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WHOLE EFFLUENT TOXICITY REDUCTION GUIDANCE Rev. 10/01

This document has been prepared by the N.C. Water Quality Section's Aquatic Toxicology Unit to aid NPDES permittees, their consultants, and state regulatory staff with the development of whole effluent toxicity identification and reduction plans. As has been the operating strategy of the Water Quality Section in the past, this document will not attempt to present a strictly defined procedure to accomplish toxicity reduction, as such defined processes limit the ability to design programs custom fitted to the situation of each discharge. Rather, this document will attempt to present a series of logical steps that can be initiated to help track effluent toxicity sources, trends, and investigate possible avenues of toxicity reduction. Nearly all steps presented herein have originally been described by documents published by the U.S. Environmental Protection Agency including:

United States Environmental Protection Agency. 1991. *Methods for Aquatic Toxicity Identification Evaluations: Phase I. Toxicity Characterization Procedures*. 2nd Edition. EPA-600-6-91-003. National Effluent Toxicity Assessment Center, Duluth, MN.

United States Environmental Protection Agency. *Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I*. EPA/600/6-91/005F. May 1992. National Effluent Toxicity Assessment Center, Duluth, MN.

United States Environmental Protection Agency. 1993. *Methods for Aquatic Toxicity Identification Evaluations-Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity*. EPA-600-R-92-080. National Effluent Toxicity Assessment Center, Duluth, MN.

United States Environmental Protection Agency. 1993. *Methods for Aquatic Toxicity Identification Evaluations-Phase III Toxicity Confirmation Procedures for Samples Exhibiting Acute and Chronic Toxicity*. EPA-600-R-92-081. National Effluent Toxicity Assessment Center, Duluth, MN.

United States Environmental Protection Agency. 1996. *Marine Toxicity Identification Evaluation (TIE): Phase I Guidance Document*. EPA/600/R-96-054. National Health and Environmental Effects Laboratory, Narragansett, RI.

United States Environmental Protection Agency. *Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants*. EPA-833B-99-002. Office of Water, Washington, D.C.

United States Environmental Protection Agency. 1989. *Generalized Methodology for Conducting Industrial Toxicity Reduction Evaluations*. EPA-600-2-88-070. Office of Research and Development, Cincinnati, OH.

United States Environmental Protection Agency. "Clarifications Regarding Toxicity Reduction and Identification Evaluations in the National Pollutant Discharge Elimination System Program." March 27, 2001. Office of Wastewater Management, Washington, D.C.

These documents should be available from:

National Technical Information Service
5285 Port Royal Rd.
Springfield Va. 22161
(703) 487-4650

Anyone developing a toxicity reduction plan should obtain copies of one or more of these documents as appropriate in order to better understand the strengths and weaknesses of each step

and be better able to plan further actions. Included in this guidance are outlines of general toxicity reduction evaluations for both industrial and municipal wastewater treatment facilities. These outlines demonstrate decision paths that may be encountered in performing a TRE, as described in detail by the EPA documents.

A logical starting place for investigations of toxicity sources and reduction is a thorough information gathering phase. At this stage, several preliminary issues should be investigated and information evaluated for potential causes/sources of toxicity, effluent variability, treatment system efficiency, etc.

For municipal wastewater treatment plants (WWTPs) this information may include:

- The NPDES permit
- Treatment system design criteria, flow diagrams, descriptions of treatment elements
- Influent and effluent flow data
- Influent and effluent conventional pollutant data and removal efficiencies
- Effluent toxicity data and trends
- Process control and operational data and histories
- In-plant chemical usage (polymers, coagulants, chlorine)
- Treatment upset histories and reports
- Pretreatment information
 - Industrial waste surveys
 - Industrial user self-monitoring reports
 - Industrial user operational schedules and flow patterns
 - Waste hauler monitoring and manifests
 - Hazardous waste inventories

For industrial wastewater treatment WWTPs this information may include:

