

Health Consultation

Evaluation of Public Health Implications of Crabbing

HORSESHOE ROAD

SAYREVILLE, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJD980663678

FEBRUARY 16, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

**Hazardous Site Health Evaluation Program
Consumer and Environmental Health Services
Division of Epidemiology, Environmental and Occupational Health
New Jersey Department of Health and Senior Services
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**

Background

Statement of Issues

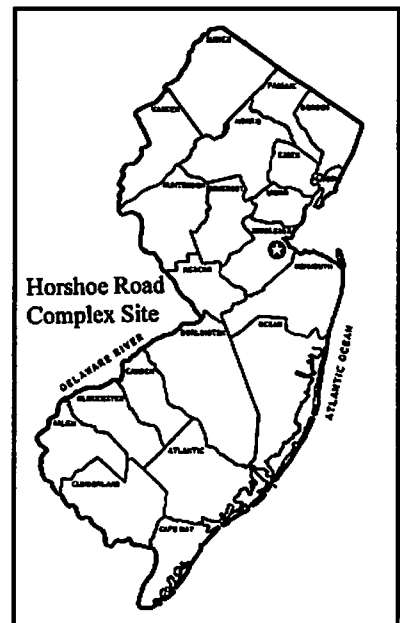
In January of 1999, the Edison Wetlands Association (EWA) requested that the Agency for Toxic Substances and Disease Registry (ATSDR) perform an evaluation of the potential public health threat posed by persons trespassing on the site, and, to consumers of edible biota (specifically “blue crabs”: *Callinectes sapidus*) from commercial and subsistence fishing that occurs in the Raritan River adjacent to the Horseshoe Road Complex (HRC) site.

The U.S. Environmental Protection Agency (USEPA) has performed surface water, sediment, and biota sampling (among “blue crabs” and mummichogs, a forage fish) adjacent, upriver, and downriver of the site. The public health significance of potential exposures resulting from persons trespassing on the HRC site has been evaluated by the ATSDR/New Jersey Department of Health and Senior Services (NJDHSS) in a June 28, 2000 health consultation.⁽¹⁾ The purpose of this Health Consultation is to evaluate the public health significance of potential exposures to persons consuming “blue crabs” from the Raritan River adjacent to the HRC study area, by evaluating the data generated by the USEPA during the Remedial Investigation of the HRC site.⁽²⁾

Site Background

The HRC site occupies about 17 acres located on Horseshoe Road near the Raritan River in northern Sayreville, Middlesex County, New Jersey (see inset). Specifically, the site is located at a relatively remote location at the end of Horseshoe Road along the south shore of the Raritan River (see Appendix A, Figure 1). The former chemical processing site includes three sub-areas: (1) the Horseshoe Road Drum Dump (HRDD); (2) the former Atlantic Development Corporation (ADC); and (3) the Sayreville Pesticide Dump (SPD). These three areas have been grouped together as one site on USEPA’s National Priorities List (NPL), based on the proximity and the assumption that the contaminants are co-mingled and threatening the same resources. The former Atlantic Resources Corporation (ARC) is also located on the HRC site but is not part of the NPL site. However, portions of the ARC are included in USEPA’s investigation of the site.⁽³⁾

The site’s predominant features include deteriorated structures, which comprise the defunct ADC and ARC facilities. The SPD and HRDD are contiguous with the ADC and ARC properties and are relatively inconspicuous. The site is bounded by the Raritan River and its wetlands to the north and northwest, railroad tracks to the south and east, and woodlands to the west.⁽³⁾



Over the last 30 years, various industrial operations were conducted at the sub-areas collectively referred to as the HRC site. Poor waste management practices and dumping of waste material resulted in site-wide contamination of soil, sediment, and groundwater with hazardous substances. Releases of hazardous substances to the Raritan River, adjacent to the site, have been reported.⁽⁴⁾ The following summaries describe the contaminated environmental media associated with these areas.

Horseshoe Road Drum Dump and Atlantic Resources Areas^(5,6)

Located at the end of Horseshoe Road, the Atlantic Resources Corporation (ARC) conducted various industrial operations from 1972 to August, 1985, including: solvent reclamation; hazardous waste incineration; and precious metal recovery (Appendix A, Figure 2). Between 1968 and 1972, the International Recycling Company conducted similar operations at the site. Operations at the Atlantic Resources site ended in 1985 soon after 2,3,7,8 TCDD (Dioxin) was found on the property by NJDEP. In addition to precious metal recovery by means of incineration, ARC received printed circuit boards, casting sweeps and fines for metal reclamation and refining. Fourteen "reverse platers" were used to dip circuit boards in a sodium cyanide acid baths to release metals into solution. The recovered metals were smelted into ingots. Employee documentation, collected by NJDEP, suggests that the ARC dumped drums of unknown materials into the Raritan River; disposed of drums of potassium cyanide, nitric, muriatic, and hydrochloric acids and hydrogen peroxide into the wooded area behind Horseshoe Road; and conducted precious metal recovery at night to minimize the visibility of "ruby red fumes" that are generated by the process.

In an area on the west side of ARC, known as The Horseshoe Road Dump (HRDD)(Appendix A, Figure 2), there is a fill area where it is suspected that drums were buried. Included in the Horseshoe Road Drum Dump area is a drainage swale to the northwest, and a wooded knoll which lies to the northeast. The Middlesex County Utilities Authority (MCUA), while installing a forced sewer main through the site, encountered numerous sub-surface drum fragments. Also noted was the presence of a strong organic/ester type odor, and the soil and groundwater was reported to be very acidic (pH ~ 2.0). Chemical analysis of drum samples taken from the HRDD, showed the presence of lead, chromium, cadmium, phenols, phthalates, PCB's, pesticides, acetonitrile and silver cyanide. In addition, there is some documentation that another company, Brodun Chemical, operated on the site in the early 1970's, and may have dumped ammonia into three lagoons.

The U.S. Environmental Protection Agency (USEPA) began limited remediation at these areas in early 1987. Remedial activities at the site have included: drum and storage tank removal; laboratory chemical removal; and the covering of dioxin contaminated soil. This section of the site was also stabilized by repairing and adding barbed wire to the fence.

Atlantic Development^(5,7)

The Atlantic Development (ADC) area is comprised of three buildings (referred to as: Atlantic Development; Sayreville Compounding; and Clover Chemical), and numerous storage tanks

(Appendix A, Figure 2). Between the years 1965 and 1981, many companies conducted a variety of industrial operations at these sites. These operations have included manufacturers of chemical and insecticidal products, oils, paints, pigments and varnishes. In addition, some companies operating on the ADC study area produced polymers and resins, dyes, roofing materials (using coal tar and asbestos), and sealants and feedstock products.

On the ADC sub-site, there exist open floor drains leading from the process buildings which terminate in the wetlands to the west. There is documentation which indicates that hazardous materials have been discharged to the wetlands and river via these drains. Information available to the NJDHSS/ATSDR indicate that there may be underground storage tanks at various locations on the ADC property. Scattered drums can be observed throughout the site, and there are numerous 1-10 gallon pails strewn over the property. There are approximately 7-10 above ground storage tanks distributed throughout the area.

Removal activities, in the ADC area, were initiated by USEPA in October, 1991. These activities involved initial site stabilization which included: containment of surficial contamination; container staging, inventory and sampling; and, submission of samples for analysis. In addition, containers and drums were staged in the on-site buildings, while metal pails and empty drums were crushed and placed in roll-offs containers. By August 1992, most of these materials were shipped off-site to an approved disposal site.

The Sayreville Pesticide Dump^(5,8)

The Sayreville Pesticide Dump (SPD) is located at the southern end of Horseshoe Road (Appendix A, Figure 2). The SPD is situated in a wooded area, and contains numerous exposed, partially buried and completely buried drums. The SPD area contained piles of a tar-like substance and in many areas an unknown gelatinous substance could be observed. The name of this area appears to be a misnomer because there is no information indicating pesticide dumping occurred there. Waste disposal in the SPD area began in the 1960's and continued through the early 1980's. The volume of the dump has been estimated to be about 50,000 square feet. This figure may be considerably underestimated because the entire perimeter of the dump has not been delineated. A fence encloses the majority of the visible dump; however, there was evidence of dumping beyond the fence, e.g. drum skeletons, tar-like piles, laboratory jars, gloves etc.

