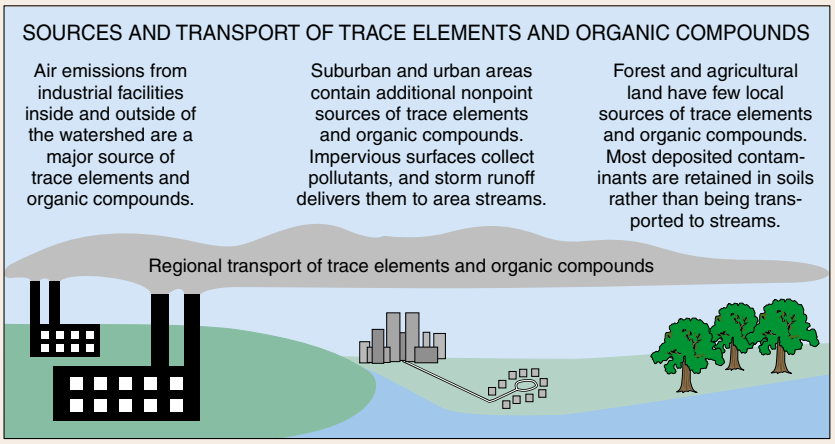
Spatial surveys of bed and bottom sediments in rivers, reservoirs, and wetlands of the ACF River Basin were performed (see maps on pages 26–27) to determine the extent of environmental contamination by trace elements (mostly heavy metals) and synthetic organic compounds. Samples from 48 sites were analyzed to compare contaminant concentrations in the recently deposited sediments of watersheds with different predominant land uses and hydrogeology. Contaminant concentrations also were compared to quantities of the contaminants released to the atmosphere from permitted facilities located within and around the Study Unit. Twenty-one sites are located on main-stem rivers or reservoirs, five sites are on large tributaries to the Flint River, and 22 sites are on streams draining smaller watersheds with a predominant land use.

The largest trace-element enrichment (summarized in illustration on page 19) was in (1) urban and suburban watersheds draining portions of Metropolitan Atlanta and Columbus, (2) main-stem and reservoir settings on the Chattahoochee River downstream from Atlanta, and (3) the Flint River downstream from Albany. Some exceptions to this pattern are evident, including: (1) copper enrichment throughout the Piedmont, (2) mercury and lead enrichment in small forested watersheds in the Coastal Plain, (3) mercury and copper enrichment in the Chattahoochee River upstream from Atlanta, and (4) cadmium and mercury enrichment in the large Coastal Plain tributaries to the Flint River.

Much of the transport and deposition of trace-element contaminants to receiving watersheds may occur along regional atmospheric pathways. However, urban landscapes with high percentages of impervious areas, such as industrial and transportation areas, enhance the movement of airborne trace elements to waterways.



Exposure to high concentrations of trace elements and organic compounds in aquatic sediments are a health risk both to the aquatic life and terrestrial animals (including people) that consume food resources taken from our waterways. Although soils and rocks contain low concentrations of most trace elements, much of the current pollutant load of these contaminants is derived from industrial emissions and urban nonpoint sources. The dominant pathways involve regional atmospheric transport and deposition on land. Urban land areas have high percentages of impervious surfaces that collect pollutants and storm drains that carry pollutants to nearby streams.

Facilities reporting releases of metals and organics to the atmosphere within 300 miles of Albany, Georgia, from 1987 to 1993. Data from: http://www.epa.gov/opptintr/tri

	TRACE ELEMENTS						ORGANICS				
Industry	As	Cd	Hg	Cu	Pb	Zn	PAHs	Phe-nols	Phthal-ates	Total[1] metals	Total[1] organics
Food preparation	5	0	0	44	0	33	0	0	0	48	0
Textiles	0	0	0	3	4	9	24	2	11	12	36
Lumber and wood	65	0	0	65	0	0	20	18	3	69	31
Paper products	0	0	0	0	0	8	5	31	1	8	35
Chemicals	6	1	5	46	28	86	54	55	45	121	123
Petroleum and coal	0	0	0	4	3	9	7	2	0	11	9
Rubber and plastics	1	6	1	3	12	47	4	5	28	59	37
Stone, clay, glass	0	0	0	3	6	10	4	9	6	12	16
Metal products	6	11	0	109	95	93	21	28	4	185	40
Industrial machinery	0	0	0	11	6	5	1	2	2	16	5
Electronics	0	3	3	31	25	15	0	6	0	60	6
Transportation equipment	0	0	0	13	13	13	2	7	10	29	19
Total facilities	**83**	**21**	**9**	**332**	**192**	**328**	**142**	**165**	**110**	**630**	**357**
Total emission 1987-93, in thousands of pounds	**48**	**11**	**41**	**1,200**	**960**	**4,900**	**4,500**	**4,400**	**1,600**	**7,200**	**10,500**

