UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MEMORANDUM

DATE: April 25, 2000

SUBJECT: Evaluation of Capping and dredging to address exposed contaminated sediments at Sediment Management Unit 56/57

FROM: James Hahnenberg

TO: File

Capping and dredging are the leading potential remedies which may be available to address increased risk to human health and the environment brought about by exposure of contaminated sediments in the Sediment Management Unit 56/57 (SMU 56/57). Both of these potential remedies are evaluated herein. In addition, natural recovery is considered below.

Natural Recovery

At the conclusion of the 1999 dredging project at SMU 56/57, high levels of PCBs were left exposed at the surface of the sediment. The highest concentrations of PCBs anywhere in the Lower Fox River are currently exposed, and have a high degree of potential risk for release and migration at SMU 56/57. These PCBs add to already high risks to human health and the environment posed by PCBs in the Lower Fox River and Green Bay.

Potential migration of contaminated sediments currently exposed at SMU 56/57 was documented in a report by the Fox River Group (FRG) entitled "Effectiveness of Proposed Options for Additional Work at SMU 56/57," dated March 2000 ("FRG Report"). On page 3-3, the FRG Report states:

> ...February results for the four additional pass subunits 25, 26, 27, and 28 - show much higher PCB concentrations at the center sample location than the December results (Figure 3-7, Table 3-4). The February average is 26 ppm (subunit range = 15 to 34 ppm) compared to 3.2 ppm (subunit range = 0.03 to 10.8 ppm) for December samples. These differences were statistically significant ($p<0.05$). The lowest concentration from any one of the five February samples collected within each subunit was 6.2 ppm in subunit 28; the highest concentration was 79 ppm in subunit 26.

In other words, this data suggests that contaminated materials may have migrated into areas previously which had been dredged. The FRG Report did not consider possible migration to other parts of the river or Green Bay. However, lower sediment solids content and sediment densities (described in the FRG Report), indicate exposed sediments have a greater likelihood to migrate than prior to sediment disturbance and exposure due to incomplete dredging at SMU 56/57.

Review of river survey data by the Wisconsin Department of Natural Resources also documents movement of water bottom sediments, and suggests a probability of migration of PCB contaminated sediments. This is discussed in the evaluation of capping effectiveness below.

Additionally, reliance of natural recovery is dependant upon modeling predictions. A recent report entitled, "Peer Review of Models Predicting the Fate and Transport of PCBs in the Lower Fox River Below DePere Dam, A Report of the Lower Fox River Fate and Transport of PCBs Peer Review Panel," Administered by the American Geological Institute, Edited by John C. Tracy, Desert Research Institute and Christopher M. Keane, American Geological Institute, dated April 14, 2000, suggests that additional data collection, refinement and sensitivity analyses are necessary before existing models can be relied upon for decision making.

In the FRG Report, it is stated that dredging has, "the potential to set back natural recovery in the Lower Fox River." It *is* true that the current site status is worse now than its pre-dredging condition. This greater risk status will continue if the dredging is left in its current, uncompleted status. This argues for further actions to address site risks. Reliance on "natural recovery" is tenuous and uncertain at best. Leaving PCB contaminated sediments unattended in their present exposed condition would present an imminent and substantial endangerment to human health and the environment. Consequently, natural recovery is not an acceptable alternative.

Capping

Generally, capping would consist of placement of geotextile, sand, gravel or larger stones (or some combination thereof) over the sediments at SMU 56/57 where exposed

concentrations of PCBs are high. Capping would attempt to cover and isolate contaminated areas to reduce or eliminate PCB exposures to biota in the Lower Fox River. Capping would also be designed to minimize further migration or release of PCBs. Capping is given further consideration below.

Dredging

Dredging consists of removal of sediments by either hydraulic or mechanical means. Dredging can be "wet dredging" (i.e., underwater removal) or "dry dredging" (i.e., excavation of sediments after hydraulic isolation and pumping out water from the dredge area). After removal by dredging, sediments are dewatered (if needed), and disposed off-site at a licensed/approved facility. Any water removed with the sediments would be treated to State surface water discharge standards prior to its discharge back into the river. Dredging is given further consideration below.