Remedial Activity

The USEPA has performed several actions at the site.⁽⁴⁾ Most recently, the USEPA's removal actions have addressed the following issues:

- The removal of potentially contaminated surface debris from several areas (fragments of tar-like solids, resinous/gelatinous, glue-like material, glass containers, corroded/rusted drum

carcasses, and other miscellaneous debris) found outside the fence, including areas adjacent to the Horseshoe Road and SPD;

- The removal of ash (primarily contaminated with dioxin and metal compounds) on concrete pads, in open kilns, and other contaminated materials in building at the ARC facility;
- The posting of signs along the Raritan River adjacent to the site summarizing the State (NJDEP) health advisory regarding fish and crab consumption;
- The repair/re-installation of damaged sections of fencing around the site; and, drainage control to minimize off-site migration of contaminated sediments.
- The above removal actions were completed by June 7, 1999.
- USEPA began the removal of the HRC's buildings at the end of 2000.

Prior ATSDR/NJDHSS Activities

The New Jersey Department of Health and Senior Services (NJDHSS), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared a Public Health Consultation for the HRC site in 1991.⁽¹²⁾ In addition, the ATSDR prepared a Preliminary Public Health Assessment for the Horseshoe Road Complex (HRC) site in 1995.⁽¹³⁾ The U.S. Environmental Protection Agency (EPA) completed a Remedial Investigation (RI) of the site in 1999. Following completion of the RI, the ATSDR conducted a Health Consultation dated June 28, 2000.⁽¹⁾ The June 28, 2000, Health Consultation served to evaluate the public health significance the actual and potential exposure to site-related contaminants by persons trespassing on the site.

Site Visit

ATSDR and NJDHSS personnel have visited the HRC site on several occasions beginning in December of 1993, with the most recent visit attended by J. Winegar, Sharon Kubiak and Stella Manchun Tsai. The NJDHSS staff were accompanied by representatives of the USEPA and the ATSDR. The following observations were made during the July 2000 site visit:

- The Horseshoe Road Site is currently abandoned. The main access road to the site is fenced with locked gates to prevent trespassers from walking on the site. Signs are posted along the fence line indicating the presence of a Superfund site.
- Check dams, put in place during the last removal action by the USEPA, to help prevent the off-site migration of contaminants to the Raritan River, were observed.
- The "purple" puddle observed in the HRDD area during the March 1999 site visit was present.

- It had rained at the site within the last few days and some puddles of water were noticed on the site. Several of these puddles had a “pink” tint.
- No unusual odors were noted during the visit; however, the site visit team did not access the ADC fenced area (where odors were noted during the March 1999 visit).
- Signs of wildlife were observed. Recent deer and racoon tracks were observed in the mud at the bottom of a few puddles.
- Several spent shotgun shell casings were observed.

Discussion

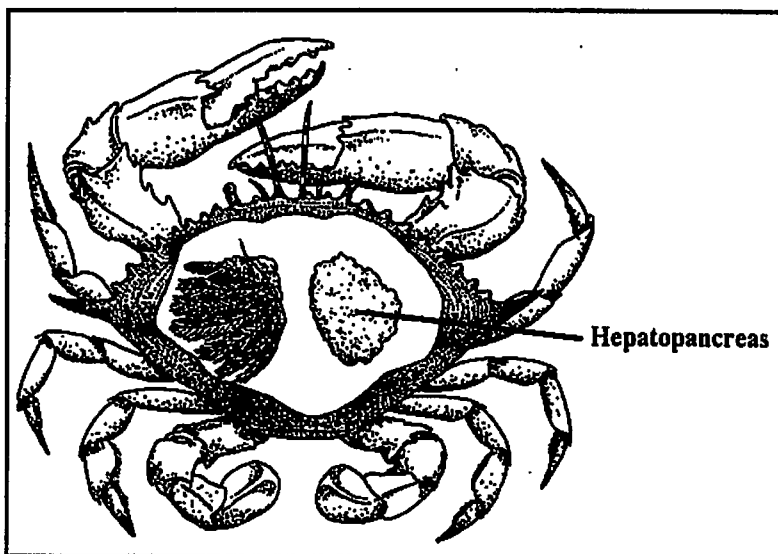
As previously noted, the purpose of this Health Consultation is to evaluate the potential public health significance of persons consuming blue crabs from the Raritan River adjacent to the HRC site. This discussion section, therefore, begins with a brief description of the blue crab, aspects of crabbing in New Jersey, and a discussion of the several NJDEP studies of blue crab contamination in the State.

The Blue Crab

The blue crab (*Callinectes sapidus*) is the most common edible crab along the eastern coasts of North and South America (Inset). Blue crabs are most commonly found in the protected waters of bays and estuaries on the Atlantic Coast. They range from Massachusetts all the way to Texas and a few have been reported as far north as Nova Scotia and as far south as Uruguay. They like to stay in brackish (mixed salt and fresh) water in the summer, and move on to the deeper ocean in winter.

Blue crabs are crustaceans with five pairs of legs. The first pair is modified as pinchers and the last four pairs are walking legs. Blue crabs have their last pair of legs modified into “paddles” so they can swim rapidly. Other common crustaceans are shrimps, lobsters, crayfish, and barnacles.

Blue crabs are omnivorous scavengers, feeding upon other aquatic plants and animals according to opportunity.



The “Blue” Crab (*Callinectes sapidus*)

“Crabbing” in New Jersey

Commonly referred to as “crabbing”, fishing for the blue crab is a very popular activity in New Jersey. According to the NJDEP’s Division of Fish, Game and Wildlife, of all of the State’s marine fish and shellfish, more effort is expended in catching the blue crab than any other single species.⁽¹⁴⁾ The State has conducted surveys which indicate that three-quarters of the State’s saltwater fisherman go crabbing and that crabbing accounts for about 30 percent of all marine fishing activity.

Both commercial and recreational crabbing are known to take place in the Raritan Bay and the tidal portions of the Raritan River, which includes the area adjacent to the HRC site. This total area, known as the Raritan Bay Complex, is currently subject to a crab consumption advisory promulgated by the NJDEP. The consumption advisory states that the green gland (hepatopancreas) of the blue crab should not be consumed (see inset above). This recommendation is based on NJDEP research (see below) that has shown elevated levels of chemical contamination in the blue crab hepatopancreas. Further, the NJDEP advisory also recommends that the hepatopancreas be removed before cooking and that after cooking the cooking water should be discarded and not used for any juices, sauces or soups.⁽¹⁵⁾ Signs warning people about the crab consumption advisory are posted by NJDEP along the banks of the river.

NJDEP Studies of Blue Crab Contamination

Between 1986 and 1988, the New Jersey Department of Environmental Protection (NJDEP) conducted studies of the bioaccumulation of polychlorinated biphenyls (PCBs), chlordane, and DDT in striped bass, white perch, blue fish and blue crabs from the Raritan River in areas at the Route 35 Bridge (downriver of the HRC site) and the Kin Buc Landfill (upriver of the site). The levels of contaminants detected in each species are listed in Appendix B. For the blue crab, the total PCB levels ranged from 0.14 to 0.6 mg/kg (ppm) in crab meat only, from 2.99 to 5.4 ppm in hepatopancreas tissue only, and from 1.06 to 2.07 ppm in whole blue crab samples.^(9,10)

In 1999, the NJDEP conducted a study of 88 blue crabs from several Raritan River areas. The analysis results for these samples are expected by Spring 2001 (NJDEP, Personal communication, 2000).⁽¹¹⁾

Environmental Contamination

Site-related contaminants are suspected to have migrated through environmental media and, potentially, into the biota (food chain) of the Raritan River. Contaminant summaries for on-site soils, marsh sediments, and water and sediments of the Raritan River are presented below.

