CASE STUDY

Establishing Environmentally Acceptable End Points for the Management of Sediments and Soils

Edward R. Neuhauser, *Niagara-Mohawk Power Corporation*

I want to introduce you to an aspect of decision making that is somewhat narrower than some of the things talked about earlier. You might say, why is this guy from an Upstate New York utility attending a dredging symposium? Well, remember the Erie Canal? We still have problems with that. I will introduce you to a national program in which I am involved and talk about how we propose to deal with sediments placed in upland situations from the dredging of the Erie Canal.

I am part of the National Environmentally Acceptable End Points Program. It is headed by the Gas Research Institute (GRI) because a lot of utilities once had manufactured-gas plants, which, from about the 1840s to the 1950s, supplied gas from the coking of coal. This left a whole series of sites contaminated with polyaromatic hydrocarbons (PAHs). The coal, in many cases, was transported by water; consequently, contaminated sites ended up right next to waterways.

We started work on these sites almost 13 years ago, taking sediments from the sites and treating them biologically. (My training is in biology. My coworkers are all engineers, so I am woefully outnumbered.) We took the sediments out, aerated them, and put them in a tank with water and bubbles to expose them to a lot of oxygen. We consistently saw that, in most cases, we got a rapid reduction in contaminant levels and then a plateau. We call this the hockey-stick effect. We saw this in a number of places with a number of agricultural chemicals and other contaminants as well. This was a phenomenon that we neither understood nor knew how to handle at the time.

Are there concentrations of materials—in our case, PAHs—that would be safe? The concentrations are not zero, but are they safe enough to enable reuse of these sites in a beneficial way? The national program is trying to determine if that can take place. The chemicals in soils are not all instantaneously available. If you reduce their bioavailability, then you reduce the exposure and risk. A number of famous scientists are working in this area. We all began to see this common phenomenon, and we decided we needed to understand what was going on.

When we do risk assessments, we make very conservative assumptions (and rightfully so) because we simply do not know what is happening out there. Actual data are relatively scarce. There are very few field data for some of the parameters that I will describe. When I talk to the state and federal regulators about this, they say, "This is great, Ed. Show me the data." Some people want to see money; other people want to see data.

We are going after a couple of key issues. We are not disputing that, in the sediment particle itself, there is some release to both plants and humans. That is always happening. But there is also a release to the groundwater that takes place over time, and during that release, an attenuation takes place. We want to understand those two key issues.

We have property along the Erie Canal near Utica, New York. There is a peninsula, Harbor Point, which in the 1920s was the largest energy center in the Northeast. There was a huge manufactured-gas plant there, and a lot of the contaminants are around that area. There is PAH contamination in the soils and sediments around the site. How do we, as a company, manage those sites today to reduce risk? We know we need some basic information. We need to understand the release and attenuation rates of these chemicals. We need to know how much and how fast, because we do not have a good handle on that.

To start this program, we came up with a series of hypotheses. As I mentioned already, the availability of these contaminants in soil is decreasing over time. We think that release occurs very slowly. We know there is a natural degradation that occurs over time. In the national program, we are adding a different twist by working with sediments. I also happen to work for my company on the development of biomass resources. We have a question: Can we use the plants that we are developing under the Department of Energy (DOE) biomass program to enhance that natural degradation?

In New York State, we decided to concentrate on sediments because we wanted to understand the release and sequestration rates. We were going to take these sediments and put them in upland situations, which is really the only option for us because they want to use the canal system for recreation. We do not have the option of putting the material in some other part of the canal. We want to look at this attenuation concept in the presence and absence of the plants. We believe that the addition of biological materials from the growth of the plants can enhance the degradation rates of these chemicals. We are looking at a series of ecological receptors to try to get a whole-ecosystem picture of this idea.

We divided the project into three basic areas. We have a laboratory phase in which we look for a measurement tool, something we can use to get a quick evaluation of how dangerous a sediment is. Second, we have greenhouse growth chambers, in which we are growing these plants, and also a larger growth chamber to get information that we cannot get readily or inexpensively from the field. Third, we want to go to the field, because we know that, unless you show the regulatory community exactly what you are going to do, they never believe you.

What do we need from the lab? We need something like a toxic characteristics leaching procedure test for sediments to give us an indication of the amounts of available chemicals. We need something that is relatively inexpensive and can be done in a laboratory fairly rapidly. We are looking at two things for this particular site.

First, a series of earthworm tests were developed by the Environmental Protection Agency (EPA) in the early 1980s. This is an effective test; it gives you an indication biologically of what that organism is seeing. It is an integrator. The worm takes in the material and processes it through its gut, and then you measure the concentrations in the tissue. There is also a solid-phase extraction test, which we are working on now. It currently uses a matrix with a carbon-18 (C-18), waxy-like compound on it. We put a series of these disks in a slurry and shake them over time. The test gives us an indication of what is biologically available.

