# Whole Effluent Toxicity (WET) Evaluation Summary

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# WET Program Evaluation Summary

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## I. Introduction

The Water Quality Program's Permit Management Section has planned from the beginning to evaluate the implementation of the state's regulation on Whole Effluent Toxicity (WET) adopted in October 1993. Since then, we have been very active in evaluating the performance of WET tests and have developed a detailed review process for the WET test results. This document summarizes our experience with WET testing and effluent toxicity. It also presents our thoughts on the interaction of regulation and science in controlling toxicity in the state's waters. If you wish, we have available another version of this document which is twice as long, contains greater detail, and cites references.

The first three sections of this document provide background and a description of the WET program as it exists today. The fourth section discusses improvements to the implementation of the WET program and offers new strategies for consideration. The fifth section considers various scientific issues involved in WET testing. The last section evaluates the relationship between science and regulation and presents our regulatory philosophy for WET.

Even though our state's WET program has generated no serious controversy in the last five years, at the national level, WET is one of the most controversial elements of water quality-based permitting. Concerned congressional representatives have introduced individual bills on the subject of WET alone. The Environmental Protection Agency (EPA) has responded by consulting stakeholders and the scientific community, especially the Society of Environmental Toxicology and Chemistry (SETAC). How these discussions will affect our WET program has yet to be seen.

## II. History and Background

### A. What is WET Testing?

Chemical analysis of wastewater discharges is inadequate by itself for regulating toxicity. Many toxic pollutants cannot be detected by commonly available methods. Many of the chemicals that can be detected have little, or no, toxicity information available on them. Many of the chemicals with known toxicity have unknown additive or synergistic effects when present in wastewater. The toxicity of effluents, or ambient waters can be measured directly by exposing living organisms and measuring their response. Toxicity tests measure the combined effects of all toxic constituents of the effluent sample, which is why it is called WET testing.

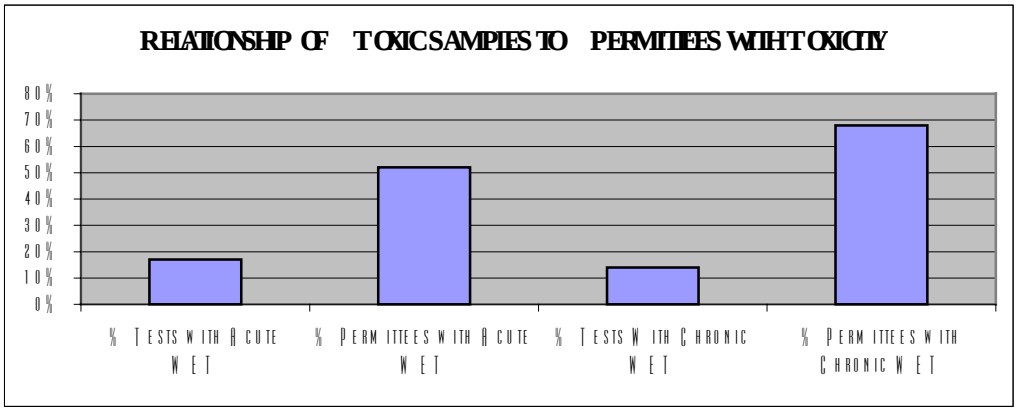
Acute WET tests involve exposing test organisms to serial dilutions of effluent in order to determine survival at 48 or 96 hours. Chronic WET tests either are short-term (7-day) chronic tests which evaluate survival and growth or reproduction or are critical lifestage tests assessing fertilization or development. The chronic point of compliance is the edge of a mixing zone where receiving water must be suitable for long-term habitation. Inside of the mixing zone and close to the discharge point is the acute point of compliance where there must be no lethality as measured by an acute WET test.

### B. How Toxic are Effluents in this State?

An important conclusion from examining the occurrence of acute and chronic WET in Washington State is that the technology-based permitting program was fairly successful in controlling toxicity. Forty-seven percent of acute tests had 100 percent survival in 100 percent effluent, and 72 percent

had 90 percent survival or better in 100 percent effluent. A majority of the chronic tests also show no toxicity at levels of regulatory concern. The average effluent concentration at the edge of an acute mixing zone is 17 percent effluent. The edge of the acute mixing zone is used in our state as the cutoff for regulatorily significant chronic toxicity and the need for a chronic WET limit. Eighty-four percent of the No Observed Effects Concentration (NOEC) in the database from chronic tests were greater than or equal to 17 percent effluent and estimated to be of no regulatory concern. The NOEC or "no observed effects concentration" is the highest concentration of effluent showing no statistically significant difference from the control. Fifty-nine percent of chronic NOECs were 100 percent effluent, which demonstrates no toxicity at end of pipe. The bivalve development and echinoderm fertilization tests are exceptions with only 30 percent of 151 tests having NOECs above concentrations of regulatory concern due to the toxicity of the industrial effluents commonly evaluated with these tests.

