DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ME-WM 16 March 1988

SUBJECT: Water Quality Information Paper Number 5

BIOMONITORING FOR WATER QUALITY

1. PURPOSE. To summarize, for preventive medicine and environmental science personnel in the field, concepts of biomonitoring as they relate to studies of water quality, to outline regulatory background of same, and to describe field services in biomonitoring available from the U.S. Army Environmental Hygiene Agency (USAEHA).

2. BACKGROUND. Reference 9 summarized timely information regarding the role of biomonitoring under the National Pollutant Discharge Elimination System (NPDES). Since that document was published, substantial interest in regulatory and research aspects of biomonitoring has arisen at the U.S. Environmental Protection Agency (EPA) and among State regulators. There is a perceived need for more current information in these areas.

a. Concepts. Biomonitoring, in general, is the use and analysis of, aquatic organisms to assess water quality. Biomonitoring can provide a more timely and cost effective means of assessing: the synergistic and/or additive effects of compounds, the toxicity of a given discharge when its composition is unknown, the toxicity of compounds when little water quality criteria exists, and the relative health of a given ecosystem. Biological effects which are more commonly used in biomonitoring include death, immobility, reproduction, growth, mutation, and species diversity of populations. In general, pollution effects can be demonstrated from the macromolecular (e.g., enzyme function) to the ecosystem level (e.g., community structure and function) of biological organization. As used for assessment of water quality at USAEHA, biomonitoring comprises the following three types of studies.

(1) Traditional field surveys of populations or assemblages of aquatic organisms to assess health of aquatic ecosystems.

(2) Biological toxicity testing ("bioassays") of effluents, ambient waters, or military-specific substances (e.g., explosive residues).

(3) Detailed analysis of levels of toxic substances (e.g., insecticides and other anticholinesterases) in tissues of aquatic organisms where chemical analysis of ambient water samples do not detect same, to detect bioconcentrated concentrations of toxicants which may be harmful to human health.

