REVIEW OF ANNEX 1

OF THE

GREAT LAKES WATER QUALITY AGREEMENT

A workshop sponsored by the

Parties Implementation Work Group

of the Science Advisory Board

of the International Joint Commission

in collaboration with the

Great Lakes Commission

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Click here for Background Report
Prepared by Limno Tech, Inc.

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WORKSHOP PROGRAM

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Note: This transcript, prepared by Karen Ure and Marty Bratzel, has been lightly edited to ensure that the substance is clear and correct.

Introduction - How We Got Here and What We Will Do Today

Jay Unwin

Unwin: My name is Jay Unwin. I am the U.S. co-chair of the IJC Science Advisory Board Parties Implementation Work Group. I would like to welcome you on behalf of the Work Group and the SAB, and also on behalf of the Great Lakes Commission who helped us arrange this workshop.

What I want to do is get us started off by explaining a little bit of how we came to the point of holding this workshop and what we hope to accomplish today. In the fall of 1999 we started planning our work for the next biennium, the work cycle we are in now, and tried to think what we could do as a Work Group, given the fairly limited resources available to us. I had just been to a conference in Muskegon, Michigan where I had heard some of the first results from EPA's Lake Michigan Mass Balance Project and I found that very exciting.

Shortly after that meeting, I went to one of our planning meetings for the Work Group and said, why don't see if we can figure out something we can do with these newly available data from Lake Michigan. We decided that we would try to obtain the data and look at how they compared with the Specific Objectives in the Great Lakes Water Quality Agreement, Annex 1. We did that. It took some time to do it but, by mid-summer, we realized that what we were looking at were data from Lake Michigan that were - for water concentrations anyway - literally orders of magnitude below the Specific Objectives for the compounds we looked at. We met with folks at EPA and learned a little bit more about the data, had some discussions back and forth, and came to the conclusion that what we really needed to look at was not the data but at the objectives themselves. One person at the meeting in Chicago made a statement that I remembered and that is that, while the mercury number for Lake Michigan is orders of magnitude below the Specific Objective, yet we still have problems with mercury, including fish consumption advisories. So that led to the trail we are on now.

Shortly after that meeting, we prepared a white paper which we presented to the Commissioners at their semi-annual meeting in Ottawa, and proposed to carry out a review of the Specific Objectives in Annex 1. Part of that proposal was to hold a workshop to hear from stakeholders about what should be done about Annex 1, if anything. So we're glad that you stakeholders are here and we hope you will share your thoughts with us, especially this afternoon.

Another part of the proposal was to have a background report prepared by a contractor. We did do that. Those of you who registered in advance received notice that a draft of that report was available on line. *[Note: The final version of the report may be accessed at http://www.ijc.org]* That report will be summarized and presented later today. It does a comparison of the data, not just the few data we

looked but data from a number of different sources with the Specific Objectives. It also looks at regulations compared to the Objectives, and some other matters that we'll discuss later.

This morning, we have a series of context presentations. This morning is more like a seminar than a workshop, that is, we will learn what's in Annex 1, where it came from. We will hear a presentation of the background report I just mentioned. We have a couple of scientific presentations - after all, we are the Science Advisory Board - and we thought it would be appropriate to look at how, these days, water quality standards are set or should be set, given the science that's available. And we're also going to have a presentation on compliance assessment, because there is language in the Agreement that talks about how to judge achievement of the Specific Objectives. After lunch, we have a panel of folks who are going to share their perspectives on what they think should be done with Annex 1. We're hoping that will spur a good discussion this afternoon which we're going to capture and make part of our report to the Commission.

The heart of this workshop - the real workshop - is this afternoon where we want people to open up and share with us their opinions of how Annex 1 should be revised, if it should be revised - just what should be done with Annex 1.

After that panel, we have a good amount of time set aside for general discussion. I hope everyone will participate in that.

We put together some questions that are going to be the focus of that discussion. They are:

- -Is Annex 1 still relevant and useful? Why or why not?
- -Should Annex 1 be revised? If so, how?
- -Is there a role for ecological indicators (e.g. SOLEC) in the Agreement?
- -How should achievement of Specific Objectives be judged?

Please think about them and share with us your answers this afternoon.

I would like to proceed to our first speaker who will give us a background in history about Annex 1. Joel Fisher is the senior scientist of the U.S. Section of the IJC and an environmental advisor to the U.S. Commissioners. He has over 35 years of professional experience in the environmental field,

having begun his work during military service where he was assigned to research projects on destruction of chemical and other munitions with minimal environmental impact. He worked on early biotic surveys to the Alaska pipeline before it was built, and he was the charter secretary of EPA's Science Advisory Board when it was established in 1974. He holds degrees from Cooper Union, Vanderbilt University, and University of Pennsylvania and, most importantly for this workshop, he holds a great amount - maybe the most of anyone - of organizational memory in the IJC. So we would like to welcome Dr. Fisher to the podium to share with us his knowledge of Annex 1.

Review of Annex 1 and its History

Joel L. Fisher, International Joint Commission

Fisher: The conveners of this workshop have asked me to give a history of Annex 1. The original Annex 1 was in the 1972 Agreement. Everything proceeds as either an evolution or change from that. That is probably the one thing that has been lost in history, the original Annex 1 and what it looked like and, really, a lot of what we have now is nothing more than the same old thing.

There are actually three such agreements -- the 1972 Agreement, the 1978 Agreement, and the 1987 Protocol to the 1978 Agreement. All of these Agreements reflected the convergence of two separate themes: a political one related to the 1972 Water Quality Amendments of the Clean Water Act (United States Public Law 92-500), and a scientific one related to a constantly changing and evolving state of aquatic toxicology at the time any version of the Agreement came into force.

The 1972 Clean Water Act Amendments called for the promulgation of water quality criteria for the navigable waters of the United States, and the achievement of said quality by July 1983. The 1972 Agreement came into force as an international agreement shortly after the passage of this act. Although the 1972 Agreement contained language that referred to the Boundary Waters Treaty of 1909, President Nixon chose not to submit the 1972 Agreement to the U.S. Senate for ratification as a treaty. Without treaty ratification, the agreement became an international agreement with no force in domestic U.S. law.

However, under Canadian domestic law, where the treaty powers are different, there was a force to the Agreement. So we immediately had a disjunction of how the two countries viewed the Agreement from the start. Later, the 1978 Agreement and the 1987 Protocol followed the same pattern -- the international agreement came into force without any status in domestic law of the U.S.

Under the circumstances, how does a party to an international agreement implement that agreement, if it does not have any force? In the U.S., the Office of Management and Budget, under the president's direction, has the authority to review the terms of an international agreement to make sure that nothing in the agreement would commit the United States to any financial or other requirements which is not in keeping with the existing authorities, appropriations, or legislative priorities in the current laws. The overall effect is that the United States did not have to spend any money on the Great Lakes Agreement unless those programs matched existing requirements under U.S. law.

More relevant to this workshop is, how does one deal with Annex 1 of the Agreement? The answer lies in Annex 1 itself. Each Specific Objective that coincides with, or is more lenient than an existing domestic U.S. objective, criterion, regulation, program requirement, or whatever, theoretically becomes part of the U.S. commitment to the Agreement. If a Specific Objective differs from the associated domestic requirement in the U.S. in a manner which is more stringent, or sometimes more costly, then the United States has no legal obligation to meet the differing objective. Even the choice of language makes any formal commitment tenuous because objectives are criteria or voluntary guidelines, not enforceable under law, that represent desirable goals to be achieved at some future time. In U.S. law, only standards have legal status, as they are converted readily into regulations.

In 1990, the passage of the Great Lakes Protection Act gave the 1987 Protocol version of the Agreement some status under U.S. domestic law. In a very rare appearance before Congress, both co-chairs of the IJC, in a presentation carefully crafted to prevent that presentation from being quoted as, or the establishment of any precedent with regard to Congressional testimony, both Commissioners testified before Senator Levin's committee in support of that law, and the law ultimately passed.

So much for the political and legislative background of Annex 1, and now for its scientific concerns. Annex 1 can be considered as a synoptic example of continuous catch-up. It may have been a marvel of diplomacy to have obtained any environmental agreement that looks systematically at water quality and its various physical, chemical, and biological parameters both as needed objectives to support aquatic life and, later, aquatic ecosystems. But almost as soon as pen was put to paper, and "de foi en quoi" (which means "equally faithful and valid" in both French and English) was sealed on the Agreement, much of the material in Annex 1 was arguably obsolete.

At the time of the 1972 Agreement, there was a certain state of science and practice with regard to water quality criteria, emphasizing microbiological pollutants and some early toxicology for chemical

pollutants. Annex 1 was cobbled together according to what was available in federal, state / provincial, and local practices. The slide [to be inserted] shows what Annex 1 looked like.

"Final" means that the knowledge of water quality criteria at the time was sufficiently developed for these parameters that it was possible to agree on objectives of a form -- subject to future findings from research at least five years away -- that you could freeze "final" at least in time for that period.

"Interim" implied that revised or new objectives for these parameters would be forthcoming in the very near future. These included temperature, mercury, and other toxic metals, persistent organic contaminants, settleable and suspended materials, oil, etc.

With respect to "compliance" with specific objectives -- a policy consideration -- and the need for them to be based on a statistical sampling plan. I don't know of a statistician worth his pedigree who understands the concept of "statistical validity" with regard to sampling. Sampling is more art than science. One wishes to validate or verify specific findings or hypotheses, but sampling is performed in a manner appropriate to the problem, with due concern to avoid bias and other known undesirable situations.

This section with mixing zones was an issue. EPA considered them illegal under the Clean Water Act, a variant of "dilution as the solution for pollution." This component of Annex 1 was not even considered by the Parties until 1983, when it became necessary to consider the formulation of a Great Lakes toxics strategy and come to grips once and for all with the mixing zone issue. It has since become a non-issue, as attention was focused elsewhere under the RAP [Remedial Action Plan] and LAMP [Lakewide Management Plan] programs.

In the period of 1972 to 1976, several major references of water quality came on the scene, including the 1974 famous "blue book," which is the National Academy of Sciences Water Quality Criteria, the EPA "red book," which was called Quality Criteria for Water, and the "orange book," which was Eutrophication Causes Correction, etc. from the National Academy of Sciences. The colors refer to the fact that these were all hard-cover books, a rarity for the U.S. Government Printing Office, since everything used to be paperback. So, these really had some status, even within GPO.

The 1978 Agreement objectives basically referred back to the 1976 "red book" which was supposed to update the "blue book." The Specific Objectives for metallic elements, for example, copper, lead, and nickel were based on aquatic toxicity test data "with an appropriate local species." The state of bioassay technology at the time was the flow-through chronic bioassay, and endpoints of reproduction and morbidity were also included, as well as mortality. Within the next four years, bioassay technology advanced so that we could do life cycle studies of certain species, and even call on certain life stages as bioassay test species are called. We could selectively do work on eggs, adults, neonates, smolts, swim-up stage, whatever. Also, the number of fresh-water species expanded. We went beyond the sheepshead minnow and the bluegill to include brown trout, beyond *Daphia pulex* to include *Daphnia magna* , we now have *Ceriodaphnia* and associated species. We started looking at fresh water clams and oysters, the gastropods snails, and several species of algae, including one which became the standard bioassay test to determine if water had eutrophication potential. It even also had toxicity potential. At the macrophyte level, the duckweed became the macrophyte of choice. To this was added Atlantic and Pacific salmon, which had previously been used exclusively for physiological testing, mainly by Wall and Brett out of Nanaimo, British Columbia, who pioneered the temperature standards that later became part of both United States and Canadian thermal pollution requirements.

Another change in Annex 1 between the 1972 and the 1978 Agreement was a limited attempt to tailor an objective to a geographical reality by making the lead requirement different for Lakes Superior, Huron, and the others, starting with 10 ug/L in Lake Superior, moving up to 25 ug/L in Erie and Ontario. This reflected basically the higher water hardness, which is a protective factor against lead toxicity in these other lakes. This type of geographical tinkering was not done for any of the other parameters.

Most of the changes pertained to Specific Objectives for organic compounds. That is somewhat a nightmare when one realizes that all organic compounds -- all 10 million of the Bielstein compendium -- were theoretically included. The organic compounds listed in 1972 were mainly the hard pesticides. These were chemicals of long degradation time in the environment and, for all practical purposes, were essentially non-degradable. They were also responsible for most of the documented fish kills due to pesticides. They included such things as aldrin, dieldrin, chlordane, DDT and its metabolites, endrin, heptachlor and heptachlor epoxide, lindane, methoxychlor, mirex, and toxaphene.

Although EPA had other hard pesticides on its list, notably kepone, which is a congener of mirex, and phosphyl, which was banned from commerce, the 1978 Agreement reflected only those chemicals in current use or previous use in the Great Lakes region. The major problem with kepone was in the James River in southern Virginia. Phosphyl was only allowed to be exported until it was discovered by a researcher at the University of North Carolina that it caused multiple sclerosis and a syndrome in a whole variety of animal species and people, and then it was taken off the list entirely. But that did not stop the possibility that some of these things would be re-imported into North America because what was banned for local use did not necessarily mean that it was banned from being put on crops or seeds and could come back somehow and get back into the Great Lakes.

Also added to the list of organic compounds was a new group, in 1978 called "other compounds." This consisted of phthalic acid esters, PCBs, and "unspecified organics." Concerns about phthalates related to their use as plasticizers and their widespread occurrence in the polymer materials used in automobile seat covers to hospital blood transfusion bags. Phthalates are very soluble in organic materials, including body fluids. They have a slow degradation time, although their bioaccumulation potential has never really been documented. More worrisome is that some phthalates are mildly carcinogenic to laboratory animals and, presumably, to humans. The reason to include phthalates on the list was sparked by the Delaney Amendment, a portion of the Food and Drug Act which specified that an animal carcinogen could not be deliberately added to either the packaging or the foodstuffs or any other aspect of a food material, where it could get into a food supply.

PCBs have since come under bans and phaseouts in the United States and Canada, but they still represent major contaminants because of their widespread use in transformers and electrical equipment and their presence in hazardous waste disposal sites.

"Unspecified organic compounds" is a catchall designation, originally designed to consider chemicals due to commerce but which might pose a threat because of their toxicity, lack of biodegradability, or some other factor. The idea behind this category was to provide a future mechanism to set objectives for chemicals which have bioaccumulation potential, despite their biodegradability.

The non-persistent or biodegradable organic compounds became a new category in Annex 1 which included the three soft pesticides -- guthion, diazanon, and parathion. Noticeably absent was malathion, a congener to parathion. Malathion was widely found in some 90% of the herbicide and weed-killing compounds sold in garden supply stores and hardware stores in North America, and was the standard herbicide test used in aquatic bioassays during the 1970s and 1980s. In fact, it was often the control toxicant in certain tests. One can infer or derive an objective for malathion from one on parathion, because the common mode of degradation has known chemical rate constants.

The use of parathion has virtually disappeared. Its use in a particular form is almost exclusively given over to the destruction of marijuana plants by aerial spraying by DEA officers overseas.

The most widely used pesticide now is atrazine, which would come under the "other" category, because it is biodegradable. However, this pesticide has nitrogen in three valence forms within the

compound and that confers a combination of chemical and biological properties not anticipated by the Agreement at the time. First, it is almost equally soluble in aqueous and lipid systems. Two, it can cross biological membranes because the secondary and tertiary amine groups of the parent molecules are found in standard biological carrier molecules. Three, it can interact because of its modes of solubility with many other soluble compounds that would otherwise not react with pesticides.

The objective for the "other" category is the appropriate 96-hour TLM. However, in this case, the appropriate test species turns out to be a terrestrial mammal, the vole, because it turns out that atrazine causes behavioural abnormalities and is synergistic with the nitrates in drinking water. For more information on this, one is referred to the work of Warren Porter at the University of Wisconsin.

Also revised was the Specific Objective for asbestos. The 1978 Agreement retained the 1972 objective but now treated the substance as a "physical parameter." At the time, EPA regulations for asbestos called for a particle count of asbestiform fibres in a water sample. Although the test for asbestos was for a physical property, namely a colligative property of the substance, asbestos is a mineral and really a chemical parameter. The regulation virtually required every water laboratory to have on call an electron microscope to perform the particle count. EPA wound up supporting the purchase of large numbers of electron microscopes at the time, without any understanding that it takes about $50,000 a year to maintain this, not only as a special technician but to power the air conditioning to keep the room cool when it is used.

The reason for including asbestos in Annex 1 related to the asbestos mineral content of taconite tailings in Lake Superior and the possibility that asbestos particles contaminated the source water used in the bioassay work of EPA's Duluth laboratory. EPA was facing the possibility that every bioassay study that it had performed for water quality criteria would have to be revised because of the possible asbestos contamination of the source water.

Another important change between 1972 and 1978 related to the Specific Objective on phosphorus. The 1978 Agreement not only looked at aquatic concentrations but also introduced mass loadings. The control of phosphorus is related to the control of eutrophication of freshwater systems, a condition stimulated by the levels of phosphate in waters acting as a nuisance nutrient.

If we now go to the 1987 Protocol to revise the Agreement, the Protocol in theory was not a revision. The word "protocol" is kind of a diplomatic trick. However, one of the things the Protocol did was add a Supplement to Annex 1.

The Protocol actually addressed several loose ends in the Agreement. First, it addressed the definition of something that was absent from the system, as something not detectable using the best available technology, including biological indicators. Further, the concept would be revised when detection technology became more sensitive.

It authorized the keeping of lists on substances that were known or believed to cause harm to aquatic, terrestrial, or human life. In the 13 years of the Protocol, I have not seen any lists. They may be out there, but I have not seen them.

At the time of the 1987 Protocol, there was considerable discussion about the temperature objective. The EPA had proposed a thermal standard appropriate for salmonid streams subject to thermal pollution, and the entrainment of organisms in the cooling water systems of large power plants subject to run-of-the-river cooling water capacity. This standard was not appropriate as a general temperature objective for the open waters of the Great Lakes. The relevancy of thermal criteria to streams, tributaries, and the thermal effluents from nuclear plants on Lake Michigan were covered by the domestic United States and Canadian regulations. The temperature objective remained, fortunately, unchanged in the various versions of the Agreement.

Although the 1987 Agreement changed the radioactivity objective to one based on alpha, beta, and gamma radiation exposure through drinking water, this was consistent with the International Commission on Radiation Protection (ICRP) standards at the time. It did not, and the 1987 Protocol still does not, consider specific isotopes in the Great Lakes that may be a problem on their own, in particular, tritium. Between 1978 and 1987, the nuclear power plants in the Great Lakes region had, on the average, one "unscheduled" release of radioactive material into the lake. An unscheduled release is a euphemism for a legally allowed, otherwise illegal discharge of an otherwise dangerous material, because the amount that is held in storage exceeds the storage capacity of the nuclear fuel cycle processes. Several groups have asked for a tritium objective for the Great Lakes, without success, and the tritium concern remains simply because a large number of the reactors on the Great Lakes are heavy-water-based systems.

The 1987 Protocol added a new concept of "ecosystem objectives" -- two of them, one on lake trout and one on *Pontoporeia hoyi* , an anthropod. The lake trout has years of statistical and field testing behind it. Not so for the one for the anthropod. The work that was originally done -- very fine work -- looked at its abundance as a function of depth in the Great Lakes as a food species for the trout. However, no monitoring attempts were made to match the abundance curves of the original research

with what was found out in the field. Beware of organisms that are either too fast or too smart that you cannot sample them. They just get away from you. And that's the problem with *Pontoporeia hoyi* . People do not see it because they do not use equipment that goes fast enough, nets that are fine enough, and those animals are very smart. They can go up and down the water column at will and, to me, the whole thing simply did not make any sense, besides which, again, in the 13 years of the Protocol, I have not seen any data on *Pontoporeia hoyi* either in any of the monitoring studies.

Revisions of Annex 1 have not been made for selenium or silver, although the Commission-sponsored study groups recommended new or revised Specific Objectives for these parameters. The Commission did not recommend these parameters for new Specific Objectives because of other factors. In the case of selenium, it was discovered that marine fishes, notably tuna and swordfish, selenium acted as a biological protection against mercury and other heavy metals. The Food and Drug Administration at the time was petitioned to change the mercury standard in tuna and swordfish to prevent bankruptcy in the fishing fleets. Biochemical studies with selenium showed that the high selenium content in tuna and swordfish acted as an antagonist to the action of mercury. While the mechanisms of this protection have not been completely determined, it is known that it involves vitamin B-12 and vitamin C. It prompted the FDA to change the standard from mercury to that of methyl mercury, the neurologically active form. The Agreement did not make such a change. The Agreement still talks in terms of plain mercury and, therefore, it becomes a problem if one wishes to look at selenium.

The work on silver was interrupted by the release of the 1987 Protocol which eliminated the Commission-sponsored task forces charged with assembling the information. Further, silver is sufficiently valuable that industrial sources, primarily in the dental industry and photographic industry, found it very profitable to recover silver from waste streams, even mine it from their wastes, and so it has become essentially almost a non-problem, at least as an industrial discharge.

There have been no changes or additions to Annex 1 since the 1987 Protocol, but the state of toxicity and eco-toxicology has moved on. Most agencies now use a risk assessment-based procedure in the regulatory processes or the administrative aspects of determining what priorities for regulation. There is no risk assessment built into Annex 1. Life cycle studies and flow through bioassays, except as the most elementary of testing, have largely been replaced with molecular probes: gene-splicing techniques, cell lines, and a variety of techniques that are very effective but are never even touch whole organisms. The fads about microcosms, mesocosms, and macrocosms have come and gone, with some of them remaining, but multi-tiered bioassays and microcosms also are not built in. The only advanced-level study that is built in is effluent bioassays, and those are strictly toxicity-based TLM testing, albeit for a mixture.

