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Screening of Contaminants in Waste Area Grouping 2 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BAF	bioaccumulation factors
BCF	bioconcentration factors
BMAP	Biological Monitoring and Abatement Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRRFI	Clinch River RFI
DOE	Department of Energy
EC	effective concentration
EPA	Environmental Protection Agency
ER	environmental restoration
ESP	Environmental Surveillance Program
FFA	Federal Facility Agreement
HEAST	Health Effects Assessment Summary Tables
HFIR	High Flux Isotope Reactor
HRE	Homogeneous Reactor Experiment
HSWA	Hazardous and Solid Waste Amendments
IRIS	Integrated Risk Information System
LC	lethal concentrations
LD	lethal dose
NAWQC	National Ambient Water Quality Criteria
NOEC	no observed effects concentration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
QSAR	quantitative structure-activity relationships
RCRA	Resource Conservation and Recovery Act of 1976
RFD	reference dose
RFI	RCRA facility investigation
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	screening index
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UCL	upper confidence limit
WAG	waste area grouping
WOC	White Oak Creek
WOCE	White Oak Creek Embayment
WOL	White Oak Lake
WOD	White Oak Dam

EXECUTIVE SUMMARY

Waste Area Grouping 2 (WAG 2) of the Oak Ridge National Laboratory (ORNL) is located in the White Oak Creek Watershed and is composed of White Oak Creek Embayment, White Oak Lake and associated floodplain, and portions of White Oak Creek (WOC) and Melton Branch downstream of ORNL facilities. Contaminants leaving other ORNL WAGs in the WOC watershed pass through WAG 2 before entering the Clinch River. Health and ecological risk screening analyses were conducted on contaminants in WAG 2 to determine which contaminants were of concern and would require immediate consideration for remedial action and which contaminants could be assigned a low priority for further study.

For screening purposes, WAG 2 was divided into four geographic reaches: Reach 1, a portion of WOC; Reach 2, Melton Branch; Reach 3, White Oak Lake and the floodplain area to the weirs on WOC and Melton Branch; and Reach 4, the White Oak Creek Embayment, for which an independent screening analysis has been completed.

Screening analyses were conducted using data bases compiled from existing data on carcinogenic and noncarcinogenic contaminants, which included organics, inorganics, and radionuclides. Contaminants for which at least one sample had a concentration above the level of detection were placed in a detectable contaminants data base. Those contaminants for which all samples were below the level of detection were placed in a nondetectable contaminants data base.

Health Risk. Screening indices were used to evaluate the potential human health risk from contaminants found in WAG 2. The screening index for a carcinogen is an estimate of exposure (ingestion, inhalation, external) multiplied by an Environmental Protection Agency (EPA)-approved or -suggested slope factor to indicate the potential lifetime risk of excess cancer. A risk $\geq 10^{-4}$ excess cancers for a lifetime exposure to carcinogens is considered an action level by the EPA. Risks between 10^{-4} and 10^{-6} excess cancers per lifetime is a range where risk levels are of concern and negotiation on remedial action alternatives occurs and additional investigation is probably justified. A risk below 10^{-6} excess cancers per lifetime indicates that a carcinogen is of little concern and can be assigned a low priority for further investigation.

Screening indices for noncarcinogens are an estimate of the daily ingestion or inhalation of the contaminant divided by a "reference dose (RfD) factor". The RfD is an EPA-approved daily noncarcinogenic contaminant exposure level below which adverse effects should not occur. For noncarcinogens a screening index ≥ 1.0 is considered an action level, an index between 0.1 and 1.0 requires further investigation before taking action, and an index ≤ 0.1 indicates a low priority for further action.

A conservative and nonconservative screening approach was used in the health risk analysis. Conservative screening is designed to not underestimate potential risk and was used to identify contaminants with a low priority for further consideration; nonconservative screening is designed to provide a more realistic estimate of potential risk and was used to identify contaminants that have a high priority and require immediate consideration for remedial action. In addition an intruder (illegal hunter/fisherman)

scenario was included, which represents a realistic, although highly improbable, situation that could occur under current conditions.

Because relatively high levels of ^{137}Cs are known to exist in the sediment and floodplain soils of White Oak Lake, the area will require remedial action before public access is allowed. However, WAG 2 is surrounded by a personnel exclusion fence that is patrolled on a regular schedule, and it is highly unlikely that institutional control will be lost in the near future. Therefore, only the following four hypothetical exposure pathways were considered: (1) external exposure to sediment or floodplain soils, (2) ingestion of fish, (3) ingestion of soil, and (4) ingestion of water. Analytical results were available for all media in these pathways.

Nonconservative screening of the carcinogens in the detectable contaminants data bases identified the following as high priority for remedial action: ^{60}Co in Reaches 1, 2, and 3 for external exposure, ^{137}Cs in Reaches 1 and 3 for external exposure, PCBs (Aroclor 1254) in Reach 1 and 3 for the fish ingestion, and arsenic in Reaches 2 and 3 for the drinking water pathway. Arsenic is a possible artifact because of the small number of samples with detectable concentrations.

Ten carcinogens (dichlorobromomethane, Aroclor-1254, Aroclor-1260, ^{137}Cs, ^{90}Sr, ^{3}H, ^{152}Eu, ^{134}Cs, ^{154}Eu, and ^{234}U) in the detectable contaminants data bases were classified as requiring further investigation in one or more reaches. Limited data were available for ^{134}Cs, ^{152}Eu, ^{154}Eu and ^{234}U for some of the reaches; therefore, additional analyses are needed. Although they were not classified as requiring further action, data for ^{241}Am, ^{244}Cm, ^{238}Pu, and ^{239}Pu were limited and additional data will be required.

Nonconservative screening of the detectable contaminants data bases for noncarcinogens identified only thallium in Reaches 1, 2, and 3 as a high priority contaminant. However, this is a possible artifact, because only one sample was analyzed in each reach; thus, additional data are needed. Mercury in Reach 1 in the fish ingestion pathway and arsenic in Reach 2 in the water ingestion pathway will also require further investigation because their screening indices were between 0.1 and 1.0.

Conservative screening of the detectable contaminants data bases identified the following as low priority contaminants for further consideration: 3 organics, 12 radionuclides, and most metals in one or more reaches of WAG 2. However, because of limited information on some of these contaminants, additional data will be needed.

For contaminants with no detectable concentrations, a screening was conducted using the nominal value of the detection limits. Results of the nondetectable contaminants data bases should be viewed with caution because of the uncertainty associated with the contaminant concentrations. Nonconservative screening identified as high priority contaminants one organic carcinogen (acenaphthylene) in the fish ingestion pathway and two (benzidine and n-nitrosodimethylamine) in the sediment ingestion pathway as high priority contaminants. However, better detection limits are needed or a review of source-term data is appropriate. None of the noncarcinogens in the nondetectable

contaminants data bases were identified by nonconservative screening as high priority contaminants in WAG 2.

Groundwater was screened as an independent pathway. Nonconservative screening of the detectable contaminants data base for groundwater indicated that none of the carcinogens or noncarcinogens could be assigned a high priority. However, because of the lack of verification of the limited data base, additional data will be required for groundwater. Lead was not included in the screening analysis because an EPA-approved RfD was not available, but an EPA Uptake/Biokinetic model predicted that it would be a problem in groundwater in Reaches 1 and 3.

Results of the hypothetical intruder scenario indicated that the potential lifetime risk of excess cancers was $>10^{-4}$ from the ingestion of fish in Reaches 1 and 3 and from external exposure in Reaches 1, 2, and 3. PCBs and ^{137}Cs in Reach 1 and PCBs in Reach 3 were the greatest contributors to risk in the fish ingestion pathway. Cobalt-60 and ^{137}Cs in Reaches 1 and 3 and ^{60}Co in Reach 2 had screening indices $>10^{-4}$ in the external exposure pathway.

Ecological Risk. A screening assessment of ecological effects in WAG 2 was conducted concurrently with the human health assessment. This assessment considered three lines of evidence concerning the risks to nonhuman organisms posed by contaminants in WAG 2: biological surveys, toxicity tests of ambient media, and exposure/response analysis for measured contaminant concentrations. The biological survey data indicate that aquatic effects are not severe because a diverse and productive aquatic community is found in WAG 2. However, comparison of the aquatic biota to those of reference streams indicates that the composition of the benthic invertebrate community may be modified and fish reproduction may be disrupted. Biological survey data are not available for terrestrial biota.

Recent toxicity tests of water from WAG 2 do not indicate toxicity to *Ceriodaphnia dubia* or to larval fathead minnows in 7-day exposures. No toxicity tests have been performed on sediments or soils.

Comparison of media concentrations to toxicological benchmarks produced ambiguous results because of the large number of chemicals that were not detected but had limits of detection higher than potentially toxic concentrations. Mercury and PCBs were found at potentially toxic concentrations in both water and sediments in all reaches. Aluminum, cadmium, chromium, copper, and lead exceeded national ambient water quality criteria and state standards, and twelve other metals exceeded potentially toxic concentrations. Of the chemicals that had been detected in sediments and for which available concentrations could be estimated, barium, cobalt, mercury, silver, zinc, benzene, di-n-butyl phthalate, methylene chloride, and PCBs are potentially toxic to benthic organisms. Selenium and possibly cadmium were found in fish flesh at concentrations indicative of toxic effects. Mercury and PCBs occurred in fish flesh at concentrations that are potentially toxic to piscivorous wildlife based on dietary toxicity data, and many other chemicals occurred at concentrations that would exceed the reference dose for human health effects when wildlife consumption rates were used. No analyses could be performed for toxic effects on terrestrial organisms other than piscivorous wildlife.

One can conclude from this evidence that ecotoxicological effects may be occurring in WAG 2, but they are not as severe as would be suggested by the exposure/response analysis using the reported chemical concentrations. This discrepancy is due in part to the conservatism of the screening criteria, but the authors believe that the principal factor is the inappropriateness of many of the analyses as estimators of bioavailable concentrations. Therefore, future activities should focus on estimation of actual exposure levels. In addition, chemical and biological data are needed from terrestrial portions of WAG 2. Future assessments will focus on improving the relevance of exposure/response estimates to conditions in WAG 2 and will continue to attempt to reconcile the three lines of evidence concerning ecological effects.

1. INTRODUCTION

The purpose of this report is to present the results of a health risk and ecological risk screening analysis for Waste Area Grouping 2 (WAG 2) using available data to identify contaminants and environmental pathways that will require either further investigation or immediate consideration for remediation based on the screening indices. The screening analysis will also identify contaminants that can be assigned a low priority for further investigation and those that require additional data.

WAG 2 is located in the White Oak Creek (WOC) watershed and is the integrating WAG for the Oak Ridge National Laboratory (ORNL) because it receives effluents from many upgradient WAGs. WAG 2 receives subsurface flow and surface drainage from the ORNL Main Plant area (WAG 1), from solid waste storage areas (WAGs 3, 4, 5, and 6), liquid waste seepage pits and trenches (WAG 7), and the experimental reactor facilities (WAGs 8 and 9). Any contaminated water from these WAGs flows through WAG 2 to the Clinch River. WAG 2 is surrounded by a personnel exclusion fence that is patrolled on a regular schedule.

A full-scale Remedial Investigation (RI) and an implementation of corrective measures are not planned for WAG 2 until remediation of upgradient WAGs is completed. However, there is an obvious need to have a quantitative understanding of contaminants entering WAG 2 and the fluxes of these contaminants to (1) protect the public and environment, (2) monitor contaminants released from ORNL WAGs, and (3) develop information and data for preparing a remedial action plan for WAG 2. The RI for WAG 2 (ORNL 1990) calls for characterizing the area, monitoring contaminant levels, performing a risk assessment, and identifying remedial action needs and alternatives.

The U. S. Department of Energy (DOE) Oak Ridge Reservation (ORR) was added to the National Priorities List (NPL) in December 1989. A Federal Facility Agreement (FFA) [under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendment and Reauthorization Act (SARA) and Section 6001 of the Resource Conservation and Recovery Act (RCRA)] between DOE, the Environmental Protection Agency (EPA) Region IV, and the Tennessee Department of Environment and Conservation (TDEC) has been signed. These parties intend to coordinate DOE's CERCLA/RCRA response obligation with the corrective measures required and conducted by DOE under its current permit under the Hazardous and Solid Waste Amendments (HSWA) of 1984 to RCRA of 1976, and they expect that the response actions under the FFA, together with corrective measures, will achieve comprehensive remediation of releases and potential releases of contaminants from ORNL. The current screening analysis is part of WAG 2's RI, which is being initiated in compliance with Section 3004(u) of the HSWA of RCRA.

2. DESCRIPTION OF AREA

WAG 2 is located in the WOC watershed, which has a drainage area of approximately 16.8 km^2 (6.5 sq miles) (Fig. 2.1). The creek originates on Chestnut Ridge and flows southward for approximately 2.5 km (1.6 miles) before entering the fenced area of ORNL. As the stream flows through ORNL, the flow rate is increased substantially by waste water entering the stream from ORNL facilities. Melton Branch, which has a drainage area of 3.8 km^2 (1.5 sq miles), enters WOC at km 2.5 (mile 1.56). White Oak Dam (WOD), a small earthen dam constructed in 1943, is located on WOC 1 km (0.6 miles) upstream from the Clinch River. White Oak Creek Embayment (WOCE) extends downstream from WOD to the Clinch River at km 33.5 (mile 20.8).

WAG 2 consists of the WOC drainage downstream of the ORNL discharge points and includes associated floodplain and subsurface environments. Because of the large number of waste sites and the hydrologic complexity at ORNL, hydrologic units that contain contiguous remedial action sites have been placed into WAGs. WAG 2 is made up of WOCE, White Oak Lake (WOL) and its former lake bed and current floodplain area, WOC and associated floodplain upstream to WOC km 3.45 at the 7500 Bridge on Melton Valley Drive, and Melton Branch and associated floodplain to Melton Branch km 1.5 just above the tributary entering Melton Branch from the High Flux Isotope Reactor (HFIR). Detailed maps of the area are given in the WAG 2 RI (ORNL 1990). Because WAG 2 interfaces with the other WAGs, the boundaries between WAG 2 and these WAGs have not been clearly defined.

For screening purposes, WAG 2 was divided into 4 units identified as reaches (Fig. 2.2). Reach 1 extends from the weir on WOC at km 2.65 (mile 1.56) to the 7500 bridge on Melton Valley Drive at WOC km 3.54. Reach 2 extends from the weir on Melton Branch at km 0.16 upstream to km 1.5, which is just above the tributary from HFIR. Reach 3 extends upstream from WOD to the WOC and Melton Branch weirs. Reach 4 is WOCE, which is not included in the current screening analysis because an independent screening analysis was completed for the embayment (Blaylock et al. 1991). For a detailed description and history of these areas, see the RI Plan for WAG 2 (ORNL 1990) and the Interim Site Characterization and Contaminant Screening Report on the WOCE (Blaylock et al. 1991).

2.1 WHITE OAK LAKE

WOL was created in 1943 by placing interlocking steel pilings and a sluice gate upstream from a culvert and road fill that was constructed at km 1.0 on WOC by TVA in 1941. The lake is currently maintained at an elevation of 745 ft msl which results in a standing pond behind the dam of approximately 6.9 ha (17 acres); however, the size of the standing pond has changed many times during the past five decades from the original 17.9 ha (44.2 acres) to about one acre when the lake was drained in 1955 (ORNL 1990, Blaylock et al. 1991).

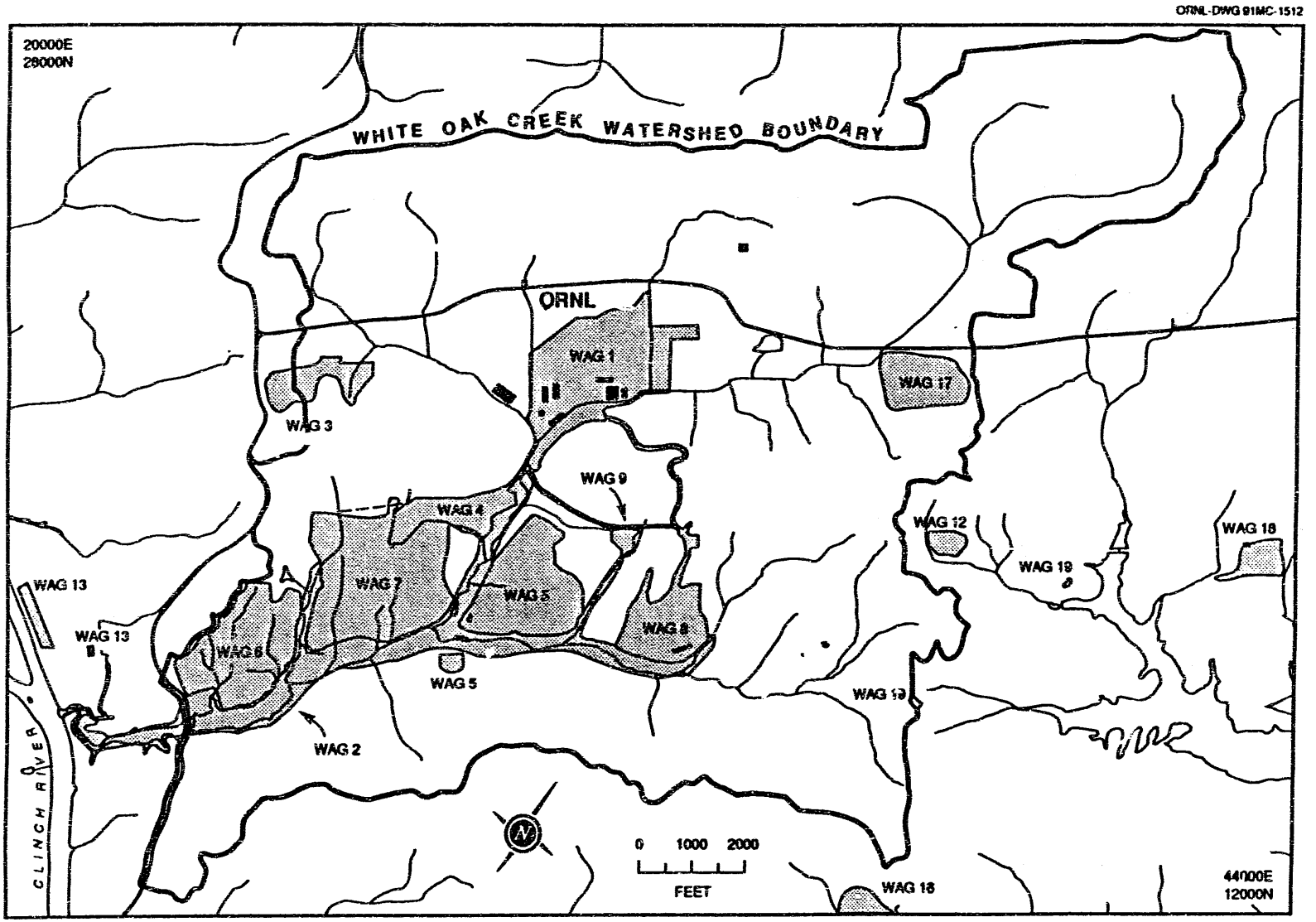


Fig. 2.1. Waste Area Grouping in White Oak Creek Watershed.

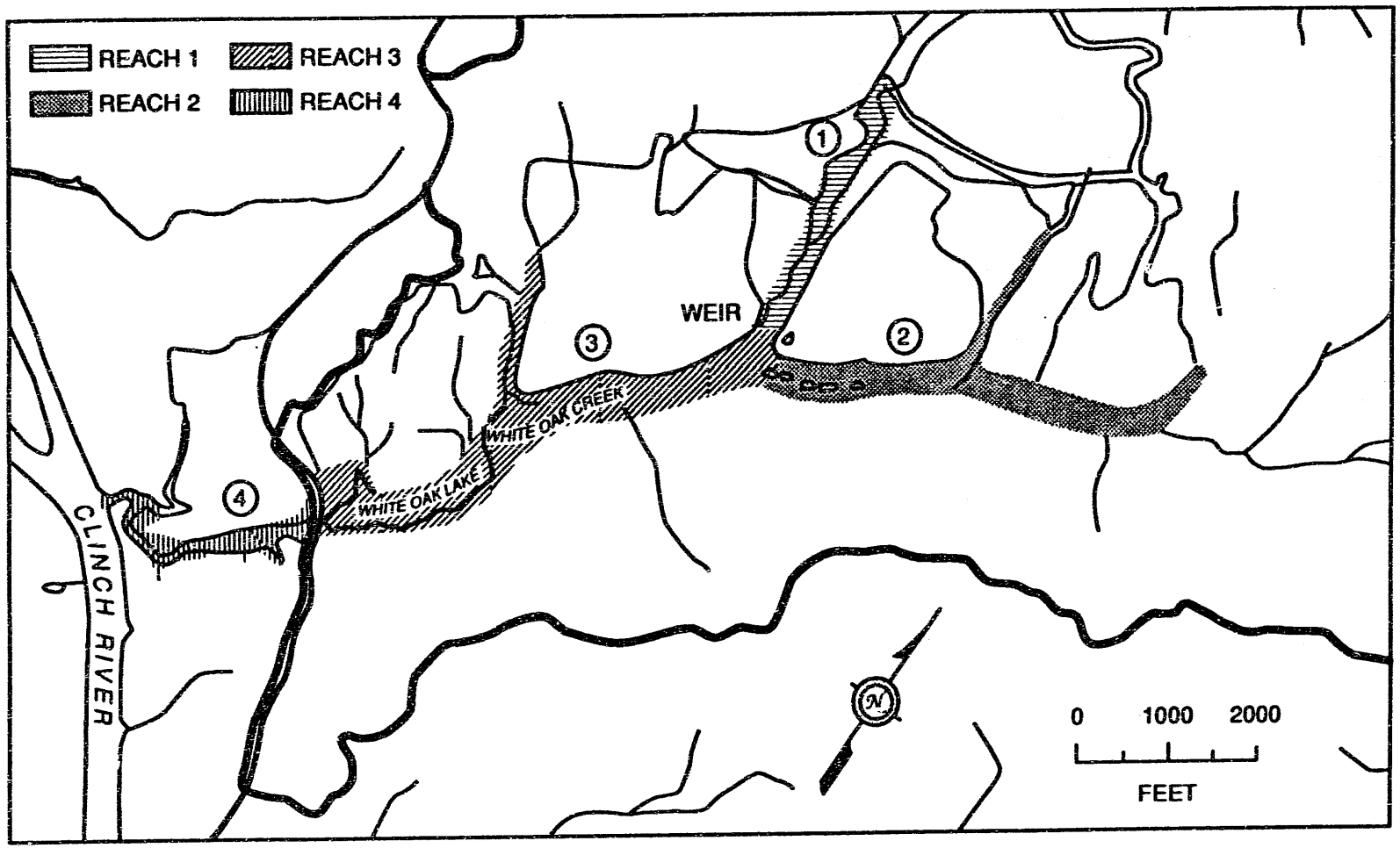


Fig. 2.2. Reaches in Waste Area Grouping 2.

The lake has served as the final settling basin for low-level radioactive effluents from ORNL since 1943. Although low levels of radioactivity have been released over the dam since 1943, current levels are much lower than releases made in previous years (Table 2.1) (Blaylock et al. 1991). Radionuclides and other contaminants have accumulated in the bottom sediments of WOL (Lomenick and Gardiner 1965; Oakes et al. 1982; Sherwood and Loar 1987; and Loar ed. 1989). The most recent estimate of the radionuclide inventory of 434 Ci of different radionuclides in the sediment of WOL was made by Blaylock and Mohrbacher (Loar ed. 1989) in 1988.

2.2 FLOODPLAIN

The former lake bed and floodplain of WOL and WOC extend from the upper reaches of the standing pond at an elevation of 745 ft msl to WOC and Melton Branch weirs. In 1943, the floodplain area was cleared of trees but is now covered with secondary growth and is being reforested with sycamore, ash, and maple trees. Since WOL is maintained at a lower elevation than when it was first formed, a large portion of the former lake bed is now exposed (ORNL 1990). The former lake bed contains concentrations of radionuclides similar to those in the sediment of WOL.

2.3 WHITE OAK CREEK

Upstream from the lake, WOC is a small stream passing through a second growth forest. The mean annual flow of WOC at the weir (km 2.65) is approximately 230 L/s (Loar ed. 1988; 1991). The floodplain upstream from the weir is covered by forest and contains, at WOC km 3.2 and km 3.4, the former sites of two earthen dikes, which were washed out in 1944. The former ponds, which contained trace quantities of ^{238}Pu, $^{239,240}Pu$, ^{241}Am, and ^{244}Cm, are now a 3-ha contaminated floodplain covered by a second growth forest. This area is estimated to contain 0.5 Ci of $^{239,240}Pu$ in the top 20 cm of soil. Another weir and monitoring station is located just below the bridge on Melton Valley Drive at WOC km 3.4.

2.4 MELTON BRANCH

Melton Branch, which originates at the eastern end of Melton Valley and joins WOC at km 2.6 (Fig. 2.1), is the largest tributary of WOC. It is a small stream with an annual average flow of about 60 L/s at the Melton Branch Weir (km 0.16) (Loar ed. 1988; 1991). No flow has been recorded on several occasions during dry periods at the upper gaging station at km 1.93 (Loar ed. 1988). Stream flow in lower Melton Branch is augmented by periodic discharges from several process waste basins and by cooling tower blowdown from HFIR. Cobalt-60 and tritium (^{3}H) are the radionuclides that are found at the highest concentrations in Melton Branch.

Table 2.1. Estimated discharges of selected radionuclides from White Oak Creek to the Clinch River (curies)

Year	^{137}Cs	^{106}Ru	^{90}Sr	^{131}I	^{60}Co	^{3}H	TRU[a]
1949	77	110	150	77		NA[b]	0.04[c]
1950	19	23	38	19			0.04
1951	20	18	29	18			0.08
1952	10	15	72	20			0.03
1953	6	26	130	2			0.08
1954	22	11	140	4	NA		0.07
1955	63	31	93	7	7		0.25
1956	170	29	100	4	46		0.28
1957	89	60	83	1	5		0.15
1958	55	42	150	8	9		0.08
1959	76	520	60	1	77		0.68
1960	31	1900	28	5	72		0.19
1961	15	2000	22	4	31		0.07
1962	6	1400	9	0.4	14		0.06
1963	4	430	8	0.4	14		0.17
1964	6	190	7	0.3	15	1,900	0.08
1965	2	69	3	0.2	12	1,200	0.50
1966	2	29	3	0.2	7	3,100	0.16
1967	3	7	5	0.9	3	13,300	1.03
1968	1	5	3	0.3	1	9,700	0.04
1969	1	2	3	0.5	1	12,200	0.20
1970	2	1	4	0.3	1	9,500	0.40
1971	1	0.5	3	0.2	1	8,900	0.05
1972	2	0.5	6	0.3	1	10,600	0.07
1973	2	0.7	7	0.5	1	15,000	0.08
1974	1	0.2	6	0.2	0.6	8,600	0.02
1975	0.6	0.3	7	0.3	0.5	11,000	0.02
1976	0.2	0.2	5	0.03	0.9	7,400	0.01
1977	0.2	0.2	3	0.03	0.4	6,200	0.03
1978	0.3	0.2	2	0.04	0.4	6,300	0.03
1979	0.2	0.1	2.4	0.04	0.4	7,700	0.03
1980	0.6	0	1.5	0.04	0.4	4,600	0.04
1981	0.2	0.1	1.5	0.04	0.7	2,900	0.04
1982	1.5	0.2	2.7	0.06	1.0	5,400	0.03
1983	1.2	0.2	2.1	0.004	0.3	5,600	0.05
1984	0.6	0.2	2.6	0.05	0.2	6,400	0.03
1985	0.4	0.007	3.0		0.6	3,700	0.008
1986	1.0	0	1.8		0.54	2,600	0.024
1987	0.6	0	1.2		0.12	2,500	0.006
1988	0.4	0	1.1		<0.07	1,700	
1989	1.2	0	2.9		0.13	4,100	
1990	1.1	0	3.1		0.12	3,100	
	696.3	6,931.6	1,204.9	175.33	325.26	175,200	5.248

[a]Transuranics.
[b]No analysis performed.
[c]Estimated from measurements made during the last quarter of 1949.

2.5 WHITE OAK CREEK EMBAYMENT

WOCE extends 1 km downstream from WOD and is the hydrologic link between WOD and the Clinch River. The surface area of the creek as it flows through the embayment is controlled by the summer and winter elevations of Watts Bar Reservoir. At the summer pool elevation of 741 ft msl at the mouth of the embayment, the creek covers approximately 8.5 acres; but, at the winter pool level, much of the embayment is a mud flat with a small stream meandering through it to the Clinch River.

A screening analysis has been completed for WOCE (Blaylock et al. 1991); therefore, the embayment will not be included in the current screening analysis of WAG 2. However, the results of the screening analysis of WOCE will be considered in the conclusions.

3. SOURCES OF INFORMATION

The data used in the screening analyses include a compilation of existing data from previous and current monitoring programs, surveys, and scientific studies. Monitoring activities and scientific studies have been conducted on WOL and the WAG 2 area for more than four decades; and, as a result, a large amount of data has accumulated. A systematic review of all available data was conducted to compile a data base suitable for a screening analysis. These data were summarized to obtain source terms for predicting the risk level to humans and biota exposed to the environmental contaminants. Data from many of the earlier radiological studies were not included in the data base because many of the radionuclides previously reported are no longer released and have relatively short half-lives; therefore, the environmental concentrations of these radionuclides are very low. For example, ^{106}Ru, which was one of the major dose contributors found in WOL in the early 1960s, is practically undetectable today because of its relatively short half-life (1 year) and because it was readily transported from the WAGs in the water. The current data bases represent measurements of contaminants in sediment, surface water, groundwater, and fish. Data used in the screening analyses are contained in the appendices.

4. SCREENING RISK ASSESSMENT FOR HUMAN EXPOSURE

4.1 APPROACH

The approach used in the current screening analysis is similar to the one used for the preliminary screening analysis of the Clinch River off-site environment (Hoffman et al. 1990) and WOCE (Blaylock et al. 1991). Because of the relatively high levels of ^{137}Cs that are known to exist in the sediments and floodplain of WOL, the area will require remedial action. In addition, WAG 2 is surrounded by a personnel exclusion fence that is patrolled on a regular schedule, and it is highly unlikely that institutional control of this area will be lost; therefore, calculations based on a homesteader scenario and inclusion of dredging and irrigation scenarios were not considered in this screening analysis. Two screening procedures—a conservative and a nonconservative approach—were used in this analysis. The conservative approach is highly unlikely to underestimate potential maximum exposures to individuals who might use the WAG 2 environment, but may substantially overestimate the majority of the actual exposures to individuals. The nonconservative screening approach provides a more realistic estimate of exposure and should not substantially overestimate the maximum exposure to individuals in the area. However, under some circumstances, nonconservative screening could underestimate maximum exposures. Calculations were also made for an intruder (illegal entry) scenario similar to the one made for the WOCE (Blaylock et al. 1991).

4.2 SCREENING INDICES

The screening index for a carcinogen is an estimate of exposure to the contaminant via external exposure, ingestion, or inhalation multiplied by the EPA approved or suggested slope factor for radioactive and nonradioactive substances to indicate the potential lifetime risk of excess cancer (EPA 1990). The slope factor is based upon an estimate of the lifetime risk of additional cancer incidence per unit of exposure.

The screening index for noncarcinogens is an estimate of the daily ingestion or inhalation of the contaminant divided by a "reference dose (RfD) factor". The RfD is an EPA-approved, daily noncarcinogenic-contaminant exposure level below which adverse effects should not occur.

To estimate the potential risk from all contaminants in a particular exposure pathway, the screening indices are summed for all contaminants in the pathway. Summation is conducted separately for carcinogens and noncarcinogens. To estimate the potential risk from exposure to multiple pathways, the screening indices are summed across pathways.

4.3 PATHWAYS

Only four exposure pathways were considered: (1) external exposure from shoreline sediment and floodplain soils, (2) ingestion of sediment and floodplain soil, (3) ingestion

of fish, and (4) the ingestion of water, both surface and groundwater. The ingestion of surface water was included in the basic screening analysis, and groundwater was screened separately (Sect. 4.8.4). Other exposure pathways were not considered because WAG 2 is surrounded by a personnel exclusion fence and it is highly unlikely that institutional control of the area will be lost in the foreseeable future. Modeling concentrations for exposure pathways was unnecessary because measured concentrations of most contaminants were available for the environmental media of concern. All scenarios are hypothetical and were created for screening purposes only.

4.4 INTRUDER SCENARIO

In addition to the conservative and nonconservative screening analyses, calculations were made for an intruder scenario. Such a scenario represents a more realistic, although highly improbable, situation that could occur under current conditions. The scenario selected involves an individual who illegally enters WAG 2 to hunt and fish. For fishing, he enters the area 10 days per year for 25 years and remains in the area for 4 hours per trip. He catches an average of 10 kg of fish per year, of which 33% is edible. The same intruder is also a deer and waterfowl hunter who enters WAG 2 to hunt deer 10 days per year for 10 years and remains in the area for 6 hours each day. The hunter kills one deer per year, which weighs 54 kg, of which 33% is edible tissue. The intruder enters WAG 2 to hunt waterfowl 5 days per year for 10 years and remains in the area for 4 hours per day. He kills a total of 10 waterfowl per year, which weigh 1 kg each, of which 33% is edible tissue. The intruder is assumed to consume all the fish and game he poaches. Because of the short amount of time the intruder spends on WAG 2, the only pathway other than fish and game ingestion that was considered was external exposure from floodplain soil and shoreline sediment.

4.5 DATA BASES

The data were divided into two categories—detectable and nondetectable contaminants. Contaminants for which at least one measurement was above the level of detection were included in the detectable data bases. Contaminants for which all measurements were below the level of detection were included in the nondetectable data bases. For conservative screening, the upper 95% confidence limit of the arithmetic mean of the lognormally distributed data for both the detectable and nondetectable contaminant data sets was used to represent the concentration in the environmental medium. For nonconservative screening, the geometric mean of each contaminant in the detectable data set and the lowest detection limit in the nondetectable data set were used as the contaminant concentration in the environmental medium.

4.6 USAGE FACTORS

Usage factors for conservative and nonconservative screening are listed in Table 4.1. These factors are similar to the ones used by Hoffman et al. (1990) and Blaylock et al.

Table 4.1. Usage factors for conservative and nonconservative screening[a]

Exposure route	Conservative screening	Nonconservative screening
Ingestion		
Fish		
Carcinogens[b]	33 g/d	3.3 g/d
Noncarcinogens[c]	65 g/d	6.5 g/d
Drinking water	2.0 L/d	0.2 L/d
Sediment	0.1 g/d	0.01 g/d
External exposure		
Radioactive sediment	1000 h/year	100 h/year

[a]Usage factors for the intruder scenario are given in Sect. 4.4.
[b]Exposure duration 350 d/year for 30 years.
[c]Exposure duration 350 d/year for 1 year.

(1991). However, EPA has reconsidered the maximum exposure duration and now recommends a lifetime exposure period of 350 days per year for 30 years. The usage factor for carcinogens is then a 30-year intake divided by a 70-year lifespan (OSWER 1991).

Noncarcinogens, unlike carcinogens, have a threshold value; therefore, a maximum intake of a noncarcinogen over a short period, which would result in exceeding the threshold value, is more critical than a long-term, low-level ingestion of the contaminant. To obtain a realistic maximum exposure for conservative screening for noncarcinogenic contaminants, the usage factor for fish ingestion was assumed to be two 0.5-lb (230-g) fish meals per week or 65 g/day for an exposure duration of one year.

4.7 SCREENING CRITERIA

A risk $\geq 10^{-4}$ excess cancers for a lifetime exposure to carcinogens is considered an action level by EPA (Federal Register, March 8, 1990). Between 10^{-4} and 10^{-6} excess cancers per lifetime is a range where risk levels are of concern, negotiation on remedial action alternatives occurs, and additional investigation is probably justified. A risk below 10^{-6} excess cancers per lifetime indicates that a carcinogen is of little concern and can be assigned a low priority for further investigation. The conservative screening approach is

used to identify contaminants that have a low priority for further investigation. In contrast, the nonconservative screening approach is used to identify contaminants with a high priority that require either immediate consideration for remedial action or further study.

4.7.1 Carcinogen Screening

Screening criteria used in this report for carcinogens are summarized in Fig. 4.1. For conservative screening of carcinogens, substances having screening indices $\leq 10^{-6}$ are low priority for further consideration. Carcinogens with screening indices between 10^{-6} and 10^{-4} require further investigation before either taking action or designating these substances as low priority. Carcinogens with screening indices $\geq 10^{-4}$ require further investigation before taking action.

For nonconservative screening of carcinogens, substances having screening indices $\geq 10^{-4}$ are high priority substances which require immediate consideration for remedial action. Carcinogens with screening indices between 10^{-4} and 10^{-6} are substances requiring further investigation before taking action (i.e., re-examination of the data base, checking parameter values, recalculating screening indices, etc.). Because nonconservative screening employs parameter values that should not greatly overestimate maximum exposures to a contaminant, nonconservative screening is not used to identify contaminants with low priority for further consideration.

4.7.2 Noncarcinogen Screening

Figure 4.2 summarizes the screening criteria for noncarcinogens. For conservative screening of noncarcinogens, contaminants with screening indices (exposure divided by an RfD) ≤ 0.1 are low priority for further consideration, and contaminants with screening indices between 1.0 and 0.1 require further investigation before either taking action or designating the substance as a low priority substance. Noncarcinogens with conservative screening indices ≥ 1.0 require further investigation before taking action.

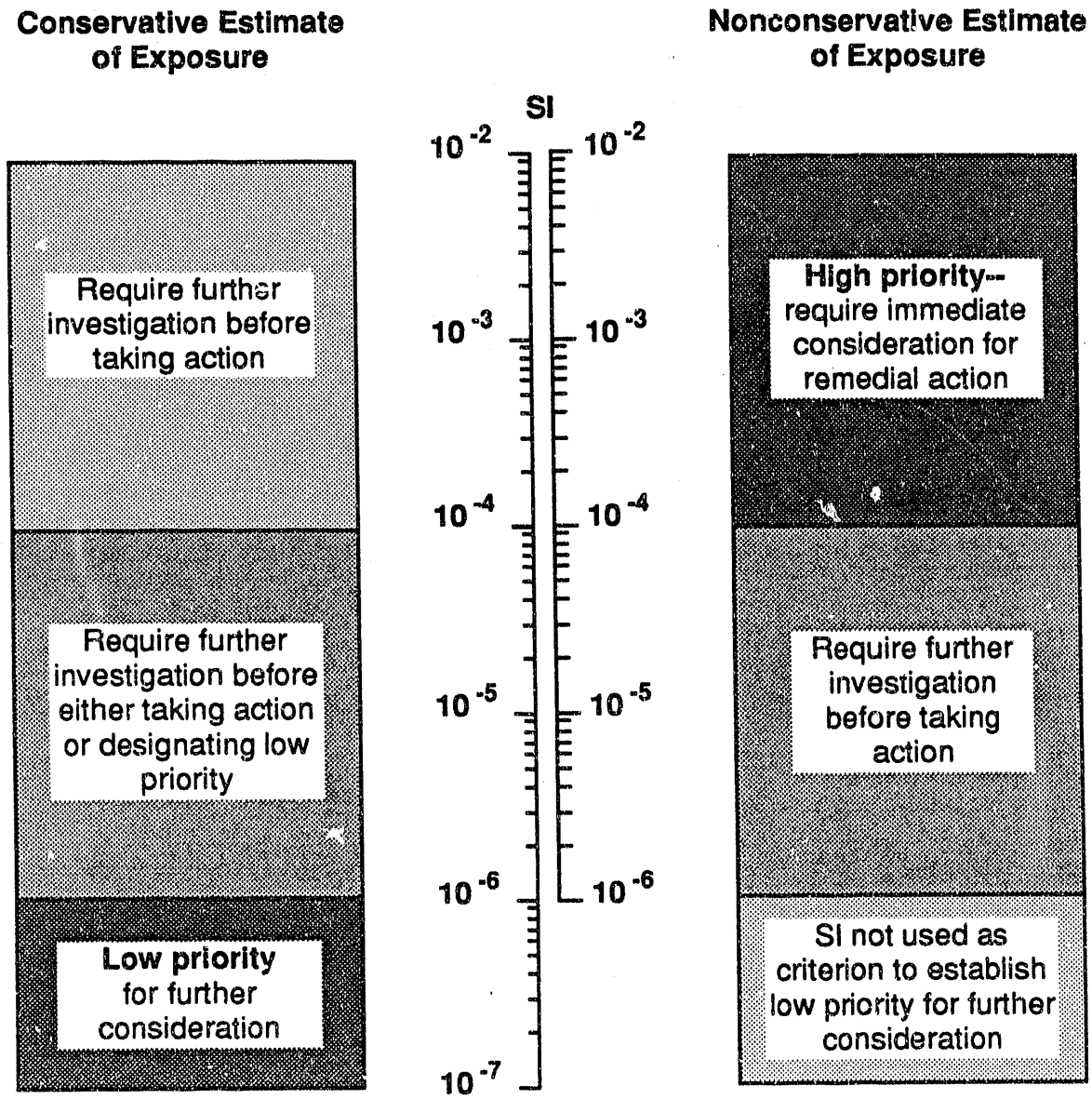
For nonconservative screening of noncarcinogens, contaminants with screening indices ≥ 1.0 are high priority substances requiring immediate consideration for remedial action, and contaminants with screening indices between 1.0 and 0.1 require further investigation before taking action. Screening indices <0.1 are not used to designate low priority substances for reasons similar to those previously given for nonconservative screening of carcinogens (i.e., nonconservative screening employs parameter values that should not greatly overestimate maximum exposures to a contaminant).

4.8 CONTAMINANT SCREENING RESULTS

4.8.1 Detectable Contaminants

Results of nonconservative and conservative screening for individual contaminants for each of the three reaches that had at least one value above the detection limit are given

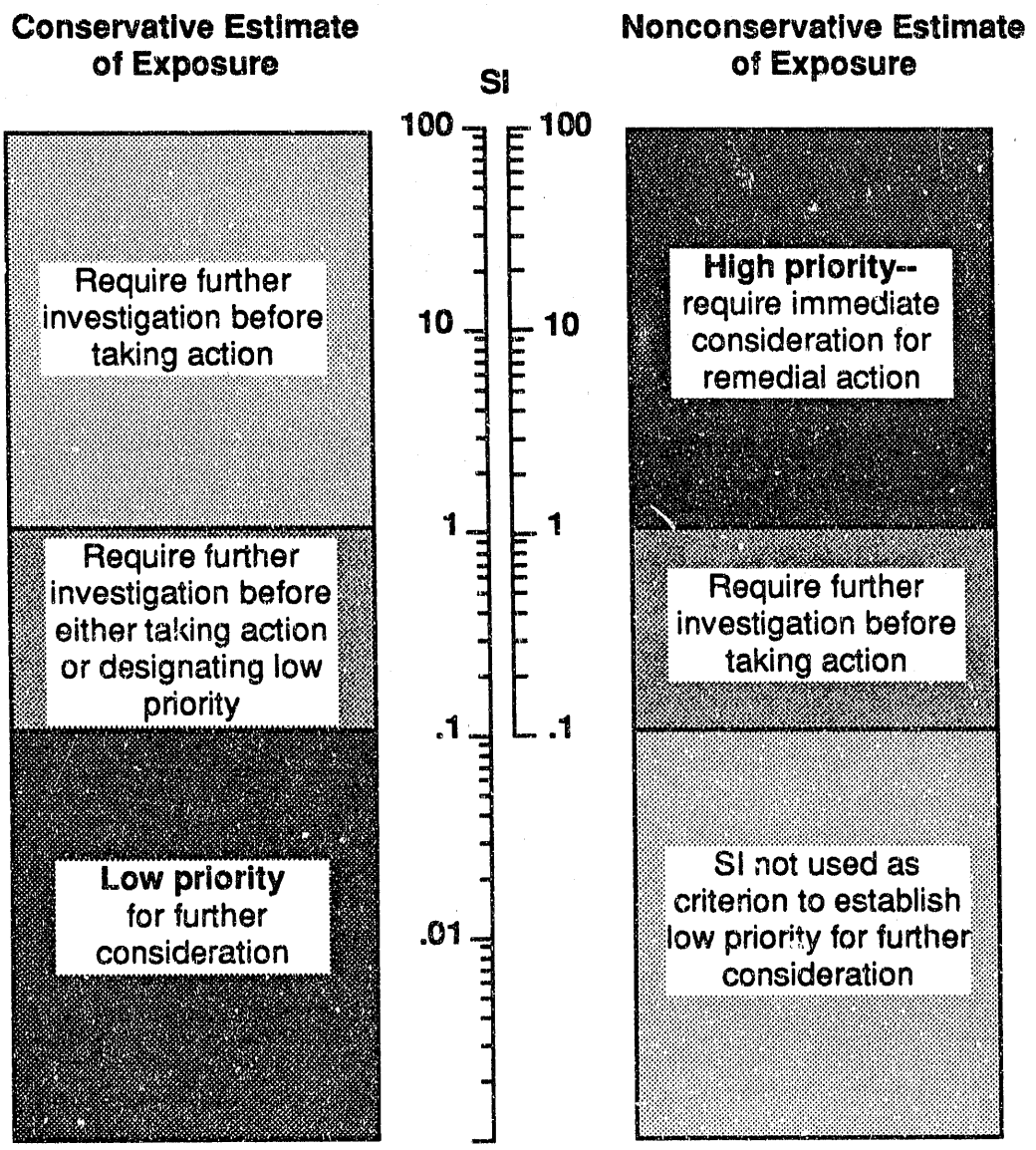
Screening Criteria for Carcinogens



Screening index (SI) = exposure multiplied by a lifetime cancer slope factor

Fig. 4.1. Criteria for conservative and nonconservative screening of carcinogens.

Screening Criteria for Noncarcinogens



Screening index (SI) = exposure divided by reference dose factor (RfD)

Fig. 4.2. Criteria for conservative and nonconservative screening of noncarcinogens.

in Appendix A and Appendix B. Results of the screening for the intruder scenario are given in Appendix C.

4.8.1.1 Nonconservative screening of detectable contaminants

Nonconservative screening is conducted to identify contaminants with a high priority for immediate consideration for remedial action. In the current screening analysis, individual carcinogens that have a screening index $\geq 10^{-4}$ and noncarcinogens that have a screening index ≥ 1.0 were classified as high priority contaminants (Figs. 4.1 and 4.2).

Carcinogens. A summary is given in Table 4.2 of nonconservative screening indices for the classes of contaminants (radionuclides, organics, and inorganics), exposure pathways, and individual reaches. Screening indices for individual carcinogens are given in Table A1 (Appendix A). Screening indices are summed for the classes of contaminants and for exposure pathways, which are then summed to obtain the total screening index for the individual reach.