On-Site Surface Soil Contamination

The June 2000 health consultation by ATSDR summarized the contaminants of concerns (COCs) detected from surface soil samples on site.⁽¹⁾ The COCs (for both completed and potential exposures pathways) from surface soil samples include antimony, arsenic, cadmium, lead, inorganic mercury, methoxychlor, PCBs and polynuclear aromatic hydrocarbons (PAHs).

Marsh Sediment Contamination

The HRC marsh (marsh) is a wetland located in the northwestern portion of the site adjacent to the Raritan River. From December 6 to December 8, 1999, the USEPA's contractor (CDM Federal) collected a total of 44 sediment samples from 11 locations in the marsh (Figure 3). The samples were collected for determining the vertical extent of site contamination. Samples were collected at each location from four depth intervals: 0 to 6, 6-18, 18-30, and 30-42 inches below the sediment surface. All marsh samples were analyzed for volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), pesticides, PCBs, metals and cyanide.⁽²⁾

The southern portion of the marsh, including sample locations #01 through #06, received surface water runoff from the ADC and SPD. The northern portion of the marsh, including sample locations #07 through #11, received surface water runoff primarily from the ARC.

Generally, the higher levels of detected VOCs were found at intervals of 6-18 and 18-30 inches. Sample location #11 yielded elevated levels of VOCs including; 1,4-dichlorobenzene of 79,000 ug/kg at 6-18 inches, methylcyclohexane of 6,700 ug/kg at 6-18 inches, chlorobenzene of 14,000 ug/kg at 18-30 inches, 1,2,4-trichlorobenzene of 4,400 ug/kg at 6-18 inches, and m-dichlorobenzene at 33,000 ug/kg at 6-18 inches.

Most detected SVOCs in marsh samples were PAHs including; naphthalene, 2-methylnaphthalene, acenaphthene, benzo[a]pyrene, benzo[a]anthracene, dibenzo[a,h]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, and indeno[1,2,3-cd]pyrene. Non-PAH SVOCs detected in marsh samples including phthalates, phenol, benzaldehyde, and acetophenone. At 0-6 inches, the higher concentrations of SVOCs were detected in the southern portion of the marsh from locations #01 through #04. Location #01 yielded a concentration of 420 ug/kg of 2-methylnaphthalene, and the highest non-PAH concentration of 52,000 ug/kg of bis(2-ethylhexyl) phthalate.

The distribution of pesticide and PCB contamination in marsh samples are similar to SVOC contamination. The highest concentrations of pesticides and PCBs were detected at locations #01 through #04 at the southern portion of the marsh, and at location #11. At the 0-6" interval, location #03 yielded heptachlor epoxide at 580 ug/kg, dieldrin at 380 ug/kg, endrin at 76 ug/kg, 4,4'-DDD at 130 ug/kg, Aroclor-1248 at 22,000 ug/kg and Aroclor-1260 at 5,300 ug/kg. At the same interval, location #01 yielded pesticide concentrations of endrin at 150 ug/kg, 4,4'-DDD at 420 ug/kg, and Aroclor-1248 at 32,000 ug/kg.

Metals were commonly detected in marsh samples. The highest concentrations were detected in samples #01 through #04 and #11. At 0-6" interval, sample #01 yielded a mercury level of 385 mg/kg.

Raritan River Surface Water and Sediment Contaminations

The Raritan River at this location is classified by the New Jersey Department of Environmental Protection (NJDEP) as SE1 with designated uses including shellfish harvesting. Samples of river surface water and sediment adjacent to the site were collected to evaluate the impacts from the site.⁽²⁾ Reference sampling from about one-half mile upriver and downriver of the site was conducted to determine the general condition of the river.

A total of 64 sediment samples were collected from 16 locations near the HRC site at four depth intervals: 0-6, 6-18, 18-30 and 30-42 inches (Figure 3). All samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and dioxin. Most contaminants were at higher concentrations in the interval of 0-6 inches. The highest concentrations of contaminants were commonly detected at location #03 through #10 which are immediately upriver of the principal drainageway that discharges site-derived surface runoff from the adjacent marsh. In the sediment samples collected from four background locations, the levels of VOCs, SVOCs, and most pesticides were low. Metals were consistently detected in background sediment samples, however, the levels of cadmium and chromium were not elevated.

A total of 22 surface water samples were collected from 20 locations in the Raritan River adjacent to the HRC site (Figure 3). The water sampling locations include the sediment sampling locations, two reference locations which are about one-half mile upriver and two were downriver of the Site. All samples were analyzed for VOCs, SVOCs, pesticides/PCBs, metals and cyanide. Higher arsenic levels exceeding the New Jersey surface water screening criteria were detected in several samples including background samples.

Biota Contamination

Blue crabs and forage fish samples were collected from the Raritan River adjacent to the Site and from two reference areas upriver and downriver of the site by CDM Federal in September and October in 1999. Using baited crabpots, muscle tissue and hepatopancreas tissue samples were obtained from blue crabs collected in the Raritan River. Forage fish samples were collected using baited minnow traps. All biota samples were analyzed for VOCs, SVOCs, pesticides/PCBs and metals. Figure 4 presents sampling locations.

A total of 24 blue crab samples were collected from 11 locations including two reference sites upriver and downriver of the Site. It included 12 crab muscle tissue samples and 12 crab hepatopancreas tissue samples. One crab muscle tissue sample and one hepatopancreas sample were

composited from three sampling locations (04, 05 and 07). Crab samples from two reference sites upriver and downriver of the Site were also collected. Some VOCs, SVOCs, heptachlor epoxide, dieldrin, 4,4'-DDE, endosulfan II, 4,4'-DDD and metals were detected in crab muscle tissue. Some VOCs, SVOCs, heptachlor epoxide, dieldrin, 4,4'-DDE, endosulfan II, 4,4'-DDD, endosulfan sulfate, 4,4'-DDT, Aroclor 1260 and metals were detected in crab hepatopancreas tissue.

Contaminant levels in blue crab muscle tissue samples collected during the recent RI were similar to levels detected in previous studies of the entire Raritan Bay Complex.

A total of 10 whole forage fish tissues were collected at nine locations from the Raritan River adjacent to the Site. One sample was composited from five sampling locations (04, 05, 11, 13 and 14). One reference sample was collected upriver of the Site. Some VOCs, SVOCs, heptachlor epoxide, dieldrin, 4,4'-DDE, 4,4'-DDD, and Aroclor 1260 were detected in forage fish samples.

Biota samples collected from reference locations yielded pesticide levels similar to those locations adjacent to the Site.

Biota contamination vs. Environmental Contamination

Table 1 lists the maximum concentrations of VOCs, SVOCs, pesticides and metals detected in crab muscle tissue. This table also includes the maximum concentrations of these chemicals detected in crab hepatopancreas tissue, forage fish, the Raritan River sediment at the interval of 0-6 inches, the marsh sediment at the interval of 0-6 inches and the Raritan River surface water.

The maximum concentrations of VOCs, SVOCs, pesticides and metals detected in crab muscle tissue were compared with the USEPA Region III Risk-Based Concentrations (RBCs) for fish tissue.⁽¹⁶⁾ RBCs are used as health comparison values in this health consultation. Those compounds with concentration above the RBCs will be discussed in the toxicological evaluation section. Sodium, calcium and potassium, which are commonly detected in diet and saline water, are not considered as the contaminants of concerns in this case. No available health comparison value is available for lead in the current public health literature. Therefore, further assessment for lead detected in crab muscle tissue will also be discussed in the toxicological evaluation section.