In closing, I wish to note that I personally feel that Annex 1, however pioneering it was in 1972, has somewhat become fossilized over time, thanks to the status of the science. Some people may feel that it is worth keeping, perhaps as a statement of principles rather than as a compendium of numerical goals. Monitoring and surveillance seems to put little store in the numbers anyway, and I hope this workshop will come to grips with this uncomfortable reality. Thank you.

Questions and Discussion

Unwin: Will you answer the first question, "Is Annex 1 still relevant and useful?"

Fisher: My feeling in the matter is that I tend to agree that maybe it is a statement of principles, but I don't think it works as a compendium of numbers. There would need to be too many things to bring it up to date on that score, and I don't know whether it's worth trying to make it scientifically up-to-date, only to watch it go through a rapid obsolescence process with the next evolution in techniques that are looking at these numbers. But perhaps a statement of valid long-term principles that could last beyond the numbers themselves might be the better approach.

Unwin: Thank you. As I said in my introduction, we commissioned a background report by a contractor, that contractor being Limno-Tech Inc., here in Ann Arbor. We will now hear a presentation of that report. I want to note though that I think the contractors validated our choice in that we presented them with a fairly daunting task, a rather short schedule, and a rather short budget to accomplish it. They accomplished the task and they accomplished it ahead of time. We saw this three weeks ago and it's an excellent report, a very good background report. If you are interested in this topic, you should get a copy of it [final version is available on the web at app_d.pdf]. Appendix D to the report stands alone as a wonderful reference piece for the rules and regulations on water quality in the Great Lakes basin.

Speaking to us today will be Wendy Larson and Joe DePinto. Wendy is a senior project scientist at Limno-Tech, having joined them in 1991 after four years as an environmental scientist with the Metropolitan Waste Control Commission in St. Paul, Minnesota. She's responsible for managing a wide variety of projects in the Great Lakes region and nationwide relating to conventional and toxic chemical modeling, sediment assessment and management, waste-load allocation, TMDLs [total maximum daily loads], and permit negotiations, both public and private clients.

Joe DePinto, who will wrap up the presentation, doesn't need near as much introduction. Most people here have at least heard of Joe if they haven't met him. He is a senior scientist at Limno-Tech and has been since June of 2000. Before that, he spent 27 years in academic realm throughout the Great Lakes basin. During that time, he played an active part in Great Lakes research community and he's continuing to do so in his role at Limno-Tech. He is currently a member of IJC Council of Great Lakes Research Managers and he chairs the International Association for Great Lakes Research's Publications Committee and he is an associate editor for the *Journal of Great Lakes Research* . So we'll start with Wendy. Thank you.

Presentation of Background Report

Wendy Larson and Joe DePinto, Limno-Tech, Inc.

Click here to access the visuals that accompanied this presentation.

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Larson: We appreciate the opportunity to be part of this review of Annex 1. We've spoken with some of you over the past two months and, if we did, I want to say how much we appreciate your help. We realized early on when we began this project that we were going to need a lot of data and a lot of information in a really short period of time from a lot of busy people. So if you were one of those busy people, or your staff, please know we really appreciated your support, cooperation, and it made our job a lot easier. If you don't have a copy of the report, it's on the web.

First, I am going to give you an overview of what Joe and I are going to cover in this half-hour presentation. We're going to start out going through our charge from the Science Advisory Board -- what were the objectives of the review, what questions did they ask us to answer, and then present the approach that we took to accomplish that, and also give you highlights of our findings and refer you to the report for more details. There's an awful lot in there so I'll only be able to give some general overview of the findings. After that, Joe DePinto is going to go through some of the issues that came to light when we were conducting the review, just to stimulate some discussion in this afternoon's session.

The objectives of the review were four-fold. We were asked to assess the current status of the Great Lakes relative to the chemicals listed in Annex 1. The second objective was to assess the relationship of current policy values in the Great Lakes region to the specific objectives. The third was to gather information on the conceptual basis and rationale for those current policy values, and then finally determine if and how each agency assesses compliance with their policy values and this would be for the open waters of the Great Lakes, because that's generally what the Annex 1 objectives are assumed to apply to.

First, a caveat. This is an important one. In the time and resources we had available, we did not conduct an exhaustive compilation of all the data that are out there. We know there are plenty of data sets that we didn't obtain and review. We do, however, feel that the data we obtained were sufficient and adequate to answer the questions that we were asked to answer. It was a screening level comparison. The data do not represent comprehensive spatial or temporal coverage in each lake. We did assume that they QA/QC'd [quality assurance / quality control]. We did not interview every agency with a regulatory mandate in the Great Lakes although we feel that we did a pretty good job with the contacts that we did make. Your comments are welcome related to any key omissions that you see in this report. It is a draft. *[Note: The comments received were incorporated into the final version of the report, posted on the web site noted above.]*

The Annex 1 Specific Objectives are categorized in four categories: chemical, physical, microbiological, and radiological. This review focused primarily on the chemical objectives. The chemical objectives are broken down into persistent toxic substances, non-persistent toxic substances, and a category of other substances which applies to conventional pollutants, like dissolved oxygen. This simplified version of Table 2-20 and the following two slides show that the specific objectives are written in terms of three media. It's a little hard when you look at the actual document to break down which are in which so we created these tables to show which were in which. This was important because it led to what data we needed to collect.

The first slide shows for organic persistent toxic substances includes pesticides and PCBs. There are specific objectives for water in this category and, for some of them such as DDT and its metabolites, not only is there a specific objective for water but also for whole-body fish tissue. For four of the pesticides, there's a specific objective in edible fish.

The next slide shows the same type of information for inorganic persistent toxic substances and, in this case, this is primarily the metals which are in terms of water concentrations and then for mercury, there's a whole-body fish tissue concentration specified.

The next table shows the non-persistent toxic substances. This would include some pesticides and these unspecified non-persistent toxic substances and complex effluents. There are also other substances not shown on the slide but that are part of this category. These are all written in terms of water concentrations. There are no fish objectives in this category. For a couple of them there are toxicity-based objectives for water.

The first question we were asked was, how do the specific objectives compare to recent data in the Great Lakes. This was a screening-level comparison. We looked at data collected over the past approximately five years. Most of the data we collected, we were able to stick to that time frame. We selected data for the open waters of the Great Lakes only, avoiding as much as possible, the near-shore areas because the Annex 1 objectives are commonly assumed to apply to ambient open waters of the Great Lakes.

We selected data that are representative and sufficient to make these comparisons. We were trying to determine if the data are less than, equal to, or greater than the objectives. We primarily contacted federal agencies that monitor the open waters, but we also got a great deal of information, particularly with respect to the fish data, from Ontario Ministry of the Environment as well as some of the states. When we went to get data, we only collected and reviewed data that related to the way the objective was written. For example, for PCBs, the specific objective is written in terms of whole-body fish tissue. So we went and looked for whole-body fish tissue for PCBs. We didn't collect and review edible fish tissue for PCBs, even though we understand that's important information.

Our primary sources of data, for water, we obtained data Great Lakes National Program Office [GLNPO] and Environment Canada. These two agencies have routinely monitored the open waters of the Great Lakes for a variety of purposes, including monitoring long-term trends, and they use consistent protocols within their own sampling programs. They're both very robust data sets, so we felt these would be sufficient for the comparisons that we were trying to make. For whole-body fish tissue, we obtained data from GLNPO, the Canada Department of Fisheries and Oceans, and the State of Michigan which had quite a bit of data available for the four lakes that border on Michigan. Then, for edible fish tissue, we requested data from GLNPO, the Ontario Ministry of the Environment sport-fish contaminant monitoring program, and also the State of Michigan.

So what did we do when we had multiple data sets available and we were trying to make some sense out of it and what to use. If we had the data, we did present it in this report. You'll see in Appendix B, there are some very detailed tables where we provided all the information that we had, the statistics,

and quite a bit of background information, contact information, if you are interested in any particular data sets. There we provided means and ranges, that kind of information.

In the report, for clarity, we also wanted to pick a number that we felt would be representative for screening level comparisons, an average value. We needed to make some decisions about which data sets we wanted to use for that.

For the water data, interestingly enough, for a particular parameter, we usually found that data were available for a particular lake, if they were not available from GLNPO, they were available from Environment Canada. So, we able to put together a fairly complete data set, although we did find some Annex 1 parameters where there were no data available from the agencies that we contacted.

For fish, we were given a lot of data for a variety of species and different types of processing, composited by age, composited by length - a wide range of protocols. Since Annex 1 does not specify the species of fish, we selected adult, top-predator species preferentially, looking for the most conservative species that we anticipated would have the highest concentrations. We chose lake trout for Lake Superior, Michigan, Huron, and Ontario and walleye for Lake Erie, because there are not that many trout in Lake Erie to get a robust data set.

When we had edible fish data, we had skin-on fillet data and dorsal plug data. Which did we use? We looked at the data sets that we had and, in those data sets, we found that, generally, the concentrations were higher in the skin-on fillet data and we chose to use those because they were considered to be more conservative for this comparison.

What did we find? For water, the pesticides in all of the lakes, with really very few exceptions, the concentrations were less than the Specific Objectives. For metals, we found the same thing -- in water, the concentrations were less than the Specific Objectives in all lakes. Not all parameters were monitored in all lakes. One example that comes to mind, when I was listening to Joel's presentation, was phthalate esters. That was one category where we were not able to find any water data from the sources that we contacted.

The next slide shows the results of the data comparisons in whole fish. This category is for the protection of fish-consuming birds in the objectives. For DDT and metabolites, the data from Lake

Michigan indicated that the concentrations in whole fish exceeded the Specific Objective of 1 ug/g wet weight and, in the other lakes, the average concentrations were less than the Objective.

For mirex, in all the lakes but Lake Ontario, the Objective was not exceeded, but it was in Lake Ontario. For mirex, the Objective is "shall be substantially absent" and it specifies less than detection, but the detection limit is a moving target. It is different for different data sets, and it does not specify a detection limit, but we did find that, with the detection limits we were provided, this was our result.

For PCBs in whole fish, all the lakes, the PCB concentrations exceeded the Objective of 0.1 ug/g. For mercury in whole fish, in all lakes, it was less than the Specific Objective of 0.5 ug/g.

This is the data comparisons for edible fish tissue. There are four pesticides listed for edible fish tissue in Annex 1. For all four, the Objective is 0.3 ug/g. In all cases, we found that the concentrations were less than the Specific Objective.

I'm going to move on now to the next question that we were asked, which was, how do the Specific Objectives compare to current policy values? You are probably wondering what I mean by that term. Because criteria, guidelines, objectives, standards are different names used by the various agencies, we needed a term, and we decided to call them all policy values, so that we did not have to say all those words every time we referred to them. So, a policy value is any of those that have been promulgated by an agency in the Great Lakes region.

Why are we interested in policy values? They tell us about the current state of the knowledge related to exposure to, and effects of contaminants in the environment. They reflect an interest in protecting multiple uses of water, sediment, and tissue, and they also reflect improvements in analytical methods since Annex 1 was adopted, such as lower detection limits.

In terms of policy values for water, there are some Specific Objectives for water that it is unspecified what they are protecting. There are also some Specific Objectives that specifically protect aquatic life - this is stated in the Objective. Other current policy values that are protective of aquatic life include the Canadian Water Quality Guidelines, Ontario Provincial Water Quality Objectives, and U.S. EPA's Great Lakes Water Quality Guidance [GLI] criteria. All of the states have adopted criteria that are at

least as stringent as the GLI, so we have put those into the same category. You can find information on that in the report, showing what the criteria are for each state, compared to the GLI.

There are also policy values for the protection of human health that are written in terms of water, under the Great Lakes Water Quality Guidance. Those are based on fish tissue targets. And there are water quality policy values for the protection of wildlife under the GLI, again based on fish tissue targets.

What did we find when we compared these? Well, it was kind of all over the board. It is hard to make general statements, but I pulled some out. There were a lot of inconsistencies between the Specific Objectives and the policy values. The report contains detailed tables showing how the Objectives compared to each of the guidelines, criteria, and standards that we located.

Compared to the policy values for the protection of aquatic life, the Specific Objectives in terms of protecting aquatic life were often the most stringent value. The Great Lakes Water Quality Guidance criteria for the protection of human health and wildlife usually are the lowest values overall, compared to all other values for the protection of all uses. Some policy values for metals are hardness dependent, in addition to lead. Finally, policy values have been promulgated for many substances that are not listed in Annex 1.

In terms of policy values for whole fish, for the protection of wildlife consumers of fish, there are four parameters under Annex 1 that are specifically for the protection of fish-consuming birds, written in terms of whole fish, and these are for DDT, mirex, PCBs, and mercury. The Canadian tissue residue guidelines specify, for DDT, PCBs, and toxaphene, guidelines for the protection of wildlife consumers of aquatic biota. The Ontario fish tissue residue criteria specify, for DDT and mercury, values for the protection of fish-consuming birds and, in the case of mercury, aquatic life. Under the GLI and in the states, there are water criteria, not whole-body fish tissue numbers, for the protection of wildlife, and these have been derived from fish-tissue triggers for DDT, mercury, PCBs, and dioxin.

For edible fish tissue, these policy values are for the protection of human health. There are five pesticides specified under Annex 1 and, since Annex 1, we have the Uniform Sport Fish Consumption Advisory protocol for PCBs; an abundance of state trigger values, action levels, and consumption guidelines for PCBs, pesticides, mercury, and many other contaminants; FDA action levels for PCBs, pesticides, mercury, other contaminants; and, finally, there are GLI criteria for the protection of

human health that are based on fish tissue triggers -- those are in terms of water and are for PCBs, pesticides, mercury, and other contaminants. Details can be found in the report.

This would be lacking if I did not mention the sediment quality policy values that are out there, including the Canadian Sediment Quality Guidelines, Ontario Provincial Sediment Quality Guidelines, U.S. EPA's draft Freshwater Sediment Quality Criteria, and New York state's Sediment Criteria. We have included those in the report as well because there are sediment quality criteria for many of the parameters that are listed in Annex 1.

These sediment quality criteria generally are used in Areas of Concern to assess the impacts of sediment contamination. To remind everybody why we are here today, I show this very depressing picture of a carp collected in the Ottawa River this past summer where sediment contamination is quite a bit of a problem. It is amazing that this adult fish lived as long as it did, considering its mouth and body. This highlights the importance of considering sediment, although this is a topic for discussion because the Annex 1 objectives are commonly for open waters.

The last question we were asked related to the procedures for assessing compliance being used by Great Lakes agencies. We made quite a number of phone calls and talked with some of you. We spoke with the states and Ontario and asked the question, "Do you have a program in place to routinely compare open-lake data to your state or province's standards that apply to those waters?" The answer was no, they primarily focus on nearshore areas. Efforts are directed at sediment contamination, like in the Ottawa River, and the effects on aquatic life. There is no systematic program in place to look at the open waters. They generally turn to the federal agencies to collect those data, although these agencies do collect some open-water data.

In terms of federal agencies, Environment Canada told us that they do routinely review their data and flag parameters for which the 90th percentile value is greater than their own guidelines. They also look at the most sensitive policy values in the U.S. and Canada. There is no formal reporting process for this information. It is found in internal documents such as the Lakewide Management Plans.

U.S. EPA, at least from the folks we spoke with, does not have a systematic program currently in place to review the data and compare them to criteria.

The last slide has contact information, including e-mail and telephone. Limno-Tech would welcome any questions and comments.

DePinto: As Wendy mentioned earlier, we were basically charged with doing a fact-finding project. We were specifically asked, do not make any value judgements. However, we did run across a number of issues that we felt were necessary to bring to you. Most of them are mentioned at some point in the report but, for the purposes of our discussions and deliberations, it would be useful to summarize those issues or questions relative to the review of Annex 1 and what we are going to do with it.

First of all, there are a number of issues related to the overall process of collecting and managing the data that would be used to compare with Annex 1. I was a member of the IJC's Indicators Implementation Task Force, and a lot of these issues are the same as we ran into when we tried to compile data sets that could be valuable in identifying our status relative to indicators in the Great Lakes. It's a very similar type of situation.

First of all, we ran into a variety of ways to deal with censored data. Many of these compounds that we are looking at have, of course, quite low concentrations, particularly in the water, and one oftentimes ends up with a lot of non-detects. It was difficult, particularly when we were just given an average as opposed to being given all the raw data, to know whether that censored data or less-than-detects were given the value of zero, or the value of the detection limit, or half the detection limit, or whether there was a real systematic statistical approach, something like a maximum likelihood, to use to determine what those non-detects might most likely be, and then take that into account in coming up with an average. In most cases, we tried to follow up with the agency or with the contact, to determine exactly what they did with non-detects and, in many of the cases, they were actually set to zero and that, of course, would affect the average, if there were a lot of them in the data set.

Another issue was, there are two sides to the border, two federal agencies, a number of states and provinces, and all of them have various kinds of monitoring programs and their own protocols in general, because they have their own objectives, and the question oftentimes came up, of whose data do we use, or how do we combine from two different sources that maybe don't use exactly the same protocols.

A big issue with the data, of course, was spatial and temporal coverage or reference of the data. What is the definition of open water? Where do we cut the line? What about fish that are traditionally open-

water fish but maybe were caught in an Area of Concern or in a nearshore area? How does that factor in? Those kind of things.

Open-water monitoring programs don't cover all seasons. They usually go out in the spring and again in the fall, or something like that, late summer. How does that relate to some sort of annual average, if you will, of the system? When is sampling done and how does that factor in?

Of course, how much spatial coverage there is in the system, the number of stations, is it statistically significant in terms of spatial variability in the system? That may be a lake-specific answer, which adds another level of complexity to the issue.

Finally, with regard to data management, we found variations in the sampling and the analytical protocols, particularly for the persistent organic substances, the hydrophobic organics that there are differences in the analytical protocols for EPA versus Environment Canada. They have looked at these and have talked about them before, but the fact is that there are differences, and does this make a difference? I'm not sure.

The question of whole fish versus edible fish -- what should it be? Of course, that depends on what one's target is and what one is trying to protect. We ran into the whole issue, as Wendy mentioned, of species of fish, their size and age and, again, there are differences between the sampling programs in terms of what size fish, or whether one wants to categorize the data -- all adults, or all fish greater than a certain age or a certain length, versus actually putting them into age categories and doing an analysis that depends on the length or the age of the fish in terms of the concentrations.

The actual policy values, at least for fish consumption advisories, are different in the two countries, because of the difference in how they put the data together that they collect.

That is a summary of the data management issues and questions. There are also a number of policy-related issues that we need to resolve, if we are going to move forward with any revision or review of Annex 1. There are a number of Objectives that specify both water and fish tissue concentrations. In going through those where there are both, the question comes up, and in some cases we have answered it, there is really an inconsistency between the water and the fish objective. In the GLI, the guidelines are given as water concentrations, but actually they were derived from a bioaccumulation

factor for fish, so there is an internal consistency in those numbers, if one believes the BAFs that were used to make the conversion. It is not clear that that was done in all cases with the Annex 1 Objectives. We need to look at that. It is also possible that there are different things you are protecting with a water number versus a fish number, particularly if it is an edible-fish number, in which case one may not need that internal consistency. But, in terms of people who have to set or specify regulations, or set targets or develop monitoring programs, they need to know at least what that number is for.

The specification of fish "policy values," we used this term used to cover a large breadth of different things, but basically it includes criteria, targets, management objectives, and similar such, so it is not necessarily a standard which has a legal basis or foundation. There are whole fish versus edible fish. The whole fish generally is used for ecosystem and wildlife protection versus human health protection where one would look at the edible portions of fish. Of course, the actual targets and the resulting advisories that are established, there are variations among the agencies, as we all know, in the Great Lakes as to how they apply these data.

We also found a number of discrepancies -- not surprising, since Annex 1 was established in 1978, the actual numbers that were used were earlier than 1978 -- between the Annex 1 objectives and the Parties' listing of what they called parameters of concern. There were a number of parameters with "policy values" or some sort of criteria but that were not listed in Annex 1. There were also, in a few cases, parameters that are listed in Annex 1 -- the phthalate esters are an example -- that really are not monitored to any extent in the system. For example, we found, in the Canadian Water Quality Guidelines, 44 additional organic substances or groups of substances that are not listed in Annex 1. We found 5 metals and 5 other organic substances or physical properties. With the GLI, we found 11 additional substances not in Annex 1, and there are a whole slew of Tier II options that some states have adopted.

This in itself speaks to the suggestion by Dr. Fisher that maybe we ought not to try to be quantitative about every chemical that could come along with regard to what we do with Annex 1 but, rather, have some sort of statement of general purpose or perspective on this.

Lastly, there are a couple of additional policy issues that we think ought to be mentioned. First of all, in looking at the conceptual basis for the Annex 1 objectives, this was not specified for all of the parameters. In many cases, the conceptual basis that was specified was not necessarily consistent with the policy values of the states or the agencies. How to deal with the variation among those would really be an issue.

Finally, it is important in our deliberations with regard to the Annex 1 objectives, that we recognize and attempt to have some consistency with several other ongoing programs in the Great Lakes, to name a few, the Lakewide Management Plan process, the indicators that are being developed and applied with the SOLEC (State of the Lakes Ecosystem Conference) process, and the Great Lakes Binational Toxics Strategy. Make sure that we consider those sorts of things when we consider revising or reviewing Annex 1.

Questions and Discussion

Pupp: Regarding the monitoring aspect of the work that you did, did you consider what that would contribute to the question of what to do with Annex 1? Of course, we would like to know the state of the lakes, what are the levels and, of course, we would like to compare these with the goals, but if we are questioning whether the goals set in Annex 1 are valid, how would one use the monitoring data that have been collected to answer the question?

DePinto: I think that all we can do with the existing data is what we have done, that is, a screening-level analysis to determine if we are consistently and significantly below or above an existing objective. That is where the monitoring comes in. If we were going to actually or literally apply Annex 1 or some revision of Annex 1 as a hard set of numbers to shoot for, then I am quite sure that Dr. El Shaarawi will tell us that we really need to design a monitoring program that will allow that to be done in a "statistically valid" way, if such exists, but at least in some sort of a well thought out and un-biased way to make those comparisons.

