Chesapeake Bay Toxics of Concern List Information Sheets

Chesapeake Bay Program

Basinwide Toxics Reduction Strategy Commitment Report

May 1991

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Prepared by the Chesapeake Bay Program Toxics Subcommittee's
and
Living Resources Subcommittee's
Joint Criteria and Standards Workgroup

May 1991

Printed by the United States Environmental Protection Agency
for the
Chesapeake Bay Program

EXECUTIVE SUMMARY

The 1987 Chesapeake Bay Agreement identified the improvement and maintenance of water quality as the most critical elements in the overall restoration and protection of the Chesapeake Bay. In order to achieve a reduction of toxics consistent with the Water Quality Act of 1987, the Agreement called for the development and adoption of a Basinwide Toxics Reduction Strategy. The Strategy, adopted by the Chesapeake Executive Council in January 1989, contains a number of commitments in the areas of research, monitoring and toxics management necessary to achieve a comprehensive approach to toxics reduction in the Chesapeake Bay. One of the commitments specifies the creation of a Chesapeake Bay Toxics of Concern List and supporting matrix of information to be used to establish priorities for future toxics research and management initiatives.

The Chesapeake Bay Program's Toxics and Living Resources Subcommittees convened the joint Criteria and Standards Work Group in October 1989 to develop the Toxics of Concern List. The work group finalized its development approach in the form of a publicly reviewed workplan (Appendix A). After months of data collecting and analyzing of chemical ranking systems, ambient concentrations of toxic substances and aquatic toxicity data, the work group identified the toxic substances which represented immediate or potential threat to the Chesapeake Bay system. The initial Toxics of Concern List was derived using an interim process because all the necessary data bases and information systems described in the workplan were not available. This list and the supporting information (Appendix B) was presented and approved by both the Toxics Subcommittee and the Living Resources Subcommittee, with final approval by the Implementation Committee on January 31, 1991.

The toxic substances included on the initial Toxics of Concern List are:

Atrazine
Benzo[a]anthracene
Benzo[a]pyrene
Cadmium
Chlordane
Chrysene
Chromium
Copper
Fluoranthene
Lead
Mercury
Naphthalene
PCBs
Tributyltin

The Basinwide Toxics Reduction Strategy requires the Toxics of Concern List to be reviewed and revised as necessary every two years after the initial list is developed. The work group plans to complete a revision of the initial list within one year in order to institutionalize a more comprehensive ranking and selection process, and then to follow the two year revision/update schedule outlined in the Strategy. Future revisions of the Toxics of Concern List will incorporate the latest available information to the Chesapeake Bay Program on point and nonpoint source loadings, ambient concentrations, aquatic toxicity, and federal and state regulations and/or restrictions.

1990 TOXICS OF CONCERN LIST
CRITERIA AND STANDARDS WORK GROUP FINAL REPORT TO THE TOXICS SUBCOMMITTEE

This report presents the findings of the members of the Criteria and Standards Work Group who gave their time and expertise to produce this initial Toxics of Concern List (TOCL).

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Robin Laird, Chesapeake Bay Liaison Office/Chesapeake Research Consortium, acting as staff to the Work Group, provided a significant contribution. Her efforts are largely responsible for the successful development of this list and supporting documentation.

The Work Group would also like to acknowledge the efforts of the following people who attended the Work Group's meetings and were instrumental in developing the initial Toxics of Concern List.

Richard Jackson
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Deirdre Murphy
Maryland Dept. of the Environment

Chuck Prorok
Computer Sciences Corporation

RECOMMENDATIONS

'The Work Group established a set of recommendations for each toxic substance on the Toxics of Concern List (see Appendix B). The following is a cumulative list of all the recommendations developed for the toxic substances on the Toxics of Concern List:'

(1) The research needs identified by the Work Group in its recommendations for each substance be made a priority for any research sponsored by the Toxics Subcommittee and the Chesapeake Bay Program.

(2) The Toxic Loading Inventory development effort emphasize data collection for these toxic substances and those identified below as candidates for the Toxics of Concern List pending further review.

(3) The pesticide usage surveys conducted in the Bay watershed be designed to ensure the inclusion of any pesticides on the TOCL and those toxic substances identified elsewhere in this report as potential candidates for the TOCL, pending further review.

(4) Any research monitoring funded by the Chesapeake Bay Program or the Signatories to the Chesapeake Bay Agreement be required to submit the raw data from the research or monitoring to the Chesapeake Bay Program Computer Center in the appropriate format for easy inclusion. The documentation shall include the quality control/quality assurance procedures used to assure the validity of sample collection and analyses. Publication of data in peer reviewed literature should be encouraged.

(5) Programs directed at the minimization or elimination of the discharge of these toxic substances target non-point as well as point sources.

(6) The State signatories to the Bay Agreement give the substances listed as Toxics of Concern priority for consideration of water quality criteria adoption during their triennial review.

(7) Monitoring programs in all media within the Bay watershed include these substances in order to further identify sources and quantify loadings to the Bay system. To ensure best use of limited resources, monitoring efforts should recognize the seasonal variations associated with certain substances such as pesticides.

(8) Where monitoring demonstrates that concentrations of a particular toxic substance(s) in the ambient water column are elevated, the potential for toxicity impact should be investigated.

(9) Where monitoring demonstrates that a toxic substance does not appear in quantities sufficient to cause an impact, discontinue monitoring.

(10) Where monitoring and investigation show a toxic substance is causing an impact, or has reasonable potential to cause an impact, the development of water quality criteria should be given priority.

(11) Where existing gaps in the acute and chronic toxicity data necessary for aquatic life water quality criteria development are identified, appropriate toxicity tests using Bay resident or other representative species necessary to complete the data base be given top priority in Bay research.

(12) The success of existing regulatory actions for the TOCL be evaluated in 1993 to determine the need for further controls. The evaluation should include a review of monitoring data, substance usage where appropriate, environmental trends, permitting controls, and enforcement actions.

(13) Formally adopted water quality criteria be integrated into the respective states' total regulatory program. Where available data demonstrate exceedance of criteria, states should initiate appropriate regulatory investigation and controls.

(14) Priority be given to the acquisition and integration of data into the Chesapeake Bay Program Computer Center database for use in revising the TOCL in the next year. This includes data from existing water column, tissue and sediment monitoring programs, and effluent and other sample data as well as the results of scientific investigations.

(15) The following management practices be considered for implementation:

(a) Aggressive public education campaigns be launched to educate the general public as to their role in preventing pollution in the Bay.

(b) Citizens be encouraged to conserve energy to save fossil fuels, thereby lessening pollution by:

- increasing home heating efficiency;
- servicing their home oil burners regularly to keep them running at peak efficiency;
- lowering home thermostats to 68° F. in the winter;
- using caulk and weather stripping to stop home heat loss;
- recycling used motor oil from cars, lawn mowers, and other mechanical devices at licensed service centers;
- repairing automotive leaks of fluids and oils; and
- careful handling and efficient use of fuels in recreational vehicles and boats.

(c) To limit pesticide application, IPM programs for home, garden and institutional use be developed.

(d) Jurisdictions that do not have household hazardous waste days and used oil disposal programs be encouraged to start these programs.

(e) Hazardous waste days similar to the programs for household chemicals be established to provide farmers with the opportunity to dispose of leftover lots of pesticides and other toxics substances.

OBJECTIVE

The principal objective of the Toxics of Concern List (TOCL) is to identify and provide concise documentation on key toxic substances either adversely impacting the Bay system or for which the reasonable potential to do so exists. This list will provide Chesapeake Bay resource managers and regulators with the information needed to target these toxic substances for additional research, monitoring and assessment. The TOCL may also be used to strengthen existing or to establish new regulatory control and prevention actions. Potential management uses of the TOCL include non-point source control targeting (agriculture, urban, stormwater); point source permits and regulations; restriction on banning of products; criteria development and standards promulgation; and decisions to require monitoring or assessment of specific sources.

All managers involved with environmental decision-making related to toxic substances are faced with the task of compiling and assessing a wide diversity of scientific and technical information in order to deal effectively with toxic issues. The TOCL provides a Baywide consensus of priority toxic substances. The comprehensive compilation of toxic substance information associated with the TOCL in the consistent format necessary to establish priorities will assist responsible agencies in addressing regional and Baywide toxicant-specific problems. The States will be able to use the list to target development of water quality criteria and promulgation of standards, where applicable, consistent with the commitments contained within the Basinwide Toxics Reduction Strategy.

INTRODUCTION

The Criteria and Standards Work Group was created in October 1989 to accomplish the task of implementing the following commitment from the Chesapeake Bay Toxic Reduction Strategy.

> "The Signatories commit to develop and update a Chesapeake Bay Toxics of Concern list, maintain a matrix of supporting information, and utilize the list and the supporting matrix to establish priorities for future standards adoption, monitoring, assessment, research, and toxic reduction actions as described within this Strategy."

In developing the Toxics of Concern List (TOCL), the Work Group had to assess the extent and pertinence of the information available. The formidability of this task quickly became apparent as the Work Group, together with the Chesapeake Bay Liaison Office (CBLO) staff, struggled with data collection and evaluation. Information available from federal, state and research institutions varies from the extremes of raw field measurements to unpublished and published reports. Generally, for the purposes of developing the TOCL, the necessary supporting information concerning the quality control/quality assurance procedures associated with most data was lacking. Many measurements were reported without detection levels, as estimates, or with insufficient documentation to determine their validity. The experience of the Work Group in developing the first TOCL illustrates the overwhelming need for coordination of research objectives, data collection and comprehensive analyses in order to accurately assess the Bay's toxicity problems. This need includes the provision of appropriate quality control/quality assurance procedures to ensure that the sample collection and analyses are valid and that the raw data collected for any project funded by any signatory of the Bay Agreement is submitted in an appropriate format for the data's immediate inclusion in the Chesapeake Bay Program Computer Center.

The disparity and lack of cohesiveness in the data base search made quantitative and qualitative assessment of toxic impact difficult on a baywide basis. Cognizant of this problem, the Work Group grappled with the need to validate the perception of impact associated with certain toxic substances. The available information in many cases was strongly suggestive of potential or actual impact but not definitely conclusive. This finding is reflected in many of the Work Group's recommendations which call for additional monitoring and impact assessment prior to water quality criteria development and adoption of additional regulatory controls.

Some substances, such as chlordane and PCBs, were included in the Toxics of Concerns List although usage is banned or severely restricted. Although it may appear at first glance that no further regulatory controls are needed, some of these substances continue to have an impact and are addressed through fish advisories or discovery of potential "hot spots". The relative importance of continuing non-point source (NPS) contribution of the substances needs to be documented and evaluated to determine whether NPS controls are needed and what technologies are available.

Some toxic substances which have been associated with localized impacts in the Bay watershed do not appear on the TOCL. Their absence in no way diminishes their importance in a specific situation or locality. For example, Kepone contamination in the Bay watershed is confined to the James River. The TOCL addresses the broad watershed perspective of the Chesapeake Bay and attempts to identify toxic substances, the impacts, of which have ramifications across jurisdictional boundaries and throughout the fresh, estuarine and salt water environments.

APPROACH

To accomplish its task, the Work Group developed a Work Plan which detailed the process to be followed in developing the Toxics of Concern List (TOCL). The full Work Plan is attached to this report as Appendix A. The main components of the Work Plan are:

* Solicit public comment and input to the draft Work Plan;
* Identify the toxic substances discharged to the Chesapeake Bay watershed;
* Develop a computerized information matrix for all toxic substances that may enter the Bay watershed;
* Develop and apply a numerical ranking system to assist in prioritizing the relative importance of toxic substances discharged into the Bay watershed;
* Verify that the substances on the draft TOCL cause or have reasonable potential to cause an adverse impact on natural resources or human health in the Bay watershed;
* Identify the need for water quality criteria development for the TOCL and the need to generate additional information as necessary;
* Recommend to the Toxics Subcommittee specific actions for the regulation, management, control or prevention of discharge for each toxic of concern;
* Present the final TOCL to the Implementation Committee for final approval and adoption; and
* Update the TOCL on a biennial basis using the procedure outlined in the Work Plan.

The Chesapeake Bay Basinwide Toxics Reduction Strategy required the Signatories to the Bay Agreement to hold a public meeting to invite input from the public on the Work Plan for developing the TOCL. This meeting was held on December 19, 1989 in Washington, D.C. under the sponsorship of the Chesapeake Bay Program's Citizen Advisory Committee.

Because most of the information sources and data compilations identified in the Work Plan are in their embryonic stages, the Work Group was forced to compensate for data inadequacies. Specifically, the Work Group modified its adherence to the Work Plan as follows:

1) Chesapeake Bay Basin Comprehensive List of Toxic Substances - Since this list is constantly evolving as the Toxics Loading Inventory and ambient concentrations database expand, the Work Group used the listing of 360 substances available as of January 30, 1990.

2) Ranking System - The Work Plan presents a ranking system to prioritize the relative importance of the toxic substances in an objective, uniform manner. Unfortunately, the data base to support the ranking system is just beginning to be developed. Data available in a usable and accessible form was limited to the 1989 SARA Title III listing of chemicals. After considerable discussion, the Work Group elected to edit the SARA listing to include only those chemicals identified as discharged in the Chesapeake Bay watershed. This Bay subset of 166 substances was ordered, by priority, using the ranking system.

3) Chesapeake Bay Verification - The Work Group selected the top 10% (17 substances) of the 166 ranked Bay toxic substances listing for closer examination. This examination was focused to verify that these substances were currently being directly discharged to surface waters of the Bay watershed, to identify known sources and, where possible, the quantities discharged and their impacts. This process identified a myriad of inadequacies in the available information systems and data bases. It also highlighted the need for adequate support staff for this Work Group to function.

Completion of this exercise left the Work Group dissatisfied with the results. The Work Group elected to augment its activities through a more informal process. Work Group members were given two weeks to solicit from their respective organization(s) a listing of those toxic substances believed important in the Bay watershed. The lists were cross-matched with the draft list developed through the Work Plan. From this process a list of fourteen primary substances and ten potential candidate substances emerged.

The Work Group then turned its attention to refining and verifying this list. An information sheet was developed for each of the fourteen substances to be included in the Toxics of Concern List. The information sheet summarizes relevant information concerning human health effects, aquatic life effects, usage, environmental fate and persistence, known criteria or standards, known concentrations in the Bay watershed, research and management recommendations and information sources. The information sheets (Appendix B) represent the first level of the matrix of supporting information required under the Chesapeake Bay Basinwide Toxic Reduction Strategy commitment.

The Work Group also identified a secondary group of toxic substances which, pending review, may ultimately be considered for inclusion in future Toxics of Concern Lists. This list includes:

Alachlor
Aldrin
Arsenic
Dieldrin
Diflubenzuron (dimilin)
Fenvalerate
Metolachlor
Permethrin
Toxaphene
Zinc

4) Recommendation - The information sheet developed for each substance included in the TOCL contains specific recommendations for further investigation or future management of the substance. Recommendations to assist with the gathering of additional information and the further review of the toxic substances identified as potential candidates for the TOCL are included in Appendix C.

5) TOCL Revisions - Future revisions of the Toxics of Concern List will incorporate the latest available information on point and non-point source loadings, ambient concentrations, aquatic toxicity characteristics, and federal and state regulations or restrictions. The Strategy requires the Toxics of Concern List to be reviewed and revised as necessary every two years after the initial list is developed, either adding or deleting toxic substances as appropriate. Since the Work Plan could not be fully implemented by the Work Group because various key components remain incomplete, the Work Group plans to complete a revision of the list within one year. This more complete demonstration that the process can work will provide the foundation for the biennial updates required.

FUTURE DIRECTION

This report, which presents the initial Chesapeake Bay Toxics of Concern List and supporting matrix of information, meets the Basinwide Toxics Reduction Strategy Commitment for the creation of a Toxics of Concern List. The Work Group plans to update the Toxics of Concern List within one year of this initial list's publication. This immediate revision exceeds the biennial requirement stated in the Toxics Reduction Strategy. The Work Group felt this was necessary in order to consider the latest data available and to formalize the process used to rank and select the toxic substances for the Toxics of Concern List.

Simultaneously, the Work Group will investigate current EPA commitments for criteria development for any or all of these substances. The Work Group will also explore mechanisms available for potential criteria development among the signatories to the Bay Program and will report its findings to the Subcommittee.

CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees' Criteria and Standards Work Group

CHESAPEAKE BAY TOXICS OF CONCERN INFORMATION SHEETS

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

CHESAPEAKE BAY TOXICS OF CONCERN INFORMATION SHEETS

ATRAZINE

Chemical Names: 6-Chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine; 2-chloro-4-ethylamino-6-iso-propylamine-s-triazine.
Other Names: AAtrex; Atranex; Gesaprim; Primatol A (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o This pesticide should be incorporated into the individual states' pesticide use surveys.
- o Monitor surface water column to determine atrazine in the Bay watershed and to demonstrate its decreased usage. Monitoring should be timed to periods of highest applications. If atrazine is detected, then consider conducting decay rate monitoring.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates atrazine concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Encourage farmers to dispose of leftover lots of atrazine and other restricted use or banned pesticides by sponsoring throughout the Bay watershed pesticide disposal days similar to the programs for household chemicals.
  - Use county extension agents, farm bureaus and other farm oriented groups to promote participation.
  - Prepare flyers providing locations to be distributed through various farm groups and farm suppliers; include lists of targeted pesticides to help farmers identify small lots to be disposed of.

Research Recommendations/Proposed Management Actions (continued):

- o Encourage jurisdictions that do not have household hazardous waste disposal days to start one.
- o Encourage homeowners and any facility requiring garden maintenance to have plant pests identified accurately for proper treatment.
- o Encourage judicious use of pesticides by homeowners and strict adherence to label directions.
- o Encourage development of integrated pest management (IPM) for home, garden and industrial use.
- o Select plant and lawn varieties that are naturally resistant to identified pest problems.

General Description:

Usage Summary:

Atrazine is a restricted use herbicide. Use is primarily on corn in the Bay region, with minor uses on fruit and vegetable crops. Atrazine is usually applied either before plant germination or after plants are approximately 12 inches tall. Multiple applications may be used to control yellow nutsedge, quackgrass, or canada thistle. 1,170,000 pounds of atrazine were applied in Maryland in 1988 compared to the 1,600,000 pounds applied in 1985 (MDA, 1990 & 1986). In 1985, within three Pennsylvania watersheds, 60,780 pounds of atrazine were applied on 53,610 acres and an undetermined amount of acreage for other crops (PDA, 1986).

Environmental Fate and Persistence:

Atrazine has been identified as a potential groundwater contaminant. Atrazine exhibits low vapor pressure, moderate solubility in water, high leaching potential,slow degradation in soils, and moderate adsorption to soils (US EPA, 1990b). Atrazine's half-life in soils is variable with a range of 28-181 days being reported (Walker and Zimdahl, 1981). Its half-life in water has been reported as 66 days (NOAA, 1989).

Regulatory Status / Restrictions:

Effective September 1, 1990 products containing atrazine will be labeled for restricted use and may then only be purchased and used by a certified applicator. Exempt from this are lawn care products which contain 2% or less atrazine in the formulation (US EPA, 1990b).

Atrazine is subject to regulation by its inclusion on the list of toxic chemicals subject to the provisions of the Safe Drinking Water Act Amendments of 1986 (List of Lists, 1988).