The bad news associated with our experience with WET test results is the wide distribution amongst permittees of those tests showing significant toxicity. Only 48 percent of permittees have never shown acute WET at levels of regulatory concern, and only 39 percent have never reported chronic WET test results at levels of regulatory concern. The 14 percent of chronic tests with toxicity of regulatory concern were distributed across 68 percent of the permittees in the database. These occasional excursions have unknown duration and environmental impact because of inadequate monitoring frequencies.




## C. Laws and Regulations of Importance

The Clean Water Act Amendments of 1987 directed EPA and the states to identify waters and discharges with a toxic pollutant problem and to develop a control strategy including individual permit limits to attain water quality standards. In July 1989, EPA promulgated regulations (40 CFR 122.44) which require states to place limits on whole effluent toxicity in NPDES permits when a reasonable potential to exceed water quality standards has been determined.

The State of Washington has added its own legal requirements for acute and chronic biomonitoring through both law and regulation. RCW 90.48.520 requires that the overall toxicity of effluents be controlled. Chapter 173-201A WAC, **Water Quality Standards**, contains requirements for each of the different criteria classes of water to have concentrations of toxics below levels, which cause acute or chronic damage to the aquatic biota. In addition to these standards, Section 173-220-130 WAC, Effluent limitations, water quality standards

and other requirements for permits, instructs the Department of Ecology to apply the requirements of RCW 90.48.520 to any permit issued under the NPDES.

### D. The State's WET Rule

In October 1993, Ecology adopted a WET regulation (Chapter 173-205 WAC) that was written to satisfy the laws and regulations discussed above. It was also written as a part of an agreement to settle appeals of NPDES permits.

The state's WET regulation received support in writing from cities, industries, and environmental groups. There have been no serious appeals of the WET requirements in our permits in five years.

The regulation complies with the national WET policy, but it is also innovative in containing incentives to reduce toxicity beyond what is necessary to meet WET limits. A WET limit will be eligible for removal upon permit renewal if the permittee has consistently attained a level of toxicity so low that no reasonable potential exists to violate water quality standards. The permitting process under the WET Rule works as follows:

Step 1 - The process begins with a NPDES permit application.

Step 2 - Section 173-205-040 of the WET rule contains a list of circumstances under which a discharge is required to be characterized for WET.

Step 3 - WET testing usually begins with an effluent characterization in the first year of the permit term. Characterization establishes the baseline toxicity level and determines the need for WET limits.

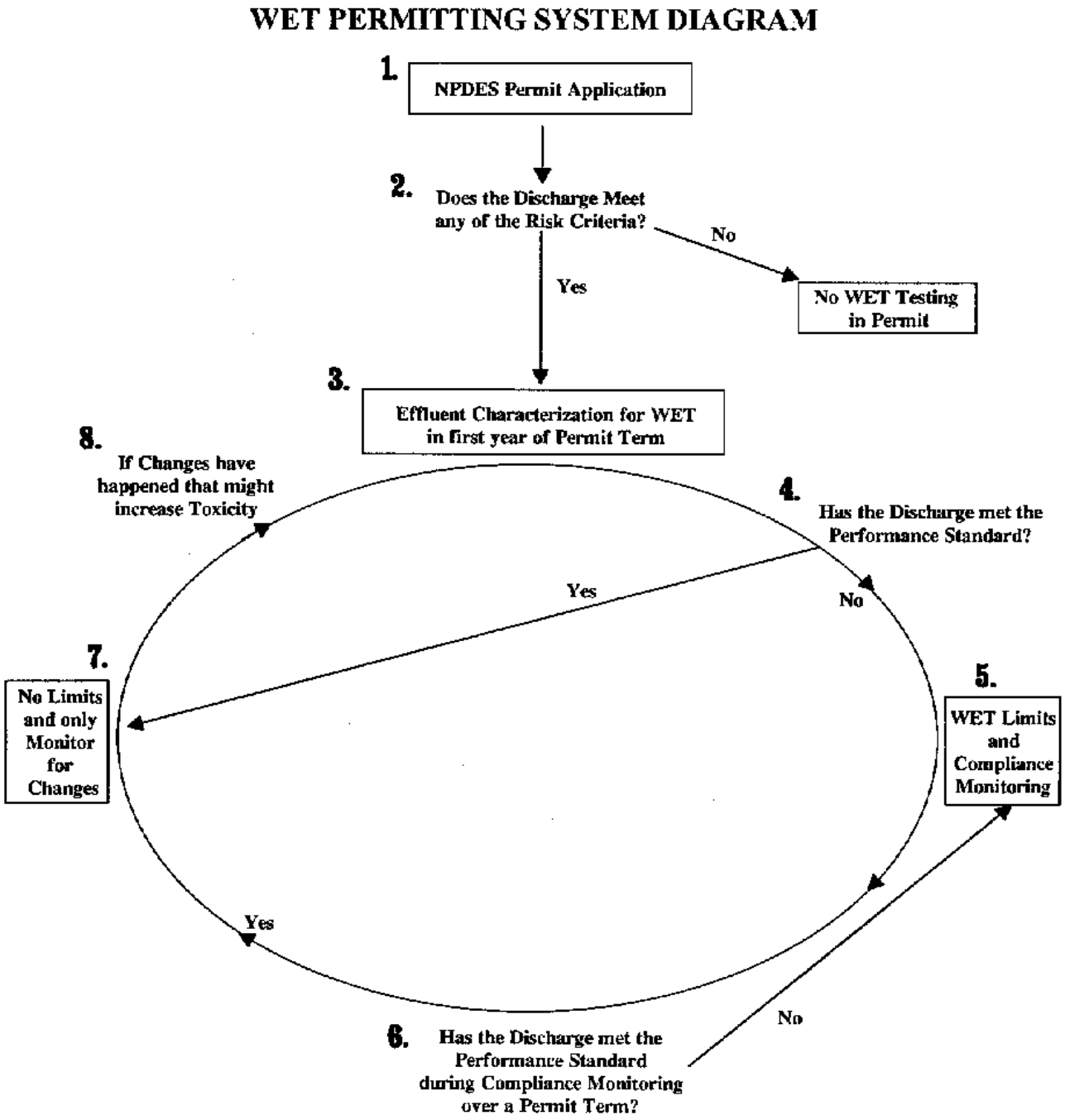
Step 4 - The permit will require that the permittee determine at the end of effluent characterization whether the WET performance standards have been met for acute and chronic toxicity. The performance standard for acute toxicity is a median of at least 80 percent survival in 100 percent effluent with no single test showing less than 65 percent survival in 100 percent effluent. The performance standard for chronic toxicity is no chronic toxicity in a concentration of effluent representing the edge of the acute mixing zone or the Acute Critical Effluent Concentration (ACEC) Those permittees who meet the performance standards will not get WET limits or compliance monitoring (will go straight to Step 7).