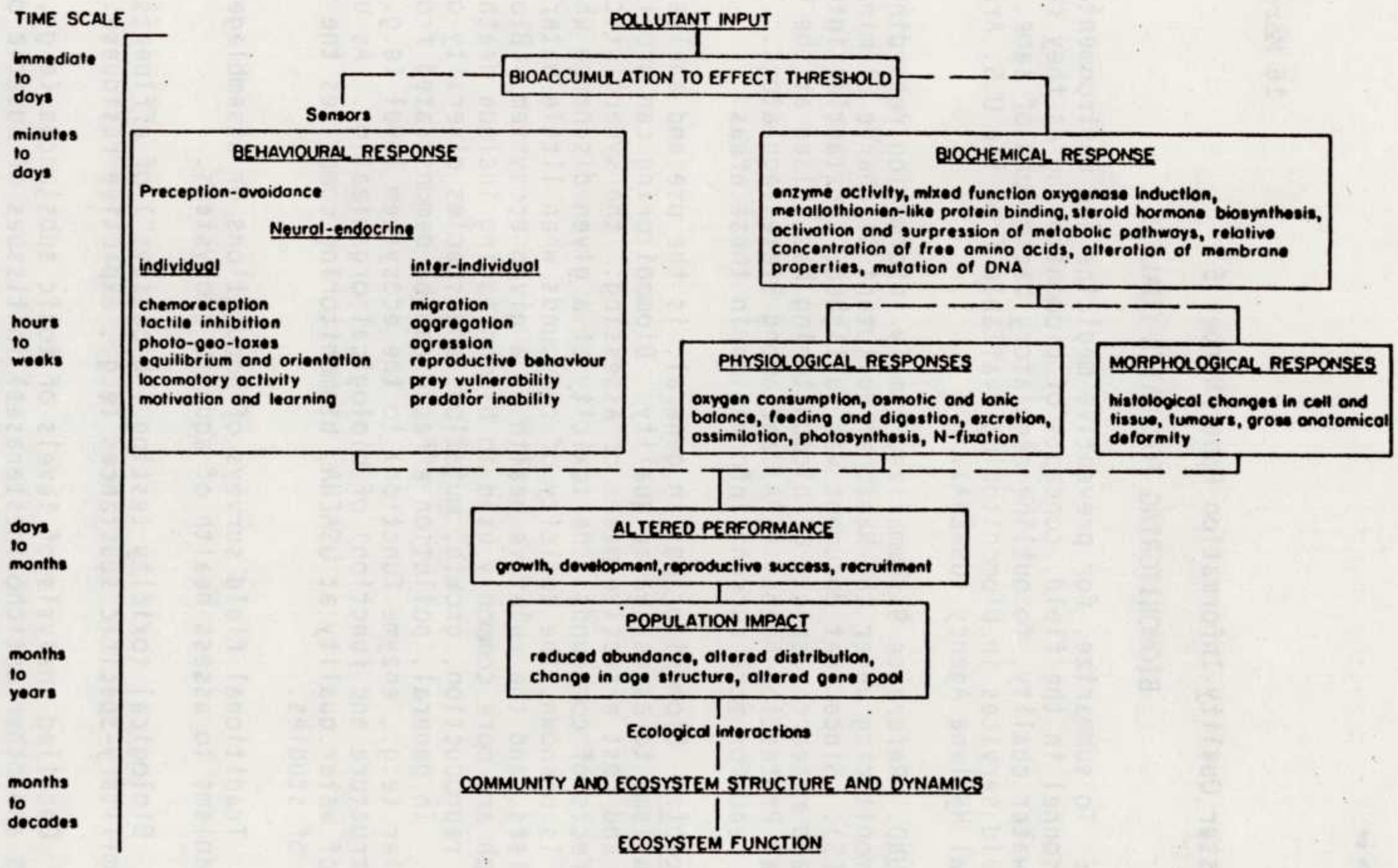

Figure . Conceptual chronology of induce biological effects following exposure to toxic contaminants, emphasizing responses in individuals and populations
Source: Reference 11, page 53.

b. Research Efforts (EPA). Substantial effort by the EPA has been directed at producing dependable methodology for routine biomonitoring to detect negative impacts of effluents on receiving waters, both freshwater and marine. A recent report (reference 5) disseminates type-protocols and upgrades quality assurance (QA) procedures for measuring acute toxicity. The Table, reproduced from that report, lists species which are recommended for bioassays. The great number of species listed suggests logistical problems for activities conducting bioassays in finding sources of appropriate organisms in good health, since QA procedures require that unhealthy organisms not be used for bioassays. A second EPA report (reference 6) establishes short methods for estimating chronic toxicity and emphasizes methods for fathead minnow larvae (Pimephales promelas), the water flea (Ceriodaphnia), and a species of single-celled alga (Selenastrum). These contributions will improve standardization of methods for conducting such tests, but high standards of QA will require frequent repetition of bioassays, considering the inherent variability of biological material. Beginning approximately 1980, the EPA began a Complex Effluent Toxicity Testing Program to support an emerging trend toward water quality toxics control in NPDES (reference 15). The EPA has recently released three reports (references 4, 7, 8 and 9) validating the use of such testing as compared with the results of more traditional parameters of water quality, as revealed by long-term effects of discharges upon population and community structure.

c. Regulatory Interest. As the initial round of NPDES permits for Army installations expire, EPA regions and State agencies of the various States having primacy for Federal activities have inserted, in an increasing number of cases, NPDES permits provisions for biomonitoring or Toxicity Reduction Evaluations (TRE) based upon preliminary bioassay screens. Historically, the principal focus of regulators in establishing discharge limits for NPDES permits was for control of conventional pollutants [biochemical oxygen demand (BOD), pH, fecal coliforms] because those contaminants most urgently needed controls. In requiring biomonitoring, regulators are attempting to meet the following objectives (reference 12).

(1) To serve as a screening mechanism, isolating toxic conditions which may not have been detected in routine chemical-specific analyses.

(2) To evaluate effluents which are in compliance with State water quality standards.

(3) To provide monitoring to act as an early warning system for toxicants which may or may not be limited via Best Conventional Technology/Best Available Technology.

(4) To serve as a surrogate pollutant test preliminary to setting priorities for more resource-intensive chemical-specific analysis.

Preventive medicine and environmental science personnel advising Army users of their service in the field should expect to provide advice regarding methodology and procedures relating to biomonitoring.

