.9	5.8	7	7.1	7	7	7.2	7	7.1	6.8	6.7
1-Jul-01	19	14:30-15:10	4	6.9	4.4	7	7.1	7	6.9	7.2	7	7.1	5.9	6.9
2-Jul-01	20	07:00-08:30	1	7.8	5.4	7.3	7.3	7	7.3	7.1	7.1	7.2	7	7
2-Jul-01	20	07:00-08:30	4	7.6	3.6	7.3	7.1	7	7.2	7.3	7.1	7.1	6.5	7
2-Jul-01	20	14:30-15:10	2	6.9	4.5	6.9	7	6.7	7	7.1	6.9	7	6.8	6.6
2-Jul-01	20	14:30-15:10	4	7	5	6.9	6.9	6.9	6.7	7.1	6.9	7	6.8	6.8
3-Jul-01	21	07:00-08:05	4	7.5	5.2	6.8	7.1	6.8	7	7.2	7	6.7	6.7	6.8
3-Jul-01	21	07:00-08:05	6	7.4	2.6	6.9	7	6.7	6.9	7	6.5	6.8	7	6.8
3-Jul-01	21	15:15-16:15	4	6.9	6.4	6.8	6.9	6.7	7	6.8	6.9	6.7	6.4	6.8
3-Jul-01	21	15:15-16:15	8	6.9	4.6	6.8	6.8	6.7	6.8	6.8	6.6	6.7	6.7	6.8
4-Jul-01	22	06:55-08:40	4	7.5	5.2	7	6.9	6.7	6.9	6.9	6.8	6.8	6.1	6.8
4-Jul-01	22	06:55-08:40	5	7.4	3.7	6.9	7	6.7	6.7	6	6.3	6.9	6.8	6.6
4-Jul-01	22	15:10-16:00	2	6.9	5.3	7	6.9	6.7	7	6.8	6.7	6.7	6.8	6.8
4-Jul-01	22	15:10-16:00	4	6.8	5.3	7	6.8	6.9	6.9	7	6.9	6.8	5.3	6.8
5-Jul-01	23	07:00-08:00	4	7.3	4.6	7.1	7.1	6.9	7	7.2	7	6.8	5.5	6.7
5-Jul-01	23	07:00-08:00	7	7	6.3	7.1	6.8	7	7	6.8	6.6	6.8	6.8	6.2
5-Jul-01	23	15:00-15:37	3	7.2	6.9	7.2	7.2	7.3	7.2	7.3	7.2	7.2	6.8	7.3