Step 5 - Those permittees who do not meet a performance standard during effluent characterization will receive WET limits. Acute WET limits are met by showing no statistically significant toxicity in the ACEC. Chronic WET limits are met by showing no statistically significant toxicity in the Chronic Critical Effluent Concentration (CCEC) which represents the edge of the chronic mixing zone). Failing a compliance test for a WET limit will trigger additional WET testing, and if any of the additional tests fail to meet the WET limit, a toxicity identification/reduction evaluation (TI/RE) will be required to find and fix the source of toxicity.

Step 6 - If a permittee with a WET limit meets the performance standard for an entire permit term, then the WET limit will not be placed into subsequent permits. If a permittee fails to meet the performance standard during compliance monitoring, then the WET limit and compliance monitoring will remain in future permits until the performance standard is met.

Step 7 - Permittees who have attained the performance standards can remain indefinitely without WET limits or compliance monitoring. The only WET testing requirement will be a set of WET tests submitted with each permit application. Some permittees are required to conduct rapid screening testing. All facility changes must be evaluated for increases in toxicity.

Step 8 - If changes have occurred which might increase toxicity, then the next permit will contain a requirement for a new effluent characterization. The new effluent characterization will start the process all over again beginning at Step 3. WET limits might result from the new effluent characterization or the permittee could end up back at Step 7 with no WET limits.



The projected status of Washington State permittees under the WET Rule is as follows:

An evaluation of the WET test data for all permittees represented in the database was conducted. The evaluation considered 132 permittees with 1800 acute WET tests. The chronic WET test status was evaluated for the 54 permittees (55 percent of the dischargers with chronic tests) with a known ACEC. The ACEC and CCEC are known for only 55 percent of the permittees represented in the WET database. The data provided the following estimates:

- 52 percent of permittees are predicted to be assigned an acute WET limit.
- 61 percent of permittees are predicted to be assigned a chronic WET limit.
- About one third of the permittees are predicted to get both acute and chronic WET limits and another third may not get any WET limits.

***Estimate of Number of Discharges Needing Acute WET Limits***

| Discharge Type | # Permittees | # Acute Limits | % Acute Limits |
|---|---|---|---|
| POTWs | 53 | 30 | 57% |
| General Industry | 33 | 12 | 36% |
| Power Plants | 2 | 0 | 0% |
| Pulp Mills | 16 | 9 | 56% |
| Oil Refineries | 7 | 6 | 86% |
| Aluminum Smelters | 7 | 5 | 71% |
| Treated Groundwater | 1 | 1 | 100% |
| Ind. Process & Storm. | 3 | 2 | 67% |
| Industrial Stormwater | 10 | 4 | 40% |
| ***TOTAL*** | 132 | 69 | 52% |

***Estimate of Number of Discharges Needing Chronic WET Limits***

| Discharge Type | # Permittees | # Chronic Limits | % Chronic Limits |
|---|---|---|---|
| POTWs | 21 | 14 | 67% |
| General Industry | 4 | 4 | 100% |
| Pulp Mills | 13 | 7 | 54% |
| Oil Refineries | 5 | 2 | 40% |
| Aluminum Smelters | 6 | 2 | 33% |
| Noncontact Cooling Water | 2 | 1 | 50% |
| Ind. Process & Storm. | 3 | 3 | 100% |
| ***TOTAL*** | 54 | 33 | 61% |

Nineteen percent of acute WET tests did not meet the state's acute toxicity performance standard. Between a quarter to a half of all WET tests failing to meet the acute toxicity performance standard were also toxic at effluent concentrations near a typical acute WET limit indicating that the acute performance standard is a reasonable indicator for many permittees of the potential to exceed water quality standards for toxicity.