Table 1. Maximum concentrations of VOCs, SVOCs, pesticides and metals detected in crab muscle*, hepatopancreas, forage fish, Raritan River sediments at 0 to 6 inches, the marsh sediments at 0-6 inches, and Raritan River surface water.⁽²⁾ The USEPA Region III's Risk-Based Concentrations (RBCs) for fish were used as health comparison values. **Compounds above health comparison value are in bold face.**

Compounds	RBC	Muscle Tissue	Hepatopancreas Tissue	Forage Fish	River Sediment	Marsh Sediment	Surface River Water
VOCs	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/l
Acetone	140000 N	140	80	440	550	380	BDL
Carbon disulfide	140000 N	15	17	15	830	180	BDL
Dichloromethane	420 C	4	4	3	500	2	BDL
2-Butanone	81000 N	13	27	37	160	BDL	BDL
Xylenes, total	2700000 N	2	4	2	BDL	BDL	BDL
Semi VOCs							
Di-n-butylphthalate	14000 N	390	170	740	BDL	1300	1
2-Methylphenol	68000 N	34	BDL	BDL	BDL	BDL	BDL
Dimethylphthalate	14000000 N	35	BDL	BDL	BDL	BDL	BDL
2,2'-oxybis(1-Chloropropane)	45 C	29	BDL	BDL	BDL	BDL	BDL
Pentachlorophenol	26 C	20	16000	BDL	BDL	BDL	BDL
Pyrene	41000 N	60	BDL	BDL	2700	2200	BDL
bis (2-Ethylhexyl) phthalate	230 C	350	3300	BDL	16000	52000	2
Pesticides							
Heptachlor epoxide	0.35 C	21	32	21	20	580	0.054
Dieldrin	0.2 C	9.7	12	12	22	380	0.11
4,4'-DDE	9.3 C	120	180	120	59	16	0.11
Endosulfan II	8100 N	11	6.8	BDL	4.7	BDL	0.11
4,4'-DDD	13 C	110	160	110	30	420	0.11
Metals							
Aluminum	1400000 N	6	BDL	7.2	19900	18000	424
Antimony	540 N	0.14	0.22	0.23	18	33.7	BDL
Arsenic	2.1 C	1	1.6	0.77	654	8220	5.2
Barium	95000 N	0.58	4.7	2.4	117	182	42
Beryllium	2700 N	0.04	0.05	0.05	3.1	2.8	0.3
Cadmium	1400 N	0.08	0.55	0.03	6.6	5.6	1.8
Calcium metal	N/A	2700	7670	18900	43300	29700	150000
Chromium ⁽¹⁾	4100 N	0.19	0.54	0.93	214	4950	2.4
Copper	54000 N	17.3	41.7	4.2	417	4040	22.8
Iron	410000 N	18.1	89.9	42.7	77300	306000	3550
Lead	N/A	1.3	1.4	1.2	246	338	4.8
Magnesium	N/A	430	693	581	8150	6850	480000
Manganese	190000 N	2.3	9.3	9.7	316	2520	65.9
Mercury ⁽²⁾	140 N	0.07	0.04	0.04	3.2	385	BDL
Nickel	27000 N	0.51	0.42	0.41	64.6	671	10.2
Potassium	N/A	2620	1450	2610	3530	3340	188000
Selenium	6800 N	1.3	0.84	0.96	20.4	7.9	BDL
Silver	6800 N	0.74	1.5	0.06	18.1	63	0.8
Sodium	N/A	5680	5590	2140	15100	15400	4220000
Zinc	410000 N	49.7	46.6	67	522	650	51.2

* A contaminant is not listed if it was not detected in muscle tissue (e.g., PCBs).

BDL=below method detection limit.

RBC=risk-based concentration.

C=carcinogenic effects.

N=noncarcinogenic effects.

(1) Chromium (VI) (2) methylmercury

Pathways Analysis and Public Health Implications

A completed exposure pathway consists of five elements: sources of contamination, environmental media and transport mechanisms, point of exposure, routes of exposure, and receptor population.⁽¹⁷⁾ Blue crabs are taken from the Raritan Bay and the tidal portions of the Raritan River, including the area adjacent to the Site on a commercial and recreational (subsistence) basis. In addition, biota samples collected in the vicinity of the Site have shown that contaminants, principally metals and pesticides, are present in blue crab tissue samples. Based on the information available to the NJDHSS and the ATSDR, it is reasonable to assume that a completed exposure pathway exists to those individuals who consume blue crabs from the Raritan River adjacent to the Site.

Exposure Assessment

Health effect evaluations are accomplished by estimating the amount (or dose) of those contaminants that a person might come in contact with on a daily basis. This estimated exposure dose is then compared to established health guidelines. People who are exposed for some crucial length of time to contaminants of concern at levels above established guidelines are potentially more likely to have associated illnesses or disease.⁽¹⁷⁾

Health guidelines are developed for contaminants commonly found at hazardous waste sites. Examples of health guidelines are the ATSDR's Minimal Risk Level (MRL) and the USEPA's Reference Dose (RfD). MRLs are developed for each type of exposure, such as acute (less than 14 days), intermediate (15 to 364 days), and chronic (365 days and greater). ATSDR presents these MRLs in Toxicological Profiles. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status. When exposure (or dose) is below the MRL or RfD, then non-cancer, adverse health effects are unlikely to occur.

The toxicological effects of the contaminants detected in the crab muscle tissue have been considered singularly. The cumulative or synergistic effects of mixtures of contaminants may serve to enhance their public health significance. Some research on the toxicity of mixtures indicates that adverse health effects are unlikely when the mixture components are present at levels well below their individual toxicologic thresholds.⁽²³⁾ Additionally, individual contaminants or mixtures of contaminants may have the ability to produce greater adverse health effects in children as compared to adults. This situation depends upon the specific chemical being ingested, its pharmacokinetics in children and adults, and its toxicity in children and adults.

The following section contains a discussion of health effects in both adults and children exposed to contaminated blue crab muscle tissue. The maximum levels of contaminants detected in crab muscle tissue were used in dose estimates (Table 1).

Dose Estimate

The maximum detected concentrations of five compounds (bis(2-ethylhexyl) phthalate, heptachlor epoxide, dieldrin, 4,4'-DDE and 4,4'-DDD) detected in crab muscle tissue were above the USEPA Region III Risk-Based Concentrations (RBCs) for fish tissue.⁽¹⁶⁾

To estimate exposure doses of persons consuming blue crabs harvested from the Raritan River adjacent to the site on the site, the following assumptions were made. It was assumed that the crabs were consumed by adults (weighing 70 kilograms), one time per week, for a period of one year, and that they would ingest six (6) crabs or about 252 grams (g) of crab meat during each meal for nine years (the national median for time at one residence). In addition, it was assumed that the crabs were consumed by children (weighing 13.2 kilograms), one time per week, for a period of one year, and that they would ingest three (3) crabs or about 140 grams (g) of crab meat during each meal.

The primary source of data for the evaluation of potential health concerns from persons consuming blue crabs harvested from the Raritan River adjacent to the site was provided by the Remedial Investigation (RI) performed by USEPA's contractor CDM Federal.⁽²⁾ To evaluate the worst-case exposure scenario, exposure doses for contaminants detected in crab muscle were calculated using the maximum concentrations detected. Toxicological evaluation will focus on compounds which are above available health comparison values, and compounds of concern with no available comparison values.

Bis(2-ethylhexyl)phthalate⁽¹⁸⁾

Bis(2-ethylhexyl)phthalate (also known as DEHP) is a colorless liquid chemical which is commonly used in the manufacture of plastics to increase flexibility. DEHP is not toxic at the low levels usually present in the environment. In animal studies, high levels of DEHP affected the liver and kidney functions, and reproductive ability. The maximum exposure dose to DEHP for adults and children were below the available chronic oral RfD (non-carcinogenic adverse health effects) reported by the USEPA. It is unlikely that non-carcinogenic adverse health effects would occur through ingestion of crab muscle tissue containing DEHP at this level. Therefore, ingestion of DEHP at the maximum detected level does not constitute a concern for non-carcinogenic adverse health effects.