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
27-Jun-01	15	07:30-09:15	4	6.1	5.5	6.8	6.6	5.7	5.6	7.1	6.9	6.8
27-Jun-01	15	07:30-09:15	7	7	5.4	6.2	5.9	5.5	5.1	7.1	6.8	6.7
27-Jun-01	15	15:05-15:40	3	6.8	5.2	5.8	5.9	4.7	4.8	6.8	6.9	6.5
27-Jun-01	15	15:05-15:40	4	6	6.7	6.3	5.8	4.8	5.7	7	6.3	6.9
28-Jun-01	16	07:30-08:40	1	7	6.1	6.9	6.6	6.4	4.3	6.8	7.1	7.1
28-Jun-01	16	07:30-08:40	4	6.9	6.2	6.9	6.8	5.5	5.7	7.2	7	7
28-Jun-01	16	15:00-15:40	4	6.2	6.1	6.5	6	5	5.3	6.9	6.9	6.5
28-Jun-01	16	15:00-15:40	8	6.8	6.3	6.8	6.3	5.8	5	7.1	7.1	7
29-Jun-01	17	07:45-09:30	4	6.7	6.5	6.9	6.8	5.7	5.4	7.4	6.8	6.6
29-Jun-01	17	07:45-09:30	6	7.2	6.5	6	6.3	6.8	4	7	7.1	6.9
29-Jun-01	17	14:50-15:35	4	6	6.1	6.6	5.8	4.5	4.5	7.5	7	6.9
29-Jun-01	17	14:50-15:35	8	6.8	5.7	6.2	5.1	5.5	4.6	7.3	6.8	6.7
30-Jun-01	18	08:45-09:30	4	5.6	6.5	6.9	5.8	4.9	4.8	6.8	6.8	6.8
30-Jun-01	18	08:45-09:30	5	7.1	6.5	6.2	5.7	4.5	4.7	7	6.7	6.9
30-Jun-01	18	14:30-15:00	2	7.4	5.4	6.1	5.8	5.3	3.2	7.4	7.3	7
30-Jun-01	18	14:30-15:00	4	7.4	6.8	6.9	5.8	4.2	4.4	7.3	6.7	6.9
1-Jul-01	19	08:30-09:15	4	7.3	6.9	7.1	5.7	4.1	5.8	7.3	7.3	7
1-Jul-01	19	08:30-09:15	7	7.1	6.8	7.2	5.8	4.4	3.8	7.5	7.3	7.3
1-Jul-01	19	14:30-15:10	3	7.3	5	6.4	5.7	4.8	3.7	7.1	7.1	7.2
1-Jul-01	19	14:30-15:10	4	7.3	6.1	7	5.5	4.5	5.7	7.1	6.8	7.1
2-Jul-01	20	07:00-08:30	1	7	5.6	6.3	6.9	6.1	1.7	7	6.8	6.9
2-Jul-01	20	07:00-08:30	4	7	6.1	6.9	6.3	4.7	6.4	7	7	7.1
2-Jul-01	20	14:30-15:10	2	7.2	4.8	6.8	6.7	6	3.9	7.3	7.1	6.9
2-Jul-01	20	14:30-15:10	4	7.3	5.6	6.8	6.3	4.8	5.3	7.1	7	6.9
3-Jul-01	21	07:00-08:05	4	6.9	5.5	6.9	6.1	5	4.9	6.8	6.8	6.7
3-Jul-01	21	07:00-08:05	6	7	5.6	6.7	5.6	6.4	3.3	6.8	6.8	6.7
3-Jul-01	21	15:15-16:15	4	7.3	5.6	6.8	5.4	4.5	4.1	6.5	6.3	6.5
3-Jul-01	21	15:15-16:15	8	7.2	6.2	6.5	6.1	5.2	3.8	7	6.7	6.6
4-Jul-01	22	06:55-08:40	4	6.9	5.9	6.9	5.6	5.1	4.6	6.9	6.7	6.4
4-Jul-01	22	06:55-08:40	5	6.9	6.4	6.4	5.7	4.9	5.8	6.9	6.8	6.9
4-Jul-01	22	15:10-16:00	2	7.3	5.3	6.7	5.3	4.9	3.1	7.1	7	6.9
4-Jul-01	22	15:10-16:00	4	7.3	5.8	6.9	5.4	4.4	3.8	7.1	7	6.9
5-Jul-01	23	07:00-08:00	4	7.1	6.3	6.9	6	4.8	4.5	7	6.7	6.8
5-Jul-01	23	07:00-08:00	7	6.7	7	6.8	4.9	4.2	3.5	7	6.7	6.5
5-Jul-01	23	15:00-15:37	3	7.8	6.8	7.1	5.7	4.6	3.6	6.9	7	7.2

