FLYING BLIND NO MORE:

DATA & MONITORING AS INDISPENSABLE TOOLS

OF WATER MANAGEMENT

PLENARY ADDRESS

of

G. TRACY MEHAN, III[1]

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[1] Principal, The Cadmus Group, Inc. (www.cadmusgroup.com), and former Assistant Administrator for Water, U.S. Environmental Protection Agency, 2001-2003.

Introduction

Good morning. I am grateful for the opportunity to discuss a topic which has long been near and dear to my professional heart: information-based environmental programs. Specifically, I am pleased to share my thoughts on the paramount place of water monitoring, in both its qualitative and quantitative aspects including the natural flow regime, biological integrity and adaptation to a changing and variable climate.

Let me thank all the sponsors of this impressive conference, especially Pixie Hamilton, Chuck Spooner, and Leslie McGeorge for inviting me to Denver to share my thoughts with you today.

At the outset, I want to associate myself with remarks offered to the Sixth National Water Monitoring Conference by Lisa Jackson, Administrator of the U.S. Environmental Protection Agency (EPA), speaking in her role, at the time, as commissioner for New Jersey's environment, on the protection of that state's rich diversity of water resources:

> Supporting these resources in order to ensure continued use of the state's waters for these diverse needs requires understanding how the systems work and to collect data on a continuing basis that can be converted into information that is used in environmental resources management. The foundation of this process is water quality monitoring.[2]

[2] Lisa Jackson, New Jersey Commissioner of the Environment, *Commissioner Jackson's Talking Points-National Water Conference,* undated, p. 1. I want to thank Leslie McGeorge of the New Jersey Department of Environmental Protection for sharing Administrator Jackson's remarks with me.

Having served in state and federal government for nearly 15 years, I appreciate the immense challenges of funding and maintaining any kind of data collection, monitoring or assessment program over the long haul. When times are tough, these are the environmental programs which are often cut first. I have long believed that the exact opposite should be the case, i.e., they should be the last to be cut.

In other words, we need to invest "patient capital"-for the long run-in water data, monitoring, assessment, and, yes, analysis. I thank my friend and colleague, Bob Hirsch of USGS, for reminding me of the importance of patience and analysis, a virtue and a skill both of which I sorely lack.

Given the inevitable limitations on resources, the pressure to evaluate performance or results demanded by policy makers and citizens, and the need to inform the work of the many and varied stakeholders involved in watershed protection—public, private, and non-profit—I was persuaded, long ago, that almost all other priorities in the National Water Program are secondary to the necessity of developing sound water quality standards and a system of monitoring progress, or lack thereof, against those standards.

I know that this may sound like an extreme position, but I fear we cannot earn the support of the public and their elected representatives, at both the state and federal levels, unless we can demonstrate, clearly, what progress we have made and how to pinpoint the next steps to cost-effectively restore the waters of the United States. The political pendulum swings back and forth, the stock market goes up and down. Through it all, water managers need to be able to document facts on the ground, or in the water more precisely, so that the policy debate can factor in the realities and adapt accordingly.

Although a good part of my career has been focused on water quality, I distinctly recall the problems of data gaps on water use during my work as a private attorney for the state of Missouri on Missouri River diversion and management issues. If Mark Twain really did say that whiskey is for drinking, and water is for fighting, he had to be thinking of the Missouri.

Since passage of the Flood Control Act of 1944, and the building of six main-stem dams, controversy has persisted between upper basin states, lower basin states, Indian tribes, recreation, navigation, agriculture, drinking water utilities, the Army Corps of Engineers, the Fish and Wildlife Service.

Many times I found myself lamenting the absence of a good water census or accounting of water use on that interstate stream split between state jurisdictions following either the Prior Appropriation or the Riparian doctrines with overlapping claims for federal and tribal reserved water rights. And don't forget about the Endangered Species Act!

Sound data and information wouldn't have resolved all disagreements, but it would certainly have informed the discussions, established facts and clarified issues.

Can't we all just agree?

If there was one federal function on which all-left, right and center-might agree, you would think it would be maintaining robust, state-of-the art data collection, monitoring, and assessment necessary for the management of our nation's waters. We consider the federal government as the indispensable collector, custodian and generator of most economic, employment and trade information. It seems to me that all parties, regardless of their political or ideological bent, should support maintaining consistent data sets, again, over time, to guide environmental and natural resources management and policy for that most precious of commodities, water.

Can't we all just agree on that? Evidently, not.

