CONCLUSIONS AND RECOMMENDATIONS

The compilation shown here only begins to display the CARP data. Loading calculations and mass transport still require a great deal of further effort. Furthermore, more work will go into integrating results from the biota and sediment programs with the water section. Much of the focus of the present discussion has been on sources. The major tributaries seem to be the dominant loading sources for all of the analytes but some congener evidence suggests, for PCBs and dioxins, significant unidentified sources. The efficiency of transport of toxic substances through 150 miles of estuary still needs research. This has begun.

For the most part, areas of the harbor thought to be cleanest are freest of the target substances and those areas thought to be most contaminated, are. Perhaps the weakest element in sampling was the CSOs. These should have been sampled more intensively but the logistics of CSO sampling, even wet-weather influents, are formidable. Tributary sampling can also be improved. The Wallkill New Paltz site may have been too far from the river's mouth. The timing of the upper Hudson samples may have been somewhat inappropriate in that CARP concentrated on high flow periods to the neglect of times when biopertubation may have resulted in significant loads. Too much effort may have gone into sampling wastewater treatment plants. They do not appear to be particularly significant loading sources.

One of the most unexpected discoveries was the prevalence of a hither to unknown PCB congener, 3,3'-dichlorobiphenyl. Trackdown work has both confirmed the source and opened questions (the source of and disappearance of IUPAC 77) that have yet to be resolved. While very important in a few sewage treatment plant outfalls, 3,3'DiCB is probably not a significant component of sediments or of biota. CARP has confirmed significant loadings from the upper Hudson River. However, downstream PCB loads are apparent in the changing congener distributions between upstream and downstream areas. A clear PCB source is seen in the 26th Ward WPCF in Brooklyn. However, the impact of this source on the receiving body, Jamaica Bay, is not apparent. There is also not a clear route to the remediation of the 26th Ward Aroclor 1260. Initial trackdown work at the Newtown Creek WPCF suggests the desirability of tracking PCBs back on two sewer mains. This has not yet been done.

Dioxin/furan "fingerprints" have turned out to be stable and perhaps diagnostic. Reduction in harbor dioxin concentrations will require gaining a much better understanding of the sources of some of the non-2,3,7,8-TCDD congeners. There may be a significant source of 2,3,4,7,8-PeCDF in the lower Hudson. Some other dioxins might turn out to be characteristic of urban wastewater. Related investigations from the World Trade Center disaster suggest that other dioxin-like substances should be addressed. These other substances include the co-planar PCBs and the brominated dioxins/furans. Better analytical methods and a great deal of toxicological work are required before routine monitoring of some of these dioxin-like materials becomes practical.

An early discovery of CARP was the significance of the Wallkill as a source of DDTs and dieldrin. Control of this source will require attention of sediment transport and sediment loading. Mechanisms for doing this have yet to be revealed. The actual impact of the Wallkill pesticides on the Hudson River and on the Harbor may be confused by the location of the sampling point, upstream of a deposition area (Sturgeon Pool).

Among the weakest parts of CARP was PAH sampling. The problems of addressing at least two very different models of PAH impact were not sufficiently appreciated at the beginning and were not corrected during CARP. There also needs to be a better toxicological understanding of the impact of PAHs on benthic test organisms. Further sampling might be postponed until the toxicology is better understood and the sampling problems are corrected. We lack a good way to field-concentrate dissolved PAHs. CARP has shown that some of the methylated PAHs are very abundant.

Metal loading appears to be largely driven by the major tributaries, but there are exceptions. Mercury trackdown at Rockland WPCF was unsuccessful, but that work should be completed. Metals sources to the Newtown Creek WPCF appear numerous but success in identifying and reducing sources will be challenging. Some of the CSOs may also be significant metals sources but the limited sampling calls the ultimate value of the loadings into question. There should be more work done on metals from CSOs and SWOs. Portable low-level mercury analyzers may play a useful role in describing mercury sources and in ultimate remediation.

Perhaps the most fruitful area for follow up will be the accessory parameters, particularly suspended sediment and POC. These very inexpensive parameters may yield important information on the behavior of the overall estuarine/harbor system. Sampling for the accessory parameters was weak as the numerous holes in the database attest. Effort is underway to begin developing suspended sediment data from the Hudson (ny.usgs.gov/projects/poused/index.html), Schoharie Creek, and the Wallkill. This should lead to better information about loadings of sediment to the basin which, in turn, may help in reducing the sediments.

CARP has been very successful in the development of field and analytical methods, particularly for PCBs, chlorinated dioxins/furans, and some of the chlorinated pesticides. Substances often reported as non-detected or simply ignored because of detection limits were routinely quantitated. The measurement of trace organic chemicals in the open ocean is perhaps unique. CARP has led to the development of powerful data management systems without which the volume of data would have utterly swamped the investigators.

This report is the conclusion of the first phase of CARP. Subsequent work could include addressing areas of weakness, follow-up on chemical source identification, and the design and implementation of a cost-effective long term monitoring program that would document effective clean-up and timely identification of emerging pollutants.

ABBREVIATIONS

Table 122. Abbreviations and acronyms.

abbr.	full name
AAS	Axys Analytical Services, a contract laboratory
Ag	silver
AMB	abbreviation for "ambient"
BAF	bioaccumulation factor
CARP	Contaminant Assessment Reduction Project
CCMP	Comprehensive Conservation Management Plan
Cd	cadmium
CFS	cubic feet per second
CSO	combined sewer overflow
DOC	dissolved organic carbon
DU	duplicate
EB	equipment blank
Eff.	effluent
EPA	US Environmental Protection Agency
FB	field blank
FGS	Frontier Geoscience, a contract lab
FK	Fresh Kills
HCB	hexachlorobenzene
HCH	hexachlorocyclohexane
HEP	Harbor Esturary Program
Hg	mercury
HMDC	Hackensack Meadowlands Development Commission
HpCDD	heptachlorodibenzo dioxin
HpCDF	heptachlorodibenzo furan
HRGC	high resolution gas chromatography
HRMS	high resolution mass spectrometry
HxCDD	hexachlorodibenzo dioxin
HxCDF	hexachlorodibenzo furan
Inf	influent
IUPAC	International Union of Applied and Physical Chemistry
mg	milligram
mg/L	milligram per liter, part per million
MGD	million gallons per day
ng	nanogram
ng/L	nanogram/liter, or part per trillion
NYCDEP	New York City Department of Environmental Protection
NYCDOS	New York City Department of Sanitation
NYSDEC	New York State Department of Environmental Conservation
OCDD	octachlorodibenzo dioxin
OCDF	octachlorodibenzo furan
PAH	polynuclear aromatic hydrocarbon
Pb	lead

Table 129 continued.

abbr.	full name
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo dioxin
PeCDF	pentachlorodibenzo furan
pg	picogram
pg/L	picogram per liter (part per quadrillion)
PISCES	Passive In-Situ Chemical Extraction Sampler
POC	particulate organic carbon
PVSC	Passaic Valley Sewerage Commissioners
QTS	Quanterra, now called Severn Trent Laboratories, a contract lab
SA	sample
SDG	sample delivery group
SS	suspended sediment
SWO	storm water outfall
TCDD	tetrachlorodibenzo dioxin
TCDF	tetrachlorodibenzo furan
TDDT	total DDT
TEF	toxic equivalency factor
TEQ	toxic equivalence
TSS	total suspended solid
USACOE	US Army Corps of Engineers
USGS	US Geological Survey
WHO	World Health Organization
WPCF	water pollution control facility
WQS	water quality standard
WSU	Wright State University, acting as a contract lab
XAD	XAD, not an abbreviation.