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October 25, 1988

Douglas C. Allen
E.C. Jordon Co.
New Bedford Harbor Site Manager
261 Commercial Street
P.O. Box 7050
Portland, Maine 04112

Dear Mr. Allen:

This is in response to your request of EPA/ERL-Narragansett for a summary of the information available on the in-situ biodegradation of PCBs in New Bedford Harbor. Several papers authored by John F. Brown et al. from the General Electric Research and Development Center (Northeastern Environmental Science 3: 167-179 (1984); Science 236: 709-712 (1987); Environmental Toxicology and Chemistry 6: 579-593 (1987)) have reported the in-situ dechlorination of PCBs in sediments from the Hudson River and Silver Lake in Massachusetts. Also, Mark P. Brown and colleagues from the State of New York presented an alternative explanation to the PCB patterns in the Hudson River (Science 240: 1674-1675 (1988)) and John Brown et al responded (Science 240: 1675-1676 (1988)). These are the only reports that we are aware of in the peer reviewed scientific literature that describe in-situ anaerobic dechlorination. The findings of several of these studies are discussed in the attached memo from the Microbial Ecology and Biotechnology Branch, EPA/ERL-Gulf Breeze.

The 1987 Science article by the General Electric Group mentions that there is limited evidence for anaerobic PCB dechlorination in the sediments of New Bedford Harbor but provides no data. We also have a copy of a report to Mr. Paul Galvani of Ropes and Gray from S.J. Eisenreich of the University of Minnesota. This report presents the results of statistical analyses performed by Dr. Eisenreich on PCB data generated by John Brown et al. at General Electric. The report concludes that the analyses "support the hypothesis that weathering and/or degradation of PCBs is occurring in the sediments of the Acushnet River estuary upstream of the inner harbor". We feel that the data presented in this report are not conclusive and could mostly

be explained by the differential mixing of various Aroclors in the sediments of the estuary.

We have analyzed 12 sediment cores from the location of the Pilot Dredging Project in New Bedford Harbor for PCBs. These analyses did not specifically address the anaerobic dechlorination of PCBs as only the levels of Aroclor 1242, Aroclor 1254 and thirteen PCB congeners were measured. Visual inspection of the chromatograms, however, indicates little or no change in the relative peak heights with depth in the cores. This suggests, but does not prove, that the anaerobic dechlorination of PCBs is not a significant process at this site. We are presently in the process of rigorously studying the concentrations of numerous PCB congeners at several stations within the harbor to determine if anaerobic dechlorination is an important process in the New Bedford Harbor estuary. The results of these studies should be available in approximately six months.

In summary, we believe that insufficient data have been generated to conclusively determine if anaerobic dechlorination has occurred in the sediments of New Bedford Harbor.

Sincerely yours,

Richard J. Pruell

Richard J. Pruell, Ph.D
Research Chemist

James L. Lake

James L. Lake, Ph.D
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cc: Charles Bering, EPA Region I
Frank Ciavattieri, EPA Region I
Leroy Folmar, EPA Narragansett
Walt Galloway, EPA Narragansett

Summary of the Recent Work of Brown et al (GE) on Anaerobic Fate of PCB's

Brown and his colleagues at General Electric have recently summarized their findings with respect to PCB dechlorination in aquatic sediments (Science 236 709-712, 1988) from which they conclude that slow dechlorination of heavily chlorinated PCB congeners by selective, reductive loss of chlorine substituents is occurring through the agency of anaerobic microorganisms. These conclusions are based upon the following:

(i) Detailed analyses of up to 118 PCB congeners (separated, identified, and measured by GC/MS) currently present in sediment cores from sites in the upper Hudson river particularly those where low hydrodynamic shear gives "hot spots" with PCBs of 50ppm or more at depths of 15-30 cm.

(ii) Plant records of PCB purchase and use by GE between 1955 and 1971 showing the composition of GE releases to the Hudson river to be almost entirely Aroclor 1242 with minor contributions of Aroclor 1254, 1260/1268 were used to estimate a PCB congener mix originally present.

(iii) Reviews of earlier archived GC analytical data of numerous Hudson river samples generated in 1977.

The authors concluded that the proportions of tetra-tri-,di-, and mono-chlorobiphenyls found in their analyses were sufficiently different from the presumed composition of the originally introduced PCBs that a significant conversion of higher chlorobiphenyls to mono-, di-, and tri-chlorobiphenyls had occurred particularly in the subsurface sediments (considered to be from 15 to 30 years old).

Analyses of data obtained for sediments from a second PCB-contaminated site, Silverlake, MA, considered to have received almost exclusively Aroclor 1260, showed, in 50% of the examined cases, significant differences consistent with a major conversion of higher to lower PCB congeners.

Examination of analytical data from other PCB sites also supports this conclusion that dechlorination has occurred. Of particular note is the identification of two unusual trichlorobiphenyls the 2,5,3- and 2,4,3- isomers not present in more than trace levels in the Aroclors originally thought to have been present.