The estimated noncompliance rate amongst permittees with chronic WET limits is 60 percent and represents 30 percent of the total of 54 permittees with known ACECs and CCECs which allowed

this evaluation to be made. The chronic toxicity performance standard of no statistically significant toxicity at the ACEC is a very good predictor of chronic WET limit violations. These percentages also predict that many TI/REs will need to be conducted. The fact that few TI/REs have been done so far is mostly because the rewriting of permits to include WET limits is a slow process.

Three TI/REs have been initiated in Washington State in order to meet WET requirements in an NPDES permit. One TI/RE was stopped before completion because the point of compliance was changed when the permit was reissued. The other two were completed successfully.

The first discharger to conduct a successful TI/RE was also having trouble complying with a permit limit for Total Suspended Solids (TSS). When TSS levels rose, the discharger would add a big dose of flocculant to the settling pond, which would cause toxicity to *Ceriodaphnia*. Improvements in the settling pond and installation of a device to provide a metered dose of flocculent solved both the TSS and WET compliance problems.

The other discharger to successfully complete a TI/RE had one of the most toxic effluents seen in the state. The lowest concentration of effluent tested, 5 percent effluent would sometimes kill all *Ceriodaphnia* in less than 24 hours. Effluent toxicity was episodic and frustrated efforts to schedule toxicity identification attempts. Permittee time and money were expended in several fruitless attempts to sample the effluent, verify with a toxicity test that it was sufficiently toxic, and complete the identification of the toxic agent. At this time, the WET Coordinator advised the permittee that examining production chemicals at the plant might reveal one with a constituent, which matched the general characteristics known for the toxicant. A material was soon discovered containing tetramethylammonium hydroxide. Tetramethylammonium hydroxide was verified as the toxicant, the expensive toxicity identification efforts were ceased, and effective treatment was determined.

### E. EPA WET Policy

In July 1994, EPA published the final **WET Control Policy (**EPA 833-B-94-002). **The WET Control Policy** consists of eight statements of policy that either address a step in the general EPA process for WET control or address a controversial subject. Our program currently meets all eight statements.

### F. Results of the EPA WET Stakeholder's Meeting

Because of continuing controversy surrounding EPA's WET program, two important meetings were held to evaluate current approaches and recommend changes where needed. The Society of Environmental Toxicology and Chemistry conducted the Pellston Workshop on WET testing in September 1995, in order to resolve important scientific issues involving the regulatory application of WET testing. In September 1996, EPA hosted the WET Stakeholder's Meeting to get broader input in developing the Pellston Workshop recommendations into a new strategy for regulating WET.

EPA is working on a new WET implementation strategy, which is now out in draft except for one element, a weight-of-evidence approach, which will be developed as a part of the revision of the water quality standards regulations.

The following items discuss some elements of the new strategy:

- Independent applicability (which means that the results of WET testing, bioassessment, or chemical analysis are considered separately from one another) might be replaced by weight-of-evidence (where the results of all types of evaluation are considered together). EPA promises to set high standards for the quantity and quality of information involved in weight-of-evidence. When the minimum information necessary for weight-of-evidence is unattainable, independent applicability will be used. One advantage that independent applicability had for us was that we could develop WET testing, evaluation of the chemical-specific water quality criteria, and the bioassessment/biocriteria process separately. We will be forced by weight-of-evidence to integrate these approaches.

- Narrative WET criteria are preferred because they allow the regulatory flexibility necessary for weight-of-evidence. Because we currently have narrative toxicity criteria in our Water Quality Standards, we already have the flexibility to use either WET or chemical-specific limits when a reasonable potential to exceed has been demonstrated. See 40 CFR 122.44(d)(1)(v).

- WET criteria should take into consideration beneficial uses and use attainability. These considerations must especially be taken into account in order to avoid unnecessarily burdening discharges to low (or no) flow streams.

## III. How Does Our WET Program Work?

### A. WET Test Review and Report

The database contains over 3,000 WET tests from about 120 permittees. We believe that our database is the most extensive in the nation. The database allows us to provide a valuable service to permit managers and permittees who can request a summary table of WET test results. A table produced from our database has accurate numbers and focuses on the information that will be used to make regulatory decisions. Test review and database entry is closely integrated and has many activities in common. This means that for a slight effort beyond database entry we also get a detailed test review, and for a slight increase in effort over a detailed test review we get a database entry.

WET tests are reviewed for consistency with the test method and to see that any adverse effects detected were due to toxicity, and not to variability, or another source of organism stress. Labs send the WET test report first to the permittee whose effluent is tested. Very few permittees have the time, or expertise, to review a WET test report. The permittee then sends the WET test report to the Ecology regional office (or to the Industrial Section) responsible for the permit. The regional offices and Industrial Section generally lack the time, expertise, and tools to conduct a detailed review of a WET test report. The test report is then forwarded to the Water Quality Program's Permit Management Section where the WET Coordinator conducts a detailed review of test quality and makes a database entry.

