Dredging can continue to be an important option, but we need to develop sound dredging approaches that are more precise, more cost-effective, and environmentally sound. Dredging often involves large volumes of material, so we need to develop cost-effective treatment technologies. I was encouraged to hear some of the earlier presentations indicating that less costly treatment-combination technologies are on the horizon. That is important. Finally, site assessment is where it all starts, because these are site-specific problems. We need to improve site assessment techniques.

I want to leave you with recommendations on where to focus future efforts. Although we believe that sustainable management and beneficial use are very important, we would keep focusing on risk analysis. Our three recommendations all are geared in that direction. We need to develop risk analysis techniques that have broad acceptance across a broad array of stakeholders and that lead to decisions. A lot of us give lip service to risk analysis, but when it comes down to making a decision, how often does that carry the day? Maybe this approach lacks credibility in terms of whether it will get us where we want to go. Some comments at this symposium certainly indicate concern about the present techniques.

We need to quantify the relationship between contaminant availability and the real risk to people and the environment. I appreciated the presentation by John Connolly about the possibility of developing a prognostic model. I think we need these types of models to look at the cause-and-effect relationship, which is key. Monitoring is also important. If we want to give credibility to the long-term risks, capping technologies, and the effectiveness of natural recovery, we must do the long-term monitoring that can show us what happens.

Forest Products Industry Perspective

C.L. (Skip) Missimer

Before getting to recommendations, I would like to do a little storytelling. Contaminated sediments are not a pervasive concern in the forest products industry, either in the forestry or wood products segments of the industry or in the pulp and paper segments. That is not to say, however, that individual mills and companies have no specific sites where they have issues. Rachel Friedman-Thomas spoke about a site contaminated with mercury from a pulp and paper facility, and several speakers have referred to the sediment capping project that took place outside the Simpson Tacoma mill in Washington State.

However, we are interested in a few issues. Perhaps the single largest contaminated-sediments issue in the forest products industry involves the manufacturing and recycling of carbonless copy paper. Between 1954 and 1971, carbonless copy paper was manufactured using Aroclor 1242 as the primary constituent of the ink-containing capsules on the back of the sheet. Mills that recycled waste paper and converted trimmings containing carbonless copy paper or off-spec carbonless copy paper were not aware until later that these papers contained PCBs. Therefore, PCB contamination from recycling operations is a concern at three or more Comprehensive Environmental Response, Cleanup, and Liability Act (Superfund) sites and one other large site that is not under Superfund.

Given that this recycling activity ended more than 25 years ago, the overwhelming majority of sediments containing PCBs from recycling have been covered with more than 25 years of "uncontaminated" sediments. At these sites, therefore, we see a sediment profile showing low-to-moderate concentrations of PCBs at depths of 1 to 3 ft (.3 to .9 m), with very low concentrations of PCBs near the surface, usually less than 5 parts per million. Furthermore, the tissue monitoring conducted since the mid-1970s reveals an unabated decline in fish tissue concentrations of PCBs. For example, lipid-normalized tissue concentrations in fish from the Fox River near Green Bay, Wisconsin, are decreasing by 50 percent every five to seven years for most species.

Most of the contaminated sediment sites associated with the forest products industry are not in ports and waterways, where navigational dredging is a primary objective. Because these sites are located in nonnavigational waters, the primary objective should be risk reduction. This raises several questions concerning human health and ecological risk. For example: What are the true human health and ecological risks currently at these sites? How are these risks changing over time, and what is the effect of natural recovery on reducing risks? I echo what John Connolly said about modeling, suggesting that we can use models to answer this question.

Other questions include the following: Are there remedial actions (e.g., mass removal, hot-spot removal, capping) that will accelerate significantly the current rate of natural recovery and lower the risk, or does it just make us feel better because we did something about it? What are the risks associated with mass removal? Are those risks greater or less than those associated with other remedial activities, including natural recovery?