All three reaches had screening indices $>10^{-4}$, requiring immediate consideration for remediation for all three (Table 4.2). Reaches 1 and 3 had screening indices $\geq 10^{-3}$. In Reach 1, the exposure pathways that contribute the greatest risk are ingestion of fish and external exposure to sediment. These pathways had screening indices of 2×10^{-4} and 7×10^{-4}, respectively. Organic contaminants contribute the greatest risk in the fish ingestion pathway. Radionuclides in sediment, the only external exposure pathway, had an external exposure screening index of 7×10^{-4}. The ingestion of water, with a screening index of 7×10^{-5}, requires further investigation.

In Reach 2 external exposure to sediment and ingestion of water had screening indices $\geq 10^{-4}$, requiring immediate consideration for remedial action (Table 4.2). Inorganics in the water ingestion pathway and radionuclides in the external exposure pathway are the primary contributors to the screening indices.

In Reach 3 all pathways, except the ingestion of sediment, had screening indices $\geq 10^{-4}$, requiring immediate consideration for remedial action (Table 4.2). External exposure to radionuclides in sediment had the highest screening index of 1×10^{-3}. Organic contaminants in the fish ingestion pathway and inorganic contaminants in the water ingestion pathway were the major contributors to the screening indices.

Individual carcinogens designated as high priority by nonconservative screening (screening indices $>10^{-4}$) and those requiring further investigation (screening indices 10^{-4} to 10^{-6}) are listed in Table A1 (Appendix A) according to contaminant type, reach, and exposure pathway. The following contaminants have screening indices $\geq 10^{-4}$ and are designated as high priority contaminants that require immediate consideration for remedial action: arsenic in water in Reaches 2 and 3; PCB (Aroclor 1254) in fish in Reaches 1 and 3; external exposure from ^{60}Co in sediment in Reaches 1, 2, and 3; and external exposure from ^{137}Cs in sediment in Reaches 1 and 3.

Table 4.2. Summary table for nonconservative screening of detected carcinogens

Reach	Media	Contaminant type	Sums of carcinogen screening indices
1	Fish	Organic	2E-04
1	Fish	Radionuclide	7E-05
1	**Fish**	**All**	**2E-04**
1	Sediment ingestion	Inorganic	1E-06
1	Sediment ingestion	Organic	5E-07
1	Sediment ingestion	Radionuclide	7E-07
1	**Sediment ingestion**	**All**	**2E-06**
1	External exposure	Radionuclide	7E-04
1	**Sediment**	**All**	**7E-04**
1	Water	Organic	5E-05
1	Water	Radionuclide	2E-05
1	**Water**	**All**	**7E-05**
1		**Reach total**	**1E-03**
2	Fish	Organic	3E-05
2	Fish	Radionuclide	2E-05
2	**Fish**	**All**	**5E-05**
2	Sediment ingestion	Inorganic	5E-07
2	Sediment ingestion	Organic	4E-07
2	Sediment ingestion	Radionuclide	2E-07
2	**Sediment ingestion**	**All**	**1E-06**
2	External exposure	Radionuclide	5E-04
2	**Sediment**	**All**	**5E-04**
2	Water	Inorganic	3E-04
2	Water	Organic	2E-05
2	Water	Radionuclide	1E-05
2	**Water**	**All**	**3E-04**
2		**Reach total**	**9E-04**
3	Fish	Organic	2E-04
3	Fish	Radionuclide	1E-05
3	**Fish**	**All**	**2E-04**
3	Sediment ingestion	Inorganic	1E-06
3	Sediment ingestion	Organic	3E-07
3	Sediment ingestion	Radionuclide	9E-07
3	**Sediment ingestion**	**All**	**2E-06**
3	External exposure	Radionuclide	1E-03
3	**Sediment**	**All**	**1E-03**
3	Water	Inorganic	2E-04
3	Water	Organic	2E-05
3	Water	Radionuclide	5E-05
3	**Water**	**All**	**2E-04**
3		**Reach total**	**1E-03**

Arsenic was detected in only 4 of 75 water samples analyzed for Reach 2 and in only 2 of 38 samples analyzed for Reach 3 (Table A1); therefore, it is questionable whether arsenic should be assigned to the category requiring immediate consideration for remedial action.

Contaminants requiring further investigation (screening indices of 10^{-4} to 10^{-6}) in different reaches and pathways are shown in Table 4.3. Dichlorobromomethane was detected in only 3 of 29 water samples in Reach 1 and may be an artifact of sample analysis (Table A1, Appendix A). Of the 7 radionuclides listed as requiring further investigation, limited data are available for ^{134}Cs, ^{152}Eu, ^{154}Eu, and ^{234}U for some of the reaches and pathways (Table A1); therefore, additional data are needed. For the same reasons, radionuclides such as ^{241}Am, ^{244}Cm, ^{238}Pu, and ^{239}Pu in sediment, which were not listed as requiring further consideration in Reach 1 because the screening was based on measurements made of only one sample, should be considered for further sampling and analysis.

Noncarcinogens. Nonconservative screening indices for reaches, classes of contaminants, and exposure pathways are summarized for the detected noncarcinogens in Table 4.4. The noncarcinogen analyses do not include an external exposure pathway because radionuclides that produce the external exposure are classified as carcinogens. Reaches 1, 2, and 3 had screening indices ≥ 1.0 and were classified as requiring immediate consideration for remediation. In all three reaches, inorganics in the water ingestion pathway was the only class of contaminant that had screening indices >1.0. Inorganics in the fish ingestion pathway in Reach 1 was the only class of contaminant that had a screening index between 0.1 and 1.0 and requires further investigation before taking action (Fig. 4.2). Table 4.5 shows that thallium in the water ingestion pathway was the only contaminant that had a screening index ≥ 1.0. Based on the screening index, thallium would be classified as a contaminant requiring immediate consideration for remedial action; however, because only one water sample from each reach was analyzed for thallium (Table A2, Appendix A), additional data are required before classifying it.

Mercury in the fish ingestion pathway in Reach 1 and arsenic in water in Reach 2 were the only contaminants that had screening indices between 0.1 and 1.0, requiring further investigation before taking action. Arsenic was detected in only 4 of 75 water samples analyzed for Reach 2; therefore, it may be an artifact of sample analysis.

4.8.1.2 Conservative screening of detectable contaminants

Conservative screening is conducted to identify contaminants that can be assigned a low priority for further investigation. In the current screening analysis, low priority contaminants include individual carcinogens that have a screening index $\leq 10^{-6}$ and noncarcinogens that have a screening index ≤ 0.1 (Figs. 4.1 and 4.2).

Carcinogens. Screening indices for the individual contaminants are summed by classes of carcinogens (radionuclides, organics, and inorganics) for each exposure pathway. The sum for each pathway and each individual reach are given in Table 4.6. All pathways and reaches had screening indices $\geq 10^{-6}$; therefore, none of the pathways or reaches can be

Table 4.3. Carcinogens assigned to different screening categories by nonconservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Reach	Exposure pathway
	High priority—require immediate consideration for remedial action Screening indices $\geq 10^{-4}$		
Inorganic	Arsenic	2,3	water ingestion
Organic	PCB-1254 (Aroclor 1254)	1,3	fish ingestion
Radionuclide	^{60}Co	1,2,3	external exposure
	^{137}Cs	1,3	external exposure
	Require further investigation before taking action Screening indices 10^{-4} to 10^{-6}		
Organic	Dichlorobromomemthane	1	water ingestion
	PCB-1254 (Aroclor 1254)	2	fish ingestion
	PCB-1254 (Aroclor 1254)	1	water ingestion
	PCB-1254 (Aroclor 1260)	1,2,3	fish ingestion
	PCBs (total)	1,2,3	water ingestion
Radionuclide	^{137}Cs	1,2,3	fish ingestion
	^{137}Cs	2	external exposure
	^{137}Cs	1,3	water ingestion
	^{90}Sr	1,2,3	water ingestion
	^{3}H	1,2,3	water ingestion
	^{152}Eu	1,2,3	external exposure
	^{152}Eu	2	water ingestion
	^{134}Cs	1,2,3	external exposure
	^{154}Eu	1,2,3	external exposure
	^{154}Eu	2	water ingestion
	^{234}U	3	water ingestion

Table 4.4. Summary table for nonconservative screening of detected noncarcinogens

Reach	Media	Contaminant type	Sums of noncarcinogen screening indices
1	Fish	Inorganic	1E-01
1	Fish	All	1E-01
1	Water	Inorganic	4E+00
1	Water	Organic	4E-03
1	Water	All	4E+00
1		Reach total	4E+00
2	Fish	Inorganic	5E-02
2	Fish	All	5E-02
2	Sediment ingestion	Inorganic	3E-03
2	Sediment ingestion	Organic	8E-06
2	Sediment ingestion	All	3E-03
2	Water	Inorganic	4E+00
2	Water	Organic	3E-03
2	Water	All	4E+00
2		Reach total	4E+00
3	Fish	Inorganic	7E-02
3	Fish	All	7E-02
3	Sediment ingestion	Inorganic	4E-03
3	Sediment ingestion	Organic	1E-05
3	Sediment ingestion	All	4E-03
3	Water	Inorganic	4E-03
3	Water	Organic	1E-05
3	Water	All	4E-03
3		Reach total	3E+00

Table 4.5. Noncarcinogens assigned to different screening categories by nonconservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Reach	Exposure pathway
	High priority—require immediate consideration for remedial action Screening indices $\geq$1.0		
Inorganic	Thallium	1,2,3	water ingestion
	Require further investigation before taking action Screening indices 0.1 to 1.0		
Inorganic	Arsenic	2	water ingestion
	Mercury	1	fish ingestion

Table 4.6. Summary table for conservative screening of detected carcinogens

Reach	Media	Contaminant type	Sums of noncarcinogen screening indices
1	Fish	Organic	3E-03
1	Fish	Inorganic	1E-03
1	**Fish**	**All**	**4E-03**
1	Sediment ingestion	Inorganic	2E-05
1	Sediment ingestion	Organic	3E-05
1	Sediment ingestion	Radionuclide	5E-05
1	**Sediment ingestion**	**All**	**1E-04**
1	External exposure	Radionuclide	1E-01
1	**Sediment**	**All**	**1E-01**
1	Water	Organic	8E-04
1	Water	Radionuclide	4E-04
1	**Water**	**All**	**1E-03**
1		**Reach total**	**1E-01**
2	Fish	Organic	2E-03
2	Fish	Radionuclide	3E-04
2	**Fish**	**All**	**2E-03**
2	Sediment ingestion	Inorganic	8E-06
2	Sediment ingestion	Organic	2E-05
2	Sediment ingestion	Radionuclide	2E-05
2	**Sediment ingestion**	**All**	**5E-05**
2	External exposure	Radionuclide	5E-02
2	**Sediment**	**All**	**5E-02**
2	Water	Inorganic	3E-03
2	Water	Organic	4E-04
2	Water	Radionuclide	1E-03
2	**Water**	**All**	**4E-03**
2		**Reach total**	**6E-03**
3	Fish	Organic	3E-03
3	Fish	Radionuclide	3E-04
3	**Fish**	**All**	**4E-03**
3	Sediment ingestion	Inorganic	5E-05
3	Sediment ingestion	Organic	4E-05
3	Sediment ingestion	Radionuclide	6E-05
3	**Sediment ingestion**	**All**	**5E-02**
3	External exposure	Radionuclide	2E-01
3	**Sediment**	**All**	**2E-01**
3	Water	Inorganic	2E-03
3	Water	Organic	5E-04
3	Water	Radionuclide	6E-04
3	**Water**	**All**	**3E-03**
3		**Reach total**	**2E-01**

given low priority for further consideration (Fig 4.1). Reaches 1 and 3 had screening indices $\geq 10^{-1}$ and Reach 2 had a screening index of 6×10^{-3}. Exposure to the sediment pathway in all reaches was the major contributor to the total screening index for each reach. Fish ingestion in Reaches 1 and 2 and the ingestion of sediment in Reach 3 were the next most important pathways.

Table 4.7 lists the carcinogens with screening indices $<10^{-6}$, which can be given a low priority for further consideration based on conservative screening. However, because of the small number of sediment samples analyzed for ^{241}Am, ^{244}Cm, ^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, and ^{238}U in Reaches 1, 2, and 3 (Table B1, Appendix B), these contaminants cannot be eliminated from consideration for the sediment pathways and require further investigation. Table 4.7 also lists contaminants (screening indices 10^{-6} to 10^{-4}) that require further investigation before either taking action or designating them as low priority and contaminants with screening indices $\geq 10^{-4}$ that require further investigation before taking action. The radionuclides already listed in this paragraph require further investigation or designation as a low priority for the water ingestion pathway. However, the data for the uranium isotopes (^{234}U, ^{235}U, and ^{238}U) are too limited to provide reliable screening results (Table B1).

Noncarcinogens. Summaries of the conservative screening indices for the noncarcinogens in the detectable data base are given in Table 4.8. All reaches had screening indices >0.1 and therefore cannot be given a low priority for further consideration. The screening indices for all reaches were $\geq 3 \times 10^{1}$; however, these indices are misleading because they result primarily from concentrations of thallium obtained from a single water sample taken from each reach. For this reason, the data are insufficient other than to conclude that thallium was detected and additional sampling is needed (Table B2, Appendix B). In addition, thallium has an RfD that is one to two orders of magnitude less than the RfDs for other inorganics so that concentrations near the detection limits can produce relatively high screening indices.

The sediment ingestion pathways in Reaches 1 and 2 have screening indices <0.1 and can be assigned low priority for further consideration, as can organics in the water ingestion pathways for all reaches. The fish ingestion pathways in Reaches 1 and 3 have screening indices ≥ 1.0 and require further investigation before taking action (Fig. 4.2). All other sediment and fish pathways have screening indices between 0.1 and 1.0, thus requiring further investigation before assigning the pathway a low priority or taking action.

Noncarcinogens that can be assigned a low priority in the detectable data base by conservative screening (screening indices <0.1) are listed by contaminant, reach, and exposure pathway in Table 4.9. Most inorganics for which data are available can be assigned a low priority for further study for sediment ingestion in all reaches. Barium, copper, mercury, nickel, and zinc can be assigned a low priority for further study in all reaches for the water and sediment ingestion pathways. All detectable noncarcinogenic organics in all reaches for which data are available can be assigned a low priority for further investigation (Table B2). Noncarcinogenic contaminants with screening indices of 0.1 to 1.0, which require further investigation before taking action or designating the

Table 4.7. Carcinogens assigned to different screening categories by conservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Reach	Exposure pathway
	Low priority for further consideration ***Screening indices $<10^{-6}$***		
Organic	Benzene	3	sediment ingestion
	Chloroform	3	sediment ingestion
	Methylene chloride	3	sediment ingestion
Radionuclide	^{241}Am	1,2,3	external exposure
	^{241}Am	1,2,3	sediment ingestion
	^{244}Cm	1,2,3	external exposure
	^{244}Cm	1,2,3	sediment ingestion
	^{60}Co	3	fish ingestion
	^{134}Cs	1,2,3	sediment ingestion
	^{152}Eu	1,2,3	sediment ingestion
	^{154}Eu	1,2,3	sediment ingestion
	^{238}Pu	1,2,3	external exposure
	^{238}Pu	1,2,3	sediment ingestion
	^{238}Pu	3	water ingestion
	^{239}Pu	1,2,3	external exposure
	^{239}Pu	1,2,3	sediment ingestion
	^{239}Pu	3	water ingestion
	^{90}Sr	2,3	sediment ingestion
	^{234}U	1,2,3	external exposure
	^{234}U	1,2,3	sediment ingestion
	^{235}U	1,2,3	external exposure
	^{235}U	1,2,3	sediment ingestion
	^{238}U	1,2,3	external exposure
	^{238}U	1,2,3	sediment ingestion
	Require further investigation before taking action or designating as low priority ***Screening indices 10^{-6} to 10^{-4}***		
Inorganic	Arsenic	1,2,3	sediment ingestion
	Beryllium	1,2,3	sediment ingestion
Organic	Benzene	1	water ingestion
	Chloroform	1,2,3	water ingestion
	Dichlorobromomethane	1	water ingestion
	Methylene chloride	1,2,3	water ingestion
	PCB-1254 (Aroclor 1254)	1,2,3	sediment ingestion
	PCB-1260 (Aroclor 1260)	1,2	sediment ingestion
	Tetrachloroethylene	1,3	water ingestion
	Trichloroethylene	1,2,3	water ingestion

Table 4.7 (continued)

Contaminant type	Contaminant	Reach	Exposure pathway
Radionuclide	^{241}Am	3	water ingestion
	^{244}Cm	3	water ingestion
	^{60}Co	1,2,3	sediment ingestion
	$^{60}C0$	1,3	water ingestion
	^{137}Cs	1,2,3	sediment ingestion
	^{137}Cs	2,3	water ingestion
	^{154}Eu	1	external exposure
	^{154}Eu	2	water ingestion
	^{90}Sr	3	fish ingestion
	^{90}Sr	1	sediment ingestion
	^{234}U	3	water ingestion
	^{235}U	3	water ingestion
	^{238}U	3	water ingestion
	Require further investigation before taking action Screening indices $\geq 10^{-4}$		
Inorganic	Arsenic	2,3	water ingestion
Organic	PCBs (total)	1,2,3	water ingestion
	PCB-1254 (Aroclor 1254)	1,2,3	fish ingestion
	PCB-1254 (Aroclor 1254)	1	water ingestion
	PCB-1260 (Aroclor 1260)	1,2,3	water ingestion
Radionuclide	^{60}Co	1,2,3	external exposure
	^{60}Co	2	water ingestion
	^{134}Cs	1,2,3	external exposure
	^{137}Cs	1,2,3	fish ingestion
	^{137}Cs	1,2,3	external exposure
	^{137}Cs	1	water ingestion
	^{152}Eu	1,2,3	external exposure
	^{152}Eu	2	water ingestion
	^{154}Eu	2,3	external exposure
	^{3}H	1,2,3	water ingestion
	^{90}Sr	1,2,3	water ingestion

Table 4.8. Summary table for conservative screening of detected noncarcinogens

Reach	Media	Contaminant type	Sums of noncarcinogen screening indices
1	Fish	Inorganic	2E+00
1	**Fish**	**All**	**2E-00**
1	Sediment ingestion	Inorganic	9E-02
1	**Sediment**	**All**	**9E-02**
1	Water	Inorganic	4E+01
1	Water	Organic	6E-02
1	**Water**	**All**	**4E+01**
1		**Reach total**	**4E+01**
2	Fish	Inorganic	8E-01
2	**Fish**	**All**	**8E-01**
2	Sediment ingestion	Inorganic	4E-02
2	Sediment ingestion	Organic	2E-04
2	**Sediment ingestion**	**All**	**4E-02**
2	Water	Inorganic	4E+01
2	Water	Organic	5E-02
2	**Water**	**All**	**4E+01**
2		**Reach total**	**4E+01**
3	Fish	Inorganic	1E+00
3	**Fish**	**All**	**1E-00**
3	Sediment ingestion	Inorganic	2E-01
3	Sediment ingestion	Organic	3E-04
3	**Sediment ingestion**	**All**	**2E-01**
3	Water	Inorganic	3E+01
3	Water	Organic	6E-02
3	**Water**	**All**	**3E+01**
3		**Reach total**	**3E+01**

Table 4.9. Noncarcinogens assigned to different screening categories by conservative screening of data base where at least one value for each contaminant was above detection limits

Contaminant type	Contaminant	Reach	Exposure pathway
	Low priority for further consideration *Screening indices <0.1*		
Inorganic	Antimony	1,2	sediment ingestion
	Arsenic	1,2,3	sediment ingestion
	Barium	1,2,3	sediment ingestion
	Barium	1,2,3	water ingestion
	Beryllium	1,2,3	sediment ingestion
	Boron	1,2,3	sediment ingestion
	Cadmium	1,2,3	sediment ingestion
	Chromium	1,2,3	sediment ingestion
	Chromium	1,2	water ingestion
	Copper	1,2,3	fish ingestion
	Copper	1,2,3	sediment ingestion
	Copper	1,2,3	water ingestion
	Mercury	1,2,3	sediment ingestion
	Mercury	1,2,3	water ingestion
	Molybdenum	1,2,3	sediment ingestion
	Nickel	1,2,3	sediment ingestion
	Nickel	1,2,3	water ingestion
	Selenium	3	fish ingestion
	Selenium	1,2,3	sediment ingestion
	Silver	1,2,3	sediment ingestion
	Tin	1,2,3	sediment ingestion
	Vanadium	1,2,3	sediment ingestion
	Vanadium	2	water ingestion
	Zinc	1,2,3	fish ingestion
	Zinc	1,2,3	sediment ingestion
	Zinc	1,2,3	water ingestion
Organic	1,1-Dichloroethane	2	water ingestion
	1,2-Dichloroethane (total)	2	water ingestion
	4-Methyl-2-pentanone	3	water ingestion
	Acetone	1,2,3	water ingestion
	Carbon disulfide	1,2,3	water ingestion
	Chloroform	3	sediment ingestion
	Chloroform	1,2,3	water ingestion
	Dichlorobromomethane	1	water ingestion
	Di-n-butyl phthalate	2,3	sediment ingestion
	Ethylbenzene	1	water ingestion
	Methylene chloride	3	sediment ingestion
	Methylene chloride	1,2,3	water ingestion
	Tetrachloroethylene	1.3	water ingestion
	Toluene	3	sediment ingestion
	Toluene	1,2,3	sediment ingestion
	Xylene	1,2,3	water ingestion
			water ingestion

Table 4.9 (continued)

Contaminant type	Contaminant	Reach	Exposure pathway
	Require further investigation before taking action or designating as low priority Screening indices 0.1 to 1.0		
Inorganic	Antimony	3	sediment ingestion
	Cadmium	1,2,3	fish ingestion
	Cadmium	2	water ingestion
	Chromium	3	water ingestion
	Mercury	2,3	fish ingestion
	Selenium	1,2,3	fish ingestion
	Require further investigation before taking action Screening indices ≥ 1.0		
Inorganic	Arsenic	2,3	water ingestion
	Mercury	1	fish ingestion
	Thallium	1,2,3	water ingestion

contaminant as low priority, and contaminants with screening indices $\geq$1.0, which require further investigation before taking action, are also listed in Table 4.9.

4.8.1.3 Intruder scenario

The intruder scenario is a hypothetical situation that is intended to represent a maximally exposed individual who enters WAG 2 illegally to hunt and fish and consumes game and fish from the area. Only the detectable contaminants data bases were used in the intruder scenario. The assumptions are reasonable but would be applicable to very few individuals because of security and other safeguards that are intended to limit human access to the area. The ingestion rates used in the intruder scenario are less conservative than those used in the nonconservative screening because the intruder enters WAG 2 a limited number of times. Only the ingestion of fish, venison, and waterfowl and external exposure to radionuclides accumulated in the shore line sediment and floodplain soil were considered in this scenario. The ingestion of waterfowl was considered only for Reach 1 (Table 4.10) because most of the waterfowl are associated with WOL and the floodplain area. The ingestion of soil and the consumption of water were not considered because of the limited amount of time (4 to 6 hours per trip) the intruder would spend in the WAG 2 area.

Carcinogens. Calculations for the intruder scenario were made using only the detectable contaminants data base. Results of these calculations are summarized for the carcinogens in Table 4.10 for each class of contaminant (organics, inorganics, and radionuclides), for each exposure pathway, and for each reach. The screening indices for individual carcinogens are given in Table C1 (Appendix C) along with the geometric means of the data that were used as the concentration of each contaminant. All reaches had screening indices $>10^{-4}$. The fish ingestion pathway contributed the greatest risk for all reaches; radionuclides in fish contributed the greatest risk in Reaches 1 and 2, and organic contaminants in fish the greatest in Reach 3.

The screening indices for the external exposure pathway for all reaches were $>10^{-4}$, which was less than the values calculated for nonconservative screening. This result can be attributed to the relatively short time (maximum of 120 hours per year for 25 years or less) that the intruder spent in WAG 2. Individual radionuclides and their contribution to the external exposure screening indices are given in Table C2 (Appendix C).

Noncarcinogens. Results of the calculations for noncarcinogens in the intruder scenario are listed in Table 4.11, and the screening indices for individual contaminants are given in Table C3 (Appendix C), along with the geometric mean for the concentrations of individual contaminants. Only the ingestion pathways were considered for the noncarcinogens, and the sums of the screening indices for noncarcinogens for all reaches were <1.0. The noncarcinogen showing the highest screening index (1.5×10^{-1}) was mercury in fish in Reach 1.

Table 4.10. Summary table for intruder screening scenario for detected carcinogens

Reach no.	Exposure pathway	Contaminant type	Carcinogen screening indices
1	Fish ingestion	Radionuclide	2E-04
1	Fish ingestion	Organic	2E-04
1	**Fish total**		**3E-04**
1	Venison ingestion	Radionuclide	1E-06
1	**Total ingestion**		**3E-04**
1	External Exposure	Radionuclide	4E-04
1	**Reach total**		**8E-04**
2	Fish ingestion	Radionuclide	4E-05
2	Fish ingestion	Organic	3E-05
2	**Fish total**		**8E-05**
2	Venison ingestion	Radionuclide	1E-06
	Total ingestion		**8E-05**
2	External Exposure	Radionuclide	3E-04
2	**Reach total**		**4E-04**
3	Fish ingestion	Radionuclide	3E-05
3	Fish ingestion	Organic	2E-04
3	**Fish total**		**2E-04**
3	Venison ingestion	Radionuclide	1E-06
3	Duck flesh ingestion	Radionuclide	4E-07
3	**Game total**		**1E-06**
3	**Total ingestion**		**2E-04**
3	External Exposure	Radionuclide	6E-04
3	**Reach total**		**8E-04**

Table 4.11. Summary table for intruder screening scenario for detected noncarcinogens

Reach no.	Exposure pathway	Contaminant type	Noncarcinogen screening indices
1	Fish ingestion	Inorganic	2E-01
1	**Reach total**		**2E-01**
2	Fish ingestion	Inorganic	6E-02
2	**Reach total**		**6E-02**
3	Fish ingestion	Inorganic	9E-02
3	Duck flesh ingestion	Inorganic	7E-03
3	**Reach total**		**1E-01**

4.8.2 Nondetectable Contaminants

The nondetectable contaminant data base contained approximately three times as many contaminants as the detectable contaminant data base. Some contaminants are included in both data bases because the contaminant was present in detectable quantities in one medium and not in another. Screening would not be complete without including the nondetectable contaminants; however, caution should be exercised in interpreting the results because of the uncertainty associated with the contaminant concentrations.

4.8.2.1 Nonconservative screening

Nonconservative screening of the nondetectable contaminants is used to identify contaminants that have a high priority for action to lower detection limits and those for which source-term data are needed to determine whether, in the past, extremely small, if any, quantities of these contaminants have been released from ORNL. Results of the nonconservative screening for the nondetectable contaminant data bases are given in Tables D1 and D2 (Appendix D). Screening indices for individual contaminants are listed according to exposure pathway and reach, and concentrations are the minimum detection limits in the data base. Pathways for which values are not given are either in the detectable contaminant data base or data were not available. Screening indices were not summed for contaminant type, pathway, or reach because the uncertainty resulting from using detection limits would make the sums overly conservative.

Carcinogens. Only three organic carcinogens—acenaphtylene in the fish ingestion pathway and benzidine and n-nitrosodimethylamine in the sediment ingestion

pathway—had screening indices $>10^{-4}$ (Table D1, Appendix D). Normally, such screening indices would identify these carcinogens as high priority contaminants that require immediate consideration for remedial action; however, because the screening analysis was based on minimum detection limits, the indices indicate that better detection limits are needed and/or a review of source-term data is appropriate. Two inorganics and 57 organic contaminants had screening indices between 10^{-4} and 10^{-6}, which would require further investigation before taking action.

Noncarcinogens. All noncarcinogens in the nondetectable contaminant data base had screening indices <1.0 (Table D2, Appendix D); therefore, they would not be considered high priority contaminants requiring immediate consideration for remedial action. Antimony in the fish and water ingestion pathways, 4,6-dinitro-ortho-cresol in the fish ingestion pathway, and heptachlor epoxide in the sediment ingestion pathway had screening indices between 0.1 and 1.0 and would require further investigation before taking action.

4.8.2.2 Conservative screening

The purpose of conservative screening is to identify contaminants with a low priority for further consideration: contaminants that have screening indices $<10^{-6}$ for carcinogens and <0.1 for noncarcinogens (Figs. 4.1 and 4.2). Values for nondetectable contaminants are based on detection limits; therefore, contaminant concentrations that were used in the screening are greater than concentrations actually present in the samples. This bias can significantly increase the conservatism of the screening, so the number of contaminants identified as low priority will probably be small.

Carcinogens. Conservative screening of the nondetectable contaminants data base for carcinogens showed that 25 organic contaminants in the sediment ingestion pathway had screening indices $<10^{-6}$ and can be assigned low priority for further consideration (Table E1, Appendix E). Two inorganics, arsenic and beryllium, in the fish and water ingestion pathways and 46 organics in at least one pathway had screening indices $\geq 10^{-4}$ and would require further investigation before taking action. The remaining organic contaminants had screening indices between 10^{-4} and 10^{-6}, which would require further investigation before taking action or designating the contaminants as low priority.

Noncarcinogens. Inorganic noncarcinogens that had screening indices <0.1 and can be assigned low priority for further considerations include the following: chromium and nickel in the fish ingestion pathway; boron, vanadium, and tin in the water ingestion pathway; cyanide in the sediment ingestion pathway; and silver and beryllium in the fish and water ingestion pathways (Table E2, Appendix E). Thirteen organics in the fish ingestion pathway and two in the sediment ingestion pathways also had screening indices <0.1 and can be assigned low priority for further consideration.

Inorganic noncarcinogens that have screening indices >1.0 in one or more reaches and that would require further investigation before taking action are antimony in the fish ingestion and antimony and arsenic in the water ingestion pathways. Molybdenum, selenium, and cadmium in the water ingestion pathway, and thallium in the sediment

ingestion pathway have screening indices between 0.1 and 1.0. Eight organics contaminants in the fish ingestion pathway, including two in both the fish and sediment ingestion pathways, had screening indices >1.0. The remaining organics listed in Table E2 (Appendix E) have screening indices between 0.1 and 1.0 and would require further consideration before taking action or designating the contaminants as low priority.

4.8.3 Nonclassified Contaminants

Contaminants in the detectable and nondetectable contaminants data bases for which RfDs or slope factors were not available are listed in Table 4.12. Dose conversion factors are available for the radionuclides listed in Table 4.12; however, the EPA has not provided slope factors for these radionuclides. Groundwater is not included in the nondetectable contaminant listing because the data are undergoing verification. Lead is the only contaminant that was detected in fish (Reaches 1 and 3) that did not have a screening factor, but it is doubtful that lead concentrations would present a problem in the fish ingestion pathway (Sect. 4.8.5).

4.8.4 Groundwater

Groundwater was screened independently of the other pathways for Reaches 1, 2, and 3. Either groundwater or surface water can be used for the water ingestion pathway, but because the consumption rate (2 L/d) is limited, only one source can be summed with the other pathways to obtain a screening index for a reach. Because the data base for groundwater is being revised and additional data are becoming available, the decision was made to use surface water in the screening analysis and perform independent calculations for the groundwater pathway. In addition, the data base for the nondetectable contaminants for groundwater has not been verified; therefore, conservative and nonconservative screening will be conducted only on the detectable data base.

4.8.4.1 Nonconservative screening of detectable contaminants in groundwater

Carcinogen. Screening indices for the nonconservative screening of carcinogens in the groundwater are given in Appendix F for each class of contaminant, exposure pathway, and reach. Reach 3 had a screening index for groundwater $\geq 10^{-4}$, indicating it as a high priority reach requiring immediate consideration for remedial action (Table F1, Appendix F). However, screening indices for individual contaminants in the groundwater in Reach 3 range from 2×10^{-5} to 8×10^{-9}, and only the contaminants that have screening indices between 10^{-4} and 10^{-6} require investigation before taking action. One of the major contributors to the screening index in Reach 3 was arsenic, but because it was detected in only 2 of 74 samples analyzed, it is a possible artifact of the analytical procedure. The other major contributors to the screening index in Reach 3 were the radionuclides ^{224}Ra, ^{234}Th, and ^{234}U. These data are questionable because of the small number of samples analyzed for these radionuclides; therefore, additional sampling is required. Reaches 1 and 2 had total screening indices 1×10^{-5} and 2×10^{-5}, respectively, indicating that further action is required before taking action. In Reach 1, the major contributor to the screening index was beryllium, with a screening index of 1×10^{-5}. In Reach 2, the major contributor was tritium, with a screening index of 1×10^{-5}. Additional data are needed because of the

Table 4.12. Contaminants that were reported in either the detectables or nondetectables data bases for which screening factors were not available

Detectable contaminants

Media name	Contaminant name	Reach	Ratio of detected to total samples	Geometric mean (mg/kg wet)	95% upper conf bound on mean (mg/kg wet)
Fish	Lead	1	7/43	4.3E-02	1.7E-01
Fish	Lead	3	7/36	5.6E-02	2.1E-01
				(mg/L)	(mg/L)
Groundwater	1,2-Benzenedicarboxylic acid	3	1/5	7.9E-03	1.2E-02
Groundwater	2-Pentanone(4,4-dimethyl)	3	1/1	4.0E-03	4.0E-03
Groundwater	Aluminum	1	13/19	4.4E-01	9.0E+00
Groundwater	Aluminum	2	12/15	2.5E-01	4.7E+00
Groundwater	Aluminum	3	19/35	2.4E-01	4.7E+00
Groundwater	Benzenamine, n-phenyl	3	1/1	7.0E-03	7.0E-03
Groundwater	Benzene, methyl	3	1/5	4.2E-03	6.1E-03
Groundwater	Beta-BHC	3	2/7	6.3E-05	9.8E-05
Groundwater	Cobalt	1	3/19	7.0E-03	1.9E-02
Groundwater	Cobalt	2	2/15	6.3E-03	1.2E-02
Groundwater	Cobalt	3	9/36	1.2E-02	2.2E-02
Groundwater	Dichloromethane	3	4/5	8.9E-03	1.6E-02
Groundwater	Hexane,3,4-bis(1,1-dimethyl)	3	1/1	3.8E-02	3.8E-02
Groundwater	Lead	1	1/19	5.8E-02	1.7E-01
Groundwater	Lead	3	6/74	2.4E-02	6.6E-02
Groundwater	Lithium	1	1/18	2.2E+00	1.2E+01
Groundwater	Strontium	1	18/18	3.7E-01	1.4E+00
Groundwater	Strontium	2	11/11	1.9E-01	5.8E-01
Groundwater	Strontium	3	13/13	3.1E-01	7.4E-01
Groundwater	Titanium	1	3/18	2.1E-02	2.1E-02
Groundwater	Titanium	2	2/11	2.4E-02	5.0E-02
Groundwater	Titanium	3	5/13	2.6E-02	3.8E-02
Groundwater	Total Uranium	1	2/8	5.8E-04	7.8E-04
Groundwater	Total Uranium	2	1/9	5.1E-04	5.4E-04
Groundwater	Total Uranium	3	3/12	8.1E-04	7.4E-03
Groundwater	Trichloromethane	3	1/5	4.5E-03	5.7E-03

Table 4.12 (continued)

Detectable contaminants

Media name	Contaminant name	Reach	Ratio of detected to total samples	Geometric mean (mg/kg or Bq/kg dry)	95% upper conf bound on mean (mg or Bq/kg)
Sediment	Aluminum	1	31/31	1.3E+03	5.3E+03
Sediment	Aluminum	2	111/111	6.0E+02	2.0E+03
Sediment	Aluminum	3	58/58	1.5E+03	1.0E+04
Sediment	^{57}Co	2	4/4	8.0E+01	1.6E+02
Sediment	^{57}Co	3	2/2	2.7E+02	5.9E+02
Sediment	Cobalt	1	31/31	6.4E+00	8.8E+00
Sediment	Cobalt	2	111/111	1.0E+01	1.1E+01
Sediment	Cobalt	3	54/58	1.2E+01	1.9E+01
Sediment	^{155}Eu	2	13/13	1.1E+02	2.4E+02
Sediment	^{155}Eu	3	8/8	1.2E+02	2.2E+02
Sediment	Lead	1	15/31	1.1E+01	2.1E+01
Sediment	Lead	2	41/111	3.4E+00	5.6E+00
Sediment	Lead	3	34/62	8.0E+00	2.6E+01
Sediment	Lithium	2	4/111	5.6E+00	2.6E+02
Sediment	Lithium	3	2/54	1.5E+01	5.5E+02
Sediment	^{191}Os	2	1/1	2.9E+01	2.9E+01
Sediment	^{125}Sb	1	2/2	7.4E+02	1.7E+03
Sediment	^{125}Sb	3	4/4	2.5E+02	3.9E+02
Sediment	^{75}Se	3	2/2	8.6E+01	4.2E+02
Sediment	Strontium	1	31/31	6.1E+00	9.1E+00
Sediment	Strontium	2	111/111	8.2E+00	8.8E+00
Sediment	Strontium	3	54/58	6.7E+00	9.5E+00
Sediment	Titanium	1	22/31	5.5E+00	5.1E+01
Sediment	Titanium	2	95/111	9.0E-01	2.2E+01
Sediment	Titanium	3	55/58	4.9E+00	7.3E+02
Sediment	Total Plutonium	3	4/4	4.6E+02	5.1E+02
Sediment	Zirconium	1	24/31	1.9E+00	2.9E+00
Sediment	Zirconium	2	106/111	1.2E+00	1.5E+00
Sediment	Zirconium	3	53/58	2.3E+00	4.0E+01
				(Mg or Bq/L)	(Mg or Bq/L)
Surface water	1,2-Dichloroethene (total)	2	2/29	4.9E-03	6.9E-03
Surface water	Aluminum	1	27/32	3.0E-01	9.9E-01
Surface water	Aluminum	2	27/32	4.8E-01	2.7E+00
Surface water	Aluminum	3	28/32	5.7E-01	1.2E+00
Surface water	^{155}Eu	2	6/6	8.4E+00	1.6E+01
Surface water	Lead	1	4/33	5.4E-03	1.3E-02
Surface water	Lead	2	5/76	1.4E-02	2.4E-02
Surface water	Lead	3	7/33	5.2E-03	1.3E-02
Surface water	^{191}Os	3	2/2	3.3E+00	3.3E+00
Surface water	Strontium	1	3/3	8.7E-02	1.1E-01
Surface water	Strontium	2	3/3	1.1E-01	1.7E-01
Surface water	Strontium	3	3/3	9.0E-02	9.6E-02
Surface water	Titanium	2	1/3	2.9E-02	9.4E-02

Table 4.12 (continued)

Nondetectable contaminants

Media type	Contaminant name	Reach	Total number of samples	Minimun detection limits (mg/kg wet)	95% upper conf bound on mean (mg/kg wet)
Fish	1,3-Dichlorobenzene	1	12	2.0E-01	2.0E+00
Fish	1,3-Dichlorobenzene	2	8	2.0E-01	1.9E+00
Fish	1,3-Dichlorobenzene	3	16	2.0E-01	2.0E+00
Fish	2-Methylnaphthalene	1	12	2.0E-01	2.0E+00
Fish	2-Methylnaphthalene	2	8	2.0E-01	1.9E+00
Fish	2-Methylnaphthalene	3	16	2.0E-01	2.0E+00
Fish	2-Methylphenol	1	12	2.0E-01	2.0E+00
Fish	2-Methylphenol	2	8	2.0E-01	1.9E+00
Fish	2-Methylphenol	3	16	2.0E-01	2.0E+00
Fish	2-Nitroaniline	1	12	1.0E+00	9.8E+00
Fish	2-Nitroaniline	2	8	1.0E+00	9.5E+00
Fish	2-Nitroaniline	3	16	1.0E+00	9.9E+00
Fish	2-Nitrophenol	1	24	2.0E-01	6.0E+00
Fish	2-Nitrophenol	2	16	2.0E-01	5.5E+00
Fish	2-Nitrophenol	3	32	2.0E-01	6.2E+00
Fish	3-Nitroaniline	1	12	1.0E+00	9.8E+00
Fish	3-Nitroaniline	2	8	1.0E+00	9.5E+00
Fish	3-Nitroaniline	3	16	1.0E+00	9.9E+00
Fish	4-Bromophenyl phenyl ether	1	12	2.0E-01	2.0E+00
Fish	4-Bromophenyl phenyl ether	2	8	2.0E-01	1.9E+00
Fish	4-Bromophenyl phenyl ether	3	16	2.0E-01	2.0E+00
Fish	4-Chlorophenyl phenyl ether	1	12	2.0E-01	2.0E+00
Fish	4-Chlorophenyl phenyl ether	2	8	2.0E-01	1.9E+00
Fish	4-Chlorophenyl phenyl ether	3	16	2.0E-01	2.0E+00
Fish	4-Nitroaniline	1	12	1.0E+00	9.8E+00
Fish	4-Nitroaniline	2	8	1.0E+00	9.5E+00
Fish	4-Nitroaniline	3	16	1.0E+00	9.9E+00
Fish	Bis(2-chlorodisopropyl)ether	1	12	2.0E-01	2.0E+00
Fish	Bis(2-chlorodisopropyl)ether	2	8	2.0E-01	1.9E+00
Fish	Bis(2-chlorodisopropyl)ether	3	16	2.0E-01	2.0E+00
Fish	Bis(2-chloroethoxy)methane	1	12	2.0E-01	2.0E+00
Fish	Bis(2-chloroethoxy)methane	2	8	2.0E-01	1.9E+00
Fish	Bis(2-chloroethoxy)methane	3	16	2.0E-01	2.0E+00
Fish	Delta BHC	1	12	5.0E-03	3.9E-02
Fish	Delta BHC	2	8	5.0E-03	3.8E-02
Fish	Delta BHC	3	16	5.0E-03	4.0E-02
Fish	Dibenzofuran	1	12	2.0E-01	2.0E+00
Fish	Dibenzofuran	2	8	2.0E-01	1.9E+00
Fish	Dibenzofuran	3	16	2.0E-01	2.0E+00
Fish	Endosulfan sulfate	1	12	9.0E-03	2.0E-01
Fish	Endosulfan sulfate	2	8	9.0E-03	1.9E-01
Fish	Endosulfan sulfate	3	16	9.0E-03	2.0E-01
Fish	Endrin ketone	1	12	9.0E-03	3.9E-02
Fish	Endrin ketone	2	8	9.0E-03	3.8E-02
Fish	Endrin ketone	3	16	9.0E-03	4.0E-02

Table 4.12 (continued)

Nondetectable contaminants

Media type	Contaminant name	Reach	Total number of samples	Minimun detection limits (mg/kg wet)	95% upper conf bound on mean (mg/kg wet)
Fish	Lead	2	19	2.0E-02	3.4E-01
Fish	Parachlorometa cresol	1	12	2.0E-01	2.0E+00
Fish	Parachlorometa cresol	2	8	2.0E-01	1.9E+00
Fish	Parachlorometa cresol	3	16	2.0E-01	2.0E+00
				(mg/kg dry)	(mg/kg dry)
Sediment	1,2-Dichloropropene	3	2	1.0E-02	1.0E-02
Sediment	1,3-Dichlorobenzene	1	2	1.0E+01	1.0E+01
Sediment	1,3-Dichlorobenzene	2	10	1.0E+01	1.0E+01
Sediment	1,3-Dichlorobenzene	3	16	9.1E-01	1.1E+01
Sediment	2-Chloroethyl vinyl ether	3	1	1.0E-02	1.0E-02
Sediment	2-Chlorovinyl ether	3	1	1.0E-02	1.0E-02
Sediment	2-Methylnaphthalene	1	2	1.0E+01	1.0E+01
Sediment	2-Methylnaphthalene	2	10	1.0E+01	1.0E+01
Sediment	2-Methylnaphthalene	3	14	1.0E+01	1.0E+01
Sediment	2-Methylphenol	1	3	1.0E+01	1.0E+01
Sediment	2-Methylphenol	2	10	1.0E+01	1.0E+01
Sediment	2-Methylphenol	3	14	1.0E+01	1.0E+01
Sediment	2-Nitroaniline	1	2	1.0E+01	2.8E+02
Sediment	2-Nitroaniline	2	10	1.0E+01	4.1E+01
Sediment	2-Nitroaniline	3	14	1.0E+01	2.8E+01
Sediment	2-Nitrophenol	1	3	1.0E+01	3.1E+01
Sediment	2-Nitrophenol	2	10	1.0E+01	2.0E+01
Sediment	2-Nitrophenol	3	14	1.0E+01	2.0E+01
Sediment	3-Nitroaniline	1	2	1.0E+01	2.8E+02
Sediment	3-Nitroaniline	2	10	1.0E+01	4.1E+01
Sediment	3-Nitroaniline	3	14	1.0E+01	2.8E+01
Sediment	4-Bromophenyl phenyl ether	1	2	1.0E+01	1.0E+01
Sediment	4-Bromophenyl phenyl ether	2	10	1.0E+01	1.0E+01
Sediment	4-Bromophenyl phenyl ether	3	16	9.1E-01	1.1E+01
Sediment	4-Chlorophenyl phenyl ether	1	2	1.0E+01	1.0E+01
Sediment	4-Chlorophenyl phenyl ether	2	10	1.0E+01	1.0E+01
Sediment	4-Chlorophenyl phenyl ether	3	16	9.1E-01	1.1E+01
Sediment	4-Nitroaniline	1	2	1.0E+01	2.8E+02
Sediment	4-Nitroaniline	2	10	1.0E+01	4.1E+01
Sediment	4-Nitroaniline	3	14	1.0E+01	2.8E+01
Sediment	4-Nitrophenol	1	3	5.0E+01	5.0E+01
Sediment	4-Nitrophenol	2	10	5.0E+01	5.0E+01
Sediment	4-Nitrophenol	3	16	9.1E-01	5.3E+01
Sediment	Bis(2-chloroethoxy)methane	1	2	1.0E+01	1.0E+01
Sediment	Bis(2-chloroethoxy)methane	2	10	1.0E+01	1.0E+01
Sediment	Bis(2-chloroethoxy)methane	3	16	9.1E-01	1.1E+01
Sediment	Delta BHC	1	2	1.0E+01	1.0E+01
Sediment	Delta BHC	2	6	1.0E+01	1.0E+01
Sediment	Delta BHC	3	13	9.1E-01	1.1E+01
Sediment	Dibenzofuran	1	3	1.0E+01	1.0E+01
Sediment	Dibenzofuran	2	10	1.0E+01	1.0E+01
Sediment	Dibenzofuran	3	14	1.0E+01	1.0E+01

Table 4.12 (continued)

Nondetectable contaminants

Media type	Contaminant name	Reach	Total number of samples	Minimun detection limits mg/kg dry	95% upper conf bound on mean mg/kg dry
Sediment	Endosulfan sulfate	1	1	1.0E+01	1.0E+01
Sediment	Endosulfan sulfate	2	6	1.0E+01	1.0E+01
Sediment	Endosulfan sulfate	3	13	9.1E-01	1.1E+01
Sediment	Endrin aldehyde	1	1	1.0E+01	1.0E+01
Sediment	Endrin aldehyde	2	6	1.0E+01	1.0E+01
Sediment	Endrin aldehyde	3	13	9.1E-01	1.1E+01
Sediment	Gallium	1	18	2.9E+00	1.5E+01
Sediment	Gallium	2	98	3.0E+00	6.2E+00
Sediment	Gallium	3	45	2.9E+00	2.4E+01
Sediment	Lithium	1	30	2.0E+00	1.0E+03
Sediment	Parachlorometa cresol	1	2	1.0E+01	1.0E+01
Sediment	Parachlorometa cresol	2	10	1.0E+01	1.0E+01
Sediment	Parachlorometa cresol	3	16	9.1E-01	1.1E+01
Sediment	Silvex	3	5	1.0E+01	1.0E+01
				(Mg or Bq/L)	(Mg or Bq/L)
Surface water	1,2-Dichloroethene (total)	1	29	5.0E-03	7.1E-03
Surface water	1,2-Dichloroethene (total)	3	28	5.0E-03	7.2E-03
Surface water	2-Hexanone	1	29	1.0E-02	1.4E-02
Surface water	1,2-Dichloroethene (total)	2	29	1.0E-02	1.4E-02
Surface water	2-Hexanone	3	28	1.0E-02	1.4E-02
Surface water	Cobalt	1	3	4.0E-03	4.0E-03
Surface water	Cobalt	2	3	4.0E-03	4.0E-03
Surface water	Cobalt	3	3	4.0E-03	4.0E-03
Surface water	^{129}I	3	10	1.0E-02	1.0E-01
Surface water	Lithium	1	3	1.5E+01	1.5E+01
Surface water	Lithium	2	3	1.5E+01	1.5E+01
Surface water	Lithium	3	3	1.5E+01	1.5E+01
Surface water	Titanium	1	3	2.0E-02	2.0E-02
Surface water	Titanium	3	3	2.0E-02	2.0E-02
Surface water	Zirconium	1	3	2.0E-02	2.0E-02
Surface water	Zirconium	2	3	2.0E-02	2.0E-02
Surface water	Zirconium	3	3	2.0E-02	2.0E-02

limitations of the data bases used in the screening analyses of groundwater; however, the detectable contaminants in the data bases are useful to verify that a contaminant is present in groundwater.