Test reviews always begin with the raw data on the lab bench sheets in order to check for entry errors and arithmetic mistakes by the lab. Data entry and arithmetic errors are the most common mistakes currently being made by labs now that problems with sample handling and test conditions have been reduced by conducting a detailed review of all WET test reports received for the last three years. Less detailed reviews were conducted on some WET tests as long as five years ago but were not as

effective in improving lab performance. Sample handling and test conditions such as temperature, number of replicates, and test organism age are checked and occasional problems are still found.

Another important reason for WET test review is the identification of anomalous test results where adverse effects on test organisms do not fit a concentration-response relationship. Factors other than toxicity (disease, contaminated glassware, test method variability, etc.) can produce adverse effects on test organisms, but only toxicity tends to produce a concentration-response relationship where response increases with concentration. Excluding tests without a good concentration-response relationship reduces the chance for a false positive having negative consequences for a permittee.

### B. Services provided to Ecology Staff, Permittees, and Labs

The WET Coordinator in the Permit Management Section of the Water Quality Program provides the following technical assistance to other Ecology staff, permittees, and labs:

- Ecology staff in the regional offices and Industrial Section is assisted with establishing permit conditions for WET.

- Permittees are advised on selecting a lab and how to use test review summaries to track lab performance. Permittees are also assisted in understanding permit requirements for WET testing.

- Ecology staff is assisted with review of TI/RE plans. Permittees and labs are given advice on TI/RE strategies. A permittee gave Water Quality Program staff credit in a report for giving advice that saved much time and money in finishing a difficult TI/RE.

- Labs are assisted in understanding permit requirements so they can perform tests that best meet the needs of the permittees. Labs are kept informed of their test performance by the test review summaries. The WET test database is sometimes used to provide a lab with information on how their test performance compares to other labs in order to encourage improvement.

### C. Services provided to EPA, States, and the Scientific Community

Because the database of WET test results is so comprehensive and accurate, it provides useful information far beyond the borders of the state. Examples of the uses for the data include:

- A panel of scientists reviewed bivalve development test control results to determine if mussels and oysters really do perform differently as had been assumed. They discovered that mussel controls perform as well as oyster controls. The test method will be revised to reflect this fact.

- The State of Wisconsin requested all of the *Selenastrum* test results from the database in order to assist in a decision on whether to implement the use of this test in their program.

- EPA has contracted a statistician to develop a bioequivalence approach for WET tests. Bioequivalence is a promising statistical technique, which could reduce both false positive and false negative WET test results and has been recommended by scientists at the Pellston Workshop as a potential solution to problems with WET test statistics. The statistician will be using *Ceriodaphnia* and fathead minnow chronic test results from our database in this effort.

- The Water Quality Program will be using the database to inform interested parties around the nation that monitoring frequencies are too low because of WET test cost. Effluent toxicity is usually episodic and common monitoring frequencies are inadequate for characterizing or even reliably detecting it.

### D. Status of the Tools to provide these Services

We have developed standard permit language, internal guidance in the *Permit Writer's Manual*, two levels of guidance for permittees, detailed guidance for labs, and the nation's largest and most comprehensive database of test results. The status of each of these tools is discussed below:

- New standard permits language that is shorter and simpler was distributed in April 1997. The new language also implemented a switch to West Coast species and a more common sense approach to WET testing of chlorinated discharges.

- The *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* document (canary book) was finalized and given a July 15, 1997, effective date. The canary book provides instructions on everything from sample handling to report submission and will allow simplification of permit language by directly communicating to lab instructions that we previously put in permits.

- The two guidance documents for permittees are three years old and could be updated and expanded. A helpful addition would be guidance on choosing a lab. Guidance could be written on how to use our test reviews to evaluate a lab's ongoing performance.

- The *Permit Writer's Manual* was updated in July 1997 to explain the use of West Coast species, to give instructions on the new strategy for handling chlorinated effluents, and to address the withdrawal of Appendix C of 40 CFR Part 403 which is referenced in the WET Rule.

- The WET information system is divided into two incompletely integrated databases. Our test review system would be more time-efficient if the databases were completely integrated and combined with the correct statistics package. One database interacts with the test data and statistics and the other keeps records of test reviews and permittee information. There are two statistical packages used, but only one interacts with the database. The statistical package that interacts with the database is flawed in many ways; one of which is that it cannot be used to determine compliance with our WET limits. This flawed statistics package has been dropped by its producer and is very inflexible in test setup which will cause trouble because there will be no updates when test methods change. The statistics package that analyzes tests properly is flexible with test setup. A software producer is currently programming the good statistics package to have database capability. When ready, it will be available for about $2,000, and will justify the expense though increased efficiency and productivity.