Pupp: If we are going to use the monitoring data at this stage, should we figure which are the quantitative numbers to shoot for, and then look and compare the monitoring data?

DePinto: I think we can do that, perhaps revise the monitoring program, based on this screening-level comparison to a certain extent but, on the other hand -- I'm a modeller, and people always ask, what's wrong with the model, what's the model error, but I turn around and say, there is error with the data as well, and that has to be taken into consideration. That sort of principle is valid here. We first have to decide whether these Objectives we set in 1978 are still valid and whether we even want to make the comparison. In some cases, the concentrations, in the water in particular, for some of these

compounds, toxaphene, for example, are well above what we would set, if we were setting today. Those things have to be looked at as well.

Larson: There were also contaminants, we were told, that the agencies stopped monitoring for, because the levels were so low that they did not see any point. Endrin was an example?

Fisher: To what extent did you find that those parameters for which the objectives came from the Food and Drug Administration originally, were really dominating the ones that were not being monitored? In my experience, of all the parameters on the Great Lakes lists that received the least monitoring, the ones that originally came from the Food and Drug Administration were among them, almost universally. It sort of made me wonder that maybe that was one of -- In terms of the phthalates, originally tainting was in the Food and Drug list. By the way, I wouldn't expect to find any fresh-water data. All of the data I've seen is for the marine systems, and not the marine systems here. The most recent data I've seen is for the Houston ship channel. But the origin of a lot of the parameters, you compare the ones that show up on the Food and Drug Administration are the ones that are not being monitored.

DePinto: We have not made that comparison specifically, but it would be a good thing to follow up on. It is potentially that those numbers are really well above what maybe they should be for the lake protection objectives, and maybe that's why they are not being monitored any more.

Pupp: Joel said that it would be worthwhile to drop the numbers from the Specific Objectives, but we need some numbers. Would we use the GLI values, would we call them environmental quality guidelines? We do not agree ...

Fisher: What I'm afraid of is, if we get too married or too stuck in the numbers, the state of the science is continuously changing, and those targets, even if we chose them well, become obsolete almost as soon as we put pen to paper. When we have chemicals like endocrine disruptors, techniques like molecular probe methods, radio-immunoassay techniques which look at excruciatingly small amounts, literally one can detect one molecule of a given substance in a cell by some of these techniques, what does it mean to put an objective on it? The science itself so boggles the interpretation of an objective in philosophical terms, that I would be very leery. I don't think throw them all. We have to be very careful that you run into the trap of continuously obsoleting oneself. When a colleague told me that she could detect a single molecule of insulin in a cell, that's when I knew that Specific Objectives were off the wall.

Unwin: I want to clarify -- when I said that the Work Group looked at a couple of parameters and that they were orders of magnitude below the Specific Objectives, what we looked at was mercury and trans-nonachlor, both from the Lake Michigan Mass Balance data base. We compared mercury with the mercury objective and, indeed, it is about three orders of magnitude below, at least in Lake Michigan. We compared trans-nonachlor, a component of chlordane, with the chlordane objective and, again, it is about three orders of magnitude below. It turns out that those two are among the largest discrepancies that were identified. That's how we got to this review of Annex 1 and this workshop today.

Our next speaker is Jim Whitaker, who is a senior technical consultant and the manager of the Knoxville, Tennessee Office of EA Engineering, Science and Technology. He is a nationally, at least U.S. nationally, recognized leader in state and federal water-quality-based regulations under the Clean Water Act. He works in the area of permitting - whole effluent toxicity, toxicity reduction evaluations, and water quality assessments. Jim served as a member of the public participation group when the Great Lakes Water Quality Guidance, the GLI, was being formulated. Jim is a good choice for this presentation on water quality standard setting, because he showed during those deliberations the deep knowledge of how water quality standards should be set, and had a real influence on how the GLI was finally put together. He is going to talk to us about the science of standard setting. The Work Group felt that it would be appropriate background for this workshop to touch on this topic as a setting for discussions this afternoon which, as the question we had earlier, may involve talking about, "How should you do that? And what standards should you set if you're going to revise the Specific Objectives?" I will turn it over to you now Jim.

The Science of Standard Setting

Jim Whitaker, EA Engineering, Science and Technology

Click here to access the visuals that accompanied this presentation.

Whitaker: Thank you for inviting me to speak today, and I should point out that I was told to share my opinions so you're stuck with that. The topic of this workshop is certainly a timely one. In recent years there has been a great deal of debate and sometimes heated disagreement about what benchmarks to use in determining the health of aquatic ecosystems. One thing we all can agree on is that we need such benchmarks. Now, ideally, we have one number for each chemical that we know that, if it was met, would protect aquatic life, human health, and wildlife. And this number would be

based on an extensive database and the latest scientific information on the toxicity of that chemical to all important species in the ecosystem, as well as to humans. Unfortunately, there are few or no data for most chemicals for many important species, and even fewer data on effects to humans directly. So recognizing these limitations, we look for a reasonable scientific path to find benchmarks that best approximate our goals. But the first thing we run into is a roadblock that is created by a communication problem. This was already touched on this morning. What was the term that was used? Policy value. You could use that to cover this whole blanket here. And we've already talked a little bit about the confusion introduced by the terminology. The terms water quality standards and water quality criteria are often used almost interchangeably. As Wendy pointed out earlier, water quality standards are enforceable, whereas criteria are simply guidance. Of course our topic today is the Specific Objectives but, you also see terms like guidelines, action levels and you could probably come up with 10 other terms you've seen that fit this category.

Well, do all these terms mean the same thing? You see different numerical values associated with these different terms. Are they interchangeable? Can you compare one to another? Can you really take a single value and use that for each chemical and say, "We meet this and we know we're okay." The reason I'm here is to talk about - what is the best approach based on the current science?

I want to talk first about water quality standards and spend a little time on what a standard is, what it means. A true water quality standard consists of two parts, and it is often forgotten that this is a two part term. The first is a designated use about (we'll look at designated uses in a moment). The second part is the water quality criteria that are necessary in order to protect that use. Often all we think about is the second part.

Designated uses, I could not really come up with a definition. It's best defined I think by example, because it just kind of makes sense to us what these uses are. Most water bodies will have an aquatic life use assigned to it, based on the habitat that is present and what can be expected to live there. That may be a warm water fishery, it may be a cold water fishery, it may be a trout stream. It may have some kind of special protection status associated to it. Sometimes a habitat is limited to uses only expected to be survival of aquatic organisms. The fish will not live there long enough to reproduce. However, most cases you are looking at a lifetime use of the water by those organisms that they can reproduce and thrive. Of course there are also human health uses. Obviously drinking water is an important use, but non-drinking uses as well - being able to safely eat the fish that you catch from those waters. And wildlife uses, not just birds that were discussed earlier but also piscivorous mammals that feed on the fish that live in these waters.

A couple of other uses we don't think about as often - recreational uses. And this is human recreation, be it wading or swimming, or whatever. And typically these are health-based, they are bacteriological

- fecal coliform levels, e coli, that sort of thing. There are also agricultural uses, and a lot of these arose out of the Red Book that Joel talked about this morning for safe levels for irrigation of crops and for watering livestock. And there are even industrial uses of water that require certain quality. The important thing in designated uses is we are not just talking about what concurrently can be achieved in a given body of water, but what is attainable, what is possible, based on the habitat and the natural conditions. If there is a man-made problem that is causing the uses not to be attained right now, what would be possible in the absence of that environmental insult? And the process for going about determining this is called *Use Attainability Analysis* .

Moving on to the criteria - there are two types. The first is the narrative criterion that appears in nearly every state's water quality standards in the United States, something to the effect of "no toxics in toxic amounts." There are also a wide number of numeric criteria. These are the chemical concentrations that have been determined to be necessary to protect different designated uses I talked about a minute ago.

When you start looking at the different water quality criteria for a variety of different uses, you can see a very wide range. I just kind of picked this one out almost at random from the state of Ohio - the various water quality criteria for total chromium for different designated uses. There are aquatic life uses. This is for warm water fishery. These are based on a hardness of 100 mg per litre, and there are aquatic life criteria for both acute protection for short-term exposures and chronic for long-term exposures. You see the huge difference between acute and chronic criteria. There are also two different human health criteria for drinking and non-drinking uses. They differ by two orders of magnitude. And there is an agricultural water supply criterion. In many cases, it is the agricultural use that actually drives the whole permitting process, that number back from the Red Book. When I look at this example, I look back to the Specific Objectives which, frankly, I have to admit I don't use on a daily basis in water-quality-based permitting in the U.S. But the number for total chromium is 50 parts per billion and it is stated that that is the number for protection of raw water for drinking water supply. So, it is a very different number, there for a very different reason, but it is more stringent than all the others.

Which of these numbers is right? That's the question. There are three components to a proper water quality criterion and all too often we only pay attention to the first one and that is magnitude. How much of a chemical can be present before you expect to see an effect on the organisms using that use. But the other two are important as well. Duration - how long can organisms be exposed to that concentration before you expect to see an effect. And finally, frequency - how often can that number be exceeded before you would expect to see any kind of effect. Magnitude in and of itself means nothing if these other things are not taken into account.

I want to talk about two particular types of criteria in looking at the U.S. EPA approach, just to give examples of the type of scientific process that goes on in deriving criteria. I'm not going to do this in an exhaustive sense, but just kind of an introductory overview. For aquatic life criteria, EPA guidelines have been pretty much established for many years. They have been virtually unchanged since 1985, except for a little bit of tweaking. It is a very rigorous statistical procedure and the data requirements are pretty stringent. They require that you have toxicity data for at least eight different families of aquatic life - a real diversity. And these procedures are the basis for the aquatic life procedures in the GLI and virtually all the states in the U.S.

The way the process works is basically EPA or the state will assemble all the aquatic toxicity data for a given chemical and then rank the species for sensitivity, from the most sensitive all the way up or down, depending on how you want to look at it, to the least sensitive species. The procedures are designed to protect the 95 th percentile of the most sensitive species out of that database. The procedures develop both acute and chronic criteria, as I said before. In many cases, particularly for the metals, there is a strong relationship between water hardness and toxicity, so that the criteria are not just a single number, they are expressed as a function of hardness - the softer the water, the more toxic the metal.

What really drives the numbers? What is the procedure sensitive to? Well, the way the procedures are set up, the calculations actually only use the data for the four most sensitive species. You are only really looking at the data for four species. The rest of it is pretty much ignored, except for in fact that it enters into the total number of species (which is the second bullet). If those four most sensitive species are kind of consistent, you have a continuum of data. That is one case. But if your four most sensitive species are far more sensitive than the rest, than they may not be as representative of the remainder of the database.

The number of species is also important. The way the procedures work, the more species for which you have data, the less conservative the procedures are - and it drives a higher criterion, if you will - less safety factor built in, whatever terminology you want to use. But if you have only a handful of species, it tends to make the criteria much more stringent.

Acute-chronic ratio - typically for most chemicals you have acute data, short-term exposure data for a lot of different species, but very few for chronic exposures. So you look at the relationship between acute and chronic toxicity for the handful of species for which you have both, and then assume that that relationship will be the same for all of the other species. There is generally not any data to support that, one way or the other.

What about duration? EPA's guidance has traditionally said that acute criteria should be expressed as a one-hour average concentration, and the chronic criteria as four-day average concentrations. How do these compare to the actual exposures in the toxicity tests? Acute tests are typically anywhere between 24 hours to maybe a week long, depending on species that you are dealing with but, generally, they are in the magnitude of a couple to four days. The chronic can be as long as several months, depending on whether you might be doing a life-cycle test. Yet we reduce those down to express the criteria as a one-hour or four-day average. Why is that? There is not really anything magical about the one hour and the four day. It is an assumption that all chemicals act very quickly and, if you are exposed in that first short critical period of time, that is when the effect is going to be seen - even if you continue the exposure over a long period of time, or put them back in clean water. If they are exposed for that short period in the beginning, you are going to see the same effect. The assumption that all chemicals are that fast acting really is not true. Chemicals act in many different ways. EPA has begun to recognize this, and has begun to back away somewhat from the one-hour average and has allowed the states more flexibility in saying it needs to be short in duration - whatever that means.

Frequency is a bit of a mystery also. EPA guidance has always said, "This criterion can be exceeded once every three years without expecting there to be any problem." Where does that come from? There is really not an ecological basis to that exceedence frequency. It is kind of similar to what they expect the frequency to be for the designed stream flows that they use for water quality modeling, but it doesn't really have a relationship to ecological recovery. It would seem intuitive that, in order to look at frequency, you would have to know how great was that exceedence. If your criterion is 100 ppb, if you measure 101 versus measuring 500, it would seem you could have 101 more often than you could have 500, but that magnitude difference isn't something that is built into the guidance. And again, would the relationship be the same for all chemicals?

One thing that EPA provides is a set of established procedures for developing site-specific criteria. There are three tools in the toolbox that they give us. One is the recalculation procedure. As I said, you start out with this long list of acute toxicity data for all these different species, and EPA or the state will allow someone to go into that database for a particular water body and say, this one, this one, this one and this one, these are examples - it's a flag fish that is found in streams in very arid areas - it is in a lot of the databases. There are other things that just clearly could never be present in that water body. You could try to make the case that that ought to be removed from the database. One stumbling block to that, and rightfully so, is that EPA says, "We need to know that that sensitive species that is not present in this particular water body might not be representative of other sensitive species that are present but you don't have data for." If there is any way which they are representative of other organisms, they need to be kept in. That is a hard demonstration to make.

The other thing is, as I said, these procedures are very sensitive to the number of species that you test. And as you pull these data out, and drive that total "n" down, you are going to also be tending to drive the criterion to be more stringent. I should point out that this is site-specific - it is not biased to reducing or increasing the criteria, but most of the people that are going out to use this are using it because they have a water-quality-based permit limit that they cannot comply with because of the criterion and they are trying to see if the criterion may be adjustable. Typically that is what people are looking at - bringing the criterion up.

Water-effect ratio is simply going back and doing the toxicity test in site water, collected from the water body you're concerned about, and comparing it to results in laboratory water. Often the natural waters, the toxicity would be somewhat lower, and you need a higher criterion.

Residence species is hardly ever done. You collect the organisms of the species that are present there in that water body, conduct a test on them, and derive the criteria. Very data intensive, difficult to do, and expensive.

Human health criteria. Again, just talking about EPA guidelines. These were updated very recently. I did some review of some of those procedures, and the guidance was final last fall [2000]. In fact, the procedures as they ended up, a lot of the things that they changed from the earlier national guidance were similar to what was done in the GLI. Of course, there are procedures for both carcinogens as well as non-carcinogens.

What drives the numbers of human health criteria? I know you are familiar with some of these issues. Fish consumption rate is a huge issue. The fall in consumption rate now in the national level in the U.S. is about three times what it had been before. But even more importantly, the guidance recognizes that there are particular subgroups, be they subsistence fishermen or whatever, that may have much higher consumption rates, and protection needs to be provided for these sub-populations as well. Also, there may be particularly sensitive groups such as women of child-bearing age or young children. If the toxicity data really points at that being the key group to protect, then consumption levels for that particular group can be used to derive the criteria. It also strongly emphasizes whenever you can, use site-specific fish consumption rate and not national defaults.

The guidance now calls for using bioaccumulation factors rather than bioconcentration factors, and clearly for the bioaccumulative chemicals that leads to much more stringent criteria. When there are good field validated BAFs it certainly is the right direction to go. The problem is there are not really

good site-specific field validated BAFs for all the chemicals. There are models available for predicting BAFs however.

Cancer risk level is a policy decision. EPA allows the states to choose from within a range. But what is the appropriate level? Somewhere between one additional cancer in ten thousand to one additional cancer in one million. There are uncertainty factors put in there to extrapolate from mammalian data - mice or whatever - to humans. Relative source contribution is something that is built into the procedures now, recognizing that for a lot of chemicals it is not just the exposure you're getting from the water and the fish, but other environmental sources as well - from the air and so forth.

The duration for human health criteria is quite a bit different from aquatic life. We are talking about a lifetime of exposure here. Lifetime as defined by EPA is 70 years. If you live better than that, I am not sure what EPA says, but you're protected for 70 years anyway. Which right away says, if you are looking at a human health criterion in a given water body and you compare it to a chronic aquatic life criterion - exposure in one case is 70 years the other is four days - how do you compare the numbers? Frequency is something that I have never seen addressed with human health criteria yet. If EPA has said it, I've missed it. How often can that number be expected to be exceeded in a 70-year exposure before you expect there to be a problem? I'm not sure anybody has the answer to that.

Wildlife criteria are so key in this region. We talked earlier about what wildlife criteria are and the fact that there are only limited data to the key target species. That is why, as was pointed out earlier, there are only four wildlife criteria so far. Again, these are the water concentrations we are talking about, derived from BAFs. It is important to point that out that the Specific Objectives include something you would call wildlife criteria. However, they are expressed as tissue concentrations - and here I am strictly talking about water.

What is going on now? What is expected in the near future? At least in the U.S., something which received a great deal of emphasis the last few years is the aquatic life criteria for metals. The key issue here is what is commonly called bioavailability. What concentration does the organism actually see at the point that causes the toxicity? In most cases with metals you are talking about it at the gill. It was recognized several years ago by EPA that dissolved metal much more closely approximates a true concentration than does total metal. Total metal is much over-estimated in many cases. How much metal is really present to cause toxicity? EPA is working on a model now with help from many outside the agency to look even closer about how the metal behaves around that gill surface. There are going to be even more and more changes in how that is dealt with, but it just points out the importance of exposure. What is the actual concentration which the organism sees, not what you measure analytically. There may be a very big difference.

Tier II values, everybody heard a lot about during the GLI, a lot of talk about that. In many cases we don't have data to a whole lot of species for some of these chemicals, and yet we were concerned that there may be a problem. What do you do in the absence of those data? Tier II provides a shortcut procedure, if you will, with some safety factors built in, that allows you to derive a value that you can at least try to compare to the true Tier I criteria. What do you do with those numbers? Can you use them in the same sense that you use Tier I? Would it be appropriate to take them and combine them with a use and call it an enforceable water quality standard?

Nutrient criteria on eco-region level is something that EPA has recently been coming out with> Just two months ago EPA came out with its first tissue-based criterion for methyl mercury. It is interesting to note how long the Specific Objectives have had tissue criteria, this is the first one that EPA has published. The other things you see down there at the bottom [sediment criteria / guidelines, biocriteria] are things that are receiving a lot of attention.

A few issues that come to my mind, and some of these questions are things to keep in the back of your mind in the discussions this afternoon. First of all, what is it that you are trying to protect? It is not a question that can be tossed up really easily. It needs to be considered carefully. Criteria in the absence of designated uses and appropriate and attainable uses really are just numbers; they don't mean anything else. Are you trying to protect every individual - for humans, clearly that's appropriate - but when you are talking about wildlife and fish, are you trying to protect every fish that is out there, or are you trying to protect the populations of those fish? What is the actual exposure? That gets to what I was talking about with bioavailability a minute ago. What is an acceptable level of risk? I mentioned cancer risk, but there is also an assumption built into those aquatic life procedures. We can use a 95 th percentile most sensitive species - you are saying right away, there's 5% you're not protecting. Is that considered to be acceptable?

Where do the criteria apply? That is a biggie. Obviously it applies when you start thinking about, "Should we or should we not have mixing zones?" It also applies when you start thinking about, "Do you use the same criteria for open waters as you do in harbors, as you do in tributaries?" Habitats are very different. Can you use a one-size-fits-all criterion for all of those cases? Another example is with drinking water criteria. Do you need to meet the drinking water criterion everywhere in the lake, or you do you need to ensure that is met at the point of drinking water withdrawal, or even after whatever treatment occurs at drinking water withdrawal? What is the appropriate point?

Are you better off with national one-size-fits-all numbers so there is consistency from state to state? And a lot of the states in the U.S. are very concerned about that. They don't want economic disadvantage in their state, to have more stringent criteria, and have business move out. Do you do them on a regional level like the GLI? Do you do them on a watershed basis, or do you try to make them as site specific as possible? Clearly, the more site specific you make it, the more confidence you have that they are appropriate to your use and your area. However, that is very data intensive and very expensive to try to derive site-specific criteria for all of these chemicals on a site-specific level. What chemicals do you set criteria for? This was another one that was discussed earlier. There are thousands and thousands of chemicals out there. How do we generate all the data that is needed, and how do we go through the laborious process of calculating all of this criteria? What do you do when those minimum data requirements are not met? Do you have Tier II procedures put in place, like the GLI did?

Finally, how do you assess compliance? I know that's the next topic and it is a nice segue. The reason that I put it up here is just to point out again the example of the human health criterion. If you go out and collect a grab sample in Lake Michigan and it exceeds the human health criterion, what does that tell you? If the exposure assumption is a 70-year lifetime exposure, does the grab sample exceedence mean anything? I know many of these are policy, rather than scientific issues, so I will not pontificate without any data. And I always appreciate that.

And again, my opportunity to state my opinion, if I were to just state three characteristics of a "quality" water quality criterion. The first would be that it would be robust. My definition of robust is not a statistical definition but based on extensive database across a range of species in order to minimize the effects of your statistical analyses and to minimize also the use of uncertainty factors. To the greatest extent possible criteria should be localized. They must be appropriate for that ecosystem or whatever level of which you are setting your criteria, and appropriate for the designated use.

Finally they must be flexible, not only as I say here, to be adjustable using reasonable but defensible site-specific procedures, but also to be flexible in the sense, as new data become available that the procedures can be used to constantly update criteria. Again - all the speakers have been great, I can't remember who said what - but it was pointed out that, as you get more and more data, criteria are sort of our moving target. That shouldn't be seen as a bad thing. That is a good thing, that we are learning more, and can come up with better and better criteria as time goes on. Thank you very much.