Noncarcinogen. Screening indices for the nonconservative screening of detectable noncarcinogens are listed in Table F2, Appendix F. All reaches had screening indices <1.0, indicating that noncarcinogens in groundwater in the three reaches are not high priority contaminants that would require immediate consideration for remedial action. Reaches 1 and 2 had screening indices of 6.5×10^{-1} and 1.0×10^{-1}, respectively, which would require further investigation before taking action. Antimony, with a screening index of 5.7×10^{-1}, is the only noncarcinogen that would require further investigation in Reach 1. However, this analysis is based on two detectable measurements out of a total of 20 analyzed, indicating that additional sampling is needed and that the analytical procedures should be reviewed. All other contaminants in Reach 1 have screening indices <0.1. For Reach 3, the screening index for inorganics was 1.0×10^{-1}; however, none of the individual contaminants had screening indices ≥ 0.1.

4.8.4.2 Conservative screening of detectable contaminants in groundwater

Carcinogen. Conservative screening of carcinogens in groundwater did not eliminate from further investigation any of the contaminants in the detectable contaminants data base (Table F3, Appendix F). All reaches had screening indices $>10^{-3}$. Beryllium and tritium had screening indices $>10^{-4}$ in all three reaches. Strontium-90 in Reaches 1 and 2 and arsenic, ^{234}U, ^{60}Co, ^{224}Ra, ^{241}Am, and ^{234}Th in Reach 3 had screening indices $>10^{-4}$. However, the data for ^{234}U, ^{224}Ra, ^{241}Am, and ^{234}Th in Reach 3 is limited and should only be used to support additional data collection.

Noncarcinogen. Conservative screening of noncarcinogens in groundwater indicated that none of the reaches could be assigned low priority for further consideration (Table F4, Appendix F). Organics in Reach 3 was the only class of noncarcinogens that could be assigned a low priority for further investigation. Antimony in Reach 1 was the only carcinogen that had a screening index ≥ 1.0. Four inorganics in Reach 1, six in Reach 2, and five in Reach 3 had screening indices <0.1, but most of these cannot be eliminated from further consideration because of the limited data.

4.8.5 Special Case—Lead

Although an action level for lead of 0.015 mg/L has been adopted by EPA (EPA 1991), specific toxicity values are not available (Table 4.12); therefore, an EPA Uptake/Biokinetic model designed to a target population of children (0 to 6 years old) was used to evaluate the risk from lead in WAG 2. Results obtained using this model indicate that concentrations in groundwater in Reaches 1 and 3 would present a problem. This scenario is hypothical because WAG 2 is a fenced area where public access is not allowed.

4.9 CONCLUSIONS FOR SCREENING RISK ASSESSMENT FOR HUMAN EXPOSURE

4.9.1 Reaches 1 through 3

Nonconservative screening of the detectable and nondetectable contaminants data bases for four exposure pathways was used to identify high priority contaminants for the three reaches of WAG 2. The carcinogens in the detectable contaminants data bases that were assigned high priority were ^{60}Co in Reaches 1, 2, and 3 and ^{137}Cs in Reaches 1 and 3 for the external exposure pathway; PCB (Aroclor 1254) in Reach 1 and 3 for the fish ingestion pathway; and arsenic in Reaches 2 and 3 for the drinking (surface) water pathway. Arsenic is a possible artifact because of the small number of samples in which the concentration was above the limits of detection.

Ten carcinogens (dichlorobromomethane, Aroclor 1254, Aroclor 1260, ^{137}Cs, ^{90}Sr, ^{3}H, ^{152}Eu, ^{134}Cs, ^{154}Eu, and ^{234}U) in the detectable contaminants data bases were classified as requiring further investigation in one or more reaches. Three of these contaminants were organics and seven were radionuclides. Limited data were available for ^{134}Cs, ^{152}Eu, ^{154}Eu and ^{234}U for some of the reaches; therefore, additional analyses are needed for these radionuclides. Limited data also were available for ^{241}Am, ^{244}Cm, ^{238}Pu, and ^{239}Pu; thus, although they were not classified as requiring further action, additional data are required.

For noncarcinogens in the detectable contaminants data bases, only thallium was assigned high priority for immediate consideration for remedial action in Reaches 1, 2, and 3. However, because only one sample was analyzed in each reach, thallium may be an artifact and it requires additional data. Mercury in Reach 1 in the fish ingestion pathway and arsenic in Reach 2 in the water ingestion pathway were the only noncarcinogens in the detectable contaminants data bases that would require further investigation.

Conservative screening of the detectable contaminants data bases identified 3 organic and 12 radionuclides in one or more reaches of WAG 2 as low priority carcinogens for further consideration. However, because of limited information on some of these contaminants, additional data are needed. Most inorganic noncarcinogens in the sediment ingestion pathway in all reaches can be assigned a low priority. Low priority was assigned to barium, copper, mercury, nickel, and zinc in the sediment and water ingestion pathways in all reaches.

Results of the nondetectable contaminants data bases should be viewed with caution because of the uncertainty associated with the contaminant concentrations. Nonconservative screening identified as high-priority contaminants one organic carcinogen in the fish ingestion pathway and two in the sediment ingestion pathway. However, because the screening analysis was based on minimum detection limits, better detection limits are needed, and a review of source-term data is appropriate. None of the noncarcinogens were identified by nonconservative screening as high priority contaminants in WAG 2.

Conservative screening of the nondetectable data bases identified 25 organic carcinogens that can be assigned low priority for further consideration in the sediment ingestion pathway. Low priority can also be given to 29 organic noncarcinogens plus chronium and nickel in the fish ingestion pathway; boron, vanadium, and tin in the water ingestion pathway; cyanide in the sediment ingestion pathway; and silver and beryllium in the fish and water ingestion pathways.

Nonconservative screening of the detectable contaminants data base for groundwater indicated that no carcinogen or noncarcinogen could be assigned a high priority. However, because of the lack of verification of the limited data base, additional data will be required for groundwater. Lead was not included in the screening analysis, but an EPA Uptake/Biokinetic model predicted that it would be a problem in groundwater in Reaches 1 and 3.

Results of the intruder scenario indicated that the greatest risk in this hypothetical scenario was from the ingestion of fish in all reaches. In the fish ingestion pathway, radionuclides contributed the greatest risk in Reaches 1 and 2 and PCBs in Reach 3.

4.9.2 Results for Screening Risk Assessment for Human Exposure for WOCE

As the result of a CERCLA removal action in response to uncontrolled contaminated sediments in WOCE, the information available for the extent of contamination in WOCE was more thorough than that available for the remainder of WAG 2 (Blaylock et al. 1991). A screening analysis was conducted using methods similar to those described herein. The screening analysis for carcinogens identified several substances as definitely high priority and requiring immediate consideration: arsenic in water ingestion, PCBs in fish ingestion, and ^{60}Co and ^{137}Cs in the sediment external exposure pathway. Arsenic in water was a possible artifact, because arsenic was detected in only 2 of 24 samples analyzed. Two organic contaminants, six inorganic, and six radiological contaminants had screening indices that would require further investigation before taking action.

The screening for noncarcinogens did not identify any contaminant that could definitely be assigned high priority.

Screening of the WOCE nondetectable contaminants data base identified 16 organic carcinogens as definitely high priority. For these compounds it will be necessary to either improve the detection limits or to use source-term data to verify their presence.

5. SCREENING ASSESSMENT OF ECOLOGICAL RISKS

As discussed in Sect. 1, the purpose of the screening risk assessment is to identify hazards associated with wastes in WAG 2, prioritize them with respect to their potential risks, and identify data needs on the basis of that analysis. The ecological assessment is concerned with risks to populations and communities of nonhuman organisms that occur on the site or may occur there in the future. The assessment uses the format of a standard risk assessment, with a hazard definition phase followed by parallel exposure and effects assessments and ending with risk characterization.

5.1 ECOLOGICAL HAZARD DEFINITION

The hazard definition phase of a risk assessment defines the scope of the assessment, the sources being assessed, and the endpoints of the assessment. An ecological hazard consists of a source of potentially toxic exposure combined with a valued and potentially susceptible receptor (the endpoint organisms) in a particular environment.

5.1.1 Sources and Routes of Exposure

WAG 2 consists of two streams (WOC and Melton Branch) and their associated floodplains, which continue to receive seepage and runoff from waste sites as well as point source emissions. Therefore, the ultimate sources of contaminant exposure in WAG 2 are the aqueous point sources, which are permitted under NPDES and are not of concern in this assessment, and the releases of contaminants by waste sites, which are the subject of the ongoing environmental restoration process. The proximate sources of exposure are (1) contaminants in the stream sediments and floodplain soils, (2) water contamination (which results from current point and nonpoint input, desorbtion and resuspension from sediments, and erosion and leaching from floodplain soils), and (3) contaminants in the biota, which act as a source of exposure for their consumers (e.g., contaminated fish eaten by herons). These sources are characterized by chemical analyses. The sources and nature of these data and the procedure used to compile them are discussed in Sect. 3; however, the existing data do not constitute a complete description of the proximate sources. In particular, contamination of floodplain soils has not been characterized for chemicals other than radionuclides.

5.1.2 Exposed Environment

The spatial scope of the assessment (see Sect. 2 for a more detailed description) is WOL, WOC below the main ORNL plant (i.e., WAG 1), Melton Branch, and the floodplains of the creeks and lake. WOC is coded as Reach 1, Melton Branch is Reach 2, and WOL is Reach 3. The ecology of this area is described in Loar (1988-1991), Loar et al. (1981 and 1987), Boyle et al. (1982), Mann and Kitchings (1982), Oakes et al. (1982), and Sherwood and Loar (1987).

The aquatic communities of WAG 2 are well characterized due to five years of monitoring by the Biological Monitoring and Abatement Program (BMAP) (Loar et al.

1987, Loar 1988-1990). The BMAP has identified 14 species of fish in the watershed, including seven species of centrarchids (relatively large predatory species that could serve as game fish). Fish production is generally similar to similar streams in the region, although considerable variation occurs among reaches (Loar 1990).

The floodplains of WOC and Melton Branch are dominated by hardwood forests. The floodplain of WOL, particularly at the confluence of the creek, is dominated by shrubby vegetation, principally box elder and willows.

Although several federally listed threatened or endangered species occur in the region (Kroodsma 1987), none are known to occur on WAG 2. However, the endangered Indiana bat (*Myotis sodalis*) is suspected to occur on the lower East Fork Poplar Creek and may occur on WOC as well. Several state-listed species occur on the Oak Ridge Reservation and may occur on WAG 2 (Table 5.1).

Wetlands and floodplains are protected by Executive Orders 11990 and 11988, respectively. Although no official wetlands survey has been conducted for WAG 2, apparent wetlands occur in the floodplains of the creeks and the lake, and the floodplains clearly qualify as floodplains.

5.1.3 Ecological Endpoints

The endpoints for this assessment are those described and justified in the "Approach and Strategy for Performing Ecological Risk Assessments for the Oak Ridge Operations Environmental Restoration Program" (in press). In brief, they are (1) no reduction greater than 20% in the abundance or productivity of populations of fishes, birds, mammals, or vascular plants, (2) no injury of individuals of threatened or endangered species sufficient to impair survival or reproduction, and (3) no loss of wetland or floodplain communities. The 20% figure in the first endpoint is derived from an analysis of EPA regulatory criteria and is intended to approximate the agency's *de facto* but unstated level of protection (Suter et al. 1992). No particular species are chosen to represent the endpoints because most-sensitive species cannot be identified *a priori*, and in most cases the toxicity and exposure data do not permit discrimination among individual members of taxa or trophic groups.

5.2 EXPOSURE ASSESSMENT

5.2.1 Water

Fish and invertebrates inhabiting the water column are assumed to be exposed to chemicals in the water primarily through respiratory uptake. This assumption is accurate for nearly all chemicals except for the few that bioaccumulate through food chains to a significant extent (i.e., PCBs, methyl mercury, and selenium). However, measured body burdens are more reliable measures of exposure (Sect. 5.2.3). In addition, the sample preparation and analysis techniques used to measure concentrations in water are intended to measure total contaminant concentrations rather than bioavailable concentrations.

Table 5.1. Federally and state listed threatened and/or endangered species and species designated In Need of Management by the State of Tennessee known or expected to occur on the Oak Ridge Reservation

Common Name	Scientific Name	Administrative Status*
Fish		
Tennessee dace	*Phonixus oreas*	IMN
Birds		
Black-crowned night heron	*Nycticorax nycticorax*	INM
Black Vulture	*Coragyps atratus*	INM
Common barn owl	*Tyto alba*	INM
Cooper's hawk	*Accipiter cooperii*	ST
Grasshopper sparrow	*Ammodramus savannarum*	ST
Osprey	*Pandion haliaetus*	SE
Red-shouldered hawk	*Buteo lineatus*	ST
Sharp-shinned hawk	*Accipter striatus*	ST
Mammals		
Indiana bat	*Myotis sodalis*	FE,SE
Plants		
Spreading false foxglove	*Aureolaria patula*	ST
Appalachian bugbane	*Cimicifuga rubifolia*	ST
Pink lady's slipper	*Cypripedium acaule*	SE
Tall larkspur	*Delphinium exaltatum*	SE
Northern bush honeysuckle	*Diervilla lonicera*	ST
Nutall waterweed	*Elodea nuttallii*	SS
Mountain witch alder	*Fothergilla major*	ST
Golden seal	*Hydrastis canadensis*	ST
Butternut	*Juglans cinerea*	ST
Canada lily	*Lilium canadense*	ST

Table 5.1 (continued)

Common Name	Scientific Name	Administrative Status*
Michigan lily	*Lilium michiganense*	ST
Fen orchid	*Liparis loeselii*	SE
Ginseng	*Panax quinquefolium*	ST
Tubercled rein orchid	*Platanthera flava var herbiola*	ST
Purple fringeless orchid	*Platanthera peranoena*	ST
Carey saxifrage	*Saxifraga careyana*	SS
Lesser ladies' tresses	*Spiranthes ovalis*	SS

*Status Codes:

FE - Federally Endangered
FT - Federally Threatened
SE - State Endangered
ST - State Threatened
SS - State Special Concern
INM - In Need of Management according to the State of Tennessee

Therefore, the reported concentrations may be very conservative estimates of aqueous exposure.

5.2.2 Sediment

The sediment composition data available for this assessment are concentrations in dry sediment. However, effects of a particular dry sediment concentration on sediment-dwelling (benthic) organisms are highly inconsistent, because benthic organisms are exposed primarily to chemicals in the aqueous phase of sediments (Adams et al. 1985, OWRS 1989); therefore, it is necessary to estimate the concentration in pore (interstitial) water. In riffles, the substrate consists of stones and gravels that retain relatively low concentrations of sorbed contaminants, and exchange of water occurs between the substrate and overlying water. For those areas, the surface water analyses are the best estimators of the exposure of benthic organisms to contaminants. However, there is obviously a gradient from large gravels which are bathed in surface water to fine sediments with distinct pore water.

In WOL and in pools of the streams where finer sediments collect, pore-water concentrations must be estimated from sediment concentrations. Pore-water concentrations of neutral (non-ionic) organic chemicals can be calculated by assuming equilibrium partitioning between the pore water and the organic matter fraction of the sediment (OWRS 1989). The partitioning coefficient (K_p) is the product of the organic matter/water partitioning coefficient (K_{oc}) and the fractional organic matter content of the sediment (f_{oc}). Because sediment-dwelling organisms are approximately as sensitive to chemicals in water as the population of species that was used to derive the National Ambient Water Quality Criteria (NAWQC) (OWRS 1989), the same screening criteria can be used as for water but corrected for partitioning. The formula is:

$$C_s = K_p C_w \text{, or}$$
$$C_s = K_{oc} f_{oc} C_w \text{,}$$

where C_s and C_w are equivalent concentrations in sediment and water, respectively. K_{oc} is seldom available, but it is accurately approximated by the octanol/water partitioning coefficient (K_{ow}) (DiToro 1985). This approach is being used by the EPA to derive sediment quality criteria (OWRS 1988).

Concentrations of ionic organic chemicals and inorganic chemicals in pore water could, in theory, also be calculated from an equilibrium partitioning model. However, these chemicals are sorbed to multiple sediment components so they would require several-phase partitioning models with a partitioning coefficient and concentration in sediment for each phase; such information is not available. We assume that ionic organics behave like neutral organics, only partitioning between water and sediment organic matter. This is a conservative assumption because partitioning to other phases would lower the aqueous-phase concentration, thereby lowering the toxicity of a given whole-sediment concentration. For metals in sediments, we use generic K_p values from the International Atomic Energy Agency (1982).

Another approach is to derive site-specific, sediment-water partitioning coefficients. Blaylock et al. (in review) have proposed a sediment-water partitioning coefficient for mercury in Watts Bar Reservoir of 10^5. This value is derived from concentrations of mercury in suspended particulate matter and filtered water from Tennessee River Mile 545. It is probably a reasonable estimate of the mercury K_p, although suspended solids differ from bed sediments, and K_p varies with solids concentration and redox potential (OWRS 1989).

Besides the risks to benthic organisms, it is necessary to consider risks to water-column species from chemicals associated with resuspended sediments. We believe that the screening criteria for benthic organisms are sufficiently conservative for this purpose. That belief is based on the following arguments: (1) the screening criteria are based on an assumption of chronic exposure, but exposures to suspended sediments would be acute; (2) dilution would rapidly decrease the aqueous concentration outside the plume and also within the plume once the particulate concentration dropped sufficiently to prevent attainment of equilibrium; and (3) the biological component of the sediment criteria is applicable because it is based primarily on water-column species.

5.2.3 Tissue Concentrations as Indicators of Effects on Fish

Tissue concentrations can be used in two ways to derive screening criteria. First, for a few chemicals there are data on the tissue concentrations at which effects occurred. When they are available, these data will be used to derive criteria. When they are not available, it is necessary to use conventional aquatic toxicity data that are expressed as aqueous concentrations. In that case, bioaccumulation factors (BAFs) or bioconcentration factors (BCFs) are used to estimate the average water concentrations to which fish have been exposed (fish tissue concentration/BAF = water concentration). When available, field-derived BAFs are used. Otherwise, laboratory-derived BCFs or BCFs derived from models of laboratory data [i.e., quantitative structure-activity relationships (QSARs)] are used. The laboratory-derived factors are likely to overestimate the water concentrations for those chemicals that are accumulated through food chains, but these overestimates will tend to highlight those chemicals. The same upper and lower criteria that are used for water concentrations are then applied to the calculated water concentration to serve as a screen for the fish tissue concentrations.

5.2.4 Tissue Concentrations and Piscivorous Wildlife

The contamination in fish and aquatic invertebrate tissues represents a route of exposure for piscivorous animals. Doses (mg of chemical/kg of animal) must be converted to concentrations in food by dividing by consumption (kg of food/kg of animal). Local piscivorous birds range from kingfishers to great blue herons, ospreys, and bald eagles. The highest dose would be obtained by the smallest bird (because of higher metabolism), and a predatory bird the size of a kingfisher consumes food equivalent to approximately 8% of its body weight per day (Kenaga 1973). The principal piscivorous mammal in the area is the mink. We assume that mink consume food equal to 5% of their body weight per day and that the food consists entirely of fish. The 8% figure is used to calculate the screening criteria because it is more conservative, but we consider effects on mink in the discussion of results because of their sensitivity. For the conversion of acute dose to

concentration in diet, we assume that one day's consumption is equivalent to an acute dose.

Because the studies of chemical concentrations in fish that were conducted in the Oak Ridge area were designed for human health risk assessments, the reported concentrations refer to the "edible portion." Piscivores typically consume the entire fish, and the organs and bones contain higher levels of nearly all chemical contaminants than the muscles. Metals concentrations in whole fish (minus gut contents) tend to be approximately 1.5 to 2 times as high as in fillets or carcasses (Lemly and Smith n.d., Brumbaugh and Kane 1985). Hydrophobic organic chemicals like PCBs occur in whole fish at 2 to 3 times the concentration in fillets. Therefore, we apply a factor of 2 to metal concentrations in fish and a factor of 3 to organic chemical concentrations in fish when calculating lower screening criteria.

Another source of error is the moisture content of the food. The concentrations reported from dietary toxicity data are usually based on the weight of the food as consumed by the animal (i.e., fresh weight), but may be reported as dry weight. In addition, the water content of foods is variable and is often unreported in dietary toxicity studies. The concentrations in fish provided for this assessment are fresh weight. We assume, unless the source indicates otherwise, that the toxic concentrations are also fresh weight and that the water content of the diet and of fish fillets is approximately equal. This assumption could result in an error of approximately a factor of 5 in the results.

In addition to the uncertainties discussed above, this analysis of risks to piscivorous birds and mammals does not include other animals that feed on aquatic organisms. Reptiles and amphibians feed on aquatic invertebrates and fish, but few data exist on dietary toxicity for these taxa. Raccoons and diving ducks consume aquatic invertebrates, but tissue analyses are not available for invertebrates in the waters being assessed. We assume that, because they feed from a variety of sources other than aquatic invertebrates, these populations will be protected by the criteria for piscivores. Dabbling ducks consume aquatic macrophytes, but there are not enough data concerning contamination of these sources to perform an assessment. Dietary exposure of predatory fish to contaminated fish and invertebrates is not a significant route of exposure except for the most bioaccumulative chemicals, which are discussed along with the results on exposure to water.

5.3 EFFECTS ASSESSMENT

In a screening assessment the exposure/response relationship is reduced to a threshold concentration or dose below which exposures can be assumed to be safe (the lower screening criterion) and a concentration or dose above which severe effects are certain (the upper screening criterion). In this section both the approaches used to develop these benchmark values and the derivation of the individual values are explained.

5.3.1 Methods for Deriving Benchmarks

5.3.1.1 Water

The NAWQC for protection of freshwater aquatic life are ARARs; therefore, they provide the basis for the screening criteria for contaminants in water. The acute NAWQC are calculated by the EPA as the fifth percentile of the distribution of 48- to 96-hr LC_{50} values or equivalent effective concentration (EC_{50}) values for each criterion chemical (Stephan et al. 1985). Hence, the acute NAWQC correspond to concentrations that would cause 50% mortality in 5% of exposed populations in a few days. This is a reasonable upper screening criterion because this assessment is concerned with continuous exposures, rather than the episodic exposures to which the acute NAWQC is applied. The chronic NAWQC are based on the threshold for statistically significant effects in chronic or subchronic toxicity tests, adjusted to estimate the concentration that would equal that threshold in 5% of species (Stephan et al. 1985). It is intended to be protective in chronic exposures and is used in this assessment as one estimator of the lower screening criterion.

If NAWQC are not available for a chemical, they are estimated using the method of for calculating advisory values when there are insufficient data to calculate criteria. Advisory values are concentrations that would be expected to be higher than NAWQC in no more than 5% of cases. Therefore, they serve as conservative estimates of the ARARs.

For particular chemicals, the lower screening criterion could be lower than the chronic NAWQC for any one of the following five reasons. First, the chronic NAWQC are based on a threshold for statistical significance rather than biological significance. In some chronic tests, because of highly variable results, the statistical threshold corresponds to greater than 50% effect on a response parameter (Stephan and Rogers 1985, Suter et al. 1987). Second, not all important responses are included in the subchronic toxicity tests that are used to calculate many chronic NAWQC. In particular, effects on fecundity, which is the most sensitive response parameter on average in fish toxicity tests (Suter et al. 1987), are not included. Third, the chronic NAWQC are based on the most statistically sensitive of the measured response parameters in each chronic or subchronic test. Therefore, cumulative effects over the life cycle of fish and invertebrates are not considered. Fourth, the criteria are set at a level that protects "most species most of the time." A lower screening criterion should protect all species nearly all of the time. Finally, because many of the criteria have not been revised since 1980, they do not incorporate recent data. In addition, available data for most chemicals are insufficient to calculate water quality criteria.

For these reasons, we evaluate six alternative benchmarks, and, for the sake of this screening assessment, we use the lowest benchmark for each chemical as the lower screening criterion (Table 5.2). The first is the chronic NAWQC, which is discussed above (this section). The second and third are the lowest chronic values for fish and invertebrates reported in the literature. The fourth is the highest tested concentration causing less than 20% reduction in (1) the weight of young fish per initial female fish in a life cycle or partial life cycle test or (2) the weight of young per egg in an early life-stage test. The fifth is the highest tested concentration causing less than 20% reduction in the

Table 5.2. Summary of Benchmarks for Priority Contaminants in Freshwater (all values in µg/l)

Chemical name	NAWQ Criteria * approximated		Lowest Chronic Value for:		Lowest EC20 Value for:		
	Acute	Chronic	Fish	Daphnids	Fish	Daphnids	5%EC20
INORGANICS							
Aluminum	750	87	5800	1900	4700	540	21
Antimony	* 220	* 18	1600	5400	2310	1900	-
Arsenic III	360	190	2962	914.1	633	633	105
Arsenic V	* 17	* 0.47	891.6	-	1500	>932	-
Barium	* 4.4	* 0.11	-	-	-	-	-
Beryllium	* 40	* 0.44	-	5.3	-	3.8	-
Boron	-	-	-	-	-	7	-
Cadmium	3.9	1.1	1.7	0.15	1.8	0.75	0.032
Calcium	-	-	-	-	-	-	-
Chromium III	1700	210	68.83	<44	89	-	69
Chromium VI	16	11	73.18	6.132	51	0.5	0.13
Cobalt	* 24	* 0.29	290	5.1	810	<4.4	-
Copper	18	12	3.873	0.23	5	0.205	1.1
Cyanide	22	5.2	7.8	-	<5.7	-	<2.9
Fluorine	* 2700	* 140	-	4400	-	3706	-
Iron	-	1000	-	158	-	16	-
Lead	82	3.2	18.88	12.26	22	-	1.5
Lithium	-	-	-	-	-	-	-
Magnesium	* 6.5	* 0.16	-	-	-	-	-
Manganese	* 330	* 11	1770	<1100	1270	<1100	-
Mercury II	2.4	0.012	<0.23	0.96	0.87	0.87	1.3
Molybdenum	* 2200	* 30	-	880	-	360	-
Nickel	1400	160	<35	<5	35	<45	10
Niobium	-	-	-	-	-	-	-
Potassium	* 5.3	* 0.13	-	-	-	-	-

Table 5.2 (continued)

Chemical name	NAWQ Criteria * approximated Acute	NAWQ Criteria * approximated Chronic	Lowest Chronic Value for: Fish	Lowest Chronic Value for: Daphnids	Lowest EC20 Value for: Fish	Lowest EC20 Value for: Daphnids	5%EC20
INORGANICS (continued)							
Potassium	* 5.3	* 0.13	-	-	-	-	-
Selenium	260	35	88.32	91.65	40	25	15
Silver	4.1	0.12	0.12	2.6	0.20	<0.56	0.18
Sodium	* 19,000	* 480	-	-	-	-	-
Strontium	-	-	-	-	-	-	-
Thallium	* 24	* 2.2	57	130	81	64	-
Thorium	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-
Titanium	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-
Vanadium	* 36	* 9.4	80	1900	41	430	-
Zinc	120	110	36.41	46.73	47	-	7.5
Zirconium	-	-	-	-	-	-	-
ORGANICS							
Acenapthene	* 29	* 2.2	413	-	<197	-	-
Acetone	* 25,000	* 640	-	-	-	-	-
Anthracene	* 0.00058	* 0.00001	-	<2.1	-	>8.2	-
Benzene	* 100	* 2.6	-	>98,000	21	-	-
Benzidene	* 1.5	* 0.037	-	-	-	-	-
Benzo(a)anthracene	* 0.11	* 0.0027	-	-	-	-	-
Benzo(a)pyrene	* 0.053	* 0.0013	-	-	>2.99	-	-
Benzo(b)fluoranthene	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-	-	-

Table 5.2 (continued)

Chemical name	NAWQ Criteria * approximated Acute	Chronic	Lowest Chronic Value for: Fish	Daphnids	Lowest EC20 Value for: Fish	Daphnids	5%EC20
ORGANICS (continued)							
Benzo(k)fluoranthene	-	-	-	-	-	-	-
Benzoic acid	* 18	* 0.45	-	-	-	-	-
Benzyl alcohol	* 1.0	* 0.025	-	-	-	-	-
BHC (lindane)	2.0	0.08	14.6	14.5	<1.1	<11	0.066
BHC (other)	* 9.5	* 0.24	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	* 2.6	* 0.087	8.4	<3	>54	<3	-
Butane,							
1,1-oxybis	-	-	-	-	-	-	-
(2,1-ethanediyloxy)bis	-	-	-	-	-	-	-
2-Butanone	* 55,000	* 1400	-	-	-	-	-
4-chloro-4,4-difluoro-	-	-	-	-	-	-	-
Carbon disulfide	* 36	* 0.91	-	-	-	-	-
Carbon tetrachloride	* 610	* 55	>3400	-	65	-	-
Chlordane	2.4	0.0043	1.6	16	<0.25	12.1	0.020
Chlorobenzene	* 340	* 8.4	-	-	-	-	-
Chloroethane	-	-	-	-	-	-	-
Chloroform	* 570	* 14	-	-	8400	-	-
Chrysene	-	-	-	-	-	-	-
DDD							
p,p'	* 0.0016	* 0.00004	-	-	-	-	-
other	-	-	-	-	-	-	-
DDT	1.1	0.001	0.74	-	0.35	-	0.016
Decane	* 190	* 4.8	-	-	-	-	-
Di-n-butyl phthalate	* 32	* 3.1	717	551	270	500	-

Table 5.2 (continued)

Chemical name	NAWQ Criteria * approximated Acute	NAWQ Criteria * approximated Chronic	Lowest Chronic Value for: Fish	Lowest Chronic Value for: Daphnids	Lowest EC20 Value for: Fish	Lowest EC20 Value for: Daphnids	5%EC20
ORGANICS (continued)							
Dibenzofuran	* 80	* 2.0	-	-	-	-	-
Dichlorodifluoromethane	-	-	-	-	-	-	-
1,1-Dichloroethane	* 20	* 0.51	-	-	-	-	-
1,2-Dichloroethane	* 2000	* 130	20,000	15,200	29,000	<11,000	-
1,1-Dichloroethene	* 520	* 13	>2800	-	-	-	-
1,2-Dichloroethenes	* 14	* 0.34	-	-	-	-	-
1,3-Dichloropropene							
trans-	-	-	-	-	-	-	-
total	* 100	* 2.6	-	-	-	-	-
Diethyl phthalate	* 1100	* 27	-	-	-	-	-
Di-n-octyl phthalate	-	-	5700	570	<100	310	-
Dimethyl naphthalene	-	-	-	-	-	-	-
4,6-Dinitro-ortho-cresol	-	-	-	-	-	-	-
Ethenyl methyl benzene	-	-	-	-	-	-	-
Ethyl benzene	* 780	* 20	>440	-	-	-	-
Ethyl methyl benzene	-	-	-	-	-	-	-
Ethyl dimethyl benzene	-	-	-	-	-	-	-
Fluoranthene	* 69	* 1.7	-	-	-	-	-
Freon 113	-	-	-	-	-	-	-
Freon 123	-	-	-	-	-	-	-
Heptachlor	0.52	0.0038	1.26	-	0.86	-	0.0089
Hexane	* 82	* 2.1	-	-	-	-	-
2,5-Hexanedione	-	-	-	-	-	-	-
2-Hexanone	* 43	* 1.1	-	-	-	-	-
1-methylpentyl							

Table 5.2 (continued)

Chemical name	NAWQ Criteria * approximated Acute	NAWQ Criteria * approximated Chronic	Lowest Chronic Value for: Fish	Lowest Chronic Value for: Daphnids	Lowest EC20 Value for: Fish	Lowest EC20 Value for: Daphnids	5%EC20
ORGANICS (continued)							
hydroperoxide	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	-	-	-	-	-	-	-
Methyl cyclopentane	-	-	-	-	-	-	-
1-Methyl naphthalene	* 0.90	* 0.023	-	-	-	-	-
2-Methyl naphthalene	-	-	-	-	-	-	-
4-Methyl-2-pentanone	* 51	* 2.3	75,000	-	-	-	-
2-Methyl phenol	* 160	* 4.1	-	-	-	-	-
Methyl propenyl benzene	-	-	-	-	-	-	-
Methyl mercury	* 0.0028	* 0.00005	0.52	<0.04	<0.03	0.87	-
Methylpropyl benzene	-	-	-	-	-	-	-
Methylene chloride	* 3800	* 190	108,000	-	410	-	-
Naphthalene	* 45	* 1.8	620	-	450	>600	-
Nitrophenols							
4-	* 190	* 11	-	7100	-	5000	-
total	-	-	-	-	-	-	-
N-Nitroso-di-n-propylamine	-	-	-	-	-	-	-
N-Nitrosodiphenylamine	* 100	* 2.5	-	-	-	-	-
Nonane	-	-	-	-	-	-	-
3-Octanone	* 1400	* 34	-	-	-	-	-
9-Octadecenamide, (z)	-	-	-	-	-	-	-
PCB's							
Aroclor® 1221	* 0.12	* 0.0029	-	-	-	-	-
Aroclor® 1232	* 0.23	* 0.0058	-	-	-	-	-
Aroclor® 1242	* 0.016	* 0.00097	9.0	-	<2.9	-	-
Aroclor® 1248	* 0.15	* 0.0062	0.2	4.3	0.4	2.5	-

Table 5.2 (continued)

Chemical name	NAWQ Criteria * approximated Acute	NAWQ Criteria * approximated Chronic	Lowest Chronic Value for: Fish	Lowest Chronic Value for: Daphnids	Lowest EC20 Value for: Fish	Lowest EC20 Value for: Daphnids	5%EC20
ORGANICS (continued)							
Aroclor® 1260	* 4.5	* 0.11	2.3	-	2.1	-	-
1-Pentanol	* 240	* 5.9	-	-	-	-	-
Phenanthrene	* 8.4	* 0.43	-	200	-	110	-
Phenol	* 260	* 12	1369	-	<230	-	-
2-Propanol	* 100	* 2.6	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	* 350	* 27	2400	9900	1400	<420	-
Tetrachloroethene	* 130	* 6.5	840	750	500	510	-
Toluene	* 300	* 7.5	-	-	<26	-	-
1,1,1-Trichloroethane	* 4.0	* 0.24	-	1770	-	1300	-
1,1,2-Trichloroethane	* 1400	* 92	9400	18,400	14,800	13,000	-
Trichloroethene	* 490	* 30	11,060	-	5758	-	-
Trichlorofluoromethane	-	-	-	-	-	-	-
Trimethyl benzene	-	-	-	-	-	-	-
Vinyl acetate	* 1.3	* 0.034	-	-	-	-	-
Vinyl chloride	* 38	* 0.95	-	-	-	-	-
Xylene	* 10	* 0.25	-	-	2680	-	-

product of growth, fecundity, and survivorship in a chronic test with a daphnid species. The sixth is the lowest of benchmarks two through five, adjusted to approximate the fifth percentile of the species sensitivity distribution for the chemical as in the chronic NAWQC (Stephan et al. 1985).

NAWQC for several metals are functions of water hardness; the criteria are lower for lower hardness levels. Individual hardness measurements in WAG 2 range from 51 to 800 mg/L with a mean of 150 mg/L. Therefore, we used 100 mg/L to calculate criteria that are conservative but not extreme for WAG 2.

5.3.1.2 Consumed fish flesh

As with the other analyses, the upper screening criteria for piscivores are based on acute lethality. Usually these are acute median lethal doses (LD_{50}), but lethal concentrations in food (LC_{50} or LC_x) are preferred.

The lower screening criteria for aquatic foodchain exposures are quite diverse, because test data for chronic oral exposures to birds and mammals are quite diverse. When data are available concerning the dietary toxicity of a chemical to wildlife, the lowest test concentration that reflects a potential effect on populations is used. If there are no wildlife data, any available data on domestic animals other than ruminants are used. In many cases, there are no useful wildlife or domestic animal data, and the same laboratory rodent data that are used for human health effects are used in the screening criteria. Toxicity data for ruminants are the least desirable because their peculiar digestive systems make their responses unrepresentative of nonruminants. Data from dietary toxicity tests are preferred to chronic oral dosing tests. The effects include systemic toxicity, reduced reproduction, severe histological damage, and terata. An alternative benchmark for the wildlife is the RfD developed by the EPA for assessment of risks of toxic effects other than cancer in humans. We do not assess cancer induction in nonhuman species, because the higher wildlife exposure is not sufficient to overcome the extremely low frequencies of cancer induction (i.e., 10^{-6}) used for the human health screening analysis. Although tumors have frequently been found in fish in other studies, effects of cancer on fish population size or productivity have not been demonstrated.

Unlike the screening criteria that are based on NAWQC, these criteria do not reflect the diversity of organisms that are exposed by this route. If chronic sublethal effects data are available for either mammals or birds but not both, a correction factor of 10 for differences in sensitivity is applied. This factor is based on limited studies that indicate that birds and mammals can differ in sensitivity by at least an order of magnitude, and either can be more sensitive (Sigal and Suter 1989). If there are data for both birds and mammals, but fewer than five species with fewer than two birds, a factor of 5 correction for differences in sensitivity is assumed. If there are data for five or more species including at least two avian species, we assume that the variance in sensitivity of the test species approximates the variance in all avian and mammalian species and apply no factor for differences among species. If the most sensitive test end point is death or another severe effect (e.g., reproductive failure), a factor of 5 is applied to estimate the threshold for effects on individuals that could result in population reductions (Tucker and Lietzke 1979). These factors are not applied to the upper criterion, which is intended to be a concentration at which effects are certain.

5.3.2 Screening Criteria for Individual Chemicals

5.3.2.1 Water

The alternative aquatic toxicity benchmarks for the contaminants that have been detected on the Oak Ridge Reservation are listed in Table 5.2. The lowest benchmark for each chemical is used as the lowest screening criterion for aquatic life, and the acute criteria or estimated acute criteria are used as the upper screening criterion. The sources of data for the approximated criteria are listed in Appendix G, and sources for the other benchmarks are discussed later in this section. For chemicals that are not listed in Table 5.2, NAWQC are used as screening criteria.

INORGANICS

Aluminum. The toxicity of aluminum has been shown to vary widely with water hardness and pH (among others are Ingersoll et al. 1990a and b; Woodward et al. 1989; and Sadler and Lynam 1988). The benchmarks were calculated using only tests in circumneutral water. Lowest chronic values for fish are from Kimball (Manuscript) and for daphnids from McCauley et al. (1986). Lowest EC20 values are from Kimball (Manuscript). The 5% EC20 is lower than the chronic criterion.

Antimony. Chronic and EC20 values for antimony are from Kimball (Manuscript).

Arsenic III. Official criteria are listed for arsenic III. The lowest chronic values for fish and daphnids are given by Call et al. (1983) and Lima et al. (1984). The EC20 values are from Lima et al. (1984) for fish and from Call et al. (1983) and Lima et al. (1984) for daphnids.

Arsenic V. The chronic and EC20 values for fish are from Defoe (1982), and the EC20 for daphnids is from Spehar et al. (1980).

Beryllium. The chronic and EC20 values for daphnids are from Kimball (Manuscript).

Boron. The EC20 value for daphnids is from Gerisch (1984).

Cadmium. There are official criteria listed for cadmium. The lowest chronic value is from Sauter et al. (1976) for fish and Chapman et al. (Manuscript) for daphnids. The EC20 values are from Carlson et al. (1982) for fish and Elnabarawy et al. (1986) for daphnids. The latter report, which post dates the latest NAWQ report (EPA 1980g), needs comment. The EC20 value is not particularly low, but the acute-EC20 ratio is unusually high. For this reason, the 5% EC20 value varies significantly from the final chronic value.

Chromium III. Official criteria are listed for chromium III. The lowest chronic value is from Stevens and Chapman (1984) for fish and from Chapman et al. (Manuscript) for daphnids. Stevens and Chapman (1984) also provided data for the EC20 value for fish. The 5% EC20 value is notably lower than the chronic criterion.

Chromium VI. There are official criteria for chromium VI. The chronic and EC20 values for fish are from Sauter et al. (1976). For daphnids, the chronic value is EPA (1985b) and EC20 from Elnabarawy et al. (1986). As with cadmium, this latter report provided an unusually large acute-EC20 ratio for Chromium VI, thus explaining the orders of magnitude difference between the 5% EC20 and the chronic criterion.

Cobalt. The chronic and EC20 values for Cobalt are from Kimball (Manuscript).

Copper. Official criteria are listed for copper. The chronic and EC20 values for fish are from Sauter et al. (1976). The chronic and EC20 values for daphnids are from Dave (1984a). The 5% EC20 level is considerably lower than the chronic criterion. Dave (1984a), which was not considered in the most recent NAWQC support document (EPA 1985c), contributes unusually low EC20 and chronic values.

Cyanide. There are official criteria for cyanide. The chronic and EC20 values for fish were both from Koenst et al. (1977).

Fluoride ion. Chronic and EC20 values for daphnids are from Dave (1984b).

Iron. The data for the effects of iron on daphnids was from Dave (1984c).

Lead. There are official criteria listed for lead. The lowest chronic value for fish is from Goettl et al. (1972), Davies and Everhart (1973), and Davies et al. (1976) and for daphnids from Chapman et al. (Manuscript). The EC20 value for fish is from Sauter et al. (1976). The 5% EC20 level is lower than the chronic criterion, apparently due to a high acute value in the latter report. The acute-EC20 ratio from which the 5% EC20 was calculated had to be obtained using a species mean acute value for *Salmo gairdneri* (EPA 1985d), since no acute value was reported by Sauter et al.

Manganese. All chronic and EC20 values for manganese are from Kimball (Manuscript).

Mercury II. Mercury has official criteria. The chronic and EC20 values for fish are from Call et al. (1983) and those for daphnids are from Biesinger and Christensen (1972). The 5% EC20 is higher than the chronic criterion. The acute-EC20 ratio used to calculate this value had to be derived using a species mean acute value (EPA 1985e), as no acute value was reported in Biesinger and Christensen. The EC20 derived from Call et al. was equivalent to that in Biesinger et al., but the acute-EC20 ratio for *Daphnia magna* (the species used in the latter report), 3.629, is lower than that of *Pimephales promelas* (used by Call et al.), 172.4. As a conservative measure, the lower acute-EC20 ratio was used in the calculation.

Molybdenum. The chronic and EC20 values for daphnids are from Kimball (Manuscript).

Nickel. There are official criteria for nickel. The chronic and EC20 values for fish are from Nebeker et al. (1985). For daphnids, the chronic value was from Lazareva (1985), and the EC20 was from Münzinger (1990). The EC20 value from Nebeker et al. is lower than the chronic criterion, and the acute value is higher than the

NAWQC acute value; thus, the acute-EC20 ratio is high and the 5% EC20 is significantly lower than the chronic criterion.

Selenium. Official criteria are listed for selenium. The chronic and EC20 values for fish are from Goettl and Davies (1976). The chronic value for daphnids is from Kimball (Manuscript), and the EC20 is from Johnston (1987). The 5% EC20 is lower than the chronic criterion. The acute-EC20 ratio from which the latter value was calculated had to be derived using a species mean acute value for *Daphnia magna* (EPA 1987a), because no acute value was reported by Johnston.

Silver. There is an official acute criterion for silver. The chronic value for fish is from Davies et al. (1978). The chronic value for daphnids and the EC20 for fish are from Nebeker et al. (1983). The EC20 for daphnids is from Elnabarawy et al. (1986). The 5% EC20 level is higher than the approximated chronic criterion, though this is expected since approximations lean heavily to the conservative side.

Thallium. All chronic and EC20 values are from Kimball (Manuscript).

Vanadium. The chronic and EC20 values for fish are from Holdway and Sprague (1979) and for daphnids from Kimball (Manuscript).

Zinc. There are official criteria for zinc. The chronic and EC20 values for fish are from Spehar (1976), and the chronic value for daphnids is from Chapman et al. (Manuscript). The acute LC50/chronic EC20 ratio calculated from Spehar's data is high, because of a relatively large acute value; in fact, the acute-chronic ratio based on a chronic value from Spehar is the highest reported by the EPA (1987b). The 5% EC20 level, then, is considerably lower than the chronic national criterion.