TABLE. RECOMMENDED SPECIES, TEST TEMPERATURES, AND LIFE STAGES

Species		Test Temperature (°C)*	Life Stage†
Freshwater			
Vertebrates			
Cold Water			
Brook trout:	Salvelinus fontinalis	12	30 - 90 days
Coho salmon:	Oncorhynchus kisutch	12	30 - 90 days
Rainbow trout:	Salmo gairdneri	12	30 - 90 days
Warm Water			
Bluegill:	Lepomis macrochirus	20	1 - 90 days
Channel catfish:	Ictalurus punctatus	20	"
Fathead minnow:	Pimephales promelas‡	20	"
Invertebrates			
Cold Water			
Stoneflies:	Pteronarcys spp.	12	Larvae
Crayfish:	Pacifastacus leniusculus	12	Juveniles
Mayflies:	Baetis or Ephemerella spp.	12	Nymphs
Warm Water			
Amphipods:	Hyalella, spp.,	20	Juveniles
	Gammarus lacustris,		"
	G. fasciatus, or		"
	G. pseudolimnaeus	20	"
Cladocera:	Daphnia magna or D. pulex§,	20	1 - 24 h
	Ceriodaphnia spp.	20	1 - 24 h
Crayfish:	Orconectes or Cambarus spp.	20	Juveniles
	Procambarus spp.,	20	"
Mayflies:	Hexagenia limbata or	20	Nymphs
	H. bilineata		
Midges:	Chironomus spp.	20	Larvae
Marine and estuarine			
Vertebrates			
Cold Water			
English sole:	Parophrys vetulus	12	1 - 90 days
Sanddab:	Citharichthys stigmaeus	12	"
Winter flounder:	Pseudopleuronectes americanus	12	Post-metamorphosis

See footnotes on page 5.

Species		Test Temperature (°C)*	Life Stage†
Warm Water			
Flounder:	Paralichthys dentatus		
	P. lethostigma	20	1 - 90 days
Longnose killifish	Fundulus similis	20	"
Mummichog:	Fundulus heteroclitus	20	"
Pinfish:	Lagodon rhomboides	20	"
Sheepshead minnow:	Cyprinodon variegatus	20	"
Silverside:	Menidia spp.	20	"
Spot:	Leiostomus xanthurus	20	"
Threespine stickleback:	Gasterosteus aculeatus	20	"
Invertebrates			
Cold Water			
Dungeness crab:	Cancer magister	12	Juvenile
Oceanic shrimp:	Pandalus jordani	12	"
Green sea urchin:	Strongylocentrotus droebachiensis	12	Gametes/embryo
Purple " ":	S. purpuratus	12	" "
Sand dollar:	Dendraster excentricus	12	" "
Warm Water			
Blue crab:	Callinectes sapidus	20	Juvenile
Mysid:	Mysidopsis spp.	20	1 - 5 days
	Neomysis spp.	20	" "
Grass shrimp:	Palaemonetes spp.	20	1 - 10 days
Penaid shrimp:	Penaeus setiferus	20	Post larval
	P. duorarum	20	" "
	P. aztecus	20	" "
Sand shrimp:	Crangon spp.	20	" "
Pacific oyster:	Crassostrea gigas	20	" "
American oyster:	Crassostrea virginica	20	Embryo/larval

* To avoid unnecessary logistical problems in trying to maintain different test temperatures for each test organism, it would be sufficient to use one temperature (12 °C) for cold water organisms and one temperature (20 °C) for warm water organisms.

† The optimum life stage is not known for all test organisms.

‡ Mayes et al., 1983, (reference 15) found no significant difference in the sensitivity of fish ranging in age from 10 to 100 days, in tests with nine toxicants.

§ Daphnia pulex is recommended over D. magna because it is more widely distributed in the United States, test results with this species are less sensitive to feeding during tests, and it is not as easily trapped on the surface film.

3. REGULATORY BACKGROUND. Biomonitoring requirements for NPDES permits were established by the standards and enforcement of the Federal Water Pollution Control Act (PL 92-500) and were also incorporated in the Clean Water Act (CWA) of 1977 (PL 95-217) (reference 2).

a. Standards and Enforcement Sections of PL 95-217. Although Sections 301, 304, 305, 307, 308, 316, and 403 deal with biomonitoring requirements, only the biomonitoring requirements of Sections 301, 307, and 308 are applicable to NPDES. These NPDES-related sections are as follows:

(1) Section 301(g). "(1) The Administrator, with the concurrence of the state, shall modify the requirements of subsection (b)(2)(A)*" ... "upon showing by the owner or operator of such point source satisfactory to the Administrator that...." "(C) such modification will not interfere with the attainment or maintenance of that water quality which shall assure protection of public water supplies, and the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities, in and on the water, and such modification will not result in the discharge of pollutants in quantities which may reasonably be anticipated to pose an unacceptable risk to human health or the environment because of bioaccumulation; persistency in the environment, acute toxicity, chronic toxicity (including carcinogenicity, mutagenicity or teratogenicity), or synergistic properties."

(2) Section 307(a). "(1) The Administrator shall, within ninety days after the date of enactment of this title, publish (and from time-to-time thereafter revise) a list which includes any toxic pollutant or combination of such pollutants for which an effluent standard (which may include a prohibition of the discharges of such pollutants or combination of such pollutants) will be established under this section. The Administrator in publishing such list shall take into account the toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms and the nature and extent of the effect of the toxic pollutant on such organisms."