The USEPA and the US Department of Health and Human Services (DHHS) have determined that DEHP may reasonably be anticipated to be a carcinogen based on animal studies. The USEPA and USDHHS have determined that DEHP is a probable human carcinogen. There is no evidence that DEHP causes cancer in humans, but high exposures in rats and mice increased liver cancer. The maximum concentration of DEHP detected in crab muscle tissue was above the risk-based concentration for fish based on carcinogenic effects. Based upon the chronic exposure scenario for adults consuming crab muscles from the Raritan River adjacent to the Site, estimations of the lifetime excess cancer risk indicate no apparent (10^{-5}) increased risk of cancer. Therefore,

carcinogenic adverse health effects are not likely to occur in the exposed population consuming crab muscle tissue.

Heptachlor epoxide ⁽¹⁹⁾

Heptachlor epoxide is a chemical which was utilized extensively as a pesticide in homes and in agriculture, the use of which was discontinued 1988. Heptachlor epoxide has been demonstrated to be toxic to the human nervous system. Exposure to high levels of heptachlor epoxide for short periods of time can cause liver damage in rats and mice. Animal studies also associate exposure to heptachlor with adverse pregnancy outcomes.

The maximum exposure dose to heptachlor epoxide for adults and children were below the available chronic oral RfD for non-carcinogenic adverse health effects reported by the USEPA. It is unlikely that non-carcinogenic adverse health effects would occur through ingestion of crab muscle tissue containing heptachlor epoxide at this level based on the individual chemical evaluation. Therefore, ingestion of heptachlor epoxide at the maximum detected level does not constitute a concern for non-carcinogenic adverse health effects.

The USEPA classifies heptachlor epoxide as a probable human carcinogen based on animal studies, though the International Agency for Research on Cancer (IARC) has determined that heptachlor epoxide is not classifiable as a human carcinogen because insufficient data are available.

The maximum concentration of heptachlor epoxide detected in crab muscle tissue was above the risk-based concentration for fish based on carcinogenic effects. Based upon the chronic exposure scenario for adults consuming crab meat from the Raritan River adjacent to the Site, estimations of the lifetime excess cancer risk indicate no apparent (10^{-5}) increased risk of cancer. Therefore, carcinogenic adverse health effects are not expected to occur in the exposed population consuming crab muscle tissue.

Dieldrin ⁽²⁰⁾

Dieldrin is an insecticide which is commonly encountered in the form of a white powder having a mild chemical odor. Due to the concerns of damage to the environment and human health, the USEPA banned this insecticide in 1987. Dieldrin may affect the central nervous system. Studies on workers exposed to dieldrin did not show increased cancers. However, mice exposed to high levels of dieldrin did develop liver cancers.

The maximum exposure dose to dieldrin for adults and children were below the available chronic oral RfD for non-carcinogenic adverse health effects reported by the USEPA. It is unlikely that non-carcinogenic adverse health effects would occur through ingestion of crab muscle tissue containing dieldrin at this level based on the individual chemical evaluation. Therefore, ingestion of dieldrin at the maximum detected level does not constitute a concern for non-carcinogenic health effects.

The USEPA classifies dieldrin as a probable human carcinogen based on animal studies, though the International Agency for Research on Cancer (IARC) has determined that dieldrin is not classifiable as a human carcinogen because no direct evidence is available. The maximum concentration of dieldrin detected in crab muscle tissue was above the risk-based concentration for fish based on carcinogenic effects. Based upon the chronic exposure scenario for adults consuming crab meat from the Raritan River adjacent to the Site, estimations of the lifetime excess cancer risk indicate no apparent (10^{-5}) increased risk of cancer. Therefore, carcinogenic effects are not expected to occur in the exposed population consuming crab muscle tissue.

4,4'-DDE and 4,4'-DDD ⁽²¹⁾

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane) is a compound which was commonly used for insect control in the past. It was a manufactured chemical not occurring naturally in the environment. DDE (1,1-dichloro-2,2-bis(chlorophenyl) ethylene) and DDD (1,1-dichloro-2,2-bis(p-chlorophenyl)ethane) were commonly found as contaminants for a technical grade of DDT. DDT in soil usually breaks down to DDE or DDD.

The USEPA established a RfD for DDT of 0.0005 mg/kg/day, but no RfDs for either DDD or DDE. Based on limited animal studies, the lowest available LOAEL for chronic oral exposure to DDD is 12 mg/kg/day on rats for 78 weeks, and the lowest available NOAEL for chronic oral exposure to DDE is 85 mg/kg/day on rats for 78 weeks. The maximum exposure doses to DDE and DDD for adults and children were far below the available chronic NOAEL and LOAEL of these chemicals for non-carcinogenic adverse health effects in animal studies. It is unlikely that non-carcinogenic adverse health effects would occur through ingestion of crab muscle tissue containing DDD and DDE at levels based on the individual chemical evaluation. Therefore, ingestion of DDD and DDE at the maximum detected level does not constitute a health concern.

The USEPA has determined that DDD and DDE are probable human carcinogens. The maximum concentrations of DDE and DDD detected in crab muscle tissue were above the risk-based concentrations for fish based on carcinogenic effects. Based upon the chronic exposure scenario for adults consuming crab muscles from the Raritan River adjacent to the site, estimations of the lifetime excess cancer risk indicate no apparent (10^{-5}) increased risk of cancer. Therefore, carcinogenic adverse health effects are not expected to occur in the exposed population.

Lead ⁽²²⁾

The most sensitive organ to lead exposure is the central nervous system, especially for young children. The USEPA and DHHS have determined that lead is a probable human carcinogen based on studies in animals. However, quantitative estimation of carcinogenic effects from oral exposure to lead is not currently available. No MRL or RfD has been derived for lead because it was decided that no thresholds have been demonstrated for the most sensitive human effects. ATSDR developed a regression analysis method to estimate the blood lead level in the human body using environmental

lead concentrations. Based on the conservative assumptions, the increased blood lead level for adult consuming crab muscle from the Raritan River adjacent to the site is 0.2 ug/dL and for children is 0.8 ug/dL. The CDC level of concern for blood lead in young children is 10 ug/dL. Therefore, It is unlikely that non-carcinogenic adverse health effects would occur through ingestion of crab meat containing lead at levels documented.

ATSDR Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from a waste site. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors closer to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. NJDHSS/ATSDR evaluated the potential for children to be exposed to lead and other contaminants of concerns contained in samples of tissue from contaminated crabs in the Raritan River near the HRC site. As previously mentioned, it is not expected that adverse health effects would occur for the children who ingest crab meat containing lead and other contaminants of concerns at the concentrations cited above. However, for lead, it is prudent public health practice to minimize as much as possible the amount of lead children are exposed to.

Conclusions

Based on the data and information reviewed from the U.S. EPA's Remedial Investigation for the Horseshoe Road Complex site, exposures to the *known* contaminants detected in biota (blue crab muscle tissue) at the HRC site, would not likely result in serious adverse health effects. Therefore, ATSDR/NJDHSS has determined that, in this context, the HRC site represents no apparent public health hazard. This evaluation is based on the following:

- Although biota sampling near the HRC site has shown that the blue crab muscle tissue is contaminated, and several contaminants are present at levels above the USEPA Region 3 Risk-Based Concentrations, a toxicological evaluation, using known site data and standard assumptions, did show that human exposure is not at levels likely to result in adverse health effects.
- Compared to the blue crab muscle tissue samples, relatively higher levels of contaminants were detected in blue crab hepatopancreas tissue samples. The NJDEP has a blue crab consumption advisory for the Raritan Bay Complex that recommends against the

consumption of the hepatopancreas. The ATSDR/NJDHSS feel that the advisory is appropriate and protective of the public health.

- Although the HRC site is likely contributing to the contamination burden of the Raritan River, the blue crab muscle tissue samples collected during the recent RI were not unlike crab muscle tissue collected in previous studies of the Raritan Bay Complex and at the reference locations. Therefore, it does not appear that the crabs caught near the HRC site are substantially different from the rest of the crabs in the river or bay.

Recommendations

A. Cease/Reduce Exposure Recommendations

Based upon available data and information, there is a identifiable exposure pathway associated with the Horseshoe Road Complex (HRC) site. Persons consuming Blue Crabs captured near the HRC site should continue to follow NJDEP advisory recommendations concerning the consumption of Blue Crabs from the Raritan Bay Complex. This includes not eating the green gland (hepatopancreas) of the crab.