Human Health Summary:

Although little information is available on the toxicity of atrazine to humans, laboratory research indicates a high potential for human toxicity (MDE, 1990). The primary routes for human exposure are inhalation and dermal exposure during application, and ingestion of contaminated drinking water. An interoffice U.S. EPA group is currently reviewing available data to determine atrazine's potential human carcinogenicity (IRIS, 1990).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):
Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
None	None	None	None	None	None

(U.S. EPA, 1986)

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. **Adult Lifetime Health Advisory Level for Drinking Water** = 3.0 ug/L (U.S. EPA, 1989).

FDA Action Level (regulated level for fish and shellfish tissue) - None.

State/D.C. Standards Adopted (ug/L)
The following is a list of the standards adopted by the Chesapeake Bay Program states and D.C. for atrazine:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	None	None	None	None	None	None
MD	None	None	None	None	None	None	None
PA	None	None	None	None	None	N/A	N/A
VA	None	None	None	None	None	None	None

Concentrations in Chesapeake Bay Watershed

Atrazine was measured during the period from 1977 through 1986, in surface waters, sediments, rain water, fog, air, groundwater, surface run-off and drinking water supplies in the Chesapeake Bay Watershed (Beane, 1977; Wu, 1979; Wu et al, 1980; Glotfelty et al, 1984; Glotfelty et al, 1986; Elmore and Weaver, 1987; Glotfelty et al, 1987; Brinsfield, et al, 1987; Brinsfield, et al, 1988; and Takita, 1989).

Water

Atrazine concentrations in the Wye River during 1981-1983, were at least an order of magnitude lower than in the tributaries, and decreased with increasing salinity. Atrazine levels in the Wye decreased with a 30 day half life over the growing season (Glotfelty, et al, 1984).

During 1981, atrazine concentrations in the open waters of the Chesapeake Bay rarely exceeded 1 ug/L; in major tributaries, such as the Choptank and Rappahannock Rivers, concentrations of 5 ug/L occurred after a major spring runoff. These runoffs sometimes generated transient, 2- to 6-hour concentrations up to about 40 ug/L in secondary tributaries (Kemp, et al. 1983).

Concentration	Site	Year	Reference
.006-2.5 ug/L	Rhode River, MD Choptank River, MD Poplar River, MD	1976-1978	Beane, 1977 and Wu, 1979
≤ 300ug/L	Wye River, MD	1981-1983	Glotfelty, et al 1984

Sediment

Concentration	Site	Year	Reference
< 0.2 - 799 ug/kg	Rhode River, MD Choptank River, MD Poplar River, MD	1976	Beane, 1977

Tissue

Still acquiring available data.

Toxicity to Chesapeake Bay Biota or Surrogate Species

Atrazine is moderately toxic to aquatic invertebrates and fish (U.S. EPA, 1986).

Acute Toxicity
LC50 = Lethal Concentration to 50% of the laboratory test population.
EC50 = Effect Concentration to 50% of the laboratory test population.
LC100 = Lethal Concentration to 100% of the laboratory test population.

Acute Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species: Alga, Anabaena	LC50	60 ug/L	CIBA-GEIGY,1989
Eelgrass, Zostera marina	LC50 2 day	100-540 ug/L	AQUIRE, 1988
Navicula	LC50	220 ug/L	CIBA-GEIGY,1989
Rainbow trout	LC50 4 day	24,000 ug/L	AQUIRE, 1988
Bluegill	LC50 4 day LC50 7 day	42,000 ug/L 6,700 ug/L	AQUIRE, 1988 Macek et al 1976
Estuarine/Saltwater species:			
Alga, Cyclotella meneghiniana	oxygen inhibition	1.0 ug/L	Millie and Hersh 1987
Copepod, Acartia tonsa	LC50 4day	94 ug/L	AQUIRE, 1988; Ward and Ballantine,1985
Wild celery, Vallisneria americana	LC 100 3 day	120 ug/L	Correll and Wu, 1982
Channel catfish Ictalurus punctatus	LC50 4 day	310-340 ug/L	AQUIRE, 1988
Daphnia magna	LC50 2 day	6900 ug/L	Macek et al 1976
Sheepshead Minnow	LC50	16000 ug/L	CIBA-GEIGY,1989
Other: Birds	LC50	>5,000,000 ug/L	CIBA-GEIGY,1989

Chronic Toxicity

IC50 = Inhibitory Concentration of net photosynthesis to 50% of the laboratory population.

Species	Endpoint	Concentration	Reference
Freshwater species:			
Wild Celery, *Vallisneria americana*	IC50	163-532 ug/L	Forney and Davis, 1981
Estuarine/Marine Species:			
Sago pondweed *Potamogeton pectinatus*	IC50	29 ug/L	Fleming, Momot and Ailstock, 1988
Redhead Grass, *Potamogeton perfoliatus*	IC50	55 ug/L	Kemp et al 1985; Larsen et al, 1986
Potamogeton perfoliatus	IC50	30-130 ug/L	Kemp et al. 1982;1985
Potamogeton perfoliatus	decreased growth 4 week	130 ug/L	Cunningham et al. 1984
Potamogeton perfoliatus	IC50	907 ug/L	Forney and Davis, 1981
Eurasian Watermilfoil, *Myriophyllum spicatum*	IC50	91 ug/L	Kemp et al. 1982;1985
Myriophyllum spicatum	IC50	1104 ug/L	Forney and Davis, 1981

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

CHESAPEAKE BAY TOXICS OF CONCERN INFORMATION SHEETS

CADMIUM (Cd)

Research Recommendations/Proposed Management Actions:

- The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- Research the relative contribution of various sources, particularly nonpoint sources, of cadmium to the Bay basin.
- Fund Baywide research targeted monitoring of point and nonpoint sources to determine existing cadmium concentrations.
- Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates cadmium concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.

General Description:

Usage Summary:

Cadmium is a naturally occurring element. Cadmium is used in electroplating other metals, batteries, pigments, stabilizers for plastics, nuclear reactor rods, and as a catalyst. It is a component of easily fusible alloys, soft solder for aluminum, process engraving, and photoelectric cells. It is also found in tires and gasoline and other fossil fuel products. The powder is also used as an amalgam in dentistry. Cadmium enters the environment primarily through industrial and municipal effluents, landfill leaching, nonpoint source runoff and atmospheric deposition (U.S. EPA, 1990).

Environmental Fate and Persistence:

Cadmium does not degrade and tends to bind to sediment. Cadmium is slightly soluble in water (Merck Index, 1989). Readily bioaccumulated by aquatic organisms, higher concentrations of cadmium are found in tissue than in water.

In most well oxygenated fresh waters that are low in total organic carbon, free divalent cadmium will be the predominant form. In salt waters with salinities from 10 - 35 parts per thousand, cadmium chloride complexes predominate. In both fresh and salt waters particulate matter and dissolved organic material may bind a substantial portion of the cadmium (U.S.EPA, 1985).

Regulatory Status / Restrictions:

Cadmium is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

- o CERCLA Reportable Quantities List,
- o toxic chemicals subject to the provisions of the Clean Water Act Amendments (Priority Pollutant List),
- o RCRA Appendix VIII List,
- o RCRA Appendix IX Groundwater Monitoring List,
- o toxic chemicals subject to the provisions of the Safe Drinking Water Act Amendments of 1986,
- o toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986, and
- o the Superfund Target Compound List.

Human Health Summary:

Depending on mode and duration of exposure, cadmium may be highly toxic. The primary route for human exposure is inhalation, and in some cases, ingestion of drinking water (U.S. EPA, 1986). Although occupationally inhaled cadmium has been implicated in cancers of the prostate and lung, oral exposure is not considered a cancer risk (IRIS, 1989). Kidney toxicity is the most sensitive effect following chronic exposure to low levels of cadmium (U.S. EPA, 1985b). Chronic exposure to high levels of cadmium in Japanese rice resulted in Itai-Itai disease (bone disease) in older women. Human symptoms following acute oral exposures to high levels, include nausea, vomiting, diarrhea, muscular cramps and salivation (Arena, 1963).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):
Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
3.9*	1.1*	43	9.3	10	None

* The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- 10 ug/L (U.S. EPA, 1989 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) - None.

States/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for cadmium:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	1.1*	None	None	10	None	None
MD	3.9*	1.1*	43	9.3	None	None	10
PA	3.9*	1.1*	None	None	10	N/A	N/A
VA	Virginia is currently awaiting approval of its proposed standards by the state review board.						

* The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).

Concentration Reported in Chesapeake Bay Watershed

Water

Concentration Range	Site	Year	Reference
Non detects - 4.7 ug/L	Possum Point, Potomac River, MD	April 1990	Hall, personal communication
Non detects - 14.0 ug/L	Possum Point-Quantico, Pot. R.	April 1988	Hall et al., 1989
Non detects - 15.0 ug/L	Cherry Hill, Potomac River	April 1986	Hall et al., 1987
7 - 93 ug/L 8 detects/105 samples	Elizabeth River	1988	VWCB, Toxics Data Base,1990
5 - 7 ug/L 4 detects/55 samples	55 sites in MD Ches. Bay basin	Feb. 1989	MDE Toxics Data Base, 1990
5 - 13 ug/L 9 detects/55 samples	55 sites in MD Ches. Bay basin	April 1989	MDE Toxics Data Base, 1990

Sediment

Concentration Range	Site	Year	Reference
0.20 - 2.90 ug/g wet weight	MD sediments within Chesapeake Bay basin	1984	MDE Toxics Data Base, 1990
0.14 - 2.40 ug/g wet weight	MD sediments within Chesapeake Bay basin	1985	MDE Toxics Data Base, 1990
200 - 6,000 ug/g dry sediment 14 detects/40 samples	VA sediments within Chesapeake Bay basin	undetermined	VWCB Toxics Data Base, 1990

Tissue

Cadmium accumulated by fish from water is eliminated slowly, but cadmium accumulated from food is eliminated much more rapidly (U.S. EPA, 1985).

Concentration Range	Site	Year	Reference
< 10 - 1500 ppb whole fish	MD waters in the Chesapeake Bay basin	1970s to present	MDE Toxics Data Base, 1990
< 10 - 2700 ppb fillet/edible portions	MD waters in the Chesapeake Bay basin	1970s to present	MDE Toxics Data Base, 1990
< 10 - 6400 ppb wet weight, oyster	MD waters in the Chesapeake Bay basin	1981-1985	MDE Toxics Data Base, 1990
< 70 - 1,880 ppb wet weight, crab	Baltimore Harbor and 9 Bay tributaries	1981-1985	Garreis and Murphy, 1986
30 - 800 ppb wet weight, fish and shellfish 7 detects/17 samples	VA waters within Chesapeake Bay basin	undetermined	VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

The toxicity of cadmium on aquatic organisms depends in its chemical form. Different species and their lifestages exhibit different sensitivities to cadmium. Water quality parameters affecting the toxicity of cadmium to aquatic life include: hardness, temperature, salinity, dissolved oxygen and the presence of dissolved organic substances (U.S. EPA, 1985).

Acute Toxicity

Cadmium has high acute toxicity to aquatic life. The acute toxicity of cadmium generally increases as salinity decreases (US EPA, 1985).

Freshwater acute values for cadmium are available for species in 44 genera and range from 1.0 ug/L for rainbow trout to 28,000 ug/L for a mayfly (U.S. EPA, 1985). The freshwater biota is the most sensitive group with concentrations of 0.8 to 9.9 ug Cd/L in water causing lethality to several species of aquatic insects, crustaceans, and teleosts (Eisler, 1985).

Saltwater fish species are generally more resistant to cadmium than freshwater fish species. Acute values for thirty species of invertebrates species range from 15.5 ug/L for a mysid to 135,000 ug/L for a oligochaete worm. Saltwater molluscs have species mean acute values from 227.9 ug/L for the Pacific oyster to 19,170 ug/L for the mud snail. (US EPA, 1985) Marine decapod crustaceans lethal concentrations have been observed from 14.8-420 ug/L. (Eisler, 1985)

Acute Toxicity

Species	Endpoint	Water Concentration	Reference
Freshwater species:			
Striped bass larvae	96 h LC50	3.7 ug/L	Columbia National FisheriesResearch Laboratory, 1983
Estuarine/Saltwater species:			
Mysid, *Neomysis americana*	96 h LC50	30 ug/L	Roberts, Jr., et al, 1981
Mysidopsis bahia	96 h LC50	50-60 ug/L	Roberts, Jr., et al, 1981
Copepod, *Eurytemora affinis*	96 h LC50	60 ug/L	Roberts, Jr., et al, 1981
Eastern Oyster (larva) *Crassostrea virginica*	96 h LC50	3800 ug/L	Calabrese et al 1973
Acartia tonsa	96 h LC50	380 ug/L	Roberts, Jr., et al, 1981
Atlantic silverside, *Menidia menidia*	96 h LC50	340 ug/L	Roberts, Jr.,et al, 1981
Menidia menidia (larvae)	96 h LC50	577 - 1054 ug/L	Cardin, 1982
Sheepshead minnow, *Cyprinodon variegatus*		960 ug/L	Roberts, Jr., et al, 1981

Acute Toxicity (continued)

Species	Endpoint	Concentration	Reference
Mud snail, *Nassaruis obsoletus*	96 h LC50	10,500 ug/L	Eisler, 1971
Juvenile mummichog, *Fundulus heteroclitus*	96 h LC50	29,000 - 114,000 ug/L	Voyer, 1975
Oligochaete worm, *Monophylephorus cuticalatus*		135,000 ug/L	Chapman et al 1982

Chronic Toxicity

Sublethal effects in freshwater biota include decreased growth, inhibited reproduction, and population alterations which occur in cadmium concentrations between 0.7 - 5.0 ug/L. These effects are most pronounced in waters of low alkalinity. Marine sublethal effects occurring in concentrations of 0.5 - 10 ug/L, include decreased growth, respiratory disruption, altered enzyme levels, and abnormal muscular contractions. These effects were associated with marine waters with relatively low salinities and high temperatures (Eisler, 1985).

EC50 = concentration which caused 50% inhibition of carbon uptake.
LOEC = Lowest Observed Effect Concentration.

Species	Endpoint	Concentration	Reference
Freshwater species: *Ceriodaphnia reticulata*	LOEC	3.4 - 7.2 ug/L	Spehar and Carlson, 1984a,b
Smallmouth bass, *Micropterus dolomieni*	LOEC	4.3 - 12.7 ug/L	Eaton et al 1978
Aquatic plants		2 - 7,400 ug/L	U.S. EPA, 1985
Marine Species: Microalgae: *Prorocentrum minimum*	EC50	12,000 ug/L	Roberts, Jr., et. al., 1981
Pseudoisochrysis paradoxa	EC50	167,000 ug/L	Roberts, Jr., et. al., 1981
Skeletonema costatum	EC50	681,000 ug/L	Roberts, Jr., et. al., 1981

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CHESAPEAKE BAY PROGRAM
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TOXICS OF CONCERN INFORMATION SHEETS

CHLORDANE

Chemical Name: 1,2,4,5,6,7,8,8-octachloro-4,7-methane-3a,4,7,7a-tetrahydro-indane.
Other Names: Chlordan; CD-68; M-410; Octachlor; Belt; Chlor-Kil; Chlortox; Velsicol 1068; Toxichlor; Niran; OrthoKlor; Prentox; Kilex; Synklor; Corodane; Gold Crest C-50; Termi-Ded (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
o This pesticide should be incorporated into the individual states' pesticide use surveys.
o No further regulatory action is recommended because of the complete ban on chlordane as of April 15, 1988.
o Investigate the relative contribution of chlordane to Bay waterways, including perhaps monitoring to provide estimates of continued input from runoff. Recommend needed controls of nonpoint sources where technology exists.
o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates chlordane concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
o Encourage farmers, pesticide applicators and home owners to dispose of chlordane and other restricted use or banned pesticides by sponsoring throughout the Bay watershed pesticide disposal days similar to the programs for household hazardous chemicals.
o Target existing household hazardous waste programs to include chlordane.
o Encourage jurisdictions that do not have household hazardous waste disposal days to start one.
o Encourage homeowners and any facility requiring garden maintenance to have plant pests identified accurately for proper treatment.

Research Recommendations/Proposed Management Actions (continued)

- o Encourage judicious use of pesticides by homeowners and strict adherence to label directions.
- o Encourage development of integrated pest management (IPM) for home, garden and industrial use.
- o Select plant and lawn varieties that are naturally resistant to identified pest problems.

General Description:

Usage Summary:
Technical grade chlordane is an insecticide composed of a mixture of various chlorinated hydrocarbons. Prior to the moratorium on its use in 1988, chlordane was commercially applied for termite control on residential as well as commercial establishments. It was also used prior to 1980 on home gardens, and agricultural crops such as corn. Only existing stocks of chlordane already purchased by homeowners are allowed to be applied (US EPA, 1986). Because of its widespread use in the past, chlordane enters the environment in agricultural and residential runoff. 1,900 pounds of chlordane were applied in Maryland in 1988 compared to 256,000 pounds applied in 1985 (MDA, 1990 & 1986).

Environmental Fate and Persistence:
Chlordane is slightly soluble in water, with 1 mg or less mixing in one liter of water. It is highly persistent in water, with a half-life of > 200 days. Chlordane may have a potential for contaminating surface water (US EPA, 1986). Chlordane tends to accumulate within the soils it has been applied to more so than in adjacent aquatic sediments and water. (U.S. EPA, 1990) Chlordane degrades under natural environmental conditions to photoisomers which are more toxic to certain animals and also show higher bioaccumulation (IRIS, 1989). Chlordane is readily soluble in fats and fat soluble substances (Brooks, 1974).

Regulatory Status / Restrictions:

Most registered agricultural uses of chlordane were cancelled by the EPA, Office of Pesticide Programs - December, 1978. Its sale and distribution has been prohibited in the U.S. since April 15, 1988. Commercial use of existing stocks of these termiticide products is also prohibited. Use of existing stocks of termiticide products in the possession of homeowners is also permitted (US EPA, 1990a).

Chlordane is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

- o CERCLA Reportable Quantities List,
- o Hazardous Substances under Section 311 (b)(2)(A) of the Federal Water Pollution Control Act,
- o Priority Pollutant List,
- o RCRA Appendix VIII List,
- o RCRA Appendix IX Groundwater Monitoring List,

Regulatory Status / Restrictions: (continued)
- o SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
- o the toxics chemicals subject to the provisions of the Safe Drinking Water Act Amendments of 1986,
- o the toxics chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986,
- o compounds on the "Acutely Toxic Chemicals" List in EPA's Chemical Emergency Preparedness Program.

Human Health Summary:

Technical grade chlordane has been labelled moderately hazardous by the World Health Organization (WHO, 1984). Human symptoms from consumption of technical grade chlordane range from dizziness, headache, fatigue and slight involuntary muscular movements to involuntary contractions of muscles, epileptiform convulsions and death (Curley and Garrettson, 1969; Klemmer, Budy and Takahashi, 1977). Chronic exposures to elevated dietary levels result in liver damage and central nervous system effects in animal studies. Although insufficient data are available for identification as a known human carcinogen, EPA considers chlordane a probable human carcinogen (US EPA, 1989).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
2.4	.0043	.09	.004	.00046+	.00048 ug+

+ These human health criteria apply to the water column and reflect a cancer risk level of one in one million, and are back calculated to prevent residue concentrations in fish. (US EPA, 1980)

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. **Adult Longer-term Health Advisory** = 0.5 ug/L. Proposed Maximum Contaminant Level = 2.0 ug/L (U.S. EPA, 1989 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) - 300 ppb.