(3) Section 308(a)(4). "(A) The Administrator shall require the owner or operator of any point source to ...." "(iii) install, use, and maintain such monitoring equipment or methods (including, where appropriate, biological monitoring methods)."

b. Regulatory and Judicial Interpretations of PL 92-500.

(1) Biological monitoring entails both stream studies and bioassays -- a bioassay being the exposure of organisms to an effluent or chemical to determine toxicity. Congress, however, did not intend variances associated with stream studies of Section 316 (Thermal Discharges) to be applied to other effluent limitations. Originally, the NPDES limited point source discharges

*Effluent requirements of nonconventional pollutants.

of pollutants and toxic substances, but it did not establish toxic limits for effluents. Under these conditions, effluents often met NPDES conventional pollutant requirements (those of BOD, total suspended solids, fecal coliforms, oil and grease, and pH), yet still had negative impacts on receiving streams. In other words, toxic substances were often discharged into the environment via point sources when the applicable NPDES permits did not specifically point out that this should not happen.

(2) The National Resource Defense Council et al vs Train (8 ERC 2120, DDC 1976) forced the EPA to implement Section 307 of PL 92-500 and develop a list of toxic pollutants and proposed effluent criteria (including prohibition, if necessary). The EPA not only had difficulty establishing safe levels of toxic substances in water; it also had difficulty identifying toxic substances in effluents. Since information on the toxicity of many substances is lacking and actual toxicity levels are dependent upon the nature of the receiving stream, the EPA and some States decided to determine the toxicity of some effluents through bioassays. Bioassays were incorporated into NPDES permits by requiring them as a warning system and/or establishing toxic limits i.e., 80 percent of test organisms must survive 100 percent of an effluent.

c. The Water Quality Act (WQA) of 1987 (reference 3). In considering provisions of the WQA of 1987, the Congress considered that technology-based limitations were sometimes insufficient to attain the nation's water quality goals as established by CWA. In those considerations, they reflected EPA concerns which had been disseminated earlier as a National Policy Statement (Enclosure 1). The WQA of 1987 established two statuatory deadlines for control of toxic discharges [Section 304 (1)]. By 4 February 1989, States are required to submit to EPA:

(1) a list of waters where technology-based limitations will not attain or maintain water quality standards.

(2) a determination of those point sources in waterways which are preventing attainment of such standards.

(3) individual control strategies which will permit attainment of standards within three years. By 4 June 1992, point sources are required to implement such strategies permitting attainment.

d. Toxic Substances Control Act of 1976 (reference 1).

(1) Section 4(a)(2) states

"The administrator shall by rule require that testing be conducted on such substances or mixtures to develop data with respect to the health and environmental effect for which there is an insufficiency of data and experience and which are relevant to a determination that the manufacture-distribution in commerce, processing, use, or dispersal of such substances or mixtures, or that any combination of such activities, does or does not present an unreasonable risk of injury to health or the environment."

(2) These requirements are further defined in Sections 3(5) and 3(12), respectively.

"The term 'environment' includes water, air and land and the interrelationships which exist among and between water, air, and land and all living things.

The term 'standards for the development of test data' means a prescription of the health and environmental effects, and information relating to toxicity, persistence, and other characteristics which affect health and the environment..."

4. BIOMONITORING ROLE OF USAEHA FOR ARMY USERS. In addition to studies evaluating impact of Army practices upon water quality, USAEHA can provide bioassay services according to the following brief descriptions. Type protocols can be provided upon request, and further consultation regarding biomonitoring can be obtained by contacting Mr. Stephen L. Kistner, AUTOVON 584-3289, or Mr. Carl Bouwkamp, AUTOVON 584-3919. It should be pointed out that USAEHA resources do not permit assuming routine biomonitoring for Army installations; however, one-time bioassays are possible to identify potential problems in meeting regulatory requirements, and scopes of work can be developed in contracting for such services.

a. Fish Bioassays. From an environmental viewpoint, a bioassay of an effluent should determine its effects on the most sensitive organisms in the receiving stream. If the most sensitive organisms in a stream are protected, other organisms are protected also. Fish, however, that are often less sensitive than the insects on which they feed, are the most common aquatic bioassay organisms because of the lag between ecological knowledge and environmental law. Judicial cases are better justified when dead trout rather than dead mayflies are brought into court. One, nevertheless, should choose the proper species even for fish bioassays. Fathead minnows, bluegills, and channel catfish are often used for bioassays related to typical streams in the temperate zone. Trout are usually used for bioassays associated with cold-water streams. Both fish and invertebrate bioassays produce a value known as a LC_{50} - the concentration which is lethal to 50 percent of the organisms exposed to it.