For many years, I have been troubled by the problems encountered by the U.S. Geological Survey (USGS), through good economic times and bad, in maintaining a nationwide system of stream gauges across America. What could be more basic to good management and policy than measuring flow, again, over extended time frames?

My thanks to Mike Norris, Coordinator of USGS's National Streamflow Information Program,[3] who patiently explained to me that it was the *instability* in the network, not simply the number of stream gauges,[4] which is the most problematic in terms of discontinuity in the data.

While there has been a net loss of 600 gauges between 1970 and 2008, there was also "a swing of about 1,500 streamgages [*sic*]." The current network is approximately 7,600 gauges. Gauges are usually lost when one or more of USGS's 850 funding partners are short of funds. Since the USGS has no funds to keep them operating, the gauge is lost to the system. The program is at only 23 percent of full funding in 2010.

The bottom line? The USGS stream gauging effort has been less than robust, relative to the objective scientific need, and has actually lost ground. It is prey to instability in the network because of erratic, decreasing funding.

In my other adopted state of Michigan, while I was in charge of its Office of the Great Lakes, we were facing the usual problems of anemic or even non-existent funding for ambient water and other kinds of monitoring, even in the go-go years of the 1990s.

[3] http://water.usgs.gov/osw/lost_streamgages.html
[4] E-mail from J. Michael Norris to G. Tracy Mehan, III, April 7, 2010.

We were able to convince my boss, Governor John Engler, and then the legislature, to include $45 million in a Clean Michigan Initiative (CMI) bond issue within the $675 million to be raised through general obligation bonds[5] for environmental clean-up and protection. The Governor believed, strongly, that things were getting better in terms of conventional water pollution, and he wanted to document that progress. He also understood that efficient, performance-based management of any kind required good information or metrics to be successful.

Fortunately, this innovative approach to public financing of a fundamental water program passed muster with the Michigan voters in 1998, along with the entire bond issue. I always urge my state colleagues to keep an eye out for opportunities such as this. Clearly, state general revenues are in the tank and will remain so far some time, recovering only slowly and unlikely to return to pre-recession levels in my humble opinion. Creative, dedicated revenue-sourcing will be a necessity, not an option, in terms of monitoring and other environmental programs.

The Michigan CMI funds were to provide an increase of approximately $3 million a year to implement a 1997 strategy for surface water quality monitoring relating to fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring.[6]

Our colleague, Gary Kohlhepp of the Michigan Department of Natural Resources and Environment (DNRE), informs me that the program is going strong and, despite the serious economic conditions in Michigan, CMI monitoring funds have not been diverted to other priorities.[7] In fact, the program has been spending less than anticipated and funding is likely to

[5] For more information on Michigan's monitoring program, see www.michigan.gov/dnre. Click on "Water," then "Water Quality Monitoring," and, finally, "Assessment of Michigan Waters" to find "Monitoring Elements."
[6] See http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-32609--,00.html.
[7] E-mail from Gary Kohlhepp to G. Tracy Mehan, III, April 12, 2010.

continue through 2016, at which time the issue of continuity in program funding will, once again, present itself.

A rude awakening

While serving as Assistant Administrator for Water at EPA, I received a rude awakening as to the difficulty of the National Water Program to evaluate and assess the condition of the waters of the United States with anything resembling scientific rigor, at least enough to satisfy Congress, OMB, the upper management at EPA, and me.

At the time, EPA Administrator Christine Todd Whitman was pushing hard to issue the landmark *Draft Report on the Environment 2003*. However, it became clear that the scientists and experts in the Office of Research and Development, and others throughout the agency, simply could not endorse the aggregation of the data generated by the states for purposes of a *national* assessment.

The CWA was then thirty-one years old, and the National Water Program had focused primarily on end-of-the-pipe discharges from point sources and not enough on the entire watershed including nonpoint sources, physical and biological threats. Historically, ambient water quality monitoring and assessment were not a priority given the initial focus on discharges at the end of the pipe and technology-based standards, just as Congress had intended.

This audience will understand that, say, in 2000 states reported to EPA that they monitored the water quality of only 20 percent of their total miles of rivers and streams, 40 percent of their lake

acres and estuary miles.[8] Moreover, state standards and assessment methods vary which made it impossible to use data to reach national-scale conclusions.

The first *Draft Report on the Environment* had hoped to address the condition of U.S. waters and watersheds, but it eventually concluded that "at this time, there is not sufficient information to provide a national answer to this question with confidence and credibility."[9]

This conclusion mirrored similar ones made by the General Accounting Office (as we used to call it), the National Research Council of the National Academies, and the H. John Heinz II Center for Science, Economics, and the Environment.