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
5-Jul-01	23	15:00-15:37	4	7.2	6.5	7.4	7.2	7.1	7.3	7.4	7.3	7.5	6.4	7.2
6-Jul-01	24	07:45-09:00	1	7.6	5.9	7.3	7.6	6.9	7.5	7.3	7.5	7.3	7.2	7.2
6-Jul-01	24	07:45-09:00	4	7.5	7.1	7.4	7.4	7.2	7.4	7.5	7.4	7.4	5.6	7.3
6-Jul-01	24	15:20-16:05	4	7.2	7.3	7.2	7.2	7	7.1	7.1	7.1	7.2	5.9	7.1
6-Jul-01	24	15:20-16:05	6	7	4.9	7.3	7.2	6.9	6.8	6.3	6.6	7.1	6.5	6.5
7-Jul-01	25	08:30-09:05	4	7.4	5.6	7.4	7.3	7.1	7.3	7.3	7.2	6.9	6.2	7.2
7-Jul-01	25	08:30-09:05	6	7.2	7	7.3	7.3	6.9	7.1	7.1	6.9	7.2	7	6.9
7-Jul-01	25	15:30-16:00	4	7.7	5.9	7.3	7.3	7.2	7.2	7.2	6.8	7.1	5.2	7.3
7-Jul-01	25	15:30-16:00	8	7.4	5.9	7.3	7.2	7.2	7.2	6.1	7.1	7.2	6.4	6.9
8-Jul-01	26	08:30-09:25	4	7.7	4.7	6.8	7	6.9	6.9	7.1	6.7	6.8	6.4	6.7
8-Jul-01	26	08:30-09:25	5	7.4	5.5	6.8	7	6.7	6.8	6.1	6.6	6.8	6.4	6.5
8-Jul-01	26	14:30-15:45	2	7.9	4.9	7.5	7.5	7.4	7.5	7.5	7.4	7.5	7.3	7.3
8-Jul-01	26	14:30-15:45	4	7.9	4.9	7.5	7.5	7.4	7.5	7.6	7.5	7.3	7.4	7.5
9-Jul-01	27	06:45-07:30	4	8.3	4.3	7.8	7.8	7.5	7.6	7.9	7.7	7.6	7.4	7.7
9-Jul-01	27	06:45-07:30	7	8	5.2	7.9	7.5	7.7	7.6	7.8	7.3	7.7	7.2	7
9-Jul-01	27	14:40-15:30	3	7.6	7.6	7.5	7.7	7.4	7.5	7.6	7.5	7.5	7.5	7.5
9-Jul-01	27	14:40-15:30	4	7.7	3.8	7.6	7.7	7.4	7.5	7.7	7.5	7.5	7.5	7.5
10-Jul-01	28	06:30-08:30	1	7.9	6.2	7.6	7.6	7.4	7.4	7.8	7.7	7.6	7.7	7.6
10-Jul-01	28	06:30-08:30	2	7.8	5.1	7.6	7.6	7.5	7.6	7.8	7.5	7.6	7.7	7.4
10-Jul-01	28	06:30-08:30	3	7.9	6.4	7.6	7.7	7.5	7.6	7.8	7.6	7.7	7.7	7.5
10-Jul-01	28	06:30-08:30	4	7.9	6.9	7.6	7.7	7.5	7.5	7.8	7.6	7.6	7.5	7.6
10-Jul-01	28	06:30-08:30	5	7.8	4.2	7.6	7.7	7.5	7.3	6.8	7.4	7.7	7.5	7.2
10-Jul-01	28	06:30-08:30	6	7.8	6.1	7.6	7.8	7.4	7.6	7.3	7.5	7.6	7.6	7.5
10-Jul-01	28	06:30-08:30	7	7.8	5.3	7.6	7.6	7.6	7.6	7.6	7.5	7.6	7.1	7.4
10-Jul-01	28	06:30-08:30	8	7.7	5.8	7.6	7.6	7.7	7.6	7.6	7.5	7.6	7.6	7.6
		Average		**7.0**	**5.2**	**6.8**	**6.8**	**6.6**	**6.8**	**6.8**	**6.6**	**6.6**	**6.5**	**6.6**
		Minimum		5.7	2.2	4.6	4.6	4.1	4.9	4.6	4.1	4.0	4.2	3.9
		Maximum		8.3	7.6	7.9	7.8	7.7	7.6	7.9	7.7	7.7	7.7	7.7