(1) Static 96-Hour Fish Bioassays. This is a standard test whereby fish under controlled conditions are exposed to serial dilutions of a grab sample taken from an effluent or chemical solution. The simplicity of this test makes it very useful. The disadvantage of this test is that the toxicity of the sample tested may change during the bioassay due to degradation, volatilization, precipitation and/or absorption of the toxicant or due to the uptake of the toxicant by organisms. For example, oils are degraded by some bacteria; ammonia volatilizes; and polychlorinated biphenyls settle out or "adsorb" to the glass walls of bioassay chambers. Consequently, static bioassays are particularly applicable to effluents that contain certain conservative substances and that have minor fluctuations in the concentrations of toxicants.

(2) Ninety-six Hour Flow-through Bioassay, which continually pumps an effluent or toxicant and the dilutions of it through bioassay chambers, has the advantage of minimizing the effects of altering the toxicant during the test procedure and of accounting for the variability of toxic chemicals in the waste stream. The disadvantage of this type of bioassay is that it requires large holding tanks for dilution water, dilutor systems, pumps, and other costly pieces of equipment.

b. Other Tests. All of the following tests can provide useful information concerning the toxicity of effluents, but they are usually not required by NPDES permits, although they may be of value to developing TRE plans when required (reference 11).

(1) Larval Fish Bioassays. Larval fathead minnows are exposed to an effluent and dilutions of it in order to estimate the effects of long-term toxicity.

(2) Invertebrate Bioassays. Invertebrates such as mayflies, caddisflies, stoneflies, water fleas, and scuds constitute a major portion of the food supply for some fish. A reduction in the number of invertebrates in a stream receiving toxic substances, therefore, can have a negative impact on fish. Although flow-through bioassays for invertebrates do exist, generally 48-hour static bioassays are performed in accordance with reference 5.

(3) Algal Tests. Static algal bioassays have the advantage of assessing not only toxic but also biostimulatory effects of an effluent. Since algal tests measure the growth rates of algal cultures exposed to an effluent or chemical, algal toxicity is expressed as an EC_{50} value -- the effective concentration which reduces an algal growth rate 50 percent.

(4) Rapid Assessment Techniques. When fish are subjected to toxic substances, they respond physiologically through changes in their heart and respiration rates. Various techniques accounting for these and other physiological responses have been used to biomonitor effluents. When fish exposed to an effluent show enough stress to indicate that the effluent is harmful, the wastewater can be diverted for additional treatment or the existing treatment system can be altered to solve the problem.

(5) Ames Test. This test detects chemical mutagens and potential carcinogens by measuring the mutation rates of special strains of a species of bacteria, Salmonella typhimurium, exposed to chemicals or effluents. Its chief advantages are that it only requires 48 hours and is far less expensive than the long term mutagenicity studies involving rats and other laboratory animals.

(6) Microtox®. This rapid method of assessing acute aquatic toxicity measures the amount of light reduction which occurs when a specific quantity of luminescent bacteria (Photobacterium phosphoreum) is exposed to various concentrations of a toxicant. The EC_{50} value which it yields, in this case, is the toxicant concentration which reduces the light output of the exposed bacteria by 50 percent.

5. RESEARCH NEEDS. The USAEHA perceives a need for biological toxicity/testing which is less resource-intensive than those presently available. One suggestion has been a probe-type device with associated instrumentation, in which changes of biological activity due to toxicants by membrane-immobolized microbes or enzyme systems can be detected by changes in electromotive potential or by/changes in spectrophotometric properties.

6. REFERENCES. A list of references is included as Enclosure 2.

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* Microtox is a registered tradename of Microbics Corporation, Carlsbad, California. Use of this tradename does not imply endorsement by the U.S. Army but is only intended to assist in identification of a specific product.

[OW-FRL-2533-1]

Development of Water Quality-Based Permit Limitations for Toxic Pollutants; National Policy

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: EPA has issued a national policy statement entitled "Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants." This policy addresses the technical approach for assessing and controlling the discharge of toxic substances to the Nation's waters through the National Pollutant Discharge Elimination System (NPDES) permit program.

FOR FURTHER INFORMATION CONTACT: Bruce Newton or Rick Brandes, Permits Division (EN-336), Office of Water Enforcement and Permits, U.S. Environmental Protection Agency, Washington, D.C. 20460, 426-7010.

