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U.S. EPA. REGION II
EMER. & REM. RES. DIV.
2001 AUG 14 AM 11:45
DIRECTOR'S OFFICE

August 9, 2001

Mr. Doug Tomchuk
Project Manager
Hudson River PCBs Site
USEPA – Region 2
290 Broadway, 19th Floor
New York, NY 10007-1866

Dear Mr. Tomchuk:

Thank you for faxing me a copy of Representative Young and Representative Duncan's letter of August 1, 2001 to Administrator Whitman regarding the consistency of EPA's proposed Hudson River remedy with the recent National Research Council report entitled "A Risk-Management Strategy for PCB Contaminated Sediments." This letter addresses the issues raised relative to my work, generally in the order in which they were raised. Please feel free to use this in your response in any manner you wish.

As you are aware, my involvement in the Hudson River project began in October 2000 with an inquiry about my research related to water quality impacts resulting from dredging contaminated sediments. I am the lead author on the only resuspension source estimate model published in the peer-reviewed literature. I should point out that my research is aimed at providing reliable estimates of both sediment and toxic constituent water quality impacts, not either supporting or disproving dredging as an effective remedial tool. Research in this area has been limited and methodologies for predicting impacts are still in the developmental stage. After some discussions, TAMS asked me to prepare a technical memorandum that eventually became Appendix E.6 of the Hudson River Superfund Feasibility Study. Since the Feasibility Study was entering its final stages, the technical memorandum addressed only the selected remedy (REM 3/10/select).

The first comment related to my efforts in Representative Young and Representative Duncan's letter questions the general approach used to model resuspended sediment and associated contaminant transport. Polychlorinated Biphenyls (PCBs) are hydrophobic constituents that preferentially adsorb to particulate matter when suspended matter is present; this preferential adsorption is the mechanism through which the bottom sediments became contaminated with PCBs. Transport of these hydrophobic contaminants in natural systems is dominated by the presence of suspended matter. Three of the aspects noted as necessary to properly assess the impact of bottom sediment resuspension events by DePinto et al. (1991) are:

- *"prediction of the resuspension flux of particulate matter as a function of controlling environmental conditions;*
- *prediction of the advective and dispersive transport resuspended sediments in the water column;*
- *prediction of the contaminant phase redistribution during a resuspension event."*

These aspects are the focus of the Technical Memorandum. The fourth aspect mentioned is related to biological exposure and is beyond the scope of the Technical Memorandum. Lest you get the impression that my approach was based solely upon the work by DePinto *et al.*, the same approach is detailed in all

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current water quality modeling texts. Chapra (1997) is an excellent example. DiGiano, et al (1993) conducted extensive laboratory tests on New Bedford sediments to simulate resuspension and contaminant release at the point of dredging and isolate release mechanisms. Their research shows the strong relationship between suspended particulate concentrations and water column PCB concentrations. The equilibrium contaminant phase redistribution model used is also consistent with the approach recommended in the recent NRC report (2001).

Some of the confusion results from a misunderstanding of statements made in reference to the Fox River studies. The letter quotes "...neither turbidity nor TSS was sufficient in predicting PCB transport..." from a publication by the Wisconsin Water Resources Research Center (2000) implying their disagreement with this approach. The remainder of the sentence seems to have been missed as it continues "...because the PCB concentration on the suspended particulate matter and the dissolved phase PCB concentrations were variable and at least partially dependent on the deposit concentration in which the dredge was operating." The point of the statement is suspended particulate concentrations alone are inadequate to evaluate water quality impacts of on-going dredging operations since sediment PCB concentrations vary spatially. Many statements in the report strongly support the relationship between suspended particulates and water column PCB concentrations.

The second topic raised by the letter is the resuspension flux of particulate matter and questions the approach that I used to estimate that flux. Specifically, the letter states that the model used was not calibrated to any field data. The model is in fact empirical in nature, i.e. it is based primarily on field data, although theoretical analyses were used to identify the contributing variables. The model is only applicable to modest size (10 to 18-inch) conventional hydraulic cutterhead dredges the data used to calibrate the model were this size. The model has been under development for a number of years with the primary goal of providing a priori estimates of suspended sediment flux rates resulting from specific operational conditions. It has evolved through a variety of forms since its initial development in 1986 as additional data have been collected. Hayes, et al. (2000) calibrated the model using 106 field observations from four sites – James River (VA), Back River (GA), Calumet Harbor (IL), and New Bedford Pilot Study (MA). Subsequently, Wu and Hayes (2000) validated the accuracy of the model by showing that the results reasonably matched 282 additional field observations from a 12-inch cutterhead dredge working in Lavaca Bay (TX). We would now call this a validated model. However, in an attempt to improve the accuracy of the model even further, we then used all 388 observations to develop refined empirical models. These refined models, published in Wu and Hayes (2000), were the ones used to make initial estimates for hydraulic cutterhead dredging operations in the Hudson River. These models should are correctly referred to as "calibrated" models. It is not entirely correct to refer to them as "validated" models since they have not been tested against independent data. However, since they should be more accurate that the previous models that were validated with independent field data.