Mark Brown et al have-criticized the conclusions of the GE group (Science 240, 1674-1675, 1988) particularly on their assumption of a prior PCB composition for river sediments and argue that physical and chemical processes in factories, waste water treatment, river transport and sedimentation could explain the variation in patterns of PCB congeners also observed by them.

Brown et al have answered this criticism (Science 240: 1675-1676, 1988) by pointing out the need to identify whether data relates to surface or subsurface sediments and to the prevailing PCB concentrations (Brown et al disregard congener distribution measurements on samples containing less than 2ppm PCB's). They accept that loss of lower PCB congeners will occur from sediment surface deposits by elution into water and by aerobic biodegradation but stress that their analyses and conclusions are largely based on analyses of subsurface sediments with high PCB content (50ppm or more) left undisturbed by hydrodynamic processes

Their counter argument is strengthened by their observations that:

(i) extensive loss of chlorines appears to occur in a selective manner from non-ortho positions (consistent with some biological specificity).

(ii) the formation of novel PCB congeners not usually formed in any quantity during chlorination of biphenyl.

(iii) the net increases in quantities of lower congeners.

(iv) the variability in congener patterns seen (again consistent with alternative biological mechanisms).

(v) the most extensive changes occurring in the deeper, most heavily contaminated sediment layers (consistent with long term, strictly anaerobic processes proceeding in the absence of physical perturbation).

Support for their conclusions that these processes are mediated by anaerobic microorganisms is provided by a preliminary report by Tiedje and coworkers (Abstr #416, 8th Ann. Mtg., SETAC, Pensacola, Florida 1987). Incubation of specific PCB congeners with contaminated Hudson River sediments for one year led to substantial dechlorination, not found in sterile controls. No dechlorination at ortho positions was observed.

In summary, data supplied by the GE group support the conclusion that slow, specific, anaerobic, biological processes are occurring in the anaerobic layers of sediments to give selective loss of chlorines from the higher chlorinated PCB congeners. The apparent stability of certain tetrachlorobiphenyl congeners (2,4-2'4'; 2,4-2'5' and 2,5-2'5') is explained by their formation by dechlorination of penta- and hexachlorobiphenyl precursors and their concurrent removal by dechlorination to trichlorobiphenyls.

It is the position of scientists at the Microbial Ecology and Biotechnology Branch, ERL, USEPA, Gulf Breeze that the conclusions of Brown appear reasonable explanations of the data and are entirely consistent with the selective action of anaerobic organisms present in sediments subjected to long term exposure to elevated concentrations of PCBs in Aroclors.

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P.J.
Providence Journal

For your info.

Bacteria appear to make toxic PCBs less harmful

WASHINGTON (AP) — Oxygen-starved bacteria working in sediment beneath the Hudson River are transforming toxic PCB compounds into less dangerous forms, raising hopes of a significant easing of a PCB cleanup problem nationwide, researchers said yesterday.

The resulting types of PCBs do not accumulate in living tissue, a government scientist said.

The researchers from Michigan State University said their results with anaerobic or oxygen-free bacteria could mean that not every contaminated sediment would have to be cleaned up, and cleanups that do proceed might be much less risky than people have assumed.

'Enormous significance?'

"If it is true, it could have enormous significance," said Richard D. Morgenstern, head of the Office of Policy Analysis in the Environmental Protection Agency.

Sally Valdez Cogliani, an EPA ecologist and sediment specialist, said the discovery showed promise, but she was more restrained than Morgenstern. "Probably most situations are not anaerobic. I'd wonder about its general applicability," she said.

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PCBs are a common toxic waste problem. In some of the better-known cases, they have contaminated harbor sediments at New Bedford, Mass., and Waukegan, Ill.

Millions of pounds of PCBs were used from 1929 to 1977.

The nation's utilities are faced with the massive task of draining them from their transformers by the early 1990s, and PCB spills all over the landscape are a frequent problem.

The Michigan State findings appear to substantiate a theory put forward by General Electric Corp., source of most Hudson River PCBs.

The New York State Department of Environmental Conservation said it wanted to dredge up and place in a landfill 360,000 cubic yards of PCB "hot spots" in the Hudson River above Albany resulting from legal GE waste discharges from 1951 to 1973.

R.W. Groneman, spokesman for the department, said of the new findings, "It's a good theory, but what does it mean in the real world?"

Until EPA banned manufacture in 1977, some mixtures of the 209 possible PCB compounds, polychlorinated biphenyls, were widely used as coolants and insulators in electrical equipment such as transformers and capacitors.

The fluids do not transmit electricity and are extremely difficult to burn.

Congress required EPA to act because of findings that PCBs appeared to cause cancer, skin and reproductive disorders in laboratory animals.

PCBs accumulate in fatty tissue, and findings of high levels in fish led New York authorities to ban the taking of striped bass from the Hudson or ocean waters inshore.