Another question: What are the collateral risks associated with mass removal? These risks range from the volatilization of PCBs out of acid-watering facilities to running dump trucks filled with contaminated sediments up and down neighborhood streets and highways. In short, is "mass removal equals risk reduction" a testable hypothesis? To my knowledge, this hypothesis has not been tested. Therefore, I would like to make three recommendations.

It seems appropriate that the work of the NRC committee that produced this report should be extended to address three issues that are particularly relevant to environmental remediation:

- First, we should develop improved site assessment and characterization techniques, including monitoring techniques, to assess the efficacy of remedial alternatives after implementation.
- Second, we should improve the linkage between site assessments and risk assessments. This effort should include the development of models that predict reductions in risks for various remedial options, including natural recovery, as John Connolly suggested. In other words, we need improved decision-making tools before we start spending millions of dollars on remedies that may not have any effect.
- Third, we need to test the hypothesis that mass removal equals risk reduction, and we need to do this at multiple sites to better understand when mass removal might or might not make sense.

Mining Perspective

Paul Ziemkiewicz

I will focus on the interests of the coal industry as a user or recipient of some of these sediments. This material has a lot of potential in the coal industry. We are near many sources of sedimentation along the East Coast, where we have two types of mining settings. There are abandoned mine lands, which are pre-1977 mines and are, in a sense, orphans of the state. There are also active mines. Thus, we have two very different types of regulatory environments.

We also have underground mines and surface mines. To give you some idea of how much volume can be involved, a relatively small underground mine of 10 mi^2 (25.9 km^2) in the Pittsburgh basin, or even in the anthracite country here, normally has 25 million yd^3 (19.1 million m^3) of storage capacity, or something along those lines. Of course, you need to find out several things: Is the roof in good shape? Has it fallen in yet? Have the pillars collapsed? Structural things have a lot to do with the geology of the area and how long it has been since the mining was completed. But the potential volumes are very high.

In a surface mine, if you put a 2-ft (.6 m) layer of sediment on an acre of ground, you probably can get something like 30 to 100 tons per acre of dredged sediments, given the densities I have heard for this material. For example, within 80 mi (128.8 km) of New York City is the anthracite region in northeastern Pennsylvania, where extensive underground workings have existed for a long time. You also have 10,000 acres (4050 ha) of unreclaimed surface mines and tailings in the Luzerne and Lackawanna county areas. We are looking at transportation costs to get materials from New York City to that area.

In the coal industry, we always assume 10 cents to load per ton, and 10 cents/mi (6 cents/km). This means transportation costs—running legally on a 22-ton dump trailer—would be in the range of $8/ton to move it from New York City to Wilkes-Barre, Pennsylvania. What does it cost to get dredged material hauled? We have made slurries and mine grouts out of coal ash and other materials, and we need to bring in the ash and the cementing agent, normally concrete kiln dust or some type of scrap. We normally get them hauled for something less than $5/ton. I know nothing about dredging costs or port handling issues.

What are the applications for this type of material in the mining setting? One is mine grouting. A lot of mines, when we are finished with them, wind up with 50 percent voids, because we must keep about 50 percent of the coal in place to hold up the roof. When we pull out, there are enormous underground reservoirs of 10 to 30 mi^2 (25.9 to 77.7 km^2), which might be tipped at 30 degrees or be relatively flat. They eventually start filling up with water, particularly if they are below the natural water table. We wind up with an anoxic environment, reducing conditions, carbon dioxide gas, saturation in the water, and often very strongly acid water.

There are many occasions when you start pushing water up out of the ground again, and you can actually get "blowouts," in which the side of the hill fails and tens of millions of gallons of pH 2.5 water show up overnight. Blowouts can kill people; these are very serious events. Blowout protection, which involves trying to control the pressures inside these mines, is a major interest of the state abandoned mine land (AML) agencies and the active industry.

There is the potential of replacing these acid-forming voids or reservoirs with an inert grout. To turn sediments into grout, we would need to add a cementing agent. We would need to make sure the material would remain stable in the weathering environment of low-pH reducing conditions in an underground mine. A lot needs to be done to realize this idea, but it has major potential.