On my way out the door of EPA, I published an editorial[10] in a research journal and offered the following observation:

> Water monitoring and assessment programs in the United States are at a historic turning point. We have collected years of data of all types and sources, yet today we cannot describe, in a scientifically defensible way, the quality of our waters. Moreover, we cannot quantify the progress we have made to date in cleaning those waters, nor where we need to go to fix remaining problems. We run the risk of 'flying blind' when it comes to making decisions about how best to address water quality problems and allocate our limited resources for cleanup, pollution prevention, and restoration. It is time to turn our national water-monitoring program in a new direction.

[8] For a fuller discussion, see G. Tracy Mehan, III, *Monitoring Is the Key,* Water Environment & Technology (WE&T), November 2003, p. 24

[9] *Id.*

[10] G. Tracy Mehan, III, "Better Monitoring for Better Water Management," Editorial, Water Environment Research (Water Environment Federation), January/February 2004, pp. 3-4.

Fortunately, Administrator Whitman and Deputy Administrator Linda Fisher understood, completely, that this condition could not persist in the era of watershed management. Notwithstanding the pressures of September 11th, which immediately inserted homeland and water security into all of our job descriptions and scrambled budgets for a few years, the Administrator demonstrated her resolve by leaving the tough language in the *Draft Report on the Environment 2003* and directing new resources into data collection and monitoring, enhancing existing efforts and opening new opportunities. Some of you will be reporting on programs that resulted from this new interest.

From my perch as Assistant Administrator for Water, the chronic underfunding of state and interstate monitoring required putting more resources into Section 106 funding which today, while still modest, is a big improvement over the past.

Again, any extra dollars usually go exclusively to enforcement, permitting and the like. Hopefully, we were able to begin a change in that traditional state of affairs.

Flying blind no more

From my perspective, today water managers, policy makers and the broader public are more aware, more committed to better information, data, monitoring and assessment, reflecting a greater appreciation of the complexity of our challenges in managing watersheds and source water protection areas for drinking water at landscape scale.

Last year 122,599 people worldwide visited local streams, rivers, lakes and other water bodies in celebration of World Water Monitoring Day which is sponsored by the Water Environment Federation and the International Water Association. This was a 67 percent increase over 2008.[11]

In 2006 I had the pleasure of addressing[12] the New Jersey Water Monitoring and Assessment Technical Workshop. Our colleague Leslie McGeorge of the New Jersey Department of Environmental Protection and her colleagues at USGS packed the house at the Rutgers EcoComplex. It was a most impressive gathering, one that is being emulated by water monitoring councils across the country.

In that speech I outlined four things which the water community needed to do to achieve our common goal of better monitoring for better water management in the new Age of Information. I believe these items represent a solid baseline to "gauge" our progress over time (if I may use that term).

First, we needed to continue to provide the resources necessary to strengthen state monitoring, assessment and standards programs so that they can generate comprehensive, comparable and sound water information. You have made substantial progress. I am told that Congress and EPA have provided an increment of over $60 million, over the last five years, to states implementing their monitoring strategies.

Second, we must develop and promote the use of multiple monitoring tools such as statistically-based surveys, predictive monitoring, and remote sensing to support the full range of water

[11] http://www.worldwatermonitoringday.org/About/2-17-2010_News_Release.html

[12] G. Tracy Mehan, III, *Water Monitoring In the Age of Information*, Remarks, New Jersey Water Monitoring and Assessment Technical Workshop (New Jersey Water Monitoring Council), April 20, 2006. These remarks were the basis for my article of the same title which appeared in ECOStates (The Environmental Council of the States), Spring 2006, pp. 21-24, accessible at http://www.ecos.org/files/2196_file_ECOStates_Spring_2006.pdf.

quality decisions. Statistically based surveys, for example, provide a scientifically rigorous way to sample a subset of waters and then provide an estimate of the quality of all waters. However, such surveys cannot answer all of our water quality information questions. No one size fits all. We must keep that in mind.

Third, we must improve electronic data systems to manage and share monitoring information and make data more accessible to the public.

These first three items I would amend to incorporate Bob Hirsch's wise counsel that patience, a long-term commitment to analyzing trends, especially relative to wet weather issues such as nonpoint source pollution and stormwater,[13] is fundamental to success.

"The water quality issues of today didn't come about overnight and they will not end overnight," opines Dr. Hirsch. There "has to be a dedication to taking action over many years and continuing to monitor and evaluate over many years." Indeed, "The current focus on 'results' [to which I must plead guilty myself] can cause us problems because the results we seek in water quality will take time, and monitoring is the only way we will determine if we are moving forwards or away from our goals."