Appendix Table 15 (continued). Dissolved oxygen (ppm) for 28 day Hyalella azteca test (UV)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
5-Jul-01	23	15:00-15:37	4	7.9	6.6	7.2	6.1	4.5	4.3	7.3	7.1	7.2
6-Jul-01	24	07:45-09:00	1	7.8	6.8	7.3	7.3	5.1	4.1	7.2	7.2	7.2
6-Jul-01	24	07:45-09:00	4	7.8	6.7	7	6.1	4.9	5.1	7.3	7.2	7.1
6-Jul-01	24	15:20-16:05	4	7.7	6.2	6.7	5.4	4	4.2	7.2	7	7.2
6-Jul-01	24	15:20-16:05	6	7.3	5.4	6.8	5.1	3.2	4.1	7	7	7.2
7-Jul-01	25	08:30-09:05	4	7.5	6.5	6.9	6	5.8	4.9	7.2	7.3	7.3
7-Jul-01	25	08:30-09:05	6	7.2	6.2	7.2	5.7	4	4.5	7.2	7.3	7
7-Jul-01	25	15:30-16:00	4	7.7	6.9	7.2	5.7	4.7	4.1	7.3	6.9	7
7-Jul-01	25	15:30-16:00	8	7.8	5.7	6.5	5.5	5.9	3.5	7	7.2	7.3
8-Jul-01	26	08:30-09:25	4	7	6.6	6.7	6.9	4.8	5	6.8	7	7.1
8-Jul-01	26	08:30-09:25	5	6.9	6.9	6.4	6.1	5	2.8	6.8	6.9	7.1
8-Jul-01	26	14:30-15:45	2	8.3	6.2	7.4	6.5	5	3.7	7.3	7.2	7.3
8-Jul-01	26	14:30-15:45	4	8.5	6.9	7.4	7.1	4.5	3.9	7.4	7.4	7.4
9-Jul-01	27	06:45-07:30	4	7.6	6.4	7.6	7.1	5.6	5	7.5	7.3	7.5
9-Jul-01	27	06:45-07:30	7	7.3	6.6	7.6	6	4.2	4.9	7.4	7.5	7.4
9-Jul-01	27	14:40-15:30	3	8.1	7.4	7.5	6.1	4.2	3.7	7.5	7.5	7.6
9-Jul-01	27	14:40-15:30	4	8.1	7.5	7.6	6.6	4.5	3.8	7.6	7.5	7.3
10-Jul-01	28	06:30-08:30	1	7.7	7.3	7.7	6.8	5.1	5.4	7.4	7.3	7.5
10-Jul-01	28	06:30-08:30	2	7.9	6.4	7.6	6.8	5.2	4.6	7.7	7.5	7.5
10-Jul-01	28	06:30-08:30	3	8	7.1	7.7	6.2	4.9	5.7	7.7	7.5	7.4
10-Jul-01	28	06:30-08:30	4	7.8	7.1	7.7	7	4.6	5	7.7	7.4	7.6
10-Jul-01	28	06:30-08:30	5	8	7	7.6	5.8	4.9	5	7.7	7.6	7.6
10-Jul-01	28	06:30-08:30	6	8	6.8	7.6	6	5	5.8	7.7	7.6	7.6
10-Jul-01	28	06:30-08:30	7	7.8	7.1	7.7	5.9	4.5	5.6	7.7	7.6	7.5
10-Jul-01	28	06:30-08:30	8	7.6	6.5	7.7	5.9	6	5.7	7.7	7.5	7.5
		Average		**6.6**	**6.1**	**6.5**	**6.0**	**5.3**	**5.2**	**6.8**	**6.8**	**6.6**
		Minimum		3.7	4.0	4.9	4.1	3.1	1.7	4.9	4.5	4.6
		Maximum		8.5	7.5	7.7	7.3	6.8	7.0	7.7	7.6	7.6

Appendix Table 16. Water quality for 28 day *Hyalella azteca* test (UV)