- Process and wastewater generating process diagrams and descriptions
- Production records
- Diagrams and descriptions of non-process wastewater sources (cooling towers, boilers, floor drains)
- In-plant flow records and water usage
- Chemical inventories and usage records
- Chemical labels, material safety data sheets (MSDS), and toxicity information
- Operating schedules with emphasis on how these schedules affect wastewater flow/composition
- WWTP operational data and histories
- Wastewater monitoring records(chemical and toxicity)

The overall importance of this initial information gathering phase to the success of a toxicity reduction evaluation cannot be overestimated both in terms of eventual outcome as well as the efficiency with which that outcome is achieved. In many instances, it is likely that sources of toxicity can be escalated or de-escalated as targets for investigation by simple calculation rather than further testing, greatly reducing the cost of the investigation. This information gathering phase will often be accomplished by the permittee prior to contact with any paid consultants and before any actual testing takes place. By carefully reviewing the information gathered and comparing trends in flow patterns, treatment efficiency, wastewater loading and effluent constituents with toxicity patterns observed over time, the permittee may be able to narrow the scope of further investigations and possibly even identify problem constituents.

Following information acquisition, emphasis should next be placed on maximizing in-house treatment efficiency and assuring that housekeeping practices are not contributing unnecessarily to final effluent toxicity. Waste treatment efficiency must be maximized during this process in order that it does not present a moving target in itself. Industrial facilities should identify and regulate all possible contributions to the wastewater system, including floor drain discharges where unwanted materials may be disposed without the knowledge of wastewater treatment staff. In addition to the obvious industrial process waste streams, side streams such as cooling tower discharge, boiler blowdown, or airwash discharges should be reviewed for the presence of sometimes very toxic chemicals. Toxicity information is now readily available for many commonly used biocidal compounds used in these applications. Municipal systems should investigate the toxicity of any added treatment chemicals and review effluent toxicity vs. use records of such chemicals. Effluent chlorination and ammonia frequently prove to be two of the most commonly encountered causes of effluent toxicity. Over-chlorination and excess variation in chlorination should be high on the list as potential toxicity problems.

At this point a good informational base should have been developed and wastewater treatment efficiency should be at peak sustainable levels. If still necessary, a Toxicity Identification Evaluation (TIE) could now be initiated to help characterize the chemical/physical nature of the problem constituents. This series of tests, described by the EPA TIE manuals referenced previously consists of a series of chemical/physical manipulations of the wastewater followed by subsequent toxicity tests that can identify or rule out possible toxicants. A TIE will most likely require the expertise of a team of biologists, chemists, and possibly wastewater engineers experienced with these protocols due to the site-specific decisions that must be made in development and interpretation of results. Some of the complex analytical procedures required by TIE protocols may not be available in many wastewater laboratories. As such, consultants specializing in toxicity reduction may need to be sought. A TIE series should be carefully planned and monitored through its duration with interim findings communicated back to the collection and treatment system managers for immediate investigation. Where these interim findings point to a possible source of toxicity, modifications in chemicals being used or disposal/use patterns may be modified to efficiently solve toxicity problems.

Once problem constituents have been characterized and/or identified, in either an individual industrial discharge or in a municipal system, the sources of these constituents can be tracked to the source and addressed through product substitution, waste reduction, or recycle/reuse systems. With few exceptions, removal of these problem constituents will be more cost effective by these means than by treatment. If treatment is necessary, TRE efforts can shift to bench or pilot scale treatability studies.

In municipal treatment systems where the sources of problem constituents are not known, a procedure referred to as Refractory Toxicity Assessment (RTA) can be employed, as described by EPA-833B-99-002. This approach utilizes bench scale treatment of various influent sources to determine which wastestreams pass through the treatment system without effective detoxification.

For either industrial or municipal discharges, custom designed toxicity tests to answer specific questions can be beneficial. If well designed, these tests can be significantly reduced in both complexity and cost from those required for NPDES compliance testing. Such tests could address the toxicity of individual streams contributing to the whole effluent or tests of process or treatment chemicals to address relative toxicity. Consultants experienced with performing

toxicity reduction work should be able to design such tests and significantly reduce costs by doing so. As stated earlier, the position of the N.C. Water Quality Section is that the goal of this process is to reduce observed toxicity in the effluent. Finding the most efficient means of reaching this goal is encouraged so that unnecessary testing and costs are not incurred.