  In 1995, we recorded and reviewed 333 acute WET tests and 165 chronic tests. That represents an average of 15 hours per week of staff time. This time may increase due to growing inefficiencies described above. If the measures described above to increase efficiency are

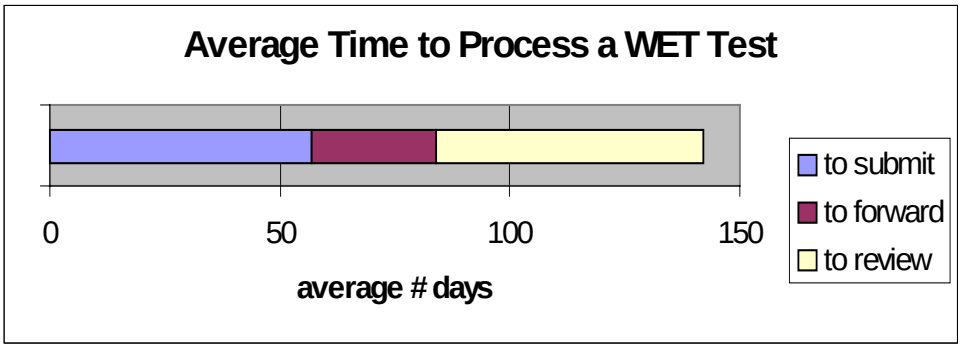
implemented, the 15 hours per week will move down closer to 10 hours per week. This improvement is especially needed since one person now performs all WET activities.

## IV. Future Directions for the WET Program

### A. Improvements to the Existing Program

***Better Information Flow***

The most critical problem facing the WET program is poor information flow. Permits require permittees to take action in response to effluent toxicity within a specified number of days. We do not even reach a decision on test acceptability before most of these time limits have expired. This is especially true for transient toxicity report and toxicity identification/reduction evaluation plan submittals. If the permittee responds on the basis of a poorly understood or poorly prepared lab report, then they run the risk of either wasting resources or ignoring an important regulatory requirement. If the permittee waits for the summary report from the Ecology facility manager, then the time limit will often expire without the required response. As permit limits for WET become more common, this situation is likely to cause trouble.




Another aspect of the information flow problem is that the results of a WET test are not considered final until the WET Coordinator has reviewed the report, checked data and statistics, evaluated concentration-response, and provided a regulatory interpretation. Each place to which the test report is sent prior to submission for review adds time to the process and increases exposure to potentially faulty or incomplete information. The test review summaries should retrace the path completely, but frequently the test review summaries do not reach the permittees. (They even more rarely get back to the labs conducting the tests).

WPLCS coordinators have difficulty making accurate entries for WET test submissions because the reports are complex and the review by the WET coordinator has not happened yet. Entries are made inconsistently around the state. An incomplete entry might cause a permittee to be assumed by the public someday to have not complied with a permit requirement for WET testing.

The first step toward resolving the information flow problem is to shorten the path for WET test reports as much as possible. The average length of time since January 1996 from test start date to submission for review was 88 days and can be much longer. The shortest and most efficient path would be from the lab directly to the WET Coordinator in the Water Quality Program. The lab could send a simultaneous report to the permittee. If direct submission from the labs is not acceptable, then permittees should send the WET test reports directly to the WET Coordinator.

The next step would be to upgrade the WET test information management system (WETTIMS) to automatically generate cover letters for transmitting WET test review summaries to permittees and labs. A link would also need to be established between WETTIMS and WPLCS. A set of consistent standard fields for statewide use in tracking WET information in WPLCS should be implemented. Scripts could then be written to automatically update these fields from WETTIMS entries. WPLCS would be kept updated with complete and timely information and the WPLCS coordinators would have extra time for more appropriate projects than attempting to figure out WET test reports.

Test review and database entry by the WET Coordinator since January 1996 added an average of 58 days to the process. The goal is to shorten this to 14 days. The *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* document will streamline test review decisions and reduce the amount of effort for substandard tests (more will be rejected) after the July 15, 1997, effective date. WET test performance and reporting has generally improved over the years making test review easier. The speed of test processing has also been improved by computer upgrades and will improve again when obsolete software is replaced. The WET Coordinator will primarily be concentrating on test review, technical assistance, updating the *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* document, and coordinating the evaluation of rapid screening tests. These duties should be compatible with a 14-day test turn-around time.

## B. Improvements Possible with Changes in State Regulations

***Use WET to Evaluate Metals Compliance***

WAC 173-201A-040 could be revised to allow consistent passing of the acute WET performance standard to substitute for evaluating the discharge for the acute water quality criteria for metals. This action can save many permittees the cost of monitoring for metals because the acute metals criteria more often result in permit limits than the chronic metals criteria do. It would also simplify the writing of those permits. Allowing passed WET tests to count for compliance with metals criteria is a more efficient approach than repeated development of site-specific criteria or water effects ratios. The incentive system in chapter 173-205 WAC would be strengthened, because the reward for meeting the acute WET performance standard will be substantially increased.

***Give More Realistic Credit for Dilution***

The 1000:1 credit for dilution contained in WAC 173-205-040(3), which was taken from a recommendation in EPA's *Technical Support Document*, is in error. The WET database contains several tests which showed statistically significant toxicity at a dilution of around 1000:1 or lower. The worst case WET test had statistically significant toxicity at a 4000:1 dilution (0.025 percent effluent). The dilution credit in WAC 173-205-040(3) needs to be lowered to at least 4000:1 for the industries demonstrating toxicity at very low levels.