EFFECTIVENESS

Capping

Issues relating to effectiveness necessary to resolve for capping:

1. Cap permanence. Would the cap be resistant to high flow events? Would the cap be able to withstand other actions or forces that could impact its long-term performance? This would include such processes as bioturbation, ice scour, propwash, and contaminant migration relating to gas generation. A report by Wisconsin Department of Natural Resources (Model Evaluation Workgroup, *Technical Memorandum 2g. Quantification of Lower Fox River Sediment Bed Elevation Dynamics through Direct Observations*, July 23, 1999) demonstrates potential for water bottom losses in the area near SMU 56/57. This report summarizes survey data for transects (or "profiles") between DePere Dam and Green Bay. A transect immediately upstream of SMU 56/57 shows an average elevation change of 45 centimeters during the period from 1977 to 1982, and a maximum elevation change of 55 centimeters. This shows that there are significant movements of river sediments in this portion of the river. These survey techniques by the U.S. Army Corps of Engineers are consistent with surveys discussed in the FRG Report on SMU 56/57, with the FRG implicitly endorsing the reliability of these survey techniques. Finally, it should be noted that there were no large storm or flooding events during this period - if these events occurred, potential for movement could be greater than documented.
2. Containment effectiveness. The effectiveness of whether a cap would be effective in containing PCBs is mostly unknown and untested in this environment (a river with high flow events). If a cap remains in place, it is likely to be effective at particulates containing PCBs. However, PCBs dissolved in water would not

be contained by a conventional (sand) cap. Thus, migration of PCBs from advection of groundwater through a cap is unknown. To evaluate this, the quantity of ground water that would be likely to flow through a cap and pore water PCB concentrations would need to be determined. Monitoring data discussed in the FRG Report shows that pore water from sediments contains quantities of PCBs. While this quantity is small relative to a limited duration dredging project, a cap would allow these contaminants to continue to migrate over long periods and could be a significant cumulative release.

3. Monitoring. Evaluation of a caps environmental effectiveness is difficult, if not impossible. To evaluate leaks or releases, it is not known how – or if – a cap would be monitored, particularly for PCBs dissolved in water.

Capping design has been proposed by the FRG to address current exposures at SMU 56/57. However, this proposal does not address the issues outlined above, but rather states, "that the cap design would be completed in cooperation with EPA capping experts." No site specific cap evaluation or design has been completed that substantively addresses administrative or implementability concerns, discussed above.

In conclusion, capping has not been demonstrated to be effective at SMU 56/57.

Dredging

Based upon results on the 1999 dredging by Wisconsin Department of Natural Resources and the Fox River Group at SMU 56/57 (FRG Report, and in a Memorandum by Bob Paulson, Wisconsin Department of Natural Resources, February 21, 2000), and Deposit N (Wisconsin Department of Natural Resources, Summary Report, Fox River Deposit N, April 2000 [WDNR Deposit N Report], and the FRG Report), dredging has demonstrated effectiveness at the SMU 56/57 project. In three of the four 100x100-foot subunits at SMU 56/57 where a second dredging pass or a "cleanup pass" was conducted, decreases in surficial residual concentrations were reduced an average 5-fold when compared to pre-dredging concentrations. Concentration reductions were 2 to 310 times less than maximum pre-dredging concentrations in that subunit.

These concentration reductions are similar to similar dredging projects in the Great Lakes and internationally (Hahnenberg, James J., "Environmental Results on Dredging Projects," March 7, 2000 ["Hahnenberg, 2000"]). Post-dredging surface sediment concentrations have been reduced by an average of 72 times and 2000 times (for wet and dry dredging projects, respectively) in other similar projects (Hahnenberg, 2000). These projects have also shown post-dredging concentration reductions in surface waters and biota.

In the fourth 100x100-foot subunit where a cleanup pass was conducted at SMU 56/57,

surficial concentrations were not reduced, but **average** concentrations for the sediment column were reduced from 220 ppm to 11 ppm (a greater than 20-fold reduction). Surficial pre-dredge concentrations were 2.7 ppm, and post-dredge concentrations were 11 ppm, a 4-fold increase. However, based on results for other areas where a second pass was completed, as well as the overall concentration reduction in average PCB concentrations for this subunit, it is anticipated that another cleanup pass would reduce surficial concentrations further -- probably producing results similar to other areas where a cleanup pass was conducted at SMU 56/57.

In areas where only a single dredging pass was completed at SMU 56/57, surficial PCB concentrations increased. This is not surprising, because a single dredging had the effect of digging into higher surface PCB concentrations without returning to "finish the job" in that area. However, as discussed above, where an additional dredging pass was completed, reductions in PCB concentrations can be reasonably anticipated.