ORGANICS

Acenapthene. The chronic and EC20 values for fish are from Cairns and Nebeker (1982).

Anthracene. The chronic and EC20 values for daphnids are from Holst and Giesy (1989).

Benzene. The lowest chronic value for daphnids is given by EPA (1978) and the EC20 value for fish is from Black and Birge (1982). Black and Birge conducted a series of screening tests for a large number of chemicals on several freshwater organisms. Survival was only recorded to four days post-hatch, and no statistical analysis was done on the results. These tests, then, are not representative of most of the other chronic tests cited in this report.

Benzo(a)pyrene. The EC20 for fish is derived from Hannah et al. (1982).

BHC (lindane). There are official criteria listed for lindane. All chronic and EC20 values are from Macek et al. (1976a). The 5% EC20 level is comparable to the chronic criterion. The acute-EC20 ratio from which the 5% EC20 was calculated was derived

using a species mean acute value for *Salvelinus fontinalis* (EPA 1980s) since no acute data was reported by Macek et al.

Bis(2-ethylhexyl)phthalate. The chronic and EC20 values for fish are from Mehrle and Mayer (1976). The chronic and EC20 values for daphnids are from Mayer and Sanders (1973).

Carbon tetrachloride. The chronic value for fish is from EPA (1978), and the EC20 value is from Black and Birge (1982).

Chlordane. Official criteria are listed for chlordane. The chronic values for fish and daphnids and the EC20 value for fish are from Cardwell et al. (1977). The EC20 value for daphnids is from Cardwell et al. (1977). The 5% EC20 level is higher than the chronic criterion.

Chloroform. The EC20 value for fish is from Black and Birge (1982).

DDT. Official criteria are listed for DDT. The chronic and EC20 values for fish are from Jarvinen et al. (1977). The 5% EC20 level is higher than the chronic criterion.

Di-n-butyl phthalate. All chronic and EC20 values are from McCarthy and Whitmore (1985).

1,2-Dichloroethane. The chronic value for fish is from Ahmed et al. (1984), and the EC20 value for fish is from Benoit et al. (1982). The chronic and EC20 values for daphnids are from Richter et al. (1983).

1,1-Dichloroethene. The chronic value for fish is from EPA (1978).

Di-n-octyl phthalate. All chronic and EC20 values are from McCarthy and Whitmore (1985).

Ethyl benzene. The chronic value for fish is from EPA (1978).

Heptachlor. There are official criteria listed for heptachlor. The chronic and EC20 values for fish are from Macek et al. (1976b). The 5% EC20 value was calculated using an acute-EC20 ratio that was derived from a species mean acute value for *Pimephales promelas* (EPA 1980r) because no acute data is available from Macek et al.

4-Methyl-2-pentanone. The chronic value for fish is from Veith et al. (1983).

Methyl mercury. The chronic and EC20 values for fish are from McKim et al. (1976). The chronic and EC20 values for daphnids are from Biesinger and Christensen. (1982).

Methylene chloride. The chronic value for fish is from Dill et al. (1987), and the EC20 value is from Black and Birge (1982).

Napthalene. The chronic and EC20 values for fish are from DeGraeve et al. (1982), and the EC20 value for daphnids is from Geiger and Buikema (1982).

4-Nitrophenol. The chronic and EC20 values for daphnids are from Francis et al. (1986).

PCBs: Aroclor® 1242. The chronic and EC20 values for fish are from Nebeker and Puglisi (1974).

PCBs: Aroclor® 1248. The chronic and EC20 values for fish are from DeFoe et al. (1978), and the chronic and EC20 values for daphnids are from Nebeker and Puglisi (1974).

PCBs: Aroclor® 1254. The chronic value for fish is from Mauck et al. (1978), and the EC20 value is from Nebeker and Puglisi (1974). The chronic and EC20 values for daphnids are from Nebeker and Puglisi (1974).

PCBs: Aroclor® 1260. The chronic and EC20 values for fish are from DeFoe et al. (1978).

Phenanthrene. The chronic and EC20 values for daphnids are from Geiger and Buikema (1982).

Phenol. The chronic and EC20 values for fish are from DeGraeve et al. (1980).

1,1,2,2-Tetrachloroethane. The chronic and EC20 values for fish are from Ahmed et al. (1984), and the values for daphnids are from Richter et al. (1983).

Tetrachloroethene. The chronic and EC20 values for fish are from Ahmed et al. (1984). The chronic and EC20 values for daphnids are from Richter et al. (1983).

Toluene. The EC20 value for fish is from Black and Birge (1982).

1,1,1-Trichloroethane. The chronic and EC20 values for daphnids are from Thompson and Carmichael (1989).

1,1,2-Trichloroethane. The chronic and EC20 values for fish are from Ahmed et al. (1984), and the chronic and EC20 values for daphnids are from Richter et al. (1983).

Trichloroethene. The chronic and EC20 values for fish are from Smith et al. (1991).

Xylene. The EC20 value for fish is from Black and Birge (1982).

5.3.2.2 Consumed fish flesh

Alternative lower screening criteria are provided by the RfD values for human health assessment (from IRIS and HEAST) and the values developed from dietary toxicity data using the criteria presented in Sect. 5.3.1.2. The latter are discussed next in this section, along with upper screening criteria.

INORGANICS

Antimony. Antimony causes liver damage in rabbits at 5.5 mg/kg in diet (National Research Council 1980). Application of a factor of 10 for variance in sensitivity and 2 for the whole-fish conversion yields a lower criterion of 0.3 mg/kg for piscivores.

Arsenic. The toxicity and bioaccumulation of arsenic are highly dependent on the form. The most toxic and bioaccumulative form is inorganic trivalent arsenic (arsenite salts). Median lethal dietary concentrations for wildlife range from 99.8 mg/kg in cowbirds to >5000 mg/kg in mallards depending on the arsenical species as well as the biological test species (National Research Council 1977, NIOSH 1988), so the upper criterion for piscivores is set at an approximate median of 1000 mg/kg. Reported sublethal effects of inorganic arsenic largely fall in this interval, but there is very little information on sublethal effects on birds. The most sensitive reported dietary effect in mammals or birds is the NOEC for growth of rats of 31 mg/kg (National Research Council 1977, EPA 1985a). Applying a factor of 5 for species sensitivities and 2 for whole fish results in a lower criterion of 3 mg/kg for effects on piscivores.

Beryllium. Beryllium is a serious respiratory toxin and carcinogen, but has not been noted to cause dietary toxicity. The oral LD_{50} in rats is 9.7 mg/kg (EPA 1980r), giving a dietary upper screening criterion of 120 mg/kg. Weight loss occurred in rats fed a diet containing 500 mg/kg beryllium (EPA 1987c). Applying a factor of 10 for variance in sensitivity and 2 for the whole-fish conversion yields a lower screening criterion of 25 mg/kg for piscivores.

Cadmium. The National Research Council (1980) set the maximum tolerable level for cadmium in animal feed at 0.5 mg/kg based on observed toxic effects in mammals on 1-mg/kg diets. This appears to be sufficient to protect birds because the lowest-reported-effects level in birds is 4 mg/kg (Heinz et al. 1983). The factor of 2 for whole-fish concentrations gives a lower screening criterion of 0.25 mg/kg for piscivores.

Chromium. Chromium is most toxic to aquatic organisms in the hexavalent form, the form used in cooling towers, and the form that we assume for the aqueous chromium concentrations used in this assessment. However, it is likely that much of the chromium has been reduced to the trivalent form in fish tissues. There are little appropriate data for estimating chromium effects on wildlife, but young black ducks experienced reduced growth and survival at 10 mg/kg chromium (III) in diet (Eisler 1986). We apply a factor of 5 for variance in sensitivity and 2 for whole fish to derive a lower screening criterion of 1 mg/kg for piscivores.

Copper. Copper is a well-regulated essential nutrient that is seldom toxic in terrestrial vertebrates. The National Research Council (1980) set the maximum tolerable level for the most sensitive mammal (sheep) at 25 mg/kg, for nonruminant mammals at 100 to 800 mg/kg, and for chickens and turkeys at 300 mg/kg. Applying a factor of 2 to the lowest nonruminant level yields a lower screening criterion of 50 mg/kg for piscivores.

Lead. The National Research Council (1980) recommended that lead in livestock food be limited to 30 mg/kg, which appears to be protective of other species (EPA 1984a,

Eisler 1988). We apply a factor of 2 for whole fish to derive a lower screening criterion of 15 mg/kg for piscivores.

Mercury. A U.S. Fish and Wildlife Service report has recommended that mercury in wildlife food be limited to 0.1 mg/kg, because this concentration of methylmercury caused reduced reproduction in ducks (Eisler 1987). Applying a factor of 5 for threshold effects and 2 for whole fish yields a lower criterion of 0.01 mg/kg for piscivores. Lethal dietary concentrations of methylmercury range from 1 mg/kg for mink to 250 mg/kg for chickens (National Research Council 1980, Sheffy and St. Amant 1982, Wren et al. 1987, Eisler 1987). We use 30 mg/kg, the approximate median LC_{50}, as an upper criterion for piscivores. Inorganic mercury is not relevant to this endpoint, because the mercury in local fish is almost entirely methylmercury.

Nickel. The National Research Council (1980) set the maximum tolerable level of nickel at 50 mg/kg, based on weight loss of cattle at 100 mg/kg in diet, but no observed effects at 50 mg/kg. Chickens, the only tested bird, showed a statistically significant decrease in growth at 500 mg/kg in diet, but not at 300 mg/kg (National Research Council 1980). Application of factors of 5 for variance in sensitivity and 2 for whole-fish concentration yields a lower chronic criterion of 50 mg/kg for piscivores. The oral LD_{50} in rats is 350 mg/kg (National Research Council 1980). Conversion to dietary concentration yields an upper criterion of 4400 mg/kg, which is consistent with the sublethal dietary toxicity data.

Selenium. Dietary selenium effects are difficult to assess because the toxic levels are near the deficiency levels, uptake is highly variable among species, and uptake is highly dependent on the form of the selenium and how it is incorporated into food. Rats experience histological damage and reduced longevity in lifetime exposures to 3 mg/kg in naturally contaminated feed, but the same effects occurred at 0.75 mg/kg in spiked feed (Eisler 1985). Five mg/kg was a no-observed-effects level in feeding studies of mallards, and 6 to 9 mg/kg in feed reduced the hatchability of chicken eggs (Eisler 1985). Mortality and severe reproductive effects in birds occurred in an area with concentrations of 22 to 175 mg/kg in food items (Ohlendorf et al. 1986). Based on these data, the lowest observed effects level is 1 mg/kg, which is just above recommended concentrations in diet to prevent selenium deficiency of 0.1 to 0.05 mg/kg (Eisler 1985). That threshold value is divided by 2 for the whole-fish conversion for a lower screening criterion of 0.5 mg/kg in fish for piscivores. The upper criterion is set at 100 mg/kg, the lethal dietary concentration in mallards (Eisler 1985).

Silver. The National Research Council (1980) set the maximum tolerable level for silver in animal food at 100 mg/kg based on studies of rats, chickens, and turkeys. Application of factors of 5 for variance in sensitivity and 2 for the whole-fish conversion yields a lower screening criterion of 10 mg/kg for piscivores.

Thallium. Thallium is highly toxic to mammals, and thallium salts have been used as rodenticides (Venugopal and Luckey 1978). It is also highly toxic to birds with an acute lethal threshold in diet of 12 mg/kg in bobwhite quail (EPA 1980a). The no-observed-effect level for thallium in the diet of rats is 5 mg/kg (EPA 1980a). Applying factors of 5 for variance in sensitivity and 2 for the whole-fish conversion yields a lower

screening criterion of 0.5 mg/kg for piscivores. The upper criterion is set at the dietary LC_{50} of 30 mg/kg in rats (EPA 1980a).

Zinc. The National Research Council (1980) set the maximum tolerable level for zinc in sheep feed at 300 mg/kg and in swine and poultry feed at 1000 mg/kg, but adverse effects on young Japanese quail fed laboratory diets occurred at 125 mg/kg (Hamilton et al. 1979). Using the Japanese quail datum as the lowest-observed-effect level and applying a factor of 2 for the whole-fish conversion yields a lower screening criterion of 60 mg/kg for piscivores.

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Hexachlorobenzene (HCB). The acute lethal dose for HCB is 1000 mg/kg or greater (EPA 1980i, EPA 1984b, NIOSH 1988), so the upper criterion for concentrations in fish is 12,500 mg/kg. HCB causes liver damage in Japanese quail at 5 mg/kg in diet (EPA 1980i) and causes immunosuppression in mink and ferrets (by different criteria) at 25 and 1 mg/kg in diet (Bleavins et al. 1983). Using the 1 mg/kg level as the lowest-observed-effects level and applying a factor of 3 for whole-fish basis yield a lower screening criterion of 0.3 mg/kg for piscivores.

DDT and metabolites. DDT and its metabolites DDD and DDE are notorious for their effects on piscivorous birds. Birds experience reduced survival or reproduction at 3 to 0.15 mg/kg in diet (Lincer 1975, Anderson et al. 1975). Applying a factor of 5 for an effects threshold and 3 for the whole-fish conversion yields a lower criterion of 0.01 mg/kg for piscivores. The acute oral LD_{50} for birds is approximately 1000 mg/kg (Matsumura 1985), which is equivalent to a dietary concentration of approximately 12,500 mg/kg in kingfishers, the upper criterion for piscivores. Fish themselves experience effects at 3 to 11 mg/kg body burden (EPA 1980m). Because 3 mg/kg is lethal to cutthroat trout fry, we apply the factors of 5 for an effects threshold and 3 for whole-fish basis to obtain a lower criterion of 0.2 mg/kg for protection of fish.

Polychlorinated biphenyls (PCBs). PCBs are persistent, bioaccumulative, and highly toxic. Mink are the most sensitive species to PCBs, experiencing reproductive failure at 0.64 mg/kg in diet (Ringer 1983, Fuller and Hobson 1986). Birds experience reproductive and immunotoxic effects at 10 to 40 mg/kg in diet (Peakall 1986). Because these levels induce catastrophic reproductive effects, the International Joint Commission (1988) recommends a concentration of 0.1 mg/kg in fish to protect piscivores. Using the mink-effects level and applying the factor of 5 for effects thresholds approximately yield this criterion. Applying the factor of 3 for organics in whole fish yields a lower criterion of 0.04 mg/kg for piscivores. The acute dietary LC_{50} in birds is 747 to 12,000 mg/kg (Peakall 1986). Using 1000 mg/kg and dividing by 3 for the whole-fish conversion yields an upper criterion of 300 mg/kg.

Other organics. All of the other organic chemicals that were analyzed in fish tissues were not detected. Except for the pesticides, which are not generated or used in large amounts by DOE operations, there are very few dietary toxicity data or avian toxicity data of any sort for these chemicals. If available, RfDs were used as screening criteria for these chemicals.

5.3.2.3 Radionuclides

Effects of radionuclides on nonhuman biota are not analyzed in this assessment for three reasons. First, previous studies of radionuclide exposure and effects in WOL found no evidence of effects or of exposures sufficient to cause effects in controlled exposures (Blaylock and Trabalka 1978). Second, the mode of action of radionuclides is the same in nonhuman organisms as in humans, so the ranking of radionuclides produced by the human health assessment, which includes bioaccumulation by fish and ingestion of fish by humans, would be applicable to ecological effects. Third, a screening assessment of radionuclide effects on nonhuman populations would have no consequences, because an extensive off-site radionuclide monitoring program will be conducted for human health assessment regardless of potential ecological effects. The results of those studies, including body burden data for fish, birds, and mammals, will be analyzed for evidence of ecological risks in future assessments.

5.4 RISK CHARACTERIZATION

Risk characterization is based on three independent lines of evidence. First, the estimates of exposure (Sect. 5.2) are compared to the toxicological benchmarks (Sect. 5.3) to determine for which chemicals the benchmarks are exceeded. Second, toxicity tests have been conducted with water collected from WOC and Melton Branch. These tests can be used to determine whether the waters have been toxic to standard test organisms. Third, biological surveys have been conducted in WAG 2 that can be used to estimate the actual levels of effects experienced by the receiving community.

5.4.1 Exposure/Response Integration

Exposure/response integration for this screening assessment is performed by calculating the quotients of chemical concentrations divided by screening criteria. For each detected chemical two exposure concentrations are used, the geometric mean and the arithmetic upper 95% confidence limit (UCL). If the calculated UCL exceeded the maximum observed concentration, the maximum value was used. These values were chosen to be consistent with the human health risk assessment (Sect. 4.5) because they are reasonable estimates of the chronic and episodic exposure levels, respectively. The concentrations, screening criteria, and quotients are presented in Tables G.3 to G.11, located in Appendix G.

5.4.1.1 Aqueous concentrations/aquatic life effects

The reported mean concentrations of most of the 17 metals and 6 out of 15 organic chemicals detected in water exceeded the lower screening criteria (Table G.4). Aluminum, cadmium, chromium, copper (UCL only), lead, and PCB concentrations exceed their chronic criteria. The largest quotients were for mercury and PCBs. In all reaches mean total mercury concentrations exceeded the lower screening criterion, which is the approximated chronic criterion for methyl mercury. (The actual chronic criterion for mercury is not used because it is based on mammalian toxicity rather than toxicity to aquatic life.) The mean and UCL total mercury concentration also exceed the lowest chronic value for daphnids and the lowest EC20 value for fish, but are well below all of

the benchmarks for divalent mercury. The Arochlor® 1254 detected in WOC (Reach 1) and the total PCB concentrations in all reaches greatly exceeded the approximated acute and chronic criteria for all of the Arochlor® mixtures and barely exceeded chronic values and EC20s for fish. Based on these results, the water in all reaches should be causing toxic effects in aquatic populations.

Most of the detection limits for chemicals that were not detected in water exceeded lower screening criteria. In addition, arsenic, cadmium, selenium, silver, and PCB detection limits exceed chronic NAWQC.

5.4.1.2 Concentrations in sediment/aquatic life effects

Sediment K_d values could be found for only six of the metals detected in WAG 2 sediments (Table G.6). All of these (barium, chromium, cobalt, mercury, silver, and zinc), have estimated pore-water values that exceed the lower screening criteria for aquatic life. In addition, mercury, silver, and zinc are estimated to exceed their chronic NAWQC in pore-water. Of the few organic chemicals detected in WAG 2 sediments, estimated pore-water concentrations exceeded lower screening criteria for benzene, di-n-butyl phthalate, methylene chloride, an PCBs. Pore-water concentrations estimated to occur at the detection limits of most of the chemicals not detected in WAG 2 exceeded lower screening criteria for aquatic life (Table G.7).

5.4.1.3 Concentrations in fish/fish effects

Only seven chemicals were detected in fish flesh (Table G.8). Of these, only selenium in Reach 1 occurred at mean concentrations that suggested that the fish may have been exposed to toxic aqueous concentrations. Upper confidence limits on the distributions of concentrations of cadmium and selenium in all reaches were barely high enough to suggest that toxic aqueous concentrations were exceeded. Seven metals and many organic compounds were not detected in fish flesh but had detection limits that exceeded concentrations that imply toxic aqueous concentrations (Table G.9).

5.4.1.4 Concentrations in fish/piscivore effects

Of the seven chemicals detected in fish flesh, only mercury and PCBs occurred at concentrations that could be toxic to piscivorous wildlife by the lower screening criteria for wildlife (Table G.10). However, cadmium, selenium, and zinc concentrations were sufficient to exceed the RfD for an organism consuming fish equal to 8% of its body weight per day (e.g., a kingfisher). Many undetected chemicals had detection limits in fish flesh that exceeded either lower screening criteria for wildlife or RfDs for kingfishers (Table G.11).

5.4.2 Ambient Media Toxicity Tests

The toxicity of surface waters in WOC and Melton Branch have been tested on a regular basis since 1986. Because of the major changes that have occurred in effluent input and toxicity in that interval, this discussion will emphasize the most recent results (Loar 1991). The tests employed are the standard 7-d static renewal tests measuring the growth and survival of fathead minnow (*Pimephales promelas*) larvae and the survival and

growth of the daphnid cladoceran *Ceriodaphnia dubia* (Horning and Weber 1985). During 1990, one or both of these tests were performed monthly with water taken from WOC just above the confluence of Melton Branch and from Melton Branch just above its mouth. In all cases, survival and growth of *C. dubia* were high. Fathead minnow survival was less than 70% for the Melton Branch samples in four months and for the WOC samples in one month. However, in each case of low survival, minnow growth was good and variance in survival among replicates was high. Hence, the observations of low minnow survival were attributed to disease rather than toxicity by the authors (A. J. Stewart and L. A. Kszos in Loar 1991). Results in 1989 were similar but with a higher frequency of tests with low minnow survival (Loar 1990).

5.4.3 Biological Surveys

The following brief discussion of biological survey results is based on the results of studies done by the Biological Monitoring and Abatement Program at ORNL (Loar et al. 1987, Loar 1988-1991).

5.4.3.1 Fish

Redbreast sunfish (*Lepomis auritus*) have been collected from WOC in WAG 2 (WCK 2.2 — 2.7) and from three reference streams for studies of the biomarkers of contaminant exposure, indicators of the health of individual fish, and population parameters. The fish from WAG 2 differed from those of the reference sites in the following ways:

1. liver detoxification enzymes were elevated;
2. creatinine levels were elevated, a possible sign of kidney damage;
3. condition indices were slightly lower; and
4. fish were larger.

The redbreast sunfish in WAG 2 appear to be exposed to organic contaminants to the extent of elevating enzymes that may affect hormone levels; they are in slightly poorer condition on average but are growing well; and they are producing abundant viable eggs, but are reproducing earlier in the season than at reference sites. The early reproduction, which may be due to elevated water temperatures, may be the cause of the larger fish. Adams and Greeley (in Loar 1991) suggest that poor early life-stage survival may also be involved, but no direct evidence currently exists for this hypothesis.

Surveys of the fish community have also been conducted by electrofishing. Thirteen of the fourteen species occurring in the WOC watershed were found in WAG 2 in 1990. The density is relatively stable at approximately 0.5 fish/m^2. Growth rates of redbreast sunfish are indistinguishable from those at a reference stream (Brushy Fork) and bluegill (*Lepomis macrochirus*) growth rates are higher.

A fish/amphibian kill was observed in Melton Branch in 1990, apparently due to high temperatures associated with the operation of the HFIR reactor. Other kills that have been reported in the WOC watershed have also been associated with point-source effluents rather than wastes.

5.4.3.2 Benthic macroinvertebrates

Surveys of benthic macroinvertebrates in WAG 2 are available only through 1987. Those surveys found low taxonomic richness and relatively high frequencies of "pollution tolerant species" (Loar 1991). However, the community characteristics are improved relative to upstream areas that are more directly exposed to point-source effluents. The cause of the apparently degraded condition of the benthic macroinvertebrate community is unclear. Possible causes include upstream point-source emissions, siltation, temperature, and natural factors as well as toxicant sources within WAG 2. Interpretation is particularly inhibited by the lack of data from reference streams; all comparisons were to reference sites that were upstream in WOC and Melton Branch.

5.4.3.3 Periphyton

Periphyton, along with allochthonous material, form the base of the food web in streams. Periphyton downstream of ORNL, including Melton Branch and WOC in WAG 2, are more productive than those in uncontaminated reference sites. This result is attributed to nutrient input and indicates that the base of the food web is unimpaired. "Chlorophyll-adjusted photosynthetic rates" of periphyton in WAG 2 (WCK 3.4, WCK 2.9, and MEK 0.6) have been low during some measurement periods, but it is not clear whether this is due to natural factors or upstream effluents. In any case, this effect has no apparent ecosystem-level consequences.

5.4.3.4 Terrestrial

The terrestrial studies conducted in WAG 2 have addressed bioaccumulation and transfer of contaminants rather than effects of contaminants. Species used in bioaccumulation studies have included turtles, small mammals, waterfowl, and vascular plants. The abundant vegetation of WAG 2 suggests that severe phytotoxic effects are not occurring. Avian and mammalian wildlife appear to be abundant on WAG 2. However, given the mobility of these species, one cannot infer from this that wildlife on WAG 2 are unaffected. Even high mortality rates or very low reproductive rates could be replaced by immigrants from surrounding habitats.

5.4.4 Weight of Evidence and Uncertainties

5.4.4.1 Water

The analysis of chemical concentrations in water indicates that toxic effects on aquatic organisms cannot be precluded from consideration but are not likely to be severe. The toxicological benchmarks that were exceeded are intended to be conservative, and the concentrations that were reported may overestimate bioavailable concentrations, so the quotients are expected to be conservative estimators of the potential for effects. The possibility that exposure is overestimated is supported by the relatively low concentrations in fish flesh, which are suggestive of lower water concentrations than are reported in the analyses. However, this analysis is based on concentrations in fillets, which are likely to be lower than whole fish concentrations that are the basis for the bioconcentration factors. The results of recent toxicity tests with WAG 2 water do not indicate toxicity, but they include only two species and one life stage of the fish. The most recent aquatic biological

survey results indicate that sources in WAG 2 are not causing severe toxic effects. However, fish reproduction may be disturbed in WAG 2, and the benthic invertebrate community may be affected by an unidentified source of toxic or physical stress.

5.4.4.2 Sediments

Estimated sediment pore-water concentrations of several chemicals are sufficient to cause toxic effects. However, these estimates are uncertain because they are not based on site-specific partitioning data. The apparent effects on the benthic invertebrate community are consistent with mild toxic effects, but, because riffle areas were sampled, the surface water may be the primary source of exposure. No sediment toxicity tests have been conducted with WAG 2 sediments.

5.4.4.3 Fish and piscivores

Mercury and PCB concentrations in fish flesh are high enough to indicate a hazard to piscivorous wildlife. There are no biosurvey data for piscivorous wildlife in WAG 2, but elevated PCB and mercury concentrations have been found in eggs at a great blue heron rookery at K-25. Great blue herons that forage in WAG 2 are believed to be from this rookery.

5.4.4.4 Terrestrial communities

Nothing is known about the nonradiological contamination of the floodplain habitats in WAG 2. There is no apparent ecological damage to the floodplain community, but no studies of potential toxic effects have been conducted.

5.4.4.5 Summary of the ecological risk characterization

Because there is no complete inventory of the chemicals that have been disposed of in the White Oak Creek watershed, it is not possible to identify a list of potential contaminants of concern *a priori*. Instead, it is necessary to either establish that no significant toxic effects are occurring in WAG 2 or perform a survey of watershed contaminants that is sufficiently sensitive and reliable for a complete screening to be performed. This assessment was not able to complete either of these strategies. Although severe effects are not occurring in the aquatic habitats of WAG 2, there is some evidence of effects on fish reproduction and on benthic invertebrate community composition. Toxicity tests of surface water have not found toxicity, but tests have not been conducted for sediment or soil. Some chemicals in all media occurred at concentrations that are potentially toxic and many chemicals that were not detected had detection limits that were higher than both toxic and regulatory thresholds. Therefore, although it is clear that severe toxic effects are not occurring, there are still significant uncertainties concerning the ecological risks posed by WAG 2. These uncertainties are reflected in the following list of data needs.

5.5 DATA NEEDS

5.5.1 Biota and Communities

A survey of threatened and endangered species should be conducted.

Wetland communities and seeps where contaminants may accumulate should be identified.

Benthic invertebrate communities in fine sediments should be surveyed in WAG 2 and reference sites.

5.5.2 Sources and Exposure

Species of arsenic, chromium, and mercury should be determined in each medium.

Sediment pore-water should be extracted and analyzed at a set of sites that are representative of the range of sediments (other than gravels) found in WAG 2. These samples will be used to derive site-specific K_d values. Percent organic matter and acid-volatile sulfides should be determined for those sediments.

Whole fish should be analyzed, including some small fish representative of the fish consumed by kingfishers. For the larger fish that are currently filleted, the non-fillet remainder of fish should be analyzed to establish fillet-to-whole-fish ratios. Whole-fish analysis is the best measure of piscivore dietary exposure and is the most generally useful measure of fish internal exposure.

Soil should be analyzed for nonradiological chemicals in areas where contaminants are likely to have accumulated. Aqueous extracts as well as the conventional acid and organic extracts should be analyzed.

Water should be analyzed for dissolved chemical concentrations.

5.5.3 Toxicity Testing

If pore-water analyses indicate potential sediment toxicity, sediment toxicity tests should be performed.

If soil analyses indicate potential soil toxicity, soil toxicity tests should be performed.

Tests of effects of WAG 2 waters on fish reproduction should be continued to resolve the nature and cause of apparent effects.

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APPENDIX A

NONCONSERVATIVE SCREENING OF THE DETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

WHITE OAK CREEK WATERSHED REFERENCES

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Table A1. Results of nonconservative screening for carcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (mg/kg wet)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
1	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	79/79	3.2E-01	7.7E+00	1.5E-05	1E-04
			PCB-1260 (Aroclor 1260)	11096-82-5	79/79	1.2E-01	7.7E+00	5.6E-06	4E-05
1	Fish	Organic	Total						2E-04
						(Bq/kg wet)	(1/Bq)	(Bq/lifetime)	
1	Fish	Radionuclide	Cs-137	10045-97-3	42/42	2.6E+03	7.6E-10	9.1E+04	7E-05
1	Fish	All	Total						2E-04
						(mg/kg dry)	1/(mg/kg/d)	(mg/kg/d)	
1	Sed ingestion	Inorganic	Arsenic	7440-38-2	13/31	3.8E+00	1.8E+00	5.4E-07	1E-06
			Beryllium	7440-41-7	19/27	2.4E-01	4.3E+00	3.4E-08	2E-07
1	Sed ingestion	Inorganic	Total						1E-06
1	Sed ingestion	Organic	PCB-1260 (Aroclor 1260)	11096-82-5	7/13	2.8E-01	7.7E+00	4.0E-08	3E-07
			PCB-1254 (Aroclor 1254)	11097-69-1	13/13	1.3E-01	7.7E+00	1.8E-08	1E-07
1	Sed ingestion	Organic	Total						5E-07
						(Bq/kg dry)	(1/Bq)	(Bq/lifetime)	
1	Sed ingestion	Radionuclide	Cs-137	10045-97-3	17/18	5.5E+03	7.6E-10	5.8E+02	4E-07
			Sr-90	10098-97-2	33/33	2.0E+03	8.9E-10	2.1E+02	2E-07
			Co-60	10198-40-0	18/18	1.3E+03	4.1E-10	1.4E+02	6E-08
			Am-241	14596-10-2	1/1	1.4E+01	8.4E-09	1.5E+00	1E-08
			Cm-244	13981-15-2	1/1	1.8E+01	5.4E-09	1.9E+00	1E-08
			Cs-134	13967-70-9	8/8	7.8E+01	1.1E-09	8.2E+00	9E-09
			Pu-238	13981-16-3	1/1	2.0E+00	7.6E-09	2.1E-01	2E-09
			U-234	13966-29-5	1/1	3.8E+00	3.8E-09	4.0E-01	2E-09
			Eu-152	14683-23-9	4/4	2.3E+02	5.7E-11	2.4E+01	1E-09
			Pu-239	15117-48-3	1/1	1.0E+01	8.4E-10	1.1E+00	9E-10
			U-238	7440-61-1	1/1	1.6E+00	3.5E-09	1.7E-01	6E-10
			Eu-154	15585-10-1	1/1	4.3E+01	8.1E-11	4.5E+00	4E-10
			U-235	15117-96-1	1/1	4.2E-01	3.5E-09	4.4E-02	2E-10
1	Sed ingestion	Radionuclide	Total						7E-07
1	Sed ingestion	All	Total						2E-06

Table A1 (continued)

Resch no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (Bq/kg dry)	Cancer slope factor (1/Bq)	Daily intake (Bq/lifetime)	Carcinogen screening indices
1	Sed ext exp	Radionuclide	Cs-137	10045-97-3	17/18	5.5E+03	9.2E-10	3.8E+05	4E-04
1			Co-60	10198-40-0	18/18	1.3E+03	3.5E-09	8.8E+04	3E-04
1			Eu-152	14683-23-9	4/4	2.3E+02	1.7E-09	1.5E+04	3E-05
1			Cs-134	13967-70-9	8/8	7.8E+01	2.4E-09	5.4E+03	1E-05
1			Eu-154	15585-10-1	1/1	4.3E+01	1.8E-09	2.9E+03	5E-06
1			Am-241	14596-10-2	1/1	1.4E+01	4.3E-11	9.6E+02	4E-08
1			U-235	15117-96-1	1/1	4.2E-01	2.6E-10	2.9E+01	8E-09
1			Cm-244	13981-15-2	1/1	1.8E+01	1.6E-12	1.2E+03	2E-09
1			Pu-239	15117-48-3	1/1	1.0E+01	7.0E-13	6.8E+02	5E-10
1			U-234	13966-29-5	1/1	3.8E+00	1.5E-12	2.6E+02	4E-10
1			Pu-238	13981-16-3	1/1	2.0E+00	1.6E-12	1.4E+02	2E-10
1			U-238	7440-61-1	1/1	1.6E+00	1.2E-12	1.1E+02	1E-10
1	Sed ext exp	Radionuclide	Total						7E-04
1	**Sediment**	**All**	**Total**						**7E-04**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
1	Water	Organic	PCBs total	1336-36-3	2/30	1.1E-03	7.7E+00	3.0E-06	2E-05
			PCB-1254 (Aroclor 1254)	11097-69-1	1/28	1.0E-03	7.7E+00	2.9E-06	2E-05
			Dichlorobromomethane	75-27-4	3/29	4.3E-03	1.3E-01	1.2E-05	2E-06
			Tetrachloroethylene	127-18-4	1/29	5.1E-03	5.1E-02	1.5E-05	8E-07
			Benzene	71-43-2	1/28	4.8E-03	2.9E-02	1.4E-05	4E-07
			Trichloroethylene	79-01-6	4/46	4.4E-03	1.1E-02	1.3E-05	1E-07
			Methylene chloride	75-09-2	15/29	3.7E-03	7.5E-03	1.1E-05	8E-08
			Chloroform	67-66-3	18/30	3.6E-03	6.1E-03	1.0E-05	6E-08
1	Water	Organic	Total						5E-05
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
1	Water	Radionuclide	Sr-90	10098-97-2	34/34	5.1E+00	8.9E-10	1.1E+04	1E-05
			H-3	10028-17-8	34/34	2.4E+03	1.5E-12	5.1E+06	8E-06
			Cs-137	10045-97-3	29/34	2.7E+00	7.6E-10	5.7E+03	4E-06
			Co-60	10198-40-0	3/34	1.2E-02	4.1E-10	2.5E+01	1E-08
1	Water	Radionuclide	Total						2E-05
1	**Water**	**All**	**Total**						**7E-05**
1			**Reach total**						**1E-03**

Table A1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (mg/kg wet)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
2	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	24/24	4.7E-02	7.7E+00	2.2E-06	2E-05
			PCB-1260 (Aroclor 1260)	11096-82-5	24/24	4.0E-02	7.7E+00	1.9E-06	2E-05
2	Fish	Organic	Total						3E-05
2	Fish	Radionuclide	Cs-137	10045-97-3	10/10	7.0E+02	7.6E-10	2.4E+04	2E-05
2	**Fish**	**All**	**Total**						**5E-05**
						(mg/kg dry)	**1/(mg/kg/d)**	**(mg/kg/d)**	
2	Sed ingestion	Inorganic	Arsenic	7440-38-2	4/111	1.5E+00	1.8E+00	2.2E-07	4E-07
			Beryllium	7440-41-7	81/99	1.0E-01	4.3E+00	1.4E-08	6E-08
2	Sed ingestion	Inorganic	Total						5E-07
2	Sed ingestion	Organic	PCB-1260 (Aroclor 1260)	11096-82-5	3/13	3.2E-01	7.7E+00	4.6E-08	4E-07
			PCB-1254 (Aroclor 1254)	11097-69-1	11/13	5.9E-02	7.7E+00	8.4E-09	7E-08
2	Sed ingestion	Organic	Total						4E-07
						(Bq/kg dry)	**(1/Bq)**	**(Bq/lifetime)**	
2	Sed ingestion	Radionuclide	Co-60	10198-40-0	121/134	1.4E+03	4.1E-10	1.5E+02	6E-08
			Cs-137	10045-97-3	130/134	6.3E+02	7.6E-10	6.7E+01	5E-08
			Cs-134	13967-70-9	10/10	1.4E+02	1.1E-09	1.5E+01	2E-08
			Eu-152	14683-23-9	11/11	8.2E+02	5.7E-11	8.6E+01	5E-09
			Sr-90	10098-97-2	91/95	4.5E+01	8.9E-10	4.7E+00	4E-09
			U-234	13966-29-5	4/4	9.1E+00	3.8E-09	9.5E-01	4E-09
			Eu-154	15585-10-1	14/14	3.5E+02	8.1E-11	3.7E+01	3E-09
			Cm-244	13981-15-2	4/4	4.1E+00	5.4E-09	4.3E-01	2E-09
			U-238	7440-61-1	4/4	4.1E+00	3.5E-09	4.3E-01	2E-09
			Am-241	14596-10-2	4/4	1.2E+00	8.4E-09	1.2E-01	1E-09
			Pu-238	13981-16-3	4/4	3.8E-01	7.6E-09	3.9E-02	3E-10
			U-235	15117-96-1	4/4	6.6E-01	3.5E-09	6.9E-02	2E-10
			Pu-239	15117-48-3	4/4	8.5E-02	8.4E-10	8.9E-03	8E-12
2	Sed ingestion	Radionuclide	Total						2E-07
2	**Sed ingestion**	**All**	**Total**						**1E-06**

Table A1 (continued)

Resch no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (Bq/kg dry)	Cancer slope factor (1/Bq)	Daily intake (Bq/lifetime)	Carcinogen screening indices
2	Sed ext exp	Radionuclide	Co-60	10198-40-0	121/134	1.4E+03	3.5E-09	9.6E+04	3E-04
2			Eu-152	14683-23-9	11/11	8.2E+02	1.7E-09	5.6E+04	1E-04
2			Eu-154	15585-10-1	14/14	3.5E+02	1.8E-09	2.4E+04	4E-05
2			Cs-137	10045-97-3	130/134	6.3E+02	9.2E-10	4.3E+04	4E-05
2			Cs-134	13967-70-9	10/10	1.4E+02	2.4E-09	9.8E+03	2E-05
2			U-235	15117-96-1	4/4	6.6E-01	2.6E-10	4.5E+01	1E-08
2			Am-241	14596-10-2	4/4	1.2E+00	4.3E-11	7.9E+01	3E-09
2			U-234	13966-29-5	4/4	9.1E+00	1.5E-12	6.2E+02	9E-10
2			Cm-244	13981-15-2	4/4	4.1E+00	1.6E-12	2.8E+02	5E-10
2			U-238	7440-61-1	4/4	4.1E+00	1.2E-12	2.8E+02	3E-10
2			Pu-238	13981-16-3	4/4	3.8E-01	1.6E-12	2.6E+01	4E-11
2			Pu-239	15117-48-3	4/4	8.5E-02	7.0E-13	5.8E+00	4E-12
2	Sed ext exp	Radionuclide	Total						5E-04
2	**Sediment**	**All**	**Total**						**5E-04**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
2	Water	Inorganic	Arsenic	7440-38-2	4/75	5.1E-02	1.8E+00	1.5E-04	3E-04
2	Water	Organic	PCBs total	1336-36-3	2/30	1.0E-03	7.7E+00	3.0E-06	2E-05
			Trichloroethylene	79-01-6	10/46	3.6E-03	1.1E-02	1.0E-05	1E-07
			Methylene chloride	75-09-2	15/29	3.2E-03	7.5E-03	9.1E-06	7E-08
			Chloroform	67-66-3	6/30	3.5E-03	6.1E-03	1.0E-05	6E-08
2	Water	Organic	Total						2E-05
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
2	Water	Radionuclide	H-3	10028-17-8	63/64	1.9E+03	1.5E-12	4.0E+06	6E-06
			Eu-154	15585-10-1	5/5	1.9E+01	8.1E-11	4.0E+04	3E-06
			Eu-152	14683-23-9	2/2	1.8E+01	5.7E-11	3.8E+04	2E-06
			Sr-90	10098-97-2	43/66	8.4E-01	8.9E-10	1.8E+03	2E-06
			Co-60	10198-40-0	27/74	1.2E-01	4.1E-10	2.5E+02	1E-07
			Cs-137	10045-97-3	15/74	1.1E-02	7.6E-10	2.2E+01	2E-08
2	Water	Radionuclide	Total						1E-05
2	**Water**	**All**	**Total**						**3E-04**
2			**Reach total**						**9E-04**

Table A1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (mg/kg wet)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
3	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	79/79	2.9E-01	7.7E+00	1.4E-05	1E-04
			PCB-1260 (Aroclor 1260)	11096-82-5	79/79	1.7E-01	7.7E+00	7.8E-06	6E-05
3	Fish	Organic	Total						2E-04
						(Bq/kg wet)	(1/Bq)	(Bq/lifetime)	
3	Fish	Radionuclide	Cs-137	10045-97-3	106/106	5.2E+02	7.6E-10	1.8E+04	1E-05
			Sr-90	10098-97-2	13/13	2.5E+01	8.9E-10	8.6E+02	8E-07
			Co-60	10198-40-0	9/70	5.5E-05	4.1E-10	1.9E-03	8E-13
3	Fish	Radionuclide	Total						1E-05
3	**Fish**	**All**	**Total**						**2E-04**
						(mg/kg dry)	1/(mg/kg/d)	(mg/kg/d)	
3	Sed ingestion	Inorganic	Arsenic	7440-38-2	6/60	3.2E+00	1.8E+00	4.6E-07	8E-07
			Beryllium	7440-41-7	40/54	2.4E-01	4.3E+00	3.5E-08	2E-07
3	Sed ingestion	Inorganic	Total						1E-06
3	Sed ingestion	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	4/15	2.8E-01	7.7E+00	4.0E-08	3E-07
			Benzene	71-43-2	1/7	1.8E-02	2.9E-02	2.6E-09	8E-11
			Methylene chloride	75-09-2	2/7	2.4E-02	7.5E-03	3.4E-09	3E-11
			Chloroform	67-66-3	2/7	8.7E-03	6.1E-03	1.2E-09	8E-12
3	Sed ingestion	Organic	Total						3E-07
						(Bq/kg dry)	(1/Bq)	(Bq/lifetime)	
3	Sed ingestion	Radionuclide	Cs-137	10045-97-3	223/223	1.0E+04	7.6E-10	1.0E+03	8E-07
			Co-60	10198-40-0	204/208	1.1E+03	4.1E-10	1.1E+02	5E-08
			Sr-90	10098-97-2	60/60	2.0E+02	8.9E-10	2.1E+01	2E-08
			Cs-134	13967-70-9	7/7	1.1E+02	1.1E-09	1.1E+01	1E-08
			Eu-152	14683-23-9	2/2	3.5E+02	5.7E-11	3.7E+01	2E-09
			U-234	13966-29-5	1/1	4.2E+00	3.8E-09	4.4E-01	2E-09
			Eu-154	15585-10-1	9/9	1.8E+02	8.1E-11	1.8E+01	2E-09
			U-235	15117-96-1	1/1	3.2E+00	3.5E-09	3.4E-01	1E-09
			U-238	7440-61-1	1/1	3.0E+00	3.5E-09	3.2E-01	1E-09
			Cm-244	13981-15-2	1/1	1.5E-01	5.4E-09	1.6E-02	9E-11
			Am-241	14596-10-2	1/1	6.3E-02	8.4E-09	6.6E-03	6E-11
			Pu-238	13981-16-3	1/1	5.8E-02	7.6E-09	6.1E-03	5E-11
			Pu-239	15117-48-3	1/1	8.7E-02	8.4E-10	9.1E-03	8E-12
3	Sed ingestion	Radionuclide	Total						9E-07
3	**Sed ingestion**	**All**	**Total**						**2E-06**

Table A1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric means (Bq/kg dry)	Cancer slope factor (1/Bq)	Daily intake (Bq/lifetime)	Carcinogen screening indices
3	Sed ext exp	Radionuclide	Cs-137	10045-97-3	223/223	1.0E+04	9.2E-10	6.8E+05	6E-04
3			Co-60	10198-40-0	204/208	1.1E+03	3.5E-09	7.4E+04	3E-04
3			Eu-152	14683-23-9	2/2	3.5E+02	1.7E-09	2.4E+04	4E-05
3			Eu-154	15585-10-1	9/9	1.8E+02	1.8E-09	1.2E+04	2E-05
3			Cs-134	13967-70-9	7/7	1.1E+02	2.4E-09	7.5E+03	2E-05
3			U-235	15117-96-1	1/1	3.2E+00	2.6E-10	2.2E+02	6E-08
3			U-234	13966-29-5	1/1	4.2E+00	1.5E-12	2.9E+02	4E-10
3			U-238	7440-61-1	1/1	3.0E+00	1.2E-12	2.1E+02	3E-10
3			Am-241	14596-10-2	1/1	6.3E-02	4.3E-11	4.3E+00	2E-10
3			Cm-244	13981-15-2	1/1	1.5E-01	1.6E-12	1.0E+01	2E-11
3			Pu-238	13981-16-3	1/1	5.8E-02	1.6E-12	4.0E+00	6E-12
3			Pu-239	15117-48-3	1/1	8.7E-02	7.0E-13	6.0E+00	4E-12
3			Total						1E-03
3	Sed ext exp	Radionuclide	Total						1E-03
3	Sediment	All	Total						
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
3	Water	Inorganic	Arsenic	7440-38-2	2/38	3.1E-02	1.8E+00	8.8E-05	2E-04
3	Water	Organic	PCBs total	1336-36-3	2/30	1.0E-03	7.7E+00	2.9E-06	2E-05
			Tetrachloroethylene	127-18-4	1/28	5.1E-03	5.1E-02	1.5E-05	8E-07
			Trichloroethylene	79-01-6	1/44	5.0E-03	1.1E-02	1.4E-05	2E-07
			Methylene chloride	75-09-2	16/28	3.1E-03	7.5E-03	8.8E-06	7E-08
			Chloroform	67-66-3	12/29	3.1E-03	6.1E-03	9.0E-06	6E-08
3	Water	Organic	Total						2E-05
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
3	Water	Radionuclide	H-3	10028-17-8	49/49	8.5E+03	1.5E-12	1.8E+07	3E-05
			Sr-90	10098-97-2	51/51	6.7E+00	8.9E-10	1.4E+04	1E-05
			Cs-137	10045-97-3	131/135	1.7E+00	7.6E-10	3.5E+03	3E-06
			U-234	13966-29-5	1/1	1.9E-01	3.8E-09	4.0E+02	2E-06
			U-235	15117-96-1	1/1	6.4E-02	3.5E-09	1.3E+02	5E-07
			U-238	7440-61-1	1/1	3.4E-02	3.5E-09	7.1E+01	3E-07
			Co-60	10198-40-0	103/135	1.7E-01	4.1E-10	3.5E+02	2E-07
			Am-241	14596-10-2	14/19	8.2E-03	8.4E-09	1.7E+01	1E-07
			Cm-244	13981-15-2	8/10	1.0E-02	5.4E-09	2.2E+01	1E-07
			Pu-238	13981-16-3	5/20	8.3E-04	7.6E-09	1.7E+00	1E-08
			Pu-239	15117-48-3	11/20	1.2E-03	8.4E-10	2.5E+00	2E-09
3	Water	Radionuclide	Total						5E-05
3	Water	All	Total						2E-04
3			Reach total						1.4E-03