On the other hand, the WET database could be examined for justification to lower the 1000:1 dilution in WAC 173-205-040(3) for POTWs. The same criterion used by EPA to determine the 1000:1 cutoff recommended in the *Technical Support Document* for chronic WET testing would apply. If an adequate number of toxicity tests are present in the database to define a "worst case" toxicity for POTWs as a category of dischargers, then effluent concentrations below the "worst case" could be considered likely to be safe and no chronic WET testing would be required. An initial review of the

database indicates that the worst case might be close to 150:1 dilution, and even though only about 10 POTWs have this dilution ratio, the cost saving would be considered significant by them.

### C. New Strategies for Regulating Effluent and Receiving Water Toxicity

The new effluent monitoring and toxicity control strategy proposed below would require revision of chapter 173-205 WAC. The benefits gained would include more realistic monitoring frequencies, avoidance of the controversy associated with water quality-based WET limits, knowing the pattern of toxicity before beginning a TI/RE, and use of more cost-effective toxicity measurement and control techniques. A gradual shift in emphasis from point source discharges to direct evaluations of state waters is also involved.

***Effluent Monitoring and Toxicity Control***

1. Evaluate NPDES permit applicants in accordance with WAC 173-205-040 (either revised as above or the same as today) to determine if an effluent characterization for WET is necessary.

2. Discharges determined to need an effluent characterization for WET are required to conduct rapid screening tests at some frequency such as monthly or every other week. These rapid screening tests are initially conducted in as high a concentration of effluent as practical in order to maximize test sensitivity. More discussion of the use of rapid screening tests is contained below in section V. D. Variability of Effluent Toxicity and the Use of Rapid Screening Tests.

3. If toxicity is detected by a rapid screening test, then the monitoring frequency is increased in order to determine the pattern of toxicity. The length of time needed to develop a pattern of toxicity will vary. Continuous or frequent toxicity will move the investigation immediately into the next step. The pattern for infrequent toxicity will take longer to determine, but will make for more cost-effective use of standard WET tests and TIE procedures, which will be scheduled when effluent toxicity is more likely. The pattern itself may contain hints as to the source of toxicity.

4. When a pattern begins to emerge, the standardized WET tests are also conducted in order to develop a correlation with the rapid screening tests and determine the need for further investigation.

5. If a rapid screening test is significantly more sensitive than the standardized WET tests, then the concentration of effluent tested with the rapid screening test is lowered to be more equivalent to the WET test. Only the rapid screening tests and standardized WET tests providing a consistent response to toxicity are continued in use.

6. If a standardized WET test demonstrates toxicity at concentrations representing the point of compliance, i.e., edge of mixing zone during low flow conditions, then a TI/RE plan is developed and implemented. The TI/RE plan should focus primarily on identifying and reducing toxicants in the discharge, but should also not ignore other measures, which might be adequately protective such as restricting potentially toxic activities during low flows or increasing the monitoring frequency during low flows. A water quality-based WET limit would be a part of any toxicity remedial measure involving an increased monitoring frequency during low flows.

7. If a discharger believes that no remedy for toxicity is economically reasonable and the Water Quality Program agrees, then the discharger may begin gathering information to be used in a weight-of-evidence analysis of the potential impact of the discharge. The persistence and fate of the toxicant should be determined. Bioassessments, ambient toxicity testing and *in situ* toxicity testing should also be used if appropriate. The circumstances during low flow events must be considered. If the weight-of-evidence analysis demonstrates that indigenous organisms in the vicinity of the outfall have a negligible risk of adverse effects from the discharge during low flows, then toxicity reduction will be considered unnecessary.

8. Any information gathered by the Department of Ecology as a part of an ambient monitoring program can be used to supplement the weight-of-evidence information supplied by a discharger.

9. After completion of the TI/RE or weight-of-evidence analysis, the discharger will return to the original monitoring frequency with rapid screening tests.

***Shifting Focus to Evaluations of Ambient Waters***

Routine ambient toxicity testing would identify toxicity hotspots allowing resources to be allocated to fixing problems sooner and more efficiently. Where there are no problems, then we would have justification for a lower commitment of agency or permittee resources. NPDES permits could have minimal requirements and expense. The database of ambient toxicity test results could become a success measure or environmental index. The ambient testing for a watershed should be centrally coordinated to be cost-effective and maintain a high level of confidence in the results. The case for regulating nonpoint sources (stormwater, agriculture, etc.) would also be strengthened by focusing on toxicity from all sources. Ambient toxicity testing in Chesapeake Bay has correlated with fish community diversity, detected exceedances of water quality criteria, and found unknown toxicants.

The advantages of ambient toxicity testing are:

- Toxicity tests are broad spectrum and will detect any toxicant or toxicant combination. When there is a large number of potential toxicants or the possibility of unknown toxicants, toxicity testing is the best method for assessing water quality.

- Ambient toxicity tests assess environmental impacts under real world conditions. There is no need to worry whether the analytical method is over-estimating impacts by including nonbioavailable fractions. The controversy over dissolved versus total recoverable metals is completely avoided.