The FRG Report examines results on dredging projects at Manistique, Deposit N, and SMU 56/57. The FRG Report asserts that concentration reductions have not been achieved at those sites and implies concentration reductions are not likely at SMU 56/57. This evaluation neglects successful results on those projects, and fails to consider each sites unique characteristics.

First: the Manistique project is not yet completed. Comparisons to-date are against an uncompleted project, and therefore must recognize that these interim results distinguish it from SMU 56/57.reducing further the validity of any Manistique -- SMU 56/57 comparison.

Second: the Manistique project has unique site characteristics that make dredging more difficult. Fundamental differences to SMU 56/57 (and unique to Manistique) are:
1) bedrock immediately underlays contaminated sediments;
2) extensive rock debris remains from the bedrock blasting operations that took place during the excavation of the navigation channel;
3) slabwood debris -- residual log debris remaining from the lumbering era. Island docking facilities were constructed of logs -- much of this debris now underlies the river and harbor.
Debris and underlying bedrock have created site conditions that make dredging significantly more difficult when compared to SMU 56/57. SMU 56/57 has less debris, and soft "clean" sediments underlying contaminated materials. This allows "overdredging" into uncontaminated sediments.

Third: despite these limitations, the post-dredge average surficial concentrations have nevertheless been reduced to 17.9 ppm from pre-dredging surficial concentrations of 30.2 ppm. This is despite only partial project completion. Residual concentrations are likely to be reduced further upon project completion.

Project objectives at Deposit N did not focus on sediment concentrations. The project met the primary objective (among others) to remove 7,200 cubic yards of PCB contaminated sediment, including 112 pounds of PCBs (WDNR Deposit N Report). Concentrations were reduced, but (as expected) not eliminated. The average PCB concentrations in the remaining sediment was reduced to 13 ppm from an average of 25 ppm of pre-project concentrations (ranging from 20 to 130 ppm).

Furthermore, Deposit N has a fundamental physical difference to SMU 56/57. At Deposit N, bedrock underlies contaminated sediment (similar to Manistique). The FRG Report states on page 3-1, Section 3.1:

> ***The Deposit N and SMU 56/57 demonstration projects provide two different dredging environments.*** At Deposit N, sediments were no more than 3 feet thick, settled on a layer of bedrock. ***At SMU 56/57***, the soft sediment layer was more than 15 feet thick, with PCB concentrations of greater than 1 ppm found as deep in the sediment bed as 11 feet. ***No bedrock was present to limit the dredging depth, and therefore the dredge head could potentially remove 'clean' sediments beneath the layer containing PCBs.*** [emphasis added]

This makes abundantly clear the fundamentally different physical conditions at Deposit N (and Manistique) compared to SMU 56/57 (illustrated in Figure 7 in the WDNR Deposit N Report). These different physical conditions have important implications in the evaluation of ability to achieve concentration reductions at SMU 56/57. SMU 56/57 conditions allow "overdredging," and the ability to achieve concentration reductions in residual sediments. Results to-date at SMU 56/57 support this expectation of greater concentrations reductions at SMU 56/57, particularly if a second dredging pass is completed.

In the FRG Report, it is also stated that the areas that had a second pass did not achieve the 0.25 "target concentration" (the preliminary cleanup goal in the draft Remedial Investigation/Feasibility Study, dated February 1999). While this is true, it is also irrelevant. Achieving a final ***total river*** cleanup goal (whether it is 0.25 ppm or some other level) would anticipate some areas would be higher than the final goal (particularly in areas that currently have the highest concentrations in the river, such as SMU 56/57). Other areas that would probably achieve lower concentrations. Finally, regardless of final cleanup goals, if risk reduction can be achieved (as demonstrated in completed dredging areas at Deposit N and SMU 56/57), then it is clearly a prudent and necessary action. This is especially true for SMU 56/57 where greatly increased PCB exposures present significant increased risks, and interim goals are acceptable. This is not necessarily a final river cleanup action for this area -- that will be determined upon

completion of the Remedial Investigation and Feasibility Study for the Lower Fox River and Green Bay.

The FRG Report also references irregular topography left after dredging at the SMU 56/57 project and Manistique. First, while this true, it is primarily because of uncompleted dredging. Secondly, for areas where a second pass is conducted and remaining sediments are "clean," bottom irregularities are irrelevant to site risk.