B. Site Characterization

Site data and information is currently available for review by the NJDHSS and the ATSDR is adequate for evaluation of the public health implications of the Horseshoe Road Complex (HRC) site with respect to the issue of bioaccumulation of contaminants in crabs.

Public Health Action Plan

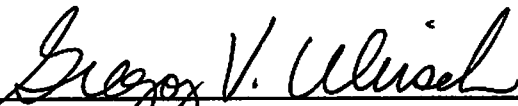
The Public Health Action Plan (PHAP) for the Horseshoe Road Complex site contains a description of the actions to be taken at or in the vicinity of the site. The purpose of the PHAP is to ensure that this health consultation not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included, is a commitment on the part of ATSDR and NJDHSS to follow-up on this plan to ensure that it is implemented. ATSDR will provide an annual follow-up to this PHAP, as needed, outlining the actions completed and those in progress. This report will be placed in repositories that contain copies of this health consultation, and will be provided to persons who request it. The public health actions taken or to be implemented are as follows:

Actions Planned

1. Additional biota data will be reviewed (when available) by the ATSDR/NJDHSS for potential public health implications. Should these data indicate a need, the public health implications of contaminated biota will be re-evaluated.
2. ATSDR/NJDHSS will continue to work with the Edison Wetlands Association and the U.S. EPA to evaluate the public health implications of completed and potential exposure pathways to contaminants associated with the Horseshoe Road Complex site.
3. ATSDR will provide follow up to this PHAP, as needed, outlining the actions completed and those in progress. This report will be placed in repositories that contain copies of this Health Consultation, and will be provided to persons who request it.

Certification

The Health Consultation for the Horseshoe Road Site was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.



Technical Project Officer, SPS, SSAB, DHAC

The Superfund Site Assessment Branch (SSAB), Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.