The variety of conditions that exist in the Hudson River make using the model to develop a single sediment flux estimate difficult. Twelve-inch cutterhead dredges, the same size dredge anticipated by the Feasibility Study to be used in the Hudson River, were used for two of the dredging operations for which data are available – Lavaca Bay and Calumet Harbor. Thus, all of the data from these two operations were plotted on a histogram (Figure 1 of the Appendix E.6). The observed data from these two field studies were all less than 0.35%. Since the estimates from the Wu and Hayes model were also below this range, 0.35% sediment loss is expected to be a conservative estimate for hydraulic cutterhead dredges.

The estimates for the hydraulic cutterhead dredges discussed above do not apply to the bucket dredges that are likely to be used in at least part of the project. The sediment resuspension mechanisms are entirely different. Unfortunately, no reliable models are currently available for closed bucket dredges. Historical data from a variety of dredging operations using non-environmental buckets and no operational restrictions were used as the basis for the 0.3% estimate. Dredge buckets used during the Hudson River remediation will have leakage reduction seals and operate using very restrictive parameters. Thus, this estimate should be conservative.

Representative Young and Representative Duncan imply that Nakai's (1978) Turbidity Generation Unit (TGU) approach should have been the basis for my estimates. Nakai's approach, which is described in only one non-peer reviewed paper, is discussed in detail in the Technical Memorandum. A close evaluation of the TGU method shows fundamental technical problems. As published, the method suggests that suspended sediment flux increases with increasing particle sizes. The paper provides a summary table of sediment flux values for many sizes of both cutterhead and bucket dredges and describes the general field procedure used to collect the data from which the values were derived. This fundamental flaw means the accuracy of the sediment resuspension values presented in association with the approach cannot be ascertained. Further, the paper does not describe the environmental conditions (flows, water depths, etc.), dredge characteristics, or variability associated with the values presented. I have written Mr. Nakai several times since the mid-1980's to clarify these issues and request the original data so it could be added to our data set. I have not received a response. I had hoped to discuss this issue with Mr. Nakai in 1993 when I was a delegate to the U.S./Japan Experts Meeting on Contaminated Bottom Sediments in Kitakyushu, Japan. Unfortunately, he was not at the meetings. Since the original data are not available for review, obvious errors exist in the paper, the original paper and model were never subjected to peer review, and the data are for substantially larger dredges than will be used in the Hudson, it would be inappropriate to rely on it.

Sediment resuspension received only a brief discussion of in the recent NRC report. I know several of the committee members and made a presentation to the committee in September 1999, for which I received very positive feedback. Therefore, I was a bit puzzled when I read the short summary in the report. A recent discussion with one of the committee members revealed that since the paper was published closer to the end of their effort (June 2000), the resuspension section had already been written. Additionally, the 106 data points included in the paper were presented as mass flux rates rather than % loss units. It seems that the committee did not realize the information to convert them % loss with a simple calculation was provided.

Representative Young and Representative Duncan's letter does not specifically question the suspended sediment transport models used. These application-specific models were also published in peer-reviewed journals. It is worth noting that water quality benefits from the silt curtains expected to enclose the dredging site on the Hudson River were not considered. These water quality benefits were ignored for conservatism and because a reliable methodology for estimating the water quality impact that results does not currently exist. Silt curtains should reduce the downstream transport of both particulate and dissolved phase contaminants.