pH

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	11:30	1	7.9	7.8	7.2	7.4	7.3	7.8	7.4	7.6	7.7	7.7	7.9
12-Jun-01	0	11:30	4	7.9	7.5	7.5	7.2	7.2	7.8	7.4	7.1	7.7	7.7	7.9
12-Jun-01	0	11:30	5	8.02	7.3	7.5	7.4	7.2	7.9	7.3	7.9	7.9	7.8	7.8
12-Jun-01	0	11:30	8	7.9	7.7	7.8	7.7	7.2	7.7	7.7	7.8	7.9	7.6	7.8
15-Jun-01	3	08:35-0945	4	8.08	7.79	8.02	8.05	7.82	7.98	8	8.01	7.98	8.06	8.05
15-Jun-01	3	08:35-0945	7	8.05	7.37	7.98	8.05	7.85	8.08	8.02	7.99	7.84	8.05	7.84
18-Jun-01	6	06:15-09:30	4	8.04	7.71	8.02	7.95	7.96	7.79	8.06	8.04	7.97	7.98	8.02
18-Jun-01	6	06:15-09:30	5	8.03	7.62	7.89	8.02	7.86	8.06	7.98	8.03	7.99	8.05	7.92
20-Jun-01	8	08:05-09:30	4	7.94	7.9	7.93	7.95	7.94	7.83	8	7.89	7.81	7.84	7.79
20-Jun-01	8	08:05-09:30	6	7.9	7.7	7.67	7.97	7.92	7.96	7.96	7.83	7.86	7.98	7.7
22-Jun-01	10	08:00-09:30	4	7.92	7.26	7.88	7.89	7.98	7.89	7.99	7.85	7.95	7.9	7.91
22-Jun-01	10	08:00-09:30	5	7.99	7.15	7.81	7.97	7.79	7.96	7.97	7.81	7.78	7.98	7.76
25-Jun-01	13	07:35-09:15	4	8.05	6.72	7.93	8.02	8.01	8.03	8	7.95	8.01	8.03	8.01
25-Jun-01	13	07:35-09:15	6	8.04	6.71	7.95	8.02	8.02	8.01	8.04	7.84	7.89	8.03	7.92
27-Jun-01	15	07:30-09:15	4	8.03	6.66	7.95	8.02	7.86	7.97	8	7.94	7.99	7.95	7.98
27-Jun-01	15	07:30-09:15	7	8.03	7.33	7.88	8	7.99	8.01	7.96	7.88	7.86	7.73	7.97
29-Jun-01	17	07:45-09:30	4	8.06	7.07	7.89	8.05	8.05	7.92	8.05	8.02	8.06	7.72	8
29-Jun-01	17	07:45-09:30	6	8.05	6.71	7.95	8.05	8.04	8.05	8.03	8.02	8.06	7.96	8.08
2-Jul-01	20	07:00-08:30	1	8.02	7.6	7.87	8.05	8.05	8.05	8.06	8.01	8.04	8	7.95
2-Jul-01	20	07:00-08:30	4	8.02	6.89	7.93	8.01	7.99	8.04	8.04	8.04	8.01	7.83	7.94
4-Jul-01	22	07:00-08:45	4	8.04	7.91	7.94	8.07	8.03	8.03	8.03	8	8.02	7.75	7.97
4-Jul-01	22	07:00-08:45	5	8.05	7.54	7.95	8.08	7.95	8.02	7.98	7.87	8.04	8.02	7.93
6-Jul-01	24	07:45-9:00	1	8.06	7.23	7.89	8.06	8.04	8.06	8.05	8.04	8.05	7.95	7.94
6-Jul-01	24	07:45-9:00	4	8.02	7.4	7.95	8.05	8.02	8.05	8.05	8.03	8.05	7.57	7.99
10-Jul-01	28	06:30-08:30	1	8.02	7.3	7.92	8.07	8.04	8.02	8.02	7.99	8.04	8.02	8.02
10-Jul-01	28	06:30-08:30	4	8.02	7.53	7.94	8.06	8.04	8.02	8.04	7.93	8.02	7.96	8.01
10-Jul-01	28	06:30-08:30	5	8.04	6.75	7.92	8.06	8.02	8.09	7.97	7.97	8.06	7.97	7.9
10-Jul-01	28	06:30-08:30	8	8.03	7.23	7.97	8.06	8.07	8.07	8.02	7.99	8.07	7.97	8.01
		Average		**8.01**	**7.34**	**7.86**	**7.94**	**7.87**	**7.97**	**7.93**	**7.91**	**7.95**	**7.90**	**7.93**
		Minimum		7.90	6.66	7.20	7.20	7.20	7.70	7.30	7.10	7.70	7.57	7.70
		Maximum		8.08	7.91	8.02	8.08	8.07	8.09	8.06	8.04	8.07	8.06	8.08

Appendix Table 16 (continued). Water quality for 28 day *Hyalella azteca* test (UV)