Encl 1

SUPPLEMENTARY INFORMATION: As the water pollution control effort in the United States progresses and the "traditional" pollutants (oxygen demanding and eutrophying materials) become sufficiently treated to protect water quality, attention is shifting towards pollutants that impact water quality through toxic effects. Compared with the traditional pollutants, regulation of toxic pollutants is considerably more difficult. The difficulties include (1) the great number of toxic chemicals that may potentially be discharged to receiving waters and the difficulties in their analysis; (2) the changes in the toxic effects of a chemical resulting from reactions with the matrix of constituents in which it exists; and (3) the inability to predict the effects of exposure to combinations of chemicals.

To overcome some of these problems, EPA and the States have begun to use aquatic toxicity tests and various human health assessment techniques to complement chemical analyses of effluents and receiving water samples. Because these techniques or their application to effluent testing are new, EPA and the States have been cautious in their use. Based on EPA's evaluation of these techniques and the experiences of several States, EPA is now recommeding the use of biological techniques as a complement to chemical-specific analyses to assess effluent discharges and express permit limitations. EPA has issued these recommendations through a statement of policy and is developing a technical guidance document to help implement the policy.

The complete test of the national policy statement follows:

Policy for the Development of Water Quality-Based Permit Limitations for Toxic Pollutants

Statement of policy

To control pollutants beyond Best Available Technology Economically Achievable (BAT), secondary treatment, and other Clean Water Act technology-based requirements in order to meet water quality standards, the Environmental Protection Agency (EPA) will use an integrated strategy consisting of both biological and chemical methods to address toxic and nonconventional pollutants from industrial and municipal sources. Where State standards contain numerical criteria for toxic pollutants, National Pollutant Discharge Elimination System (NPDES) permits will contain limits as necessary to assure compliance with these standards. In addition to enforcing specific numerical criteria, EPA and the States will use biological techniques and available data on chemical effects to assess toxicity impacts and human health hazards based on the general standard of "no toxic materials in toxic amounts."

EPA, in its oversight role, will work with States to ensure that these techniques are used wherever appropriate. Under section 308 and section 402 of the Clean Water Act (the Act), EPA or the State may require NPDES permit applicants to provide chemical, toxicity, and instream biological data necessary to assure compliance with standards. Data requirements may be determined on a case-by-case basis in consultation with the State and the discharger.

Where violations of water quality standards are identified or projected, the State will be expected to develop water quality-based effluent limits for inclusion in any issued permit. Where necessary, EPA will develop these limits in consultation with the State. Where there is a significant likelihood of toxic effects to biota in the receiving water, EPA and the States may impose permit limits on effluent toxicity and may require an NPDES permittee to conduct a toxicity reduction evaluation. Where toxic effects are present but there is a significant likelihood that compliance with technology-based requirements will sufficiently mitigate the effects, EPA and the States may require chemical and toxicity testing after installation of treatment and may reopen the permit to incorporate additional limitations if needed to meet water quality standards. (Toxicity data, which are considered "new information" in accordance with 40 CFR 122.62(a)(2), could constitute cause for permit modification where necessary.)

To carry out this policy, EPA Regional Administrators will assure that each Region has the capability to conduct water quality assessments using both biological and chemical methods and provide technical assistance to the States.

Background

The Clean Water Act establishes two principal bases for effluent limitations. First, existing dischargers are required to meet technology-based effluent limitations that reflect the best controls available considering economic impacts. New source dischargers must meet the best demonstrated technology-based controls. Second, where necessary, additional requirements are imposed to assure attainment and maintenance of water quality standards established by the States and approved by EPA. In establishing or reviewing NPDES permit limits, EPA must ensure that the limits will result in the attainment of water quality standards and protect designated water uses, including an adequate margin of safety.

For toxic and nonconventional pollutants it may be difficult in some situations to determine attainment or nonattainment of water quality standards and set appropriate limits because of complex chemical interactions which affect the fate and ultimate impact of toxic substances in the receiving water. In many cases, all potentially toxic pollutants cannot be identified by chemical methods. In such situations, it is more feasible to examine the whole effluent toxicity and instream impacts using biological methods rather than attempt to identify all toxic pollutants, determine the effects of each pollutant individually, and then attempt to assess their collective effect.

The scientific basis for using biological techniques has advanced significantly in recent years. There is now a general consensus that an evaluation of effluent toxicity, when adequately related to instream conditions, can provide a valid indication of receiving system impacts. This information can be useful in developing regulatory requirements to protect aquatic life, especially when data from toxicity testing are analyzed in conjunction with chemical and ecological data. Generic human health effects methods, such as the Ames mutagenicity test, and structure-activity relationship techniques are showing promise and should be used to identify potential hazards. However, pollutant-specific techniques are the best way to evaluate and control human health hazards at this time.