States/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for chlordane:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	0.0043	None	None	.0005	None	None
MD	None	None	None	None	None	None	None
PA	2.4	0.0043	None	None	0.0005	N/A	N/A
VA	Virginia is currently awaiting approval of its proposed standards by the state review board.						

MD - Maryland has three areas (Baltimore Harbor, Back River and Lake Roland), for which fish consumption advisories, for selected species (american eel and channel catfish from the 2 estuarine waters, black crappie and carp from Lake Roland), have been issued in response to findings of mean chlordane levels exceeding the FDA action level.

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
0.152 ug/L (48-h composite)	Potomac River	1988	Hall et al.1989
All non-detects from 110 samples (det. level= 0.16-0.2 ug/L)	55 sites in MD Ches. Bay basin	February & April 1989	MDE Toxics Data Base, 1990

Sediments

Virginia has reported chlordane concentrations ranging between 2 - 16 ppb dry sediments (VWCB Toxics Data Base, 1990).

Tissue

Chlordane has been monitored, by MDE, in fish and shellfish tissue since the early 1970s. Highest concentrations have been reported in fish from urban areas or near areas of past chlordane usage for agricultural purposes. Highest levels, among species, have been observed in bottom feeding fish, with high lipid content (e.g. channel catfish and eels). Levels have ranged from non detectible to greater than 300 ppb, wet weight.

Tissue (continued)

Concentration (ppb)	Species/Site	Year	Reference
5.0 - 699.0 (63 samples)	White Perch Back River, MD		Garreis and Murphy, 1986
82.0 - 1,791.0 (40 samples)	Channel Catfish Back River, MD		"
5.0 - 614.0 (88 samples)	Brown Bullhead Back River, MD		"
184.0 - 482.0 (6 samples)	American Eel Back River, MD		"
4.0 - 614.0 (29 samples)	White Perch Patapsco River, MD		"
187 - 858.0 (4 samples)	Channel Catfish Patapsco River, MD		"
20.0 - 205.0 (7 samples)	Brown Bullhead Patapsco River, MD		"
80.0 - 668.0 (19 samples)	American Eel Patapsco River, MD		"
80.0 - 1,181.0 (32 samples)	Carp Lake Roland, MD		"
47.0 - 360.0 (20 samples)	White Sucker Lake Roland, MD		"
161.0 - 1,033.0 (26 samples)	Black Crappie Lake Roland, MD		"
< 10 - 86.0 wet weight, oyster	MD waters within Chesapeake bay basin	1981-1985	MD Toxics Data Base, 1990
< 10 - 55.0 wet weight, crab	Baltimore Harbor and 9 Bay tributaries	1981-1985	MD Toxics Data Base, 1990
6.0 - 18.0 8 shellfish detects	VA waters within Chesapeake bay basin	undetermined	VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Although chlordane was used as an insecticide for many years, our knowledge of its toxicity including its chemical components and degradation products to aquatic life is limited. The importance of salinity, temperature, or other water quality factors also needs further study.

Acute Toxicity

Chlordane has high acute toxicity to aquatic life. Acute toxicity of chlordane to freshwater fish and invertebrate species occurs at concentrations ranging from 3 to 190 ug/L, with most values falling between 15 and 60 ug/L. Acute toxicity to saltwater fish and invertebrate species occurs at concentrations ranging form 0.4 to 480 ug/L (U.S. EPA, 1980).

Species	Endpoint	Concentration	Reference
Freshwater species: Rainbow Trout, *Salmo gairdneri*	LC50	8 ug/L	Mehrle et al 1974
Bluegill, *Lepomis macrochirus*	LC50	22 ug/L	Henderson et al 1959
Cladoceran, *Daphnia magna*	LC50	35 ug/L	U.S. EPA, 1980
Estuarine/Saltwater species: Carp, *Cyprinus carpio*	LC50	3 ug/L	Rao et al 1975
Grass shrimp, *Palaemonetes pugio*	LC50	4.8 ug/L	Parrish et al 1976
Eastern Oyster, *Crassostrea virginica*	LC50	6.2 ug/L	Parrish et al 1976
Striped bass, *Morone saxatilis*	LC50	11.8 ug/L	Korn & Earnest 1974

Chronic Toxicity

Chronic toxic effects may include shorter lifespan, reproductive problems, lower fertility, and changes in appearance or behavior. Chlordane has high chronic toxicity to aquatic life (US EPA, 1990).

Chronic Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Brook Trout, *Salvelinus fontinalis*	Reduced embryo viability 13 months	0.32 ug/L	Cardwell et al 1977
Bluegill, *Lepomis macrochirus*		1.6 ug/L	"
Midge, *Chironomus* No. 51	larval growth	1.7 ug/L	"
Fathead minnow, *Pimephales promelas*	survival, growth, reproduction 11 months	> 6.03 ug/L	"
Scud, *Hyallela azteca*	reduced growth	11.5 ug/L	"
Cladoceran, *Daphnia magna*		16 ug/L	"
Estuarine/Saltwater species:			
American oyster, *Crassostrea virginica*	EC50 96 hrs	10 ug/L	Mayer, 1987
Blue crab, *Callinectes sapidus*	EC50 48 hrs	480 ug/L	Butler, 1963
Natural phytoplankton community	94% decrease in productivity 4 hours	1,000	Butler, 1963

Chlordane is chronically toxic to the saltwater sheepshead minnow in a full life-cycle exposure at concentrations of 0.8 ug/L or greater; survival of juveniles was reduced at 18 ug/L and their survival through adulthood is reduced at 2.8 ug/L (Parrish, et al., 1978).

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

TOXICS OF CONCERN INFORMATION SHEETS

CHROMIUM (Cr)

Research Recommendations/Proposed Management Actions:

- The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- Research the relative contribution of various sources, particularly nonpoint sources, of chromium to the Bay watershed.
- Fund targeted (point and nonpoint source) monitoring to determine existing trivalent (Cr +3) and hexavalent (Cr+6) concentrations.
- Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates chromium concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.

General Description:

Usage Summary:

Chromium is an important trace element that exists mainly in the trivalent (+3) or hexavalent (+6) oxidation states in natural bodies of water. Chromium greatly increases the resistance and durability of metals and is used in the manufacture of chrome-steel or chrome-nickel-steel alloys (stainless steel) and for chromeplating of other metals. Chromium enters the environment primarily through industrial sources such as electroplating and metal finishing industries, tanneries, cooling towers and oil drilling operations (Eisler, 1986). Other sources include chemically treated wood products, urban and industrial runoff and municipal treatment plants.

Environmental Fate and Persistence:

Chromium occurs in water in two primary forms (chromium (+3) and chromium (+6)) and either form can be converted to the other under appropriate natural conditions (Callahan, et al. 1979, Jan and Young, 1978, Smillie, et al. 1981) The chemical and toxicological properties of the two oxidation states appear to be quite different and the toxicities of the two states have not been shown to be additive (US EPA, 1985). Thus, chromium (+3) and chromium (+6) will be treated as separate materials in this discussion.

Regulatory Status / Restrictions:

Chromium is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

o CERCLA Reportable Quantities List,
o Priority Pollutant List,
o RCRA Appendix VIII List,
o RCRA Appendix IX Groundwater Monitoring List,
o SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
o toxic chemicals subject to the provisions of the Safe Drinking Water Act Amendments of 1986,
o toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986,
o Superfund Target Compound List.

Human Health Summary:

Chromium toxicity is due primarily to the hexavalent form, which, upon consumption of toxic concentrations, has been shown to cause damage to liver and kidney, internal hemorrhage, dermatitis and respiratory problems (U.S. EPA, 1985). Trivalent chromium is an essential nutrient required in trace amounts for normal glucose metabolism (U.S. EPA, 1985).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):
Chromium (+6):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
16	11	1,100	50	50	None

(U.S. EPA, 1985)

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- for total chromium = 50 ug/L. Proposed MCL = 100 ug/L (U.S. EPA, 1990).
FDA Action Level (regulated level in fish and shellfish tissue) - None.

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L): Chromium(+3):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
1,700+	210+	10,300*	---	170,000	3,433,000

+ The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).
* L.O.E.L. - Lowest Observed Effect Level (insufficient data to develop Criteria (U.S. EPA, 1985).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- for total chromium = 50 ug/L. Proposed MCL = 100 ug/L (U.S. EPA, 1989).

FDA Action Level (regulated level in fish and shellfish tissue) - None.

States/D.C. Standards Adopted (ug/L):
The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for chromium:

(Chromium +6)
Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	10	None	None	50	None	None
MD	16	11	1100	50	50	None	10
PA	16	11	None	None	50	N/A	N/A
VA	16	11	1100	50	170	3400	None

States/D.C. Standards Adopted (ug/L):
The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for chromium:
Chromium (+3)
Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	None	None	None	None	None	None
MD	1700	210	None	None	None	3,433,000	10
PA	1716T	221T	None	None	170,050T	N/A	N/A
VA	1700	210	None	None	33,000	670,000	None

(T = values are for total chromium.)

Concentrations Reported in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
14, 15, 17 and 110 ug/L	Potomac River (Possum Point area)		Hall et al., 1987
6 ug/L	Potomac River (Possum Point area)	1988	Hall, personal communication
29 ug/L (48h composite)	Potomac River (Possum Point area)	1989	Hall, personal communication
150 ug/L	Potomac River (Possum Point area)	1990	Hall, personal communication
30 - 130 ug/L 40 hits/105 samples	James and Elizabeth Rivers	1983,'85, '87, '88	VWCB Toxics Data Base, 1990
13 - 52 ug/L 6 hits/ 55 samples	55 sites in MD Ches. Bay waters	February 1989	MDE Toxics Data Base, 1990
11 - 119 ug/L (1 @ 5950 ug/L) 13 hits/55 samples	55 sites in MD Ches. Bay waters	April 1989	MDE Toxics Data Base, 1990

Sediments

Among estuarine sediments, chromium concentrations tend to be highest in sediments of small grain size and high organic and iron content (Eisler, 1986). Adsorption of chromium by sediments is salinity-dependent, adsorption is greatest at salinities of 0.1 to 1.0 ppt (Mayer and Schick, 1981).

Concentration	Site	Year	Reference
9.50 - 62.00 ug/g	MD sites within Chesapeake Bay basin	1984	MDE Toxics Data Base, 1990
3.50 - 47.90 ug/g	MD sites within Chesapeake Bay basin	1985	MDE Toxics Data Base, 1990
No detections detection limit = 10 ug/g	5 sites in Baltimore	1988	MDE Toxics Data Base, 1990
4,000 - 185,000 ppb dry sediment 37 detects/40 samples	VA sites within Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Tissue

Chromium has been monitored, by MDE, in fish and shellfish tissue since the early 1970s.

Concentration (ppb)	Site	Year	Reference
< 500 - 4,000 ppb wet weight, whole fish samples	MD sites within Chesapeake Bay basin	1970 to present	MDE Toxics Data Base, 1990
< 500 - 2,100 ppb wet weight, fillet or edible portions	''	1970 to present	MDE Toxics Data Base, 1990
< 100 - 1,500 ppb wet weight, oyster tissue	''	1981-1985	MDE Toxics Data Base, 1990
500 - 1,880 ppb wet weight, crab tissue	Baltimore Harbor and 9 Bay tributaries	1983	MDE Toxics Data Base, 1990
30 - 1,100 ppb wet weight finfish and shellfish 11 detects/17 samples	VA sites within Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Acute Toxicity

Chromium (+3)

Different species exhibit different sensitivities to chromium (+3). Hardness has a significant influence on toxicity with chromium (+3) being more toxic in soft water. Acute values for chromium (+3) for freshwater animal species in 18 genera range from 2,221 ug/L for a mayfly to 71,060 ug/L for a caddisfly. The most sensitive genus, Ephemerella, is about 32 times more sensitive than the most resistent genus, Hydropsyche; interestingly, both are insects (US EPA, 1985).

Species	Endpoint	Concentration	Reference
Freshwater species:			
Rainbow trout eggs	LC100 30-d	495 ug/L	Stevens and Chapman 1984
Fathead minnow	LC50 96-h	5,070 - 67,400 ug/L (soft and hard water	Pickering and Henderson, 1966

Acute Toxicity
Chromium (+3) (Continued)

Species	Endpoint	Concentration	Reference
Freshwater species: Bluegill	LC50 96-h	7,460 - 71,900 ug/L (soft and hard water	Pickering and Henderson, 1966
Daphnia magna	48-h	16,800 (soft water) to 58,700 ug/L (hard water)	Chapman, et al Manuscript
Estuarine/Saltwater species:			
Eastern oyster		10,300 ug/L	U.S. EPA, 1985
Mummichog		31,500 ug/L	U.S. EPA, 1985

Chromium (+6):

Acute toxicity values for chromium (+6) are available for freshwater animal species in 27 genera and range from 23.07 ug/L for a cladoceran to 1,870,000 ug/L for a stonefly. All five tested species of daphnids are especially sensitive. The few data that are available indicate that the acute toxicity of chromium (+6) decreases as hardness and pH increase (US EPA, 1985).

Species	Endpoint	Concentration	Reference
Freshwater species: Cladoceran, *Daphnia magna*	LC50 96-h	435 ug/L	Jouany et al 1982
Estuarine/Saltwater species:			
Polychaete worm	LC50	2,000 ug/L	U.S. EPA, 1985
Crustaceans	LC50	3,100 ug/L	Eisler, 1986
Mud snail	LC50	105,000 ug/L	U.S. EPA, 1985

Chronic Toxicity

Chromium (+3):

Species	Endpoint	Concentration	Reference
Freshwater species: Daphnia magna	lifecycle	66 ug/L (soft water) 44 ug/L (hard water)	U.S. EPA, 1985 ''
Green algae		397 ug/L (soft)	''
Eurasian watermilfoil	root growth inhibition	9,900 ug/L	''
Estuarine/Saltwater species: Fathead minnow	lifecycle	1,025 ug/L (hard)	''

Chromium +6:

Species	Endpoint	Concentration	Reference
Freshwater species: Daphnids (5 species)		< 2.5 - 40 ug/L	U.S. EPA, 1985
Rainbow trout and brook trout		264.7 ug/L	''
Macroalgae		1,000 - 5,000 ug/L	''
Fathead minnow		1,987 ug/L	''
Estuarine/Saltwater species: Polychaete		< 13 - 36.74 ug/L	''
Mysid		132 ug/L	''

* Except for the fathead minnow, all the tests were conducted in soft water.

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
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TOXICS OF CONCERN
INFORMATION SHEETS

COPPER (Cu)

Research Recommendations/Proposed Management Actions

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o Fund acute and chronic toxicity studies designed to narrow the wide gap of uncertainty that surrounds the applicability of existing EPA copper water quality criteria.
  - Document naturally occurring concentrations of copper in estuarine and marine waters in the Bay watershed.
  - Fund toxicity studies using Chesapeake Bay basin species to determine if copper concentrations at or near naturally occurring conditions are toxic to Bay species.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Research the relative contributions of copper to the Bay watershed from natural, point sources and nonpoint sources; focus at least part of the nonpoint research on the contribution of copper from treated wood and boat paints.
- o Measure changes in copper ambient levels resulting from the increased use of copper in boat bottom paints with the restricted use placed on tributyltin (TBT) as a component of antifouling paints.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates copper concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Sponsor public education efforts regarding municipal and nonpoint sources of copper to the Chesapeake Bay basin (e.g. boat scraping).

General Description:

Usage Summary:

Copper, a naturally occurring element, is a minor nutrient for plants, animals and humans (Merck Index, 1989). Copper is widely used in the electrical industry, and plumbing, roofing and building construction. It is used in the manufacture of bronzes, brass, other copper alloys, electrical conductors, ammunition, copper salts, and works of art. It is also used in chemical and pharmaceutical machinery, boat paints, as algicide in water treatment and as copper arsenate in wood treatment. Human activities which introduce copper into the environment include municipal and industrial effluents, particularly from smelting, refining, or metal plating industries, nonpoint source runoff, commercial and recreational boating, mining and water treatment for algae control (Harrison and Bishop, 1984; Hutchinson, 1979).

Environmental Fate and Persistence:

Copper and its salts are highly soluble in water. It is highly persistent in water. Aquatic life bioaccumulates copper in tissue.

Regulatory Status / Restrictions:

Copper arsenate is under voluntary cancellation because of its oncogenicity (the ability to cause tumors) (US EPA, 1990 (February)).

Copper is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

o CERCLA Reportable Quantities List,
o Priority Pollutant List,
o RCRA Appendix IX Groundwater Monitoring List,
o SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
o Safe Drinking Water Act Amendments of 1986,
o toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986, and
o the Superfund Target Compound List.

Human Health Summary:

Copper is an essential human nutrient (U.S. EPA, 1980). Copper toxicity may result from very high dietary levels or a nutritionally deficient intake (U.S. EPA, 1980). Drinking water guidelines are established, not due to toxicity, but for the taste which develops at high concentrations. Occurrence of such levels are extremely rare (U.S. EPA, 1980).

Acute copper poisoning, resulting from ingestion of several grams of copper, may cause a metallic taste, nausea, vomiting, gastric burning and diarrhea (Walsh et al., 1977; Hooper and Adams, 1958).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L): **

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
18*	12*	2.9	2.9	None	None

* The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).

** There is considerable debate over the applicability of these laboratory derived criteria because of the variability of the bioavailability and toxicity of copper due to the influence of multiple environmental factors (e.g. suspended solids, carbon and humic acids).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- for copper = None. Proposed MCL = 1300 ug/L (U.S. EPA, 1990 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) - None.

State/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for copper:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	12*	None	None	1000	None	None
MD	18*	12*	2.9	None	None	None	10
PA	18*	12*	None	None	1000	N/A	N/A
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

* The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).
MD - **Estuarine** Aquatic Life Acute Criteria for copper = 6.1 ug/L.

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
20 and 40 ug/L 2 hits/55 samples (detection level = 25 - 50 ug/L)	55 sites in MD Ches. Bay basin	February 1989	MDE Toxics Data Base, 1990
20 - 69 ug/L 3 hits/ 55 samples (detection level = 25 - 50 ug/L)	55 sites in MD Ches. Bay basin	April '89	MDE Toxics Data Base, 1990
10 - 13,000 ug/L 92 hits/105 samples	James and Elizabeth Rivers	1985, '87 '88, '89	VWCB Toxics Data Base, 1990
34*, 30 and 27 ug/L (Four month mean) *-from a marina	3 stations in Back Creek and Severn R	1988	Hall, personal communication
10,4 and 2.7 ug/L (Four month mean)	3 stations in Back Creek and Severn R	1989	Hall, personal communication
70 - 80 ug/L	Ches. Bay marinas	1988	Hall et al. 1988
47, 60 and 72 ug/L	Potomac River - freshwater areas	1987	Hall et al. 1987

Sediment

Concentration	Site	Year	Reference
2.50 - 56.00 ug/g	MD sites within the Chesapeake Bay basin	1984	MDE Toxics Data Base, 1990
3.70 - 47.60 ug/g	MD sites within the Chesapeake Bay basin	1985	MDE Toxics Data Base, 1990
3,000 - 922,000 ppb dry sediment 40 detects/40 samples	VA sites within the Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Tissue

Concentration (ppb)	Site	Year	Reference
< 10 - 10,000 ppb wet weight, whole fish samples	MD sites within Chesapeake Bay basin	1970 to present	MDE Toxics Data Base, 1990
< 10 - 50,000 ppb wet weight, whole fish - white perch	MD sites within Chesapeake Bay basin	1970 to present	MDE Toxics Data Base, 1990
< 10 - 38,000 ppb wet weight, fillet or edible portions	''	1970 to present	MDE Toxics Data Base, 1990
2,270 -169,000 ppb wet weight, oyster tissue	''	1981-1985	MDE Toxics Data Base, 1990
1,800 - 51,800 ppb wet weight, crab tissue	Baltimore Harbor and 9 Bay tributaries	1983	MDE Toxics Data Base, 1990
300 - 71,000 ppb wet weight finfish and shellfish 11 detects/17 samples	VA sites within Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

The toxicity of copper to aquatic life is dependent upon the physical and chemical conditions of the water. Factors such as water hardness, alkalinity, organic carbon and pH influence copper toxicity. The toxicity of copper to aquatic life has been shown to be related primarily to the activity of the cupric (Cu +2) ion, and possibly to some of the hydroxy complexes. Most organic and inorganic copper complexes and precipitates appear to be much less toxic than the free cupric ion. This greatly complicates the interpretation and application of available toxicity data, because the proportion of free cupric ion present is highly variable and is difficult to measure except in laboratory conditions (US EPA, 1985).