Thus, based on results on dredging conducted to date on SMU 56/57, we can reasonably anticipate that dredging would achieve significant concentration (and risk) reductions relative to currently exposed high concentrations of PCBs. Thus dredging has been demonstrated to be effective for remediation of sediments currently exposed at SMU 56/57.

IMPLEMENTABILITY

Capping - Administrative Issues

Capping would require resolution of the following administrative issues:

- Approval by the Wisconsin State legislature would be required by State law, as the river bottom is considered a State resource.
- A permit would be needed from the U.S. Army Corps of Engineers.

Capping - Feasibility Issues

One concern is addressing capping feasibility relating to water bottom conditions in areas left disturbed from last years uncompleted dredging at SMU 56/57. These activities have left areas in the dredging area with higher water saturations, as described in the Table 3-2 in the FRG Report entitled "Effectiveness of Proposed Options for Additional Work at SMU 56/57," dated March 2000. Table 3-2 indicates areas where there was a single dredging pass that the pre-dredging percent solids was an average of 29% (ranging from 28.5 to 30.2%), whereas post-dredging percent solids had an average of 22% (ranging from 19.7% to 26.3%). In the areas where a second dredging pass was conducted pre-dredging solids were an average of 62% (ranging from 57.7% to 70.0%), and post-dredging solids were 38% (ranging from 37.4% to 38.6%). This would likely result in lower load bearing capacity for these sediments – the effects from the weight of a cap is unknown. Thus, it is uncertain whether load bearing capacity of the sediments would be sufficient for a cap (of presently unknown design). The higher water content and lower densities also indicate a greater likelihood for migration of contaminated sediments from the dredge area. This reinforces EPA's concern regarding possible migration of PCBs from this area.

A second feasibility concern relating to the areas disturbed by dredging last season is the uneven surface that remains. Bathymetric profiles show the water bottom to be extremely irregular with elevation differences as great as 6 to 8-feet. Thus any capping project would be over very rough terrain. This could cause differential loading and would cause some areas to have a thick cap, and other areas would have a thin cap. It is unknown how this would impact the implementability for a capping project. It is unknown if capping would be practicable. Thus capping has not been shown to be implementable.

Dredging Administrative issues

Dredging has been demonstrated to be implementable for SMU 56/57, particularly if the FRG were to continue the project. Dredging was actually conducted at Deposit N and SMU 56/57 over the last two construction seasons. Most permits required for SMU 56/57 would be in place or only need a slight update. The physical infrastructure is prepared and dredging equipment could be readily mobilized. Disposal facilities have been identified and permitted, and sufficient landfill space is available.

Dredging Feasibility Issues

Dredging was shown to be feasible during the 1999 construction season at this site. Dredging was conducted, although not completed.

SUMMARY AND CONCLUSIONS

Based on the evaluation of dredging and capping effectiveness and implementability, it is determined that dredging is the preferred cleanup alternative to address PCB contaminant exposures at SMU 56/57. Dredging has been proven effective and implementable, specifically by operations to-date at SMU 56/57. Capping could mitigate short-term exposures, but has many uncertainties and unknowns regarding its installation and effectiveness, for both the short- and long-term.

REFERENCES

Blasland, Bouck & Lee (for the Fox River Group), "Effectiveness of Proposed Options for Additional Work at SMU 56/57," March 2000.

de maximus, inc., "Fox River, SMU 56/57 Engineered Cap Memorandum," April 10, 2000.

Hahnenberg, James J., "Environmental Results on Dredging Projects," March 7, 2000.

Paulson, Bob, Correspondence Memorandum, State of Wisconsin, "Post Dredging Results for SMU 56/57," February 21, 2000.

Tracy, John C., and Keane, Christopher M., "Peer Review of Models Predicting the Fate and Transport of PCBs in the Lower Fox River Below DePere Dam, A Report of the Lower Fox River Fate and Transport of PCBs Peer Review Panel," Administered by the American Geological Institute, April 14, 2000.

Wisconsin Department of Natural Resources, Summary Report, Fox River Deposit N, April 2000.

Wisconsin Department of Natural Resources, Model Evaluation Workgroup, Technical Memorandum 2g, Quantification of Lower Fox River Sediment Bed Elevation Dynamics through Direct Observations, July 23, 1999