Biological testing of effluents is an important aspect of the water quality-based approach for controlling toxic pollutants. Effluent toxicity data in conjunction with other data can be used to establish control priorities, assess compliance with State water quality standards, and set permit limitations to achieve those standards. All States have water quality standards which include narrative statements prohibiting the discharge of toxic materials in toxic amounts. A few State standards have criteria more specific than narrative criteria (for example, numerical criteria for specific toxic pollutants or a toxicity criterion to achieve designated uses). In States where numerical criteria are not specified, a judgment by the regulatory authority is required to set quantitative water quality-based limits on chemicals and effluent toxicity to assure compliance with water quality standards.

Note.—Section 308 of the Act and corresponding State statutes authorize EPA and the States to require of the owner/operator any information reasonably required to determine permit limits and to determine compliance with standards or permit limits. Biological methods are specifically mentioned. Toxicity permit limits are authorized under Section 301 and 402 and supported by Section 101.

Application

This policy applies to EPA and the States. The policy addresses the use of chemical and biological methods for assuring that effluent discharges are regulated in accordance with Federal and State requirements. This policy was prepared, in part, in response to concerns raised by litigants to the Consolidated Permit Regulations (see FR 52079, November 18, 1982). Use of these methods for developing water quality standards and trend monitoring are discussed elsewhere (see 48 FR 51400, November 8, 1983 and *Basic Water Monitoring Program* EPA-440/9-76-025). This policy is part of EPA's water quality-based control program and does not supersede other regulations, policy, and guidance regarding use attainability, site-specific criteria modification, wasteload allocation, and water quality management.

Implementation

State Role

The control of toxic substances to protect water quality must be done in the context of the Federal-State partnership. EPA will work cooperatively with the States in identifying potential water quality standards violations, assembling relevant data, developing appropriate testing requirements, determining whether standards are being violated, and defining appropriate permit limits.

Note.—Under sections 303 and 401 of the Act, States are given primary responsibility for developing water quality standards and limits to meet those standards. EPA's role is to review the State standards and limits and develop revised or additional standards or limits as needed to meet the requirements of the Act.

Integration of Approaches

The type of testing that is most appropriate for assessing water quality impacts depends on the type of effluent and discharge situation. EPA recommends that an integrated approach, including both biological and chemical techniques, be used to assess and control water quality. The principal advantages of chemical-specific techniques are that (1) chemical analyses are usually less expensive than biological measurements in simple cases; (2) treatment systems are more easily designed to meet chemical requirements than toxicity requirements; and (3) human health hazards and bioaccumulative pollutants can best be addressed at this time by chemical-specific analysis. The principal advantages of biological techniques are that (1) the effects of complex discharges of many known and unknown constituents can be measured only by biological analyses; (2) bioavailability of pollutants after discharge is best measured by toxicity testing; and (3) pollutants for which there are inadequate chemical analytical methods or criteria can be addressed.

Pollutant-specific chemical analysis techniques should be used where discharges contain few, well-quantified pollutants and the interactions and effects of the pollutants are known. In addition, pollutant-specific techniques should be used where health hazards are a concern or bioaccumulation is suspected. Biological techniques should be used where effluents are complex or where the combined effects of multiple discharges are of concern. EPA recognizes that in many cases both types of analysis must be used.

Testing Requirements

Requirements for dischargers to collect information to assess attainment or nonattainment of State water quality standards will be imposed only in selected cases where the potential for nonattainment of water quality standards exists. Where water quality problems are suspected but there is a strong indication that complying with BCT/BAT will sufficiently mitigate the impacts, EPA recommends that applicable permits include testing requirements effective after BCT/BAT compliance and reopener clauses allowing reevaluation of the discharge.

The chemical, physical, and biological testing to be conducted by individual dischargers should be determined on a case-by-case basis. In making this determination, many factors must be considered, including the degree of impact, the complexity and variability of the discharge, the water body type and hydrology, the potential for human health impact, the amount of existing data, the level of certainty desired in the water quality assessment, other sources of pollutants, and the ecology of the receiving water. The specific data needed to measure the effect that a discharger has on the receiving water will vary according to these and other factors.

An assessment of water quality should, to the extent practicable, include other point and nonpoint sources of pollutants if the sources may be contributing to the impacts. Special attention should be focused on Publicly Owned Treatment Works (POTW's) with a significant contribution of industrial waste-water. Recent studies have indicated that such POTW's are often significant sources of toxic materials. When developing monitoring requirements, interpreting data, and determining limitations, permit engineers should work closely with water quality staff at both the State and Federal levels.

A discharger may be required to provide data upon request under section 308 of the Act, or such a requirement may be included in its NPDES permit. The development of a final assessment may require several iterations of data collection. Where potential problems are identified, EPA or the State may require monitoring to determine whether more information is needed concerning water quality effects.