Questions and Discussion

Unidentified: I want to point out, on the issue of having a multiple species ... drive water quality criteria for protection of wildlife. I know that they had four or five species that they looked at for this for birds, such as kingfisher and eagles and others. And all of them were in a ... or range of a methyl mercury criterion of about 50-100 parts per quadrillion. When it was scaled up to a total mercury criterion it was about 0.9 parts per trillion. There were four or five species and all of them were within not a huge range, so I think having more species by and of itself does not guarantee that it is going to lead to kind of a less protective criterion which I thought was your implication.

Whitaker: That is true for wildlife criteria or human health criteria. However, aquatic life criteria was the example I was giving. Those procedures specifically have "n" in the calculations because those are done to protect populations. Aquatic life criteria are done looking at population-level effects whereas even the wildlife procedures are really looking at what is necessary to protect an individual kingfisher or mink or whatever. You are taking the best toxicity data you have for sets of species, taking that as a reference dose, if you will, and filling in your bioaccumulation factor and so forth. It is more driven by the sensitive species than it is by how many species or data. That's a good point.

Unwin: Article IV of the Great Lakes Water Quality Agreement contains the following statement. Article IV deals with the Specific Objectives. It says, "The determination of the achievement of Specific Objectives shall be based on statistically valid sampling data." Part of that quote was in Dr. Fisher's presentation, and I think he said something to the effect that no one really knows what that means. I have been looking forward to doing this introduction since I got the biographical write-up. Dr. Abdel El-Shaarawi is a research scientist at the National Water Research Institute in Burlington, Ontario, also a professor of Statistics at McMaster University. I am just going to go through a few of his achievements, but these are just the highlights. He is the cofounder and past president of the International Environmetrics Society, cofounder and editor-in-chief of Environmentrics, co-editor and chief of the Encyclopedia of Environmetrics, a Fellow of the American Statistical Association, an elected member of the International Statistical Institute. He received a distinguished achievement medal from the American Statistical Association's section on Statistics in the Environment. He has authored or co-authored more than 120 papers and co-edited or edited eight books and journal special issues. He serves on numerous editorial boards for statistical environmental journals. He may be the only person I have ever met who has a Bachelors, a Masters, and a PhD in statistics. What stamina! If anybody in this room knows what statistically valid sampling data is, I suspect Dr. El-Shaarawi does. Would you please tell us?

The Science of Compliance Assessment

Abdel El-Shaarawi, National Water Research Institute

Click here to access the visuals that accompanied this presentation.

El-Shaarawi: I was told not to talk about statistics even if I know what some of the statistical issues are. But this is the kind of bag that I always dabble with, and I hope that you will have some patience if I present some statistics which you do not really want to hear. What I intend to talk is to give some kind of general, statistical concept and then supplement it with some real examples that I have been looking at in the last week or so, which is connected with the accumulation of PCB in fish. I used the same data sets that Joe DePinto has presented and I think this will be just used as a guidance for what I intend to present as a concept.

The first issue that one should consider is to define what we call the "target population." The previous talk mentioned that when you want something specific for a specific area, what would be your target population? In our case is it related to some media - the sediment, or water or biota? Is it related to the nearshore zone, is it related to the open water? What is the target population? It is very important to determine what is your intention to see that you are meeting the criteria or not.

The second thing that you have to determine - what are your objectives? You are dealing with ecosystem health or dealing with human health. As the previous speaker has mentioned, ecosystem health could be a little bit more complicated because you are dealing with multiple species, you are dealing with multi-chemicals. It is a quite complicated issue and you have to look at really stating exactly what is your objective, and supplement it with some kind of robustness in the way that you are going to come up with setting your criteria or setting your sampling design, and so on and so forth.

If we talk about these things, then we come into specific issue of what is the target characteristic that you are interested in measuring. Are you interested in measuring endocrine disruptors? Are you interested in seeing the fish with a tumour - in the last slide that was presented by Joe and Wendy. Are you interested in characterizing that? What is really the characteristic that you are trying to study, or trying to see if the regulation or the criteria is meeting the condition we have. These are the questions that are very important to address.

The next slide gives the PCB concentration as it is accumulated in the lake trout tissue using 1992 data. What you see here is two aspects that are quite interesting. The sport fish has been released in a specific year so the age of fish is completely determined. You know how old the fish is. The thing that

you notice is that there is variability, and the variability is connected with two things. If you are looking at the range of concentration in the fish for a fixed age, here you will see this wide range. You have to take this variability into consideration when you are setting a limit. You cannot really just say that this is a number 0.3 the fish should not exceed in the concentration, 0.3 of the PCB accumulated, or whatever it is. You need to look at the precision.

The second thing, when you are dealing with the Great Lakes, you have a series of systems. You have Lake Superior at the upper end and then you have the other lakes. And then you have to look at the level in the different lakes and the uncertainty associated with these different lakes. Two kinds of symbols have been indicated here. The open circle indicates Lake Ontario and the closed circle indicates the concentration in Lake Superior. You can see that the distribution has been limited up to eight years of age for Lake Superior, and we have the distribution going up to 14 years of age. If you are comparing, are you comparing age specific, or are you not comparing age specific? What are the limits that we have? Then if you set some sort of limits - I put here 2 ug/g or 1 g/g. So this really has split the population into two parts, one which is above and one below. What are you going to do? Are you going calculate a summary statistic and try to compare it with this? What really is the means by which you are going to express that you are exceeding? By looking at the regulation in the Great Lakes Water Quality Agreement, I do not really see the mode of the calculations. I see a number - shall not exceed. Is this sufficient? It is my opinion that we have to consider the issue of calculation, we have to consider the issue of where we are going to collect the samples, and all these aspects have to be fed in.

I decided to list for you a number of regulations that I have seen in the Great Lakes Water Quality Agreement. The first one which is related to what I am talking about - the concentration of total PCBs in fish tissues should not exceed 0.1 ug/g for protection of birds and animals which consume the fish. Then I would add a thing - for myself, I call it, absolute. What is the meaning of absolute? Absolute that you cannot really verify that is actually happening in reality. What you are doing, you have one number and this number shall not be exceeded. Or what you can do is take samples and then, if it is exceeded, you say, "We have a problem." But if it doesn't exceed, it doesn't mean that you do not have a problem. So you are not improving things. So this is what I meant by the absolute. Here, for example one, you have to have the entire population with its variability separated on this side to accept and on that side to reject. So this is a little bit of a problem because it is really not a complete definition, in my opinion. It is not a verifiable sample or a verifiable limit. You have to think about the different variety of the way that these limits have been indicated in the system that we have.

The second one, the concentration of unspecified non-persistent pesticides should not exceed 0.05 of the median lethal concentration of the 96-hour test for any sensitive local species. What you are dealing with here, which I indicate there, experimental and then you have random effects. If you get the laboratory in CCIW, or a laboratory on the U.S. side of the Great Lakes producing some data, and then you get some numbers. These numbers would vary from one level right up to the other. What is the meaning of this? You have to take this variability into account. So, you have a population which is

coming from that. You have a number of data that people gleaned from an experiment, and you generate a sampling population, and then you go to the field and you have another sampling population, and you go to another field and get another sampling population. So if you have the 0.05 by the median, which is represented by this dotted line, then you are okay this way and not okay the other way. What is the probability of these exceedances? How do you take this probability into account? This specification is not sufficient, in my opinion. You have to determine the degree of risk. When people are talking about a nuclear accident or something like that, they say, well I need the probability to be 10 E-79 or 10 E-50, or 10 E-1, or something like that. Then what you are doing is specifying a level of risk, because you do not have the population. You are doing it through the collection of the data, and the data have variability in it, it has error in it. I think this has to be included.

The third example is determining something which deals with ratio. What you have there, the pH value should not be outside the range of 6.5 to 9. So instead of extrema, you are specifying a range and, within this range, you try to compare it. In addition to this, you see how it complicated it is. It changes the pH at the boundary of a limited use zone. You have to define what is limited use zone and what kind of distribution is there. This will be my range and then, for the ability to accept, you have to have this overlap. It is basically by putting a picture you figure out how you are going to determine what we call acceptable region and rejection region. The basic thing is you are making a decision - accept or reject - and how this is going to be determined.

Sorry for putting the sample of probability there. What I am saying, when you determine a limit, and the limit is indicated by the red line there, then this limit shall not be exceeded. This limit will determine for you a critical population distribution. I call this the critical distribution. Any distribution that falls below this limit is acceptable. If you move in the other direction, it is unacceptable. The thing that one should realize, that the distribution is not only a mean value, it has many different things. If you have the same mean value but different variance, then the acceptable area becomes larger or smaller. One has to try to look at more than one number. One number is a dangerous thing to do. What we are talking about is the probability of meeting an objective when you confront it with data sets. This is the issue: how we verify or how we come up with the conclusion that we are meeting the regulation or we are not meeting the regulation.

What is the precision of the estimates? It depends on a number of things - the number of samples (how many samples you are getting), the sample design (where you are taking, what are the locations of these samples), various sources of variability (spatial, temporal, field, analytical) - all these aspects are why it is important. And it depends on the way that you are looking at the result. If you are interested in estimating an absolute of quantities, the loading to the system, it is very different from comparing one with another. If you have a reference population - you are comparing Lake Superior with Lake Ontario, it is different. You either do it in the framework of hypothesis testing or you do it in the framework of absolute quantities that you are interested in estimating. These things have to be taken into account when you are setting this.

The other aspect which I think is quite important - having universal criteria is quite dangerous in my opinion - because if you have an area which geologically releases those particular substances, by setting this, all that you are doing is showing non-compliance when the source is a natural source. So you have to probably change the criteria to suit the target population. It should not be a constant criteria all over. It is the form of criteria, when you try to protect, let us say the people, don't eat the fish are from this particular part because locally, the fish has been adapted to the environment that they are there and then accumulation is okay. But you do not set criteria for water related to something like this in this regard.

Now I go into the examples that I started with and give you some information that might help you in setting your design. The data that I looked at is the 1992 data, and here is a graph - what we have here I put the variance, the means, and the fitted curve. We have here the mean PCB, we see is that the variability increases as the age of fish increases. You will be uncertain at higher age than at lower age. The variability at Lake Superior which is setting those at the particular age group so we can see that even the two lakes are different. They both fall on the same curve but one belongs to lower levels and the other belongs to the higher levels. You have to take these into consideration. How the variability of the contaminant is changed in the fish tissue or whatever the substance as the level increases. It is important.

Next you develop a model. I developed some sort of a model for the accumulation of the concentration of the contaminant in the fish tissue. This is for Lake Ontario and this is for Lake Superior. The model allows you to interpolate in between, it allows you to do a little bit of extrapolation if you are not going very far. It is basically the form of the model that I found for this particular data set that is quite interesting. It has two components. One is fish-specific, the other concentration-specific in that aquatic system. The one component is independent of the lake - it is the same for Lake Superior and for Lake Ontario. The other one is concentration-specific. The other thing that, when you develop these types of way of looking at the analysis is to try to get the things which are biologically meaningful. What I have, I tried to incorporate some biological information into this. So basically the data helps you in setting the model, then use the model for setting your sampling design, use the model for looking at all the possible consequences in estimating risk and things like that, which I will show in the next set of graphs.

One thing that we have to pay attention to, look for normality of the residual. This is not normal. They have to fall on a straight line. They don't like straight lines. What happens when you have variables that are not normally distributed. What would you do? One thing the statisticians can do is to do a transformation, looking for something that can transform your data to get this kind of thing. The other possibility that you might do is to analyze the data on the scale of measurement that you have. One technique which I think would be quite useful here, is to look at some sort of bootstrapping type of

distribution. I will just give you some of the results very quickly of what I want you to see. I am not talking about the technical aspects here. I show three distributions. I look at what are the predicted distribution of the concentration for different age of groups? I have here selected the three age groups - 3, 7 and 14 years old fish. Using the model, generating 1000 samples from this bootstrap distribution to generate the data that I have. This gives you a measure of the degree of risk. If you are looking at the tail area of the distribution you can determine it - if I am interested in 5% or 2% or 1 % at a specific age, what are the limits that you would do? This helps you in setting the limit for the particular distribution. The limit will have higher variability if you go with higher age groups, because you can see the distribution changes quite drastically there. You can see there is a major separation between those distributions. The difference between 4, 7 and 10 is quite substantial that you do not have to worry about the overlap.

If you are setting the regulations for the contaminants at this particular level, the PCB concentration, if you are setting it at 2, then you can safely say one can consume a fish which is 3 years old. You can discriminate. That is quite clear. There is a big separation between the distribution. So this kind of analysis is quite useful and helpful in setting what is the degree of risk, what is the probability of exceedance in this situation. I think work like this would be useful for looking at these kinds of variations.

Here we are looking at the changes in different limits. If we accept the limit as 0.1 nanograms/gram then the variability and the distribution for the number of years - I am reversing the problem. I am trying to estimate the age that corresponds to a specific limit, what kind of distribution do you get. Here you have very precise distribution when you are dealing with very low limits. It is about 0.1. But if you move to a limit of 1 nanograms/gram, then the distribution you need between two and three years. If you would limit 2 the distribution is very far. So you get this kind of diagnostic using the same data set. It will help you in understanding the mechanism of how things will look like and work in this regard.

Here is another good example. If I am using the limit as 0.1 and then, instead of using 0.1, I use the limit 0.15. You can there is overlap between the number year that you have. It is very important to study the probability of overlap because you are interested in looking at the probability of detecting at specific levels. This has to do with what we call in statistics the power of the test. If you have the power of the test you are interested in two things: you are looking for meeting the regulation, which is type 1 - you specify your risk and then you are meeting the probability of it. If you are in the opposite side, what is the probability of accepting the sample that you are in compliance when it is not in compliance? The overlap will be very important in this kind of thing.

These are a number of issues that I think would be quite important to consider and I have tried to present it to you with a real data set. Thank you for your attention. I really appreciate the opportunity of coming here.

Questions and Discussion

Unwin: Are there any questions?

Heathcote: If we were to revise the numbers in Annex 1, based on what you have said, would you recommend that we say, this number shall not be exceeded 95% of the time? Would that be a better kind of statement? Or for a particular age class 95% of the time? What sort of guidance would you give us in terms of wording?

El-Shaarawi: The guidance I will describe a picture here that might help in what I have in mind regarding that. You assume that you do not have one number - this is the first issue - you have a distribution of some sort. The previous speaker talked about tracking the species and taking the 95 percentile and stuff like that. Keep in mind that you have a reference population and a degree of risk that you are interested in looking at. You can determine the degree of risk and set load criteria here - if you specify that it is this number, you fix this probability also. So, you have two things to fix - the level and the probability. So if you have another distribution which has the same mean but a higher probability, then the degree of risk is not the same, even if you have a fixed number. So you need to fix the risk that the Great Lakes community is willing to take, to take into account in addition to this level. Two things need to be fixed.

DePinto: I think there might be a third - how many samples you collect, how many fish do you collect in the system. That depends I think, on the power of the comparison that you are shooting for, in terms of whether you have, how much overlap and that sort of thing. Would you be able to give us guidance regarding how many samples we should collect to determine if we are compliant or the probability that we are there?

El-Shaarawi: Those can be determined without actual data - the graphs that I have shown here. What you are saying is meeting the regulations or the limits with real data - how many samples you should be getting and where you should be collecting them. This requires that, to determine what is the

power of the test, or the width of the confidence limits that you would like to estimate this particular probability, this is the other side of the coin. You need to have it.

DePinto: So in other words, that should be part of setting the objective, otherwise you do not know how many samples to collect?

El-Shaarawi: No, I think you need two things. You need to set the ideal regulations, which specify what is the probability of exceedance that you are willing to take, plus this particular level. Then you should include in the guidelines how you actually are going to collect the data to meet this guideline. The frequency could be different depending on the ambient condition you are dealing with. If we are talking about the protection for a particular species, then you might try to determine what kind of risk are you willing to get rid of, accept a risk of 5% of the species disappearing, or another species replacing the species that is going to disappear. A decision has to be made, and then you need to have the sampling plan associated with actually getting the data to try to meet the conditions there.

DePinto: For the example in the case of PCBs in lake trout, would we need more samples for Lake Ontario than Lake Superior because of higher variance?

El-Shaarawi: If the whole idea is fish protection, I would concentrate on sampling the older fish, because they are the ones when you are reaching this asymptotic type of levels, the maximum accumulation you are going to get. The other thing to consider is the possibility of how many errors that you are willing to take to commute this power of the test. You need both of them. One aspect I think is quite important, also a determination of these, is how much resources you are willing to put in. There are different types of matters that have to be considered. For example, if you consider composite sampling, you might be able to take sampling from different locations, or fish of different age, mix this together, sub-sample, then, let us say, you have a general criteria, and you set your limit that reduces the level from 0.3, let us say, to 0.2 or 0.1, or something like that, depending on how the compositing is happening. Another type of sampling is what we call in statistics ranked sampling. But you have a great knowledge about the sources of pollution, you know where it is coming approximately from. Then you take random samples, and you pick the largest area which has the highest values, the second largest - there is a protocol for ranks. So, there are many sampling types of strategies. There is adaptive sampling. There are many different types of sampling strategies that you can do. We have to really show how this can be included in something like that. It's quite important to do something like that.

Options Panel

Isobel Heathcote

Heathcote: My name is Isobel Heathcote. I co-chair the Parties Implementation Work Group with Jay. That is the group that is sponsoring the session today for the Science Advisory Board. The afternoon is devoted to a panel discussion with four panelists - I will introduce them in a moment - followed by plenary discussion. In that plenary discussion we will be spending most of our time thinking about the questions that Jay raised at the beginning today. For the panel, we are going to start with people making brief presentations, perhaps fifteen or twenty minutes apiece, one after the other. We will follow with general discussion and then a focussed plenary discussion.

Doug Spry is the head of the Sediments and Soils Section for Environment Canada. He sampled water, sediment and biota from the Great Lakes in his youth and, after working in the Aquatic Toxicity Lab for Fisheries and Oceans Canada he returned to school for a Ph.D. in fish physiology which he obtained from McMaster University. He later worked at the Ontario Ministry of the Environment in the Guidelines Section for about 10 years and has recently joined Environment Canada. Doug, I will turn the floor over to you.

Doug Spry, Environment Canada

Click here to access the visuals that accompanied this presentation.

Spry: Thank you very much for the opportunity to address the group today. We were asked not to speak from agency positions so I have expunged any logos from the visuals. Those of you that have been familiar with this process, however, will recognize that some of the options that I will be talking about today were ones that we already presented to the Binational Executive Committee over the past couple of years of discussion about the revisions to Annex 1. To start with, I do not think in this forum I have to defend the use of chemical guidelines, which is not always the case these days. If you look at the effort that U.S. EPA put into the development of ambient water quality criteria for the Great Lakes Initiative, and recently Environment Canada through the Canadian Council of Ministers of the Environment and the provinces and other jurisdictions have released a guideline suite of environmental chemical specific guidelines for different media and for different users to be protected.

Is Annex 1 still relevant and useful? To be relevant, it has to fit into some kind of a framework, and I put this up for your consideration. This was kicked around at the Ontario Ministry of the Environment

a few years ago. We have two different loops - an assessment loop and a prevention or remediation loop. As a guidelines developer I would start with the set of revised measurable objectives. These could be chemical, they could be ecological. From there you move around the circle and monitor, report, judge the environmental quality, and I say judge because there may be other things than the objectives that go into it - policy decisions, one can factor in socieconomics. If the quality of the environment is acceptable, then you stay in the assessment loop and everything should be in reasonable shape and may not require any kind of management action. If the quality of your environment is judged unacceptable, then you go into the prevention / remediation loop, decide to do something, implement those management actions and then come back again to the monitoring and reporting.

To say, "Are the specific objectives still relevant?" I would like to compliment the authors of the LimnoTech report. I think they did an excellent job. But if you look at the 54 pages of the report, the last three paragraphs on the last page talk about the monitoring and how those results are communicated within the different jurisdictions. So it is a short circuiting of a lot of the loops. If we do not have a good monitoring and reporting system, then developing excellent objectives, current up-to-date wonderful objectives is not going to help to drive the management actions that the reporting is going to do. My conclusions are, "No, not in its current form." It should not come as a surprise to anybody that the objectives are out of date and they are out of date for a couple of reasons. First, they don't reflect the scientific toxicity base for any individual parameter and, second, the science of guideline setting has progressed considerably since the new revised specific water quality objectives was published in 1972/73. As I have already mentioned, I do not believe they drive management action. But we can discuss that.

How could we improve the science? Part of improving the science speaks to the advances that have happened the last couple of decades. We can concentrate on the appropriate media and, if you are concerned about bioaccumulative toxic substances, water is probably the last place that is appropriate to look for them. You should be looking at sediments, you should be looking at tissue residues to protect consumers of aquatic life. We can make better use of what we know about bioavailability. It has already talked about the biotic ligand model, the use of total versus dissolved for metals. There are other things that may affect the bioavailability of organic contaminants as well. We can look at natural background concentrations, and that has already been discussed earlier today. We now know a lot more about the measurement, sampling and procedures that are required to generate good quality dissolved trace metal analysis anywhere, particularly in the Great Lakes. We can address the uncertainty of our data bases. We may now have the statistical methods to do that. The Sediment Quality Guidelines make use of both effect and no-effect data. The Water Quality Guidelines look only at effect data. Is there some way of marrying the two - effect and no-effect data for water quality statistical procedure. We clearly need to address emerging issues or, in the case of municipal wastewater, re-emerging issues. For endocrine disruptors, mixtures - I recall an experiment that was done by Paul ... a number of years ago mixing all of the metals at their Annex 1 objectives and finding it had a ... of properties.