Table A2. Results of nonconservative screening for noncarcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
1	Fish	Inorganic	Mercury	7439-97-6	87/87	3.6E-01	3.0E-04	3.3E-05	1E-01
			Selenium	7782-49-2	35/35	3.7E-01	3.0E-03	3.5E-05	1E-02
			Cadmium	7440-43-9	35/43	1.3E-02	5.0E-04	1.2E-06	2E-03
			Copper	7440-50-8	22/35	3.0E-01	3.7E-02	2.8E-05	8E-04
			Zinc	7440-66-6	35/35	1.5E+00	2.0E-01	1.4E-04	7E-04
1	Fish	Inorganic	Total						1E-01
1	**Fish**	**All**	**Total**						**1E-01**
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
1	Sediment	Inorganic	Antimony	7440-36-0	11/27	5.8E+00	4.0E-04	8.2E-07	2E-03
			Arsenic	7440-38-2	13/31	3.8E+00	1.0E-03	5.4E-07	5E-04
			Selenium	7782-49-2	2/31	5.8E+00	3.0E-03	8.2E-07	3E-04
			Chromium	7440-47-3	23/31	8.3E+00	5.0E-03	1.2E-06	2E-04
			Mercury	7439-97-6	19/19	3.2E-01	3.0E-04	4.6E-08	2E-04
			Barium	7440-39-3	31/31	7.3E+01	7.0E-02	1.0E-05	2E-04
			Nickel	7440-02-0	27/31	1.7E+01	2.0E-02	2.4E-06	1E-04
			Silver	7440-22-4	13/31	2.5E+00	3.0E-03	3.5E-07	1E-04
			Vanadium	7440-62-2	20/22	4.9E+00	7.0E-03	7.0E-07	1E-04
			Molybdenum	7439-98-7	5/27	2.6E+00	4.0E-03	3.7E-07	9E-05
			Cadmium	7440-43-9	16/31	2.2E-01	5.0E-04	3.2E-08	6E-05
			Zinc	7440-66-6	31/31	5.2E+01	2.0E-01	7.4E-06	4E-05
			Copper	7440-50-8	27/31	6.2E+00	3.7E-02	8.9E-07	2E-05
			Beryllium	7440-41-7	19/27	2.4E-01	5.0E-03	3.4E-08	7E-06
			Boron	7440-42-8	9/30	4.2E+00	9.0E-02	6.0E-07	7E-06
			Tin	7440-31-5	9/20	4.7E+00	6.0E-01	6.7E-07	1E-06
1	Sediment	Inorganic	Total						4E-03
1	**Sediment**	**All**	**Total**						**4E-03**

Table A2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
1	Water	Inorganic	Thallium	7440-28-0	1/1	8.6E-02	7.0E-05	2.5E-04	4E+00
			Chromium	7440-47-3	25/32	7.6E-03	5.0E-03	2.2E-05	4E-03
			Barium	7440-39-3	3/3	3.3E-02	7.0E-02	9.4E-05	1E-03
			Nickel	7440-02-0	4/32	6.0E-03	2.0E-02	1.7E-05	9E-04
			Copper	7440-50-8	11/32	9.0E-03	3.7E-02	2.6E-05	7E-04
			Mercury	7439-97-6	9/32	6.0E-05	3.0E-04	1.7E-07	6E-04
			Zinc	7440-66-6	31/32	2.9E-02	2.0E-01	8.4E-05	4E-04
1	Water	Inorganic	Total						4E+00
1	Water	Organic	Tetrachloroethylene	127-18-4	1/29	5.1E-03	1.0E-02	1.5E-05	2E-03
			Chloroform	67-66-3	18/30	3.6E-03	1.0E-02	1.0E-05	1E-03
			Dichlorobromomethane	75-27-4	3/29	4.3E-03	2.0E-02	1.2E-05	6E-04
			Acetone	67-64-1	14/58	1.0E-02	1.0E-01	2.9E-05	3E-04
			Methylene chloride	75-09-2	15/29	3.7E-03	6.0E-02	1.1E-05	2E-04
			Ethylbenzene	100-41-4	1/29	5.1E-03	1.0E-01	1.5E-05	2E-04
			Carbon disulfide	75-15-0	2/29	5.1E-03	1.0E-01	1.5E-05	2E-04
			Toluene	108-88-3	4/28	4.3E-03	2.0E-01	1.2E-05	6E-05
			Xylene	1330-20-7	1/29	5.1E-03	2.0E+00	1.5E-05	7E-06
1	Water	Organic	Total						4E-03
1	Water	All	Total						4E+00
1			Reach total						4E+00

Table A2 (continued)

Reech no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
2	Fish	Inorganic	Mercury	7439-97-6	33/33	9.1E-02	3.0E-04	8.4E-06	3E-02
			Selenium	7782-49-2	11/11	2.7E-01	3.0E-03	2.5E-05	8E-03
			Cadmium	7440-43-9	11/19	3.9E-02	5.0E-04	3.6E-06	7E-03
			Zinc	7440-66-6	11/11	1.3E+00	2.0E-01	1.2E-04	6E-04
			Copper	7440-50-8	7/11	1.8E-01	3.7E-02	1.7E-05	5E-04
2	Fish	Inorganic	Total						5E-02
2	**Fish**	**All**	**Total**						**5E-02**
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
2	Sediment	Inorganic	Antimony	7440-36-0	73/99	4.9E+00	4.0E-04	7.1E-07	2E-03
			Barium	7440-39-3	111/111	1.5E+02	7.0E-02	2.1E-05	3E-04
			Arsenic	7440-38-2	4/111	1.5E+00	1.0E-03	2.2E-07	2E-04
			Chromium	7440-47-3	95/111	6.1E+00	5.0E-03	8.8E-07	2E-04
			Selenium	7782-49-2	14/111	3.1E+00	3.0E-03	4.4E-07	2E-04
			Molybdenum	7439-98-7	65/99	2.1E+00	4.0E-03	3.1E-07	8E-05
			Nickel	7440-02-0	106/111	5.0E+00	2.0E-02	7.1E-07	4E-05
			Vanadium	7440-62-2	89/91	1.7E+00	7.0E-03	2.5E-07	4E-05
			Silver	7440-22-4	13/111	7.1E-01	3.0E-03	1.0E-07	3E-05
			Zinc	7440-66-6	98/98	4.8E+01	2.0E-01	6.8E-06	3E-05
			Mercury	7439-97-6	25/25	5.2E-02	3.0E-04	7.4E-09	3E-05
			Cadmium	7440-43-9	6/111	7.6E-02	5.0E-04	1.1E-08	2E-05
			Copper	7440-50-8	101/111	2.6E+00	3.7E-02	3.7E-07	1E-05
			Boron	7440-42-8	78/111	2.7E+00	9.0E-02	3.8E-07	4E-06
			Beryllium	7440-41-7	81/99	1.0E-01	5.0E-03	1.4E-08	3E-06
			Tin	7440-31-5	10/29	3.2E+00	6.0E-01	4.6E-07	8E-07
2	Sediment	Inorganic	Total						3E-03
2	Sediment	Organic	Di-n-butyl phthalate	84-74-2	3/10	5.6E+00	1.0E-01	8.1E-07	8E-06
2	**Sediment**	**All**	**Total**						**3E-03**

Table A2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
2	Water	Inorganic	Thallium	7440-28-0	1/1	9.4E-02	7.0E-05	2.7E-04	4E+00
			Arsenic	7440-38-2	4/75	5.1E-02	1.0E-03	1.5E-04	2E-01
			Cadmium	7440-43-9	6/76	2.8E-03	5.0E-04	7.9E-06	2E-02
			Chromium	7440-47-3	54/75	7.6E-03	5.0E-03	2.2E-05	4E-03
			Barium	7440-39-3	3/3	7.3E-02	7.0E-02	2.1E-04	3E-03
			Copper	7440-50-8	53/75	3.1E-02	3.7E-02	9.0E-05	2E-03
			Vanadium	7440-62-2	1/3	2.9E-03	7.0E-03	8.4E-06	1E-03
			Nickel	7440-02-0	8/75	7.6E-03	2.0E-02	2.2E-05	1E-03
			Zinc	7440-66-6	66/75	4.5E-02	2.0E-01	1.3E-04	7E-04
			Mercury	7439-97-6	5/32	5.3E-05	3.0E-04	1.5E-07	5E-04
2	Water	Inorganic	Total						4E+00
2	Water	Organic	1,2-Dichloroethene (total)	156-59-2	2/29	4.9E-03	1.0E-02	1.4E-05	1E-03
			Chloroform	67-66-3	6/30	3.5E-03	1.0E-02	1.0E-05	1E-03
			Acetone	67-64-1	11/58	8.9E-03	1.0E-01	2.5E-05	3E-04
			Methylene chloride	75-09-2	15/29	3.2E-03	6.0E-02	9.1E-06	2E-04
			Carbon disulfide	75-15-0	2/29	5.1E-03	1.0E-01	1.5E-05	2E-04
			1,1-Dichloroethane	75-34-3	2/29	4.7E-03	1.0E-01	1.4E-05	1E-04
			Toluene	108-88-3	1/28	5.0E-03	2.0E-01	1.4E-05	7E-05
			Xylene	1330-20-7	1/29	5.0E-03	2.0E+00	1.4E-05	7E-06
2	Water	Organic	Total						3E-03
2	Water	All	Total						4E+00
2			Reach total						4E+00

Table A2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Fish	Inorganic	Mercury	7439-97-6	88/88	1.8E-01	3.0E-04	1.6E-05	6E-02
			Selenium	7782-49-2	27/28	2.4E-01	3.0E-03	2.3E-05	8E-03
			Cadmium	7440-43-9	28/36	2.0E-02	5.0E-04	1.8E-06	4E-03
			Zinc	7440-66-6	26/26	1.7E+00	2.0E-01	1.6E-04	8E-04
			Copper	7440-50-8	14/28	2.2E-01	3.7E-02	2.1E-05	6E-04
3	Fish	Inorganic	Total						7E-02
3	**Fish**	**All**	**Total**						**7E-02**
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
3	Sediment	Inorganic	Antimony	7440-36-0	24/54	5.5E+00	4.0E-04	7.8E-07	2E-03
			Arsenic	7440-38-2	6/60	3.2E+00	1.0E-03	4.6E-07	5E-04
			Selenium	7782-49-2	1/62	5.7E+00	3.0E-03	8.1E-07	3E-04
			Barium	7440-39-3	58/58	1.2E+02	7.0E-02	1.7E-05	2E-04
			Chromium	7440-47-3	44/62	5.3E+00	5.0E-03	7.6E-07	2E-04
			Vanadium	7440-62-2	48/51	3.8E+00	7.0E-03	5.4E-07	8E-05
			Silver	7440-22-4	19/61	1.4E+00	3.0E-03	2.0E-07	7E-05
			Molybdenum	7439-98-7	11/52	1.7E+00	4.0E-03	2.5E-07	6E-05
			Cadmium	7440-43-9	7/60	1.8E-01	5.0E-04	2.6E-08	5E-05
			Nickel	7440-02-0	53/60	6.7E+00	2.0E-02	9.5E-07	5E-05
			Mercury	7439-97-6	21/21	6.6E-02	3.0E-04	9.4E-09	3E-05
			Zinc	7440-66-6	57/60	1.9E+01	2.0E-01	2.7E-06	1E-05
			Copper	7440-50-8	49/60	3.1E+00	3.7E-02	4.5E-07	1E-05
			Beryllium	7440-41-7	40/54	2.4E-01	5.0E-03	3.5E-08	7E-06
			Boron	7440-42-8	25/54	2.6E+00	9.0E-02	3.8E-07	4E-06
			Tin	7440-31-5	12/29	4.9E+00	6.0E-01	7.0E-07	1E-06
3	Sediment	Inorganic	Total						4E-03
3	Sediment	Organic	Di-n-butyl phthalate	84-74-2	3/16	6.6E+00	1.0E-01	9.5E-07	1E-05
			Chloroform	67-66-3	2/7	8.7E-03	1.0E-02	1.2E-09	1E-07
			Methylene chloride	75-09-2	2/7	2.4E-02	6.0E-02	3.4E-09	6E-08
			Toluene	108-88-3	1/7	1.7E-02	2.0E-01	2.4E-09	1E-08
3	Sediment	Organic	Total						1E-05
3	**Sediment**	**All**	**Total**						**4E-03**

Table A2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Water	Inorganic	Thallium	7440-28-0	1/1	7.0E-02	7.0E-05	2.0E-04	3E+00
			Arsenic	7440-38-2	2/38	3.1E-02	1.0E-03	8.8E-05	9E-02
			Chromium	7440-47-3	28/32	1.4E-02	5.0E-03	3.9E-05	8E-03
			Selenium	7782-49-2	2/14	7.8E-03	3.0E-03	2.2E-05	7E-03
			Barium	7440-39-3	3/3	3.7E-02	7.0E-02	1.1E-04	2E-03
			Nickel	7440-02-0	3/32	6.1E-03	2.0E-02	1.7E-05	9E-04
			Copper	7440-50-8	14/32	8.7E-03	3.7E-02	2.5E-05	7E-04
			Mercury	7439-97-6	9/32	5.5E-05	3.0E-04	1.6E-07	5E-04
			Zinc	7440-66-6	30/32	2.1E-02	2.0E-01	6.0E-05	3E-04
3	Water	Inorganic	Total						3E+00
3	Water	Organic	Tetrachloroethylene	127-18-4	1/28	5.1E-03	1.0E-02	1.5E-05	2E-03
			Chloroform	67-66-3	12/29	3.1E-03	1.0E-02	9.0E-06	9E-04
			4-Methyl-2-pentanone	108-10-1	1/28	9.6E-03	5.0E-02	2.8E-05	6E-04
			Acetone	67-64-1	13/56	9.6E-03	1.0E-01	2.7E-05	3E-04
			Carbon disulfide	75-15-0	1/28	5.3E-03	1.0E-01	1.5E-05	2E-04
			Methylene chloride	75-09-2	13/28	3.1E-03	6.0E-02	8.8E-06	2E-04
			Toluene	108-88-3	4/27	4.3E-03	2.0E-01	1.2E-05	6E-05
			Xylene	1330-20-7	1/28	5.1E-03	2.0E+00	1.5E-05	7E-06
3	Water	Organic	Total						4E-03
3	Water	All	Total						3E+00
3			Reach total						3E+00

APPENDIX B

CONSERVATIVE SCREENING OF THE DETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS

Table B1. Results of conservative screening for carcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean	Cancer slope factor	Daily intake	Carcinogen screening indices
1	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	79/79	5.8E-01	7.7E+00	2.7E-04	2E-03
			PCB-1260 (Aroclor 1260)	11096-82-5	79/79	3.3E-01	7.7E+00	1.6E-04	1E-03
1	Fish	Organic	Total						3E-03
						(Bq/kg wet)	(1/Bq)	(Bq/lifetime)	
1	Fish	Radionuclide	Cs-137	10045-97-3	42/42	3.8E+03	7.6E-10	1.3E+06	1E-03
1	Fish	All	Total						4E-03
						(mg/kg dry)	1/(mg/kg/d)	(mg/kg/d)	
1	Sed ingestion	Inorganic	Arsenic	7440-38-2	13/31	7.5E+00	1.8E+00	1.1E-05	2E-05
			Beryllium	7440-41-7	19/27	4.3E-01	4.3E+00	6.2E-07	3E-06
1	Sed ingestion	Inorganic	Total						2E-05
1	Sed ingestion	Organic	PCB-1260 (Aroclor 1260)	11096-82-5	7/13	2.6E+00	7.7E+00	3.7E-06	3E-05
			PCB-1254 (Aroclor 1254)	11097-69-1	13/13	5.4E-01	7.7E+00	7.8E-07	6E-06
1	Sed ingestion	Organic	Total						3E-05
						(Bq/kg dry)	(1/Bq)	(Bq/lifetime)	
1	Sed ingestion	Radionuclide	Cs-137	10045-97-3	17/18	2.4E+04	7.6E-10	2.5E+04	2E-05
			Co-60	10198-40-0	18/18	4.4E+04	4.1E-10	4.6E+04	2E-05
			Sr-90	10098-97-2	33/33	9.2E+03	8.9E-10	9.6E+03	9E-06
			Cs-134	13967-70-9	8/8	1.1E+02	1.1E-09	1.2E+02	1E-07
			Am-241	14596-10-2	1/1	1.4E+01	8.4E-09	1.5E+01	1E-07
			Cm-244	13981-15-2	1/1	1.8E+01	5.4E-09	1.9E+01	1E-07
			Eu-152	14683-23-9	4/4	2.8E+02	5.7E-11	2.9E+02	2E-08
			Pu-238	13981-16-3	1/1	2.0E+00	7.6E-09	2.1E+00	2E-08
			U-234	13966-29-5	1/1	3.8E+00	3.8E-09	4.0E+00	2E-08
			Pu-239	15117-48-3	1/1	1.0E+01	8.4E-10	1.1E+01	9E-09
			U-238	7440-61-1	1/1	1.6E+00	3.5E-09	1.7E+00	6E-09
			Eu-154	15585-10-1	1/1	4.3E+01	8.1E-11	4.5E+01	4E-09
			U-235	15117-96-1	1/1	4.2E-01	3.5E-09	4.4E-01	2E-09
1	Sed ingestion	Radionuclide	Total						5E-05
1	Sed ingestion	All	Total						1E-04

Table B1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (Bq/kg dry)	Cancer slope factor (1/Bq)	Daily intake (Bq/lifetime)	Carcinogen screening indices
1	Sed ext exp	Radionuclide	Co-60	10198-40-0	18/18	4.4E+04	3.5E-09	3.0E+07	1.0E-01
			Cs-137	10045-97-3	17/18	2.4E+04	9.2E-10	1.6E+07	1.5E-02
			Eu-152	14683-23-9	4/4	2.8E+02	1.7E-09	1.9E+05	3.3E-04
			Cs-134	13967-70-9	8/8	1.1E+02	2.4E-09	7.7E+04	1.8E-04
			Eu-154	15585-10-1	1/1	4.3E+01	1.8E-09	2.9E+04	5.3E-05
			Am-241	14596-10-2	1/1	1.4E+01	4.3E-11	9.6E+03	4.1E-07
			U-235	15117-96-1	1/1	4.2E-01	2.6E-10	2.9E+02	7.5E-08
			Cm-244	13981-15-2	1/1	1.8E+01	1.6E-12	1.2E+04	2.0E-08
			Pu-239	15117-48-3	1/1	1.0E+01	7.0E-13	6.8E+03	4.8E-09
			U-234	13966-29-5	1/1	3.8E+00	1.5E-12	2.6E+03	3.9E-09
			Pu-238	13981-16-3	1/1	2.0E+00	1.6E-12	1.4E+03	2.2E-09
			U-238	7440-61-1	1/1	1.6E+00	1.2E-12	1.1E+03	1.3E-09
1	Sed ext exp	Radionuclide	Total						1.2E-01
1	**Sediment**	**All**	**Total**						**1E-01**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
1	Water	Organic	PCBs total	1336-36-3	2/30	2.5E-03	7.7E+00	7.0E-05	5E-04
			PCB-1254 (Aroclor 1254)	11097-69-1	1/28	1.0E-03	7.7E+00	3.0E-05	2E-04
			Dichlorobromomethane	75-27-4	3/29	6.8E-03	1.3E-01	1.9E-04	3E-05
			Tetrachloroethylene	127-18-4	1/29	7.0E-03	5.1E-02	2.0E-04	1E-05
			Benzene	71-43-2	1/28	7.1E-03	2.9E-02	2.0E-04	6E-06
			Methylene chloride	75-09-2	15/29	1.3E-02	7.5E-03	3.8E-04	3E-06
			Trichloroethylene	79-01-6	4/46	6.0E-03	1.1E-02	1.7E-04	2E-06
			Chloroform	67-66-3	18/30	6.0E-03	6.1E-03	1.7E-04	1E-06
1	Water	Organic	Total						8E-04
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
1	Water	Radionuclide	Sr-90	10098-97-2	34/34	6.3E+00	8.9E-10	1.3E+05	1E-04
			Cs-137	10045-97-3	29/34	7.3E+00	7.6E-10	1.5E+05	1E-04
			H-3	10028-17-8	34/34	3.4E+03	1.5E-12	7.1E+07	1E-04
			Co-60	10198-40-0	3/34	6.5E-01	4.1E-10	1.4E+04	6E-06
1	Water	Radionuclide	Total						4E-04
1	**Water**	**All**							**1E-03**
1			**Reach total**						**1E-01**

Table B1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean	Cancer slope factor	Daily intake	Carcinogen screening indices
2	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	24/24	2.8E-01	7.7E+00	1.3E-04	1E-03
			PCB-1260 (Aroclor 1260)	11096-82-5	24/24	1.3E-01	7.7E+00	6.3E-05	5E-04
2	Fish	Organic	Total						2E-03
						(Bq/kg wet)	(1/Bq)	(Bq/lifetime)	
2	Fish	Radionuclide	Cs-137	10045-97-3	10/10	1.0E+03	7.6E-10	3.6E+05	3E-04
2	**Fish**	**All**	**Total**						**2E-03**
						(mg/kg dry)	1/(mg/kg/d)	(mg/kg/d)	indices
2	Sed ingestion	Inorganic	Arsenic	7440-38-2	4/111	2.5E+00	1.8E+00	3.6E-06	6E-06
			Beryllium	7440-41-7	81/99	1.8E-01	4.3E+00	2.6E-07	1E-06
2	Sed ingestion	Inorganic	Total						8E-06
2	Sed ingestion	Organic	PCB-1260 (Aroclor 1260)	11096-82-5	3/13	1.6E+00	7.7E+00	2.3E-06	2E-05
			PCB-1254 (Aroclor 1254)	11097-69-1	11/13	1.3E-01	7.7E+00	1.9E-07	2E-06
2	Sed ingestion	Organic	Total						2E-05
2	Sed ingestion	Radionuclide	Cs-137	10045-97-3	130/134	1.5E+04	7.6E-10	1.6E+04	1E-05
			Co-60	10198-40-0	121/134	1.5E+04	4.1E-10	1.6E+04	6E-06
			U-234	13966-29-5	4/4	1.3E+02	3.8E-09	1.3E+02	5E-07
			Sr-90	10098-97-2	91/95	4.4E+02	8.9E-10	4.6E+02	4E-07
			Cs-134	13967-70-9	10/10	2.6E+02	1.1E-09	2.8E+02	3E-07
			Cm-244	13981-15-2	4/4	5.1E+01	5.4E-09	5.3E+01	3E-07
			U-238	7440-61-1	4/4	3.9E+01	3.5E-09	4.1E+01	1E-07
			Eu-152	14683-23-9	11/11	1.9E+03	5.7E-11	2.0E+03	1E-07
			Eu-154	15585-10-1	14/14	6.8E+02	8.1E-11	7.1E+02	6E-08
			Pu-238	13981-16-3	4/4	6.5E+00	7.6E-09	6.8E+00	5E-08
			Am-241	14596-10-2	4/4	4.6E+00	8.4E-09	4.8E+00	4E-08
			U-235	15117-96-1	4/4	3.5E+00	3.5E-09	3.7E+00	1E-08
			Pu-239	15117-48-3	4/4	6.3E-01	8.4E-10	6.6E-01	6E-10
2	Sed ingestion	Radionuclide	Total						2E-05
2	**Sed ingestion**	**All**	**Total**						**5E-05**

Table B1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (Bq/kg dry)	Cancer slope factor (1/Bq)	Daily intake (Bq/lifetime)	Carcinogen screening indices
2	Sed ext exp	Radionuclide	Co-60	10198-40-0	121/134	1.5E+04	3.5E-09	1.0E+07	3.6E-02
			Cs-137	10045-97-3	130/134	1.5E+04	9.2E-10	1.0E+07	9.4E-03
			Eu-152	14683-23-9	11/11	1.9E+03	1.7E-09	1.3E+06	2.2E-03
			Eu-154	15585-10-1	14/14	6.8E+02	1.8E-09	4.6E+05	8.4E-04
			Cs-134	13967-70-9	10/10	2.6E+02	2.4E-09	1.8E+05	4.3E-04
			U-235	15117-96-1	4/4	3.5E+00	2.6E-10	2.4E+03	6.2E-07
			Am-241	14596-10-2	4/4	4.6E+00	4.3E-11	3.2E+03	1.4E-07
			U-234	13966-29-5	4/4	1.3E+02	1.5E-12	8.6E+04	1.3E-07
			Cm-244	13981-15-2	4/4	5.1E+01	1.6E-12	3.5E+04	5.6E-08
			U-238	7440-61-1	4/4	3.9E+01	1.2E-12	2.6E+04	3.2E-08
			Pu-238	13981-16-3	4/4	6.5E+00	1.6E-12	4.4E+03	7.1E-09
			Pu-239	15117-48-3	4/4	6.3E-01	7.0E-13	4.3E+02	3.0E-10
2	Sed ext exp	Radionuclide	Total						4.8E-02
2	**Sediment**	**All**	**Total**						**5E-02**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
2	Water	Inorganic	Arsenic	7440-38-2	4/75	5.2E-02	1.8E+00	1.5E-03	3E-03
2	Water	Organic	PCBs total	1336-36-3	2/30	1.8E-03	7.7E+00	5.3E-05	4E-04
			Methylene chloride	75-09-2	15/29	1.3E-02	7.5E-03	3.6E-04	3E-06
			Trichloroethylene	79-01-6	10/46	5.6E-03	1.1E-02	1.6E-04	2E-06
			Chloroform	67-66-3	6/30	6.4E-03	6.1E-03	1.8E-04	1E-06
2	Water	Organic	Total						4E-04
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
2	Water	Radionuclide	H-3	10028-17-8	63/64	2.6E+04	1.5E-12	5.4E+08	8E-04
			Sr-90	10098-97-2	43/66	1.0E+01	8.9E-10	2.2E+05	2E-04
			Co-60	10198-40-0	27/74	1.3E+01	4.1E-10	2.8E+05	1E-04
			Eu-152	14683-23-9	2/2	9.5E+01	5.7E-11	2.0E+06	1E-04
			Eu-154	15585-10-1	5/5	3.3E+01	8.1E-11	6.9E+05	6E-05
			Cs-137	10045-97-3	15/74	1.2E+00	7.6E-10	2.4E+04	2E-05
2	Water	Radionuclide	Total						1E-03
2	**Water**	**All**	**Total**						**4E-03**
2			**Reach total**						**6E-03**

Table B1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/kg wet)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
3	Fish	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	79/79	5.4E-01	7.7E+00	2.6E-04	2E-03
			PCB-1260 (Aroclor 1260)	11096-82-5	79/79	3.8E-01	7.7E+00	1.8E-04	1E-03
3	Fish	Organic	Total						3E-03
						(Bq/kg wet)	(1/Bq)	(Bq/lifetime)	
3	Fish	Radionuclide	Cs-137	10045-97-3	106/106	9.5E+02	7.6E-10	3.3E+05	3E-04
			Sr-90	10098-97-2	13/13	7.3E+01	8.9E-10	2.5E+04	2E-05
			Co-60	10198-40-0	9/70	1.8E+00	4.1E-10	6.2E+02	3E-07
3	Fish	Radionuclide	Total						3E-04
3	**Fish**	**All**	**Total**						**4E-03**
						(mg/kg dry)	(1/Bq)	(Bq/lifetime)	
3	Sed ingestion	Inorganic	Arsenic	7440-38-2	6/60	1.7E+01	1.8E+00	2.4E-05	4E-05
			Beryllium	7440-41-7	40/54	1.2E+00	4.3E+00	1.7E-06	7E-06
3	Sed ingestion	Inorganic	Total						5E-05
3	Sed ingestion	Organic	PCB-1254 (Aroclor 1254)	11097-69-1	4/15	3.2E+00	7.7E+00	4.6E-06	4E-05
			Methylene chloride	75-09-2	2/7	6.0E-01	7.5E-03	8.6E-07	7E-09
			Benzene	71-43-2	1/7	4.5E-02	2.9E-02	6.5E-08	2E-09
			Chloroform	67-66-3	2/7	1.1E-02	6.1E-03	1.6E-08	1E-10
3	Sed ingestion	Organic	Total						4E-05
						(Bq/kg dry)	(1/Bq)	(Bq/lifetime)	
3	Sed ingestion	Radionuclide	Cs-137	10045-97-3	223/223	4.8E+04	7.6E-10	5.0E+04	4E-05
			Co-60	10198-40-0	204/208	5.0E+04	4.1E-10	5.2E+04	2E-05
			Sr-90	10098-97-2	60/60	5.5E+02	8.9E-10	5.8E+02	5E-07
			Cs-134	13967-70-9	7/7	1.7E+02	1.1E-09	1.7E+02	2E-07
			Eu-152	14683-23-9	2/2	1.2E+03	5.7E-11	1.2E+03	7E-08
			Eu-154	15585-10-1	9/9	3.5E+02	8.1E-11	3.7E+02	3E-08
			U-234	13966-29-5	1/1	4.2E+00	3.8E-09	4.4E+00	2E-08
			U-235	15117-96-1	1/1	3.2E+00	3.5E-09	3.4E+00	1E-08
			U-238	7440-61-1	1/1	3.0E+00	3.5E-09	3.2E+00	1E-08
			Cm-244	13981-15-2	1/1	1.5E-01	5.4E-09	1.6E-01	9E-10
			Am-241	14596-10-2	1/1	6.3E-02	8.4E-09	6.6E-02	6E-10
			Pu-238	13981-16-3	1/1	5.8E-02	7.6E-09	6.1E-02	5E-10
			Pu-239	15117-48-3	1/1	8.7E-02	8.4E-10	9.1E-02	8E-11
3	Sed ingestion	Radionuclide	Total						6E-05
3	**Sed ingestion**	**All**	**Total**						**1E-04**

Table B1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean	Cancer slope factor	Daily intake	Carcinogen screening indices
3	Sed ext exp	Radionuclide	Co-60	10198-40-0	204/208	5.0E+04	3.5E-09	3.4E+07	1.2E-01
			Cs-137	10045-97-3	223/223	4.8E+04	9.2E-10	3.3E+07	3.0E-02
			Eu-152	14683-23-9	2/2	1.2E+03	1.7E-09	8.0E+05	1.4E-03
			Eu-154	15585-10-1	9/9	3.5E+02	1.8E-09	2.4E+05	4.4E-04
			Cs-134	13967-70-9	7/7	1.7E+02	2.4E-09	1.1E+05	2.7E-04
			U-235	15117-96-1	1/1	3.2E+00	2.6E-10	2.2E+03	5.7E-07
			U-234	13966-29-5	1/1	4.2E+00	1.5E-12	2.9E+03	4.3E-09
			U-238	7440-61-1	1/1	3.0E+00	1.2E-12	2.1E+03	2.5E-09
			Am-241	14596-10-2	1/1	6.3E-02	4.3E-11	4.3E+01	1.9E-09
			Cm-244	13981-15-2	1/1	1.5E-01	1.6E-12	1.0E+02	1.6E-10
			Pu-238	13981-16-3	1/1	5.8E-02	1.6E-12	4.0E+01	6.4E-11
			Pu-239	15117-48-3	1/1	8.7E-02	7.0E-13	6.0E+01	4.2E-11
3	Sed ext exp	Radionuclide	Total						1.5E-01
3	**Sediment**	**All**	**Total**						**2E-01**
						(mg/L)	**1/(mg/kg/d)**	**(mg/kg/d)**	
3	Water	Inorganic	Arsenic	7440-38-2	2/38	4.7E-02	1.8E+00	1.3E-03	2E-03
3	Water	Organic	PCBs total		2/30	2.0E-03	7.7E+00	5.7E-05	4E-04
			Tetrachloroethylene		1/28	7.1E-03	5.1E-02	2.0E-04	1E-05
			Methylene chloride	75-09-2	16/28	1.3E-02	7.5E-03	3.8E-04	3E-06
			Trichloroethylene		1/44	6.3E-03	1.1E-02	1.8E-04	2E-06
			Chloroform	67-66-3	12/29	5.9E-03	6.1E-03	1.7E-04	1E-06
3	Water	Organic	Total						5E-04
						(Bq/L)	**(1/Bq)**	**(Bq/lifetime)**	
3	Water	Radionuclide	H-3	10028-17-8	49/49	1.0E+04	1.5E-12	2.1E+08	3E-04
			Sr-90	10098-97-2	51/51	7.5E+00	8.9E-10	1.6E+05	1E-04
			Cs-137	10045-97-3	131/135	3.7E+00	7.6E-10	7.8E+04	6E-05
			U-234	13966-29-5	1/1	1.9E-01	3.8E-09	4.0E+03	2E-05
			U-235	15117-96-1	1/1	6.4E-02	3.5E-09	1.3E+03	5E-06
			Cm-244	13981-15-2	8/10	3.7E-02	5.4E-09	7.7E+02	4E-06
			Am-241	14596-10-2	14/19	2.2E-02	8.4E-09	4.6E+02	4E-06
			Co-60	10198-40-0	103/135	3.8E-01	4.1E-10	8.0E+03	3E-06
			U-238	7440-61-1	1/1	3.4E-02	3.5E-09	7.1E+02	3E-06
			Pu-238	13981-16-3	5/20	5.1E-03	7.6E-09	1.1E+02	8E-07
			Pu-239	15117-48-3	11/20	8.4E-03	8.4E-10	1.8E+02	2E-07
3	Water	Radionuclide	Total						6E-04
3	**Water**	**All**	**Total**						**3E-03**
3			**Reach total**						**2E-01**

Table B2. Results of conservative screening for noncarcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily Intake (mg/kg/d)	Noncarcinogen screening indices
1	Fish	Inorganic	Mercury	7439-97-6	87/87	4.1E-01	3.0E-04	3.8E-04	1E+00
			Selenium	7782-49-2	35/35	4.5E-01	3.0E-03	4.2E-04	1E-01
			Cadmium	7440-43-9	35/43	6.9E-02	5.0E-04	6.5E-05	1E-01
			Zinc	7440-66-6	35/35	4.3E+00	2.0E-01	3.9E-03	2E-02
			Copper	7440-50-8	22/35	4.0E-01	3.7E-02	3.7E-04	1E-02
1	Fish	Inorganic	Total						2E+00
1	**Fish**	**All**	**Total**						**2E+00**
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
1	Sediment	Inorganic	Antimony	7440-36-0	11/27	8.9E+00	4.0E-04	1.3E-05	3E-02
			Nickel	7440-02-0	27/31	1.8E+02	2.0E-02	2.5E-04	1E-02
			Arsenic	7440-38-2	13/31	7.5E+00	1.0E-03	1.1E-05	1E-02
			Mercury	7439-97-6	19/19	1.8E+00	3.0E-04	2.5E-06	9E-03
			Chromium	7440-47-3	23/31	1.8E+01	5.0E-03	2.6E-05	5E-03
			Selenium	7782-49-2	2/31	9.5E+00	3.0E-03	1.4E-05	5E-03
			Barium	7440-39-3	31/31	1.8E+02	7.0E-02	2.5E-04	4E-03
			Vanadium	7440-62-2	20/22	1.3E+01	7.0E-03	1.9E-05	3E-03
			Silver	7440-22-4	13/31	5.7E+00	3.0E-03	8.2E-06	3E-03
			Molybdenum	7439-98-7	5/27	4.7E+00	4.0E-03	6.7E-06	2E-03
			Zinc	7440-66-6	31/31	2.1E+02	2.0E-01	3.0E-04	2E-03
			Copper	7440-50-8	27/31	3.5E+01	3.7E-02	5.0E-05	1E-03
			Cadmium	7440-43-9	16/31	3.3E-01	5.0E-04	4.7E-07	9E-04
			Beryllium	7440-41-7	19/27	4.3E-01	5.0E-03	6.2E-07	1E-04
			Boron	7440-42-8	9/30	7.1E+00	9.0E-02	1.0E-05	1E-04
			Tin	7440-31-5	9/20	7.0E+00	6.0E-01	1.0E-05	2E-05
1	Sediment	Inorganic	Total						9E-02
1	**Sediment**	**All**	**Total**						**9E-02**

Table B2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
1	Water	Inorganic	Thallium	7440-28-0	1/1	8.6E-02	7.0E-05	2.5E-03	4E+01
			Chromium	7440-47-3	25/32	1.1E-02	5.0E-03	3.2E-04	6E-02
			Copper	7440-50-8	11/32	2.3E-02	3.7E-02	6.5E-04	2E-02
			Barium	7440-39-3	3/3	3.7E-02	7.0E-02	1.1E-03	2E-02
			Nickel	7440-02-0	4/32	8.4E-03	2.0E-02	2.4E-04	1E-02
			Mercury	7439-97-6	9/32	7.8E-05	3.0E-04	2.2E-06	7E-03
			Zinc	7440-66-6	31/32	4.3E-02	2.0E-01	1.2E-03	6E-03
1	Water	Inorganic	Total						4E+01
1	Water	Organic	Tetrachloroethylene	127-18-4	1/29	7.0E-03	1.0E-02	2.0E-04	2E-02
			Chloroform	67-66-3	18/30	6.0E-03	1.0E-02	1.7E-04	2E-02
			Dichlorobromomethane	75-27-4	3/29	6.8E-03	2.0E-02	1.9E-04	1E-02
			Methylene chloride	75-09-2	15/29	1.3E-02	6.0E-02	3.8E-04	6E-03
			Acetone	67-64-1	14/58	1.4E-02	1.0E-01	4.1E-04	4E-03
			Ethylbenzene	100-41-4	1/29	7.0E-03	1.0E-01	2.0E-04	2E-03
			Carbon disulfide	75-15-0	2/29	7.0E-03	1.0E-01	2.0E-04	2E-03
			Toluene	108-88-3	4/28	7.0E-03	2.0E-01	2.0E-04	1E-03
			Xylene	1330-20-7	1/29	7.0E-03	2.0E+00	2.0E-04	1E-04
1	Water	Organic	Total						6E-02
1	Water	All	Total						4E+01
1			Reach Total						4E+01

Table B2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
2	Fish	Inorganic	Mercury	7439-97-6	33/33	1.3E-01	3.0E-04	1.2E-04	4E-01
			Cadmium	7440-43-9	11/19	1.4E-01	5.0E-04	1.3E-04	3E-01
			Selenium	7782-49-2	11/11	3.4E-01	3.0E-03	3.1E-04	1E-01
			Zinc	7440-66-6	11/11	5.3E+00	2.0E-01	4.9E-03	2E-02
			Copper	7440-50-8	7/11	3.6E-01	3.7E-02	3.3E-04	9E-03
2	Fish	Inorganic	Total						8E-01
2	Fish	All	Total						8E-01
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
2	Sediment	Inorganic	Antimony	7440-36-0	73/99	6.0E+00	4.0E-04	8.6E-06	2E-02
			Arsenic	7440-38-2	4/111	2.5E+00	1.0E-03	3.6E-06	4E-03
			Chromium	7440-47-3	95/111	1.2E+01	5.0E-03	1.7E-05	4E-03
			Barium	7440-39-3	111/111	1.6E+02	7.0E-02	2.3E-04	3E-03
			Selenium	7782-49-2	14/111	4.8E+00	3.0E-03	6.8E-06	2E-03
			Mercury	7439-97-6	25/25	4.6E-01	3.0E-04	6.6E-07	2E-03
			Molybdenum	7439-98-7	65/99	3.1E+00	4.0E-03	4.4E-06	1E-03
			Vanadium	7440-62-2	89/91	4.4E+00	7.0E-03	6.3E-06	9E-04
			Zinc	7440-66-6	98/98	1.2E+02	2.0E-01	1.8E-04	9E-04
			Silver	7440-22-4	13/111	1.1E+00	3.0E-03	1.6E-06	5E-04
			Nickel	7440-02-0	106/111	6.2E+00	2.0E-02	8.9E-06	4E-04
			Cadmium	7440-43-9	6/111	1.2E-01	5.0E-04	1.7E-07	3E-04
			Copper	7440-50-8	101/111	6.2E+00	3.7E-02	8.9E-06	2E-04
			Boron	7440-42-8	78/111	3.7E+00	6.0E-02	5.3E-06	6E-05
			Beryllium	7440-41-7	81/99	1.8E-01	5.0E-03	2.6E-07	5E-05
			Tin	7440-31-5	10/29	4.7E+00	6.0E-01	6.7E-06	1E-05
2	Sediment	Inorganic	Total						4E-02
2	Sediment	Organic	Di-n-butyl phthalate	84-74-2	3/10	1.0E+01	1.0E-01	1.5E-05	2E-04
2	Sediment	All	Total						4E-02

Table B2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
2	Water	Inorganic	Thallium	7440-28-0	1/1	9.4E-02	7.0E-05	2.7E-03	4E+01
			Arsenic	7440-38-2	4/75	5.2E-02	1.0E-03	1.5E-03	2E+00
			Cadmium	7440-43-9	6/76	4.0E-03	5.0E-04	1.1E-04	2E-01
			Chromium	7440-47-3	54/75	1.1E-02	5.0E-03	3.3E-04	7E-02
			Copper	7440-50-8	53/75	7.3E-02	3.7E-02	2.1E-03	6E-02
			Vanadium	7440-62-2	1/3	9.6E-03	7.0E-03	2.7E-04	4E-02
			Barium	7440-39-3	3/3	8.6E-02	7.0E-02	2.5E-03	4E-02
			Nickel	7440-02-0	8/75	1.0E-02	2.0E-02	2.9E-04	1E-02
			Zinc	7440-66-6	66/75	9.1E-02	2.0E-01	2.6E-03	1E-02
			Mercury	7439-97-6	5/32	5.9E-05	3.0E-04	1.7E-06	6E-03
2	Water	Inorganic	Total						4E+01
2	Water	Organic	1,2-Dichloroethene (total)	156-59-2	2/29	6.9E-03	1.0E-02	2.0E-04	2E-02
			Chloroform	67-66-3	6/30	6.4E-03	1.0E-02	1.8E-04	2E-02
			Methylene chloride	75-09-2	15/29	1.3E-02	6.0E-02	3.6E-04	6E-03
			Acetone	67-64-1	11/58	1.2E-02	1.0E-01	3.5E-04	4E-03
			Carbon disulfide	75-15-0	2/29	7.0E-03	1.0E-01	2.0E-04	2E-03
			1,1-Dichloroethane	75-34-3	2/29	6.9E-03	1.0E-01	2.0E-04	2E-03
			Toluene	108-88-3	1/28	7.1E-03	2.0E-01	2.0E-04	1E-03
			Xylene	1330-20-7	1/29	7.0E-03	2.0E+00	2.0E-04	1E-04
2	Water	Organic	Total						5E-02
2	Water	All	Total						4E+01
2			Reach total						4E+01

Table B2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/kg wet)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Fish	Inorganic	Mercury	7439-97-6	88/88	2.6E-01	3.0E-04	2.4E-04	8E-01
			Cadmium	7440-43-9	28/36	8.4E-02	5.0E-04	7.8E-05	2E-01
			Selenium	7782-49-2	27/28	3.1E-01	3.0E-03	2.5E-04	1E-01
			Zinc	7440-66-6	26/26	5.2E+00	2.0E-01	4.8E-03	2E-02
			Copper	7440-50-8	14/28	3.4E-01	3.7E-02	3.2E-04	9E-03
3	Fish	Inorganic	Total						1E+00
3	**Fish**	**All**	**Total**						**1E+00**
						(mg/kg dry)	(mg/kg/d)	(mg/kg/d)	
3	Sediment	Inorganic	Antimony	7440-36-0	24/54	3.4E+01	4.0E-04	4.8E-05	1E-01
			Selenium	7782-49-2	1/62	6.6E+01	3.0E-03	9.4E-05	3E-02
			Arsenic	7440-38-2	6/60	1.7E+01	1.0E-03	2.4E-05	2E-02
			Chromium	7440-47-3	44/62	7.7E+01	5.0E-03	1.1E-04	2E-02
			Mercury	7439-97-6	21/21	1.2E+00	3.0E-04	1.7E-06	6E-03
			Vanadium	7440-62-2	48/51	1.8E+01	7.0E-03	2.5E-05	4E-03
			Barium	7440-39-3	58/58	1.6E+02	7.0E-02	2.3E-04	3E-03
			Cadmium	7440-43-9	7/60	1.0E+00	5.0E-04	1.4E-06	3E-03
			Silver	7440-22-4	19/61	5.4E+00	3.0E-03	7.7E-06	3E-03
			Molybdenum	7439-98-7	11/52	6.1E+00	4.0E-03	8.6E-06	2E-03
			Nickel	7440-02-0	53/60	1.5E+01	2.0E-02	2.2E-05	1E-03
			Zinc	7440-66-6	57/60	1.5E+02	2.0E-01	2.1E-04	1E-03
			Copper	7440-50-8	49/60	2.6E+01	3.7E-02	3.8E-05	1E-03
			Beryllium	7440-41-7	40/54	1.2E+00	5.0E-03	1.7E-06	3E-04
			Boron	7440-42-8	25/54	4.7E+00	9.0E-02	6.8E-06	8E-05
			Tin	7440-31-5	12/29	1.4E+01	6.0E-01	2.1E-05	3E-05
3	Sediment	Inorganic	Total						2E-01
3	Sediment	Organic	Di-n-butyl phthalate	84-74-2	3/16	1.8E+01	1.0E-01	2.6E-05	3E-04
			Methylene chloride	75-09-2	2/7	6.0E-01	6.0E-02	8.6E-07	1E-05
			Chloroform	67-66-3	2/7	1.1E-02	1.0E-02	1.6E-08	2E-06
			Toluene	108-88-3	1/7	2.3E-02	2.0E-01	3.3E-08	2E-07
3	Sediment	Organic	Total						3E-04
3	**Sediment**	**All**	**Total**						**2E-01**