Fourth, and perhaps most importantly, we must build stronger partnerships at the federal, state, and local levels, and with volunteer organizations, to facilitate the sharing of comparable data and the use of multiple monitoring tools. The National Water Quality Monitoring Council, the organizers of this excellent conference, is a great example of the essential partnerships we need to develop and nurture. So are the dozens or more state and regional monitoring councils.

[13] E-mail from Robert M. Hirsch to G. Tracy Mehan, III, April 20, 2010.

Money is a necessary but not a sufficient condition of success. Without effective coordination and pooling of resources and expertise, we cannot accomplish our mission.

One example of collaboration, ingenuity and the blending of low-tech and high-tech approaches to monitoring is the FerryMon program which has utilized ferries crossing the Neuse River and Tamlico Sound in North Carolina, on regular routes, equipped with a system for continuous collection of water samples and water quality data since 2000.[14]

One ferry makes 40 crossings daily along the Neuse River.

"Ferries fill an important gap between traditional estuarine monitoring, where you go out once a week or once a month in small boats, and mooring-based offshore monitoring programs," said Hans Paerl, professor at the University of North Carolina at Chapel Hill's Institute of Marine Sciences.

FerryMon is commissioned by the North Carolina Department of Environmental and Natural Resources (NC-DENR) in partnership with Duke University Marine Laboratory and the state Department of Transportation (NCDOT) Ferry Division. It has a water quality monitoring system "about the size of a washing machine" which is installed on three NCDOT ferries.

According to Robert Ellison, writing in Water & Waste Digest, the heart of this system is a YSI 6200 data acquisition system, interfaced with a small, hardy YSI 6600 multiparameter monitoring sonde customized for FerryMon.

[14] Robert M. Ellison, "Gathering Comprehensive Water Quality Data," Water & Wastes Digest (www.wwdmag.com), January 2010, pp. 40-42.

The sonde does not require much attention or maintenance, except every 10 to 14 days. It allows FerryMon to document variations in estuary and coastal waters and to detect algal bloom only a few hundred meters across, raising a red flag for state and local officials.

Hans Paerl also argues that FerryMon has provided more evidence that nutrient-input controls are important and that the TMDL or total maximum daily load is "justifiable."

FerryMon is reliable, inexpensive and has been able "to create accurate, high-resolution baseline data sets to observe how water quality, water conditions and ocean life change in the same area over long periods of times," says Paerl.

The amazing turnout at this year's conference is a powerful indicator that a viable network or community of interest, at a national scale, has now formed around data collection, monitoring and assessment, encompassing government at all levels as well as the private and not-for-profit sectors.

Progress in this area is palpable. I already mentioned Michigan, New Jersey, and North Carolina, just three places where great work is well underway. Great things are also happening in Minnesota and California.

Moreover, USGS, a world-class research institution, continues to do great work, despite limited resources, in its National Water Quality Assessment Program (NAWQA).

I am serving on my third committee on the Mississippi River, the Gulf of Mexico and the Clean Water Act for the National Research Council. My colleagues and I have benefited tremendously from USGS modeling and targeting of "hot spots" or high-priority areas relative to nutrients

delivered to the Gulf of Mexico. This kind of work is indispensable for cost-effective targeting of USDA conservation dollars in the Mississippi River Valley.

Drinking water utilities are working with NOAA and other partners to downscale global climate circulation models for use in specific watersheds and service areas for purposes of adapting to climate change and variability.

Did I mention that stationarity is dead?

Bob Hirsch, and other international experts[15] have written that "stationarity" can no longer serve as "a central default assumption in water-resource risk assessment and planning." Given climate variability, "Rapid flow of such climate-change information from the scientific realm to water managers will be critical for planning, because the information base is likely to change rapidly as climate science advances during the coming decades," write Hirsch et al. And, while modeling is important, it can never replace observations. It can only synthesize them. "In a nonstationarity world, continuity of observations is critical." We now have another argument for robust data, monitoring and assessment programs in the water sector.

Our colleagues at EPA, working with partners all over the country, have made great strides with its National Aquatic Resource Surveys[16], such as those for wadeable streams, coastal and estuarine conditions, and lakes. This is a big improvement since the days of the *Draft Report on the Environment 2003.* More of these statistically-valid, probability-based surveys are coming into the public domain. I know they will be discussed at great length her in Denver the next few days.