Chief, SSAB, DHAC, ATSDR

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Appendix A

Figures

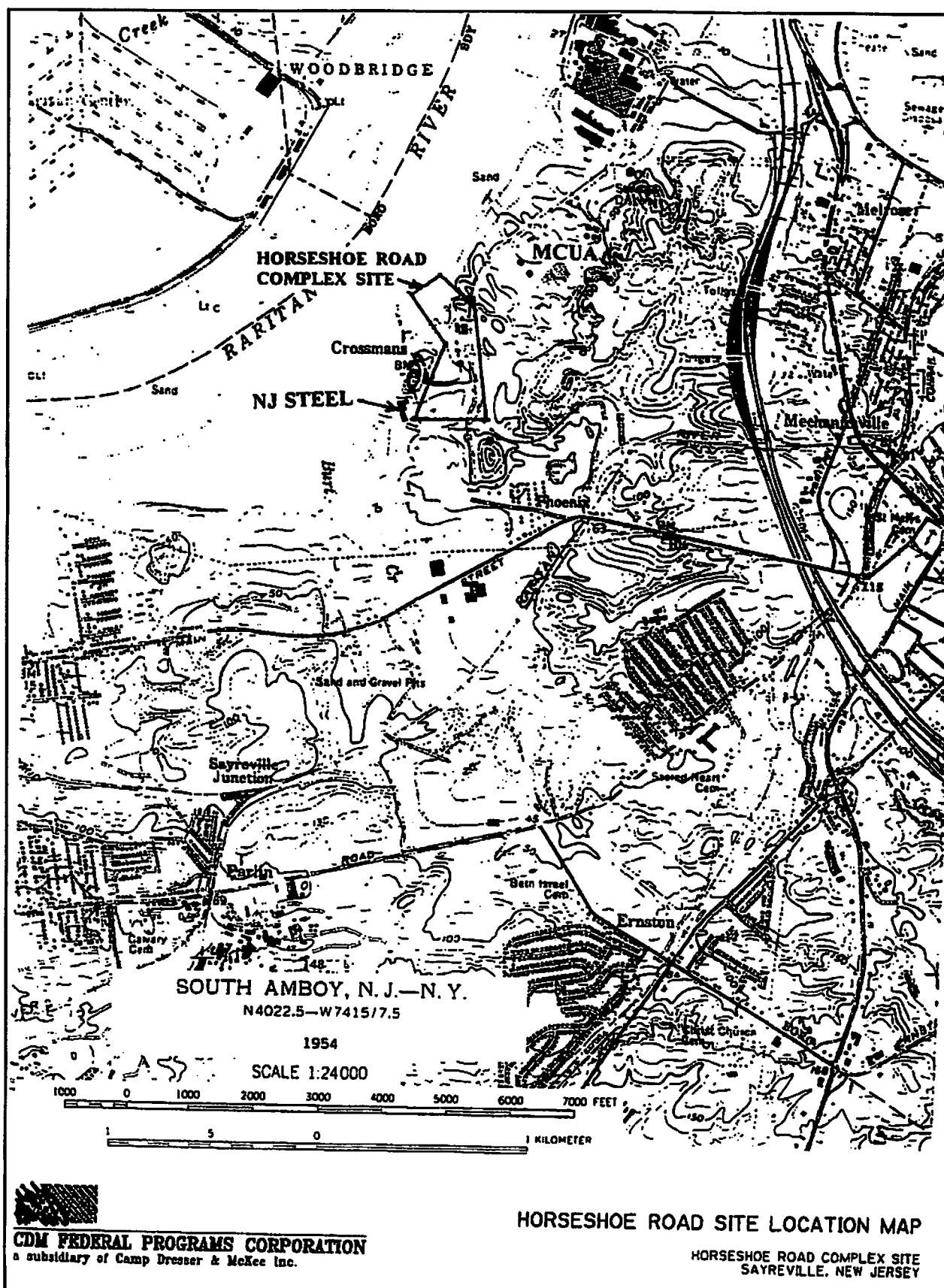


Figure 1 Horshoe Road Complex Site Map

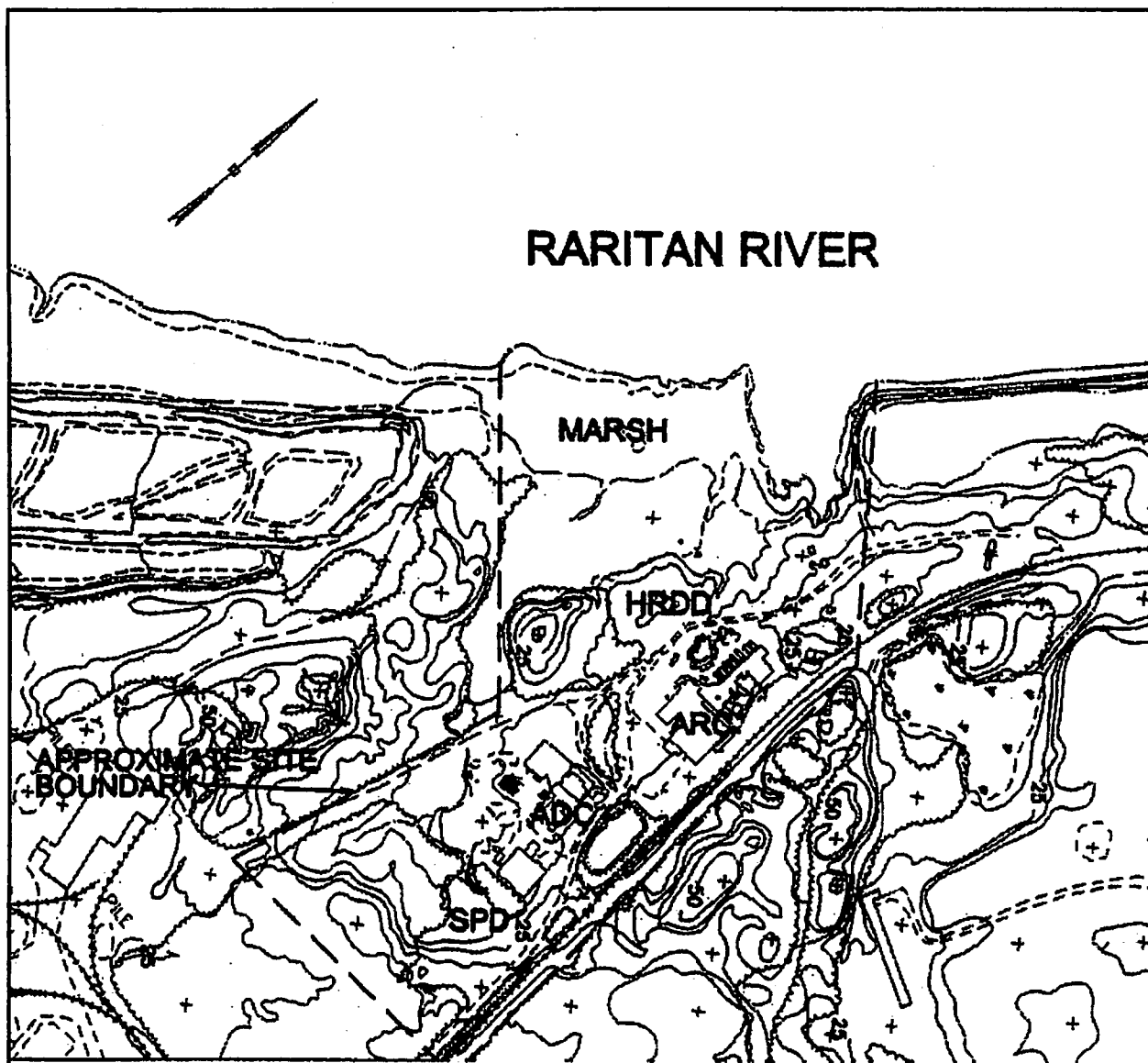


Figure 2 Site Map Detail

Legend

HRDD	Horsehoe Road Drum Dump
ARC	Atlantic Resources Corporation
ADC	Atlantic Development Corporation
SPD	Sayreville Pesticide Dump

Adapted from CDM ⁽²⁾

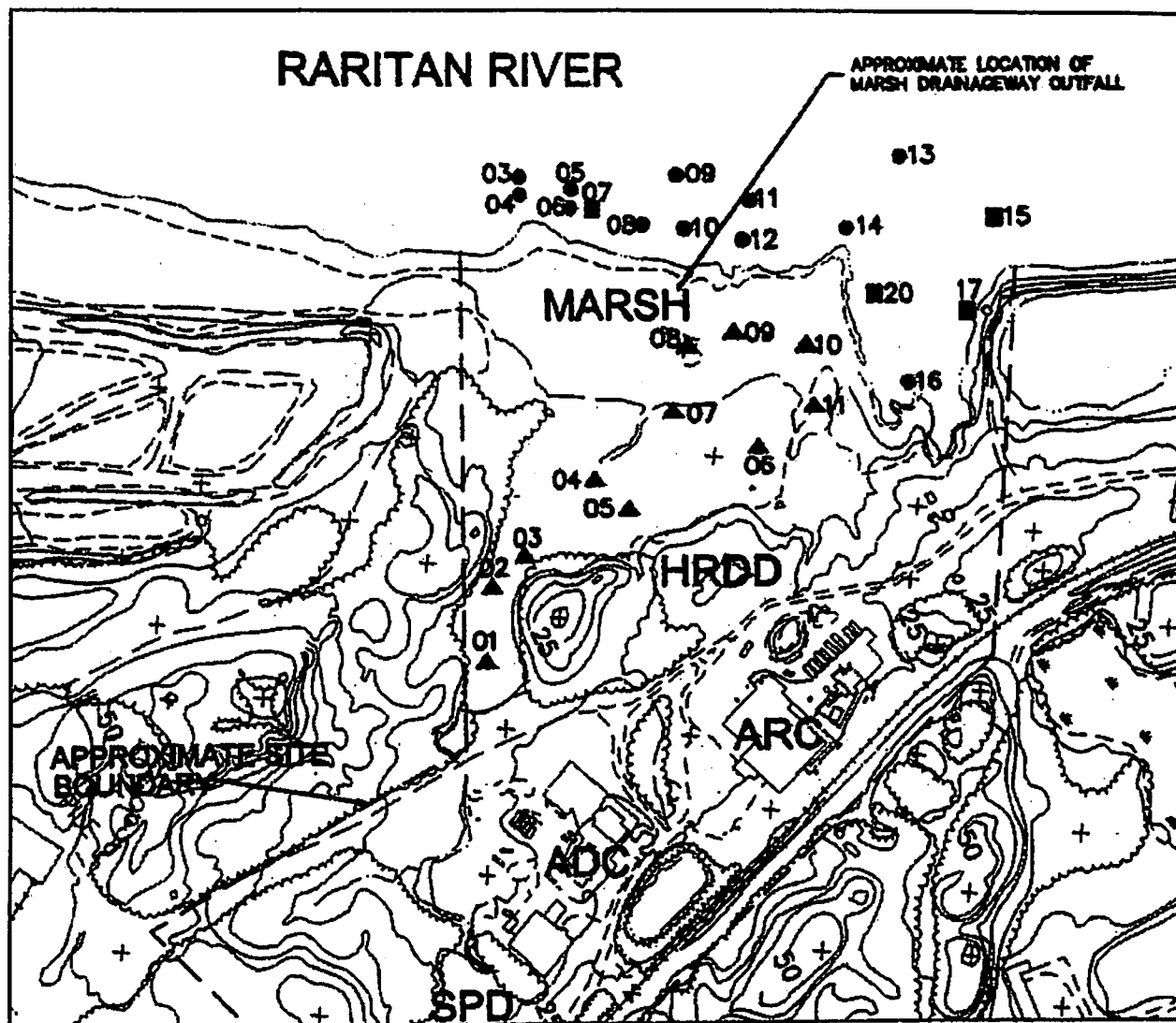


Figure 3 Sampling Map - Marsh Sediment, Raritan River Surface Water, and Sediment Sampling Locations

Legend

HRDD	Horsehoe Road Drum Dump
ARC	Atlantic Resources Corporation
ADC	Atlantic Development Corporation
SPD	Sayreville Pesticide Dump
▲	Marsh Sediment
●	Surface Water/Sediment Only
■	Surface Water/Sediment and Dioxin