Table B2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/L)	Oral RfD (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Water	Inorganic	Thallium	7440-28-0	1/1	7.0E-02	7.0E-05	2.0E-03	3E+01
			Arsenic	7440-38-2	2/38	4.7E-02	1.0E-03	1.3E-03	1E+00
			Selenium	7782-49-2	2/14	2.6E-02	3.0E-03	7.3E-04	2E-01
			Chromium	7440-47-3	28/32	2.0E-02	5.0E-03	5.6E-04	1E-01
			Barium	7440-39-3	3/3	4.9E-02	7.0E-02	1.4E-03	2E-02
			Copper	7440-50-8	14/32	2.0E-02	3.7E-02	5.7E-04	2E-02
			Nickel	7440-02-0	3/32	8.6E-03	2.0E-02	2.5E-04	1E-02
			Mercury	7439-97-6	9/32	6.2E-05	3.0E-04	1.8E-06	6E-03
			Zinc	7440-66-6	30/32	3.1E-02	2.0E-01	8.8E-04	4E-03
3	Water	Inorganic	Total						3E+01
3	Water	Organic	Tetrachloroethylene	127-18-4	1/28	7.1E-03	1.0E-02	2.0E-04	2E-02
			Chloroform	67-66-3	12/29	5.9E-03	1.0E-02	1.7E-04	2E-02
			4-Methyl-2-pentanone	108-10-1	1/28	1.4E-02	5.0E-02	4.0E-04	8E-03
			Methylene chloride	75-09-2	16/28	1.3E-02	6.0E-02	3.8E-04	6E-03
			Acetone	67-64-1	13/56	1.4E-02	1.0E-01	4.1E-04	4E-03
			Carbon disulfide	75-15-0	1/28	7.2E-03	1.0E-01	2.1E-04	2E-03
			Toluene	108-88-3	4/27	6.9E-03	2.0E-01	2.0E-04	1E-03
			Xylene	1330-20-7	1/28	7.1E-03	2.0E+00	2.0E-04	1E-04
3	Water	Organic	Total						6E-02
3	Water	All	Total						3E+01
3			Reach total						3E+01

APPENDIX C

SCREENING OF THE INTRUDER SCENARIO FOR DETECTED CARCINOGENS AND NONCARCINOGENS

Table C1. Screening of detected carcinogens in fish and game for intermittent intruder scenario

Reach no.	Contaminant type	Contaminant name	Ratio of detected to total fish samples	Geom mean of concentration in fish flesh (mg or Bq/kg)	Fish ingest carcinogen screening indices	Ratio of detected to total venison samples	Geom mean of concentration in venison* (mg or Bq/kg)	Venison ingest carcinogen screening indices	Arith mean of concentration in duck flesh (mg or Bq/kg)	Duck ingest carcinogen screening indices	Sums of carcinogen screening indices
1	Organics	PCB-1254 (Aroclor 1254)	79/79	3.25E-01	1.2E-04						1E-04
1	Organics	PCB-1260 (Aroclor 1260)	79/79	1.20E-01	4.5E-05						4E-05
1	**Organics**	**Totals**			**1.7E-04**						**2E-04**
1	Radionuclides	Cs-137	42/42	2.62E+03	1.7E-04	319/396	6.06E-02	8.6E-09			2E-04
1	Radionuclides	Sr-90**				33/33	6.26E+00	1.0E-06			1E-06
1	**Radionuclides**	**Totals**			**1.7E-04**			**1.0E-06**			**2E-04**
1		**Reach totals**			**3.3E-04**			**1.0E-06**			**3E-04**
2	Organics	PCB-1254 (Aroclor 1254)	24/24	4.72E-02	1.6E-05						2E-05
2	Organics	PCB-1260 (Aroclor 1260)	24/24	4.01E-02	1.5E-05						1E-05
2	**Organics**	**Totals**			**3.3E-05**						**3E-05**
2	Radionuclides	Cs-137	10/10	7.05E+02	4.5E-05	319/396	6.06E-02	8.6E-09			4E-05
2	Radionuclides	Sr-90**				33/33	6.26E+00	1.0E-06			1E-06
2	**Radionuclides**	**Totals**			**4.5E-05**			**1.0E-06**			**5E-05**
2		**Reach totals**			**7.7E-05**			**1.0E-06**			**8E-05**
3	Organics	PCB-1254 (Aroclor 1254)	79/79	2.89E-01	1.1E-04						1E-04
3	Organics	PCB-1260 (Aroclor 1260)	79/79	1.66E-01	6.2E-05						6E-05
3	**Organics**	**Totals**			**1.7E-04**						**2E-04**
3	Radionuclides	Cs-137	106/106	5.20E+02	3.3E-05	319/396	6.06E-02	8.6E-09	1.41E+01	3.6E-07	3E-05
3	Radionuclides	Sr-90**	13/13	2.47E+01	1.8E-06	33/33	6.26E+00	1.0E-06			3E-06
3	Radionuclides	Co-60	9/70	5.50E-05	1.9E-12						2E-12
3	**Radionuclides**	**Totals**			**3.5E-05**			**1.0E-06**		**3.6E-07**	**4E-05**
3		**Reach totals**			**2.1E-04**			**1.0E-06**		**3.6E-07**	**2E-04**

* Data for venison were applied to all reaches

** Values for Sr-90 in venison are 1/100 the concentration measured in bone

Table C2. Screening indices for external exposure to intermittent intruder from gamma radiation in surface sediments

Reach no.	Contaminant type	Radionuclide	Ratio of detected to total sed samples	Geom mean of concentration in sediment (Bq/kg)	Screening indices for exposure exposure to sediment
1	Radionuclide	Cs-137	17/18	5.52E+03	2.1E-04
1	Radionuclide	Co-60	18/18	1.29E+03	1.9E-04
1	Radionuclide	Eu-152	4/4	2.26E+02	1.6E-05
1	Radionuclide	Cs-134	8/8	7.83E+01	7.7E-06
1	Radionuclide	Eu-154	1/1	4.30E+01	3.2E-06
1	Radionuclide	Am-241	1/1	1.40E+01	2.5E-08
1	Radionuclide	U-235	1/1	4.20E-01	4.5E-09
1	Radionuclide	Cm-244	1/1	1.80E+01	1.2E-09
1	Radionuclide	Pu-239	1/1	1.00E+01	2.9E-10
1	Radionuclide	U-234	1/1	3.80E+00	2.3E-10
1	Radionuclide	Pu-238	1/1	2.00E+00	1.3E-10
1	Radionuclide	U-238	1/1	1.60E+00	7.9E-11
1	**Radionuclide**			**Reach total**	**4.2E-04**
2	Radionuclide	Co-60	121/134	1.40E+03	2.0E-04
2	Radionuclide	Eu-152	11/11	8.22E+02	5.7E-05
2	Radionuclide	Eu-154	14/14	3.51E+02	2.6E-05
2	Radionuclide	Cs-137	130/134	6.34E+02	2.4E-05
2	Radionuclide	Cs-134	10/10	1.43E+02	1.4E-05
2	Radionuclide	Mn-54	7/7	2.37E+02	1.3E-05
2	Radionuclide	U-235	4/4	6.59E-01	7.0E-09
2	Radionuclide	Am-241	4/4	1.16E+00	2.0E-09
2	Radionuclide	U-234	4/4	9.07E+00	5.6E-10
2	Radionuclide	Cm-244	4/4	4.11E+00	2.7E-10
2	Radionuclide	U-238	4/4	4.12E+00	2.0E-10
2	Radionuclide	Pu-238	4/4	3.76E-01	2.5E-11
2	Radionuclide	Pu-239	4/4	8.52E-02	2.5E-12
2	**Radionuclide**			**Reach total**	**3.4E-04**
3	Radionuclide	Cs-137	223/223	9.97E+03	3.8E-04
3	Radionuclide	Co-60	204/208	1.07E+03	1.5E-04
3	Radionuclide	Eu-152	2/2	3.48E+02	2.4E-05
3	Radionuclide	Eu-154	9/9	1.75E+02	1.3E-05
3	Radionuclide	Cs-134	7/7	1.09E+02	1.1E-05
3	Radionuclide	U-235	1/1	3.20E+00	3.4E-08
3	Radionuclide	Total Pu*	4/4	4.56E+02	1.3E-08
3	Radionuclide	U-234	1/1	4.20E+00	2.6E-10
3	Radionuclide	U-238	1/1	3.00E+00	1.5E-10
3	Radionuclide	Am-241	1/1	6.30E-02	1.1E-10
3	Radionuclide	Cm-244	1/1	1.50E-01	9.9E-12
3	Radionuclide	Pu-238	1/1	5.80E-02	3.8E-12
3	Radionuclide	Pu-239	1/1	8.70E-02	2.5E-12
3	**Radionuclide**			**Reach total**	**5.8E-04**

* Used risk factors for Pu-239

Table C3. Screening of detected noncarcinogens for intermittent intruder scenario

Reach no.	Contaminant type	Contaminant name	Ratio of detected to total fish samples	Geom mean of concentration in fish flesh (mg/kg wet)	Fish ingest noncarcinogen screening indices	Arith mean of concentration in duck flesh (mg/kg wet)	Duck ingest noncarcinogen screening indices	Sums of noncarcinogen screening indices
1	Inorganic	Mercury	87/87	3.60E-01	1.5E-01			2E-01
1	Inorganic	Selenium	35/35	3.74E-01	1.6E-02			2E-02
1	Inorganic	Cadmium	35/43	1.29E-02	3.3E-03			3E-03
1	Inorganic	Copper	22/35	3.02E-01	1.0E-03			1E-03
1	Inorganic	Zinc	35/35	1.52E+00	9.8E-04			1E-03
1	**Inorganic**	**Reach totals**			**1.8E-01**			**2E-01**
2	Inorganic	Mercury	33/33	9.10E-02	3.9E-02			4E-02
2	Inorganic	Selenium	11/11	2.71E-01	1.2E-02			1E-02
2	Inorganic	Cadmium	11/19	3.85E-02	9.9E-03			1E-02
2	Inorganic	Zinc	11/11	1.28E+00	8.2E-04			8E-04
2	Inorganic	Copper	7/11	1.83E-01	6.4E-04			6E-04
2	**Inorganic**	**Reach totals**			**6.2E-02**			**6E-02**
3	Inorganic	Mercury	88/88	1.77E-01	7.6E-02	2.00E-02	1.2E-03	8E-02
3	Inorganic	Selenium	27/28	2.43E-01	1.0E-02	7.00E-01	4.3E-03	1E-02
3	Inorganic	Cadmium	28/36	1.98E-02	5.1E-03	3.20E-02	1.2E-03	6E-03
3	Inorganic	Zinc	26/26	1.69E+00	1.1E-03			1E-03
3	Inorganic	Copper	14/28	2.25E-01	7.8E-04			8E-04
3	**Inorganic**	**Reach totals**			**9.3E-02**		**6.8E-03**	**1E-01**

APPENDIX D

NONCONSERVATIVE SCREENING OF THE NONDETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table D1. Results of nonconservative screening of carcinogens where no concentrations were above detectio (Concentrations are minimum detection limits)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Inorganic	Arsenic	1	104	5.0E-01	4.1E-05				33	1.0E-02	5.0E-05
	Arsenic	2	45	5.0E-01	4.1E-05						
	Arsenic	3	109	5.0E-01	4.1E-05						
	Beryllium	1	104	1.0E-01	2.0E-05				3	2.0E-04	2.5E-06
	Beryllium	2	45	1.0E-01	2.0E-05				3	2.0E-04	2.5E-06
	Beryllium	3	109	1.0E-01	2.0E-05				3	2.0E-04	2.5E-06
Organic	Benzidine	1				2	5.0E+01	1.6E-03			
	Benzidine	2				6	5.0E+01	1.6E-03			
	N-Nitrosodimethylamine	1				1	5.0E+01	3.6E-04			
	N-Nitrosodimethylamine	2				6	5.0E+01	3.6E-04			
	Benzidine	3				14	9.1E+00	3.0E-04			
	Acenaphthylene	1	12	2.0E-01	1.1E-04	3	1.0E+01	1.6E-05			
	Acenaphthylene	2	8	2.0E-01	1.1E-04	10	1.0E+01	1.6E-05			
	Acenaphthylene	3	16	2.0E-01	1.1E-04	16	9.1E-01	1.5E-06			
	N-nitroso-di-n-propylamine	1	12	2.0E-01	6.6E-05	2	1.0E+01	1.0E-05			
	N-nitroso-di-n-propylamine	2	8	2.0E-01	6.6E-05	10	1.0E+01	1.0E-05			
	N-nitroso-di-n-propylamine	3	16	2.0E-01	6.6E-05	16	9.1E-01	9.1E-07			
	Vinyl chloride	1							29	1.0E-02	5.4E-05
	Vinyl chloride	2							29	1.0E-02	5.4E-05
	Vinyl chloride	3				2	1.0E-02	2.7E-09	28	1.0E-02	5.4E-05
	Bis(chloromethyl)ether	3				2	9.1E-01	2.9E-05			
	Aldrin	1	12	5.0E-03	4.0E-06	2	1.0E+01	2.4E-05			
	Aldrin	2	8	5.0E-03	4.0E-06	6	1.0E+01	2.4E-05			
	Dieldrin	1	12	9.0E-03	6.8E-06	1	1.0E+01	2.3E-05			
	Dieldrin	2	8	9.0E-03	6.8E-06	6	1.0E+01	2.3E-05			
	PCB-1254 (Aroclor 1254)	2							28	1.0E-03	2.2E-05
	PCB-1254 (Aroclor 1254)	3							28	1.0E-03	2.2E-05
	PCB-1260 (Aroclor 1260)	1							28	1.0E-03	2.2E-05
	PCB-1260 (Aroclor 1260)	2							28	1.0E-03	2.2E-05
	PCB-1260 (Aroclor 1260)	3				15	1.8E-01	2.0E-07	28	1.0E-03	2.2E-05
	3,3'-Dichlorobenzidine	1	12	1.0E+00	2.1E-05	2	2.0E+01	1.3E-06			
	3,3'-Dichlorobenzidine	2	8	1.0E+00	2.1E-05	10	1.0E+01	6.4E-07			
	3,3'-Dichlorobenzidine	3	16	1.0E+00	2.1E-05	16	9.1E-01	5.9E-08			
	Acenaphthene	1	12	1.0E-03	5.4E-07	3	1.0E+01	1.6E-05			
	Acenaphthene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			

Table D1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Anthracene	1	12	2.0E-04	1.1E-07	3	1.0E+01	1.6E-05			
	Anthracene	2	8	2.0E-04	1.1E-07	10	1.0E+01	1.6E-05			
	Benzo(a)pyrene	1	12	1.0E-03	5.4E-07	3	1.0E+01	1.6E-05			
	Benzo(a)pyrene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Benzo(b)fluoranthene	1	12	1.0E-03	5.4E-07	3	1.0E+01	1.6E-05			
	Benzo(b)fluoranthene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Benzo(ghi)perylene	1	12	1.0E-03	5.4E-07	2	1.0E+01	1.6E-05			
	Benzo(ghi)perylene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Benzo(k)fluoranthene	1	12	1.0E-03	5.4E-07	2	1.0E+01	1.6E-05			
	Benzo(k)fluoranthene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Chrysene	1	12	1.0E-03	5.4E-07	2	1.0E+01	1.6E-05			
	Chrysene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Dibenz(a,h)anthracene	1	12	2.0E-03	1.1E-06	2	1.0E+01	1.6E-05			
	Dibenz(a,h)anthracene	2	8	2.0E-03	1.1E-06	10	1.0E+01	1.6E-05			
	Fluoranthene	1	12	2.0E-02	1.1E-05	2	1.0E+01	1.6E-05			
	Fluoranthene	2	8	2.0E-02	1.1E-05	10	1.0E+01	1.6E-05			
	Fluorene	1	12	2.0E-03	1.1E-06	2	1.0E+01	1.6E-05			
	Fluorene	2	8	2.0E-03	1.1E-06	10	1.0E+01	1.6E-05			
	Indeno(1,2,3-cd)pyrene	1	12	8.0E-03	4.3E-06	2	1.0E+01	1.6E-05			
	Indeno(1,2,3-cd)pyrene	2	8	8.0E-03	4.3E-06	10	1.0E+01	1.6E-05			
	Pyrene	1	12	3.0E-03	1.6E-06	2	1.0E+01	1.6E-05			
	Pyrene	2	8	3.0E-03	1.6E-06	10	1.0E+01	1.6E-05			
	Benzo(a)anthracene	1	12	2.0E-04	1.1E-07	3	1.0E+01	1.6E-05			
	Benzo(a)anthracene	2	8	2.0E-04	1.1E-07	10	1.0E+01	1.6E-05			
	Phenanthrene	1	12	1.0E-03	5.4E-07	2	1.0E+01	1.6E-05			
	Phenanthrene	2	8	1.0E-03	5.4E-07	10	1.0E+01	1.6E-05			
	Hexachlorobenzene	1	12	2.0E-01	1.5E-05	2	1.0E+01	2.3E-06			
	Hexachlorobenzene	2	8	2.0E-01	1.5E-05	10	1.0E+01	2.3E-06			
	Hexachlorobenzene	3	16	2.0E-01	1.5E-05	16	9.1E-01	2.1E-07			
	Heptachlor epoxide	1	12	5.0E-03	2.1E-06	1	1.0E+01	1.3E-05			
	Heptachlor epoxide	2	8	5.0E-03	2.1E-06	6	1.0E+01	1.3E-05			
	Fluoranthene	3	16	2.0E-02	1.1E-05	16	9.1E-01	1.5E-06			
	Bis(2-chloroethyl)ether	1	12	2.0E-01	1.0E-05	2	1.0E+01	1.6E-06			
	Bis(2-chloroethyl)ether	2	8	2.0E-01	1.0E-05	10	1.0E+01	1.6E-06			
	Bis(2-chloroethyl)ether	3	16	2.0E-01	1.0E-05	16	9.1E-01	1.4E-07			
	Alpha BHC	1	12	5.0E-03	1.5E-06	2	1.0E+01	9.0E-06			
	Alpha BHC	2	8	5.0E-03	1.5E-06	6	1.0E+01	9.0E-06			

Table D1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	1,1-Dichloroethylene	1							28	5.0E-03	**8.6E-06**
	1,1-Dichloroethylene	2							28	5.0E-03	**8.6E-06**
	1,1-Dichloroethylene	3				2	1.0E-02	**8.6E-10**	27	5.0E-03	**8.6E-06**
	Dieldrin	3	16	9.0E-03	**6.8E-06**	13	9.1E-01	**2.1E-06**			
	N-Nitrosodimethylamine	3				14	9.1E-01	**6.6E-06**			
	Heptachlor	1	12	5.0E-03	**1.1E-06**	1	1.0E+01	**6.4E-06**			
	Heptachlor	2	8	5.0E-03	**1.1E-06**	6	1.0E+01	**6.4E-06**			
	2,4-Dinitrotoluene	1	12	2.0E-01	**6.4E-06**	2	1.0E+01	**9.7E-07**			
	2,4-Dinitrotoluene	2	8	2.0E-01	**6.4E-06**	10	1.0E+01	**9.7E-07**			
	2,4-Dinitrotoluene	3	16	2.0E-01	**6.4E-06**	16	9.1E-01	**8.8E-08**			
	2,6-Dinitrotoluene	1	12	2.0E-01	**6.4E-06**	2	1.0E+01	**9.7E-07**			
	2,6-Dinitrotoluene	2	8	2.0E-01	**6.4E-06**	10	1.0E+01	**9.7E-07**			
	2,6-Dinitrotoluene	3	16	2.0E-01	**6.4E-06**	16	9.1E-01	**8.8E-08**			
	Pentachlorophenol	1	12	1.0E+00	**5.7E-06**	2	5.0E+01	**8.6E-07**			
	Pentachlorophenol	2	8	1.0E+00	**5.7E-06**	10	5.0E+01	**8.6E-07**			
	Pentachlorophenol	3	16	1.0E+00	**5.7E-06**	16	9.1E-01	**1.6E-08**			
	Indeno(1,2,3-cd)pyrene	3	16	8.0E-03	**4.3E-06**	16	9.1E-01	**1.5E-06**			
	Aldrin	3	16	5.0E-03	**4.0E-06**	13	9.1E-01	**2.2E-06**			
	1,1,2,2-Tetrachloroethane	1							29	5.0E-03	**2.9E-06**
	1,1,2,2-Tetrachloroethane	2							29	5.0E-03	**2.9E-06**
	1,1,2,2-Tetrachloroethane	3				7	1.0E-02	**2.9E-10**	28	5.0E-03	**2.9E-06**
	Beta BHC	1	12	5.0E-03	**4.2E-07**	2	1.0E+01	**2.6E-06**			
	Beta BHC	2	8	5.0E-03	**4.2E-07**	6	1.0E+01	**2.6E-06**			
	Gamma-BHC (Lindane)	1	12	5.0E-03	**4.2E-07**	2	1.0E+01	**2.6E-06**			
	Gamma-BHC (Lindane)	2	8	5.0E-03	**4.2E-07**	6	1.0E+01	**2.6E-06**			
	Cis-1,3-dichloropropene	1							29	5.0E-03	**2.6E-06**
	Cis-1,3-dichloropropene	2							29	5.0E-03	**2.6E-06**
	Cis-1,3-dichloropropene	3							28	5.0E-03	**2.6E-06**
	Trans-1,3-dichloropropene	1							29	5.0E-03	**2.6E-06**
	Trans-1,3-dichloropropene	2							29	5.0E-03	**2.6E-06**
	Trans-1,3-dichloropropene	3							28	5.0E-03	**2.6E-06**
	1,2-Diphenylhydrazine	1				1	2.0E+01	**2.3E-06**			
	1,2-Diphenylhydrazine	2				6	2.0E+01	**2.3E-06**			
	Heptachlor epoxide	3	16	5.0E-03	**2.1E-06**	13	9.1E-01	**1.2E-06**			
	Chlordane	1				2	1.0E+01	**1.9E-06**			
	Chlordane	2				6	1.0E+01	**1.9E-06**			

Table D1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Carbon tetrachloride	1							29	5.0E-03	1.9E-06
	Carbon tetrachloride	2							29	5.0E-03	1.9E-06
	Carbon tetrachloride	3				2	1.0E-02	1.9E-10	28	5.0E-03	1.9E-06
	Dichlorobromomethane	2							29	5.0E-03	1.9E-06
	Dichlorobromomethane	3				2	1.0E-02	1.9E-10	28	5.0E-03	1.9E-06
	Pyrene	3	16	3.0E-03	1.6E-06	16	9.1E-01	1.5E-06			
	Acenaphthene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Anthracene	3	16	2.0E-04	1.1E-07	16	9.1E-01	1.5E-06			
	Benzo(a)pyrene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Benzo(b)fluoranthene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Benzo(ghi)perylene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Benzo(k)fluoranthene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Chrysene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Dibenz(a,h)anthracene	3	16	2.0E-03	1.1E-06	16	9.1E-01	1.5E-06			
	Fluorene	3	16	2.0E-03	1.1E-06	16	9.1E-01	1.5E-06			
	Benzo(a)anthracene	3	16	2.0E-04	1.1E-07	16	9.1E-01	1.5E-06			
	Phenanthrene	3	16	1.0E-03	5.4E-07	16	9.1E-01	1.5E-06			
	Alpha BHC	3	16	5.0E-03	1.5E-06	13	9.1E-01	8.2E-07			
	Toxaphene	3	16	1.0E-02	5.2E-07	2	9.1E+00	1.4E-06			
	1,2-Dichloroethane	1							29	5.0E-03	1.3E-06
	1,2-Dichloroethane	2							29	5.0E-03	1.3E-06
	1,2-Dichloroethane	3				2	1.0E-02	1.3E-10	28	5.0E-03	1.3E-06
	Chlorodibromomethane	1							29	5.0E-03	1.2E-06
	Chlorodibromomethane	2							29	5.0E-03	1.2E-06
	Chlorodibromomethane	3				2	1.0E-02	1.2E-10	28	5.0E-03	1.2E-06
	Heptachlor	3	16	5.0E-03	1.1E-06	13	9.1E-01	5.9E-07			
	1,2-Dichloropropane	1							29	5.0E-03	9.7E-07
	1,2-Dichloropropane	2							29	5.0E-03	9.7E-07
	1,2-Dichloropropane	3				2	1.0E-02	9.7E-11	28	5.0E-03	9.7E-07
	Chlordane	3				13	4.6E+00	8.5E-07			
	1,1,2-Trichloroethane	1							29	5.0E-03	8.1E-07
	1,1,2-Trichloroethane	2							29	5.0E-03	8.1E-07
	1,1,2-Trichloroethane	3				2	1.0E-02	8.1E-11	28	5.0E-03	8.1E-07
	Hexachlorobutadiene	1	12	2.0E-01	7.4E-07	2	1.0E+01	1.1E-07			
	Hexachlorobutadiene	2	8	2.0E-01	7.4E-07	10	1.0E+01	1.1E-07			
	Hexachlorobutadiene	3	16	2.0E-01	7.4E-07	15	9.1E-01	1.0E-08			
	Tetrachloroethylene	2							29	5.0E-03	7.3E-07

Table D1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Toxaphene	1	12	1.0E-02	5.2E-07						
	Toxaphene	2	8	1.0E-02	5.2E-07						
	4,4'DDE	1	12	9.0E-03	1.4E-07	1	1.0E+01	4.9E-07			
	4,4'DDE	2	8	9.0E-03	1.4E-07	6	1.0E+01	4.9E-07			
	4,4'DDT	1	12	9.0E-03	1.4E-07	1	1.0E+01	4.9E-07			
	4,4'DDT	2	8	9.0E-03	1.4E-07	6	1.0E+01	4.9E-07			
	Styrene	1							29	5.0E-03	4.3E-07
	Styrene	2							29	5.0E-03	4.3E-07
	Styrene	3							28	5.0E-03	4.3E-07
	Beta BHC	3	16	5.0E-03	4.2E-07	13	9.1E-01	2.3E-07			
	Gamma-BHC (Lindane)	3	16	5.0E-03	4.2E-07	13	9.1E-01	2.3E-07			
	Benzene	2							28	5.0E-03	4.1E-07
	Benzene	3							27	5.0E-03	4.1E-07
	Methyl chloride	1							29	1.0E-02	3.7E-07
	Methyl chloride	2							29	1.0E-02	3.7E-07
	Methyl chloride	3				2	1.0E-02	1.9E-11	28	1.0E-02	3.7E-07
	4,4'DDD	1	12	9.0E-03	1.0E-07	1	1.0E+01	3.4E-07			
	4,4'DDD	2	8	9.0E-03	1.0E-07	6	1.0E+01	3.4E-07			
	4-Chloroaniline	1	12	2.0E-01	3.3E-07	2	1.0E+01	5.0E-08			
	4-Chloroaniline	2	8	2.0E-01	3.3E-07	10	1.0E+01	5.0E-08			
	4-Chloroaniline	3	16	2.0E-01	3.3E-07	14	1.0E+01	5.0E-08			
	1,4-Dichlorobenzene	1	12	2.0E-01	2.3E-07	2	1.0E+01	3.4E-08			
	1,4-Dichlorobenzene	2	8	2.0E-01	2.3E-07	10	1.0E+01	3.4E-08			
	1,4-Dichlorobenzene	3	16	2.0E-01	2.3E-07	16	9.1E-01	3.1E-09			
	4,4'DDE	3	16	9.0E-03	1.4E-07	13	9.1E-01	4.4E-08			
	4,4'DDT	3	16	9.0E-03	1.4E-07	13	9.1E-01	4.4E-08			
	Bis(2-ethylhexyl)phthalate	1	12	2.0E-01	1.3E-07	2	1.0E+01	2.0E-08			
	Bis(2-ethylhexyl)phthalate	2	8	2.0E-01	1.3E-07	10	1.0E+01	2.0E-08			
	Bis(2-ethylhexyl)phthalate	3	16	2.0E-01	1.3E-07	16	9.1E-01	1.8E-09			
	Hexachloroethane	1	12	2.0E-01	1.3E-07	2	1.0E+01	2.0E-08			
	Hexachloroethane	2	8	2.0E-01	1.3E-07	10	1.0E+01	2.0E-08			
	Hexachloroethane	3	16	2.0E-01	1.3E-07	16	9.1E-01	1.8E-09			
	Bromoform	1							29	5.0E-03	1.1E-07
	Bromoform	2							29	5.0E-03	1.1E-07
	Bromoform	3				2	1.0E-02	1.1E-11	28	5.0E-03	1.1E-07
	1,2-Diphenylhydrazine	3				14	9.1E-01	1.0E-07			

Table D1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	2,4,6-Trichlorophenol	1	12	2.0E-01	1.0E-07	2	1.0E+01	1.6E-08			
	2,4,6-Trichlorophenol	2	8	2.0E-01	1.0E-07	10	1.0E+01	1.6E-08			
	2,4,6-Trichlorophenol	3	16	2.0E-01	1.0E-07	16	9.1E-01	1.4E-09			
	4,4'DDD	3	16	9.0E-03	1.0E-07	13	9.1E-01	3.1E-08			
	Acrylonitrile	3				2	9.1E-01	7.0E-08			
	N-Nitrosodiphenylamine	1	12	2.0E-01	4.6E-08	2	1.0E+01	7.0E-09			
	N-Nitrosodiphenylamine	2	8	2.0E-01	4.6E-08	10	1.0E+01	7.0E-09			
	N-Nitrosodiphenylamine	3	16	2.0E-01	4.6E-08	16	9.1E-01	6.4E-10			
	Isophorone	1	12	2.0E-01	3.9E-08	2	1.0E+01	5.9E-09			
	Isophorone	2	8	2.0E-01	3.9E-08	10	1.0E+01	5.9E-09			
	Isophorone	3	16	2.0E-01	3.9E-08	16	9.1E-01	5.3E-10			
	Aniline	1				2	1.0E+01	8.1E-09			
	Aniline	2				6	1.0E+01	8.1E-09			
	Aniline	3				11	1.0E+01	8.1E-09			
	Tetrachloroethylene	3				7	1.0E-02	7.3E-11			
	Trichloroethylene	3				2	1.0E-02	1.6E-11			
							(Bq/kg)				
Radionuclide	H-3	3				4	5.0E+02	7.9E-11			

*Contaminants are ranked in descending order by sum of screening indices

Table D2. Results of nonconservative screening of noncarcinogens where no concentrations were above detecti (Concentrations are the minimum detection limits)

Contaminant type	Contaminant name[a]	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Inorganic	Antimony	1	104	5.0E-01	1.2E-01				3	5.0E-02	3.6E-01
	Antimony	2	45	5.0E-01	1.2E-01				3	5.0E-02	3.6E-01
	Antimony	3	109	5.0E-01	1.2E-01				3	5.0E-02	3.6E-01
	Selenium	2							3	5.0E-02	4.8E-02
	Arsenic	1	104	5.0E-01	4.6E-02				33	1.0E-02	2.9E-02
	Arsenic	2	45	5.0E-01	4.6E-02						
	Arsenic	3	109	5.0E-01	4.6E-02						
	Molybdenum	1							3	4.0E-02	2.9E-02
	Molybdenum	2							3	4.0E-02	2.9E-02
	Molybdenum	3							3	4.0E-02	2.9E-02
	Cadmium	1							33	2.0E-03	1.1E-02
	Cadmium	3							33	2.0E-03	1.1E-02
	Thallium	3				2	5.0E+00	1.0E-02			
	Chromium	1	104	5.0E-01	9.3E-03						
	Chromium	2	45	5.0E-01	9.3E-03						
	Chromium	3	109	5.0E-01	9.3E-03						
	Silver	1	104	2.0E-01	6.2E-03				33	5.0E-03	4.8E-03
	Silver	2	45	2.0E-01	6.2E-03				33	5.0E-04	4.8E-04
	Silver	3	109	2.0E-01	6.2E-03				33	5.0E-03	4.8E-03
	Selenium	1							4	5.0E-03	4.8E-03
	Boron	1							3	8.0E-02	2.5E-03
	Boron	2							4	8.0E-02	2.5E-03
	Boron	3							3	8.0E-02	2.5E-03
	Nickel	1	104	5.0E-01	2.3E-03						
	Nickel	2	45	5.0E-01	2.3E-03						
	Nickel	3	109	5.0E-01	2.3E-03						
	Beryllium	1	104	1.0E-01	1.9E-03				3	2.0E-04	1.1E-04
	Beryllium	2	45	1.0E-01	1.9E-03				3	2.0E-04	1.1E-04
	Beryllium	3	109	1.0E-01	1.9E-03				3	2.0E-04	1.1E-04
	Vanadium	1							3	2.0E-03	8.2E-04
	Vanadium	3							3	2.0E-03	8.2E-04
	Tin	1							3	5.0E-02	2.4E-04
	Tin	2							3	5.0E-02	2.4E-04
	Tin	3							3	5.0E-02	2.4E-04
	Cyanide	3				2	5.0E-01	3.6E-06			

Table D2 (continued)

Contaminsnt type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	4,6-Dinitro-ortho-cresol	1	12	1.0E+00	9.3E-01	3	2.0E+01	2.9E-02			
	4,6-Dinitro-ortho-cresol	2	8	1.0E+00	9.3E-01	10	2.0E+01	2.9E-02			
	4,6-Dinitro-ortho-cresol	3	16	1.0E+00	9.3E-01	16	4.6E+00	6.6E-03			
	Heptachlor epoxide	1	12	5.0E-03	3.6E-02	1	1.0E+01	1.1E-01			
	Heptachlor epoxide	2	8	5.0E-03	3.6E-02	6	1.0E+01	1.1E-01			
	Cis-1,3-dichloropropene	1							29	5.0E-03	4.8E-02
	Cis-1,3-dichloropropene	2							29	5.0E-03	4.8E-02
	Cis-1,3-dichloropropene	3							28	5.0E-03	4.8E-02
	Trans-1,3-dichloropropene	1							29	5.0E-03	4.8E-02
	Trans-1,3-dichloropropene	2							29	5.0E-03	4.8E-02
	Trans-1,3-dichloropropene	3							28	5.0E-03	4.8E-02
	Aldrin	1	12	5.0E-03	1.5E-02	2	1.0E+01	4.8E-02			
	Aldrin	2	8	5.0E-03	1.5E-02	6	1.0E+01	4.8E-02			
	Nitrobenzene	1	12	2.0E-01	3.7E-02	2	1.0E+01	2.9E-03			
	Nitrobenzene	2	8	2.0E-01	3.7E-02	10	1.0E+01	2.9E-03			
	Nitrobenzene	3	16	2.0E-01	3.7E-02	16	9.1E-01	2.6E-04			
	Heptachlor epoxide	3	16	5.0E-03	3.6E-02	13	9.1E-01	1.0E-02			
	Dieldrin	1	12	9.0E-03	1.7E-02	1	1.0E+01	2.9E-02			
	Dieldrin	2	8	9.0E-03	1.7E-02	6	1.0E+01	2.9E-02			
	Endosulfan I	1	12	5.0E-03	9.3E-03	1	1.0E+01	2.9E-02			
	Endosulfan I	2	8	5.0E-03	9.3E-03	6	1.0E+01	2.9E-02			
	Endosulfan II	1	12	9.0E-03	1.7E-02	1	1.0E+01	2.9E-02			
	Endosulfan II	2	8	9.0E-03	1.7E-02	6	1.0E+01	2.9E-02			
	Chlordane	1				2	1.0E+01	2.4E-02			
	Chlordane	2				6	1.0E+01	2.4E-02			
	Hexachlorobenzene	1	12	2.0E-01	2.3E-02	2	1.0E+01	1.8E-03			
	Hexachlorobenzene	2	8	2.0E-01	2.3E-02	10	1.0E+01	1.8E-03			
	Hexachlorobenzene	3	16	2.0E-01	2.3E-02	16	9.1E-01	1.6E-04			
	Methyl bromide	1							29	1.0E-02	2.0E-02
	Methyl bromide	2							29	1.0E-02	2.0E-02
	Methyl bromide	3				2	1.0E 02	1.0E-06	28	1.0E-02	2.0E-02
	Carbon tetrachloride	1							29	5.0E-03	2.0E-02
	Carbon tetrachloride	2							29	5.0E-03	2.0E-02
	Carbon tetrachloride	3				2	1.0E-02	2.0E-06	28	5.0E-03	2.0E-02
	Hexachloroethane	1	12	2.0E-01	1.9E-02	2	1.0E+01	1.4E-03			
	Hexachloroethane	2	8	2.0E-01	1.9E-02	10	1.0E+01	1.4E-03			
	Hexachloroethane	3	16	2.0E-01	1.9E-02	16	9.1E-01	1.3E-04			

Table D2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	Dieldrin	3	16	9.0E-03	1.7E-02	13	9.1E-01	2.6E-03			
	Endosulfan II	3	16	9.0E-03	1.7E-02	13	9.1E-01	2.6E-03			
	Aldrin	3	16	5.0E-03	1.5E-02	13	9.1E-01	4.3E-03			
	1,2,4-Trichlorobenzene	1	12	2.0E-01	1.4E-02	2	1.0E+01	1.1E-03			
	1,2,4-Trichlorobenzene	2	8	2.0E-01	1.4E-02	10	1.0E+01	1.1E-03			
	1,2,4-Trichlorobenzene	3	16	2.0E-01	1.4E-02	16	9.1E-01	9.9E-05			
	Chlordane	3				13	4.6E+00	1.1E-02			
	Hexachlorobutadiene	1	12	2.0E-01	9.3E-03	2	1.0E+01	7.1E-04			
	Hexachlorobutadiene	2	8	2.0E-01	9.3E-03	10	1.0E+01	7.1E-04			
	Hexachlorobutadiene	3	16	2.0E-01	9.3E-03	15	9.1E-01	6.5E-05			
	Endosulfan I	3	16	5.0E-03	9.3E-03	13	9.1E-01	2.6E-03			
	2,4-Dichlorophenol	1	12	2.0E-01	6.2E-03	3	1.0E+01	4.8E-04			
	2,4-Dichlorophenol	2	8	2.0E-01	6.2E-03	10	1.0E+01	4.8E-04			
	2,4-Dichlorophenol	3	16	2.0E-01	6.2E-03	16	9.1E-01	4.3E-05			
	Endrin	1	12	9.0E-03	2.8E-03	1	1.0E+01	4.8E-03			
	Endrin	2	8	9.0E-03	2.8E-03	6	1.0E+01	4.8E-03			
	Gamma-BHC (Lindane)	1	12	5.0E-03	1.5E-03	2	1.0E+01	4.8E-03			
	Gamma-BHC (Lindane)	2	8	5.0E-03	1.5E-03	6	1.0E+01	4.8E-03			
	4-Chloroaniline	1	12	2.0E-01	4.6E-03	2	1.0E+01	3.6E-04			
	4-Chloroaniline	2	8	2.0E-01	4.6E-03	10	1.0E+01	3.6E-04			
	4-Chloroaniline	3	16	2.0E-01	4.6E-03	14	1.0E+01	3.6E-04			
	2-Chlorophenol	1	12	2.0E-01	3.7E-03	3	1.0E+01	2.9E-04			
	2-Chlorophenol	2	8	2.0E-01	3.7E-03	10	1.0E+01	2.9E-04			
	2-Chlorophenol	3	16	2.0E-01	3.7E-03	16	9.1E-01	2.6E-05			
	1,1,2-Trichloroethane	1							29	5.0E-03	3.6E-03
	1,1,2-Trichloroethane	2							29	5.0E-03	3.6E-03
	1,1,2-Trichloroethane	3				2	1.0E-02	3.6E-07	28	5.0E-03	3.6E-03
	Pentachlorophenol	1	12	1.0E+00	3.1E-03	2	5.0E+01	2.4E-04			
	Pentachlorophenol	2	8	1.0E+00	3.1E-03	10	5.0E+01	2.4E-04			
	Pentachlorophenol	3	16	1.0E+00	3.1E-03	16	9.1E-01	4.3E-06			
	Heptachlor	1	12	5.0E-03	9.3E-04	1	1.0E+01	2.9E-03			
	Heptachlor	2	8	5.0E-03	9.3E-04	6	1.0E+01	2.9E-03			
	4,4'DDT	1	12	9.0E-03	1.7E-03	1	1.0E+01	2.9E-03			
	4,4'DDT	2	8	9.0E-03	1.7E-03	6	1.0E+01	2.9E-03			
	Endrin	3	16	9.0E-03	2.8E-03	13	9.1E-01	4.3E-04			
	Hexachlorocyclopentadiene	1	12	2.0E-01	2.7E-03	2	1.0E+01	2.0E-04			
	Hexachlorocyclopentadiene	2	8	2.0E-01	2.7E-03	10	1.0E+01	2.0E-04			
	Hexachlorocyclopentadiene	3	16	2.0E-01	2.7E-03	16	9.1E-01	1.9E-05			

Table D2 (continued)

Contaminant type	Contaminant name[a]	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	Benzidine	1				2	5.0E+01	2.4E-03			
	Benzidine	2				6	5.0E+01	2.4E-03			
	4,4'DDT	3	16	9.0E-03	1.7E-03	13	9.1E-01	2.6E-04			
	1,1-Dichloroethylene	1							28	5.0E-03	1.6E-03
	1,1-Dichloroethylene	2							28	5.0E-03	1.6E-03
	1,1-Dichloroethylene	3				2	1.0E-02	1.6E-07	27	5.0E-03	1.6E-03
	Gamma-BHC (Lindane)	3	16	5.0E-03	1.5E-03	13	9.1E-01	4.3E-04			
	Tetrachloroethylene	2							29	5.0E-03	1.4E-03
	1,2-Dichloroethene (total)	1							29	5.0E-03	1.4E-03
	1,2-Dichloroethene (total)	3							28	5.0E-03	1.4E-03
	2,4,5-Trichlorophenol	1	12	1.0E+00	9.3E-04	2	1.0E+01	1.4E-05			
	2,4,5-Trichlorophenol	2	8	1.0E+00	9.3E-04	10	1.0E+01	1.4E-05			
	2,4,5-Trichlorophenol	3	16	1.0E+00	9.3E-04	9	1.0E+01	1.4E-05			
	Bis(2-ethylhexyl)phthalate	1	12	2.0E-01	9.3E-04	2	1.0E+01	7.1E-05			
	Bis(2-ethylhexyl)phthalate	2	8	2.0E-01	9.3E-04	10	1.0E+01	7.1E-05			
	Bis(2-ethylhexyl)phthalate	3	16	2.0E-01	9.3E-04	16	9.1E-01	6.5E-06			
	Di-n-octyl phthalate	1	12	2.0E-01	9.3E-04	2	1.0E+01	7.1E-05			
	Di-n-octyl phthalate	2	8	2.0E-01	9.3E-04	10	1.0E+01	7.1E-05			
	Di-n-octyl phthalate	3	16	2.0E-01	9.3E-04	16	9.1E-01	6.5E-06			
	2,4-Dimethylphenol	1	24	2.0E-01	9.3E-04	6	1.0E+01	7.1E-05			
	2,4-Dimethylphenol	2	16	2.0E-01	9.3E-04	20	1.0E+01	7.1E-05			
	2,4-Dimethylphenol	3	32	2.0E-01	9.3E-04	32	9.1E-01	6.5E-06			
	Heptachlor	3	16	5.0E-03	9.3E-04	13	9.1E-01	2.6E-04			
	Bromoform	1							29	5.0E-03	7.1E-04
	Bromoform	2							29	5.0E-03	7.1E-04
	Bromoform	3				2	1.0E-02	7.1E-08	28	5.0E-03	7.1E-04
	Chlorobenzene	1							28	5.0E-03	7.1E-04
	Chlorobenzene	2							28	5.0E-03	7.1E-04
	Chlorobenzene	3				2	1.0E-02	7.1E-08	27	5.0E-03	7.1E-04
	Chlorodibromomethane	1							29	5.0E-03	7.1E-04
	Chlorodibromomethane	2							29	5.0E-03	7.1E-04
	Chlorodibromomethane	3				2	1.0E-02	7.1E-08	28	5.0E-03	7.1E-04
	Dichlorobromomethane	2							29	5.0E-03	7.1E-04
	Dichlorobromomethane	3				2	1.0E-02	7.1E-08	28	5.0E-03	7.1E-04
	4-Methyl-2-pentanone	1							29	1.0E-02	5.7E-04
	4-Methyl-2-pentanone	2							29	1.0E-02	5.7E-04
	Benzidine	3				14	9.1E+00	4.3E-04			

Table D2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	4-Methylphenol	1	12	2.0E-01	3.7E-04	3	1.0E+01	2.9E-05			
	4-Methylphenol	2	8	2.0E-01	3.7E-04	10	1.0E+01	2.9E-05			
	4-Methylphenol	3	16	2.0E-01	3.7E-04	14	1.0E+01	2.9E-05			
	Naphthalene	1	12	3.0E-03	7.0E-05	2	1.0E+01	3.6E-04			
	Naphthalene	2	8	3.0E-03	7.0E-05	10	1.0E+01	3.6E-04			
	2-Chloronaphthalene	1	12	2.0E-01	2.3E-04	2	1.0E+01	1.8E-05			
	2-Chloronaphthalene	2	8	2.0E-01	2.3E-04	10	1.0E+01	1.8E-05			
	2-Chloronaphthalene	3	16	2.0E-01	2.3E-04	16	9.1E-01	1.6E-06			
	1,2-Dichlorobenzene	1	12	2.0E-01	2.1E-04	2	1.0E+01	1.6E-05			
	1,2-Dichlorobenzene	2	8	2.0E-01	2.1E-04	10	1.0E+01	1.6E-05			
	1,2-Dichlorobenzene	3	16	2.0E-01	2.1E-04	16	9.1E-01	1.4E-06			
	Di-n-butyl phthalate	1	12	2.0E-01	1.9E-04	2	1.0E+01	1.4E-05			
	Di-n-butyl phthalate	2	8	2.0E-01	1.9E-04						
	Di-n-butyl phthalate	3	16	2.0E-01	1.9E-04						
	1,1,1-Trichloroethane	1							29	5.0E-03	1.6E-04
	1,1,1-Trichloroethane	2							29	5.0E-03	1.6E-04
	1,1,1-Trichloroethane	3				2	1.0E-02	1.6E-08	28	5.0E-03	1.6E-04
	Ethylbenzene	2							29	5.0E-03	1.4E-04
	Ethylbenzene	3				2	1.0E-02	1.4E-08	28	5.0E-03	1.4E-04
	1,1-Dichloroethane	1							29	5.0E-03	1.4E-04
	1,1-Dichloroethane	3				2	1.0E-02	1.4E-08	28	5.0E-03	1.4E-04
	Butylbenzylphthalate	1	12	2.0E-01	9.3E-05	2	1.0E+01	7.1E-06			
	Butylbenzylphthalate	2	8	2.0E-01	9.3E-05	10	1.0E+01	7.1E-06			
	Butylbenzylphthalate	3	16	2.0E-01	9.3E-05	16	9.1E-01	6.5E-07			
	Isophorone	1	12	2.0E-01	9.3E-05	2	1.0E+01	7.1E-06			
	Isophorone	2	8	2.0E-01	9.3E-05	10	1.0E+01	7.1E-06			
	Isophorone	3	16	2.0E-01	9.3E-05	16	9.1E-01	5.5E-07			
	Methoxychlor	1	12	5.0E-03	9.3E-05						
	Methoxychlor	2	8	5.0E-03	9.3E-05						
	Methoxychlor	3	16	5.0E-03	9.3E-05						
	Styrene	1							29	5.0E-03	7.1E-05
	Styrene	2							29	5.0E-03	7.1E-05
	Styrene	3							28	5.0E-03	7.1E-05
	Naphthalene	3	16	3.0E-03	7.0E-05	16	9.1E-01	3.3E-05			
	2,4-Dinitrophenol	3				2	9.1E-01	6.5E-05			
	Benzyl alcohol	1	12	2.0E-01	6.2E-05	3	1.0E+01	4.8E-06			
	Benzyl alcohol	2	8	2.0E-01	6.2E-05	10	1.0E+01	4.8E-06			
	Benzyl alcohol	3	16	2.0E-01	6.2E-05	14	1.0E+01	4.8E-06			