Acute Toxicity

Most of the available tests on the toxicity of copper to freshwater animals have been conducted with four salmonid species, fathead and bluntnose minnows and bluegill. Eisler (1977) demonstrated that copper toxicity varied according to the seasonal temperature, being at least 100 times more toxic to *Mya arenaria* at 22 C than at 4 C.

Acute Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species: *Daphnia magna*	LC50	6.5 ug/L -hard water	U.S. EPA, 1985
Bluegill	LC50	10,200 ug/L -hard	''
Estuarine/Saltwater species: Bay scallop	LC50	5.0 ug/L	''
Blue mussel (embryos)	LC50	5.8 ug/L	''
Pacific oyster (embryos)	LC50	7.8 ug/L	''
Green crab	LC50	600 ug/L	''
Calanoid copepods,			
Acartia tonsa	LC50	17 ug/L	''
Acartia clausi,	LC50	55 ug/L	''
Acartia tonsa	LC50 72-h	9.0-78 ug/L	Sosnowski et al. 1979
Finfishes		13.93 to 411.7 ug/L	U.S. EPA, 1985
Atlantic cod embryos	LC50 14-da	10 ug/L	U.S. EPA, 1985
Striped bass, larvae *Morone saxatilis*	LC50 96-h	24 ug/L	Wright, 1988

Chronic Toxicity

Copper and its compounds have high chronic toxicity to aquatic life. Chronic toxic effects may include shortened lifespan, reproductive problems, lower fertility, and changes in appearance or behavior. (U.S. EPA, 1990b)

Chronic values are available for fifteen freshwater species from the EPA water quality criteria document for copper. Fish and invertebrate species seem to be similar in sensitivity to the chronic toxicity of copper (U.S. EPA, 1985).

Chronic Toxicity (continued)

Species	Endpoint	Concentration	Reference
Freshwater species: Brook trout		3.873 ug/L	U.S. EPA, 1985
Northern pike		60.36 ug/L	,,
Estuarine/Saltwater species: Algae		5 - 100 ug/L	,,

References:

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

TOXICS OF CONCERN INFORMATION SHEETS

LEAD (Pb)

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o Research the relative contributions of various sources, particulary nonpoint sources, such as atmospheric deposition and urban runoff, of lead to the Bay watershed.
- o Fund life cycle toxicity studies using Chesapeake Bay zooplankton.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates lead concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Sponsor public education efforts regarding municipal and nonpoint sources of lead to the Chesapeake Bay basin (e.g. lead solder in plumbing, improper disposal of lead containing paints and automobile usage).

General Description:

Usage Summary:

Lead is a naturally occurring element. It has wide industrial use because of its properties of high density, softness, low melting point, resistance to corrosion and ability to stop gamma- and x-rays. Lead is used as construction material for tank linings, piping, and other equipment handling corrosive gases and liquids. It is also used in petroleum refining, in pigments for paints, storage batteries, ceramics, plastics, and electronic devices, as well as in the metallurgy of steel and other metals. Lead has been widely used in homes, in pipes, soldering of pipe joints, and wall paints. The use of lead to increase the octane levels in gasoline is being phased out. Human activities which introduce lead into the environment include travel by automobile, nonpoint runoff, burning of fossil fuels, and municipal and industrial discharges.

Environmental Fate and Persistence:

Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead and its compounds range in their respective water solubilities from highly soluble to practically insoluble. Lead forms an insoluble complex with sulfide in anaerobic sediments. Lead is bioaccumulated by aquatic life. (US EPA, 1990)

Regulatory Status / Restrictions:

Recent legislation limiting the lead content in paints, gasolines and the elimination of lead in the use of lead shot nationwide as of 1991 in waterfowl hunting areas should substantially reduce environmental burdens of lead (Eisler, 1988).

Lead is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

o CERCLA Reportable Quantities List,
o Priority Pollutant List,
o RCRA Appendix VIII List,
o RCRA Appendix IX Groundwater Monitoring List,
o SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
o Safe Drinking Water Act Amendments of 1986,
o toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986, and
o Superfund Target Compound List.

Human Health Summary:

No adverse effects have been reported for short-term exposures to lead in drinking water. However, chronic (long-term) ingestion of elevated lead in drinking water has several adverse effects: inhibition of red blood cell production and survival, inhibition of vitamin D synthesis, and adverse central nervous system effects in children (U.S. EPA, 1985). Prenatal exposures to elevated lead levels may result in fetal brain damage (U.S. EPA, 1985). Lead is classified by the U.S. EPA as a probable human carcinogen based upon data from rat and mouse studies involving the ingestion of lead salts; there is not adequate human evidence (IRIS, 1990).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
82*	3.2*	140	5.6	50	----

* The toxicity of this compound is hardness dependent. These criteria are derived using a hardness of 100 mg/L CaC03 (U.S. EPA, 1985).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- for lead = 50 ug/L. Proposed MCL = 5 ug/L (U.S. EPA, 1989).

FDA Action Level (regulated level in fish and shellfish tissue) - None.

State/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for lead:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	3.2	None	None	None	None	None
MD	82	3.2	140	5.6	50	None	10
PA	82	3.2	None	None	50	N/A	N/A
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
2-6 ug/L	Potomac River	1986	Hall et al. 1987
12 ug/L	Patuxent River	1988	Hall et al. 1988
6-12 ug/L	Potomac River	1988	Hall et al. 1988
4.1 ug/L	Upper Ches. Bay	1989	Hall, personal communication

Water (continued)

Concentration	Site	Year	Reference
14 ug/L	Potomac River	1990	Hall, personal communication
1 -700 ug/L 33detects/105samples	James and Elizabeth Rivers	1983, '85 '87, '88	VWCB, Toxics Data Base, 1990
5.1 - 126 ug/L 3 detects/55 samples	55 sites in MD Ches. Bay basin	Feb. 1989	MDE Toxics Data Base, 1990
5 - 62 ug/L 5 detects/55 samples	55 sites in MD Ches. Bay basin	April 1989	MDE Toxics Data Base, 1990

Sediment

Concentration	Site	Year	Reference
15,000-86,000 ug/g	MD sites within the Chesapeake Bay basin	1984	MDE Toxics Data Base, 1990
11,500-56,400 ug/g	MD sites within the Chesapeake Bay basin	1985	MDE Toxics Data Base, 1990
5,000 - 548,000 ppb dry sediment 39 detects/40 samples	VA sites within the Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Tissue

Concentration (ppb)	Site	Year	Reference
<500 - 7,300 ppb wet weight, whole fish samples	MD sites within Chesapeake Bay basin	1970 to present	MDE Toxics Data Base, 1990
500 - 4,100 ppb wet weight, fillet or edible portions	''	1970 to present	MDE Toxics Data Base, 1990
100 - 6,200 ppb wet weight, oyster tissue	''	1981-1985	MDE Toxics Data Base, 1990

Tissue (continued)

Concentration (ppb)	Site	Year	Reference
500 - 6,400 ppb wet weight, crab tissue	Baltimore Harbor and 9 Bay tributaries	1983	MDE Toxics Data Base, 1990
900 - 1,000 ppb wet weight finfish and shellfish 2 detects/17 samples	VA sites within Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Different species exhibit different sensitivities to lead, and many other factors are know to affect the results of tests on the toxicity of lead to aquatic organisms. The relative toxicity of lead in its various forms appears to be affected by water hardness, the softer (the less hard) the water, the greater the toxicity. Adverse effects on aquatic biota reported at waterborne lead concentrations of 1.0 - 5.1 ug/L include reduced survival, impaired reproduction, reduced growth, and high bioconcentration from the medium (Eisler, 1988).

Acute Toxicity

The acute toxicity of lead to several species of freshwater animals has been shown to decrease as the hardness of water increases. At a hardness of 50 mg/L the acute sensitivities of ten species range from 142.5 ug/L for an amphipod to 235,900 ug/L for a midge. The amphipod was far more sensitive to lead than a snail, cladoceran, chironomid, mayfly, stonefly, and caddisfly in exposures lasting up to 28 days. Acute values for 13 saltwater animal species range from 315 ug/L for the mummichog to 27,000 ug/L for the soft-shell clam. A species of macroalgae was affected at 20 ug/L (US EPA, 1985).

Species	Endpoint	Concentration	Reference
Freshwater species: Rainbow Trout, *Salmo gairdneri*	LC50 72 h	3.5 ug/L	Eisler,1988
Rainbow Trout (2 mos) *Salmo gairdneri*	LC50	8,000 ug/L	Hale, 1977
Saltwater species: Mummichog, *Fundulus heteroclitus*	LC50 96 h	315.0 ug/L (saltwater)	Eisler, 1988

Acute Toxicity (continued)

Species	Endpoint	Concentration	Reference
Soft-shell clam, *Mya arenaria*	LC50 168 h	8,800 ug/L	Eisler, 1977

Chronic Toxicity

Chronic effects may include shortened lifespan, reproductive problems, lower fertility, and changes in appearance and behavior. The chronic toxicity of lead also decreases as hardness increases. Data on the chronic effects of lead on freshwater animals are available for two fish and two invertebrate species.The lowest and highest chronic values 12.26 (soft water) and 128.1 ug/L (hard water) were both for a cladoceran. Freshwater algae are affected by concentrations of lead above 500 ug/L based on the data for four species. Borgmann, et al. (1978) reported lead concentrations as low as 19 ug/L significantly decreased survival, but not growth or reproduction in the snail species, *Lymnaea palustris* (US EPA, 1985). Spinal deformities have also been caused by lead in finfish (Holcombe, et al. 1976 and Sauter, et al. 1976). Saltwater species exhibited chronic effects at concentrations of 25.08 ug/L for *Mysidopsis bahia* and between 20.3 - 900 ug/L for two species of algae and two species of diatoms (US EPA, 1985).

Species	Endpoint	Concentration (ug/L)	Reference
Freshwater species: Cladoceran, *Daphnia magna*	Impaired reproduction	10.0	Eisler, 1988
Rainbow Trout, *Salmo gairdneri*	Spinal deformity	31.0 (19 months)	Davies et al. 1976
Amphipod, *Gammarus pseudolimnaeus*	LC50 28 days	28.4 ug/L	Spehar et al. 1978
Saltwater species: Alga, *Champia parvula*	Stopped sexual reproduction	20.3	Steele and Thursby, 1983
Mysid, *Mysidopsis bahia*	Reduced spawning	25.08	Lussier et al. 1985
Diatom, *Ditylum brightwellii*	EC50	40.0	Canterford & Canterford,'80

Terrestrial Organisms

Among sensitive species of birds, survival was reduced at doses of 50 - 75 mg Pb (2+)/kg body weight or 28 mg organolead/kg body weight, reproduction was impaired at dietary levels of 50 mg Pb (2+)/kg body weight, and signs of poisoning were evident at doses as low as 2.8 mg organolead/kg body weight (Eisler, 1988).

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

TOXICS OF CONCERN INFORMATION SHEETS

MERCURY (Hg)

Other Names: Liquid silver; Quick silver.

Research Recommendations/Proposed Management Actions:

o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
o Research the relative contributions of various sources, particulary nonpoint sources, of mercury to the Bay watershed.
o Fund life cycle toxicity studies using Chesapeake Bay zooplankton.
o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates mercury concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
o Sponsor public education efforts regarding municipal and nonpoint sources of mercury to the Chesapeake Bay basin.
o To better estimate thee potential for human health effects, identify the pathways and likelihood that inorganic mercury in the water column and sediments can be converted to organic mercury.

General Description:

Usage Summary:

Mercury is a naturally occurring element used in thermometers, barometers, hydrometers, pyrometers, ultraviolet lamps, fluorescent lamps, mercury boilers, mirror coating, the extraction of gold and silver from ores, and in making chemicals and electrical equipment. This trace metal is also used in pharmaceutical products, dentistry, agricultural chemicals, and antifouling paints (Merck Index, 1989). Atmospheric deposition of mercury can be significant.

Environmental Fate and Persistence:

Mercury forms alloys with most metals except iron and combines with sulfur at ordinary temperatures. Mercury is highly persistent in water. Forms of mercury with relatively low toxicity can be transformed into highly toxic forms, such as methylmercury, and can be bioconcentrated in aquatic organisms (Eisler, 1987).

Elemental mercury is oxidized to mercury (II) under natural conditions which can then be methylated by both aerobic and anaerobic bacteria into methylmercury. Demethylation may control the concentration of methylmercury in sediment and water. Demethylation also occurs in fish. (US EPA, 1985)

Regulatory Status / Restrictions:

Mercury is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

- CERCLA Reportable Quantities List,
- Priority Pollutant List,
- RCRA Appendix VIII List,
- RCRA Appendix IX Groundwater Monitoring List,
- SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
- Safe Drinking Water Act Amendments of 1986,
- Pollutants listed as hazardous under the Clean Air Act,
- toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986, and
- Superfund Target Compound List.

Human Health Summary:

Mercury toxicity is highly dependent on the form of mercury. Inorganic mercury, which is the mercury form most likely to occur in drinking water is much less toxic than the organic form.

Methylmercury is bioaccumulated by fish, shellfish and crustacea; loss of methylmercury from fish tissue is very slow. Consequently, as mercury is naturally occurring, concentrations in fish tissue increase with the age of the fish (U.S. EPA, 1980).

Methylmercury, at substantial levels, is both neurotoxic and teratogenic. Its first recognition as other than an occupational hazard came with the finding of neurological disorders in residents of Minamata, Japan, resulting from consumption of severely contaminated fish from a water body receiving industrial discharges of inorganic mercury and methylmercury (U.S. EPA, 1980). Prenatal exposures to excessive methylmercury levels may result in fetal brain damage (U.S. EPA, 1980).

No evidence is available linking either inorganic mercury or methylmercury with cancer (U.S. EPA, 1980; U.S. EPA, 1987).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
2.4	.012**	2.1	.025**	0.144	0.146

** These values are not based on adverse aquatic life effects. They are back calculated from the FDA Action Level and Bioconcentration Factor values, and therefore, represent human health effect values, **not** aquatic life values (US EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- 2.0 ug/L. (U.S. EPA, 1989 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) = 0.5 ppm for methyl mercury.

States/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for mercury:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	0.012	None	None	0	None	None
MD	2.4	0.012	2.1	0.025	2.0	0.146	None
PA	2.4	0.012	None	None	0.144	N/A	N/A
VA	Virginia is currently awaiting for final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Available data is still being acquired.

Concentration	Site	Year	Reference
0.99 ug/L 1 detect/105 samples	Elizabeth River, VA	1987-88	VWCB Toxics Data Base, 1990

Sediments

Concentration	Site	Year	Reference
0.10 - 0.80 ug/g	MD sites within the Chesapeake Bay basin	1984	MDE Toxics Data Base, 1990
0.01 - 0.16 ug/g	MD sites within the Chesapeake Bay basin	1985	MDE Toxics Data Base, 1990
80 - 4,660 ppb dry sediment 28 detects/40 samples	VA sites within the Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Tissue

Concentration (ppb)	Site	Year	Reference
< 1.0 - 295.0 ppb wet weight, whole fish samples	MD sites within Chesapeake Bay basin	1970 to present	MDE Toxics Data Base, 1990
< 1.0 - 400 ppb wet weight, fillet or edible portions	''	1970 to present	MDE Toxics Data Base, 1990
1.0 - 34 ppb wet weight, oyster tissue	''	1981-1985	MDE Toxics Data Base, 1990
3.0 - 105 ppb wet weight, crab tissue	Baltimore Harbor and 9 Bay tributaries	1983	MDE Toxics Data Base, 1990
20 - 50 ppb wet weight finfish and shellfish 5 detects/17 samples	VA sites within Chesapeake Bay basin		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Mercury has long been recognized as one of the most toxic of the heavy metals, but only recently was it identified as a serious pollutant in the aquatic environment. Numerous factors such as alkalinity, ascorbic acid, chloride, dissolved oxygen, hardness, organic complexing agents, pH, sediment, and temperature probably affect the acute toxicity and bioaccumulation of the various forms of mercury (US EPA, 1985).

Acute Toxicity

Acute toxicity data has been collected on the various forms of mercury including mercury(II), methylmercury, and other mercury compounds. Freshwater acute toxicity values indicate that the difference in sensitivity between different species to a particular mercury compound is far greater than the difference in sensitivity of a particular species to various mercury compounds (US EPA, 1985).

For Mercury(II):

Data exist on the acute toxicity of **mercury(II)** to 28 genera of freshwater animals. Fishes tend to be more resistant, and molluscs and crustaceans tend to be more sensitive to the acute effects of mercury(II) (US EPA, 1985).

Species	Endpoint	Concentration	Reference
Freshwater species: Daphnia pulex	LC50	2.2 ug/L	Canton & Adams, 1978
Guppy (116-157 mg) Poecilia reticulata	LC50	30 ug/L	Deshmukh & Marathe, 1980
Rainbow trout (juvenile) Salmo gairdneri	LC50	220 ug/L	MacLeod & Pessah 1973
Stonefly, Acroneuria lucorias	LC50	2,000 ug/L	Warnick & Bell, 1969

For mercury chloride:

Data on the acute toxicity of **mercuric chloride** are available for 29 genera of saltwater animals including annelids, molluscs, crustaceans, echinoderms, and fishes.

Species	Endpoint	Concentration	Reference
Estuarine/Saltwater species: Mysid, Mysidopsis bahia	LC50	3.5 ug/L	Gentile et al 1982 1983; Lussier et al 1985
Eastern oyster, Crassostrea virginica	LC50	5.6 ug/L	Calabrese & Nelson 1974; Calabrese, et al, 1977
Mummichog, Fundulus heteroclitus	LC50	2,000 ug/L	Klaunig et al 1975

For total mercury:

Few data are available for various organomercury compounds and mercurous nitrate, and they all appear to be 4 to 31 times more acutely toxic than mercury(II) (US EPA, 1985).

Aquatic organisms Chlorella vulgaris		0.1 - 2.0 ug/L	Eisler, 1987
Birds	acute oral	2,200 - 31,000 ug/kg dietary	Eisler, 1987
Mammals		100-500 ug/kg daily dose 1,000 - 5,000 ug/kg diet	Eisler, 1987 ''

Chronic Toxicity

Available chronic data indicate that methylmercury is the most chronically toxic of the tested mercury compounds. Tests on methylmercury with Daphnia magna and brook trout resulted in chronic values less than 0.07 ug/L. For mercury(II) a chronic value of 1.1 ug/L was obtained using Daphnia magna. In both a life-cycle test and early life-stage test with mercuric chloride on fathead minnow, the chronic value was less than 0.26 ug/L. Concentrations of mercury that affected growth and photosynthetic activity of a saltwater diatom and six species of brown algae range from 10 to 160 ug/L (US EPA, 1985).