Technical staff of the Water Quality Section reviews most toxicity reduction plans. Reviewers of these plans will judge adequacy based on information provided and the technical ability of the plans to address the problems encountered in each specific application. Generally, those plans that follow the logic of the EPA described toxicity reduction evaluation guidance will meet the intent of most TRE requirements. The EPA document “ Technical Support Document for Water Quality-based Toxics Control” (EPA/505/2-90-001, PB91-127415, March 1991, p. 116) includes a list of evaluation criteria for TRE plans that can be helpful in designing or evaluating a plan submitted by a consultant. The ideas presented by this list include important concepts that the Water Quality Section evaluates when reviewing the effectiveness of TRE proposals. That list is as follows:

- Are the objectives or targets of the TRE stated clearly and accurately?
- Are the schedule milestones for accomplishing the tasks described in the study plan?
- Are the final TRE report, progress reports, and meetings with the regulatory authority included as part of the schedule?
- Are the approaches or methods to be used described to the extent possible prior to beginning the TRE?
- Has available EPA guidance been used in designing the TRE and developing the TRE plan (or if other methods are proposed, are these sufficiently documented)?
- Does the TRE plan specify what results and data are to be included in the interim and final reports?
- Does the TRE plan provide for arrangements for any inspections or visits to the facility or laboratory that are determined to be necessary by the regulatory authority?
- Are the toxicity test methods and endpoints to be used described or referenced?
- Does the approach described build on previous results and proceed by narrowing down the possibilities in a logical progression?
- Does the plan provide for all test results to be analyzed and used to focus on the most effective approach for any subsequent source investigations, treatability studies, and control evaluations?
- Are optimization of existing plant/treatment operations and spill control programs part of the initial steps of the TRE?
- Does the TRE plan allow a sufficient amount of time and appropriate level of effort for each of the components of the study plan?
- Does the TIE use broad characterization steps and consider quantitative and qualitative effluent variability?
- Is toxicity tracked with aquatic organism toxicity tests throughout the analyses?
- Is the choice of tests for the TRE logical and will correlations be conducted if the species used are different from those used for routine biomonitoring?
- Is the laboratory analytical capability and the expertise of the investigator broad enough to conduct the various components of the evaluation?

A question that will undoubtedly arise is “What will be the State's role in the TIE/TRE process?” The Water Quality Section's regional office staff should be the first point of contact in these

issues. Most often, they will have the best knowledge of specific facilities and will be the hub of compliance activities. Staff of the Aquatic Toxicology Unit in Raleigh can provide information and technical guidance on toxicity and toxicity reduction issues. One of the responsibilities of this Unit is review of submitted TRE plans addressing the proposed logic and direction undertaken to reduce toxicity. The comments provided by this Unit incorporate the technical expertise of individuals whom, over the years, have evaluated TIE/TRE plans and provided recommendations related to those plans. Additional information on waste reduction and reuse strategies may be available from the N.C. Division of Pollution Prevention and Environmental Assistance at (919) 715-6500. The latter is a non-regulatory program designed to provide the industrial/commercial sector with information in this area.

Successful toxicity reduction can rely to a great extent on selection of a competent and qualified contractor to conduct toxicity reduction activities should the services of a qualified contractor be needed to resolve toxicity noncompliance. A simple question that should be addressed to a toxicity consultant prior to retaining services is “What has been your success and experience with conducting toxicity reduction evaluations?”

Should there be any questions related to this guidance document or to toxicity reduction strategies, we encourage you to contact Cindy Moore (cindy.a.moore@ncmail.net) or John Giorgino (john.giorgino@ncmail.net) of the Aquatic Toxicology Unit at (919) 733-2136. The most recent version of this document may be found online at <http://www.esb.enr.state.nc.us/ATUwww/Default.html>.