Use of Data

Chemical, physical, and biological data will be used to determine whether, after compliance with BCT/BAT requirements, there will be violations of State water quality standards resulting from the discharge(s). The narrative prohibition of toxic materials in toxic amounts contained in all State standards is the basis for this determination taking into account the designated use for the receiving water. For example, discharges to waters classified for propagation of cold water fish should be evaluated in relation to acute and chronic effects on cold water organisms, potential spawning areas, and effluent dispersion.

Setting Permit Limitations

Where violations of water quality standards exist or are projected, the State and EPA will determine pollution control requirements that will attain the receiving water designated use. Where effluent toxicity is an appropriate control parameter, permit limits on effluent toxicity should be developed. In such cases, EPA may also require a permittee to conduct a toxicity reduction evaluation. A toxicity reduction evaluation is an investigation conducted within a plant or municipal system to isolate the sources of effluent toxicity, specific causative pollutants if possible, and determine the effectiveness of pollution control options in reducing the effluent toxicity. If specific chemicals are identified as the cause of the water quality standards violation, these individual pollutants should be limited. If a toxicity reduction evaluation demonstrates that limiting an indicator parameter will ensure attainment of the water quality-based effluent toxicity requirement, limits on the indicator parameter should be considered in lieu of limits on effluent toxicity. Such indicator limits are not limits on causative pollutants but limits demonstrated to result in a specific toxicity reduction.

Monitoring

Where pollution control requirements are expressed in terms of a chemical or toxicological parameter, compliance monitoring must include monitoring for that parameter. If an indicator parameter is used based on the results of a toxicity reduction evaluation, periodic toxicity testing may be required to confirm the adequacy of the indicator. Where biological data were used to develop a water quality assessment or where the potential for water quality standards violations exist, biological monitoring (including instream monitoring) may be required to ensure continuing compliance with water quality standards.

EPA believes that the intelligent application of an integrated strategy using both biological and chemical techniques for water quality assessment will facilitate the development of appropriate controls and the attainment of water quality standards. EPA looks forward to working with the States in a spirit of cooperation to further refine these techniques.

Policy signed February 3, 1984 by Jack E. Ravan, Assistant administrator for Water.

Dated: February 16, 1984.

Jack E. Ravan,

Assistant Administrator for Water.

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HSHB-ME-WM
SUBJECT: Water Quality Information Paper Number 5

REFERENCES

1. Public Law 94-469, 11 October 1976, Toxic Substances Control Act of 1976.

2. Public Law 95-217, 27 December 1977, The Clean Water Act, as Amended.

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5. EPA 600/4-85-013, March 1985, Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.

6. EPA 600/4-85-014, December 1985, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.

7. EPA 600/8-85-015, 1985, Validity of Effluent and Ambient Toxicity Tests for Prediciting Biological Impact, Five Mile Creek, Birmingham, Alabama.

8. EPA 600/3-85-044, 1985, Validity of Effluent and Ambient Toxicity Tests for Predicting Biological Impact, Scippo Creek, Circleville.

9. EPA 625/8-87-013, September 1987, Biomonitoring to Achieve Control of Toxic Effluents, Cuyohoga River, Akron, Ohio.

10. U.S. Army Environmental Hygiene Agency, HSHB-EW-A, subject: Water Quality Information Pare (Paper) No. 5, NPDES Biomonitoring Requirements, 19 April 1982.

11. Scientific Committee on Problems of the Environment (SCOPE), International Council of Scientific Unions, Effects of Pollutants at the Ecosystems Level, SCOPE Monograph Number 22, John Wiley and Sons, 1984.

12. US EPA, Interim NPDES Compliance Biomonitoring Inspection Manual, Document Number MCD-62, October 1969.

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ENCL 2

HSHB-ME-SW
Subject: Water Quality Information Paper Number 6

REFERENCES

1. Public Law 94-469; 11 October 1976, Toxic Substances Control Act of 1976.

2. Public Law 95-217; 27 December 1977, The Clean Water Act, as amended.

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4. EPA 600/3-84-080; August 1984, Effluent and Ambient Toxicity Testing and Instream Community Response on the Ottawa River, Lima, Ohio.

5. EPA 600/4-85-013; March 1985, Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.

6. EPA 600/4-85-014; December 1985, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.

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9. EPA 625/8-87-013, September 1987, Biomonitoring to Achieve Control of Toxic Effluents, Cuyahoga River, Akron, Ohio.

10. U.S. Army Environmental Hygiene Agency, HSHB-EW-A, subject: Water Quality Information Care (Paper) No. 5, NPDES Biomonitoring Requirements, 19 April 1982.

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