Table D2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	Pyrene	1	12	3.0E-03	9.3E-06	2	1.0E+01	4.8E-05			
	Pyrene	2	8	3.0E-03	9.3E-06	10	1.0E+01	4.8E-05			
	Fluoranthene	1	12	2.0E-02	4.6E-05	2	1.0E+01	3.6E-05			
	Fluoranthene	2	8	2.0E-02	4.6E-05	10	1.0E+01	3.6E-05			
	Fluoranthene	3	16	2.0E-02	4.6E-05	16	9.1E-01	3.3E-06			
	Bis(2-chloroisopropyl)ether	1				2	1.0E+01	3.6E-05			
	Bis(2-chloroisopropyl)ether	2				10	1.0E+01	3.6E-05			
	Fluorene	1	12	2.0E-03	4.6E-06	2	1.0E+01	3.6E-05			
	Fluorene	2	8	2.0E-03	4.6E-06	10	1.0E+01	3.6E-05			
	Phenol	1	12	2.0E-01	3.1E-05	2	1.0E+01	2.4E-06			
	Phenol	2	8	2.0E-01	3.1E-05	10	1.0E+01	2.4E-06			
	Phenol	3	16	2.0E-01	3.1E-05	16	9.1E-01	2.2E-07			
	Vinyl acetate	1							29	1.0E-02	2.9E-05
	Vinyl acetate	2							29	1.0E-02	2.9E-05
	Vinyl acetate	3							28	1.0E-02	2.9E-05
	Acenaphthene	1	12	1.0E-03	1.5E-06	3	1.0E+01	2.4E-05			
	Acenaphthene	2	8	1.0E-03	1.5E-06	10	1.0E+01	2.4E-05			
	Benzoic acid	1	12	1.0E+00	2.3E-05	3	5.0E+01	1.8E-06			
	Benzoic acid	2	8	1.0E+00	2.3E-05	10	5.0E+01	1.8E-06			
	Benzoic acid	3	16	1.0E+00	2.3E-05	14	5.0E+01	1.8E-06			
	Diethyl phthalate	1	12	2.0E-01	2.3E-05	2	1.0E+01	1.8E-06			
	Diethyl phthalate	2	8	2.0E-01	2.3E-05	10	1.0E+01	1.8E-06			
	Diethyl phthalate	3	16	2.0E-01	2.3E-05	16	4.6E+00	8.2E-07			
	Dimethyl phthalate	1	12	2.0E-01	1.9E-05	2	1.0E+01	1.4E-06			
	Dimethyl phthalate	2	8	2.0E-01	1.9E-05	10	1.0E+01	1.4E-06			
	Dimethyl phthalate	3	16	2.0E-01	1.9E-05	16	9.1E-01	1.3E-07			
	Pyrene	3	16	3.0E-03	9.3E-06	16	9.1E-01	4.3E-06			
	Anthracene	1	12	2.0E-04	6.2E-08	3	1.0E+01	4.8E-06			
	Anthracene	2	8	2.0E-04	6.2E-08	10	1.0E+01	4.8E-06			
	Fluorene	3	16	2.0E-03	4.6E-06	16	9.1E-01	3.3E-06			
	Bis(2-chloroisopropyl)ether	3				16	9.1E-01	3.3E-06			
	Acenaphthene	3	16	1.0E-03	1.5E-06	16	9.1E-01	2.2E-06			
	Anthracene	3	16	2.0E-04	6.2E-08	16	9.1E-01	4.3E-07			
	Tetrachloroethylene	3				7	1.0E-02	1.4E-07			
	Trans-1,2-dichloroethene	3				7	6.4E-03	4.6E-08			
	Dichlorodifluoromethane	3				2	1.0E-02	7.1E-09			
	Trichlorofluoromethane	3				2	1.0E-02	4.8E-09			

*Contaminants are ranked in descending order by sum of screening indices

APPENDIX E

CONSERVATIVE SCREENING OF THE DETECTABLE CONTAMINANTS DATA BASE FOR CARCINOGENS AND NONCARCINOGENS

Table E1. Results of conservative screening of carcinogens where no concentrations were above detection limits (Concentrations are the upper 95% confidence bound of the arithmetic mean of the detection limits)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Inorganic	Arsenic	1	104	5.0E-01	4.1E-04				33	5.2E-02	2.6E-03
	Arsenic	2	45	5.0E-01	4.1E-04						
	Arsenic	3	109	5.0E-01	4.1E-04						
	Beryllium	2	45	1.0E-01	2.0E-04				3	3.8E-04	4.6E-05
	Beryllium	1	104	1.0E-01	2.0E-04				3	3.8E-04	4.6E-05
	Beryllium	3	109	1.0E-01	2.0E-04				3	3.8E-04	4.6E-05
Organic	Benzidine	3				14	5.3E+01	1.7E-02			
	Benzidine	1				2	5.0E+01	1.6E-02			
	Benzidine	2				6	5.0E+01	1.6E-02			
	Acenaphthylene	3	16	2.0E+00	1.1E-02	16	1.1E+01	1.7E-04			
	Fluorene	3	16	2.0E+00	1.1E-02	16	1.1E+01	1.7E-04			
	Acenaphthylene	1	12	2.0E+00	1.1E-02	3	1.0E+01	1.6E-04			
	Fluorene	1	12	2.0E+00	1.1E-02	2	1.0E+01	1.6E-04			
	Acenaphthylene	2	8	1.9E+00	1.0E-02	10	1.0E+01	1.6E-04			
	Fluorene	2	8	1.9E+00	1.0E-02	10	1.0E+01	1.6E-04			
	N-nitroso-di-n-propylamine	3	16	2.0E+00	6.5E-03	16	1.9E+01	1.9E-04			
	N-nitroso-di-n-propylamine	1	12	2.0E+00	6.5E-03	2	7.9E+01	7.9E-04			
	N-nitroso-di-n-propylamine	2	8	1.9E+00	6.3E-03	10	2.0E+01	2.0E-04			
	Indeno(1,2,3-cd)pyrene	3	16	9.9E-01	5.4E-03	16	1.9E+01	3.2E-04			
	Indeno(1,2,3-cd)pyrene	1	12	9.8E-01	5.3E-03	2	7.9E+01	1.3E-03			
	Indeno(1,2,3-cd)pyrene	2	8	9.5E-01	5.1E-03	10	2.0E+01	3.2E-04			
	N-Nitrosodimethylamine	3				14	5.3E+01	3.9E-03			
	N-Nitrosodimethylamine	1				1	5.0E+01	3.6E-03			
	N-Nitrosodimethylamine	2				6	5.0E+01	3.6E-03			
	3,3'-Dichlorobenzidine	3	16	9.9E+00	2.1E-03	16	4.8E+01	3.1E-05			
	3,3'-Dichlorobenzidine	1	12	9.8E+00	2.1E-03	2	2.3E+02	1.5E-04			
	3,3'-Dichlorobenzidine	2	8	9.5E+00	2.0E-03	10	4.9E+01	3.2E-05			
	Benzo(a)anthracene	1	12	9.8E-04	5.3E-06	3	9.4E+01	1.5E-03			
	Hexachlorobenzene	3	16	2.0E+00	1.5E-03	16	1.1E+01	2.4E-05			
	Hexachlorobenzene	1	12	2.0E+00	1.5E-03	2	1.0E+01	2.3E-05			
	Hexachlorobenzene	2	8	1.9E+00	1.4E-03	10	1.0E+01	2.3E-05			
	Benzo(ghi)perylene	1	12	4.9E-03	2.7E-05	2	7.9E+01	1.3E-03			
	Dibenz(a,h)anthracene	1	12	2.0E-03	1.1E-05	2	7.9E+01	1.3E-03			
	Fluoranthene	3	16	2.0E-01	1.1E-03	16	1.1E+01	1.7E-04			
	Fluoranthene	1	12	2.0E-01	1.1E-03	2	1.0E+01	1.6E-04			
	Fluoranthene	2	8	1.9E-01	1.0E-03	10	1.0E+01	1.6E-04			

Table E1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Bis(2-chloroethyl)ether	3	16	2.0E+00	1.0E-03	16	1.1E+01	1.7E-05			
	Toxaphene	3	16	2.0E+00	1.0E-03	2	1.2E+01	1.9E-05			
	Bis(2-chloroethyl)ether	1	12	2.0E+00	1.0E-03	2	1.0E+01	1.6E-05			
	Toxaphene	1	12	2.0E+00	1.0E-03						
	Bis(2-chloroethyl)ether	2	8	1.9E+00	9.9E-04	10	1.0E+01	1.6E-05			
	Toxaphene	2	8	1.9E+00	9.8E-04						
	Benzo(a)anthracene	2	8	9.6E-04	5.2E-06	10	4.9E+01	8.0E-04			
	Benzo(a)anthracene	3	16	9.9E-04	5.4E-06	16	4.8E+01	7.8E-04			
	Vinyl chloride	3				2	1.0E-02	2.7E-08	28	1.4E-02	7.8E-04
	Vinyl chloride	1							29	1.4E-02	7.7E-04
	Vinyl chloride	2							29	1.4E-02	7.7E-04
	2,4-Dinitrotoluene	3	16	2.0E+00	6.3E-04	16	1.1E+01	1.0E-05			
	2,6-Dinitrotoluene	3	16	2.0E+00	6.3E-04	16	1.1E+01	1.0E-05			
	2,4-Dinitrotoluene	1	12	2.0E+00	6.3E-04	2	1.0E+01	9.7E-06			
	2,6-Dinitrotoluene	1	12	2.0E+00	6.3E-04	2	1.0E+01	9.7E-06			
	2,4-Dinitrotoluene	2	8	1.9E+00	6.1E-04	10	1.0E+01	9.7E-06			
	2,6-Dinitrotoluene	2	8	1.9E+00	6.1E-04	10	1.0E+01	9.7E-06			
	Pentachlorophenol	3	16	9.9E+00	5.6E-04	16	5.3E+01	9.1E-06			
	Pentachlorophenol	1	12	9.8E+00	5.6E-04	2	5.0E+01	8.6E-06			
	Pentachlorophenol	2	8	9.5E+00	5.4E-04	10	5.0E+01	8.6E-06			
	Anthracene	3	16	9.9E-02	5.4E-04	16	1.1E+01	1.7E-04			
	Anthracene	1	12	9.8E-02	5.3E-04	3	1.0E+01	1.6E-04			
	Anthracene	2	8	9.5E-02	5.1E-04	10	1.0E+01	1.6E-04			
	Bis(chloromethyl)ether	3				2	1.2E+00	3.7E-04			
	Benzo(ghi)perylene	2	8	4.8E-03	2.6E-05	10	2.0E+01	3.2E-04			
	Dibenz(a,h)anthracene	2	8	2.0E-03	1.1E-05	10	2.0E+01	3.2E-04			
	Benzo(ghi)perylene	3	16	5.0E-03	2.7E-05	16	1.9E+01	3.2E-04			
	Dibenz(a,h)anthracene	3	16	2.0E-03	1.1E-05	16	1.9E+01	3.2E-04			
	Aldrin	3	16	4.0E-02	3.2E-04	13	1.1E+01	2.6E-04			
	Aldrin	1	12	3.9E-02	3.1E-04	2	1.0E+01	2.4E-04			
	Aldrin	2	8	3.8E-02	3.1E-04	6	1.0E+01	2.4E-04			
	Dieldrin	3	16	4.0E-02	3.0E-04	13	1.1E+01	2.4E-04			
	Dieldrin	1	12	3.9E-02	3.0E-04	1	1.0E+01	2.3E-04			
	Dieldrin	2	8	3.8E-02	2.9E-04	6	1.0E+01	2.3E-04			

Table E1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	PCB-1254 (Aroclor 1254)	3							28	1.1E-03	2.3E-04
	PCB-1260 (Aroclor 1260)	3				15	3.2E+00	3.6E-05	28	1.1E-03	2.3E-04
	PCB-1254 (Aroclor 1254)	2							28	1.0E-03	2.3E-04
	PCB-1260 (Aroclor 1260)	1							28	1.0E-03	2.3E-04
	PCB-1260 (Aroclor 1260)	2							28	1.0E-03	2.3E-04
	Pyrene	2	8	3.8E-02	2.1E-04	10	1.0E+01	1.6E-04			
	Acenaphthene	3	16	3.0E-02	1.6E-04	16	1.1E+01	1.7E-04			
	Benzo(a)pyrene	3	16	4.0E-03	2.2E-05	16	1.1E+01	1.7E-04			
	Benzo(b)fluoranthene	3	16	3.0E-02	1.6E-04	16	1.1E+01	1.7E-04			
	Benzo(k)fluoranthene	3	16	2.0E-02	1.1E-04	16	1.1E+01	1.7E-04			
	Chrysene	3	16	3.0E-03	1.6E-05	16	1.1E+01	1.7E-04			
	Pyrene	3	16	2.1E-02	1.1E-04	16	1.1E+01	1.7E-04			
	Phenanthrene	3	16	9.9E-03	5.4E-05	16	1.1E+01	1.7E-04			
	Heptachlor epoxide	3	16	4.0E-02	1.7E-04	13	1.1E+01	1.4E-04			
	Heptachlor epoxide	1	12	3.9E-02	1.7E-04	1	1.0E+01	1.3E-04			
	Acenaphthene	1	12	2.9E-02	1.6E-04	3	1.0E+01	1.6E-04			
	Acenaphthene	2	8	2.8E-02	1.5E-04	10	1.0E+01	1.6E-04			
	Benzo(a)pyrene	1	12	3.9E-03	2.1E-05	3	1.0E+01	1.6E-04			
	Benzo(a)pyrene	2	8	3.8E-03	2.1E-05	10	1.0E+01	1.6E-04			
	Benzo(b)fluoranthene	1	12	2.9E-02	1.6E-04	3	1.0E+01	1.6E-04			
	Benzo(b)fluoranthene	2	8	2.8E-02	1.5E-04	10	1.0E+01	1.6E-04			
	Benzo(k)fluoranthene	1	12	2.0E-02	1.1E-04	2	1.0E+01	1.6E-04			
	Benzo(k)fluoranthene	2	8	1.9E-02	1.0E-04	10	1.0E+01	1.6E-04			
	Chrysene	1	12	3.0E-03	1.6E-05	2	1.0E+01	1.6E-04			
	Chrysene	2	8	2.9E-03	1.6E-05	10	1.0E+01	1.6E-04			
	Pyrene	1	12	2.7E-02	1.5E-04	2	1.0E+01	1.6E-04			
	Phenanthrene	1	12	9.8E-03	5.3E-05	2	1.0E+01	1.6E-04			
	Phenanthrene	2	8	9.5E-03	5.2E-05	10	1.0E+01	1.6E-04			
	Heptachlor epoxide	2	8	3.8E-02	1.6E-04	6	1.0E+01	1.3E-04			
	1,1-Dichloroethylene	3				2	1.0E-02	8.6E-09	27	7.3E-03	1.2E-04
	1,1-Dichloroethylene	1							28	7.2E-03	1.2E-04
	1,1-Dichloroethylene	2							28	7.2E-03	1.2E-04
	Alpha BHC	3	16	2.0E-02	5.9E-05	13	1.1E+01	9.6E-05			
	Alpha BHC	1	12	2.0E-02	5.8E-05	2	1.0E+01	9.0E-05			
	Alpha BHC	2	8	1.9E-02	5.7E-05	6	1.0E+01	9.0E-05			
	Heptachlor	3	16	4.0E-02	8.4E-05	13	1.1E+01	6.9E-05			
	Heptachlor	1	12	3.9E-02	8.3E-05	1	1.0E+01	6.4E-05			
	Heptachlor	2	8	3.8E-02	8.1E-05	6	1.0E+01	6.4E-05			

Table E1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Hexachlorobutadiene	3	16	2.0E+00	7.3E-05	15	1.1E+01	1.2E-06			
	Hexachlorobutadiene	1	12	2.0E+00	7.2E-05	2	1.0E+01	1.1E-06			
	Hexachlorobutadiene	2	8	1.9E+00	7.0E-05	10	1.0E+01	1.1E-06			
	1,1,2,2-Tetrachloroethane	3				7	3.1E-02	8.7E-09	28	7.2E-03	4.1E-05
	1,1,2,2-Tetrachloroethane	1							29	7.1E-03	4.1E-05
	1,1,2,2-Tetrachloroethane	2							29	7.1E-03	4.1E-05
	Cis-1,3-dichloropropene	3							28	7.2E-03	3.7E-05
	Trans-1,3-dichloropropene	3							28	7.2E-03	3.7E-05
	Cis-1,3-dichloropropene	1							29	7.1E-03	3.7E-05
	Cis-1,3-dichloropropene	2							29	7.1E-03	3.7E-05
	Trans-1,3-dichloropropene	1							29	7.1E-03	3.7E-05
	Trans-1,3-dichloropropene	2							29	7.1E-03	3.7E-05
	Beta BHC	3	16	4.0E-02	3.4E-05	13	1.1E+01	2.7E-05			
	Beta BHC	1	12	3.9E-02	3.3E-05	2	1.0E+01	2.6E-05			
	4-Chloroaniline	3	16	2.0E+00	3.3E-05	14	1.0E+01	5.0E-07			
	4-Chloroaniline	1	12	2.0E+00	3.2E-05	2	1.0E+01	5.0E-07			
	Beta BHC	2	8	3.8E-02	3.2E-05	6	1.0E+01	2.6E-05			
	4-Chloroaniline	2	8	1.9E+00	3.1E-05	10	1.0E+01	5.0E-07			
	Gamma-BHC (Lindane)	3	16	2.0E-02	1.7E-05	13	1.1E+01	2.7E-05			
	Carbon tetrachloride	3				2	1.0E-02	1.9E-09	28	7.2E-03	2.7E-05
	Dichlorobromomethane	3				2	1.0E-02	1.9E-09	28	7.2E-03	2.7E-05
	Carbon tetrachloride	1							29	7.1E-03	2.6E-05
	Carbon tetrachloride	2							29	7.1E-03	2.6E-05
	Dichlorobromomethane	2							29	7.1E-03	2.6E-05
	Gamma-BHC (Lindane)	1	12	2.0E-02	1.7E-05	2	1.0E+01	2.6E-05			
	Gamma-BHC (Lindane)	2	8	1.9E-02	1.6E-05	6	1.0E+01	2.6E-05			
	1,2-Diphenylhydrazine	3				14	2.1E+01	2.4E-05			
	1,2-Diphenylhydrazine	1				1	2.0E+01	2.3E-05			
	1,2-Diphenylhydrazine	2				6	2.0E+01	2.3E-05			
	1,4-Dichlorobenzene	3	16	2.0E+00	2.2E-05	16	1.1E+01	3.6E-07			
	4,4'DDD	3	16	2.0E-01	2.2E-05	13	1.1E+01	3.7E-06			
	1,4-Dichlorobenzene	1	12	2.0E+00	2.2E-05	2	1.0E+01	3.4E-07			
	4,4'DDD	1	12	2.0E-01	2.2E-05	1	1.0E+01	3.4E-06			
	1,4-Dichlorobenzene	2	8	1.9E+00	2.2E-05	10	1.0E+01	3.4E-07			
	4,4'DDD	2	8	1.9E-01	2.1E-05	6	1.0E+01	3.4E-06			

Table E1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Chlordane	3				13	1.0E+01	1.9E-05			
	1,2-Dichloroethane	3				2	1.0E-02	1.3E-09	28	7.2E-03	1.9E-05
	Chlordane	1				2	1.0E+01	1.9E-05			
	Chlordane	2				6	1.0E+01	1.9E-05			
	1,2-Dichloroethane	1							29	7.1E-03	1.8E-05
	1,2-Dichloroethane	2							29	7.1E-03	1.8E-05
	Chlorodibromomethane	3				2	1.0E-02	1.2E-09	28	7.2E-03	1.7E-05
	Chlorodibromomethane	1							29	7.1E-03	1.7E-05
	Chlorodibromomethane	2							29	7.1E-03	1.7E-05
	1,2-Dichloropropane	3				2	1.0E-02	9.7E-10	28	7.2E-03	1.4E-05
	1,2-Dichloropropane	1							29	7.1E-03	1.4E-05
	1,2-Dichloropropane	2							29	7.1E-03	1.4E-05
	Bis(2-ethylhexyl)phthalate	3	16	2.0E+00	1.3E-05	16	1.1E+01	2.1E-07			
	Hexachloroethane	3	16	2.0E+00	1.3E-05	16	1.1E+01	2.1E-07			
	Bis(2-ethylhexyl)phthalate	1	12	2.0E+00	1.3E-05	2	1.0E+01	2.0E-07			
	Hexachloroethane	1	12	2.0E+00	1.3E-05	2	1.0E+01	2.0E-07			
	4,4'DDT	3	16	7.9E-02	1.3E-05	13	1.1E+01	5.2E-06			
	4,4'DDT	1	12	7.9E-02	1.3E-05	1	1.0E+01	4.9E-06			
	Bis(2-ethylhexyl)phthalate	2	8	1.9E+00	1.3E-05	10	1.0E+01	2.0E-07			
	Hexachloroethane	2	8	1.9E+00	1.3E-05	10	1.0E+01	2.0E-07			
	4,4'DDT	2	8	7.6E-02	1.2E-05	6	1.0E+01	4.9E-06			
	1,1,2-Trichloroethane	3				2	1.0E-02	8.1E-10	28	7.2E-03	1.2E-05
	1,1,2-Trichloroethane	1							29	7.1E-03	1.2E-05
	1,1,2-Trichloroethane	2							29	7.1E-03	1.2E-05
	Tetrachloroethylene	2							29	7.1E-03	1.0E-05
	2,4,6-Trichlorophenol	3	16	2.0E+00	1.0E-05	16	1.1E+01	1.7E-07			
	2,4,6-Trichlorophenol	1	12	2.0E+00	1.0E-05	2	1.0E+01	1.6E-07			
	2,4,6-Trichlorophenol	2	8	1.9E+00	9.9E-06	10	1.0E+01	1.6E-07			
	4,4'DDE	3	16	4.0E-02	6.4E-06	13	1.1E+01	5.2E-06			
	4,4'DDE	1	12	3.9E-02	6.3E-06	1	1.0E+01	4.9E-06			
	Styrene	3							28	7.2E-03	6.2E-06
	4,4'DDE	2	8	3.8E-02	6.1E-06	6	1.0E+01	4.9E-06			
	Styrene	1							29	7.1E-03	6.1E-06
	Styrene	2							29	7.1E-03	6.1E-06
	Benzene	3							27	7.3E-03	6.0E-06
	Benzene	2							28	7.2E-03	5.9E-06

Table E1 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest carcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest carcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest carcinogen screening indices
Organic	Methyl chloride	3				2	1.0E-02	**1.9E-10**	28	1.4E-02	**5.3E-06**
	Methyl chloride	1							29	1.4E-02	**5.3E-06**
	Methyl chloride	2							29	1.4E-02	**5.3E-06**
	N-Nitrosodiphenylamine	3	16	2.0E+00	**4.6E-06**	16	1.9E+01	**1.4E-07**			
	N-Nitrosodiphenylamine	1	12	2.0E+00	**4.5E-06**	2	7.9E+01	**5.5E-07**			
	N-Nitrosodiphenylamine	2	8	1.9E+00	**4.4E-06**	10	2.0E+01	**1.4E-07**			
	Isophorone	3	16	2.0E+00	**3.8E-06**	16	1.1E+01	**6.2E-08**			
	Isophorone	1	12	2.0E+00	**3.8E-06**	2	1.0E+01	**5.9E-08**			
	Isophorone	2	8	1.9E+00	**3.7E-06**	10	1.0E+01	**5.9E-08**			
	Bromoform	3				2	1.0E-02	**1.1E-10**	28	7.2E-03	**1.6E-06**
	Bromoform	1							29	7.1E-03	**1.6E-06**
	Bromoform	2							29	7.1E-03	**1.6E-06**
	Acrylonitrile	3				2	1.2E+00	**9.1E-07**			
	Aniline	1				2	1.0E+01	**8.1E-08**			
	Aniline	2				6	1.0E+01	**8.1E-08**			
	Aniline	3				11	1.0E+01	**8.1E-08**			
	Tetrachloroethylene	3				7	1.7E-02	**1.3E-09**			
	Trichloroethylene	3				2	1.0E-02	**1.6E-10**			
				(Bq/kg wet)			(Bq/kg dry)			(Bq/L)	
Radionuclide	H-3	3				4	8.1E+02	**1.3E-09**			

*Contaminants are ranked in descending order by sum of screening indices

Table E2. Results of conservative screening of noncarcinogens where no concentrations were above detection limits (Concentrations are the upper 95% confidence bound of the arithmetic mean of the detection limits)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Inorganic	Antimony	1	104	5.0E-01	1.2E+00				3	5.0E-02	3.6E+00
	Antimony	2	45	5.0E-01	1.2E+00				3	5.0E-02	3.6E+00
	Antimony	3	109	5.0E-01	1.2E+00				3	5.0E-02	3.6E+00
	Arsenic	1	104	5.0E-01	4.6E-01				33	5.2E-02	1.5E+00
	Selenium	1							4	7.5E-02	7.1E-01
	Selenium	2							3	5.0E-02	4.8E-01
	Arsenic	2	45	5.0E-01	4.6E-01						
	Arsenic	3	109	5.0E-01	4.6E-01						
	Molybdenum	1							3	4.0E-02	2.9E-01
	Molybdenum	2							3	4.0E-02	2.9E-01
	Molybdenum	3							3	4.0E-02	2.9E-01
	Cadmium	1							33	2.6E-03	1.5E-01
	Cadmium	3							33	2.6E-03	1.5E-01
	Thallium	3				2	5.0E+00	1.0E-01			
	Chromium	1	104	5.0E-01	9.3E-02						
	Chromium	2	45	5.0E-01	9.3E-02						
	Chromium	3	109	5.0E-01	9.3E-02						
	Silver	2	45	2.0E-01	6.2E-02				33	5.1E-03	4.9E-02
	Silver	1	104	2.0E-01	6.2E-02				33	5.0E-03	4.8E-02
	Silver	3	109	2.0E-01	6.2E-02				33	5.0E-03	4.8E-02
	Boron	1							3	8.0E-02	2.5E-02
	Boron	2							4	8.0E-02	2.5E-02
	Boron	3							3	8.0E-02	2.5E-02
	Nickel	1	104	5.0E-01	2.3E-02						
	Nickel	2	45	5.0E-01	2.3E-02						
	Nickel	3	109	5.0E-01	2.3E-02						
	Beryllium	2	45	1.0E-01	1.9E-02				3	3.8E-04	2.2E-03
	Beryllium	1	104	1.0E-01	1.9E-02				3	3.8E-04	2.2E-03
	Beryllium	3	109	1.0E-01	1.9E-02				3	3.8E-04	2.2E-03
	Vanadium	1							3	2.0E-03	8.2E-03
	Vanadium	3							3	2.0E-03	8.2E-03
	Tin	1							3	5.0E-02	2.4E-03
	Tin	2							3	5.0E-02	2.4E-03
	Tin	3							3	5.0E-02	2.4E-03
	Cyanide	3				2	2.6E+00	1.8E-04			

Table E2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	4,6-Dinitro-ortho-cresol	3	16	9.9E+00	9.2E+01	16	3.1E+01	4.5E-01			
	4,6-Dinitro-ortho-cresol	1	12	9.8E+00	9.1E+01	3	7.3E+01	1.0E+00			
	4,6-Dinitro-ortho-cresol	2	8	9.5E+00	8.8E+01	10	4.3E+01	6.2E-01			
	Nitrobenzene	3	16	2.0E+00	3.7E+00	16	1.1E+01	3.0E-02			
	Nitrobenzene	1	12	2.0E+00	3.6E+00	2	1.0E+01	2.9E-02			
	Nitrobenzene	2	8	1.9E+00	3.5E+00	10	1.0E+01	2.9E-02			
	Heptachlor epoxide	3	16	4.0E-02	2.8E+00	13	1.1E+01	1.2E+00			
	Heptachlor epoxide	1	12	3.9E-02	2.6E+00	1	1.0E+01	1.1E+00			
	Heptachlor epoxide	2	8	3.8E-02	2.7E+00	6	1.0E+01	1.1E+00			
	Hexachlorobenzene	3	16	2.0E+00	2.3E+00	16	1.1E+01	1.9E-02			
	Hexachlorobenzene	1	12	2.0E+00	2.3E+00	2	1.0E+01	1.8E-02			
	Hexachlorobenzene	2	8	1.9E+00	2.2E+00	10	1.0E+01	1.8E-02			
	Hexachloroethane	3	16	2.0E+00	1.8E+00	16	1.1E+01	1.5E-02			
	Hexachloroethane	1	12	2.0E+00	1.8E+00	2	1.0E+01	1.4E-02			
	Hexachloroethane	2	8	1.9E+00	1.8E+00	10	1.0E+01	1.4E-02			
	Endosulfan II	3	16	7.9E-02	1.5E+00	13	1.1E+01	3.0E-01			
	Endosulfan II	1	12	7.9E-02	1.5E+00	1	1.0E+01	2.9E-01			
	Endosulfan II	2	8	7.6E-02	1.4E+00	6	1.0E+01	2.9E-01			
	1,2,4-Trichlorobenzene	3	16	2.0E+00	1.4E+00	16	1.1E+01	1.1E-02			
	1,2,4-Trichlorobenzene	1	12	2.0E+00	1.4E+00	2	1.0E+01	1.1E-02			
	1,2,4-Trichlorobenzene	2	8	1.9E+00	1.3E+00	10	1.0E+01	1.1E-02			
	Aldrin	3	16	4.0E-02	1.2E+00	13	1.1E+01	5.1E-01			
	Aldrin	1	12	3.9E-02	1.2E+00	2	1.0E+01	4.8E-01			
	Aldrin	2	8	3.8E-02	1.2E+00	6	1.0E+01	4.8E-01			
	Hexachlorobutadiene	3	16	2.0E+00	9.2E-01	15	1.1E+01	7.5E-03			
	Hexachlorobutadiene	1	12	2.0E+00	9.1E-01	2	1.0E+01	7.1E-03			
	Hexachlorobutadiene	2	8	1.9E+00	8.8E-01	10	1.0E+01	7.1E-03			
	Dieldrin	3	16	4.0E-02	7.4E-01	13	1.1E+01	3.0E-01			
	Endosulfan I	3	16	4.0E-02	7.4E-01	13	1.1E+01	3.0E-01			
	Dieldrin	1	12	3.9E-02	7.3E-01	1	1.0E+01	2.9E-01			
	Endosulfan I	1	12	3.9E-02	7.3E-01	1	1.0E+01	2.9E-01			
	Dieldrin	2	8	3.8E-02	7.1E-01	6	1.0E+01	2.9E-01			
	Endosulfan I	2	8	3.8E-02	7.1E-01	6	1.0E+01	2.9E-01			
	Cis-1,3-dichloropropene	3							28	7.2E-03	6.8E-01
	Trans-1,3-dichloropropene	3							28	7.2E-03	6.8E-01
	Cis-1,3-dichloropropene	1							29	7.1E-03	6.8E-01
	Cis-1,3-dichloropropene	2							29	7.1E-03	6.8E-01

Table E2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	Trans-1,3-dichloropropene	1							29	7.1E-03	6.8E-01
	Trans-1,3-dichloropropene	2							29	7.1E-03	6.8E-01
	2,4-Dichlorophenol	3	16	2.0E+00	6.1E-01	16	1.1E+01	5.0E-03			
	Endrin	3	16	2.0E-01	6.1E-01	13	1.1E+01	5.1E-02			
	2,4-Dichlorophenol	1	12	2.0E+00	6.1E-01	3	1.0E+01	4.8E-03			
	Endrin	1	12	2.0E-01	6.1E-01	1	1.0E+01	4.8E-02			
	2,4-Dichlorophenol	2	8	1.9E+00	5.9E-01	10	1.0E+01	4.8E-03			
	Endrin	2	8	1.9E-01	5.9E-01	6	1.0E+01	4.8E-02			
	4-Chloroaniline	3	16	2.0E+00	4.6E-01	14	1.0E+01	3.6E-03			
	4-Chloroaniline	1	12	2.0E+00	4.6E-01	2	1.0E+01	3.6E-03			
	4-Chloroaniline	2	8	1.9E+00	4.4E-01	10	1.0E+01	3.6E-03			
	2-Chlorophenol	3	16	2.0E+00	3.7E-01	16	1.1E+01	3.0E-03			
	2-Chlorophenol	1	12	2.0E+00	3.6E-01	3	1.0E+01	2.9E-03			
	2-Chlorophenol	2	8	1.9E+00	3.5E-01	10	1.0E+01	2.9E-03			
	Pentachlorophenol	3	16	9.9E+00	3.1E-01	16	5.3E+01	2.5E-03			
	Pentachlorophenol	1	12	9.8E+00	3.0E-01	2	5.0E+01	2.4E-03			
	Pentachlorophenol	2	8	9.5E+00	2.9E-01	10	5.0E+01	2.4E-03			
	Methyl bromide	3				2	1.0E-02	1.0E-05	28	1.4E-02	2.9E-01
	Carbon tetrachloride	3				2	1.0E-02	2.0E-05	28	7.2E-03	2.9E-01
	Methyl bromide	1							29	1.4E-02	2.9E-01
	Methyl bromide	2							29	1.4E-02	2.9E-01
	Carbon tetrachloride	1							29	7.1E-03	2.9E-01
	Carbon tetrachloride	2							29	7.1E-03	2.9E-01
	2,4-Dimethylphenol	3	32	6.2E+00	2.9E-01	32	3.4E+01	2.5E-03			
	2,4-Dimethylphenol	1	24	6.0E+00	2.8E-01	6	5.3E+01	3.8E-03			
	Hexachlorocyclopentadiene	3	16	2.0E+00	2.6E-01	16	1.1E+01	2.1E-03			
	Hexachlorocyclopentadiene	1	12	2.0E+00	2.6E-01	2	1.0E+01	2.0E-03			
	2,4-Dimethylphenol	2	16	5.5E+00	2.5E-01	20	4.0E+01	2.8E-03			
	Hexachlorocyclopentadiene	2	8	1.9E+00	2.5E-01	10	1.0E+01	2.0E-03			
	Chlordane	3				13	1.0E+01	2.5E-01			
	Chlordane	1				2	1.0E+01	2.4E-01			
	Chlordane	2				6	1.0E+01	2.4E-01			
	4,4'DDT	3	16	7.9E-02	1.5E-01	13	1.1E+01	3.0E-02			
	4,4'DDT	1	12	7.9E-02	1.5E-01	1	1.0E+01	2.9E-02			
	4,4'DDT	2	8	7.6E-02	1.4E-01	6	1.0E+01	2.9E-02			
	Bis(2-ethylhexyl)phthalate	3	16	2.0E+00	9.2E-02	16	1.1E+01	7.5E-04			
	Di-n-octyl phthalate	3	16	2.0E+00	9.2E-02	16	1.1E+01	7.5E-04			

Table E2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	2,4,5-Trichlorophenol	3	16	9.9E+00	9.2E-02	9	3.9E+01	5.5E-04			
	2,4,5-Trichlorophenol	1	12	9.8E+00	9.1E-02	2	2.8E+02	4.1E-03			
	Bis(2-ethylhexyl)phthalate	1	12	2.0E+00	9.1E-02	2	1.0E+01	7.1E-04			
	Di-n-octyl phthalate	1	12	2.0E+00	9.1E-02	2	1.0E+01	7.1E-04			
	2,4,5-Trichlorophenol	2	8	9.5E+00	8.8E-02	10	4.1E+01	5.8E-04			
	Bis(2-ethylhexyl)phthalate	2	8	1.9E+00	8.8E-02	10	1.0E+01	7.1E-04			
	Di-n-octyl phthalate	2	8	1.9E+00	8.8E-02	10	1.0E+01	7.1E-04			
	Heptachlor	3	16	4.0E-02	7.4E-02	13	1.1E+01	3.0E-02			
	Heptachlor	1	12	3.9E-02	7.3E-02	1	1.0E+01	2.9E-02			
	Heptachlor	2	8	3.8E-02	7.1E-02	6	1.0E+01	2.9E-02			
	Gamma-BHC (Lindane)	3	16	2.0E-02	6.1E-02	13	1.1E+01	5.1E-02			
	Gamma-BHC (Lindane)	1	12	2.0E-02	5.1E-02	2	1.0E+01	4.8E-02			
	Gamma-BHC (Lindane)	2	8	1.9E-02	5.9E-02	6	1.0E+01	4.8E-02			
	1,1,2-Trichloroethane	3				2	1.0E-02	3.6E-06	28	7.2E-03	5.1E-02
	1,1,2-Trichloroethane	1							29	7.1E-03	5.1E-02
	1,1,2-Trichloroethane	2							29	7.1E-03	5.1E-02
	Fluorene	3	16	2.0E+00	4.6E-02	16	1.1E+01	3.8E-04			
	Fluorene	1	12	2.0E+00	4.5E-02	2	1.0E+01	3.6E-04			
	Fluorene	2	8	1.9E+00	4.4E-02	10	1.0E+01	3.6E-04			
	4-Methylphenol	3	16	2.0E+00	3.7E-02	14	1.0E+01	2.9E-04			
	Methoxychlor	3	16	2.0E-01	3.7E-02						
	4-Methylphenol	1	12	2.0E+00	3.6E-02	3	1.0E+01	2.9E-04			
	Methoxychlor	1	12	2.0E-01	3.6E-02						
	4-Methylphenol	2	8	1.9E+00	3.5E-02	10	1.0E+01	2.9E-04			
	Methoxychlor	2	8	1.9E-01	3.5E-02						
	Naphthalene	3	16	1.2E-01	2.8E-02	16	1.1E+01	3.8E-03			
	Naphthalene	1	12	1.2E-01	2.7E-02	2	1.0E+01	3.6E-03			
	Naphthalene	2	8	1.1E-01	2.6E-02	10	1.0E+01	3.6E-03			
	Benzidine	3				14	5.3E+01	2.5E-02			
	Benzidine	1				2	5.0E+01	2.4E-02			
	Benzidine	2				6	5.0E+01	2.4E-02			
	1,1-Dichloroethylene	3				2	1.0E-02	1.6E-06	27	7.3E-03	2.3E-02
	2-Chloronaphthalene	3	16	2.0E+00	2.3E-02	16	1.1E+01	1.9E-04			
	1,1-Dichloroethylene	1							28	7.2E-03	2.3E-02
	1,1-Dichloroethylene	2							28	7.2E-03	2.3E-02
	2-Chloronaphthalene	1	12	2.0E+00	2.3E-02	2	1.0E+01	1.8E-04			
	2-Chloronaphthalene	2	8	1.9E+00	2.2E-02	10	1.0E+01	1.8E-04			

Table E2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	1,2-Dichloroethene (total)	3							28	7.2E-03	2.1E-02
	1,2-Dichlorobenzene	3	16	2.0E+00	2.0E-02	16	1.1E+01	1.7E-04			
	Tetrachloroethylene	2							29	7.1E-03	2.0E-02
	1,2-Dichloroethene (total)	1							29	7.1E-03	2.0E-02
	1,2-Dichlorobenzene	1	12	2.0E+00	2.0E-02	2	1.0E+01	1.6E-04			
	1,2-Dichlorobenzene	2	8	1.9E+00	2.0E-02	10	1.0E+01	1.6E-04			
	Di-n-butyl phthalate	3	16	2.0E+00	1.8E-02						
	Di-n-butyl phthalate	1	12	2.0E+00	1.8E-02	2	1.0E+01	1.4E-04			
	Di-n-butyl phthalate	2	8	1.9E+00	1.8E-02						
	Chlorobenzene	3				2	1.0E-02	7.1E-07	27	7.3E-03	1.0E-02
	Bromoform	3				2	1.0E-02	7.1E-07	28	7.2E-03	1.0E-02
	Chlorobenzene	1							28	7.2E-03	1.0E-02
	Chlorobenzene	2							28	7.2E-03	1.0E-02
	Chlorodibromomethane	3				2	1.0E-02	7.1E-07	28	7.2E-03	1.0E-02
	Dichlorobromomethane	3				2	1.0E-02	7.1E-07	28	7.2E-03	1.0E-02
	Bromoform	1							29	7.1E-03	1.0E-02
	Bromoform	2							29	7.1E-03	1.0E-02
	Chlorodibromomethane	1							29	7.1E-03	1.0E-02
	Chlorodibromomethane	2							29	7.1E-03	1.0E-02
	Dichlorobromomethane	2							29	7.1E-03	1.0E-02
	Butylbenzylphthalate	3	16	2.0E+00	9.2E-03	16	1.1E+01	7.5E-05			
	Isophorone	3	16	2.0E+00	9.2E-03	16	1.1E+01	7.5E-05			
	Butylbenzylphthalate	1	12	2.0E+00	9.1E-03	2	1.0E+01	7.1E-05			
	Isophorone	1	12	2.0E+00	9.1E-03	2	1.0E+01	7.1E-05			
	Butylbenzylphthalate	2	8	1.9E+00	8.8E-03	10	1.0E+01	7.1E-05			
	Isophorone	2	8	1.9E+00	8.8E-03	10	1.0E+01	7.1E-05			
	4-Methyl-2-pentanone	1							29	1.4E-02	8.1E-03
	4-Methyl-2-pentanone	2							29	1.4E-02	8.1E-03
	Benzyl alcohol	3	16	2.0E+00	6.1E-03	14	1.0E+01	4.8E-05			
	Benzyl alcohol	1	12	2.0E+00	6.1E-03	3	1.0E+01	4.8E-05			
	Benzyl alcohol	2	8	1.9E+00	5.9E-03	10	1.0E+01	4.8E-05			
	Fluoranthene	3	16	2.0E-01	4.6E-03	16	1.1E+01	3.8E-04			
	Fluoranthene	1	12	2.0E-01	4.6E-03	2	1.0E+01	3.6E-04			
	Fluoranthene	2	8	1.9E-01	4.4E-03	10	1.0E+01	3.6E-04			
	Phenol	3	16	2.0E+00	3.1E-03	16	1.1E+01	2.5E-05			
	Phenol	1	12	2.0E+00	3.0E-03	2	1.0E+01	2.4E-05			
	Phenol	2	8	1.9E+00	2.9E-03	10	1.0E+01	2.4E-05			
	Benzoic acid	3	16	9.9E+00	2.3E-03	14	5.0E+01	1.8E-05			

Table E2 (continued)

Contaminant type	Contaminant name*	Reach no.	No. fish samples	Fish conc (mg/kg) wet wt	Fish ingest noncarcinogen screening indices	No. sediment samples	Sediment conc (mg/kg) dry wt	Sed ingest noncarcinogen screening indices	No. water samples	Water conc (mg/L)	Water ingest noncarcinogen screening indices
Organic	Diethyl phthalate	3	16	2.0E+00	2.3E-03	16	1.0E+01	1.8E-05			
	1,1,1-Trichloroethane	3				2	1.0E-02	1.6E-07	28	7.2E-03	2.3E-03
	Benzoic acid	1	12	9.8E+00	2.3E-03	3	5.0E+01	1.8E-05			
	Diethyl phthalate	1	12	2.0E+00	2.3E-03	2	1.0E+01	1.8E-05			
	1,1,1-Trichloroethane	1							29	7.1E-03	2.3E-03
	1,1,1-Trichloroethane	2							29	7.1E-03	2.3E-03
	Benzoic acid	2	8	9.5E+00	2.2E-03	10	5.0E+01	1.8E-05			
	Diethyl phthalate	2	8	1.9E+00	2.2E-03	10	1.0E+01	1.8E-05			
	Ethylbenzene	3				2	1.0E-02	1.4E-07	28	7.2E-03	2.1E-03
	1,1-Dichloroethane	3				2	1.0E-02	1.4E-07	28	7.2E-03	2.1E-03
	Ethylbenzene	2							29	7.1E-03	2.0E-03
	1,1-Dichloroethane	1							29	7.1E-03	2.0E-03
	Dimethyl phthalate	3	16	2.0E+00	1.8E-03	16	1.1E+01	1.5E-05			
	Dimethyl phthalate	1	12	2.0E+00	1.8E-03	2	1.0E+01	1.4E-05			
	Dimethyl phthalate	2	8	1.9E+00	1.8E-03	10	1.0E+01	1.4E-05			
	Pyrene	2	8	3.8E-02	1.2E-03	10	1.0E+01	4.8E-04			
	Styrene	3							28	7.2E-03	1.0E-03
	Styrene	1							29	7.1E-03	1.0E-03
	Styrene	2							29	7.1E-03	1.0E-03
	2,4-Dinitrophenol	3				2	1.2E+00	8.5E-04			
	Pyrene	1	12	2.7E-02	8.3E-04	2	1.0E+01	4.8E-04			
	Pyrene	3	16	2.1E-02	6.5E-04	16	1.1E+01	5.0E-04			
	Acenaphthene	3	16	3.0E-02	4.6E-04	16	1.1E+01	2.5E-04			
	Acenaphthene	1	12	2.9E-02	4.6E-04	3	1.0E+01	2.4E-04			
	Acenaphthene	2	8	2.8E-02	4.4E-04	10	1.0E+01	2.4E-04			
	Vinyl acetate	3							28	1.4E-02	4.1E-04
	Vinyl acetate	1							29	1.4E-02	4.1E-04
	Vinyl acetate	2							29	1.4E-02	4.1E-04
	Bis(2-chloroisopropyl)ether	3				16	1.1E+01	3.8E-04			
	Bis(2-chloroisopropyl)ether	1				2	1.0E+01	3.6E-04			
	Bis(2-chloroisopropyl)ether	2				10	1.0E+01	3.6E-04			
	Anthracene	3	16	9.9E-02	3.1E-04	16	1.1E+01	5.0E-05			
	Anthracene	1	12	9.8E-02	3.0E-04	3	1.0E+01	4.8E-05			
	Anthracene	2	8	9.5E-02	2.9E-04	10	1.0E+01	4.8E-05			
	Tetrachloroethylene	3				7	1.7E-02	2.5E-06			
	Trans-1,2-dichloroethene	3				7	9.1E-03	6.5E-07			
	Dichlorodifluoromethane	3				2	1.0E-02	7.1E-08			
	Trichlorofluoromethane	3				2	1.0E-02	4.8E-08			