The best available data on the long-term exposure of fish to mercury(II) indicate that concentrations above 0.23 ug/L cause statistically significant effects on the fathead minnow and caused whole body concentrations of total mercury to exceed 1.0 mg/kg. Species such as rainbow trout, coho salmon, and especially blue gill, might suffer chronic effects and accumulate high residues of mercury about the same as the fathead minnow (US EPA, 1985). With regard to long-term exposure to methylmercury, McKim, et al. (1976) found that brook trout can exceed the FDA action level without suffering statistically significant adverse effects on survival, growth, or reproduction.

The sublethal effects of mercury have been summarized by Eisler (1987) for the following sensitive species and respective concentrations:

aquatic species - 0.03 to 0.1 ug mercury/L;
bird species - 640 ug mercury/kg body weight daily or 50-500ug/kg in diet; and
mammal species - 250 ug mercury/kg body weight daily or 1,100 ug mercury/kg diet.

For Mercury(II):

Species	Endpoint	Concentration	Reference
Fathead Minnow, Pimephales promelas		<0.23 ug/L	Call et al. 1983
Mysid, Mysidopsis bahia	spawning time productivity	1.131 ug/L (36 days)	Gentile et al. 1982,1983 & Lussier et al.85

For other mercury compounds:

Species	Endpoint	Concentration	Reference
Alga, Anabaena flos-aquae	EC50 (growth)	2.8 ug/L	Thomas & Montes, 1978

For methylmercury:

Species	Endpoint	Concentration	Reference
Alga, Chlorella vulgaris	EC50 (growth)	0.8 - 4.0 ug/L	Rai et al. 1981
Cladoceran, Daphnia magna		<0.04 ug/L	Biesinger et al. 1982

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CHESAPEAKE BAY PROGRAM
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TOXICS OF CONCERN INFORMATION SHEETS

POLYCHLORINATED BIPHENYLS (PCBS)

Other Names: Chlorinated biphenyls, chlorobiphenyls, Aroclor, Clophen, Fenclor, Kanechlor, Phenoclor, Pyralene, Santotherm (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o No further regulatory action is recommended since PCB production and use is banned.
- o Identify locations within the Chesapeake Bay basin with elevated PCB concentrations; determine the need for, and the corrective tools that are available to evaluate the cost effectiveness of correcting these situations.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates PCB concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.

General Description:

Usage Summary:

Commercial PCBs were widely used mixtures of industrial chemicals called Arochlors. These mixtures are extremely stable, characteristics which contributed to both their commercial usefulness and subsequent long-term harmful effects. PCBs were given widespread industrial, residential and commercial use in a variety of capacities. They were primarily used in the manufacture of electrical capacitors and transformers, and lubricants. Commercial PCBs mixtures are characterized by a four digit number. The first two digits indicate that the mixture contains biphenyls (12), and the last two digits give the weight percent of chlorine in the mixture (e.g. Aroclor 1242 has biphenyls with 42% chlorine) (Merck Index, 1989).

As a result of the long life of many products containing PCBs, it is believed that a substantial portion of the PCBs manufactured before 1971 are still in service and may represent potential sources to the environment. A further complication is that several commercial PCB mixtures have been reported to contain small quantities of highly toxic contaminants such as, polychlorinated dibenzofurans (PCDFs), which also contribute to the toxic effects to animals and humans (US EPA, 1980).

Environmental Fate and Persistence:

PCBs are extremely stable compounds (Merck Index, 1989). The degree of chlorination determines the PCBs' water solubility and ultimate distribution in the aquatic environment. In general, concentrations in the aquatic sediments and terrestrial soils will be greater than in air, water, suspended solids or aquatic biota (Eisler, 1986).

PCBs are highly lipophilic and bioconcentrate to high concentrations from concentrations in water that are often below the usual detection limits. The physical properties of individual chlorinated biphenyls have been studied extensively, but are too lengthy to include here.

Regulatory Status / Restrictions:

The Toxic Substances Control Act (TSCA) was signed into law October 11, 1976 and contains provisions specifically regulating the manufacture, sale, distribution, and disposal of PCBs.

PCBs are subject to regulation at the federal level by their inclusion on the following federal lists (Lists of Lists, 1988):

- CERCLA Reportable Quantities List,
- Hazardous substances under Section 311(b)(2)(A) of the Federal Water Pollution Control Act and Reportable Quantities,
- Priority Pollutant List,
- RCRA Appendix VIII List,
- RCRA Appendix IX Groundwater Monitoring List,
- the Superfund Target Compound List.

Human Health Summary:

Ingestion of PCBs, at toxic levels, may cause damage to the liver, gastrointestinal tract, nervous system, adult reproductive system and fetus (U.S. EPA, 1980; U.S. EPA, 1989 May). The U.S. EPA considers PCBs probable human carcinogens (IRIS, 1990), although conflicting evidence regarding their carcinogenic potential exists (U.S. EPA, 1985).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
2.0	.014	10.0	.03	.000079*	.000079*

* These criteria represent a cancer risk level of one in one million (US EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. (U.S. EPA, 1989 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) = 2.0 ppm.

State/D.C. Standard Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for polychlorinated biphenyls:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	0.01	None	None	0.00008	None	None
MD	2.0	0.014	10	0.03	None	0.00079*	None
PA	2.0	0.014	None	None	0.00008	None	None
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

* MD used a Cancer Risk Level of 10 -5 for the Human Health Fish Consumption Value.

Concentration in Chesapeake Bay Watershed

Water

MDE sampled for the following PCB isomers between February 1989 and April 1989: 1221, 1232, 1242, 1248, 1254, 1260 and 1016. The results are in the chart below.

Concentration	Site	Year	Reference
No detections (detection level = 0.5 - 1.0 ug/L)	55 sites in MD Ches. Bay waters	February 1989	(MDE Toxics Data Base, 1990)

Water (continued)

Concentration	Site	Year	Reference
No detections	55 sites in MD Ches. Bay waters	April 1989	(MDE Toxics Data Base, 1990)

Sediments

Concentration	Site	Year	Reference
1-10 ppb	Baltimore Harbor Gunpowder River		Helz and Huggett 1987
0.1 - 1.0 ppb	northern Chesapeake Bay		Helz and Huggett 1987
0.1 - 1341.0 ppb 337 detections	26 sites in VA Ches. Bay waters		VWCB Toxics Data 1990

Tissue

PCB concentrations reported in fillet or edible portion finfish samples collected since 1987 by MDE have ranged from non-detectible to greater than 2 ppm, wet weight. Highest levels, among species, have been observed in bottom feeding fish, with high lipid content (ex. channel catfish and eels) (MDE Toxics Data Base, 1990).

Concentration	Site	Year	Reference
.01 - 290.0 ppb 97 detects/11 samples for shellfish	VA waters within Ches. Bay		VWCB Toxics Data Base, 1990
.005 - .0028 ppm 19 detects/669 samples	VA waters within Ches. Bay		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Because the components of the numerous PCB mixtures differ in their physical, chemical and biological properties, a comprehensive evaluation of their potential impact on the environment is complicated. In general PCB isomers with high Kow values and high numbers of substituted chlorines in adjacent positions, constitute the greatest environmental concern.

Acute Toxicity

Acute toxicity to freshwater animals to PCBs have been measured with three invertebrate and four fish species, the species mean acute values range from 2.0 to 283 ug/L. Species mean acute values for saltwater animals for PCBs range from 10.5 to 20 ug/L from six tests on three invertebrate species (U.S. EPA, 1980).

Species	Endpoint	Concentration	Reference
Freshwater species:			
Rainbow trout, *Salmo gairdneri*	LC50 96 hour	2.0 ug/L Capacitor 21	Birge et al 1979
Largemouth bass, *Micropterus salmoides*	LC50 96 hour	2.3 ug/L Capacitor 21	Birge et al 1979
Scud, *Gammarus fasciatus*	LC50	10 ug/L Arochlor 1242	Mayer et al 1977
Estuarine/Saltwater species:			
Spot, *Leiostomus xanthurus*	LC50 38 day	0.5 ug/L Arochlor 1254	Ernst, 1984
Grass shrimp, *Palaemontes pugio*	LC50 96 hour	6.1 - 7.8 ug/L Arochlor 1254	Ernst, 1984
Eastern oyster, *Crassostrea virginica*	EC50	10.2 ug/L Arochlor 1016	Hansen et al 1974a

Dietary levels of 100 ug PCB/kg fresh weight cause death and reproductive toxicity in mink, (*Mustela vison*). A tolerable daily limit for mink has been estimated at less than 1.5 ug total PCBs/kg body weight. For birds, levels in excess of 3,000 in diet, 16,000 in egg, or 54,000 in brain were associated with PCB poisoning (Eisler, 1987).

Chronic Toxicity

Eleven life-cycle or partial life-cycle tests were completed with three invertebrate and two fish species, the chronic values range from 0.2 to 15 ug/L. Two chronic tests have been done on the sheepshead minnow and provided chronic values of 7.14 and 0.098 ug/L. Some data suggest that unicellular algae are affected by concentrations of PCBs similar to those that cause chronic effects to animals.

Chronic Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Fathead minnow, *Pimephales promelas*		0.1 - 0.4 ug/L Arochlor 1248	DeFoe et al. 1978
Brook trout (fry),	reduced growth 48 days	1.5 ug/L Arochlor 1254	Eisler, 1987
Estuarine/Saltwater species:			
Diatom, *Rhizosolenia setigera*	reduced growth	0.1 ug/L Arochlor 1254	Fisher and Wurster, 1973
Sheepshead minnow (juvenile) *Cyprinodon variegatus*	lethargy, fin rot reduced feeding	$\geq$ 0.16 ug/L Arochlor 1254	Hansen et al 1973; Schimmel et al 1974

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CHESAPEAKE BAY PROGRAM
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TOXICS OF CONCERN
INFORMATION SHEETS

POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

Introduction:

Polynuclear aromatic hydrocarbons are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings. Individual chemicals within this class of compounds differ in many important characteristics such as environmental fate, biological metabolism, chemical degradation and toxicity. Because there are many PAH compounds with little significant environmental impact, the most environmentally important compounds were selected for emphasis. These include **benzo[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, and naphthalene.** These selected compounds have been identified in several water bodies across the country as having the potential to cause adverse biological effects. These compounds have also been identified in the Chesapeake Bay watershed. The selected compounds are reasonably stable and therefore persist in the environment.

PAHs are naturally occurring in fossil fuels and enter the environment through atmospheric deposition from the combustion of fossil fuels and other materials. PAHs may also be introduced through spills and disposal of petroleum products.

Usage Summary:

PAHs are present in the environment from both natural and anthropogenic sources. As a group, they are widely distributed in the environment, having been detected in animal and plant tissue, sediments, soils, air, and surface water (Radding et al. 1976). PAHs have also been detected in finished drinking water, industrial effluents, ambient river water, well water and ground water (Shackelford and Keith, 1976).

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TOXICS OF CONCERN INFORMATION SHEETS

Benzo[a]anthracene (B[a]A)

Chemical names: 1,2-Benzanthracene; 2,3-benzphenanthrene.
Other Names: Benz[a]anthracene; Benzanthrene; Naphthanthracene; and Tetraphene; (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Research the relative contributions of point and nonpoint sources, particularly atmospheric deposition, of benzo[a]anthracene to the Chesapeake Bay basin.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates benzo[a]anthracene concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Investigate alternatives to control the indiscriminate spills and disposals of motor oil.
  - Consider a law to prohibit dumping into storm drains.
  - Citizen outreach for proper disposal, vehicular maintenance and recycling programs.
  - Increase public awareness of, and if necessary the availability of, the number of recycling stations.
- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
  - Encouraging efficient fuel use and handling in recreational vehicles and boats;
  - Servicing their home oil burners regularly to keep them running at peak efficiency;

Research Recommendations/Proposed Management Actions: (continued)

- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by: (continued)
  - Recycling used motor oil from cars, lawn mowers and other mechanical devices at licensed service stations;
  - Repairing automotive leaks of fluids and oils;
  - Lowering their home thermostats to 68 F in winter;
  - Increasing home heat efficiency such as using caulk and weather stripping to stop home heat loss.

General Description:

Environmental Fate and Persistence:

PAHs will adsorb strongly onto suspended particles and biota. The transport of PAHs in the aquatic environment depends on the hydrogeologic characteristics of the ecosystem.

PAHs dissolved in the water column will probably be broken down rapidly by the action of light. The ultimate fate of those which accumulate in the sediment is believed to be biodegraded and biotransformed by benthic organisms (U.S. EPA, 1979). Numerous studies show that despite their high lipid solubility, PAHs show little tendency for bioaccumulation in the fatty tissues of animals or man (Lee, et al. 1972; Ahokas, et al. 1975; Graf, et al. 1975).

Regulatory Status / Restrictions:

Benzo(a)anthracene is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

o CERCLA Reportable Quantities List,
o Priority Pollutant List,
o RCRA Appendix VIII List,
o RCRA Appendix IX Groundwater Monitoring List,
o Superfund Target Compound List.

Human Health Summary:

Although there are no human data linking benz[a]anthracene specifically, to carcinogenesis, B[a]P is considered by EPA to be a probable human carcinogen. There are human data linking the inhalation of PAH mixtures (ex. cigarette smoke, roofing tar and coke oven emissions) to lung cancer. The animal data supporting this classification include dermal, inhalation and oral exposures (IRIS, 1988). General human exposure to PAHs occurs predominantly by direct ingestion of food and drinking water; however no studies have been performed linking the possible carcinogenic risk to humans by this route of exposure (U.S. EPA, 1980).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
None	None	None	None	.0028	.031 ug

Insufficient data exist to derive criteria for polyaromatic hydrocarbons. Available data indicate concentrations as low as 300 ug/L would cause acute toxicity for saltwater aquatic species and thus, the marine-acute lowest observed effect concentration for PAHs is 300 ug/L (U.S. EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. (U.S. EPA, 1989 (May)).

The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 ug/L. This recommendation standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,3,-cd]pyrene (US EPA, 1980).

State/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for benzo[a]anthracene:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	None	None	None	0.003	None	None
MD	None	None	None	None	None	None	None
PA	None	None	None	None	0.003	None	None
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
No detections from 110 samples (detection level = 5 - 10 ug/L)	55 sites in MD Ches. Bay waters	February & April 1989	MDE Toxics Data Base, 1990

Sediments

Concentration	Site	Year	Reference
1-1000 ug/L for PAHs	upper Chesapeake Bay		Helz and Huggett 1987
2,100- 177,800 ug/kg	Baywide	1984	Huggett, 1986
900 - 150,800 ug/kg	Baywide	1985	Huggett, 1986
400 - 23,300 ug/kg	Baywide	1986	Huggett, 1986
0.4 - 143,436 ppb 530 detects from 583 samples	VA waters within Chesapeake Bay		VWCB, 1990
3.00 -143,436.00 ug/kg 190 detections	Elizabeth River Virginia	April 1981- August 1989	VIMS Toxics Data Base, 1990
0.40 - 10,000.00 ug/kg 78 detections	Main Bay	March 1979- June 1986	VIMS Toxics Data Base, 1990
0.40 -11,617.00 ug/kg 85 detections	James River, VA	June 1980- June 1989	VIMS Toxics Data Base, 1990
161.00 - 4,718.00 ug/kg 37 detections	Patapsco River Maryland	April 1981- April 1981	VIMS Toxics Data Base, 1990
0.30 - 466.00 ug/kg 85 detections	York River, VA	March 1981- May 1986	VIMS Toxics Data Base, 1990
3.00 - 177.00 ug/kg 24 detections	Rappahannock River Virginia	June 1984- June 1986	VIMS Toxics Data Base, 1990
24.00 -130.00 ug/kg 4 detections	Potomac River, MD	June 1984 - June 1984	VIMS Toxics Data Base, 1990
49.00 - 77.00 ug/kg 2 detections	Rhode River, MD	April 1981 April 1981	VIMS Toxics Data Base, 1990

Tissue

Concentration	Site	Year	Reference
7 - 117.0 ppb from 13 detections for shellfish	VA waters within Ches. Bay		VWCB Toxics Data 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

The limited freshwater data base available for polynuclear aromatic hydrocarbons does not permit a statement concerning acute or chronic toxicity. The available data for PAHs for saltwater aquatic life indicates that acute toxicity occurs at concentrations as low as 300 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of PAHs to sensitive saltwater aquatic life (U.S. EPA, 1980).

Species	Endpoint	Concentration	Reference
Freshwater species:			
Bluegill, <ins>Lepomis</ins> <ins>macrochirus</ins>	LC87 6 month	1000 ug/L	Brown et al 1975

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CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
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TOXICS OF CONCERN INFORMATION SHEETS

POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

Introduction:

Polynuclear aromatic hydrocarbons are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings. Individual chemicals within this class of compounds differ in many important characteristics such as environmental fate, biological metabolism, chemical degradation and toxicity. Because there are many PAH compounds with little significant environmental impact, the most environmentally important compounds were selected for emphasis. These include **benzo[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, and naphthalene.** These selected compounds have been identified in several water bodies across the country as having the potential to cause adverse biological effects. These compounds have also been identified in the Chesapeake Bay watershed. The selected compounds are reasonably stable and therefore persist in the environment.

PAHs are naturally occurring in fossil fuels and enter the environment through atmospheric deposition from the combustion of fossil fuels and other materials. PAHs may also be introduced through spills and disposal of petroleum products.

Usage Summary:

PAHs are present in the environment from both natural and anthropogenic sources. As a group, they are widely distributed in the environment, having been detected in animal and plant tissue, sediments, soils, air, and surface water (Radding et al. 1976). PAHs have also been detected in finished drinking water, industrial effluents, ambient river water, well water and ground water (Shackelford and Keith, 1976).

CHESAPEAKE BAY PROGRAM
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TOXICS OF CONCERN
INFORMATION SHEETS

Benzo[a]pyrene (B[a]P)

Chemical Names: 3,4-Benzpyrene, formerly called 1,2-benzpyrene. (Merck Index, 1989)

Research Recommendations/Proposed Management Actions:

- The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- Research the relative contributions of point and nonpoint sources, particularly atmospheric deposition, of benzo[a]pyrene to the Chesapeake Bay basin.
- Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates benzo[a]pyrene concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- Investigate alternatives to control the indiscriminate spills and disposals of motor oil.
  - Consider a law to prohibit dumping into storm drains.
  - Citizen outreach for proper disposal, vehicular maintenance and recycling programs.
  - Increase public awareness of, and if necessary the availability of, the number of recycling stations.
- Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
  - Encouraging efficient fuel use and handling in recreational vehicles and boats;
  - Servicing their home oil burners regularly to keep them running at peak efficiency;

Research Recommendations/Proposed Management Actions: (continued)

- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by: (continued)
  - Recycling used motor oil from cars, lawn mowers and other mechanical devices at licensed service stations;
  - Repairing automotive leaks of fluids and oils;
  - Lowering their home thermostats to 68 F in winter;
  - Increasing home heat efficiency such as using caulk and weather stripping to stop home heat loss.

General Description:

Benzo[a]pyrene appears as yellowish plates, or needles from the mixture of benzene and methanol. It occurs in coal tar (Merck Index, 1989). Polynuclear aromatic hydrocarbons (PAHs) are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings.