As a specific example of improving the science we can look at polychlorinated biphenyls. As you know, it is a complex mixture and a lot of them start life as Arochlors but through weathering, time and movement their congener-specific profiles change and what we now know about receptor-mediated toxicity can vary by ten thousand-fold. The specific objective in the annex is for total PCBs; it is unspecified. I think it was forward thinking in that it also contains a tissue residue guideline. But recently we have developed environmental quality guidelines which look at the congener-specific analysis for 12 congeners, use those toxicity equivalents and come up with a toxicity-equivalent-based guideline. We also have a sediment guideline as well.

How can we make them more relevant? We can use them to drive management action. In other words, let's put something in the annex or the Agreement that we are going to commit to monitoring, reporting on, and taking corrective action as necessary. There are difficulties, and we went through this in 1993 when the Great Lakes Initiative was under development, we had the same kind of technical discussions and we do have different regulatory frameworks. They are based on different premises. If you consider those frameworks it is very difficult to say, "Yes, we both agree on this ...."

We could recognize other Specific Objectives. Looking through the SOLEC 2000 paper, I was encouraged to see that the indicators for Great Lakes basin ecosystem health contain what Specific Objectives would be very at-home in Annex 1. The phosphorus paper, for example, a phosphorus indicator takes the loadings from Annex 3 and develops concentration-based criteria for the individual lakes and it published clear pass/fail criteria in a chart for those numbers. The snapping turtle indicator contains tissue-specific residues for both plasma and whole eggs based on ... PCBs and the spottail shiner survey could certainly use some tissue-residue guidelines that were pioneered by Karl Suns at the Ontario Ministry of the Environment which also incorporated the tissue residues that were developed by New York State DEC. It is still appropriate to have action levels for persistent toxic substances even though they are slated for virtual elimination. If nothing else, they assist with the science assessment to prioritize where we should be putting emphasis.

Should Annex 1 be revised? I think only if it contributes something - if it drives management action or if it communicates the state of the environment to the public. As I mentioned earlier, having a wonderful set of objectives that do not drive management action, or if you cannot report to the public if things are getting better or worse.

So what are the options? We can adopt specific objectives from an existing pool of current objectives, and we have them now on either side - we have the federal numbers on either side, we have the provincial numbers for Ontario. There may be some precedent for doing this. My understanding is that the program model that is under binational forums, all the available criteria are put in the mix and the most stringent one is adopted. We can revise existing Annex 1 values to provide guidance on the

use of existing criteria. We can just refer to the criteria of the different Parties and say, this is how you should use them or how you should interpret them. We can revise and develop new objectives using current science and current techniques. This is probably the most satisfying from a scientific perspective but has a tremendous resource implications. Or we could say to the IJC, "They are your indicators, you decide what you want you want to use and use those as a reporting framework to influence the Parties."

Is there a role for ecological indicators? Yes, I think so, if they are measurable. I think the Supplement to Annex 1, although it has lake trout and pontoporeia or diporeia, it doesn't provide somewhat measurable endpoints. If we learned one thing from going through risk assessment paradigms is that, if you do not have appropriate and very specific performance measures, you are going to end up with reporting problems and decision problems and the end of the assessments. Some of the newer ecological indicators still lack hard specific objectives.

Conclusions: They are dated; everybody knows that. We can revise them if we want to. We have got a lot of new tools to do that now. Amendments are feasible but resource intensive. They should reflect the current practices and policies of both Parties. That itself is going to be an interesting topic for discussion. If it doesn't drive management actions or enhance the operation of the Annex there should be some question about how much effort to put into it.

Next steps: The political will to revise it, if we decide to do that, the resources to do that, and the necessity to focus on priority issues rather than have a broad shopping list that may need to be developed. Thank you.

Heathcote: Our next speaker is Paul Horvatin. He is the Chief of the Monitoring, Indicators and Reporting Branch of the Great Lakes National Program Office for U.S. EPA. Paul is the U.S. co-chair for the State of the Lakes Ecosystem Conference (SOLEC). He is a member of the IJC's Council of Great Lakes Research Managers. He manages the Great Lakes Monitoring Program for U.S. EPA regarding the Integrated Air Deposition Network (IADN), the Open Water Limnological Program, the Biological Monitoring Program for zooplankton, phytoplankton and benthic organisms. Paul has Bachelors and Masters degrees in biology and engineering from the University of Illinois.

Paul Horvatin, U.S. Environmental Protection Agency

Click here to access the visuals that accompanied this presentation.

Horvatin: I want to start out by saying that, at this point, EPA has no formal position for Annex 1. The agency itself has not taken a formal position one way or the other on Annex 1 or the Agreement itself in terms of revisions. We did participate and will continue to participate in deliberations to look at the overall Water Quality Agreement in terms of changes that need to be made as appropriate, but that is not at a point of closure yet. Any changes that would be made obviously - we are very strong on this - would take binational consultation with Canada. The Agreement belongs to the two federal governments. The annex is ours, so it would be up to the two governments to negotiate any changes to the Agreement.

Looking at some of the Annex 1 numbers and values that were there - there was a Binational Executive Committee meeting about a year and a half ago, no other discussions since then - the decision was made that at this time there will be no need for changes per se for one reason or another. Some of those begin with the letter "p," small "p" for political. The decision, at least on the U.S. side, was not to proceed too far, too fast, the change in administration, so we will see what happens there. The decision was made, not only Annex 1 but all the annexes, is basically fairly low priority at that time. Again with new administration who knows what will happen.

Some observations - some of this is redundant - basically, what Doug had presented, found that basically Annex 1 has little impact on domestic programs in the U.S. side right now. There are new programs that have been put in place, like the GLI, that basically supersede the Annex 1 objectives which we heard about this morning. On the other hand, the new Annex 1 could be used in its broadest sense in a very relevant, useful way and that being, on the U.S. side, the Clean Water Act requires TMDLs (total maximum daily loads). Basically these are mini mass balances, where you take a given chemical and you determine what the maximum amount of that chemical should be in the given water body. If the Annex 1 objectives were to be revisited, there is potential use for that.

SOLEC is something near and dear to my heart - a few of us in the room here have been working on it since 1992 and developing this list of indicators. We have been looking at using objectives such as those in Annex 1. Harvey Shear, my Canadian co-chair for SOLEC, and I took a crack at trying to rewrite the monitoring annex for the Water Quality Agreement, and one of the things that we did with the rewrite was basically to factor Annex 1 numbers as indicators, and then the monitoring annex of the Agreement would have had very specific requirements to monitor for that. But the whole thing got put on hold and so he keeps his copy of the draft rewrite and I have mine, but someday it might come out of the closet.

Also the concept of looking at the objectives itself, the Binational Toxics Strategy. There are discussions we have had ongoing there in terms of ways to have actually targeted if we were to do Annex 1, it could be used to support that. As well as ongoing monitoring activities, and should be driving the binational monitoring programs going back to GLISP 1, GLISP 2 and maybe we can get GLISP 3 or 4, but whatever it will be for the future. Tony [Wagner] and others have worked on that for too many years. It also could include things like LaMPs. If we did have a good strong overlay between the Specific Objectives and those general objectives - which are complementary in many respects right now with the Lakewide Management Plans - but the numbers are basically out of date and there is no potential use for that for the future. So there is a use for the annex if it was to be done right.

To keep it current, the perspective from EPA at least, is that updating it right now, is an immense effort. That is probably why it has not taken place and has not been occurring as per the requirements of the Agreement. As fast as new science comes up - probably if we were to print changes to the annex, by the time the ink dried and the electrons made it to your computer monitor, it would probably already be outdated because some new research report would say we should be doing something different.

A suggestion that we could do to keep Annex 1 current would be look at the perspective of sort of an action- or process-oriented approach. One projection that I would like to make is that we do not have to have another one of these workshops ten years or so from now. If there ever was a change made to the annex, we do not have to come back by a group of people like this to try and figure out what went wrong, 10 or 15 years from now. So if the annex was to be modified and put in place, hopefully we can get it right this time and not have to re-evaluate why it did not work. Some of us will probably be retired before that ever happens anyway, so we will have to leave that for the next generation.

On the other hand the discussions basically would require binational discussion, particularly with the toxic side of things. There is a lot of work that needs to be done from that perspective, that needs to be moving ahead. The point I am after is that, instead of redoing Annex 1 in its current format, instead of having it reflecting Specific Objectives, but basically put something with what I am going to refer to as "action levels" - numbers or some reference to a number that would take place where, if there was an exceedence of that, it would force something to happen. From an action level perspective, one concept that we talked about back in my office and with some of the other state and regional folks, would be that we could basically create a website. On there we could possibly take the most stringent standard or objective or criteria that is out there - whether it be federal, state, or provincial - but find it, use it. My comment to El-Shaarawi was, "Hopefully we will get past the statistical mumbo jumbo and figure out what a number should be." Not demeaning the science but, instead of looking at all these graphs and charts, try to come up with something that managers and the public can understand.

If you tell somebody that the number for a given chemical should be no greater than 0.017 or whatever unit you want to put on it, that is sort of a definitive objective that people can understand, that people can then measure. When you go out and collect the appropriate statistically designed monitoring program that goes along with the statistically designed number - I put that in for El-Shaarawi's sake - in the end we can be able to come up with a score card. This is where we on the SOLEC side of the house were talking about, we could use this concept to basically do the report carding - whether we are yes we are meeting it, or no we are not - but come up with a system where we do not force a right or wrong answer. We do not have the state of Ohio saying that their number for a given parameter is better than the number that the province of Ontario came up with, because then we wind up, for decades we will talk about the science behind it, the statistical deliberations, and we do not get out of this do loop that we seem to get into at times.

One suggestion that was made by someone in our office is, "Let's go ahead and pick the most protective number, realizing it is a target. It does not really mean anything per se but, if there is an exceedence of that target or trip-level number, then that would force a discussion between the Parties." The two governments have to sit down and look at the scientific basis of the information - the monitoring data if you will - whether it was in fish, whether it was in water, whether it wound up in sediments, but what caused that exceedence - and have a discussion to say, "Is this real and, if it is real, do we need additional monitoring to confirm it?" Or if in fact you confirm that it is an exceedence, then we need to look at the programs on both sides of the border to figure out what we need to reduce the loadings for that substance. The whole idea is to try and get away from the, my approach is better than yours, or with or without mixing zones, or all the other discussions we can get into, try to simplify it. This is not fixed in any perspective, but just an idea try to simplify the process.

So, if they could come up with these trigger levels, if you exceed it, it causes something to happen. Some of the actions that it could fall back - like I said, more monitoring, but also can get back into discussions with CEC [Commission for Environmental Cooperation] and others. I am attending a meeting next week to talk about IADN in Toronto to, literally, they are looking at putting together the North American Contaminants and Chemicals Action something or other. The whole concept is to put together a U.S. / Canada / Mexican monitoring program for air deposition. They are looking at using IADN as a possible template for that monitoring approach. So we can widen - we have the five master stations and multiple satellite stations in both the U.S. and Canada measuring a lot of things - we are talking about looking at expanding the list to include all the POP chemicals which we pretty much have already but we could include that in - and look to see what is also in the Binational Strategy for chemicals - as a starting point to see which of those show up in atmospheric deposition - we will monitor for in the North American continent and, if we find exceedences, have some ideas of what we can do then to pursue that, whether it is at the international level, national level, or regional level. Conceptually we are looking at options and ways that we can address some of these issues.

One of the things that is important to understand is that we have existing programs in place right now. All of the eight Great Lakes states have water quality standard programs in place. They have all

basically gone through and built the GLI into their water-quality-setting procedures. They are enforceable, they monitor for it, and compliance is basically in place. I am not saying compliance that we are meeting everything, but there are regulatory programs that are court enforceable to meet those numbers. The GLI itself would be the foundation, at least for EPA and the U.S. perspective for any position that would be taken on Annex 1. It would be a starting point for us because that is a regulatory mandated program that is in place. The U.S. would have to start with that to take a look at whatever we were to do in the future because it is required by law, there are years of rule making, it started in 1992, we have been at it now for almost 10 years and has lived through multiple court challenges. I understand there may be another court challenge coming up this week, next week or maybe it already was filed. It has been an incredible investment at this point already. Strong science would be the point where we would start from.

A suggestion - what I am proposing here is not an absolute U.S. position but an idea and concept that we would like to put out for discussion that, when we look at an action level approach, some way of finding a trigger mechanism, we could update Annex 1 if it were to do something, unless there is - every two years, three years, fours years - if we use the Internet right now and create a web site, for example, it would probably be updated much more frequently, so if people want to see what is the most current or the most restrictive, the most protective number, it wouldn't be too difficult to do that. We could probably do that fairly easily. Then the biggest thing is the last point I have up here is that the Parties do have SOLEC, we meet every two years, we find that it is good to hold ourselves accountable to the public. I know people have criticized us - why don't the Parties hold themselves accountable for the entire Water Quality Agreement to the public? That is fair criticism. We are getting there. We are starting. We started from an indicators-based perspective. There are a lot of other parts of the Agreement and annexes that we haven't quite gotten to yet in terms of true reporting, but it is a way for us to be able to say, this is what we are going to report on. As Doug had mentioned, we do have the nutrients and a few of the indicators now for turtle eggs and things of that sort, where the plan is truly to take these numbers, do the monitoring and do the reporting, and hold to it.

One concern that I will put out here is that we have been working real hard from a SOLEC perspective to be able to get agencies - federal, state and provincial - to take responsibility for a lot of the monitoring activities and report that data back out to us. We just found out that the fish monitoring program for the open waters in Canada, I understand, is slated to stop April 1, which was not the way we were hoping to go - we are going backwards - so instead of having continued monitoring activities to be able to report back out, we seem to have the risk of losing those activities. We have to all provide some diligence to maintain what we have and so keep the good science, keep the good data coming, so we can evaluate the state of the lakes. Thank you.

Heathcote: Our next speaker is George Kuper. I have a long and impressive biography for George. I'll summarize the key points. During the past three decades, George has been a recognized leader in the national effort to establish a productivity growth policy. He has been nominated by President Gerald Ford and confirmed by the U.S. Senate to serve as executive director of the then newly created

National Center for Productivity and Quality of Working Life. He has been advisor to the Center for Strategic and International Studies and the Committee for Economic Development. He has an undergraduate degree in Political Science and graduate degrees from the London School of Economics in international law and the Harvard Business School in business administration. He comes to us today in his role as the President and CEO of the Council of Great Lakes Industries.

George Kuper, Council of Great Lakes Industries

Kuper: Thank you. In that role I am going to do something uncharacteristic which is read my remarks because it is such a hard-fought consensus that if I stray too far from the script I'll be drawn and quartered.

Thank you for inviting us and including us in this discussion. It is a privilege for us to be here and to share our perspective on the issues of revising Annex 1. I found that, in this morning's discussion, there was an amazing congruity between what was said and a lot of our thinking - a little less so this afternoon, which might make for a good debate. I have copies of the presentation which will appear on our web site, which is http://www.cgli.org .

Let me start with a little history. Industry, as we represent it, has looked at the appropriateness of opening the Great Lakes Water Quality Agreement and its annexes in the past. We reviewed the issues carefully in 1997 and again in 1999. Following both of those reviews, we concluded that the principles of the Agreement should be reaffirmed but that it was unnecessary to open the Agreement and its annexes at that time. However, once again, we have gone back and looked carefully at the set of issues as represented by the Agreement and we think it is now appropriate to open up at least Annex 1, particularly if it is in accordance with some of the things that I am going to say in just a moment.

There is little argument as we have heard today that Annex 1 is out of date. A number of the standards and the attainment target dates in the annex were reached and surpassed long ago, for example, current mercury levels in Lake Michigan, as we have heard, are three orders of magnitude better than the Water Quality Agreement Annex 1 Specific Objectives for mercury. Unfortunately we still have fish consumption advisories. Many recently promulgated regulations and standards are more stringent that those specified in the annex. The science is better and the outcomes necessary to meet the Agreement's goals are better understood. I think that has been said.

Our reasons for changing our position on revising Annex 1 lie in our belief that all stakeholders have learned a lot about the issues in the past few years. As you all know, CGLI has been a very active partner in the Great Lakes Binational Toxics Strategy. Through our work in that Binational Toxics Strategy, we have a much clearer picture of the state of PBT [persistent bioaccumulative toxics] releases to the lakes, the progress that has been made toward virtually eliminating the BNTS substances and what needs to be accomplished to meet the targets and timetables of the Strategy. You will note however, that we have not come to congruity with the proper abbreviation of the Binational Toxics Strategy. We call it BNTS as opposed to BTS which I have seen it referred to. We have worked closely on the State of the Lakes Ecosystem Conference and its efforts to develop indicators for the Great Lakes basin. We have learned what it takes to make an ecosystem assessment and track the progress towards restoring and maintaining the chemical, physical, and biological integrity of the waters of the Great Lakes basin.

We have learned the relative importance of environmental stressors and that the presence of the stressors themselves also changes over time. Our insight on basin issues is further improved by industry continuing to work on international environmental policy negotiations regarding persistent toxics that bioaccumulate. There, we have learned some very important lessons that we believe must be kept in mind when addressing the revisions that we contemplate for Annex I. These are threefold:

- The focus must be on the doable because absolutes are impossible to achieve;

- Some substances cannot be absolutely eliminated, such as dioxins and furans; and

- There is no such thing as zero.

With all that we have learned and continue to learn about responding to water quality protection needs in the region, we support the following improvements to Annex I.

First, **specific numbers need to be removed from the annex.** Specific numbers in a policy document like those currently tightly cemented by the statement of Specific Objectives in Annex 1 are not useful because they quickly become dated as was said by our first speaker this morning. As scientific knowledge expands and technological improvements are made, specific numbers change, their context changes, and they become less meaningful. Therefore, we propose that these numbers be replaced with a directive to utilize the SOLEC indicators as the monitoring protocol and outcome-based measures which define the specific objectives of the Agreement.

We believe that use of the SOLEC indicators suite is consistent with Article V of the Agreement that establishes parameters for monitoring progress towards the efforts to restore and maintain chemical, physical, and biological integrity of the Great Lakes basin ecosystem. SOLEC intended that these

indicators, which have been scientifically vetted over the last four years and will continue to be so, will be continually updated biennially. The suite of SOLEC indicators will provide an ecosystem-based road map for the Parties to continue to monitor, track, and improve ecosystem restoration progress. Another advantage of using this important SOLEC monitoring and reporting framework is the ability to use the indicators to identify stressors and rank them in terms of their relative impacts on the ecosystem. The scorecard for keeping track of all of this should not be solidified within the Agreement nor annex language, but delegated to the more flexible and dynamic processes provided by SOLEC. Incidentally Annex 1 reliance on the SOLEC indicator suite will help commit the Parties to delivering the data to support those indicators. That is the big issue for us right now.

The second point - **We propose the use of a definition of virtual elimination in the Supplement to Annex I** . This definition is developed from the Virtual Elimination Task Force Report, and I quote, "Virtual elimination and/or virtually eliminate means an overall strategy, applying to all media and all sources, that requires different approaches - some preventative, some remedial - to control or eliminate different inputs and in situ contamination. Specifically, virtual elimination is defined as achieving an absence of injury and achieving the goals of restoring and maintaining ecosystem health." We support an evaluation process that provides that absence of harm be determined using an ecosystem approach. The SOLEC indicators and SOLEC review process provides an opportunity to biennially complete this evaluation.

Finally, **we support a revision to paragraph (b) of the Supplement Section 1 regarding detection levels that would deal with this important matter and the definition of zero discharge.** This revision would read, "Substances not detected and determined to be 'absent' as specified in this paragraph will be treated as 'zero' for purposes of data analysis and assessment of progress towards virtual elimination." Use of a zero discharge philosophy when applied to these PBTs recognizes that the achievement of absolute zero cannot be attained. "Zero" is therefore equated with "absent" as earlier defined. Revisions to the Supplement would permit the ability to address difficult issues relating to virtual elimination and zero discharge that we have worked so hard to understand. The lack of concise definition, we believe, has impeded our collective ability to move forward as quickly as we need to on these issues.

Finally, I must say that, in industry, we believe that this is indeed the right time to acknowledge what we have learned, review, and revise Annex 1. We look forward to working with all stakeholders and all of you here to make these important changes happen. Thank you.

Heathcote: Our final speaker is Neil Kagan. Neil is a National Wildlife Federation lawyer working on water quality and wolf issues nationally and in the Great Lakes states. Neil has a Bachelor of Science and biology from Penn State and a J.D. from the University of Oregon School of Law with a

certificate in environmental and natural resources law. Before joining the National Wildlife Federation he practiced environmental and land use law in Oregon as both a solo practitioner and as a staff attorney and lobbyist for 1000 Friends of Oregon, a land use watchdog group. He has served as a sole or lead attorney in several public interest environmental cases seeking protection of forests, wetlands, rivers and other natural resources in Oregon and seeking stronger pollution control rules.

Neil Kagan, National Wildlife Federation

Kagan: Thank you. I am here representing the environmental community, not just the National Wildlife Federation, but also Great Lakes United and others. We obviously need time to digest the report and our scientists need to have time to ask questions of the [Limno-Tech] scientists who prepared these reports that you heard about this morning. I am here mostly to listen, rather than speak, and will carry back the discussions that occur here today to the National Wildlife Foundation, Great Lakes United and many other environmental organizations throughout the Great Lakes region that are interested in these issues. I am, however, prepared to outline a few general principles.

First of all, virtual elimination should be paramount in any discussion of Annex 1. Annex 1 probably should be reopened, but not as a 10-year exercise in modelling. We do not want an exhaustive review of each number. Other systems of standards, like the GLI, should be considered, but it is too soon to decide on one alone. The IJC needs to consider zero being the standard. Even if the governments are not prepared or comfortable with setting the objectives at zero, there certainly appears to be a lot of room for progress in lowering the objectives. For instance, the mercury number in the Agreement is not at all close to the standards in the GLI.