*Contaminants are ranked in descending order by sum of screening indices

APPENDIX F

NONCONSERVATIVE AND CONSERVATIVE SCREENING OF DETECTABLE CARCINOGENS AND NONCARCINOGENS IN GROUNDWATER

Table F1. Results of nonconservative screening of groundwater for carcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/L)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
1	Groundwater	Inorganic	Beryllium	7440-41-7	2/19	9.1E-04	4.3E+00	2.6E-06	1E-05
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
1	Groundwater	Radionuclide	H-3	10028-17-8	7/9	1.8E+02	1.5E-12	3.7E+05	6E-07
			Sr-90	10098-97-2	9/17	6.0E-02	8.9E-10	1.3E+02	1E-07
			Co-60	10198-40-0	2/17	2.9E-02	4.1E-10	6.1E+01	3E-08
			Cs-137	10045-97-3	3/17	1.4E-02	7.6E-10	2.8E+01	2E-08
1	Groundwater	Radionuclide	Total						7E-07
1	**Groundwater**	**All**	**Reach total**						**1E-05**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
2	Groundwater	Inorganic	Beryllium	7440-41-7	1/15	6.4E-04	4.3E+00	1.8E-06	8E-06
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
2	Groundwater	Radionuclide	H-3	10028-17-8	6/6	3.9E+03	1.5E-12	8.1E+06	1E-05
			Sr-90	10098-97-2	12/15	2.7E-01	8.9E-10	5.7E+02	5E-07
			Cs-137	10045-97-3	3/15	1.5E-02	7.6E-10	3.2E+01	2E-08
2	Groundwater	Radionuclide	Total						1E-05
2	**Groundwater**	**All**	**Reach total**						**2E-05**

Table F1 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean (mg/L)	Cancer slope factor 1/(mg/kg/d)	Daily intake (mg/kg/d)	Carcinogen screening indices
3	Groundwater	Inorganic	Arsenic	7440-38-2	2/74	1.2E-02	1.8E+00	3.4E-05	6E-05
			Beryllium	7440-41-7	2/36	7.7E-04	4.3E+00	2.2E-06	9E-06
3	Groundwater	Inorganic	Total						7E-05
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
3	Groundwater	Radionuclide	Ra-224	13233-32-4	1/4	7.0E+00	1.3E-09	1.5E+04	2E-05
			Th-234	15065-10-8	1/1	6.9E+01	1.1E-10	1.5E+05	2E-05
			U-234	13966-29-5	3/4	1.8E+00	3.8E-09	3.7E+03	1E-05
			Am-241	14596-10-2	1/4	4.6E-01	8.4E-09	9.7E+02	8E-06
			U-238	7440-61-1	1/4	4.1E-01	3.5E-09	8.7E+02	3E-06
			Ra-226	13982-63-3	1/4	4.1E-01	3.2E-09	8.6E+02	3E-06
			Th-230	14269-63-7	3/5	9.0E-01	6.5E-10	1.9E+03	1E-06
			H-3	10028-17-8	23/28	1.5E+02	1.5E-12	3.1E+05	5E-07
			Th-228	14274-82-9	1/5	4.6E-01	4.1E-10	9.7E+02	4E-07
			Sr-90	10098-97-2	26/49	4.6E-02	8.9E-10	9.7E+01	9E-08
			Co-60	10198-40-0	19/46	3.3E-02	4.1E-10	7.0E+01	3E-08
			Cs-137	10045-97-3	16/49	1.3E-02	7.6E-10	2.7E+01	2E-08
			Tc-99	14133-76-7	6/12	1.1E-01	3.5E-11	2.3E+02	8E-09
3	Groundwater	Radionuclide	Total						7E-05
3	**Groundwater**	**All**	**Reach total**						**1E-04**

Table F2. Results of nonconservative screening of groundwater for noncarcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean of conc (mg/L)	Reference dose factor (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
1	Groundwater	Inorganic	Antimony	7440-36-0	2/20	8.0E-02	4.0E-04	2.3E-04	5.7E-01
			Cadmium	7440-43-9	3/19	3.6E-03	5.0E-04	1.0E-05	2.1E-02
			Barium	7440-39-3	11/19	4.6E-01	7.0E-02	1.3E-03	1.9E-02
			Chromium	7440-47-3	6/19	3.2E-02	5.0E-03	9.2E-05	1.8E-02
			Silver	7440-22-4	2/19	1.5E-02	3.0E-03	4.2E-05	1.4E-02
			Boron	7440-42-8	4/18	1.2E-01	9.0E-02	3.3E-04	3.7E-03
			Nickel	7440-02-0	6/19	1.6E-02	2.0E-02	4.5E-05	2.3E-03
			Vanadium	7440-62-2	5/19	5.5E-03	7.0E-03	1.6E-05	2.3E-03
			Mercury	7439-97-6	1/11	1.1E-04	3.0E-04	3.0E-07	1.0E-03
			Copper	7440-50-8	1/19	1.2E-02	3.7E-02	3.5E-05	9.5E-04
			Beryllium	7440-41-7	2/19	9.1E-04	5.0E-03	2.6E-06	5.2E-04
			Zinc	7440-66-6	2/19	1.1E-02	2.0E-01	3.0E-05	1.5E-04
1	Groundwater	Inorganic	Total						6.5E-01
1	**Groundwater**	**All**	**Reach total**						**6.5E-01**
2	Groundwater	Inorganic	Barium	7440-39-3	6/39	7.9E-01	7.0E-02	2.3E-03	3.2E-02
			Chromium	7440-47-3	2/39	2.3E-02	5.0E-03	6.4E-05	1.3E-02
			Boron	7440-42-8	4/11	1.1E-01	9.0E-02	3.2E-04	3.6E-03
			Nickel	7440-02-0	6/15	1.8E-02	2.0E-02	5.1E-05	2.5E-03
			Vanadium	7440-62-2	1/15	4.2E-03	7.0E-03	1.2E-05	1.7E-03
			Copper	7440-50-8	2/15	1.3E-02	3.7E-02	3.7E-05	1.0E-03
			Beryllium	7440-41-7	1/15	6.4E-04	5.0E-03	1.8E-06	3.7E-04
			Zinc	7440-66-6	3/15	1.1E-02	2.0E-01	3.2E-05	1.6E-04
2	Groundwater	Inorganic	Total						5.4E-02
2	**Groundwater**	**All**	**Reach total**						**5.4E-02**

Table F2 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	Geometric mean of conc (mg/L)	Reference dose factor (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Groundwater	Inorganic	Arsenic	7440-38-2	2/74	1.2E-02	1.0E-03	3.4E-05	3.4E-02
			Barium	7440-39-3	24/74	5.1E-01	7.0E-02	1.4E-03	2.1E-02
			Cadmium	7440-43-9	1/74	2.7E-03	5.0E-04	7.7E-06	1.5E-02
			Chromium	7440-47-3	7/74	2.2E-02	5.0E-03	6.3E-05	1.3E-02
			Silver	7440-22-4	4/74	7.7E-03	3.0E-03	2.2E-05	7.3E-03
			Nickel	7440-02-0	13/36	2.8E-02	2.0E-02	8.1E-05	4.1E-03
			Boron	7440-42-8	3/13	9.8E-02	9.0E-02	2.8E-04	3.1E-03
			Vanadium	7440-62-2	3/36	6.6E-03	7.0E-03	1.9E-05	2.7E-03
			Copper	7440-50-8	11/36	1.3E-02	3.7E-02	3.8E-05	1.0E-03
			Beryllium	7440-41-7	2/36	7.7E-04	5.0E-03	2.2E-06	4.4E-04
			Zinc	7440-66-6	17/36	2.0E-02	2.0E-01	5.8E-05	2.9E-04
3	Groundwater	Inorganic	Total						1.0E-01
3	Groundwater	Organic	Methyl ethyl ketone	78-93-3	2/3	1.0E-02	5.0E-02	2.9E-05	5.7E-04
			Acetone	67-64-1	4/5	1.3E-02	1.0E-01	3.6E-05	3.6E-04
			Carbon disulfide	75-15-0	2/5	5.9E-03	1.0E-01	1.7E-05	1.7E-04
3	Groundwater	Organic	Total						1.1E-03
3	**Groundwater**	**All**	**Reach total**						**1.0E-01**

Table F3. Results of conservative screening of groundwater for carcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean	Cancer slope factor	Daily intake	Carcinogen screening indices
1	Groundwater	Inorganic	Beryllium	7440-41-7	2/19	6.1E-03	4.3E+00	1.7E-04	8E-04
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
1	Groundwater	Radionuclide	Sr-90	10098-97-2	9/17	3.0E+01	8.9E-10	6.3E+05	6E-04
			H-3	10028-17-8	7/9	6.1E+03	1.5E-12	1.3E+08	2E-04
			Cs-137	10045-97-3	3/17	2.5E-01	7.6E-10	5.2E+03	4E-06
			Co-60	10198-40-0	2/17	3.7E-01	4.1E-10	7.8E+03	3E-06
1	Groundwater	Radionuclide	Total						8E-04
1	**Groundwater**	**All**	**Reach total**						**2E-03**
						(mg/L)	1/(mg/kg/d)	(mg/kg/d)	
2	Groundwater	Inorganic	Beryllium	7440-41-7	1/15	1.5E-03	4.3E+00	4.2E-05	2E-04
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
2	Groundwater	Radionuclide	H-3	10028-17-8	6/6	1.5E+05	1.5E-12	3.2E+09	5E-03
			Sr-90	10098-97-2	12/15	5.9E+00	8.9E-10	1.2E+05	1E-04
			Cs-137	10045-97-3	3/15	2.9E-01	7.6E-10	6.2E+03	5E-06
2	Groundwater	Radionuclide	Total						5E-03
2	**Groundwater**	**All**	**Reach total**						**5E-03**

Table F3 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean	Cancer slope factor	Daily intake	Carcinogen screening indices
3	Groundwater	Inorganic	Arsenic	7440-38-2	2/74	3.3E-02	1.8E+00	9.4E-04	2E-03
			Beryllium	7440-41-7	2/36	1.4E-03	4.3E+00	4.1E-05	2E-04
3	Groundwater	Inorganic	Total						2E-03
						(Bq/L)	(1/Bq)	(Bq/lifetime)	
3	Groundwater	Radionuclide	H-3	10028-17-8	23/28	4.3E+04	1.5E-12	9.1E+08	1E-03
			U-234	13966-29-5	3/4	8.3E+00	3.8E-09	1.7E+05	7E-04
			Co-60	10198-40-0	19/46	4.7E+01	4.1E-10	9.8E+05	4E-04
			Ra-224	13233-32-4	1/4	1.0E+01	1.3E-09	2.2E+05	3E-04
			Am-241	14596-10-2	1/4	9.1E-01	8.4E-09	1.9E+04	2E-04
			Th-234	15065-10-8	1/1	6.9E+01	1.1E-10	1.5E+06	2E-04
			Tc-99	14133-76-7	6/12	1.1E+02	3.5E-11	2.3E+06	8E-05
			Th-230	14269-63-7	3/5	4.0E+00	6.5E-10	8.5E+04	6E-05
			U-238	7440-61-1	1/4	5.9E-01	3.5E-09	1.2E+04	4E-05
			Ra-226	13982-63-3	1/4	5.8E-01	3.2E-09	1.2E+04	4E-05
			Sr-90	10098-97-2	26/49	1.8E+00	8.9E-10	3.7E+04	3E-05
			Cs-137	10045-97-3	16/49	1.9E+00	7.6E-10	3.9E+04	3E-05
			Th-228	14274-82-9	1/5	7.5E-01	4.1E-10	1.6E+04	6E-06
3	Groundwater	Radionuclide	Total						3E-03
3	**Groundwater**	**All**	**Reach total**						**5E-03**

Table F4. Results of conservative screening of groundwater for noncarcinogens where at least one value was above detection limits

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/L)	Reference dose factor (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
1	Groundwater	Inorganic	Antimony	7440-36-0	2/20	1.4E-01	4.0E-04	4.1E-03	1.0E+01
			Chromium	7440-47-3	6/19	1.3E-01	5.0E-03	3.6E-03	7.2E-01
			Barium	7440-39-3	11/19	9.4E-01	7.0E-02	2.7E-02	3.8E-01
			Silver	7440-22-4	2/19	3.5E-02	3.0E-03	1.0E-03	3.4E-01
			Cadmium	7440-43-9	3/19	5.4E-03	5.0E-04	1.5E-04	3.1E-01
			Vanadium	7440-62-2	5/19	3.4E-02	7.0E-03	9.6E-04	1.4E-01
			Boron	7440-42-8	4/18	3.6E-01	9.0E-02	1.0E-02	1.1E-01
			Nickel	7440-02-0	6/19	7.0E-02	2.0E-02	2.0E-03	1.0E-01
			Beryllium	7440-41-7	2/19	6.1E-03	5.0E-03	1.7E-04	3.5E-02
			Copper	7440-50-8	1/19	3.8E-02	3.7E-02	1.1E-03	2.9E-02
			Mercury	7439-97-6	1/11	1.3E-04	3.0E-04	3.7E-06	1.2E-02
			Zinc	7440-66-6	2/19	5.5E-02	2.0E-01	1.6E-03	7.9E-03
1	Groundwater	Inorganic	Total						1.2E+01
1	**Groundwater**	**All**	**Reach total**						**1.2E+01**
2	Groundwater	Inorganic	Barium	7440-39-3	6/39	9.8E-01	7.0E-02	2.8E-02	4.0E-01
			Chromium	7440-47-3	2/39	2.6E-02	5.0E-03	7.5E-04	1.5E-01
			Boron	7440-42-8	4/11	2.0E-01	9.0E-02	5.8E-03	6.5E-02
			Nickel	7440-02-0	6/15	4.5E-02	2.0E-02	1.3E-03	6.4E-02
			Vanadium	7440-62-2	1/15	1.3E-02	7.0E-03	3.8E-04	5.4E-02
			Copper	7440-50-8	2/15	6.6E-02	3.7E-02	1.9E-03	5.1E-02
			Beryllium	7440-41-7	1/15	1.5E-03	5.0E-03	4.2E-05	8.5E-03
			Zinc	7440-66-6	3/15	4.2E-02	2.0E-01	1.2E-03	6.0E-03
2	Groundwater	Inorganic	Total						8.0E-01
2	**Groundwater**	**All**	**Reach total**						**8.0E-01**

Table F4 (continued)

Reach no.	Media type	Contaminant type	Contaminant name	CAS no.	Ratio of detected to total samples	95% upper conf bound on mean (mg/L)	Reference dose factor (mg/kg/d)	Daily intake (mg/kg/d)	Noncarcinogen screening indices
3	Groundwater	Inorganic	Arsenic	7440-38-2	2/74	3.3E-02	1.0E-03	9.4E-04	9.4E-01
			Barium	7440-39-3	24/74	8.3E-01	7.0E-02	2.4E-02	3.4E-01
			Cadmium	7440-43-9	1/74	3.3E-03	5.0E-04	9.5E-05	1.9E-01
			Chromium	7440-47-3	7/74	3.1E-02	5.0E-03	9.0E-04	1.8E-01
			Silver	7440-22-4	4/74	1.7E-02	3.0E-03	4.9E-04	1.6E-01
			Nickel	7440-02-0	13/36	7.4E-02	2.0E-02	2.1E-03	1.1E-01
			Vanadium	7440-62-2	3/36	1.5E-02	7.0E-03	4.4E-04	6.2E-02
			Boron	7440-42-8	3/13	1.7E-01	9.0E-02	4.9E-03	5.5E-02
			Copper	7440-50-8	11/36	2.9E-02	3.7E-02	8.2E-04	2.2E-02
			Zinc	7440-66-6	17/36	8.3E-02	2.0E-01	2.4E-03	1.2E-02
			Beryllium	7440-41-7	2/36	1.4E-03	5.0E-03	4.1E-05	8.2E-03
3	Groundwater	Inorganic	Total						2.1E+00
3	Groundwater	Organic	Acetone	67-64-1	4/5	2.6E-02	1.0E-01	7.4E-04	7.4E-03
			Methyl ethyl ketone	78-93-3	2/3	1.0E-02	5.0E-02	2.9E-04	5.7E-03
			Carbon disulfide	75-15-0	2/5	9.5E-03	1.0E-01	2.7E-04	2.7E-03
3	Groundwater	Organic	Total						1.6E-02
3	**Groundwater**	**All**	**Reach total**						**2.1E+00**

APPENDIX G

DATA FOR ECOLOGICAL ASSESSMENT

Table G1. Data Used for National Ambient Water Quality Criteria Approximations (all values in µg/l)

Chemical name / Data type	Value	Species	Source
INORGANICS			
Antimony			
Acute values:	9000	*Daphnia magna*	EPA 1980b
	18,800	*Daphnia magna*	*ibid.*
	21,900	Fathead minnow	*ibid.*
Pesticide Acute Value:	220		
Acute-Chronic ratios:	3.481	*Daphnia magna*	Kimball, Manuscript
	13.69	Fathead minnow	*ibid.*
Pesticide A-C ratio:	12.4		
PAV / PACR:	18		
Arsenic V			
Acute values:	<8100	*Daphnia magna*	EPA 1985a
	7400	*Daphnia magna*	*ibid.*
	3600	*Daphnia pulex*	*ibid.*
	49,600	*Daphnia pulex*	*ibid.*
	850	*Bosmina longirostris*	*ibid.*
	10,800	Rainbow trout	*ibid.*
	25,600	Fathead minnow	*ibid.*
	49,000	Mosquitofish	*ibid.*
PAV:	17		
Acute-Chronic ratios:	28.7	Fathead minnow	DeFoe, 1982
PACR:	35.8		
PAV / PACR:	0.47		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
Barium			
Acute values	410,000	*Daphnia magna*	(AQUIRE)
PAV:	4.4		
PACR:	40		
PAV / PACR	0.11		
Beryllium			
Acute values:	7900	*Daphnia magna*	EPA 1980f
	2500	*Daphnia magna*	*ibid.*
	4800	Goldfish	*ibid.*
	3250	Fathead minnow	*ibid.*
	200	Fathead minnow	*ibid.*
	150	Fathead minnow	*ibid.*
	150	Fathead minnow	*ibid.*
	11,000	Fathead minnow	*ibid.*
	20,000	Fathead minnow	*ibid.*
	15,000	Fathead minnow	*ibid.*
	18,000	Fathead minnow	*ibid.*
	4400	Flagfish	*ibid.*
	3530	Flagfish	*ibid.*
	3530	Flagfish	*ibid.*
	32,000	Guppy	*ibid.*
	28,000	Guppy	*ibid.*
	32,000	Guppy	*ibid.*
	24,000	Guppy	*ibid.*
	160	Guppy	*ibid.*
	19,000	Guppy	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
Acute values (cont.):	450	Guppy	*ibid.*
	130	Guppy	*ibid.*
	200	Guppy	*ibid.*
	20,000	Guppy	*ibid.*
	13,700	Guppy	*ibid.*
	6100	Guppy	*ibid.*
	160	Guppy	*ibid.*
	12,000	Bluegill	*ibid.*
	1300	Bluegill	*ibid.*
PAV:	40		
Acute-Chronic ratios:	472	*Daphnia magna*	Kimball, Manuscript
PACR:	91.1		
PAV / PACR:	0.44		
Cobalt			
Acute values:	5990	*Daphnia magna*	Kimball, Manuscript
	3610	Fathead minnow	*ibid.*
	531	Fathead minnow	Lind et al., 1978
PAV:	24		
Acute-Chronic ratios:	1175	*Daphnia magna*	Kimball, Manuscript
	290	Fathead minnow	Kimball, Manuscript
PACR:	83.6		
PAV / PACR:	0.29		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
Fluoride ion			
Acute values:	98,000	*Daphnia magna*	Dave, 1984b
	251,000	*Daphnia magna*	Fieser et al., 1986
	390,247	Stickleback	Smith et al., 1985
	200,000	Rainbow trout	*ibid.*
	245,987	Fathead minnow	*ibid.*
	125,000	Brown trout	(AQUIRE)
PAV:	2700		
Acute-Chronic ratios:	8.33	*Daphnia magna*	Fieser et al., 1986
	22.27	*Daphnia magna*	Dave, 1984
PACR:	19.5		
PAV / PACR:	140		
Magnesium			
Acute values:	64,700	Scud	(AQUIRE)
PAV:	6.5		
PACR:	40		
PAV / PACR:	0.16		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
Manganese			
Acute values:	19,400	*Daphnia magna*	Kimball, Manuscript
	33,800	Fathead minnow	*ibid.*
PAV:	330		
Acute-Chronic ratios	19.10	Fathead minnow	Kimball, Manuscript
PACR:	31.3		
PAV / PACR:	11		
Molybdenum			
Acute values:	206,800	*Daphnia magna*	Kimball, Manuscript
PAV:	2200		
Acute-Chronic ratios:	235	*Daphnia magna*	Kimball, Manuscript
PACR	72.2		
PAV / PACR:	30		
Potassium			
Acute values:	53,200	Scud	(AQUIRE)
PAV:	5.3		
PACR:	40		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
PAV / PACR:	0.13		
Sodium			
Acute values:	1,820,000	*Daphnia magna*	(AQUIRE)
PAV:	19,000		
PACR:	40		
PAV / PACR:	480		
Silver			
Final Acute Value:	4.1		EPA 1980y
Acute-Chronic ratios:	2.0		EPA 1980y
	54		*ibid.*
PACR:	65.1		
FAV / PACR:	0.063		
Thallium			
Acute values:	2180	*Daphnia magna*	EPA 1980bb
	910	*Daphnia magna*	*ibid.*
	1800	Fathead minnow	*ibid.*
	132,000	Bluegill	*ibid.*
	121,000	Bluegill	*ibid.*
PAV:	24		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
INORGANICS (continued)			
Acute-Chronic ratios:	7.0	*Daphnia magna*	Kimball, Manuscript
	31.58	Fathead minnow	*ibid.*
PACR:	10.8		
PAV / PACR:	2.2		
Vanadium			
Acute values:	1520	*Daphnia magna*	Kimball, Manuscript
	1850	Fathead minnow	*ibid.*
	7000	Brook trout	Ernst and Garside, 1986
	11,200	Flagfish	Holdway and Sprague, 1979
	4060	*Daphnia magna*	Beusen and Neven, 1987
PAV:	36		
Acute-Chronic ratios:	10.88	Fathead minnow	Kimball, Manuscript
	140	Flagfish	Holdway and Sprague, 1979
	2.137	*Daphnia magna*	Beusen and Neven, 1987
Final A-C ratio:	14.8		
PAV / FACR:	9.4		
ORGANICS			
Acenapthene			
Acute values:	41,200	*Daphnia magna*	EPA 1980a
	1700	Bluegill	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	29		
Acute-Chronic ratios:	1.472	Fathead minnow	Cairns and Nebeker, 1982
PACR:	13.3		
PAV / PACR:	2.2		
Acetone			
Acute values:	8,300,000	Bluegill	(AQUIRE)
	8,300,000	Bluegill	*ibid.*
	1,300,000	Mosquitofish	*ibid.*
	8,140,000	Fathead minnow	*ibid.*
	7,310,000	Fathead minnow	*ibid.*
	5,540,000	Rainbow trout	*ibid.*
	13,500,000	*Daphnia magna*	*ibid.*
	12,600,000	*Daphnia magna*	*ibid.*
	13,300,000	*Daphnia magna*	*ibid.*
	12,100,000	*Daphnia magna*	*ibid.*
	8,800,000	*Daphnia pulex*	*ibid.*
	7,460,000	*Daphnia cucullata*	*ibid.*
	7,810,000	*Daphnia cucullata*	*ibid.*
PAV:	25,000		
PACR:	40		
PAV / PACR:	640		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Anthracene			
Acute values:	11.92	Sunfish	(AQUIRE)
	2.78	Bluegill	*ibid.*
PAV:	0.00058		
PACR:	40		
PAV / PACR:	0.000014		
Benzene			
Acute values:	203,000	*Daphnia magna*	EPA 1980d
	400,000	*Daphnia magna*	*ibid.*
	620,000	*Daphnia magna*	*ibid.*
	412,000	*Daphnia magna*	*ibid.*
	412,000	*Daphnia magna*	*ibid.*
	356,000	*Daphnia magna*	*ibid.*
	356,000	*Daphnia magna*	*ibid.*
	345,000	*Daphnia pulex*	*ibid.*
	265,000	*Daphnia pulex*	*ibid.*
	5300	Rainbow trout	*ibid.*
	34,420	Goldfish	*ibid.*
	33,470	Fathead minnow	*ibid.*
	32,000	Fathead minnow	*ibid.*
	36,600	Guppy	*ibid.*
	386,000	Mosquitofish	*ibid.*
	22,490	Bluegill	*ibid.*
PAV:	100		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	40		
PAV / PACR:	2.6		
Benzidene			
Acute values:	7400	Rainbow trout	EPA 1980c
	4350	Lake trout	*ibid.*
	2500	Red shiner	*ibid.*
	16,200	Flagfish	*ibid.*
PAV:	1.5		
PACR:	40		
PAV / PACR:	0.037		
Benzo(a)anthracene			
Acute values:	10*	*Daphnia pulex*	(AQUIRE)
PAV:	0.11		
PACR:	40		
PAV / PACR:	0.0027		
Benzo(a)pyrene			
Acute values:	5*	*Daphnia pulex*	(AQUIRE)
PAV:	0.053		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	40		
PAV / PACR:	0.0013		
Benzoic acid			
Acute values:	180,000	Mosquitofish	(AQUIRE)
PAV:	18		
PACR:	40		
PAV / PACR:	0.45		
Benzyl alcohol			
Acute values:	10,000 460,000	Bluegill Fathead minnow	(AQUIRE) *ibid.*
PAV:	1.0		
PACR:	40		
PAV / PACR:	0.025		
BHC (other)			
Acute values:	1000 800	*Daphnia magna* *Daphnia magna*	(AQUIRE) *ibid.*
PAV:	9.5		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	40		
PAV / PACR:	0.24		
Bis(2-ethylhexyl)phthalate			
Acute values:	11,000	*Daphnia magna*	(AQUIRE)
	133	*Daphnia pulex*	*ibid.*
	690	Channel catfish	*ibid.*
	6180	Goldfish	*ibid.*
	42,100	Largemouth bass	*ibid.*
	32,900	Largemouth bass	*ibid.*
	139,500	Rainbow trout	*ibid.*
	149,200	Rainbow trout	*ibid.*
PAV:	2.6		
Acute-Chronic ratios:	38.73	*Daphnia magna*	Knowles et al., 1987**
	17,175	Rainbow trout	Mehrle and Mayer, 1976**
PACR:	299		
PAV / PACR:	0.0087		
2-Butanone			
Acute values:	5,600,000	Mosquitofish	(AQUIRE)
	3,200,000	Fathead minnow	*ibid.*
	5,091,000	*Daphnia magna*	*ibid.*
PAV:	55,000		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	40		
PAV / PACR:	1400		
Carbon disulfide			
Acute values:	2100	*Daphnia magna*	(AQUIRE)
	135,000	Mosquitofish	*ibid.*
PAV:	36		
PACR:	40		
PAV / PACR:	0.91		
Carbon tetrachloride			
Acute values:	35,200	*Daphnia magna*	EPA 1980h
	43,100	Fathead minnow	*ibid.*
	125,000	Bluegill	*ibid.*
	27,300	Bluegill	*ibid.*
PAV:	610		
Acute-Chronic ratios:	0.8273	Fathead minnow	Kimball, Manuscript
PACR:	11.0		
PAV / PACR:	55		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Chlorobenzene			
Acute values:	86,000	*Daphnia magna*	EPA 1980j
	51,620	Goldfish	*ibid.*
	33,930	Fathead minnow	*ibid.*
	29,120	Fathead minnow	*ibid.*
	33,930	Fathead minnow	*ibid.*
	45,530	Guppy	*ibid.*
	24,000	Bluegill	*ibid.*
	15,900	Bluegill	*ibid.*
PAV:	340		
PACR:	40		
PAV / PACR:	8.4		
Chloroform			
Acute values:	28,900	*Daphnia magna*	EPA 1980
	66,800	Rainbow trout	*ibid.*
	43,800	Rainbow trout	*ibid.*
	115,000	Bluegill	*ibid.*
	100,000	Bluegill	*ibid.*
PAV:	570		
PACR:	40		
PAV / PACR:	14		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
p,p'DDD			
Acute values:	2.5	Striped bass	(AQUIRE)
	380	Stonefly	*ibid.*
	380	Stonefly	*ibid.*
	0.60	Scud	*ibid.*
	0.64	Scud	*ibid.*
	0.60	Scud	*ibid.*
	0.86	Scud	*ibid.*
	0.68	Grass shrimp	*ibid.*
	2.4	Grass shrimp	*ibid.*
	10	Aquatic sowbug	*ibid.*
	16	Aquatic sowbug	*ibid.*
	140	Fowler's toad	*ibid.*
	740	Turbellarian	*ibid.*
	70	Rainbow trout	*ibid.*
	4400	Fathead minnow	*ibid.*
	1500	Channel catfish	*ibid.*
	42	Largemouth bass	*ibid.*
	14	Walleye	*ibid.*
	42	Bluegill	*ibid.*
PAV:	0.0016		
PACR:	40		
PAV / PACR:	0.000040		
Decane			
Acute values:	48,000	*Daphnia magna*	(AQUIRE)

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	190		
PACR:	40		
PAV / PACR:	4.8		
Di-n-butyl phthalate			
Acute values:	1200	Bluegill	(AQUIRE)
	731	Bluegill	*ibid.*
	2100	Bluegill	*ibid.*
	760	Bluegill	*ibid.*
	700	Bluegill	*ibid.*
	1300	Fathead minnow	*ibid.*
	1300	Fathead minnow	*ibid.*
	2020	Fathead minnow	*ibid.*
	2910	Channel catfish	*ibid.*
	2910	Channel catfish	*ibid.*
	2900	Channel catfish	*ibid.*
	6470	Rainbow trout	*ibid.*
	6470	Rainbow trout	*ibid.*
	2600	Rainbow trout	*ibid.*
	2100	Scud	*ibid.*
	10,000	Crayfish	*ibid.*
	3700	*Daphnia magna*	*ibid.*
	5200	*Daphnia magna*	*ibid.*
PAV:	32		
Acute-Chronic ratios:	2.817	Fathead minnow	McCarthy and Whitmore,1985
	9.437	*Daphnia magna*	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	10.2		
PAV / PACR:	3.1		
Dibenzofuran			
Acute values:	7500*	*Daphnia magna*	(AQUIRE)
PAV:	80		
PACR:	40		
PAV / PACR:	2.0		
1,1-Dichloroethane			
Acute values:	202,000	Guppy	(AQUIRE)
PAV:	20		
PACR:	40		
PAV / PACR:	0.5		
1,2-Dichloroethane			
Acute values:	270,000	*Daphnia magna*	Richter et al., 1983
	218,000	*Daphnia magna*	EPA 1980k
	118,000	Fathead minnow	*ibid.*
	550,000	Bluegill	*ibid.*
	431,000	Bluegill	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	2000		
Acute-Chronic ratios:	5.9	Fathead minnow	Ahmed et al., 1984
	17.76	*Daphnia magna*	Richter et al., 1983
PACR:	16.1		
PAV / PACR:	130		
1,1-Dichloroethene			
Acute values:	11,600	*Daphnia magna*	EPA 1980n
	79,000	*Daphnia magna*	*ibid.*
	169,000	Fathead minnow	*ibid.*
	108,000	Fathead minnow	*ibid.*
	73,900	Bluegill	*ibid.*
PAV:	520		
PACR:	40		
PAV / PACR:	13		
1,2-Dichloroethene			
Acute values:	135,000	Bluegill	EPA 1980n
PAV:	14		
PACR:	40		
PAV / PACR:	0.34		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
1,3-Dichloropropene (total)			
Acute values:	6150	*Daphnia magna*	EPA 1980o
	6060	Bluegill	*ibid.*
PAV:	100		
PACR:	40		
PAV / PACR:	2.6		
Diethyl phthalate			
Acute values:	120,000*	Bluegill	(AQUIRE)
	52,000*	*Daphnia magna*	*ibid.*
	75,000*	*Daphnia magna*	*ibid.*
PAV:	1100		
PACR:	40		
PAV / PACR:	27		
Ethyl benzene			
Acute values:	75,000	*Daphnia magna*	EPA 1980p
	94,440	Goldfish	*ibid.*
	48,510	Fathead minnow	*ibid.*
	42,330	Fathead minnow	*ibid.*
	97,100	Guppy	*ibid.*
	32,000	Bluegill	*ibid.*
	155,000	Bluegill	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	780		
PACR:	40		
PAV / PACR:	20		
Fluoranthene			
Acute values:	325,000	*Daphnia magna*	EPA 1980q
	3980	Bluegill	*ibid.*
PAV:	69		
PACR:	40		
PAV / PACR:	1.7		
Hexane			
Acute values:	150,000***	Golden orfe	(AQUIRE)
	4,480,000***	Golden orfe	*ibid.*
PAV:	82		
PACR:	40		
PAV / PACR:	2.1		
2-Hexanone			
Acute values:	428,000***	Fathead minnow	(AQUIRE)

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	43		
PACR:	40		
PAV / PACR	1.1		
1-Methylnapthalene			
Acute values:	9000	Fathead minnow	(AQUIRE)
PAV:	0.90		
PACR:	40		
PAV / PACR:	0.023		
4-Methyl-2-pentanone			
Acute values:	509,000	Fathead minnow	(AQUIRE)
PAV:	51		
Acute-Chronic ratios:	608	Fathead minnow	Veith et al., 1983
PACR:	22.2		
PAV / PACR:	2.3		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
2-Methylphenol			
Acute values:	12,550	Fathead minnow	(AQUIRE)
	13,420	Fathead minnow	*ibid.*
	18,200	Fathead minnow	*ibid.*
	20,780	Bluegill	*ibid.*
	23,250	Goldfish	*ibid.*
	8400	Rainbow trout	*ibid.*
	17,400	*Daphnia cucullata*	*ibid.*
	15,500	*Daphnia cucullata*	*ibid.*
	9800	*Daphnia magna*	*ibid.*
	8600	*Daphnia magna*	*ibid.*
	23,800	*Daphnia magna*	*ibid.*
	23,100	*Daphnia magna*	*ibid.*
	15,100	*Daphnia magna*	*ibid.*
	15,800	*Daphnia magna*	*ibid.*
	15,800	*Daphnia magna*	*ibid.*
	5000	*Daphnia magna*	*ibid.*
	14,000	*Daphnia magna*	*ibid.*
	10,800	*Daphnia pulex*	*ibid.*
	8500	*Daphnia pulex*	*ibid.*
PAV:	160		
PACR:	40		
PAV / PACR:	4.1		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Methyl mercury			
Acute values:	25	Rainbow trout	EPA 1985e
	24	Rainbow trout	*ibid.*
	42	Rainbow trout	*ibid.*
	24	Rainbow trout	*ibid.*
	84	Brook trout	*ibid.*
	65	Brook trout	*ibid.*
PAV:	0.0028		
Acute-Chronic ratios:	142.3	Brook trout	EPA 1985e
PACR:	61.1		
PAV / PACR:	0.000046		
Methylene chloride			
Acute values:	220,000	Bluegill	(AQUIRE)
	193,000	Fathead minnow	*ibid.*
	502,000	Fathead minnow	*ibid.*
	220,000	*Daphnia magna*	*ibid.*
PAV:	3800		
Acute-Chronic ratios:	4.65	Fathead minnow	Dill et al., 1987
PACR:	19.5		
PAV / PACR:	190		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Napthalene			
Acute values:	8570	*Daphnia magna*	EPA 1980t
	2300	Rainbow trout	*ibid.*
	4900	Fathead minnow	*ibid.*
	8900	Fathead minnow	*ibid.*
	150,000	Mosquitofish	*ibid.*
PAV:	45		
Acute-Chronic ratios:	10.65	Fathead minnow	DeGraeve et al., 1982
PACR:	25.7		
PAV / PACR:	1.8		
4-Nitrophenol			
Acute values:	8300	Bluegill	(AQUIRE)
	59,000	Fathead minnow	*ibid.*
	62,000	Fathead minnow	*ibid.*
	41,000	Fathead minnow	*ibid.*
	7900	Rainbow trout	*ibid.*
	15,000	Channel catfish	*ibid.*
	22,000	*Daphnia magna*	*ibid.*
	8400	*Daphnia magna*	*ibid.*
	20,000	*Daphnia magna*	*ibid.*
	8400	*Daphnia magna*	*ibid.*
	7680	*Daphnia magna*	*ibid.*
	13,200	River snail	*ibid.*
PAV:	190		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Acute-Chronic ratios:	2.83	*Daphnia magna*	Francis et al., 1986**
PACR:	16.5		
PAV / PACR:	11		
N-Nitrosodiphenylamine			
Acute values:	5800 7800	Bluegill *Daphnia magna*	(AQUIRE) *ibid.*
PAV:	100		
PACR:	40		
PAV / PACR:	2.5		
3-Octanone			
Acute values:	80,000* 517,000*	Goldfish *Daphnia magna*	(AQUIRE) *ibid.*
PAV:	1400		
PACR:	40		
PAV / PACR:	34		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PCBs: Aroclor® 1221			
Acute values:	1200	Cutthroat trout	(AQUIRE)
	1170	Cutthroat trout	*ibid.*
	1170	Cutthroat trout	*ibid.*
PAV:	0.12		
PACR:	40		
PAV / PACR:	0.0029		
PCB's: Aroclor® 1232			
Acute values:	2500	Cutthroat trout	(AQUIRE)
	2500	Cutthroat trout	*ibid.*
	2500	Cutthroat trout	*ibid.*
	1900	Cutthroat trout	*ibid.*
PAV:	0.23		
PACR:	40		
PAV / PACR:	0.0058		
PCB's: Aroclor® 1242			
Acute values:	73	Scud	EPA 1980x
	10	Scud	*ibid.*
	400	Damselfly	*ibid.*
	15	Fathead minnow	*ibid.*
	300	Fathead minnow	*ibid.*

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PAV:	0.016		
Acute-Chronic ratios:	14.90	Scud	EPA 1980x
	7.454	Fathead minnow	*ibid.*
PACR:	16.4		
PAV / PACR:	0.00097		
PCB's: Aroclor® 1248			
Acute values:	52	Scud	EPA 1980x
	29	Scud	*ibid.*
PAV:	0.15		
Acute-Chronic ratios:	8.788	Scud	EPA 1980x
PACR:	24.1		
PAV / PACR:	0.0062		
PCB's: Aroclor® 1254			
Acute values:	2400	Scud	EPA 1980x
	200	Damselfly	*ibid.*
	7.7	Fathead minnow	*ibid.*
PAV:	0.0045		
Acute-Chronic ratios:	2.655	Fathead minnow	EPA 1980x

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
PACR:	16.20		
PAV / PACR:	0.00028		
PCB's: Aroclor® 1260			
Acute values:	60,900	Cutthroat trout	(AQUIRE)
	61,000	Cutthroat trout	*ibid.*
	25,000	Cutthroat trout	*ibid.*
PAV:	4.5		
PACR:	40		
PAV / PACR:	0.11		
1-Pentanol			
Acute values:	650,000	Bluegill	(AQUIRE)
	400,000	Rainbow trout	*ibid.*
PAV:	240		
PACR:	40		
PAV / PACR:	5.9		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Phenanthrene			
Acute values:	960	*Daphnia pulex*	(AQUIRE)
	490	Midge	*ibid.*
	700	*Daphnia magna*	*ibid.*
	843	*Daphnia magna*	*ibid.*
	734	*Daphnia magna*	*ibid.*
PAV:	8.4		
Acute-Chronic ratios:	4.8	*Daphnia pulex*	Geiger and Buikema, 1982
PACR:	19.8		
PAV / PACR:	0.43		
Phenol			
Acute values:[1]	248,000	Rotifer	EPA 1980v
	94,000	Snail	*ibid.*
	14,000	*Daphnia longispina*	*ibid.*
	36,400	*Daphnia magna*	*ibid.*
	58,100	*Daphnia pulex*	*ibid.*
	57,000	*Polyphemus pediculus*	*ibid.*
	122,000	*Cyclops vernalis*	*ibid.*
	108,000	*Mesocyclops leukarti*	*ibid.*
	8032	Rainbow trout	*ibid.*
	44,500	Goldfish	*ibid.*
	35,000	Fathead minnow	*ibid.*

[1]Because the list of acute values for phenol is so long, the species mean acute values have been substituted here.

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Acute values (cont.):	16,700	Channel catfish	*ibid.*
	36,300	Flagfish	*ibid.*
	26,000	Mosquitofish	*ibid.*
	34,900	Guppy	*ibid.*
	16,400	Bluegill	*ibid.*
	19,000	Mozambique mouthbrooder	*ibid.*
PAV:	260		
Acute-Chronic ratios:	14.06	Fathead minnow	EPA 1980v**
	18.19	Fathead minnow	DeGraeve et al., 1980
PACR:	21.7		
PAV / PACR:	12		
2-Propanol			
Acute values:	11,130,000	Fathead minnow	(AQUIRE)
	10,000	Fathead minnow	*ibid.*
	9,610,000	Fathead minnow	*ibid.*
PAV:	100		
PACR:	40		
PAV / PACR:	2.6		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
1,1,2,2-Tetrachloroethane			
Acute values:	21,000	Bluegill	(AQUIRE)
	20,300	Fathead minnow	*ibid.*
	20,400	Fathead minnow	*ibid.*
	62,000	*Daphnia magna*	*ibid.*
	9320	*Daphnia magna*	EPA 1980k
	20,300	Fathead minnow	*ibid.*
	21,300	Bluegill	*ibid.*
PAV:	350		
Acute-Chronic ratios:	8.46	Fathead minnow	Ahmed et al., 1984
	6.289	*Daphnia magna*	Richter et al., 1983
PACR:	12.9		
PAV / PACR:	27		
Tetrachloroethene			
Acute values:	8500	*Daphnia magna*	Richter et al., 1983
	17,700	*Daphnia magna*	EPA 1980aa
	30,840	*Tanytarsus dissimilis*	*ibid.*
	4800	Rainbow trout	*ibid.*
	5800	Rainbow trout	*ibid.*
	13,460	Fathead minnow	*ibid.*
	18,400	Fathead minnow	*ibid.*
	21,400	Fathead minnow	*ibid.*
	12,900	Bluegill	*ibid.*
PAV:	130		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Acute-Chronic ratios:	16.02	Fathead minnow	Ahmed et al., 1984
	11.35	*Daphnia magna*	Richter et al., 1983
PACR:	19.4		
PAV / PACR:	6.5		
Toluene			
Acute values:	60,000	*Daphnia magna*	EPA 1980cc
	313,000	*Daphnia magna*	*ibid.*
	22,800	Goldfish	*ibid.*
	57,680	Goldfish	*ibid.*
	34,270	Fathead minnow	*ibid.*
	42,330	Fathead minnow	*ibid.*
	59,300	Guppy	*ibid.*
	24,000	Bluegill	*ibid.*
	17,500	Bluegill	*ibid.*
PAV:	300		
PACR:	40		
PAV / PACR:	7.5		
1,1,1-Trichloroethene			
Acute values:	40,000	Bluegill	(AQUIRE)
	52,800	Fathead minnow	*ibid.*
	105,000	Fathead minnow	*ibid.*
PAV:	4.0		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Acute-Chronic ratios:	3.057[2]	*Daphnia magna*	Thompson & Carmichael,1989
PACR:	17.0		
PAV / PACR:	0.24		
1,1,2-Trichloroethane			
Acute values:	81,700	Fathead minnow	(AQUIRE)
	18,000	*Daphnia magna*	*ibid.*
	43,000	*Daphnia magna*	*ibid.*
	190,000	*Daphnia magna*	*ibid.*
	170,000	*Daphnia magna*	*ibid.*
	170,000	Great pond snail	*ibid.*
PAV:	1400		
Acute-Chronic ratios:	8.691	Fathead minnow	Ahmed et al., 1984
	9.776	*Daphnia magna*	Richter et al., 1983
PACR:	15.0		
PAV / PACR:	92		

[2]based on a 17-day LC50 (standard is 48-h.)

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Trichloroethene			
Acute values:	85,200	*Daphnia magna*	EPA 1980dd
	100,000	*Daphnia magna*	*ibid.*
	94,000	*Daphnia magna*	*ibid.*
	41,000	*Daphnia magna*	*ibid.*
	43,000	*Daphnia magna*	*ibid.*
	55,000	*Daphnia magna*	*ibid.*
	56,000	*Daphnia magna*	*ibid.*
	51,000	*Daphnia pulex*	*ibid.*
	39,000	*Daphnia pulex*	*ibid.*
	40,700	Fathead minnow	*ibid.*
	66,800	Fathead minnow	*ibid.*
	44,700	Bluegill	*ibid.*
	28,280	Flagfish	Smith et al., 1991
PAV:	490		
Acute-Chronic ratios:	2.558	Flagfish	Smith et al., 1991
PACR:	16.0		
PAV / PACR:	30		

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Vinyl acetate			
Acute values:	13,465[3]	Fathead minnow	(AQUIRE)
	18,000	Bluegill	*ibid.*
	42,330	Goldfish	*ibid.*
	31,080	Guppy	*ibid.*
PAV:	1.3		
PACR:	40		
PAV / PACR:	0.034		
Vinyl chloride			
Acute values:	356,000***	Golden orfe	(AQUIRE)
	406,000***	Golden orfe	*ibid.*
PAV:	38		
PACR:	40		
PAV / PACR:	0.95		

[3]Water hardness was varied in this test; a logarithmic regression was performed according to the National Guidelines, and 13,465 µg/l is the intercept value.

Table G1 (continued)

Chemical name / Data type	Value	Species	Source
ORGANICS (continued)			
Xylene			
Acute values:	780,000	Common carp	(AQUIRE)
	99,500	Calanoid copepod	*ibid.*
PAV:	10		
PACR:	40		
PAV / PACR:	0.25		

* These acute tests were of a non-standard duration. Standard durations are 48-h. for daphnids and midges, and 96-h. for all other aquatic animals.

** These reports contained no acute value to accompany the chronic values, so a species mean acute value derived from other available studies was used to calculate the ratio.

*** These test results are unreliable in that either a test duration was not specified or the experimental methods were not usual or not consistent, but they are the best data available.

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