Environmental Fate and Persistence:

PAHs will adsorb strongly onto suspended particles and biota. The transport of PAHs in the aquatic environment depends on the hydrogeologic characteristics of the ecosystem.

PAHs dissolved in the water column will probably be broken down rapidly by the action of light. The ultimate fate of those which accumulate in the sediment is believed to be biodegraded and biotransformed by benthic organisms (U.S. EPA, 1979). Numerous studies show that despite their high lipid solubility, PAHs show little tendency for bioaccumulation in the fatty tissues of animals or man (Lee, et al. 1972; Ahokas, et al. 1975; Graf, et al. 1975).

Regulatory Status / Restrictions:

Benzo[a]pyrene is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

o CERCLA Reportable Quantities List,
o Priority Pollutant List,
o RCRA Appendix VIII List,
o RCRA Appendix IX Groundwater Monitoring List,
o Superfund Target Compound List.

Human Health Summary:

Although there are no human data linking benzo[a]pyrene, specifically, to carcinogenesis, B[a]P is considered by EPA to be a probable human carcinogen. There are human data linking the inhalation of PAH mixtures (ex. cigarette smoke, roofing tar and coke oven emissions) to lung cancer. The animal data supporting this classification include dermal, inhalation and oral exposures (IRIS, 1988). General human exposure to PAHs occurs predominantly by direct ingestion of food and drinking water; however no studies have been performed linking the possible carcinogenic risk to humans by this route of exposure (US EPA, 1980).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
None	None	None	None	.0028	.031

Insufficient data exist to derive criteria for polyaromatic hydrocarbons. Available data indicate concentrations as low as 300 ug/L would cause acute toxicity for saltwater aquatic species and thus, the marine-acute lowest observed effect concentration for PAHs is 300 ug/L (U.S. EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. Proposed MCL = 0.2 ug/L (U.S. EPA, 1989 (May)).

The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 ug/L. This recommendation standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,3,-cd]pyrene (US EPA, 1980).

FDA Action Level (regulated level in fish and shellfish tissue) = None.

State/D.C. Standard Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for benzo[a]pyrene:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	None	None	None	0.003	None	None
MD	None	None	None	None	None	None	None
PA	None	None	None	None	0.003	None	None
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

The Virginia Water Control Board did not report any detections of benzo[a]pyrene in their water sampling. The detection limit for these studies was 0.5 ug/L.

Benzo[a]pyrene was not included in the MDE February and April 1989 study of water quality at the 55 sites in Maryland waters within the Chesapeake Bay basin.

Sediments

Concentration	Site	Year	Reference
1-1000 ug/L for PAHs	upper Chesapeake Bay		Helz and Huggett 1987
1,200- 173,300 ug/kg	Baywide	1984	Huggett, 1986
1,500-145,300 ug/kg	Baywide	1985	Huggett, 1986
3,200 - 57,300 ug/kg	Baywide	1986	Huggett, 1986
1.0 - 50,087 ppb detected in most of the 583 samples	VA waters within Chesapeake Bay		VWCB, 1990
2.00 - 50,087.00 ug/kg 203 detections	Elizabeth River Virginia	April 1981- August 1989	VIMS Toxics Data Base, 1990
1.00 - 15,581.00 ug/kg 84 detections	Main Bay	March 1979- June 1986	VIMS Toxics Data Base, 1990
1.00 - 9,638.00 ug/kg 86 detections	James River, VA	June 1980- June 1989	VIMS Toxics Data Base, 1990
217.00 - 5,299.00 ug/kg 39 detections	Patapsco River Maryland	April 1981- April 1981	VIMS Toxics Data Base, 1990
1.00 - 300.00 ug/kg 93 detections	York River, VA	March 1981- May 1986	VIMS Toxics Data Base, 1990
3.00 - 165.00 ug/kg 25 detections	Rappahannock River Virginia	June 1984- June 1986	VIMS Toxics Data Base, 1990
27.00 - 93.00 ug/kg 4 detections	Potomac River, MD	June 1984- June 1984	VIMS Toxics Data Base, 1990
36.00 - 50.00 ug/kg 2 detections	Rhode River, MD	April 1981- April 1981	VIMS Toxics Data Base, 1990

Tissue

Concentration	Site	Year	Reference
6.0 - 136 ppb shellfish, 18 detects/ unknown sample number	VA waters within Chesapeake Bay		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

The limited freshwater data base available for polynuclear aromatic hydrocarbons does not permit a statement concerning acute or chronic toxicity. The available data for PAHs for saltwater aquatic life indicates that acute toxicity occurs at concentrations as low as 300 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of PAHs to sensitive saltwater aquatic life (US EPA, 1980, October).

The following table contains both acute and chronic toxicity data retrieved from the U.S. EPA AQUIRE data base.

Species	Endpoint	Concentration	Reference
Freshwater species:			
Green algae, <u>Scenedesmus</u> <u>obliquus</u>	EC50 3 days Growth	5 ug/L	Schoeny, et. al. 1988
Cladoceran, <u>Daphnia</u> <u>pulex</u>	LC50 4 days	5 ug/L	Trucco et. al. 1983
Green algae, <u>Selenastrum</u> <u>capricornutum</u>	EC50 3 days Growth	15 ug/L	Schoeny, et. al. 1988
Estuarine/Saltwater species:			
Polychaete, <u>Nereis</u> <u>arenaceodentata</u>	LC50 4 days	< 1000 ug/L	Rossi & Neff 1978
Blue-green algae <u>Anabaena</u> <u>flos-aquae</u>	EC50 3 days Growth	> 4000 ug/L	Schoeny, et. al. 1988
Green algae, <u>Chlamydomonas</u> <u>reinhardtii</u>	EC50 3 days Growth	> 4000 ug/L	Schoeny, et. al. 1988

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Ahokas, J.T., et al. 1975. Metabolism of polycyclic hydrocarbons by a highly active aryl hydrocarbon hydrolase system in the liver of a trout species. Biochem. Biophys. Res. Comm. 63: 635.

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Neff, J.M., et al. 1976b. Accumulation of release of petroleum-derived aromatic hydrocarbons by four species of marine animals. Mar. Biol. 38: 279.

Radding, S.B. et al. 1976. The environmental fate of selected polynuclear aromatic hydrocarbons. U.S. Environ. Prot. Agency, (Office of Toxic Sub.), Washington, D.C. EPA-560/5-75-009. p. 122.

Shackelford, W. and L.H. Keith. 1976. Frequency of organic compounds identified in water. U.S. EPA, Office of Research and Development, Athens, GA. EPA-600/4-76-062. p. 618.

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POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

Introduction:

Polynuclear aromatic hydrocarbons are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings. Individual chemicals within this class of compounds differ in many important characteristics such as environmental fate, biological metabolism, chemical degradation and toxicity. Because there are many PAH compounds with little significant environmental impact, the most environmentally important compounds were selected for emphasis. These include **benzo[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, and naphthalene.** These selected compounds have been identified in several water bodies across the country as having the potential to cause adverse biological effects. These compounds have also been identified in the Chesapeake Bay watershed. The selected compounds are reasonably stable and therefore persist in the environment.

PAHs are naturally occurring in fossil fuels and enter the environment through atmospheric deposition from the combustion of fossil fuels and other materials. PAHs may also be introduced through spills and disposal of petroleum products.

Usage Summary:

PAHs are present in the environment from both natural and anthropogenic sources. As a group, they are widely distributed in the environment, having been detected in animal and plant tissue, sediments, soils, air, and surface water (Radding et al. 1976). PAHs have also been detected in finished drinking water, industrial effluents, ambient river water, well water and ground water (Shackelford and Keith, 1976).

CHESAPEAKE BAY PROGRAM
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TOXICS OF CONCERN INFORMATION SHEETS

Chrysene

Chemical Name: 1,2-Benzphenanthrene (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

- The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- Promote citizen participation in used motor oil recycling; discourage motor oil disposal in curbside storm drains.
- Research the relative contributions of point and nonpoint sources, particularly atmospheric deposition, of chrysene to the Chesapeake Bay basin.
- Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates chrysene concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- Investigate alternatives to control the indiscriminate spills and disposals of motor oil.
    - Consider a law to prohibit dumping into storm drains.
    - Citizen outreach for proper disposal, vehicular maintenance and recycling programs.
    - Increase public awareness of, and if necessary the availability of, the number of recycling stations.
- Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
    - Encouraging efficient fuel use and handling in recreational vehicles and boats;
    - Servicing their home oil burners regularly to keep them running at peak efficiency;

Research Recommendations/Proposed Management Actions: (continued)

- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
  - Recycling used motor oil from cars, lawn mowers and other mechanical devices at licensed service stations;
  - Repairing automotive leaks of fluids and oils;
  - Lowering their home thermostats to 68 F in winter;
  - Increasing home heat efficiency such as using caulk and weather stripping to stop home heat loss.

General Description:

Chrysene occurs in coal tar. It is formed during the distillation of coal, in very small amounts during distillation or pyrolysis of many fats and oils.

Environmental Fate and Persistence:
PAHs will adsorb strongly onto suspended particles and biota. The transport of PAHs in the aquatic environment depends on the hydrogeologic characteristics of the ecosystem.

PAHs dissolved in the water column will probably be broken down rapidly by the action of light. The ultimate fate of those which accumulate in the sediment is believed to be biodegraded and biotransformed by benthic organisms (U.S. EPA, 1979). Numerous studies show that despite their high lipid solubility, PAHs show little tendency for bioaccumulation in the fatty tissues of animals or man (Lee, et al. 1972; Ahokas, et al. 1975; Graf, et al. 1975).

Regulatory Status / Restrictions:
Chrysene is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

- o CERCLA Reportable Quantities List,
- o Priority Pollutant List,
- o RCRA Appendix VIII List,
- o RCRA Appendix IX Groundwater Monitoring List,
- o SARA 110 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
- o Superfund Target Compound List.

Human Health Summary:
Chrysene has not been classified by EPA as to its possible carcinogenicity. There are human data linking the inhalation of PAH mixtures (ex. cigarette smoke, roofing tar and coke oven emissions) to lung cancer (IRIS, 1988). General human exposure to PAHs occurs predominantly by direct ingestion of food and drinking water; however no studies have been performed linking the possible carcinogenic risk to humans by this route of exposure (US EPA, 1980).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
None	None	None	None	.0028	.031

Insufficient data exist to derive criteria for polyaromatic hydrocarbons. Available data indicate concentrations as low as 300 ug/L would cause acute toxicity for saltwater aquatic species and thus, the marine-acute lowest observed effect concentration for PAHs is 300 ug/L (U.S. EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. (U.S. EPA, 1989 (May)).

The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 ug/L. This recommendation standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,3,-cd]pyrene (US EPA, 1980).

FDA Action Level (regulated level in fish and shellfish tissue) = None.

State/D.C. Standard Adopted:

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for chrysene:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	None	None	None	0.003	None	None
MD	None	None	None	None	None	None	None
PA	None	None	None	None	0.003	N/A	N/A
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
No detections (detection level = 5 - 10 ug/L)	55 sites in MD in Ches. Bay basin	Feb. & April 1989	MDE Toxics Data Base, 1990

Virginia Water Control Board reported no detections of chrysene in their water sampling of the York River in 1987 (VWCB Toxics Data Base, 1990).

Sediments

Concentration	Site	Year	Reference
1-1000 ug/L for PAHs	upper Chesapeake Bay		Helz and Huggett 1987
2,700-298,000 ug/kg	Baywide	1984	Huggett, 1986
4,100-256,600 ug/kg	Baywide	1985	Huggett, 1986
1,100-36,900 ug/kg	Baywide	1986	Huggett, 1986
1.0 - 179,198 ppb detected in most of the 583 samples	VA waters within Chesapeake Bay		VWCB, 1990
3.00 -179,198.00 ug/kg 203 detections	Elizabeth River Virginia	April 1981-August 1989	VIMS Toxics Data Base, 1990
1.00 - 15,099.00 ug/kg 84 detections	Main Bay	March 1979-June 1986	VIMS Toxics Data Base, 1990
1.00 -13,891.00 ug/kg 87 detections	James River, VA	June 1980 - June 1989	VIMS Toxics Data Base, 1990
244.00 - 7,581.00 ug/kg 39 detections	Patapsco River Maryland	April 1981-April 1981	VIMS Toxics Data Base, 1990
1.00 - 534.00 ug/kg 100 detections	York River, VA	March 1981-May 1986	VIMS Toxics Data Base,1990

Sediments (continued)

Concentration	Site	Year	Reference
7.00 - 182.00 ug/kg 25 detections	Rappahannock River Virginia	June 1984 - June 1986	VIMS Toxics Data Base, 1990
50.00- 90.00 ug/kg 4 detections	Potomac River, MD	June 1984 - June 1984	VIMS Toxics Data Base, 1990
102.00-128.00 ug/kg 2 detections	Rhode River, MD	April 1981- April 1981	VIMS Toxics Data Base, 1990

Tissue

Concentration	Site	Year	Source
2.0 - 582.0 ppb shellfish tissue 18 detects/unknown samples	VA sites in the Ches. Bay		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

The limited freshwater data base available for polynuclear aromatic hydrocarbons does not permit a statement concerning acute or chronic toxicity. The available data for PAHs for saltwater aquatic life indicates that acute toxicity occurs at concentrations as low as 300 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of PAHs to sensitive saltwater aquatic life (US EPA, 1980).

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Introduction:

Polynuclear aromatic hydrocarbons are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings. Individual chemicals within this class of compounds differ in many important characteristics such as environmental fate, biological metabolism, chemical degradation and toxicity. Because there are many PAH compounds with little significant environmental impact, the most environmentally important compounds were selected for emphasis. These include **benzo[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, and naphthalene.** These selected compounds have been identified in several water bodies across the country as having the potential to cause adverse biological effects. These compounds have also been identified in the Chesapeake Bay watershed. The selected compounds are reasonably stable and therefore persist in the environment.

PAHs are naturally occurring in fossil fuels and enter the environment through atmospheric deposition from the combustion of fossil fuels and other materials. PAHs may also be introduced through spills and disposal of petroleum products.

Usage Summary:

PAHs are present in the environment from both natural and anthropogenic sources. As a group, they are widely distributed in the environment, having been detected in animal and plant tissue, sediments, soils, air, and surface water (Radding et al. 1976). PAHs have also been detected in finished drinking water, industrial effluents, ambient river water, well water and ground water (Shackelford and Keith, 1976).

CHESAPEAKE BAY PROGRAM
Toxics/Living Resources Subcommittees'
Criteria and Standards Workgroup

TOXICS OF CONCERN INFORMATION SHEETS

Fluoranthene

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Research the relative contributions of point and nonpoint sources, particularly atmospheric deposition, of fluoranthene to the Chesapeake Bay basin.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates fluoranthene concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Investigate alternatives to control the indiscriminate spills and disposals of motor oil.
    - Consider a law to prohibit dumping into storm drains.
    - Citizen outreach for proper disposal, vehicular maintenance and recycling programs.
    - Increase public awareness of, and if necessary the availability of, the number of recycling stations.
- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
    - Encouraging efficient fuel use and handling in recreational vehicles and boats;
    - Servicing their home oil burners regularly to keep them running at peak efficiency;
    - Recycling used motor oil from cars, lawn mowers and other mechanical devices at licensed service stations;
    - Repairing automotive leaks of fluids and oils;

Research Recommendations/Proposed Management Actions: (continued)

- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
  - Lowering their home thermostats to 68 F in winter;
  - Increasing home heat efficiency such as using caulk and weather stripping to stop home heat loss.

General Description:

Usage Summary:

Fluoranthene is produced in the combustion of coal and petroleum at high temperatures. It also occurs naturally as a product of plant biosynthesis (Borneff, et al. 1968). Fluoroanthene is widespread in the environment and has been detected in air, drinking waters and food (US EPA, 1980). Sources of fluoranthene include shipping and harbor oil, industrial and municipal effluents, atmospheric fallout, precipitation, and road runoff (Suess, 1970). Harrison, et al. (1975) found that industrial effluents from oil refineries, coke production, plastic and dyestuff industries, and industries using high temperature furnaces are some of the primary sources of man-made fluoranthene.

Environmental Fate and Persistence:

It is practically insoluble in water to the extent of 265 ug/L . However, its presence in the water can be increased by detergents, solvents and by adsorption on the surface of solid matter, both biotic and abiotic. There is evidence of accumulation of fluoranthene in edible aquatic organisms (US EPA, 1980).

Regulatory Status / Restrictions:

Fluoranthene is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

- o CERCLA Reportable Quantities List,
- o Priority Pollutant List,
- o RCRA Appendix VIII List,
- o RCRA Appendix IX Groundwater Monitoring List,
- o SARA 100 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
- o Superfund Target Compound List.

Human Health Summary:

Fluoranthene is currently being reviewed by EPA for carcinogenicity. There are human data linking the inhalation of PAH mixtures (ex. cigarette smoke, roofing tar and coke oven emissions) to lung cancer. The animal data indicating carcinogenicity include dermal, inhalation and oral exposures (IRIS, 1988). General human exposure to PAHs occurs predominantly by direct ingestion of food and drinking water; however no studies have been performed linking the possible carcinogenic risk to humans by this route of exposure (US EPA, 1980).

There is no epidemiological evidence to prove that polynuclear aromatic hydrocarbons in general, and fluoranthene, in particular, found in drinking water are related to the development of cancer (Andelman and Snodgrass, 1974).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
3,980*	None	40*	16*	42	54

* Insufficient data exist to derive criteria for polyaromatic hydrocarbons. Available data indicate concentrations as low as 300 ug/L would cause acute toxicity for saltwater aquatic species and thus, the marine-acute lowest observed effect concentration for PAHs is 300 ug/L (U.S. EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. (U.S. EPA, 1989 (May)).

The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 ug/L. This recommendation standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,3,-cd]pyrene (US EPA, 1980).

FDA Action Level (regulated level in fish and shellfish tissue) = None.

State/D.C. Standard Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for fluoranthene:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only	Drinking Water
D.C.	None	None	None	None	0.003	None	None
MD	None	None	None	None	None	None	None
PA	200	40	200	40	42	N/A	N/A
VA	Virginia is currently awaiting final approval of its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
0.7 - 130 ppb (3 detections)	Elizabeth and York Rivers	1987 & 1988	VWCB, Toxics Data Base, 1990
No detections (detection level = 5-10 ug/L)	MD waters in the Ches. bay basin	Feb. & April 1989	MDE Toxics Data Base, 1990

Sediments

Concentration	Site	Year	Reference
1-1000 ug/L for PAHs	upper Chesapeake Bay		Helz and Huggett 1987
2,200- 471,700 ug/kg	Baywide	1984	Huggett, 1986
3,700-462,900 ug/kg	Baywide	1985	Huggett, 1986
1,700-60,100 ug/kg	Baywide	1986	Huggett, 1986
1.0 -1,038,460 ppb detected in most of the 583 samples	VA waters within Chesapeake Bay		VWCB, 1990
7.00 -1,038,460.00 ug/kg; 203 detects	Elizabeth River Virginia	April 1981-August 1989	VIMS Toxics Data Base,1990
2.00 - 34,617.00 ug/kg 86 detections	Main Bay	March 1979-June 1986	VIMS Toxics Data Base, 1990
1.00 -45,405.00 ug/kg 88 detections	James River, VA	June 1980 - June 1989	VIMS Toxics Data Base, 1990
379.00 -18,450.00 ug/kg 39 detections	Patapsco River Maryland	April 1981-April 1981	VIMS Toxics Data Base, 1990
1.00 -1,366.00ug/kg 100 detections	York River, VA	March 1981-May 1986	VIMS Toxics Data Base, 1990
8.00 - 200.00 ug/kg 25 detections	Rappahannock River Virginia	June 1984 - June 1986	VIMS Toxics Data Base, 1990

Sediments (continued)

Concentration	Site	Year	Reference
84.00-212.00 ug/kg 4 detections	Potomac River, MD	June 1984 - June 1984	VIMS Toxics Data Base, 1990
133.00-200.00 ug/kg 2 detections	Rhode River, MD	April 1981- April 1981	VIMS Toxics Data Base, 1990

Tissue

Virginia reported fluoranthene levels ranging from 11.0 - 1040 ppb in shellfish tissue from 32 detections in an unknown number of samples (VWCB Toxics Data Base, 1990).