Adapted from CDM ⁽²⁾

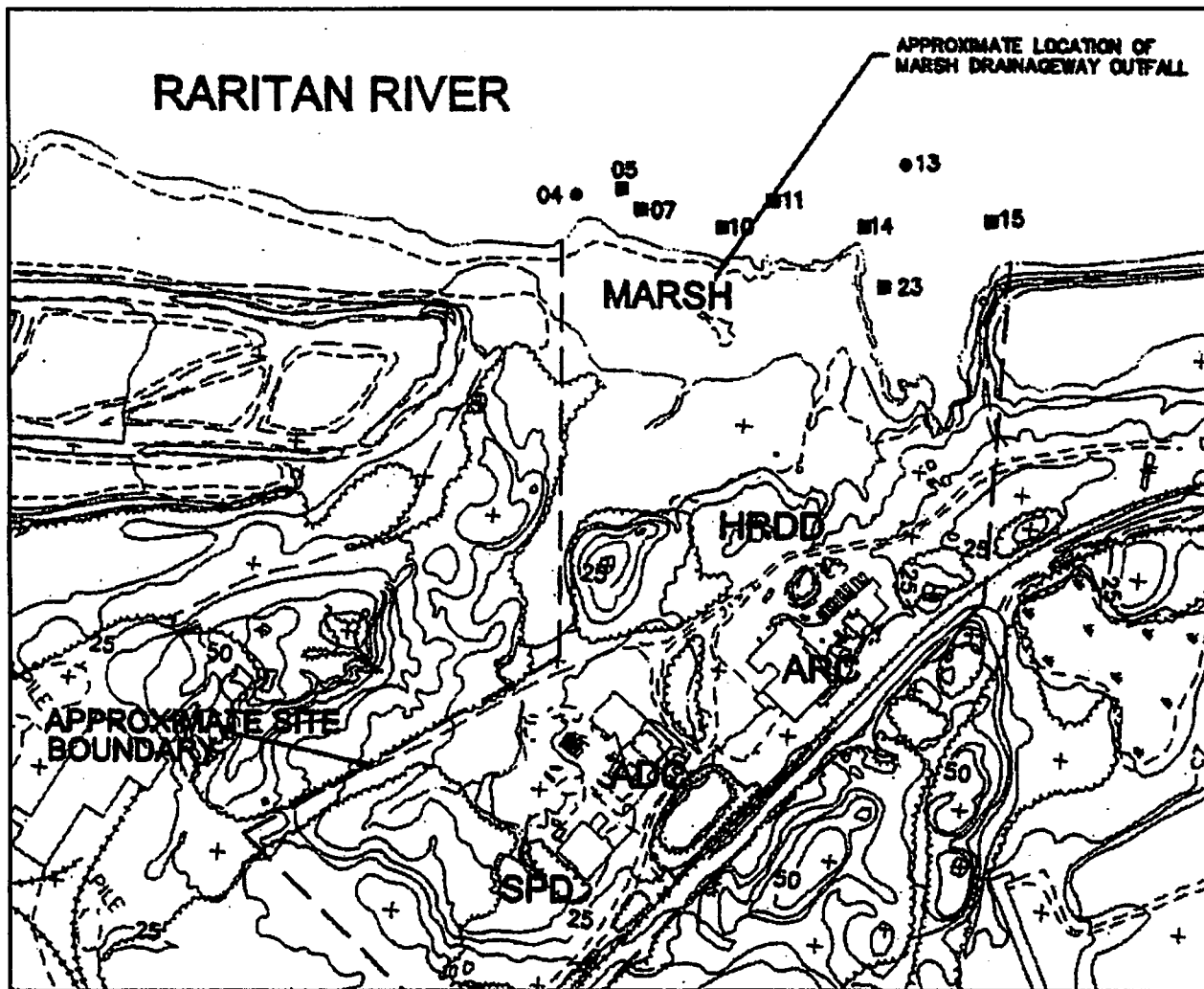


Figure 4 Sampling Map -Biota Sampling Locations

Legend

HRDD	Horseshoe Road Drum Dump
ARC	Atlantic Resources Corporation
ADC	Atlantic Development Corporation
SPD	Sayreville Pesticide Dump
● and ■	Biota

Adapted from CDM ⁽²⁾

Appendix B. Polychlorinated Biphenyls (PCBs), Chlordane, and DDT in Selected Fish and Crabs from the Raritan River Areas Between 1986 and 1988. Data was Calculated Based on Wet Weight.

Year	Sampling Location	Fish/Crab Tissue Tested	A1248 (ppm)	A1254/1260 (ppm)	Total PCBs (ppm)	Alpha- (ppb)	Beta- (ppb)	Chlordane (ppb)	DDT (ppb)	DDD (ppb)	DDE (ppb)	DDT (ppb)
1986	Route 35 Bridge	Blue Crab (H/M)	0.74	0.74	1.44	28.74	5.91	34.65	<10	95.66	96.39	192.05-202.05
	Kin Buc Landfill	Blue Crab (H/M)	0.51	0.7	1.21	25.45	2.67	28.12	<10	62.33	78.39	140.72-150.72
		Striped Bass	0.38-0.98	0.34-1	0.72-1.98	19.43-39.79	13.49-14.72	33.33-54.51	<10-16.23	55.8-66.96	49-96.43	115.96-168.46
		White Perch	0.89	0.54	1.43	45.61	14.72	60.33	12.18	63.24	44.64	120.06
1987	Route 35 Bridge	Blue Crab (H/M)	0.72	0.69	1.41	15.63	3.31	18.94	<10	85.69	117.5	203.19-213.19
		Blue Crab (H)	3.47	0.71	4.18	16.54	12.87	29.41	<10	21.17	22	43.17-53.17
		Blue Crab (M)	<0.1	0.14	0.14-0.24	<2.5	3.49	3.49-5.99	<10	11.09	12.5	23.59-33.59
		Bluefish	<0.1	<0.1	0-0.2	<2.5	<2.5	0-5	<10	<10	<5	0-25
	Kin Buc Landfill	Blue Crab (H/M)	0.91	1.16	2.07	30.35	9.06	39.41	<10	65.92	109.1	174.99-184.99
		Blue Crab (H)	3	2.4	5.4	130.21	42.61	172.82	26.04	334.8	429.7	790.55
		Blue Crab (M)	0.18	0.1	0.28	6.94	<2.5	6.97-9.44	<10	24.8	30.73	55.53-65.53
		Striped Bass	0.98	1.49	2.47	35.71	19.93	55.64	20.16	58.59	100.5	179.24
		White Perch	2.93	4.19	7.12	93.75	29.41	123.16	45.96	277.2	372.5	695.68
1988	Route 35 Bridge	Blue Crab (H/M)	0.6	0.46	1.06	6.25	5.79	12.04	<10	40.06	52.88	92.94-102.94
		Blue Crab (H)	1.23	1.76	2.99	66.49	18.9	85.39	<10	125.9	178	303.84-313.84
		Blue Crab (M)	0.5	<0.1	0.5-0.6	3.99	<2.5	3.99-6.49	<10	11.29	12.71	24-34
		Bluefish	1.21	1.6	2.81	85.1	37.79	122.89	29.56	147.6	167.4	344.5
		Striped Bass	0.63-1.47	0.5-1.26	1.13-2.73	30.36-35.16	7.63-26.47	42.79-56.53	<10-34.72	46.88-60.42	48.36-104.53	95.23-199.67
	Kin Buc Landfill	Blue Crab (H/M)	0.78	1.29	2.07	33.24	7.26	40.5	<10	58.59	103.8	162.4-172.4
		Blue Crab (H)	1.66	1.86	3.52	60.64	21.41	82.05	15.85	197.8	206	419.62
		Blue Crab (M)	0.13	0.14	0.27	3.71	<2.5	3.71-6.21	<10	15.14	15.97	31.11-41.11
		Bluefish	0.7	0.64	1.34	32.67	16.16	48.83	10.86	73.24	73.15	157.25
		Striped Bass	0.36-0.78	0.37-1	0.73-1.78	10.42-36.93	10.29-19.81	30.23-47.22	<10-13.02	58.3-75.76	58.11-85.65	116.41-174.43
		White Perch	0.74	0.87	1.61	56.11	20.58	76.69	32.55	127.8	95.59	255.98

H: Hepatopancreas tissue only

M: Muscle tissue only

H/M: Hepatopancreas and muscle tissues

APPENDIX C

DESCRIPTION OF HEALTH COMPARISON VALUES

Environmental Media Evaluation Guides (EMEGs) and Reference Dose Media Evaluation Guides (RMEG) are estimates of chemical concentrations that are not likely to cause an appreciable risk of deleterious, noncancerous health effects for fixed durations of exposure. These concentrations factor in estimates of receptor body weights and rates of ingestion. EMEGs might reflect several different types of exposure: acute (1-14 days), intermediate (15-364 days), and chronic (greater than 365 days). EMEGs are based on ATSDR's minimum risk level (see definition below) while RMEG's are based on U.S. EPA's reference dose (RfD).

Lowest-Observed-Adverse-Effect-Level (LOAEL) is defined as the lowest dose of chemical in a study, or group of studies, that produces statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

Minimum Risk Level (MRL) is defined as an estimate of daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects (non-carcinogenic) over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specified duration within a given route of exposure. MRLs are based only on noncancerous health effects, and do not consider carcinogenic effects. MRLs can be derived for acute, intermediate, and chronic durations of exposure for the inhalation route.

Other comparison values were based on New Jersey Department of Environmental Protection's (NJDEP) health-based soil clean-up criteria for non-residential contact.