pH

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	11:30	1	7.7	7.7	7.7	7.8	7.5	7.6	7.9	7.9	7.4
12-Jun-01	0	11:30	4	7.7	7.6	7.6	7.9	7.5	7.6	7.9	7.9	7.4
12-Jun-01	0	11:30	5	7.9	7.7	7.7	7.5	7.6	7.7	7.9	7.7	7.4
12-Jun-01	0	11:30	8	7.8	7.6	7.6	7.6	7.7	7.6	7.9	7.8	7.3
15-Jun-01	3	08:35-0945	4	8.04	7.86	8.05	8.03	7.87	8.03	8.02	8.05	7.99
15-Jun-01	3	08:35-0945	7	8.06	7.92	7.97	7.56	7.84	7.81	7.94	8.05	8.01
18-Jun-01	6	06:15-09:30	4	7.92	7.81	7.88	7.79	7.81	7.72	8.11	8.06	7.98
18-Jun-01	6	06:15-09:30	5	7.97	7.94	7.92	7.82		7.89	7.9	8.08	7.92
20-Jun-01	8	08:05-09:30	4	7.78	7.66	7.82	7.97	7.73	7.75	8.03	8.04	7.81
20-Jun-01	8	08:05-09:30	6	7.91	7.67	7.86	7.94	7.7	7.75	7.93	8	7.86
22-Jun-01	10	08:00-09:30	4	7.61	7.72	7.9	7.97	7.66	7.8	8.02	7.97	7.85
22-Jun-01	10	08:00-09:30	5	7.92	7.83	7.7	7.84	7.63	7.86	7.94	7.99	7.89
25-Jun-01	13	07:35-09:15	4	7.89	7.81	7.87	7.85	7.67	7.6	7.99	8.03	7.92
25-Jun-01	13	07:35-09:15	6	7.98	7.7	7.86	7.63	7.62	7.64	7.96	8.03	7.9
27-Jun-01	15	07:30-09:15	4	7.72	7.55	7.91	7.9	7.65	7.55	8.04	8	7.98
27-Jun-01	15	07:30-09:15	7	8.03	7.55	7.71	7.72	7.56	7.47	8.02	8	7.98
29-Jun-01	17	07:45-09:30	4	7.87	7.82	7.88	7.77	7.63	7.5	7.99	8.03	7.97
29-Jun-01	17	07:45-09:30	6	8.09	7.68	7.86	7.77	7.96	7.25	7.98	8	7.93
2-Jul-01	20	07:00-08:30	1	8.03	7.52	7.91	7.94	7.81	7.14	7.86	7.89	7.86
2-Jul-01	20	07:00-08:30	4	8.02	7.67	7.94	7.79	7.46	7.58	7.9	7.92	7.88
4-Jul-01	22	07:00-08:45	4	8.01	7.65	7.97	7.7	7.55	7.39	8	8.02	8
4-Jul-01	22	07:00-08:45	5	8.04	7.84	7.9	7.68	7.53	7.68	8	7.99	8.02
6-Jul-01	24	07:45-9:00	1	8.16	7.79	7.99	8	7.45	7.3	8	8.01	7.96
6-Jul-01	24	07:45-9:00	4	8.2	7.71	7.99	7.65	7.45	7.42	8.01	8.01	7.97
10-Jul-01	28	06:30-08:30	1	8.04	7.81	8.07	7.84	7.41	7.38	7.94	7.71	7.97
10-Jul-01	28	06:30-08:30	4	8.12	7.71	8.06	7.9	7.28	7.47	8.02	7.98	7.99
10-Jul-01	28	06:30-08:30	5	8.18	7.75	8.02	7.6	7.39	7.36	8.04	8.02	7.93
10-Jul-01	28	06:30-08:30	8	8	7.62	8.02	7.58	7.49	7.54	8.04	8.02	7.97
		Average		**7.95**	**7.72**	**7.88**	**7.79**	**7.61**	**7.59**	**7.97**	**7.97**	**7.86**
		Minimum		7.61	7.52	7.60	7.50	7.28	7.14	7.86	7.70	7.30
		Maximum		8.20	7.94	8.07	8.03	7.96	8.03	8.11	8.08	8.02

Appendix Table 16. Water quality for 28 day *Hyalella azteca* test (UV)