Representative Young and Representative Duncan state the most applicable data for water quality impacts that will result from remedial dredging of the Hudson River are from the two recent Fox River (WI) dredging demonstration studies at Deposit N and SMU 56/57. Based upon the monitoring data collected during these two projects (WWRI 2000; USGS 2000), downstream PCB loss rates were substantially higher than would be expected based solely upon the observed water column TSS concentrations. I strongly disagree. These results are contrary to all other reported observations, and I have spent considerable time studying the Fox River and the two demonstration studies in earnest to determine the source of these discrepancies. While I cannot fully explain the surprising results, there are many reasons why these same results should not be expected during the remedy selected for the Hudson River. Certainly, the Fox River is quite different from the Hudson River in many regards including hydrodynamics, geometry, sediments, and debris. The PCB characteristics in the Fox River are also quite different; PCBs discharged into the Fox River emulsified for use in carbonless paper processing rather than pure phase. But there are also substantive technical concerns with the data collected during these demonstration projects. First, the monitoring approaches for the projects were not designed to effectively obtain contaminant loss data. Four sampling stations were established upstream of the dredging operation and four downstream to quantify transport across the river which is about 1,000 feet wide in some places. Samples were only taken at two depths (20% and 80%) from each station and these were composited for a single TSS sample. The consistent form of velocity profiles allows average velocity to be calculated from these two observations. However, suspended sediment and PCB concentration profiles do not follow this form and there is no basis for assuming that compositing equal volume samples from these depths results in an estimate of the average concentration. Further, PCB mass flux rates were calculated using samples composited from both depths at all four stations; i.e. one sample per river cross-section. Equal-volume composite samples effectively assume equal flow fractions associated with each location. Since water depths in Fox River range from 2 feet to over 20 feet with a distinct navigation channel that provides the dominant flow path, this is not the case. In fact, the USGS (2000) specifically noted a disparity in turbidity across the river with visually turbid shallow near-bank areas and no visual turbidity in deeper, faster moving areas. Errors associated with these sampling approaches are almost certainly why both studies showed increases in PCB transport without corollary increases in suspended sediment load. In fact, the SMU 56/57 study showed a decrease in suspended sediment across the dredging area. This decrease is also likely to be an erroneous result due to the sampling approach just as the apparent increase in dissolved constituents released into the water column. Both studies also show substantial spikes that contribute significantly to their transport totals and state explicitly that external influences including ice formation, ship traffic, and silt curtain movement resulted in these spikes.

Despite these concerns, there is an even more critical distinction that precludes the Fox River demonstration dredging data from being applicable to the proposed Hudson remedy. The Technical Memorandum, consistent with the selected Feasibility Study remedy, estimated suspended sediment and contaminant flux rates for a hydraulic cutterhead dredge and enclosed clamshell dredge. It is easy to miss these distinct differences in dredge types if one is not familiar with dredging operations. The Fox River reports confuse the issue by not being entirely clear in many instances. After some effort, however, I have been able to confirm that these projects used two small hydraulic dredges, a Moray/Ultra dredge and a horizontal auger dredge. The Moray/Ultra dredge initially appears to be somewhat similar to a hydraulic cutterhead dredge, but further inspection shows that its equipment, operating style, and resuspension characteristics are quite different. Horizontal auger dredges have been used in other environmental dredging applications. Suspended sediment flux data gathered during the New Bedford pilot study showed results reasonably consistent with the Fox River studies. Although these data should not be considered conclusive, the design and operation of horizontal auger dredges seems consistent with low sediment removal rates and large amounts of sediment resuspension. Hayes (2001) explains how this combination can lead to an excessively high rate of PCB loss to the water column compared to the mass removed via dredging.

All of the issues raised by Representative Young and Representative Duncan except the Fox River data are addressed in Appendix E.6 of the Feasibility Study. The Fox River data were omitted because those dredge types are not being considered. It is also worth noting that both Fox River reports conclude that dredging was an effective remedial tool.

While the estimates in Appendix E.6 are appropriate and defendable, I want to emphasize that research in this area is very limited and there are no well-organized, long-term research efforts underway that will lead to better methodologies and more reliable estimates in the future. Research also needs to address the balance between operational restrictions and sediment removal rates. One problem is that not many people have spent sufficient time around dredging operations to fully understand the essential practicalities associated with dredging.

I hope this clarifies the issues raised by Representative Young and Representative Duncan related to Appendix E.6. I intentionally kept the discussion at a modest technical level, but I am willing to engage in a more involved technical discussion when prudent. I did not address the consistency of the proposed remedy with the recent NRC report since I was not involved in that part of the project. I am, however, familiar with their recommendations as well as those of the previous NRC panel report that I helped write (NRC 1997). It should be kept in mind that the Feasibility Study predated the NRC study by several months, so complete consistency should not be expected. However, my cursory review of the Feasibility Study suggests that EPA followed at least the general risk management principles recommended by the NRC study.

Please let me know if you or your staff would like to discuss this further. You can contact me at 801/581-7110 or hayes@civil.utah.edu.

Sincerely,

Donald F. Hayes, Ph.D., P.E.
Associate Professor

cc:

Bruce Fidler, TAMS
Doug Thompson, OA Systems

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