[15] P.C.D. Milly, Julio Betancourt, Malin Falkenmark, Robert M. Hirsch, Zbigniew W. Kundzewicz, Dennis P. Lettenmaier, and Ronald J. Stouffer, "Stationarity Is Dead: Whither Water Management?", Science, February 1, 2008, Vol. 319, pp. 573-574.

[16] http://www.epa.gov/owow/monitoring/nationalsurveys.html.

Technology is also coming to the rescue. New sensor technology and continuous monitoring, the "wave of the future for water monitoring for many parameters," says New Jersey's Leslie McGeorge, will enable cost-effective ways of providing useful information where and when water managers need it. These breakthroughs will greatly aid in the assessment of our progress in attaining water quality standards and information on what factors might be causing exceedances of applicable criteria.

Chuck Spooner tells me that he can get me a nifty sensor for just $5,000.00. Cheap! I understand that you will learn more about this and other technological marvels in nine different conference sessions this week.

Just recently, Congress has passed legislation authorizing a national water census by means of the SECURE Water Act.[17] The driver for the law appears to be climate change and adaptation, but there are a host of long-standing reasons why this kind of legislation should have been passed decades ago. Basically, it is designed to increase the acquisition and analysis of water-related data to assess long-term availability of water resources and much more.

So maybe we are flying blind no more.

The role of numeric criteria

As we move to restore entire watersheds, not just control pollution at the end of the pipe, we are going to have to pay more attention to water quality standards, specifically numeric criteria, most especially for nutrients. Many states are implementing criteria to include biological measures which are critical to restoring the full integrity of the U.S. and state waters.

[17] S. 2156 was passed as part of The Omnibus Public Land Management Act of 2009.

Several sessions this week will discuss how to develop criteria using biological measures which are critical for defining and interpreting water quality using metrics beyond those that are chemical and physical.

As Chuck Spooner of EPA has said, "Biology measured through variations in distributions of organisms and the relative abundance of different classes of organisms gives new insights, including giving a sense of the importance of long-term exposures to varying conditions. The benthic macroinvertabrates or algae live in the stream all year around and reveal the assaults of extremes that infrequent trips to sample sites might miss."[18]

Many states do have narrative criteria but that requires use of "best professional judgment" in the writing of water permits which means it doesn't get done, given the uncertainty and inevitable controversy of such a subjective approach. Without numeric criteria TMDLs lack rigor and credibility. Finally, the absence of numeric criteria makes it harder to effectively monitor and assess water quality against a valid baseline.

A recent report of the State-EPA Nutrient Innovations Task Group offers this information.[19] Of the more than 16,500 municipal POTWs (publicly-owned treatment works) or wastewater systems, only 4 percent have numeric limits for nitrogen.

43.5 percent have limits for ammonia which, unfortunately, does not reduce overall nitrogen loadings since nitrates and nitrites continue to be discharged.

Only 9.9 percent have numeric limits for phosphorus.

[18] E-mail from Charles S. Spooner to G. Tracy Mehan, III, April 22, 2010.
[19] State-EPA Nutrient Innovations Task Group, *An Urgent Call To Action-Report of the State-EPA Nutrient Innovations Task Group,* August 2009, p. 14, available at www.epa.gov/waterscience/criteria/nutrient.

If you back out the POTWS in the Chesapeake Bay watershed and the Great Lakes, these figures probably drop even lower since there are now in place cutting-edge numeric criteria for that watershed.

In other words, there are relatively few numeric criteria for nutrients which threaten not only freshwater, but our priceless marine waters such as the Gulf of Mexico. In the case of most of the Gulf, there are no nitrogen numeric criteria anywhere-not the northern Gulf or upstream including the Ohio and Missouri.

It seems to me that the development of adequate ambient water quality monitoring programs and numeric criteria for nutrient water quality standards go hand in hand. You can also roll in permitting, TMDLs, and effective targeting of conservation subsidies. You need a gyroscope, so to speak, to guide or direct effective programs across the board. And that, I submit, comes back to numeric standards.

Conclusion

I have tried to give you my sense of where we were, where we are and where we might be going in terms of water data, monitoring, assessment, and analysis, over long periods of time, across all programs, quantitative and qualitative. My aim was to highlight the convergence of the Age of Information and the era of watershed management. If nothing else, I hope I have been able to provide some perspective on the topic and, even more importantly, prompt some new thinking on the subject.

Congratulations on the progress you have made and thank you for your service to the nation, its citizens, and the water resources upon which they depend.

Good luck on your deliberations here this week.