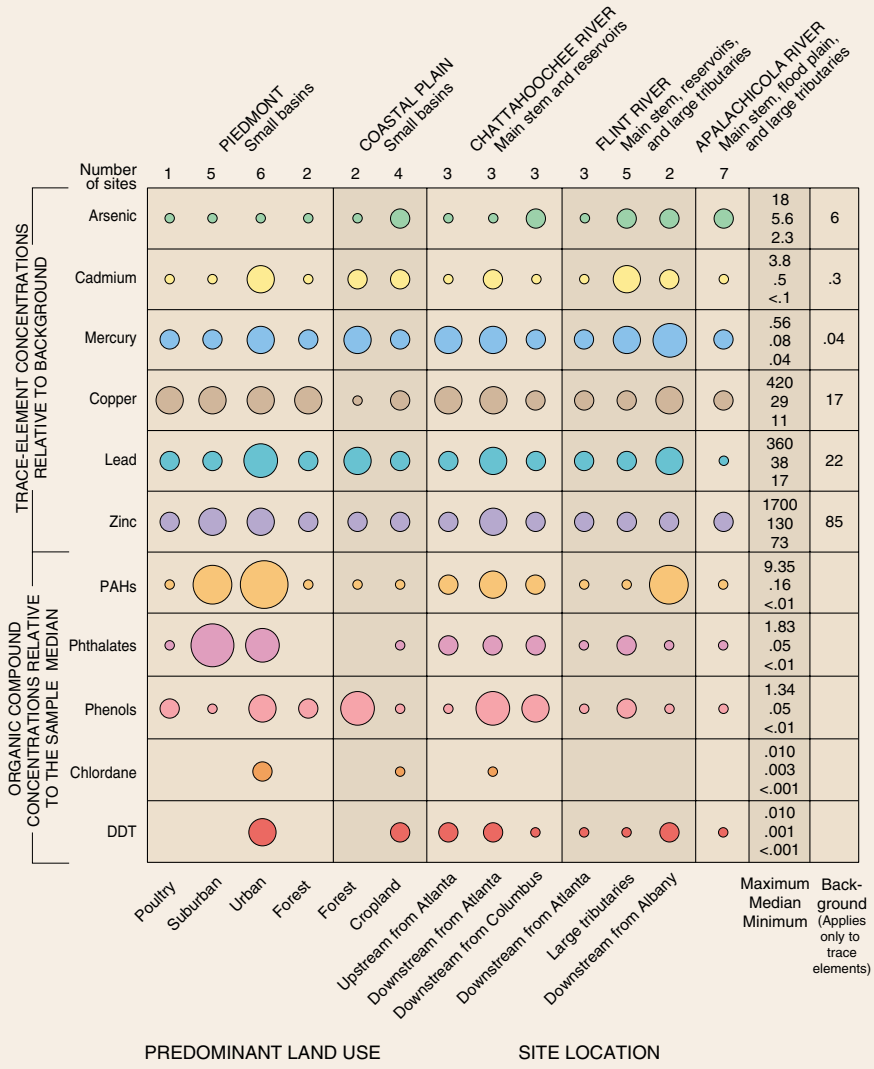
[1] The totals may not equal the sum of the parts because a particular industry may emit more than one trace element or organic compound.

Toxic Release Inventory (TRI) release-to-air data for industrial facilities within 300 miles of Albany, Georgia, are summarized for the years 1987–93 for six toxic trace elements and three categories of organic compounds that are toxic, carcinogenic, or both. The 300-mile-radius airshed was conservatively chosen as a potential contributing area to the ACF River Basin. Releases to air of arsenic, cadmium, mercury, copper, lead, and zinc were reported for 630 facilities representing 12 industrial categories. Copper, lead, and zinc accounted for 99 percent of the total load of 7.2 million pounds during 1987–93, whereas arsenic, cadmium, and mercury accounted for only 1 percent of that load. Polycyclic aromatic hydrocarbons (PAHs), phenols, and phthalates accounted for the release of 10.5 million pounds of organic compounds by 357 facilities during 1987–93.

Among organic compounds present in streambed sediments, polycyclic aromatic hydrocarbons (PAHs) and phthalates were at highest concentrations in (1) suburban and urban watersheds in Metropolitan Atlanta and Columbus, (2) main-stem reaches of the Chattahoochee River downstream from Atlanta and Columbus, and (3) the Flint River downstream from Albany. Unlike the trace elements that naturally occur at background concentrations in most soils and sediments, PAHs and phthalates are present in sediments as contaminants from industrial activity, fossil-fuel combustion, or waste incineration. PAHs are released from wood and other plant material by fires. Phthalates are used for production of plastics and plastic products. Phenols have many industrial and natural sources and are widely distributed in sediments of the ACF River Basin.