Annex 1 needs to be revised to consider new chemicals, such as dioxins, alkyl phenols, phthalates and other endocrine disrupting chemicals. Ecological indicators are good in many contexts, but we are not sure how well they would work here. We do need much better tracking of discharges and emissions from sources. As to the four questions that were posed for us to answer, here are my answers.

First, is Annex 1 still relevant? Some of it, some of it is not. The Supplement to Annex 1 contains biodiversity goals for Lake Superior that form the basis for the Binational Forum. That certainly should remain. The numbers themselves are not relevant in the U.S., of course, because they are mostly outdated, but may be relevant in Canada. I cannot be certain of that because I am not up to speed on Canadian objectives.

Second, should Annex 1 be revised? Yes, as long as it can be done quickly and cheaply. We do not yet know how that can be accomplished. But resources should be not be invested in improving the annex, so much as trying to achieve the overall goal of virtual elimination.

Third, is there a role for ecological indicators? We do not know yet. The State of the Lakes Ecosystem Conference indicators are not yet ready to be dropped into the Agreement. They are still too complex and vary too much by geographic area. We should have indicators for sources - how much are they releasing? - but we also need data on ambient levels. As we often hear, even if we zero out our releases in certain regions and do not make progress elsewhere, then loadings to the Great Lakes will continue. The only way we will know for sure that the actual target organisms - people, fish and wildlife - are being protected is to have data on ambient levels. For instance, major uses of PCBs have been phased out for 23 years, but fish tissue levels are still far above safe levels for human consumption.

Finally, how should achievement of the Specific Objectives be judged? Again, the benchmark must be virtual elimination - not the Specific Objectives. Especially for persistent bioaccumulative toxics, the Specific Objectives do not replace virtual elimination. That is all I have to say.

Questions and Discussion

Heathcote: That concludes the formal presentation and the goal now is to have some plenary discussion around these presentations. I open the floor up to questions.

DePinto: This is for Doug Spry but also Paul Horvatin. The diagram that you put right up front which had the intersecting circles - one was assessment and the other was prevention or remediation. It strikes me that the monitoring that you would do, depending on which circle you are in, could very well be very different. Yet the decision as to which circle you divert into does not happen until after you have developed the monitoring program. I am concerned that our monitoring programs with the concept of indicators - I like using indicators, but I don't think that we should limit our monitoring to just the indicators of ecosystem health that we select, because by the time you decide that the environmental quality is maybe not acceptable and have to move into a prevention/remediation, you have maybe missed monitoring things that will allow you to decide what to do. In particular, loads of particular chemicals or compounds to the system. I guess this is maybe more of a plug than a

question. I really do not think that we should eliminate the monitoring of loadings of these things to the Great Lakes in favor of just looking at ambient concentrations. I guess I would like to you to comment on that, if you would.

Spry: I put the diagram up there just to give me something to hang a discussion on. I do not mean to imply that that is the only way of doing things or even that that is the model that is used for managing the Great Lakes. Certainly your comments about monitoring I don't have any issue with. It is just a very general model. I think the question you are asking is, "Do we have good monitoring tools that are leading indicators rather than something that just is assessing the state of - you know, a snapshot of how things are now?" As far as monitoring loadings I would agree that that is certainly an obligation of the permitting agencies. How appropriate it is for Annex 1, I am not sure.

Horvatin: I will add a little bit in two areas. Back in about 1992 to about 1997 our office had an open water monitoring program for toxics. We went to all five lakes and used some very low-level techniques. We looked at DDT, PCBs, a bunch of pesticides and it got to the point where, after about four years of doing this, the analytical chemist came forward and says, "Well, we are at the point where detection limits are about part per trillion thereabouts and, if we are going to continue this program we are going to have to go to supercritical methods for extraction." At that point, being the manager, I go "time out." If we cannot detect this stuff, if we are pushing looking at chemicals, counting molecules in water - what is dissolved as well as particulate - why are we trying to measure it? We have to get our detection limits down to parts per quadrillion to be able to adequately measure this stuff. I said, "No we are not." So we cut the program out. It was a four-five year pilot program. We realized that the numbers in the open waters of all five of the lakes were so low that the best state-of-the-art technology could not get us there. So we basically ended the program.

What we did was, we decided that the fish program was probably, as one person says, fish are in some respects floating hexane bags. Basically they are bioaccumulating. So let's put our resources - and they were limited at the time - this was during the days when EPA's budgets were not growing much - we decided to put our energy into basically improving the fish monitoring program, both whole fish, our lake trout program, as well as putting money and advancing into coho and walleye, for the skin-on fillet program. We added more chemicals and more fish. We felt that was a best bet because we are going to let the fish that are in the ecosystem bioaccumulate and tell us.

We just had a workshop in my office two weeks ago with a grantee who was working with us. We are looking at expanding the list of chemicals for both human health - walleye and coho - as well as our ecosystem fish program which is our lake trout. We are going to expand to include all the binational toxic chemicals, as well as all the POPs chemicals, the chemicals that CEC is proposing, and looking to expanding for at least a three or four or maybe five year program to see what is present. We are

looking at including all the brominated flame retardant chemicals that are showing up. We are looking at expanding it to include metals that we haven't looked at before but it is probably time we should start. We are going to be expanding this to the fish monitoring program to look at some of the endocrine disrupting chemicals. We figured with very, very limited resources, where is the best place to put monitoring? But chasing molecules in the water column we just did not think was practical. Changes to any Annex 1 for the future would have to look at the reality of what resources are available to be able to measure those things. So, we are approaching it from a very practical standpoint.

The other point I want to bring up, as a long answer to your question Joe, is on phosphorus issues. We made a decision at EPA that up and through about the 1990-91 time frame, we were doing extensive phosphorus load calculations and monitoring - both atmospheric and tributaries - we realized at that point the numbers were moving within the range of the model predictions. So what we did was, we maintained the open lake monitoring program, particularly in Erie, to look to see what were the in-lake concentrations. That program was about $30,000 versus about a half-million to three-quarters of a million dollar program, to do all the load calculations and everything else. It was more cost-effective to just do surveys through Lake Erie, for example, measuring for phosphorus and DO [dissolved oxygen] for a much bigger bang for the buck.

The results that we are looking at right now is that Lake Erie is changing dramatically. It looks like Lake Erie may not - at least from the data I saw yesterday - may not be phosphorus limited anymore. It looks like Lake Erie may very well be zebra-mussel limited, because we are finding out that the silica numbers are going contrary to what we expected to happen. Phosphorus numbers are going up. The productivity is going down. Silica is going up. Which tells us that the zebra mussels are having a major impact. We are sitting down talking, "What do we need to re-evaluate our monitoring program for nutrients - stuff that we thought we did not have to do ten years ago, we may have to be back and do some of this work all over again because of the changes in the ecosystem. Again, it is not just-in-time monitoring - just in time may be five or ten year time frames - but, again, with limited resources, what is the biggest thing we can get for the resources that are available to get the data we need to manage the lakes?

DePinto: I do not disagree with the need to monitoring fish for example for bioaccumulative chemicals. What I am concerned a little bit about is, after we have done this for a few years and there are a number of these chemicals that you are seeing, your not being able to measure or statistically detect a decrease over some period of time - a trend that is statistically significant - whatever that means. Now you have to think about - What can you do about it? What should you do about it? Unless you understand why it is not dropping, in other words, how the ecosystem is functioning, then it is not clear to me that you can actually make a decision as to what to do about it.

That is what I am a little concerned about. You said you wanted the annex - if we were going to revise it - to be more action-oriented. If that is the case, then I think we need to combine understanding of the system and monitoring the system in order to develop that understanding. That includes research monitoring as well as compliance monitoring. That is what I am trying to say. I understand that you cannot do it all. There is only a fixed amount of money but, just suggesting to keep the different kinds of monitoring in mind and trying to understand why phosphorus is not going down in Lake Erie, that sort of thing.

Kuper: Joe, I have an intrinsic desire to follow through with your query here because I think it is a good one. However, I think the priorities that you and Wendy pointed out in your presentation are so much greater for the annex to deal with that I would say that this will probably fall off the table. From the lack of coordination, the amount of work you had to do to pull together the data relative to our current status is to me a gross embarrassment. It should not be that way after 28 years. We ought to be in focus in this annex on fixing that problem, which is why we are so heavily committed to taking a suite of indicators out there that are ecosystem-based and ensure that what we have discovered with that approach by the way, is that new things come along as the top priority, as Paul just described. You have to be prepared to deal with all of them. I do not know if you can be as sophisticated in your preparations as you would like us to be for now. I think you have a lot more basic problems to deal with first.

El Shaarawi: I would like to separate between two things, the research and application of the research. I don't really think the annexes or any Agreement type of thing should be continuously fast revised as a result of some confusing statement that could be found from the monitoring program. Issues like Paul was saying about zebra mussels or others, raises a problem of how you tackle the research issue and apply to endpoint some of the answers, some of the questions. If you are interested in looking at monitoring, I think you should be looking at something that is doable and is possible to communicate to others.

However, the problem of doable, as George was saying, is really a very loaded type of statement. Is it doable as a result of the resources or doable as a result of the magnitude of the problem that is there? The thing that I am really not quite sure about is the amount of data that is available that Joe and Wendy tried to integrate is really disbursed among many different agencies. Does this mean that there are no resources available, or is it better to integrate some of the resources and complement each other? I think this is a major issue in my judgement. There is lots of duplication of effort that might be reduced and going after the things that are worse relatively and ... give you a reasonable answer.

Neilson: It was interesting listening to Paul because you said, with open lake monitoring, you are not able to detect many of the contaminants in the water anymore. If you apply then the theory that

George proposed which is, if it is less than the detection limit you set it to zero, Neil, would that then meet your definition of virtual elimination in the open lakes? Would you accept from Paul's data and George's approach that we have virtually eliminated toxics in the open lake?

Kagan: I am not so sure the objective is reaching virtual elimination in terms of ambient water quality standards so much as it is in the environment. If there are fish swimming around that have levels of mercury, for instance, in their tissue that are sufficiently high to warrant fish consumption advisories, then no. Virtual elimination has not been achieved.

Horvatin: I would agree with that because, as I said, we could not detect it in the water but we are finding it in the fish. Part of the Lake Michigan Mass Balance study which also ran out of my office, we all spent more hours than we can probably add up, collecting phytoplankton, and then we took the phytoplankton and actually measured them for PCBs and mercury and trans-nonachlor and other stuff and we were finding these chemicals basically being bioaccumulated at the prior productivity level. The bottom line is that - I want to clarify - we are not finding in the water column because the numbers are so low, but it is being bioaccumulated. As long we are still finding the effect, i.e. in fish, or plankton, or zooplankton, or whatever we are going to look at - eagles, up and down the foodchain, my perspective is that we have not eliminated that chemical substance yet, because we are still finding it in the environment. It depends on how you want to define the Great Lakes. If you define it as the water, that is one thing, but if you define it as the Great Lakes ecosystem, then ecosystem has to include all components.

Phenicie(?): Excuse me. I cannot let Paul get away with this. The problem with the use of this word is, is being bioaccumulated. We all know that fish flesh is the test. I was taught that the first day of my job. And we agree. The problem is whether or not that level of loading is decreasing in fish flesh or is increasing in fish flesh. That is the kind of question we should be asking and we should be asking it with the full understanding of the kind of decay phenomena that we are looking at. As Joe has told us, you cannot look at this linearly, you probably look at it logarithmically depending on the order of process that we are ... right?

Murray: I am Mike Murray with the National Wildlife Federation. Just to follow up on the virtual elimination issue and non-detects. My problem with your position on that George is - when do you do that? You could have proposed that position say, 25 years ago with the then current state of analysis for PCBs, dioxins, mercury, what have you, in the Great Lakes. Back then, I am not sure there was much mercury analysis going on, but I am sure that the detection limits were no lower than 200 ppt and actually probably much higher than that for mercury in water. Assuming it was 200, we know it was 200 up until the past ten years or so, for more routine analysis. If we have something that is non-detect at 200 it could be 180, or 150, or 100. It could be 2 or 1 ppt. Right there, that is a two order of

magnitude difference in what the true level is, and we do not know that if we are just calling it non-detect. To me there is a problem with assuming that a non-detect is zero based on that, partly because of that phenomenon.

The other issue, just what we have seen in a lot of work in wildlife toxicology and in concerns within human health about the injury that some of these chemicals can cause at lower doses that were previously assumed to be safe. The issue of looking at these more subtle effects, endocrine disrupting effects, other things rather than more traditional toxicological effects, clinically observed effects or more acute, even chronic effects but that were more obvious clinically rather than more subtle physiological changes than we really see with more sophisticated analysis testing. I still think putting up for that position now assumes that we are kind of at a level with why these chemicals where our detection limits are in the range of basically no effects or very minimal effects on different organisms, and I just do not know if we are there yet. I think for a number of chemicals it is clear from a lot of toxicology research that there are still threats both to wildlife, aquatic life and human health from current levels.

The other issue that was touched on earlier is the issue of chemical mixtures and all the uncertainties, all the things that we do not know there. So, to me, that would auger for a more protective or precautionary approach, which would definitely not then assume that non-detects are zero.

Heathcote: It seems to me that these are important issues but we may be confusing two separate points here. I am re-reading the objective or the stated goal of Annex 1 which says, "These Objectives are based on available information on cause/effect relationships between pollutants and receptors to protect the recognized most sensitive use in all waters." It seems to me that we are talking about two things. We are talking about what Paul is calling "action levels" - we as a society need to have action levels that alert us to a condition in the environment where levels are not what we want them to be. Perhaps in that sense, the SOLEC indicators are helpful to us - when something gets beyond this point and conditions are not as they should be. The other piece that is missing is the piece you are speaking about, and that is the diagnostic function - having identified the problem, where do we go next? How do we use the information before us to trace the source of the problem and fix it? It is important to keep those two roles clear. I don't think they are currently clear in Annex 1. Maybe Annex 1 was never intended to do both those things. So I throw that on the table.

Kuper: Mike, I put your helpful comments in two different categories. One is the industry position that we just described here today. That is not a new position. We have been very quiet about it for the last half dozen years, maybe because we did not think the community was up for a constructive debate about it. We think those circumstances have changed. Not that we are going to win or lose, but that we will have a healthy debate around it and come to some better understanding. But, when you have

the IJC Commissioner getting up and saying, "Zero means zero!" You do not get very far. So this is not a new position.

The other aspect of your very important perspective on this is that, it is essentially a risk analysis situation where you assume the current detect levels are static - which is not the case. As we learn more and more about the impacts of certain substances, we may in fact work very hard on lowering those detection levels, at which point they come back into play. If you cannot detect it, you cannot figure out whether or not what you are doing to fix the problem is actually accomplishing anything, therefore you are wasting resources. That is where we are coming from. We are not advocating any kind of static nature here. It is still a dynamic nature. We are trying to poll and suggest that the annex and the Agreement be put into a policy framework as opposed to an operational framework, which any numbering system poses.

DePinto: I do not think that there are probably any chemicals out there, or say 600 or more chemicals of concern out of the 87,000 or something like that, that are in commerce now in the U.S., that should be relatively routinely monitored by the governments. I know that takes a lot more effort, a lot of academic labs can do that kind of thing but, frankly, from the work that I have done with PCBs in the Great Lakes and just older basic techniques of filtration, absorption, in use, pass a whole bunch of water through this - and the water, I would be surprised if you really have problems detecting a lot of these chemicals, if you look hard enough. There are a whole lot of newer techniques out now to do that. The issue that was raised this morning about detecting one molecule of insulin in a cell - when you get down to individual molecules per litre, that must be on the order of 12-15 orders of magnitude - in many cases lower than concentrations for a lot of these chemicals now in the Great Lakes waters. I would assume that, with the proper techniques, any of the Level 1 substances could be detected in the Great Lakes.

Unwin: Paul Horvatin, you mentioned the concept of maybe a web site or some mechanism for continuously updating the objectives and Dr. El Shaarawi addressed this. I would like to explore it a little bit more. As I think how that might work, I am a little fearful of it being too easy to change the numbers, because you need to have time for the science to work its way through. As you well know, it is not unprecedented for an article to make a big splash about something very alarming, only to find out that nobody can reproduce the results. But that takes months, maybe even years to happen, and don't you think there would have to be a mechanism of some sort to ensure that the scientific method could operate. How would that work?

Horvatin: Conceptually this was an idea that we came up with as one way to communicate what trigger or action level - whatever you want to call it, it is just a concept at this point - but something where we could - I mean the whole concept as we go through and look at state, provincial, federal

numbers that are out there, the scientific literature even, where we know that, if you have mercury over a certain amount in fish, that triggers a fish advisory. You know if you have an amount of any other chemical in fish or water, it triggers some action level. It is those numbers that I am proposing that we think about to find a mechanism to make it available so people can - the public is aware of it - I have been working for the federal government for 24 years and especially working in the SOLEC arena, I find that there is great advantage to having accountability in place. What it is that we have done at SOLECs - we have done four of them since 1994 - is at the end of every conference we tell the audience, the people there what is we are planning on doing two years from now and, two years when we do the next conference, what we are going to report on, we report on, which I think is a very good thing to do as a public official. I think if we were to take our numbers, whatever they are - I agree with you, I am not saying that we are going to just randomly go pick numbers and put them out there, but devise some sort of a process that the two governments could agree to, with public input and have the whole thing vented through the public. Then basically it becomes accountability. If we say that the right number for PCBs in fish, or dibrominated something or others in whatever it is you want to go after, you have a number that is a target that you aim for and the public and the scientific community, regulated community, knows what it is. I do not see anything wrong with that. ... (tape change) ... if this thing becomes a helium balloon, great - becomes a lead balloon - well, okay. But again, I am approaching it from the point of accountability. So if Annex 1 was to be revised it does not go by the way of the current annex, which means it becomes basically non-effective. So we find a way to make it effective so, like I said before, we do not come back 10 or 15 years from now with whiter parts on the top of our heads for some of us, and try to figure out what went wrong the second time around for Annex 1. The whole idea is to make it something that is useable, plausible and the public can look at and says, "Okay, EPA, Environment Canada, whoever, the states and provinces, you said the numbers to protect human health for fish would be this for this chemical and your data shows that it is either above or below." That way we have accountability put in place and give a report card. That is all I am proposing - is that idea as a concept. Whether it flies or not - this is not coming from the administrator of EPA or the White House. This is coming out of GLNPO. It is an idea that can be batted around in this work group. If it does not leave this work group because it was a bad idea, well then so be it.

Pupp: This is a question for Paul Horvatin. The SOLEC process is sort of intriguing because every three years you have to report as you said, but you mentioned problems with monitoring. What would influence monitoring? Originally the Specific Objectives were thought to drive the monitoring processes. Do you think SOLEC would influence what is being monitored? And if not, if you monitor something else because it's important, it is really hard to keep indicators.

Horvatin: Being somewhat of an optimist I would hope that the indicators - we have a whole bunch of reasons, we have been debating these at SOLEC the last couple of years - we have been saying that, for something to become an indicator that we plan to report on at SOLEC, the indicator or whatever the science behind it is fairly well established, that there are monitoring data to support it and, hopefully, good indicators, good monitoring data, using a little bit of slang would hopefully become somewhat of an addiction for people, because if we can start reporting quality data for indicators that represent - I am not saying the entire Great Lakes ecosystem - but a good piece of the Great Lakes ecosystem, people will learn to expect and have it there.

Then as monitoring programs change to where Canadians may not be able to do the contaminant fish monitoring program anymore, the public and whoever the public could be defined, whether the elected officials, or regulatory people, or citizens of the Great Lakes basin, say, "Whoa, wait a minute." We are looking at this 15, 20, 30 year trend for monitoring and we are showing that this is valuable to show that fish advisories and whatever the effects of what they are, has an effect. Maybe we could use that but right now my fear is that, both sides of the border, we are sort of suffering through our own successes unfortunately. The levels of contaminants, we do not have the big problems and issues that we had 10, 15 years ago that grabbed headlines for days and weeks on end. There is an occasional report that says, "We found a new chemical" but, if it makes it for the front page of the Toronto paper, the Chicago, Cleveland paper, it is there for a day or two and then it sort of disappears and nothing is ever said and done about it. So the public does not get excited about it and make demands for more information.

Something that I have been working on the last couple of weeks is - the Cleveland Plain Dealer, the Chicago Tribune ran articles last week about advancing the concept of drilling now in the Great Lakes beyond possibly Lake Erie for gas. One question came in, "Does that include oil?" Some of us cringed and said, "I hope not." EPA - in fact I was the project officer back in 1980, along with the Corps of Engineers - we did a programmatic EIS [environmental impact statement] for the U.S. on gas drilling in Lake Erie. We developed a programmatic EIS as if it was to take place on the U.S. side, recognizing that Canada has been doing it for about 30 years now. We decided that if we were going to do any gas drilling in Lake Erie we would have to follow this level of protocol. Well, the whole thing went away. The oil embargoes that were in place in the 70s went away. Now the whole energy issue has changed again, and there is a renewed interest again. I was hoping I would be able to skip through the rest of my career not worrying about oil or gas drilling - and it's back again. So we went from 1980 to 2001 and deja vu, 20 years later we are back in the same game again of worrying about drilling and pipelines in the Great Lakes. Again, I have no idea what the engagement is by the public in that, in terms of what are their interests and concerns, and does the public even care? I don't know. But this is where I think environmental groups and other organizations could help by educating the public to keep them informed of what the issues are, and their consequences.

Heathcote: Paul raises an important issue about the need for public accountability and public transparency in reporting and so on. I am concerned in the haste to provide the public with simple answers, but policy makers are also looking for simple answers around these kinds of numbers. Are we missing the point that Abdel was making earlier, that maybe there are not simple answers, simple ways of communicating this stuff to either the policy makers or to the public? So I throw that on the table.