Conductivity (umho/cm2)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	11:30	1	88	132	105	131	111	120	81	93	108	90	75
12-Jun-01	0	11:30	8	108	139	115	138	133	110	73	109	120	98	115
18-Jun-01	6	06:15-09:30	4	170	175	167	171	168	172	168	170	170	172	171
18-Jun-01	6	06:15-09:30	5	169	178	167	169	168	171	168	170	169	170	169
25-Jun-01	13	07:35-09:15	4	162	167	156	162	162	161	160	162	159	160	160
25-Jun-01	13	07:35-09:15	6	157	175	156	161	162	161	159	162	160	160	158
2-Jul-01	20	07:00-08:30	1	161	167	157	165	167	164	165	160	160	160	159
2-Jul-01	20	07:00-08:30	4	159	167	157	164	164	164	164	161	160	158	161
10-Jul-01	28	06:30-08:30	1	166	171	161	169	169	170	166	166	165	162	163
10-Jul-01	28	06:30-08:30	8	161	173	160	168	169	169	165	165	168	161	162
		Average		**150**	**164**	**150**	**160**	**157**	**156**	**147**	**152**	**154**	**149**	**149**
		Minimum		88	132	105	131	111	110	73	93	108	90	75
		Maximum		170	178	167	171	169	172	168	170	170	172	171

Ammonia (ppm)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	11:30	1	0.089	<.063	<.063	<.063	0.071	0.073	<.063	0.088	<.063	<.063	<.063
12-Jun-01	0	11:30	8	<.063	<.063	0.154	<.063	<.063	0.173	<.063	0.076	<.063	<.063	<.063
10-Jul-01	28	06:30-08:30	1	0.191	<.063	<.063	<.063	<.063	<.063	<.063	0.204	<.063	0.08	<.063
10-Jul-01	28	06:30-08:30	8	0.097	<.063	<.063	<.063	<.063	<.063	0.586	0.065	<.063	<.063	<.063
		Average		**0.102**	**<.063**	**<.063**	**<.063**	**<.063**	**0.077**	**0.170**	**0.108**	**<.063**	**<.063**	**<.063**
		Minimum		<.063	<.063	<.063	<.063	<.063	<.063	<.063	0.065	<.063	<.063	<.063
		Maximum		0.191	<.063	0.154	<.063	0.071	0.173	0.586	0.204	<.063	0.080	<.063

Appendix Table 16 (continued). Water quality for 28 day *Hyalella azteca* test (UV)

Conductivity (umho/cm2)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	11:30	1	80	85	87	113	150	88	127	115	128
12-Jun-01	0	11:30	8	110	80	150	87	145	128	124	134	106
18-Jun-01	6	06:15-09:30	4	169	169	169	169	170	167	178	171	172
18-Jun-01	6	06:15-09:30	5	170	172	170	168	170	167	174	168	171
25-Jun-01	13	07:35-09:15	4	158	161	159	160	163	165	160	161	158
25-Jun-01	13	07:35-09:15	6	158	161	159	161	162	163	159	160	158
2-Jul-01	20	07:00-08:30	1	152	161	158	158	156	178	155	156	153
2-Jul-01	20	07:00-08:30	4	152	158	157	157	158	160	155	157	153
10-Jul-01	28	06:30-08:30	1	158	159	163	163	161	163	162	167	162
10-Jul-01	28	06:30-08:30	8	160	160	163	163	160	167	162	167	161
		Average		**147**	**147**	**154**	**150**	**160**	**155**	**156**	**156**	**152**
		Minimum		80	80	87	87	145	88	124	115	106
		Maximum		170	172	170	169	170	178	178	171	172

Ammonia (ppm)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	11:30	1	<.063	<.063	0.074	0.122	0.121	<.063	0.11	0.121	0.272
12-Jun-01	0	11:30	8	<.063	<.063	0.093	<.063	0.076	<.063	0.156	0.105	0.194
10-Jul-01	28	06:30-08:30	1	<.063	<.063	<.063	0.139	0.294	0.071	<.063	.<063	.<063
10-Jul-01	28	06:30-08:30	8	<.063	<.063	<.063	0.475	<.063	0.07	0.139	.<063	.<063
		Average		**<.063**	**<.063**	**<.063**	**0.192**	**0.131**	**<.063**	**0.109**	**0.072**	**0.132**
		Minimum		<.063	<.063	<.063	<.063	<.063	<.063	<.063	<.063	<.063
		Maximum		<.063	<.063	0.093	0.475	0.294	0.071	0.156	0.121	0.272

Appendix Table 16. Water quality for 28 day *Hyalella azteca* test (UV)