Toxicity to Chesapeake Bay Biota or Surrogate Species

The available data for fluoranthene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 3,980 ug/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of fluoranthene to sensitive freshwater aquatic life.

The available data for fluoranthene for saltwater species indicate that acute and chronic toxicity occur at concentrations as low as 40 and 16 ug/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested (US EPA, 1980).

Acute Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species: Cladoceran, *Daphnia magna*	EC50 48 hours	325,000 ug/L	U.S. EPA, 1978
Bluegill, *Lepomis macrochirus*	LC50 96 hours	3,980 ug/L	U.S. EPA, 1978
Estuarine/Saltwater species:			
Mysid shrimp (juvenile) *Mysidopsis bahia*	LC50 96 hours	40 ug/L	U.S. EPA, 1978
Polychaete (immature) *Neanthes arenaceodentata*	LC50 96 hours	500 ug/L	Rossi & Neff, 1978

Sheepshead minnows exposed to fluoranthene concentrations as high as 560,000 ug/L showed no observed LC50 values (US EPA, 1980).

Chronic Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Freshwater alga, *Selenastrum capricornutum*	EC50 96 hours cell numbers	54,400 ug/L	U.S. EPA, 1978
Freshwater alga, *Selenastrum capricornutum*	EC50 96 hours chlorophyll a	54,600 ug/L	"
Estuarine/Saltwater species:			
Saltwater alga *Skeletonema costatum*	EC50 96 hours cell numbers	45,600 ug/L	"
Saltwater alga *Skeletonema costatum*	EC50 96 hours chlorophyll a	45,000 ug/L	"
Mysid shrimp, *Mysidopsis bahia*		16 ug/L	"

References:

Andelman J.B., and J.E. Snodgrass. 1974. Incidence and significance of polynuclear aromatic hydrocarbons in the water environment, in CR. Critical Reviews in Environmental Control. p. 69.

Borneff, J., et al. 1968. Experimental studies on the formation of polycyclic aromatic hydrocarbons in plants. Environ. Res. 2:22.

Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife and invertebrates: A synoptic review. U.S. Fish and Wildlife Service, Laurel, MD.

Harrison, R.M., et al. 1975. Polynuclear aromatic hydrocarbon raw potable and wastewaters. Water. Res. 9: 331.

Helz, G.R. and R.J. Huggett. 1987. Contaminants in Chesapeake Bay: The regional perspective. *In*: S.J. Majumdar, L.W. Hall, Jr. and H.M. Austin, Eds. pp. 270-297. *Contaminant Problems and Management of Living Chesapeake Bay Resources*. Easton, PA.

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Suess, M.J. 1970. Presence of polynuclear aromatic hydrocarbons in coastal waters and the possible health consequences. Revue. Int. Oceanog. Med. 18: 181.

U.S. EPA. 1978. In-depth studies on health and environmental impacts of selected water pollutants. U.S. Environ. Prot. Agency. Contract No. 68-01-4646.

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U.S. EPA. 1989. Clean Water Report. Drinking Water Regulations and Health Advisories. Office of Drinking Water, Washington, D.C.

World Health Organization. 1970. European Standards for Drinking Water, 2nd ed., Revised. Geneva.

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TOXICS OF CONCERN
INFORMATION SHEETS

POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)

Introduction:

Polynuclear aromatic hydrocarbons are a diverse class of compounds which contain substituted and unsubstituted polycyclic and heterocyclic aromatic rings. Individual chemicals within this class of compounds differ in many important characteristics such as environmental fate, biological metabolism, chemical degradation and toxicity. Because there are many PAH compounds with little significant environmental impact, the most environmentally important compounds were selected for emphasis. These include **benzo[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene, and naphthalene.** These selected compounds have been identified in several water bodies across the country as having the potential to cause adverse biological effects. These compounds have also been identified in the Chesapeake Bay watershed. The selected compounds are reasonably stable and therefore persist in the environment.

PAHs are naturally occurring in fossil fuels and enter the environment through atmospheric deposition from the combustion of fossil fuels and other materials. PAHs may also be introduced through spills and disposal of petroleum products.

Usage Summary:

PAHs are present in the environment from both natural and anthropogenic sources. As a group, they are widely distributed in the environment, having been detected in animal and plant tissue, sediments, soils, air, and surface water (Radding et al. 1976). PAHs have also been detected in finished drinking water, industrial effluents, ambient river water, well water and ground water (Shackelford and Keith, 1976).

TOXICS OF CONCERN
INFORMATION SHEETS

Naphthalene

Other Names: Naphthalin; naphthene; tar camphor (Merck Index, 1989).

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o Research the relative contributions of point and nonpoint sources, particularly atmospheric deposition, of naphthalene to the Chesapeake Bay basin.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates naphthalene concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Investigate alternatives to control the indiscriminate spills and disposals of motor oil.
    - Consider a law to prohibit dumping into storm drains.
    - Citizen outreach for proper disposal, vehicular maintenance and recycling programs.
    - Increase public awareness of, and if necessary the availability of, the number of recycling stations.
- o Encourage citizens to conserve energy to save fossil fuels and to lessen pollution by:
    - Encouraging efficient fuel use and handling in recreational vehicles and boats;
    - Servicing their home oil burners regularly to keep them running at peak efficiency;
    - Recycling used motor oil from cars, lawn mowers and other mechanical devices at licensed service stations;
    - Repairing automotive leaks of fluids and oils;
    - Lowering their home thermostats to 68 F in winter;
    - Increasing home heat efficiency such as using caulk and weather stripping to stop home heat loss.

General Description:

Naphthalene is the most abundant single constituent in coal tar. It is a bicyclic aromatic hydrocarbon. Pure naphthalene forms a white crystalline solid at room temperature whereas the crude or technical grades may range in color from brown to tan. Odor of moth balls.

Usage Summary:

Naphthalene is used as an intermediate in the production of dye compounds and in the formulation of solvents, lubricants, and motor fuels. Naphthalene enters the atmosphere primarily from fugitive emissions and exhaust connected with production and use of fuel oil and gasoline. Discharges into the aquatic environment occur mainly from spills during the storage, transport and disposal of fuel oil, coal, tar, etc. The use of naphthalene as a moth repellent and insecticide is decreasing due to the introduction of chlorinated compounds such as p-dichlorobenzene. (Merck Index, 1990)

Environmental Fate and Persistence:

Volatizes appreciably at room temperature. The solubility of naphthalene in water is between 30,000 to 40,000 ug/L of water; and approximately 33,000 ug/L for saltwater. Naphthalene is also soluble in organic solvents (US EPA, 1980). Slightly persistent in water with a half-life of between 2 - 20 days. About 97% of naphthalene will end up in the air, about 3% will end up in water and about 0.5% will end up in terrestrial soils and aquatic sediments (US EPA SARA 313 Ecological Fact Sheet, 1990).

Regulatory Status / Restrictions:

Naphthalene is subject to regulation by its inclusion on the following federal lists (Lists of Lists, 1988):

- o Hazardous substances under Section 311(b)(2)(A) of the Federal Water Pollution Control Act and Reportable Quantities,
- o List of analytes for which Community Water Systems shall monitor at the discretion of the State,
- o CERCLA Reportable Quantities List,
- o Priority Pollutant List,
- o RCRA Appendix VIII List,
- o RCRA Appendix IX Groundwater Monitoring List,
- o SARA 100 - Hazardous substances most commonly found at facilities on the CERCLA National Priorities List under Section 110 of the Superfund Amendments and Reauthorization Act, and
- o Toxic chemicals subject to the provisions of Section 313 of the Emergency Planning and Community Right to Know Act of 1986, and
- o the Superfund Target Compound List.

Human Health Summary:

Although EPA has not classified this PAH as to its possible carcinogenicity, there are human data linking the inhalation of PAH mixtures (ex. cigarette smoke, roofing tar and coke oven emissions) to lung cancer (IRIS, 1988). General human exposure to PAHs occurs predominantly by direct ingestion of food and drinking water; however no studies have been performed linking the possible carcinogenic risk to humans by this route of exposure (US EPA, 1980).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):
Criteria for the protection of:

Aquatic Life				Human Health	
Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption Only
2,300*	620*	2,350*	None	None	None

* Insufficient data exist to derive criteria for polyaromatic hydrocarbons. Available data indicate concentrations as low as 300 ug/L would cause acute toxicity for saltwater aquatic species and thus, the marine-acute lowest observed effect concentration for PAHs is 300 ug/L (U.S. EPA, 1980).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. Adult Health Advisory for RfD = 410 ug/kg/day (U.S. EPA, 1989 (May)).

The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 ug/L. This recommendation standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,3,-cd)pyrene (US EPA, 1980).

FDA Action Level (regulated level in fish and shellfish tissue) = None.

State/D.C. Standards Adopted:
The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. naphthalene:

Standards for the protection of:

	Aquatic Life				Human Health		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	None	None	None	0.003	None	None
MD	None	None	None	None	None	None	None
PA	135	43	None	None	10	N/A	N/A
VA	Virginia is currently awaiting final approval if its proposed standards by the state review board.						

Concentrations in Chesapeake Bay Watershed

Water

Concentration	Site	Year	Reference
0.05 - 2900 ppb (11 detections)	Elizabeth and York Rivers	1987 & 1988 1989	VWCB, Toxics Data Base, 1990

Naphthalene was not included in the MDE February and April 1989 study of water quality at the 55 sites in Maryland waters within the Chesapeake Bay basin.

Sediments

Concentration	Site	Year	Reference
1-1000 ug/L for PAHs	upper Chesapeake Bay		Helz and Huggett 1987
0.2 - 209.8 mg/kg	Baywide	1984	Huggett, 1986
0.6 - 240.5 mg/kg	Baywide	1985	Huggett, 1986
0.4 - 6.1 mg/kg	Baywide	1986	Huggett, 1986
1.0 -1,329,630 ppb detected in most of the 583 samples	VA waters within Chesapeake Bay		VWCB, 1990
1.00 -1,329,630.00 ug/kg; 156 detects	Elizabeth River Virginia	April 1981- August 1989	VIMS Toxics Data Base,1990
0.20 - 350.00 ug/kg 48 detections	Main Bay	Nov. 1979- June 1986	VIMS Toxics Data Base, 1990
0.20 - 9,314.00 ug/kg 79 detections	James River, VA	June 1980 - June 1989	VIMS Toxics Data Base, 1990
39.00 - 1,206.00 ug/kg 39 detections	Patapsco River Maryland	April 1981- April 1981	VIMS Toxics Data Base, 1990
0.30 - 598.00 ug/kg 52 detections	York River, VA	March 1981- May 1986	VIMS Toxics Data Base, 1990
0.30 - 7.00 ug/kg 15 detections	Rappahannock River Virginia	March1985 - June 1986	VIMS Toxics Data Base, 1990

Sediments (continued)

Concentration	Site	Year	Reference
2.00- 8.00 ug/kg 3 detections	Potomac River, MD	June 1984 - June 1984	VIMS Toxics Data Base, 1990
28.00 ug/kg 1 detection	Rhode River, MD	April 1981- April 1981	VIMS Toxics Data Base, 1990

Tissue

Concentration	Site	Year	Source
5.6 - 57.0 ppb shellfish tissue 12 detects/583 samples	VA sites within Ches. Bay basin		VWCB Toxics Data Base, 1990

Toxicity to Chesapeake Bay Biota or Surrogate Species

Acute Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Cladoceran, *Daphnia magna*	EC50 48 hours	8,570 ug/L	U.S. EPA, 1978
Rainbow trout, *Salmo gairdneri*	LC50 96 hours	2,300 ug/L	DeGraeve et al 1980
Estuarine/Saltwater species:			
Fathead minnow, *Pimephales promelas*	LC50 96 hours	4,900 ug/L at 14 C 8,900 ug/L at 24 C	" "
Mosquitofish, *Gambusia affinis*	LC50	150,000 ug/L	Wallen et al 1957
Polychaete, *Neanthes dentata*	LC50 96 hours	3,800 ug/L	Rossi & Neff 1978
Pacific oyster, *Crassostrea gigas*	LC50 96 hours	199,000 ug/L	LeGore, 1974
Grass shrimp, *Palaemonetes pugio*	LC50 96 hours	2,350 ug/L	Tatum, 1976
Copepod, *Eurytemora affinis*	LC30 10 days	50 ug/L	Eisler, 1987

Chronic Toxicity

An embryo-larval test with the fathead minnow resulted in adverse effects at a concentration of 850 ug/L of naphthalene. Freshwater algae appear to be less sensitive with effect concentrations of about 33,000 to 34,000 ug/L (US EPA, 1980).

References:

DeGraeve, G.M., et al. 1980. Effects of naphthalene and benzene on fathead minnows and rainbow trout. Submitted to Trans. Amer. Fish. Soc.

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Tatem, H.E. 1976. Toxicity and physiological effects of oil and petroleum hydrocarbons on estuarine grass shrimp, Palaemonetes pugio Holthuis. PhD. Thesis. Texas A & M Univ.

U.S. EPA. 1978. In-depth studies on health and environmental impacts of selected water pollutants. U.S. Environ. Prot. Agency. Contract No. 68-01-4646.

U.S. EPA. 1980. Ambient Water Quality Criteria for Naphthalene. Office of Water Regulations and Standards, Criteria and Standards Division, Washington, D.C. EPA-440/5-80-059.

U.S. EPA. 1989. Clean Water Report. Drinking Water Regulations and Health Advisories. Office of Drinking Water, Washington, D.C.

Wallen, I.E. et al. 1957. Toxicity to *Gambusia affinis* of certain pure chemicals in turbid waters. Sewage Ind. Wastes. 29: 695.

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TOXICS OF CONCERN INFORMATION SHEETS

Tributyltin

Other Names: TBT, Organotin (EPA, 1988).

Research Recommendations/Proposed Management Actions:

- o The State signatories to the Bay Agreement give the substances on the Toxics of Concern List priority for consideration for water quality criteria adoption during their next triennial review.
- o All data resulting from Chesapeake Bay Program (CBP) funded toxics research and monitoring will be required, as part of the contract specifications, to be reported and incorporated into the CBP toxics data base.
- o This pesticide should be incorporated into the individual states' pesticide use surveys.
- o Evaluate the success of current regulatory actions in 1993 by analyzing monitoring data and usage reports to determine whether further control actions (legislation) are needed.
- o Continue to monitor TBT in the water column and sediments at locations with established baselines to measure the results of the reduction in use achieved by the restrictions on TBT as an antifouling agent in recreational boat paints.
- o Evaluate the level of TBT residues in commercially important Chesapeake Bay seafood species.
- o Fund chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, saltwater) with emphasis on estuarine and saltwater species if monitoring demonstrates tributyltin concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.
- o Support the total integration of formally adopted water quality criteria for toxics substances into state regulatory programs, and where available data demonstrates exceedences of these criteria, initiate appropriate regulatory investigations and controls to correct the problem.
- o Encourage jurisdictions that do not have household hazardous waste disposal days to start one.

General Description:

Usage Summary:
TBT is most commonly used as an additive to boat bottom paint to inhibit biofouling. Minor uses include painting of docks, buoys, crab pots and fish nets. Industrial uses of TBT include paper and textile fungicides, addition as a stabilizer in PVC pipes, industrial cooling water biocides, an anti-yellowing agent for clear plastics, household disinfectants, and as a catalyst in many chemical processes.

Environmental Fate and Persistence:
When TBT is released from the paint matrix or polymer into the aqueous environment, it exists mainly as a mixture of TBT hydroxide, TBT chloride, and TBT carbonate. Half-life of TBT may be from 6 - 12 days in sea water, and up to 238 days in fresh water; in soils up to 116 days in aerobic soils and 815 days in anaerobic soils. TBT accumulates in sediment at levels that are one to four orders of magnitude greater than the concentrations found in the water column. Bioaccumulation is 200 to 4300 fold. (US EPA Pesticide Fact Sheet # 143, September, 1988)

Regulatory Status/Restrictions:

Tributyltin is subject to regulation by its inclusion on the following federal lists (List of Lists, 1988):

o Oil and gas, secondary recovery biocides: biocides, slimicides, and molluscides used on oil platforms.

Virginia, in January, 1986 and Maryland in July, 1986, adopted specific legislation establishing an average daily release rate of organotin of 5.0 square cm per day for antifouling paints used on all non aluminum vessels under 25 meters in length. Effective March 1, 1990, new products must be labeled as restricted-use pesticides which limits their sale and use to certified commercial applicators. The Federal Organotin Antifouling Paint Control Act of 1988 was signed into law on June 1988. This Act specifies an average daily release rate limit of 4.0 ug organotin/square cm/day, it prohibits the use of TBT antifouling paints on all non aluminum vessels under 82 feet (25 meter in length (on deck). The sale, distribution, and use of existing stocks of cancelled tributyltin products is prohibited in the U.S. (U.S. EPA 1990b).

U.S. EPA Recommended Criteria for Surface Water Quality (ug/L):

Criteria for surface water quality for tributyltin are in draft form and undergoing final review by the U.S. EPA Office of Water, Criteria and Standards Division (U.S. EPA, 1988).

Drinking Water M.C.L. (Maximum Contaminant Level in public drinking water)- None. (U.S. EPA, 1989 (May)).

FDA Action Level (regulated level in fish and shellfish tissue) = None.

State/D.C. Standards Adopted (ug/L):

The following is a list of standards adopted by the Chesapeake Bay Program states and D.C. for tributyltin:

Standards for the protection of:

	Aquatic Life				**Human Health**		
	Fresh Acute	Fresh Chronic	Marine Acute	Marine Chronic	Water & Fish Consumption	Fish Consumption	Drinking Water
D.C.	None	None	None	None	None	None	None
MD	None	0.026	None	0.01	None	None	None
PA	None	None	None	None	None	N/A	N/A
VA	None	0.0264	None	0.001	None	None	None

MD - As of 1988, the state of Maryland has restricted the use of TBT on recreational watercraft less than 25 meters. Adopted standard for freshwater is .026 ug/L and for saltwater us .010 ug/L.

Concentration in Chesapeake Bay Watershed

Elevated TBT concentrations in fresh and salt waters are primarily associated with harbors and marinas. In some cases the microlayer surface of the water contained a much higher concentration of TBT than the water column (Gucinski, 1986).