El-Shaarawi: I am really not quite sure about the mechanism for actually executing a revision. If there could be modification or changes to the annex, in what way do you anticipate that this could be done? One thing that comes to mind is th that you have a number of classifications of these pollutants, and it might be a fruitful thing, if there is a place for this, to have a group of people looking at these and write some kind of policy or statement paper which says, what is the current state of this in very a simplified way, drawing in multidisciplinary people. You can have something concrete to use as a springboard for weighing into that action. This is a concern that I have - what you want to do from here, what would be the conclusion? Because we can talk, you know but the issue ...

Heathcote: Perhaps there is a member of the Commission staff present who could comment on the process that was used in the 1987 revisions and the Protocol developments. It was just a deal struck between Canada and the United States?

Bratzel: Right, the IJC had nothing to do with revisions.

Boyer: It was mostly the non-governmental organizations and governments.

Heathcote: Peter is saying he thinks it was mostly the non-governmental organizations and the governments, sat down in a binational roundtable forum? What kind of structure was used? I remember the discussions. I can't remember what happened though. Tony?

Wagner: There were quite a few deliberations, and NGOs had observer sheets. I don't know how much they participated in the actual discussion itself. The IJC I believe had just very little observer status, and I don't know how much involvement they had at the very, very end either. This was almost totally driven by people like Ron Shimizu, Al LeFeuvre, and those guys, but they also had a fair amount of consultation with NGOs. From what I gathered, there was considerable satisfaction with the process that took place back in '87.

Heathcote: Perhaps, Jay, you want to remark on this as well, but it seems to me that one of the things that will come out of this workshop is advice to the Commission, and the Commission will then deliberate on the advice and decide whether or not to pass it on to the Parties. We hope it will form, in whatever shape it takes today and in our later advice, part of the Commission's advice to the Parties in the next biennial report. What we are hearing from the various members of the Commission staff who

are here, and from Tony Wagner who is a long-time Commission participant, is that the drive in the last round came from the Parties themselves. So it would be a response to that advice from the Commission. Jay?

Unwin: Just a little different pass on what you are talking about, and it is very biased. Something I saw on one of the slides - it's the IJC's objectives, let them take care of it. In fact they are not. The Agreement is the Parties' Agreement, not the IJC's. It has taken me a long time to learn that, but I have been around the IJC long enough to realize that now.

Heathcote: It is important to realize that, in that context, the Commission does not have the power to just go out and change these numbers by itself or to call meetings to change them. Right? That's the point you are making?

Unwin: What we are about here is advising the Commissioners so they can advise the Parties. The IJC administers the Agreement, but it is not the IJC's agreement. They are not a party to the Agreement. What we are looking for is, we are going to come up with advice for the Commissioners - they asked us to do that on Annex 1 - and we will advise them in our priorities report. Perhaps they will carry that advice through to their biennial report, perhaps they won't. We are just listening now trying to determine what that advice should be.

Neilson: In providing that advice I would just throw a cautionary note. I have heard several speakers today mention the SOLEC indicators and the Specific Objectives that are set out in Annex 1. I haven't heard a lot of disagreement with having Specific Objectives. What seems to be at issue are the endpoints for those. That is the same problem that SOLEC is facing as well. SOLEC has come up with a suite of indicators, but there aren't agreed-upon endpoints for those indicators. I don't think substituting the indicators in Annex 1 with SOLEC indicators or even adding SOLEC indicators in before there has been that scientific debate and consensus building around establishing endpoints is going to advance the cause any. I just wanted to throw out that cautionary note. I didn't know if anybody wanted to comment on that.

Kuper(?): What is the cause? You said it won't advance the cause.

Neilson: Of improving Annex 1 and giving us better measures against which to report on the health of the Great Lakes.

Kuper: My understanding of Annex 1 is it is the data support for the annex. These are the numbers that we think you ought to be shooting for to acquire the objectives the Water Quality Agreement is after. What was said, apparently universally, is that the numbers that are in there now are no good, and a lot of people here today have said, not only are the numbers out of date but the approach to tracking these numbers is out of date, and that what we need to think about is a new way of assessing how we are doing, rather than saying this is what we should be doing because what we should be doing, as Mike pointed out to us, changes over time.

Neilson: I would suggest the same thing exists in SOLEC. SOLEC has indicators, for example, we want to have a healthy sustainable zooplankton populations. But SOLEC has not dictated how that will be measured, what the benchmark is that we are aiming for, and even any kind of guidance in terms of - this is a healthy population, this is not a healthy population. I know it is a work in progress but, in my opinion, it is not nearly at the stage now where it should be incorporated into Annex 1.

Phenicie: The point on using SOLEC indicators is that, number one, it is an existing process that has undergone several years of scientific scrutiny and, while it may be that there are not endpoints for all indicators, there are some endpoints and there is a place to put endpoints, and there is a process there. Why start over and try to find a way to develop Specific Objectives that, right now, we don't know exactly what they should look like. What we are suggesting is that, here are the SOLEC indicators, with a process for periodic review, with a place to put an endpoint, and with the science community's backing and procedure for moving forward. Annex 1 can simply take this existing program and specify that that is the way for moving forward. We will have to address those issues, but you would have to do that anyway. You would have to start with a completely clean slate if you didn't choose something that is already there and available.

Wagner: This is probably the most misunderstood part of the whole Great Lakes Water Quality Agreement and that is the actual role of the Commission itself. It is very simple. The Commission has only one responsibility, and that is "the International Joint Commission shall assist in the implementation of this Agreement." Accordingly the Commission is hereby given a reference by the Parties and that is, as it indicates in Article VII, essentially they assist the Parties in the implementation of the Agreement and then they report, as a minimum, biannually to the public, giving their advice publicly to the Parties. In that, what they do is, they simply report on progress back to the Parties under the Agreement. The Boards and Council and others provide advice to the Commission - we do it every two years by virtue of a public meeting - and thereby reporting to the public as well as

they do to the governments at the same time. So it is very, very simple. The Agreement is not an instrument of the Commission. Never was and never probably will be.

Unwin: I want to shift a little bit to the second most misunderstood part of the Agreement, with a question to Neil. When you talked about virtual elimination, you said it should be paramount when we talk about Annex 1 and revising Annex 1, possibly, I think you said consideration should be given to zero as Specific Objectives. The first part of my question is, you are talking, I presume, about persistent toxic substances only when you say that. Is that true?

Kagan: Yes.

Unwin: The second part of the question is harder, that is, easy to ask, hard to answer. If you had a Specific Objective for a persistent toxic substance, say PCBs, of zero in fish flesh, how would you know whether you had ever achieved that?

Kagan: Mike?

Murray: I am not qualified to answer that question.

Unwin: But to be useful, it seems that the objective should be measurable. You should be able to tell whether you have achieved it. So I don't know. Mike, it's all on you.

Murray: It is a good question. I think as a first crack, you would look at whether you can detect the substance, whether it is PCBs or whatever. That is one thing actually that has always intrigued me about PCBs is that we have kind of looked at the trends since the major uses, open uses and high levels in capacitors and transformers and all that, were put in place in the late '70s, and we did see a relatively rapid decline through the '70s and early '80s in PCB levels in Great Lakes fish and in surface waters we were monitoring. Then the decrease started to level off. I think we were a bit optimistic in thinking that, because of the rapid decline, we were approaching a level of no concern. But with any chemical, especially for a persistent bioaccumulative toxic chemical, there is no

guarantee that we are leveling off or at least coming to a kind of asymptotic level, that is not still a level of concern. With PCBs, we know, as we have seen even in the Agreement, that the threshold is 0.1 ppm in fish, which is quite a bit below - in fact on an order of magnitude below - levels as pointed out in the LimnoTech report in the Great Lakes.

So we have already for PCBs kind of leveled off, or at least the rate of decrease has really dropped quite a bit through the late '80s and '90s. So the question is, "What else can we do with respect to PCBs to get the levels down to where we are pretty confident that they are not causing problems for human health and wildlife?" For that, I do not think there are any easy answers. Obviously going out after Areas of Concern - more work there - contaminated sediments, ongoing releases but, for me, PCBs are a lesson in what we could have done differently in exercising more precaution as far as all these chemicals are a concern, because of the amount of persistence in the environment, the long time it takes for them to be removed, and the possibility for contaminated sites to be ongoing sources of these chemicals to the water bodies.

This is a little bit of a round about way of saying I think we need to move to ever lower levels or try to shoot for non-detectable levels. If we could ever get to a point of non-detect with PCBs, we would be in pretty good shape. Again it is quite a ways down the road. Yes, obviously I agree we will never know if we are at zero. Right now we won't know that because we can't measure one molecule per litre of water for any of these. But we do know that we can ... progress can be made, we are going to be seeing detection limits go lower and lower, as long as we have concerns about these chemicals at pretty low levels, I think there is work still to be done there.

Henderson: I have a question to press a little more on the relationship of this with the SOLEC process. The initial report that has been turned in talks in just general terms about the values and as a term for trying to coordinate all these different processes, terms - standards, guidances, etc. On the panel, there have been suggestions about the SOLEC process being appropriate for a dynamic, flexible ecosystem approach. How do you start relating those? Is this a suggestion about the convergence of processes? How do you start relating these different processes in a way to end up with better reliable standards that are more easily communicated to the public at large, easily used by decision makers on the ground who have to live with a gap of uncertainty with regard to what they are finding and making decisions? What is the suggestion in terms of the underlying process of bringing these two approaches together and making them sensible and mutually coordinated? Is there a way to go about that? What is the means to do it?

Spry: I am not sure I understand the question, but I will take a crack at it. From my perspective, Annex 1 looks at a list of chemicals. Why did they choose chemicals? - because they are surrogates for what we are trying to protect, which is ecosystem integrity. It is a very difficult thing to explain, to

model, to measure. The approach in the '70s was to say, we know these chemicals cause biological effects, let's limit the chemicals. It was done from a laboratory perspective of measuring chemicals, extrapolating in the environment and saying, if we limit these chemicals we think we can protect the ecosystem integrity. As time has gone on and through ... work of Kelly Munkittrick we can now go into the field, look at fish populations, measure their metrics, and say, "Is this population healthy or not?" There may be a number of stresses that will determine why the population is healthy or isn't. They can be chemical, they can be habitat, they can be invasive species. So we are now in a position where we can look at the health of snapping turtles and say, if the health is impaired, maybe it is a chemical basis. Then we work backwards through the system and say, we are back to using a chemical as a surrogate for what we are trying to protect and we have a much better philosophical and biological grasp of why we are saying PCBs at such and such a level.

Henderson: There is a suggestion and I think the point was made earlier - there is an ongoing process within SOLEC and an indeterminancy about what a range of standards will be, and that might undercut the immediate usefulness of it for looking at Annex 1. There has been a suggestion that they be coordinated. What actually is the process beyond the specific science here. Rather, how do you coordinate these efforts, or is there a suggestion that you simply change Annex 1 by saying, "We will incorporate here the results of SOLEC," or - it's really more what are the politics of merging these things together?

Heathcote: Perhaps I can take a stab at answering that. What we have heard is that the annex is a product of Canada and the United States. It is not written by the Commission. It is the baby, the child of the Parties. All it would take is to hold a meeting and decide that they are going to replace these numbers with the SOLEC indicators, and the deed would be done. If the two Parties could agree, that would be all it would take. Your question contains many other elements but, in terms of the political process, what we have heard is, that is how it works.

Horvatin: I am going to put another spin on it. Melanie hit part of it before, that being the endpoints. That is the one part that, as Dale mentioned, we are wrestling with in SOLEC. We know that, first of all, we have the indicators that we are developing for SOLEC. We have - right now, there are 80 of them, and that number bounces around every couple of months, because we put stuff on the list, we take stuff off. We have indicators that we are trying to develop for chemicals and what would represent either good or bad chemicals in the Great Lakes. We have to have a certain amount of phosphorus so that doesn't go to zero, we don't want to virtually eliminate that. On the other hand, for bioaccumulative substances it does push towards the zero part.

We are also looking at developing indicators in terms of - for example, there is a meeting going on today. It is a wetlands corsortium group. My office is working with a whole bunch of people in the

Great Lakes trying to figure out, over the next three to four years, for example, what kind of wetlands do we need? Coastal wetlands for the Great Lakes basin, and for what purposes? We have an indicator right now that says that we need to maintain the - I have seen numbers of anywhere from 1 to 10% of remaining wetlands in the Great Lakes basin. We have lost 80 to 90% of them, depending on whose numbers you look at but, what is left, we need to keep. We need to do something. The question is, what is the function of those wetlands? What is the purpose? How are they going to be used? We don't have the answers, but there is a realization by a lot of the scientists in the Great Lakes community that it is important. We don't have the answers, we are working on it. We are working with a lot of the LaMP folks right now on the ... trying to drive that. Again, it goes beyond just the chemicals of Annex 1 but, in using this as an example, it goes above and beyond just how many micro moles of something or other that should or should not be in the lake. That is what SOLEC is doing.

The process in some respects, or work to do with Annex 1 is almost the same thing we are trying to do with SOLEC - and it is the endpoints. That is really where the end game is going to be. What is the right number or range of numbers for any given parameter, pollutant or condition that we either want to maintain for the lakes or that we don't want to have in the lakes? You don't want bad chemicals; you want the good stuff. You want wetlands, but maybe one indication is maybe you don't want too many marinas because, obviously, where do we build marinas? Oftentimes you put them in wetlands. There is sort of a connection there.

Land use is another issue. Where do we go with land use in the Great Lakes basin. Obviously there are connections between land use practices and what shows up for pollutants with runoff and development and all the associated issues. What we are trying to do at SOLEC is approach it from more of an ecosystem perspective, stepping away from just looking at chemical by chemical, but looking to see, what are the effects, how does the whole thing come together? Are we going to be absolutely perfect? I don't think so, but I think it is a way we got people - and we have about 200-300 people in the Great Lakes basin right now who are interested in helping us solve this problem and trying to work on it. Again, the endpoint is really the endpoints themselves. What is the right number? We don't have the answers. SOLEC doesn't have it. We are working on it. We are engaging the scientific community throughout the Great Lakes basin to help us with that, and it would be the same activity that would take place for Annex 1. If Annex 1 was truly to be revised, we would come up with better numbers. We are going to do the same thing there too. So in some respects, the processes would wind up in the same place. I don't know if that answers your question. How do we get there? I don't know. But we have one thing in play right now, and that is SOLEC.

Pupp: My question has to do with what Melanie said and what Paul Horvatin just brought up again about endpoints and indicators. I can't see right now any way that SOLEC can say, "These are the endpoints." Paul in his presentation talked about it. It seems to me SOLEC can say, "This is what we should monitor, and this is what the levels are," but I cannot see how SOLEC can decide what the endpoints are. The two Parties have to get together and say these are the endpoints. SOLEC can report

on them. Up until now, I don't think SOLEC has been given a mandate for endpoints or target levels. Maybe I am wrong, but I thought it really important that we discuss the problem.

El-Shaarawi: I agree with what you are saying. It is a little bit confusing because the endpoint, as I see it, is either chemical or a group of chemicals or some biota or something like that. This means that you are setting a limit to a number of variables, so the process itself has to be reasonably defined. You see what kind of chemicals or biologicals go into these indicators so they will become meaningful. I don't really think it is a small issue for a group of scientists on their own to decide this is what we would like to see and it should go this way. There are many stakeholders in this and they should have their input into the process itself. I don't really think we should just dismiss what has been done since the annex was signed and suddenly say this process was not good. I don't really know how can we say that.

Phenicie: The real issue here is one of efficiency, and George mentioned it in his presentation. We are at a critical point with two things going on two parallel tracks. There is a desire to do something about Annex 1, there is a SOLEC process which is at a critical crossroads in terms of being able to receive the commitment and the resources needed on the part of the governments to be successful and grind through the data-collecting process, the reporting processes and the establishment of endpoint processes. If you look at the SOLEC indicator sheet that describes all there is to know about each individual indicator, you are going to find on there an endpoint statement, and it has always been intended that those are going to be filled in, and that is just part of the process and, no, it is not done, but it is now eight years down the road. Do you want to start at this point, saying what are we going to do about Annex 1 and grind out for another 8-10 years until you get to some point where you actually c!n do something about it? Or do you want to take t(is product t(at has been scientifical,y vetted, hundreds of people have been involved with it, as Paul says, and make some use of it and, at the same time, put the onus on the Parties to in fact go ahead and commit to the process and see that it survives.

Horvatin: Chris and others have raised the issue. SOLEC itself is basically chartered, if you will, by the United States government and the government of Canada. It is administered through Environment Canada and U.S. EPA. Basically, it gets its origins from the Binational Executive Committee which represents the federal agencies, the provincial/state agencies, and a host of other organizations. It itself does not - we don't have a mandate or a charge to go out and absolutely create these endpoints. I view what we are trying to do is to become added information brokers - get the scientists together, people who have an interest in this to come together to sort through it. We have been waiting in some respects. That is the whole reason why we started doing basically in 1996 or 1998 to develop these indicators, because we didn't have them.

The Agreement was out there since 1972, and diddly squat was done to move us forward. There was a realization that we needed to really start doing something as a concept to make something happen. Basically a bunch of us got together - we happened to be involved with SOLEC - and we decided, let's take a cut at it and see what we can do. If there is another organization or group of people who feel they could do a much better job, God love ya, I'll support ya but, right now, there is nothing else going on out there. People have been talking about this for decades but haven't done anything. Some of us got together and decided to do something. Now whether or not we are the right group or not, I don't know, and I am not going to say we absolutely, positively are, but at least we are trying to get the scientific community together, the regulatory community, and those groups that can do something about it and implement something - we are trying to get these people together to facilitate.

Basically I see the SOLEC process is really facilitation. Whether or not at the end of the day, or the end of the year, end of the decade, we will wind up with having an absolute list of indicators that will get agreed to, and approved, and accepted and put into force - we are a ways from that yet, but at least the intent right now is to try to work on the problem and try to come up with some recommendations. SOLEC recommends its results to the two governments. It is up to the two governments then to act upon it. We ourselves don't have authorities to make it happen.

El-Shaarawi: These are peer reviewed scientifically published indicators? Or what is it?

Horvatin: Yes.

Plenary Discussion

Isobel Heathcote

Heathcote: [Based upon the background report prepared by Limno-Tech and the presentations and discussion at this workshop, the Parties Implementation Work Group will prepare and submit its advice regarding Annex 1 to the Science Advisory Board, for inclusion in the Board's 1999-2001 priorities report to the International Joint Commission. That will] ... take some time, pulling together some of the advice that we have been hearing. I am relieved to say that we don't have to achieve consensus at this meeting and it's probably a darned good thing. However, it would be good for us in the Work Group to clarify, at least, the points that are being made and, to that end, I would like to take us back to the questions that we are supposed to be considering this afternoon and spend maybe ten minutes on each for a total of about 40 minutes, to try and summarize. We will limit the discussions to ten minutes, so I ask you to be brief in your comments and just hit the high points. If we can do that

we can move through all four questions and their subquestions, and we will have a fairly coherent picture, if not consensus for the Work Group.

To the best of my ability, I will summarize what we have heard so far today. Question Number 1 is, "Is Annex 1 still relevant and useful?" We have heard a fair bit of commentary from a number of speakers that Annex 1 is now seriously outdated - lots of reasons for that. Useful? Some speakers have said, "Well, parts of it are still useful, parts of it not." What comments do you have about the usefulness and relevancy of Annex 1, or need I say anything more than what I've already said? Are there useful pieces of Annex 1? No useful pieces? Hands up anybody who thinks there is anything useful or relevant at all in Annex 1. Okay, we have a couple of hands. I would have to say there is not an overwhelming enthusiasm for the current state of Annex 1.

Twiss: I think Annex 1 is useful. It is nice to have these targets. We have obviously filled this one full of holes. It is nice to know what we should be aiming for. However, just having water quality criteria by themselves is not very useful. We have to know the processes which are involved, then having an impact on what we are interested in. What we are interested in is biotic viability in the lakes. The Great Lakes have been engineered by us. We engineered the physical aspects of it, the water levels. We have engineered the chemical concentrations in the lakes; an example - phosphorus controls is quite evident. The biological integrity of the lakes has been engineered by us. We have introduced species into the lake - on purpose and through exotics. What we have to decide on is, what kind of Great Lakes we want to have. I can make that decision myself but not everyone would probably agree. There are lots of user groups out there. Some people want nice stable water levels. People in the St. Lawrence don't want stable water levels. Stable water levels can increase the amount of methyl mercury in your fish because wetlands are methyl mercury generators. What is the kind of lakes and St. Lawrence River that we want to see? Before we do put together some targets, we have to know what we are targeting for.

Heathcote: Your comment speaks to both the first and the second question. If I could try to capture what you said about the first question, I think what you are saying is, it is useful for a society, in this case, for Canada and the United States, to have a shared vision of what they want as a desirable state of the ecosystem for the Great Lakes system in this case. Right? There is a societal advantage to that kind of vision. There is also perhaps a more specific advantage to having separate specific targets for particular parameters or populations, or whatever in that it gives us benchmarks that we can work towards. So that is piece number one.

The second part which we will come to in a moment, I think you are speaking about how we could make Annex 1 more useful and that you are saying, To be more useful you need to also understand

the mechanisms by which these numbers were developed and how they relate to cause and effect mechanisms, that sort of thing. Am I on the right wave length there?

Other comments on the first question - the utility of Annex 1? Let's move to the second question, because that is quite an interesting one. We have heard, it is fair to say, a lot more diversity of opinion on the question about, "Should Annex 1 be revised, and if so, how?" There is a lot of enthusiasm for revision. It is the "how" or the "what" you might put in there that shows more diversity of opinion. Other comments beyond what Michael has already said?

Neilson: I heard a lot of suggestions for not having prescriptive absolute numbers in the annex itself, but rather have the annex outline a process for developing and reviewing them, and also what to do if you get an exceedance. How are you going to report it and act on it?