Hardness (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	11:30	3	64	58.4	57.6	57.6	59.6	58.4	58	60	59.6	59.6	61.6
12-Jun-01	0	11:30	7	60	57.6	58.4	61.2	60.8	65.2	59.6	60.8	61.4	60	59.2
10-Jul-01	28	06:30-08:30	3	64.4	56.4	56.8	61.8	60	56.4	56	60	56	60	59.6
10-Jul-01	28	06:30-08:30	7	59.6	63.4	60.4	60	60	63.6	60	64	60	60	60.4
		Average		**62.0**	**59.0**	**58.3**	**60.2**	**60.1**	**60.9**	**58.4**	**61.2**	**59.3**	**59.9**	**60.2**
		Minimum		59.6	56.4	56.8	57.6	59.6	56.4	56.0	60.0	56.0	59.6	59.2
		Maximum		64.4	63.4	60.4	61.8	60.8	65.2	60.0	64.0	61.4	60.0	61.6

Alkalinity (ppm CaCO3)

Date	Day	Time	Rep	A Sand	B Form Sed	C West Bear	D Ref Sand	E Ref Wood	F 1% Sand	G 1% Wood	H 10% Sand	I 10% Wood	J 25% Sand	K 25% Wood
12-Jun-01	0	11:30	2	44.4	44	44.8	44.8	46	47.2	47.2	47.8	45.2	46.4	48
12-Jun-01	0	11:30	6	44.1	48	46.8	47.2	46.8	47.6	48.8	48.4	48.4	48.4	50
10-Jul-01	28	06:30-08:30	2	44.4	52.4	49.6	50.2	48	52	48	48	48.4	47.2	48
10-Jul-01	28	06:30-08:30	6	51.6	50.4	47.6	51.6	52	52	48	48	51.6	48.8	51.2
		Average		**46.1**	**48.7**	**47.2**	**48.5**	**48.2**	**49.7**	**48.0**	**48.1**	**48.4**	**47.7**	**49.3**
		Minimum		44.1	44.0	44.8	44.8	46.0	47.2	47.2	47.8	45.2	46.4	48.0
		Maximum		51.6	52.4	49.6	51.6	52.0	52.0	48.8	48.4	51.6	48.8	51.2

Appendix Table 16 (continued). Water quality for 28 day *Hyalella azteca* test (UV)

Hardness (ppm CaCO3)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	11:30	3	59.2	60	63.2	59.6	72	59.6	59.6	63.6	68.4
12-Jun-01	0	11:30	7	60.4	60.4	60.4	60.8	59.6	60.4	63.6	65.2	62.4
10-Jul-01	28	06:30-08:30	3	64	56.4	63.6	56.4	56	60	62	60	60
10-Jul-01	28	06:30-08:30	7	56	64	64.4	67.2	60	60	60	64	56
		Average		**59.9**	**60.2**	**62.9**	**61.0**	**61.9**	**60.0**	**61.3**	**63.2**	**61.7**
		Minimum		56.0	56.4	60.4	56.4	56.0	59.6	59.6	60.0	56.0
		Maximum		64.0	64.0	64.4	67.2	72.0	60.4	63.6	65.2	68.4

Alkalinity (ppm CaCO3)

Date	Day	Time	Rep	L	M	N	O	P	Q	repeat (non-uv) H	repeat (non-uv) I	repeat (non-uv) N
				50% Sand	50% Wood	Wood #2	Sand #2	100% Sand	100% Wood	10% Sand	10% Wood	Wood #2
12-Jun-01	0	11:30	2	48	48	50.8	48	48.4	50.4	48.4	54.4	52.8
12-Jun-01	0	11:30	6	55.2	48.8	48.4	48	52	48.8	49.2	50.2	50.8
10-Jul-01	28	06:30-08:30	2	48.6	48.4	50.8	52	48	56	46	52	50
10-Jul-01	28	06:30-08:30	6	51.6	48.8	50	46	48	50	52	52	50
		Average		**50.9**	**48.5**	**50.0**	**48.5**	**49.1**	**51.3**	**48.9**	**52.2**	**50.9**
		Minimum		48.0	48.0	48.4	46.0	48.0	48.8	46.0	50.2	50.0
		Maximum		55.2	48.8	50.8	52.0	52.0	56.0	52.0	54.4	52.8