Water

Concentration	Site	Year	Reference
<10 - 87 ug/L	Hampton Roads and Elizabeth River	1985 -1986 (21 months)	Seligman et al. 1987
1171 and 1801 pptr	Maryland marinas		Hall et al. '89
51 - 408 pptr	4 MD marinas	(1 year)	Hall et al. '88
48 pptr	Severn River		Hall et al. '88
39 - 1049 pptr 22 detects/22 samples	Port Annapolis	July 1985 through June 1986	Hall et al. 1987
24 - 239 pptr 17 detects/ 23 samples	Hartge		"
29 - 1049 pptr 19 detects/ 21 samples	Pier 1	"	"
27 - 1171 pptr 22 detects/ 24 samples	Piney Narrows	"	"

Water (continued)

Concentration	Site	Year	Reference
32 - 112 pptr 10 detects/ 18 samples	Baltimore	"	"
29 - 41 pptr 2 detects/ 18 samples	C & D Canal	"	"
20 and 24 pptr 2 detects/ 18 samples	Potomac River	"	"
No detections 0 detects/ 17 samples	Choptank River	"	"
10 -100 pptr	Virginia marinas southern Ches. Bay		Huggett et al. 1986
52 and 67 pptr	Elizabeth River		
<10 - 530 pptr	Annapolis, Solomons Plaindealing Creek, Maryland	Summer 1986	U.S. EPA, 1987

Two years after TBT legislation in Maryland, 4 month mean TBT concentrations from 7 stations ranged from 21 pptr in the Severn River to 177 ppb in a Back Creek marina (Hall, personal communication).

Sediment
Available data still being collected.

Tissue
Available data still being collected.

Toxicity to Chesapeake Bay Biota or Surrogate Species

Acute Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Hydra, *Hydra sp.*	LC50	0.5 ug/L	Brooke et al 1986
Fathead minnow (juvenile) *Pimephales promelas*	LC50	2.6 ug/L	"
Amphipod, *Gammarus pseudolimnaeus*	LC50	3.7 ug/L	"

Acute Toxicity (continued)

Species	Endpoint	Concentration	Reference
Freshwater species: Rainbow trout (juvenile) Salmo gairdneri	LC50	3.9 ug/L	Brooke et al 1986
Cladoceran (<24 hr) Daphnia magna	LC50	4.3 ug/L	"
Estuarine/Saltwater species:			
Mysid (juvenile) Acanthomysis sculpta	LC50	0.42 ug/L	Davidson et al 1986 a,b
Copepod (adult), Acartia tonsa	LC50	0.6326 ug/L	U'ren 1983
Eastern oyster (embryo), Crassostrea virginica	LC50	0.71 ug/L	Roberts, Manuscript
Sheepshead minnow (33 - 49 mm), Cyprinodon variegatus	LC50	2.315 ug/L	EG & G Bionomics 1976
Hard clam (embryo), Mercenaria mercenaria	LC50	1.13 ug/L	Roberts, manuscript

Chronic Toxicity

Species	Endpoint	Concentration	Reference
Freshwater species:			
Cladoceran, Daphnia magna	Lifecycle test	0.1 - 0.2 ug/L	Brooke et al 1986
Fathead minnow, Pimephales promelas	Early life-stage	0.15 - 0.45 ug/L	Brooke et al 1986
Estuarine/Saltwater species:			
Zooplankton, Acartia tonsa		16-17 ng/L	Bushong et al. 1990
Copepod neonates Eurytemora affinis	reduced survival 13 d life cycle	88 ng/L	Hall et al 1988b
Algal species (13 species)	growth reduction	56.1 to 1,782 ug/L (most 100-250 ug/L)	Blanck et al 1984

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CHESAPEAKE BAY PROGRAM
Toxics Subcommittee's and Living Resources Subcommittee's Joint Criteria and Standards Work Group

CHESAPEAKE BAY TOXICS OF CONCERN WORKPLAN

Introduction

On January 5, 1989, the signatories of the 1987 Chesapeake Bay Agreement adopted the Basinwide Toxics Reduction Strategy. This strategy was designed to fulfill the Water Quality Commitment Number 3 of the 1987 Chesapeake Bay Agreement:

"By December 1988, to develop, adopt and begin implementation of a basinwide strategy to achieve a reduction of toxics consistent with the Water Quality Act of 1987 which will ensure protection of human health and living resources. The strategy will cover both point and nonpoint sources, monitoring protocols, enforcement of pretreatment regulations and methods for dealing with in-place toxic sediments where necessary."

The Strategy has stated as its goal:

"To work towards a toxics free Bay by eliminating the discharge of toxic substances from all controllable sources. By the year 2000 the input of toxic substances from all controllable sources to the Chesapeake Bay will be reduced to levels that result in no toxic or bioaccumulative impacts on the living resources that inhabit the Bay or on human health."

In order to achieve this goal, the Strategy identified as one of its major commitments: the "creation of a Chesapeake Bay Toxics of Concern List that will provide a basis for assessing and then controlling substances that are toxic to the Bay or human health".

The signatories committed "to develop and update a Chesapeake Bay Toxics of Concern List, maintain a matrix of supporting information, and utilize the list and supporting matrix to establish priorities for future standards adoption, monitoring, assessment, research, and toxic reduction actions", as described within the Strategy. Following are the specified signatories' commitments and dates of completion:

By September 1989, the signatories commit to hold a joint public meeting to invite input from the public on a workplan for developing the Toxics of Concern list. The Water Quality Task Group will use this information in developing the workplan and the initial list.

By December 1989, the signatories commit to complete a workplan describing the specific selection criteria for toxics to be incorporated into the list; how toxics of Baywide concern will be addressed; description of the supporting matrix elements and corresponding sources of information; plans for surveying existing source and monitoring data to develop the inventory of toxics from which the list will be developed; description of the applications and timetable for using the list; the schedule for future updates of the list and supporting matrix elements and methods for including public involvement in the process.

By March 1990, an initial Toxics of Concern List will be developed for use by the Chesapeake Bay Program.

Every two years, the Toxics of Concern List will be reviewed and revised as necessary when monitoring programs and research studies identify other compounds meeting the selection criteria. A revised and updated Toxics of Concern List will be completed by March of each successive two year period after the initial list is developed.

The Chesapeake Bay Program Toxics Subcommittee will assume the lead responsibility in executing the commitments stated above. The actions and decisions of the Toxics Subcommittee will be subject to review and approval by the Implementation Committee. The participation of the Chesapeake Bay Program committees and the general public will be solicited by the Toxics Subcommittee in the development and review of the Toxics of Concern List.

Objective

The principal objective of the Toxics of Concern List and matrix is to identify and provide concise documentation on key toxic substances either adversely impacting the Bay system or with the potential to do so. This list will provide Chesapeake Bay resource managers and regulators with the information needed to target these toxic substances for additional research, monitoring and assessment, and to strengthen existing or establish new regulatory control and prevention actions. Intended management uses of the Toxics of Concern List include : nonpoint source control targeting (agriculture, urban, stormwater); point source permits and regulations; restriction/banning products; criteria development and standards promulgation; and decisions to require monitoring/assessment of specific sources.

All managers involved with environmental decision making related to toxic substances are faced with the task of synthesizing and assessing a wide diversity of scientific and technical information in order to deal effectively with toxic issues. The Toxics of Concern List and its supporting risk assessment of the Bay watershed will provide a Baywide consensus of priority toxics and a comprehensive compilation of toxic substance information in the consistent format necessary to establish priorities for the responsible agencies to address regional and Baywide toxicant specific problems. The states will be able to use the list to target promulgation of water quality criteria and standards, where applicable, consistent with the commitments contained within the Basinwide Toxics Reduction Strategy.

Approach

The Chesapeake Bay Basin Toxics Data Base will list those toxic substances presently impacting or having the potential to impact the Bay system. This inventory of toxic substances will be prioritized based on a set of ranking criteria. Toxic substances high in this ranking will be subjected to an intensive investigation to identify their impact on the Bay. This investigation will target sources, document identified impacts and provide information concerning available regulatory controls. From this process will emerge the priority listing for toxic substances, i.e. the toxics of concern list. All information for each of Bay toxics of concern will be summarized in an accompanying information matrix.

There will be a continual feedback loop between the Toxics Data Base, the Toxics Loading Inventory and the Toxics of Concern List. As the Toxics Data Base incorporates other media, additional toxic substances will be identified for possible inclusion in the Toxics of Concern List. Additional toxic substances identified through monitoring of nonpoint and point sources will be incorporated into the Toxics Loading Inventory, a component of the Toxics Data Base, for quantification of loads to the Bay basin.

Work Plan

Outlined below is a sequential listing and description of the steps to be taken to meet the Basinwide Toxics Reduction Strategy commitments to develop and update a Chesapeake Bay Toxics of Concern List.

STEP I: Public Meeting for Review of the Workplan

After preliminary approval by the Toxics Subcommittee, the Toxics of Concern workplan will be presented at a public meeting sponsored by the Chesapeake Bay Program's Citizens Advisory Committee for review and comment. (This step was completed December 19, 1989.)

STEP II: Toxics Loading Inventory

Toxic substances for which nonpoint or point sources can be identified and quantitated (e.g. volume, flow, concentration, pounds per day, pound per acre applied) will be included in the basinwide Toxics Loading Inventory. This data will be one component of the Toxics Data Base.

STEP III: Identification of Toxics Substances in the Chesapeake Bay

There are literally thousands of toxic substances which could be considered for inclusion in the Chesapeake Bay Basin Toxics Data Base. The first step is to compile an initial list of the "total population" of toxic substances that have been found within or have the potential for entering the Chesapeake Bay system. Toxic substances will be identified from any one or combination of the following sources of information or data:

* Ambient water quality data (including microlayer, surface water, water column, and groundwater studies).
* Sediment quality data (including interstitial water).
* Finfish and shellfish tissue body burden data.
* Air quality monitoring data including atmospheric deposition studies.
* NPDES permit applications and self-monitoring reports for point source dischargers within the Bay basin (including exceedences or violations of allowances for NPDES or Pretreatment permits).
* National Urban Runoff Program data and other available information on urban nonpoint sources.
* Public water supply source monitoring data.
* The Chesapeake Bay Pesticide Use Survey and other records of pesticide and herbicide inventories/usage.
* States' 304(l) lists and data sources listed in EPA's final guidance to states for developing their 304(l) lists.
* SARA Title III data.
* Special surveys, studies or reports from various sources including other federal and state agencies, the research community and Bay public interest groups.
* Recommendations by expert Bay region researchers.

For each toxic substance appearing on this initial list, the reference source(s) of its listing will be documented. Criteria will be established for adding/deleting substances to/from this comprehensive list of Chesapeake Bay toxic substances.

STEP IV: Selection Criteria and Data Collection

The first step in determining what toxic substances should be targeted for necessary action is to rank the toxic substances in relative importance. A series of selection criteria, each assigned a ranking factor, is needed to screen the initial available data for the comprehensive list of toxic substances resulting from Step III. Priority will be given to data generated in the Chesapeake Bay watershed.

After reviewing several ranking systems currently in use, the new ranking system develop by Battelle for the EPA Office of Water was selected. This ranking system may be modified in the future to accommodate additional ranking categories important to the Chesapeake Bay. Full details of the ranking system are available in "Implementation of a Chemical Ranking System", Battelle, December 1989, EPA Contract No. 68-03-3534, Work Assignment H1-B2, Task 3.

The final selection criteria currently includes:

TOXICS EFFECTS DATA

Acute aquatic toxicity
Chronic aquatic toxicity
Acute wildlife toxicity
Acute mammalian toxicity
Chronic/subchronic mammalian/human health toxicity
Mammalian/human health carcinogenicity

ENVIRONMENTAL FATE DATA

Bioconcentration/bioaccumulation
Environmental persistence
Environmental partitioning (percent in water, suspended solids, aquatic biota and sediments)

CHEMICAL EXPOSURE DATA

Production volume
Discharge amount to water
Discharge facilities
Mean concentration in ambient water
Mean concentration in aquatic sediments
Treatability (percent removal from WHERL Organics Treatability Data Base)

The ranking system may be revised to include additional factors such as:

- high toxicity to important Bay organisms with particular emphasis on those target species identified by the Chesapeake Bay Program;
- chronic wildlife effects;
- high measured microlayer concentrations;
- atmospheric deposition;
- human body burden; and,
- other factors as need becomes apparent.

The ranking for each toxic substance will be periodically updated as new information becomes available. Each time any information for a specific toxic substance is revised or updated in the ranking system, the date of update will be documented.

Plans for development of a similar ranking system for the compilation of the Chesapeake Bay Pesticide Registry will be integrated into this ranking system.

STEP V: Application of Ranking System

Using the ranking system, the toxic substances listed in the Toxics Data Base will be screened to produce a preliminary list. The screening process will assign a numerical value for those selection criteria where information is available. Decisions as to whether to include the individually ranked toxic substance for further consideration will be based on a numerical cutoff (e.g. all toxic substances with a score greater than 40) or on an arbitrary cutoff within the overall ranking system (e.g. the top 10% ranked toxic substances).

STEP VI: Chesapeake Bay Data Verification

Initially, an assessment of the risk to the Chesapeake Bay system posed by the highest ranked toxic substances will be made. Eventually, this assessment will be extended to all toxics substances identified in the Chesapeake Bay Basin Toxics Data Base. An Information Matrix will be developed to provide a comprehensive compilation, in a consistent format, of the latest information on the given toxic substance. The risk assess-ment for each top ranked toxic substance's actual impact on or potential to impact the Chesapeake Bay system will be performed based on information contained within the Matrix.

In addition to the STEP IV Selection Criteria data, the following informational categories are proposed for inclusion in the Matrix:

1) Sources of toxic substances including:
   a) point sources (municipal and type of industrial effluent; SIC code),
   b) nonpoint sources (agricultural runoff, urban runoff, and groundwater seeps, marina/boating activities),
   c) combined sewer overflow,
   d) spills in transportation or production and processing.
2) Known or suspected characteristics and sinks for toxic substances, to include information on the effects of the various toxic sub-stances in sediment, water column, and on biota and whether the toxic substance is expected to be found in the surface microlayer, fish and shellfish tissue via bioaccumulation/biomagnification/bio-activation, and its geographic distribution throughout the Bay.
3) The relative range of and average concentrations of the toxic substances in receiving waters, sediments, and fish and shellfish tissue based on existing, available data.
4) FDA action levels, cancer reference doses and carcinogenic potency factors for human consumption of finfish and shellfish.
5) The regulatory status, indicating the reference source listing(s) of each toxic substance.
6) Availability of water, sediment, and tissue analytical methods relative to the Chesapeake Bay system and their respective detection levels.
7) Established criteria, guidelines, standards and regulatory action levels for drinking water, ambient water, and sediment for protection of human health and aquatic life.
8) Interim guidelines as appropriate for sediment quality such as, screening level concentrations and apparent effects thresholds.

Upon completion of the risk assessment, the Criteria and Standards Workgroup will identify the Toxics of Concern List. This list will be forwarded to the Toxics Subcommittee for its approval.

The Matrix will also be an information reference on the toxics of concern when decisions are made on targeting the individual toxic substances for followup research, monitoring, and management actions. The toxic substances will be organized according to their common name and Chemical Abstracts Service (CAS) Registry Number. The Matrix will contain a date of update for each toxic substance revision in order to document when all revisions are made.

STEP VII. Peer Review of Toxics of Concern Ranking/Risk Assessment

The Toxics Subcommittee will seek peer review of the documented results from the ranking and risk assessments performed up through and including STEP VI.

STEP VIII. Approach for Identifying Followup Actions

Following the approval of the preliminary Toxics of Concern List, the Criteria and Standards Workgroup will produce a document outlining an approach for identifying control, corrective and preventative actions and present it to the Toxics Subcommittee for further action.

STEP IX: Water Quality Criteria Development/Data Base Needs Identification

In the absence of existing water quality criteria for the listed Toxics of Concern, and if sufficient information is not available for establishment of criteria by the states, the Toxics Subcommittee will request the EPA Criteria and Standards Division place priority on the development of national water quality criteria for these toxic substances.

For those toxic substances for which the existing toxicity data base information is not adequate for water quality criteria development, the joint Toxics Subcommittee/Living Resource Subcommittee Criteria and Standards Workgroup will list, in priority order, the Chesapeake Bay species specific toxicity test results that are required to fill in the data gaps. This listing will be circulated to state and federal agencies by the Toxics Subcommittee with a request to support necessary research to address the data base gaps. The Toxics Subcommittee will also request the Scientific and Technical Advisory Committee consider these research needs when developing its annual Chesapeake Bay research priorities list.

STEP X: Identifying Control, Corrective and Prevention Actions

Based on the review of the information contained in the risk assessment described above and after inviting comments from other Chesapeake Bay Program Committees, the Toxics Subcommittee will recommend to the Implementation Committee specific regulatory, management control or preventative actions for each toxic of concern. For those toxic substances where there is insufficient information available to recommend control actions, specific assessment actions will be identified. These actions, with time schedules for implementation, could include:

- Adoption of water quality standards/criteria as a basis for enforceable control requirements for nonpoint and point sources.
- Adoption of control policies or guidelines in lieu of enforceable standards for point and nonpoint sources.
- Recommendations for new or revised best management practices for nonpoint sources.
- Recommendations for improved pretreatment programs/NPDES permits to address specific toxic substances.
- Recommendations for additional research, particulary for nonpoint sources.
- Recommendations for additional monitoring or special surveys.
- Recommendation for restrictions on the use designation and/or application of a product (i.e. agricultural or industrial).
- Recommendations for product restrictions and bans.
- Public information/public education programs.
- Determination that a toxic substance is not currently adversely impacting the Bay system, that no corrective actions are necessary, but the potential for future impact is significant enough to warrant preventative actions.

A specific recommendation for action is anticipated for each toxic substance included on the final Toxics of Concern List. The recommended corrective actions become major Chesapeake Bay Program agency restoration and regulatory activities in regards to toxic substances.

STEP XI: <u>Process for future revisions and updates</u>

The final Toxics of Concern List and the supporting Matrix will be revised and updated by March of each successive two year period after the initial list is developed, as called for in the Basinwide Toxics Reduction Strategy. The Criteria and Standards Workgroup will develop the process for updating this list to address the completion of data gaps, and the incorporation of additional/revised data.

STEP XII: <u>Chesapeake Bay Program Approval</u>

A document will be produced listing the Toxics of Concern list, the supporting informational matrix, recommended corrective and preventative actions, and a description of the proposed process for future updates. A description of the process followed to develop the initial Chesapeake Bay Toxics of Concern List will also be outlined in the document. This document will be presented to the Implementation Committee for final review, approval and adoption.

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APPENDIX C

Recommendations to assist with the gathering of additional information and the further review of the toxic substances identified as potential candidates for the Toxics of Concern List.

The candidate substances are:

Alachlor
Aldrin
Arsenic
Dieldrin
Diflubenzuron (dimilin)
Fenvalerate
Metolachlor
Permethrin
Toxaphene
Zinc

For the substances listed above:

- Fund acute and chronic aquatic toxicity studies for Chesapeake Bay basin species (fresh, estuarine, salt waters) with emphasis on estuarine and salt water species if monitoring demonstrates concentrations in the ambient water column are sufficient to warrant investigation of potential toxicity impacts and the development of water quality criteria.

- Research the relative contributions of various sources, particularly nonpoint sources, of arsenic and zinc to the Bay watershed; target the contribution from treated wood in the arsenic investigation.

- Sponsor a literature search to document the persistence and toxicity of alachlor, fenvalerate, metolachlor, and permethrin.

- Determine if either extensive or limited monitoring in the water column is needed for alachlor, aldrin, dieldrin, dimilin, fenvalerate, metolachlor, permethrin, and toxaphene. Based on the results of the literature search, the current pesticide usage data available for the Chesapeake Bay watershed and the current Bay watershed monitoring data, Monitoring should be timed to periods of highest pesticide application and should include reasonable time periods after application to determine persistence.