Heathcote: So Annex 1 might contain not only levels but also processes or procedures, action procedures. Is that what you are saying?

Neilson: Yes. I support what Michael said. I am just saying in addition to that. I like the idea of putting in there, this is sort of the ecosystem objectives we want for the Great Lakes. These have been agreed upon. And aside from that, just having a process outlined in there, as opposed to, we want this contaminant at this level, or have the endpoints set.

Heathcote: The GLI is fairly explicit about the mechanisms that are used to develop the numbers. Is that a model for us, for Annex 1?

Pupp: I am sort of confused because there are the general objectives that actually say what we want in ecosystem objectives. And also beneficial use impairments. And are there not the desireable outcomes - they do that.

Heathcote: So perhaps the societal goal is met without Annex 1. Is that your point?

Pupp: That is what the general objectives are about, that is Annex 2, and Annex 2 is outdated. But it is certainly defined by the beneficial use impairments and by the desirable outcomes of the Indicators Evaluation Task Force. That's there.

Phenicie: I would like to answer the question, Is GLI a model? I don't think so, and I don't think so for two reasons. One is that it is a set of finite numbers again. We said we would like to get away from that. Second, it relates only to the chemical question and there is a broader ecosystem mandate that is clearly in the Agreement that we need to be paying attention to.

Heathcote: That is a fair comment. My remark actually was around the clarity that the GLI provides about how the numbers were reached, not necessarily the specific numbers. I take your point.

Phenicie: I don't know if that was particularly clear but we spent 10 years doing it.

Unwin: Just a little different spin on the second question where it says, "If so, how?" Rather than, what should any revised Annex 1 look like? I would like to hear comments on the question of how should it happen? If it were to be revised, how would people see that coming about?

Heathcote: Who should do what?

Unwin: Yes.

Heathcote: Comments? Who should do what to fix this puppy?

Unwin: For example, should the Parties be advised to get together in a formal, transparent, open setting to start talking about this? We are not going to settle it here in the next 20 minutes. Should they be advised to do that?

Heathcote: What Jay is really getting at is, we need words to advise the Commission, to advise the Parties. So what should we tell the Commission?

Kuper: Jay, you raised the thorny, clear and difficult question - in the Great Lakes basin particularly - because it is not going to happen from any one source or any one activity. When we came to the conclusion that the time to revise was upon us, it was a result of our understanding that Susan [Nameth] and her U.S. counterpart [Vicki Thomas] had already entered into some conversations about what sorts of changes to the Water Quality Agreement might be appropriate. We would expect that one of the outcomes of this meeting would be that individual and organizational representation would be made to both Susan and her U.S. counterpart, they would hear from us what we thought needed to happen for that Agreement so that it would be looked, at least on the governmental level. At the same time we expect the workshop organizers here to inform the Commissioners of what might happen by way of improvement to Annex 1. Hopefully it will reflect everything that I would like to see changed in Annex 1. The Commissioners then would start a political discussion of some sort, with the governments when they saw them, and every party of interest - we call ourselves stakeholders - would start talking about what they wanted to see happen to Annex 1 and the Water Quality Agreement. That is how things get changed. It is not a straightforward route but it would be very, very helpful for the outcome of this workshop and the Work Group of the Science Advisory Board to come up with a set of recommendations that don't have to be conclusive. They can be embracing - There was consensus that it is out of date. There was consensus that certain changes might be appropriate and they range from this to that. You don't have to come to conclusion as to what changes ultimately are - just that it is time to have those discussions publicly.

Heathcote: Jay's question was a little bit more specific, though. I think Jay was asking, Are we saying that meetings should be called? And if so, who should call that meeting? No meeting?

Kuper: No meeting. The process is now under way. We've already started.

Heathcote: Okay.

Horvatin: I would like to throw some chaos into this discussion - not that we haven't had any yet. To revise Annex 1 obviously would have merit, but I would also caution that just revising Annex 1, I'm not sure, is going to have the impact that I think people would like to see. As Annex 1 becomes a list of endpoints, for lack of a better term, you may need, I would suggest, to look at Annex 11 which is the surveillance and monitoring annex. So now, if you start with Annex 1, so you have your endpoints. Endpoints are only as good as monitoring and surveillance programs to measure for. Then, if you get into Annex 11, you need to get into Annex 2 and maybe Annex 3, because you are getting into LaMPs, RAPs and phosphorus control. The concept I am saying here is that the Great Lakes are an ecosystem and the Agreement needs to be viewed as a coherent process or program also. To change one annex without understanding and looking at the consequences to the other annexes, I think, could be problematic. Again, you can change the endpoint but if there is no surveillance and monitoring to go along with it - you've done a great job of re-writing the annex, but to what end? If it doesn't change the processes in Annexes 2 and 3, for example, then to what additional end have you gone through. Again, I am a firm believer that you start out this concept with goals, you develop objectives, you develop indicators, you develop endpoints, you have measurement or monitoring programs, you have reporting programs and the cycle comes back around. If we don't look at this from a holistic standpoint it will be a great exercise, but I'm not too sure to what end, in the end.

Heathcote: Are you saying that the Parties should be advised to take a look at the Agreement overall? The whole Agreement?

Horvatin: I'm not saying anything. All I am saying is, I'm not going down *that* road. All I am saying is, we need to think through the process. Just to change Annex 1, it should be thought through in terms of all the annexes in the entire Agreement.

Heathcote: It is very clear from the discussion earlier today that you cannot look just at Annex 1. Annex 1 has very clear implications for surveillance and monitoring programs and for, as you say, other annexes in the Agreement as well. I wonder whether it is realistic to say, Open Annexes 1, 3, 5, 7 and 14, but don't worry about the rest of the Agreement. It is a fairly big undertaking. Other thoughts?

Wagner: Could we get along without a new Annex 1?

Heathcote: Leave it as it is or do away with it all together?

Wagner: Do away with Annex 1 altogether. By that, we would expect the Parties, of course, to wholeheartedly embrace the indicator process. The indicator process would, in fact, replace Annex 1, and that would also be the reporting process.

Heathcote: One of the speakers - I think it was Paul - said that, in fact, you might just put in Annex 1 that the Parties will have their own objectives - the policy values to use that broader term - and those will apply. Is that what you want to say? Does everybody like that idea? Is there a general feeling that an Annex 1 would be useful or are you saying, get rid of Annex 1 altogether?

Wagner: I am suggesting that we make a conscious decision that we want an Annex 1.

Heathcote: Do we want an Annex 1? Yes? No? A show of hands. Everybody in favor of Annex 1? No? No to Annex 1? Get rid of it? Outdated, no use? All right, we want Annex 1 in some shape or form.

Kuper: Can I just raise a process question? With all due respect, I think that is a non-question. If you don't know what it is going to say, why do you know whether or not you want it?

Heathcote: Tony is asking a broader philosophical question.

Kuper: Which means that I don't understand a good philosophical question.

Wagner: That's just the converse of what we could want in Annex 1.

Heathcote: I think the question is, do we feel that there is value in a common set of objectives for the Great Lakes basin - in whatever form they might take - rather than unilateral sets that reside in the two countries.

Kuper: If you ask the question that way, it is a different question - whether or not you want an Annex 1. I would raise my hand, yes.

Heathcote: There is value in a common set of objectives.

Nameth: I want to point out that you cannot necessarily look at Annex 1 in and of itself. I agree with Paul's points, but I want to raise it up a little bit because the general and Specific Objectives are really a key piece of the whole Agreement. If we are going to look at removing Annex 1, then you are looking at basically removing Article IV of the Agreement, and then I think you are getting into a revision of the Agreement itself. I think it is really important to take care in looking at what the implications of what might appear to be one small change would be on the entire Agreement.

Heathcote: That is a very important point, and it does follow on from Paul's earlier point. It's a slippery slope, though, and I think that has been one of the reasons that various groups have been reluctant to embark on this process at all and why Annex 1 has stayed so long in its current format.

Wagner: That's a fair condemnation on Annex 1 then, isn't it? And the Parties - I mean, damned if they do and damned if they don't.

Heathcote: My feeling would be that the point that was just made, that the Agreement is a large and complex document, it represents a lot of time and a lot of discussion and, if you reopen the whole thing, that's a huge task. and people are just reluctant, probably because of resource implications, to even embark on that.

Wagner: Nobody has said that opening Annex 1 or updating Annex 1 is opening up the Agreement.

Heathcote: We heard from Paul, though, and from others that you cannot really look just at Annex 1.

Wagner: That's right, but that's still not opening the Agreement.

Neilson: But you can just look at Annex 1. I mean actually start at Annex 1, but it should be reviewed ...

Heathcote: And flag the implications ...

Neilson: ... every year or two and update it, so ...

Wagner: What do they want Annex 1 to do? We have already said, we don't want to chase numbers. Right?

Heathcote: Paul's point - I'm putting words in your mouth, Paul - is that Annex 1, first and foremost, has huge implications for surveillance and monitoring. So, if you make very large changes in the way Annex 1 looks - for instance you put in ecosystem objectives of some sort, I don't know what - it has fundamental implications for how you would conduct your monitoring programs. That means you would have to rewrite Annex 11 which is related to surveillance and monitoring in order to have it reflect. Once you have done that, then maybe you need to take another look at the RAPs and LaMPs and the recalculation of phosphorus loads and it is just - I don't want to go down that road. It is a slippery slope.

Unwin: It may well be that revising Annex 1 leads to those kinds of consequences, but it doesn't follow that you have to do all that at once.

Heathcote: I think that's a fair comment.

Unwin: If it's an ongoing thing, fine. The Agreement could probably use that.

Heathcote: We certainly heard from several speakers today that there is a need to revisit and revisit, and come back to these things on a regular basis. One of the reasons that we find ourselves in the fix we are in now is it has been too long since it was revisited. Let's move on to Question Number 3 which, again, we spent a lot of time on today. Question 3 says, "Is there a role for ecological indicators (for example, SOLEC) in the Agreement?" We heard a lot of suggestions that you could take the SOLEC indicators and put them into Annex 1, as the targets, if we had the endpoints that were discussed. If we had those, they could replace the Annex 1 objectives.

Horvatin: Harvey Shear and I have talked about this, on and off, for a number of years. I would resist ever putting the word SOLEC in the Agreement any place, way, shape or form. What I would suggest is we look at a process by which the two governments come together to look at indicators and report. That concept, I think, is more appropriate to go into any annexes of the Agreement or any changes for the future, but I would hopefully plead that we not ever put SOLEC itself into the Agreement, because I think that would be problematic.

Heathcote: SOLEC in a sense, is a process through which these numbers have been born.

Horvatin: We should reference the process which we go through in terms of establishing the goals, as I said before, establishing the goals, establishing objectives, creating indicators, requirements for monitoring, requirements for reporting, endpoints, what that concept - which is what we are doing in SOLEC - should be. I suggest that it be put on the table for discussion, to be viewed to put into the Agreement, but not SOLEC itself.

Heathcote: Fair enough.

Unidentified speaker: What is the problem when you say problematic?

Horvatin: SOLEC means different things for different people, and I am just leery. It reflects different things. I helped create the term SOLEC which actually somewhat started out as State of the Lakes, SOL, and then we decided that was a problem so we didn't want to be [censored], so we decided to call it SOLEC instead. It was a legitimate hour discussion that a few of us had, so, don't joke, don't laugh. Seriously we did, because we realized that would be problematic. In itself, it is something that we have got going here, but I think the process is bigger. It really is what is more important than looking at the conference itself, because the conference some day can go away - that is something that we put together every two years, to gather and meet - but it is what we are attempting to achieve that is really the heart of the matter that we should be looking at here - not that we get together, put papers, get discussions. To me that is not where the emphasis should be.

Neilson: I thought where Paul was going with the comment about being problematic is that there are the SOLEC indicators. In addition, there are other indicators that each of the LaMPs has developed or is developing. How do you decide whose list would go in there? Just by virtue of the fact that by saying that ecosystem objectives and indicators are being developed throughout the LaMP process, these should be considered as well as for state-of-the-lakes reporting.

DePinto: I absolutely think that ecological indicators as a concept should be seriously considered for Annex 1. The problem is that it is a lot easier to say this chemical kills this many critters at this value and, therefore, that's bad, than it is to have some sort of an ecological health indicator. We don't really have a unified theory for telling us whether, at this point, these indicators are telling us that the Great Lakes are healthy from an ecosystem standpoint. Whatever we would do in that area, it is important to strive for that, but whatever we do is going to be provisional for a while. We are still trying to figure out why zebra mussels have done what they have done in the system. And you know - what's next?

Heathcote: Joe mentioned earlier that he and I served on the [Commission's] Indicators Implementation Task Force which was charged with operationalizing a system of indicators, including ecosystem health indicators, and we ground to a halt on that question. Those are very difficult issues for sure.

Kuper: This question may be already settled by the Commissioners, your clients. The reference is in the 7th Biennial Report. At its 1993 biennial meeting, the Commissioners suggested the governments report on progress in eliminating toxic contaminants with the biennial state-of-the-lakes ecosystem report, starting in 1995. They are already asking for it so, from the Commissioners' point of view, it is already institutionalized and the answer to the question is, Yes.

Phenicie: Paul is not taking nearly enough credit for what he has helped create, in that SOLEC is more than the conference. SOLEC is a process. It is unfortunate that we have gotten hung up over a name like SOLEC or any other name, because what we are really talking about here is working through a process that is based in science, looks at broad ecosystem issues and questions, and tries to make sense out of what is the health of the lakes from a broad ecosystem context which includes the contaminants and a bunch of other things. SOLEC then puts that out, number one, for public consumption and public information and, then, in the final step, compares those results against a endpoint benchmark. That is what the whole thing is all about. It seems to me that we have made so much progress in that direction. We got a lot of people working together now and it has not come easily because, as Melanie points out, there are a bunch of other folks out there doing similar things on local or lake-specific bases that have looked at, what is this SOLEC snowball that is rolling down the hill here and about to engulf us, and do we agree with all that? So there is some baggage. That is why it is unfortunate that we have to stick with handles and names, but I don't know what else to call this process that we have worked so hard to get in place. That is the important point - whether you call it SOLEC or something else, or don't call it anything at all, but acknowledge that that is the kind of process we need. That is what has to go into the new Annex 1.

Heathcote: Other thoughts on SOLEC or indicators in general as a part of Annex 1? The discussion we had earlier says that Annex 1 actually does currently contain indicators or surrogate parameters. Any other thoughts on indicators? Shall we move along to the last question? The last question is the one we have probably spent the least time on today, and that is, "How should achievement of Specific Objectives be judged?" That may be a difficult question to answer in that many of the SOLEC indicators have not had specific targets set yet, but even just using the values that currently appear in Annex 1 and thinking about what Abdel said this morning about compliance assessment, how should those Specific Objectives, whatever they may be, be judged?

Unwin: No answer here. Just a question or a solicitation of those familiar with the SOLEC process. There are some goals for some of the indicators and there have actually been reports for some of those indicators. In the SOLEC process, how is achievement of the goal to be judged? Anybody want to comment on that?

Neilson: I will comment from my own experience. I was involved in the last SOLEC in terms of writing up some of the indicator reports and also in summarizing a lot of them to present at the conference. It boils down, in many cases, to best professional judgement. You present a position, substantiate it with the data you have available and, then, hopefully it undergoes a review through the conference and thereafter. That was my experience.

Heathcote: Could you give us an example of what you mean, just to clarify our thinking.

Neilson: For example, one of the papers that was submitted was on zooplankton populations. It was a binationally developed paper, with input from the Canadians and the U.S., and there was a contractor hired to write it up. They chose a couple of different measures to look at zooplankton populations that would, in their opinion, indicate if the populations were healthy. They chose to use very complex indices, and I know amongst the SOLEC Steering Committee there wasn't a lot of buy-in for the indices chosen. Perhaps that will be one of the ones addressed before the next conference. Because there isn't an endpoint that says, one has this many different species and you want to have this count of each kind of species to indicate a healthy zooplankton population, in their best professional judgement they chose some indices to use. They looked at the ratio of cyclopoids to cladocerans. That is not very easily understandable to the general public. That is what I mean in terms of the Steering Committee not being particularly happy with the choice of indices for that indicator. It needs that further endpoint development that everyone can agree on, this how we are going to measure whether we have a healthy population or not. So it was the best professional judgement.

Heathcote: That is an interesting example because, as you say, first of all, it would be difficult to develop specific numbers - you would probably have to go location specific, species specific, population specific, estimates taken into account, Abdel's variability and all that kind of stuff. Instead what you are proposing happened in this case is that experts from both sides of the border sat down together, probably took a look at the available data sets, did some of that analysis themselves and came to a judgement. So maybe that is not a bad way to go about it.

Horvatin: The key to what we do though, that we think is important is that we get scientists and people who know, whether it is zookplankton or whatever, put together a paper or report, we put it out for a peer review. Everything we do - I view that our conferences that we have every two years is 500 or 600 people are coming together for peer review - the cheapest peer review I know how to get - because we put all this information out and then we leave the record open for about six months for feedback. From my perspective, that is the beauty of what we sort of are pushing for, because we take the best science - in some cases it is not exacting science, sometimes it is more artsy - from that perspective, land use and those kinds of things.

Heathcote: We don't like to think of those as artsy, Paul.

Horvatin: Do the best we can, and then put it out there and to get reaction, get public feedback. To me, that is the value of what we are doing because, in some respects, we are trying to find ways to take the hard science and put it into a format that local decision makers, or federal / provincialists can use this stuff - I am not trying to put them down but, many cases, their attention span is very short - and if it isn't in fairly simple terms in a half page, it is hard for them to focus on some of these issues. So one, you have to digest it to basically the lowest, smallest amino acid you can, and then very briefly put it up on a piece of paper, and maybe they will react to it and do something with the information.

Heathcote: I actually think what is going on is something else, on a somewhat different level. What I am hearing you say is happening is that you take scientific advice and you open it to a wide audience and you invite commentary - I presume there is response to the commentary. In a sense, it seems to me that that is a process of societal consensus building of a sort, around a fairly narrow issue. Part of that society that is responding is an informed scientific community, but there are also people from the lay community and various other groups, the regulated community and so on. There is an interesting process going on there of transparency and accountability but also consensus building. I think you do it an injustice to say you are boiling it down to the simplest level so people can do it quick kind of thing. There is an important sort of building of momentum around opinion through that process. Other comments about how we might judge compliance on specific numbers?

DePinto: This may sound funny, but I just have one word - harshly.

Heathcote: Harshly? Oh, that's how we judge compliance. We need to be tough.

DePinto: I would point to the Everglades for an example. If we don't like the way our ecosystem is, we need to be a lot more vocal about it and to be a lot more vocal, not just within the Great Lakes basin, but on a binational level.

Heathcote: Who is "we?"

DePinto: Whoever it is that is managing the Great Lakes.

Heathcote: The reason I ask the question is that we can't ...

DePinto: We are not getting the resources that we deserve, based on the value of this resource, because I don't think we are squeaking the wheel enough.

Heathcote: You are speaking though as a citizen, right? Maybe we have undergone a shift where we are no longer expecting or relying on government to make those decisions for us, and just abiding by it. We want to be a more participative citizenry. Is that fair to say? Some more bottom up? I sense that there has been a shift in the way the public is viewing science and the way the public is using science and participating in the development of policy that is based on science. I think this discussion about SOLEC is important. I don't think we would have done things like that 20 years ago, or 25 years ago, at all - or even 10 years, 15 years ago, we wouldn't have done things like that.

Kuper: There is another thing that I believe has emerged with our experience, and that is your use of the term "compliance" when you talk about achievement of objectives. I don't know if compliance is the right word. It really is achievement. Compliance implies a regulatory goal of some kind, and I think a lot of the SOLEC indicators are being responded to by other than regulatory approaches.

Heathcote: A fair comment.

Neilson: In Abdel's absence, I will repeat what he said in his presentation which I thought was valid that, if indeed you are going to set a Specific Objective that has a numerical value associated with it, you set some of those other parameters that go along with it, that you say you want to meet it. Jim [Whitaker] mentioned the same thing in his presentation. You have to take into account how often can that be exceeded. What is the risk if you have a 5% exceedance without seeing an effect? Spatially, what area does that apply to and, how many samples does one have to collect - that kind of thing. It

would be a lot easier to judge achievement of the Specific Objective if the endpoints were much better defined.

Heathcote: One of the things that I heard from both those speakers is that you need to be very clear about what it is you are trying to protect. I think Jim used the words "designated use" and Abdel also made the same point in different language. I don't think that is clear in the current Annex 1. We have a sort of separate section that talks about beneficial uses in general, but we are trying to do all things with a single section here. Maybe that is part of the reason for confusion. Maybe that is the need to tailor the set of indicators or the set of targets to a particular use or place.

Other comments on this one? I think we are grinding to a halt here. I could open the floor to more general comments or questions. Before I do that, I am sure you are going to go away like we will and think hard about the things that have been said today. I would certainly invite you to respond to us in writing if you have thoughts after the fact and you want to send them on to Marty, who was probably your first contact. Please feel free to do so. We certainly would welcome that feedback when you have the time to think these things over.

Any closing comments or thoughts? Hearing none, I will join Jay in thanking you all for attending. It was a very lively discussion and I think we got a lot out of it. Some of it was certainly new to me, and some new ideas that will be very useful to us in our deliberations. Thank you again. Jay, is there going to be an outcome of this meeting that will be available?

Unwin: The outcome of the meeting will be our advice to the Commissioners. That will be in the ...

Heathcote: ... [Science Advisory] Board's report in the fall.

Unwin: That will be in the priorities and progress report. Which is publicly available when, Peter?

Boyer: It will be available 30 days prior to the [Commission's] Biennial Forum in September, so, middle of August.

Heathcote: Thank you again for participating, and a safe journey home everyone and we look forward to seeing you at the Biennial Meeting in the fall.

Unwin: Thank you for a good discussion everyone.

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[Also sprach Zarathustra]

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