Over time, we saw that about 60 percent of one particular contaminant type latched onto the disks, meaning it was bioavailable. Those data corresponded to what we found with the earthworm test. When we took that same sediment, treated it biologically (aerobically in this case), and then subjected it to both the earthworm test and C-18 disk test, about 90 percent of it was not biologically available. There is evidence here that the total concentration does not always give you a clear indication of the biologically available amount of the chemicals.

We started working on greenhouse tests. We needed to screen some of the willow clones to make sure that they can grow in these sediments. They seem to do quite well. The tests in the greenhouse helped us to define parameters to use in our large-scale pot studies. These are 30- to 50-gal (114-to 189-L) pots. We are mimicking the acid deposition work of the 1970s and 1980s, when they were trying to understand the effect of ozone and acid deposition on individual plants. It was very difficult to measure those parameters in the field.

Our greenhouse tests are going on at the Boyce Thompson Institute for Plant Research at Cornell University. We are looking at different varieties of willows and other crops and controls. In the initial tests, after a four-month period, there was a statistically significant decrease in PAHs in the soils with the plants in them relative to the soils without plants. We saw the greatest decrease in the five- and six-ring PAHs, which is good, because they are of the greatest concern to us.

Why would you want to use these larger growth-chamber pots? Because it is difficult to go out and measure things in the field. We want to put out these pots, run them for three to five years, and then look at changes in the total PAH concentrations and available PAHs in the soils due to the presence of the plants. We think the plants have a real role in enhancing PAH degradation. These data will be very helpful in the full-scale field project, which we know we have to do. When you analyze sediments, you learn that they are very heterogeneous; it is difficult to figure out exactly what is happening if there is a small change over time. It became clear to us that we needed to take a whole series of sediments and mix them up a great deal.

What do we hope the field demonstration will do? It will stabilize the site. The mass of plant roots will stabilize it very well; we hope that it will lower the groundwater at these sites. At most of these sites, the groundwater and surface water, for parts of the year, are equal. When I took my environmental affairs staff out to look at these plants, their first impression was, "This is a great living fence. People cannot get in there; that is what we want. We do not care about your PAHs, Ed, just keep the people out." We also are hoping to look at biodiversity. We have studies under way on micro-arthropod diversity in which we can show, with the presence of the plants, the very rapid recovery of these ecosystems after the sediments are placed there.

I want to give you an idea of what these willows can do. As part of our bioenergy project with DOE, the willows are planted as 10-in (25-cm) pieces of wood. We have commercial planters that do this now. There are about 40,000 acres (16 200 ha) of these plants in Europe now, and we are adopting the system here in the United States. We cut them in the winter to promote rapid growth in the next year. The plants take over the site. They completely cover everything; there is no weed problem at all. After three years, you have an incredible mass of biomass that nobody can get through, and it is extremely stable.

Our goal in the biomass project is 5 to 7 dry tons/acre/year (11 to 15.5 tonne/ha/year). This is the highest rate of biomass production that we can get from any of a number of different crops. We hope to adapt this technology to sediments and get a stable upland sediment situation with enhanced degradation of the PAHs.

When you put together a project like this, you have to go to a number of different organizations to raise seed money. I worked with GRI on that. We have some money from DOE and we are talking to the Department of Defense's Strategic Environmental Research and Development Program, which is interested in certain aspects; the Electric Power Research Institute; EPA; and some New York State agencies. When I put together these projects, I try to identify pieces that appeal to all those people, so they can say, for example, "Yes, I'll fund 10 percent of this for you, and then I can buy into the results of the overall project."

What do we expect out of this? What are we really targeting? A key thing is to go right to state and federal regulators. As I said earlier, they want to see data, but they are willing to work with us. Staff members of our company regularly brief them on these areas. You have to make them stakeholders right from the beginning; that has worked effectively for us. We hope to have tests for the groundwater and ecological receptors so that we can look at a sediment and say, yes, this is really dangerous, or no, this does not look so bad. For the company's sake, we hope to reduce human exposure. This is a very big issue for us; we do not want people to get hurt going to these sites. There is also the idea of making these sites into wildlife refuges. In many cases, because the sites are in the flood plain, they will become wildlife refuges.

We want to make sure we end up with a better use of these materials than our current options offer us. In the end, we hope to equalize the playing field a bit. We want to get a lot of real data out there so that people can compare options, because we do not think these things are as potentially dangerous as the current models make them out to be.