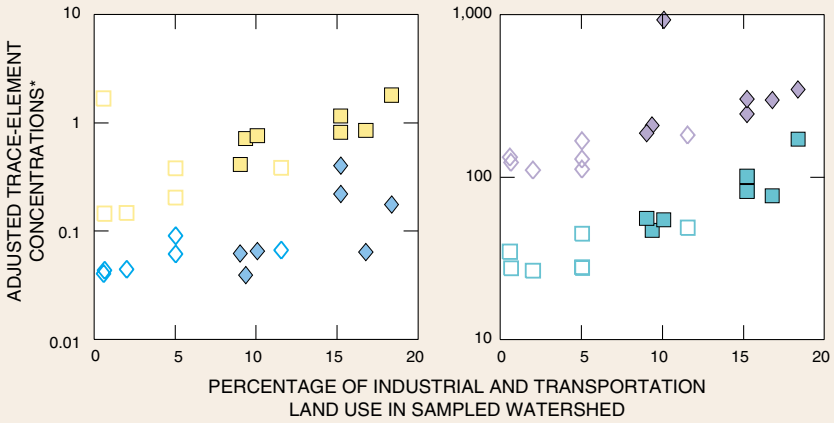
Bed-sediment samples are sieved and the silt and clay fractions are analyzed to minimize effects of grain size on patterns in trace-element chemistry.

Although most organochlorine insecticides such as chlordane and DDT have been banned from use, residual quantities of these compounds and their degradation products are common in the sediments of the ACF River Basin. Chlordane and DDT were at highest concentrations in urban watersheds of Atlanta and Columbus, but also were present in watersheds draining cropland and in main-stem and reservoir sites. Chlordane was used as an insecticide on cropland until the mid-1970's and for building and foundation protection against termite damage until the late 1980's. DDT was used through the early 1970's as an insecticide, both in agricultural and urban settings.



An Index of Geoaccumulation (Müller, 1979) was developed for the toxic trace elements arsenic, cadmium, mercury, copper, lead, and zinc and the results are shown here as circles with different diameters. The smallest circle represents index values of zero (no enrichment relative to background), and each increase in circle diameter represents up to twice the enrichment of the previous level. The Index of Geoaccumulation was modified slightly for organic compounds so that the variations in circle diameter represent positive departures from the median compound concentrations for the data set. Organic-compound concentrations that are equal to the median of the data set are shown at the smallest circle diameter; each increase in circle diameter is equal to concentrations twice that of the previous level. No circle is shown for locations where organic compounds were not detected. For trace elements, the maximum, median, minimum, and background concentrations are reported in micrograms per gram. For organic compounds, the maximum, median, and minimum concentrations are reported in micrograms per kilogram.

Although much of the transport of airborne pollutants is regional, stormwater runoff from impervious areas is a major factor in increasing trace-element concentrations in receiving streams. Concentrations of mercury, cadmium, lead, and zinc in the streambed sediments of suburban and urban watersheds in Metropolitan Atlanta and Columbus increased in direct proportion to the percentage of industrial transportation land use in these watersheds. This direct response likely is the result of deposition of emissions from regional and local sources on impervious surfaces and subsequent transport of these pollutants in stormwater runoff to streams.



Stormwater runoff from impervious areas in Metropolitan Atlanta and Columbus is a significant factor in delivering metals to streams, as indicated by increasing adjusted concentrations of mercury, cadmium, lead, and zinc with increasing percentages of industrial transportation land use in these watersheds.

EXPLANATION

Land use	Trace elements: Mercury	Cadmium	Lead	Zinc
Suburban	◇	□	□	◇
Urban	◆	■	■	◆

*Trace-element concentrations are adjusted for organic carbon and titanium to minimize effects of varying grain size

Wastewater-treatment plant

Coal-burning power plant

Litter and debris in an urban stream

Urban areas have additional local sources of trace elements and organic compounds. The USEPA Toxic Release Inventory (TRI) data base (http://www.epa.gov/opptintr/tri) contains annual emissions to air, land, and water of more than 600 toxic chemicals. Industries and Federal facilities that either manufacture more than 25,000 pounds of, or use more than 10,000 pounds of, any designated chemical per year are required to report their releases. Currently, reported releases to water are minimal and releases to land are to landfills or other secured areas with low potential for transport to waterways. Therefore, releases to air provide the best available estimate of trace-element and organic-compound inputs for regional assessments. However, smaller industrial producers and users of trace elements and organic compounds, wastewater-treatment plants, and coal- and oil-burning power plants do not contribute emissions information to the TRI data base. Also, the quantities of local inputs of trace elements and organic compounds from nonpoint sources, such as automobile emissions and litter and debris disposed along roadways and streams, are not known. (Photograph of power plant is by Steve Kandell, Atlanta Regional Commission.)