- Testing can be done with important local species. The variety of toxicity tests available for ambient testing is quite large since we are not confined to only those tests approved for NPDES compliance monitoring. Baskets of mussels can be placed in important marine waters to provide data on mortality, growth, and bioconcentration. Bivalve embryo-larval development tests could provide warning of toxic dinoflagellate blooms resulting from nutrient enrichment. Samples from estuaries can be routinely tested for impairment of salmon smoltification. Inland rivers could be monitored for acutely toxic effects to indigenous trout and their invertebrate prey. Ambient toxicity testing could be an important part of a salmon recovery strategy.

If managed correctly, an ambient toxicity testing program would better protect the environment and justify reducing permit requirements in some circumstances. The public would generally approve. Routine bioassessments of state waters would have many of the same benefits as ambient toxicity testing and would be very relevant and comprehensive measure of water quality. Bioassessments could also be a success measure or part of an environmental index.

## V. Supporting Discussions

### A. Biological Relevance of WET Tests

Each WET test has been standardized to measure one or two specific responses of a single test species of an exact age at an exact test temperature for a certain length of time. These and several other standard conditions for each test type were chosen to provide a successful test result. None were chosen to match receiving water conditions. Establishing standard test conditions has produced a suite of toxicity tests, which are as practical for use in routine monitoring as can be expected. A secondary, but equally important, reason for standard test conditions is to ensure that the tests perform predictably and consistently.

TIE procedures have only been developed for the standardized tests. Labs are gaining TIE experience mostly with the standardized tests. A TIE can become very expensive if the toxicant is not identified within a few attempts.

The biological relevance of WET tests is an area of uncertainty. The tests might be underprotective because only a few biological responses from a few standard test species are being measured. Test organisms are kept at ideal constant temperatures, handled gently, and fed regularly while receiving water organisms might be stressed, starving, and extremely susceptible to toxicity. Receiving water organisms can also be weakened by previous exposure to toxicity from another upstream effluent.

On the other hand, the WET tests might be overprotective. Standard test durations usually greatly exceed the exposure that similar organisms receive in the effluent plume. Test solutions usually have higher temperatures and lower dissolved and suspended solids than the receiving water; these differences often increase toxicity in the WET test. Receiving water organisms also have the ability to avoid effluent plumes while test organisms cannot escape the test container.

### B. Ecological Relevance of WET Tests

The validity of a test method is its ability to accurately measure or predict events in the real world. Studies by EPA and the State of North Carolina have shown whole effluent toxicity tests to correlate well with bioassessments in freshwater. In order to make a comparison between WET and receiving water impacts in saltwater, EPA sampled the wastewater from seven industrial and municipal discharges and found that the WET test results usually agreed with toxicity tests on ambient samples taken in the discharge plume.

In spite of the successful comparisons discussed above, it is not a reasonable expectation that WET tests should be completely predictive of receiving water impacts. The link between whole effluent toxicity tests and receiving water impacts cannot be demonstrated in many cases because of the complexity of the relationship between the discharge and the receiving environment. The EPA and North Carolina

validity studies demonstrated a link between toxicity testing and receiving water impacts under circumstances (mostly single discharges to effluent-dominated streams) where it was reasonable to expect to have measurable effects that correlated with WET tests. In deeper freshwaters or in marine waters, effluents will rise and any effects on receiving water organisms will be difficult to measure because of the dependence of bioassessments on benthic organisms. In large bodies of water, organisms can be recruited into the vicinity of a discharge from unaffected areas. A toxic impact from a wastewater discharge can also be hidden from observation if the receiving water is already seriously degraded by other sources or by habitat alteration.

## C. Variability of WET Tests

As a part of an agreement settling permit appeals by the marine discharging pulp mills, a study was conducted in this state to evaluate four marine chronic WET tests to determine the variability of these tests when testing pulp mill effluents. The study was designed and evaluated by a Biomonitoring Science Advisory Board (BSAB) of five highly regarded toxicologists from the West Coast. The board was chosen with industry input. These four WET tests included two that are among the most sensitive WET tests in use, and test variability tends to rise with sensitivity. Even so, both of these highly sensitive toxicity tests (bivalve development and echinoderm fertilization tests) were recommended for regulatory use by the BSAB. EPA has measured the variability of their acute and chronic toxicity test methods, and the variability was also acceptable according to the BSAB criteria and generally as good as chemical analysis.

## D. Variability of Effluent Toxicity and the Use of Rapid Screening Tests

The current EPA WET tests are so expensive that quarterly testing is the most common frequency in the nation, and frequencies above monthly are rare. Toxicity is usually episodic causing detection using such low monitoring frequencies to be mostly due to chance. As discussed in section II. B. Above, episodes of toxicity occur in about half of the permitted discharges. The true percentage of permittees with these episodes is likely to be somewhat higher because quarterly or monthly monitoring leave most of the days of a year without an evaluation for toxicity.

These occasional excursions have unknown duration and environmental impact because of inadequate monitoring frequencies. When monitoring of the effluent containing tetramethylammonium hydroxide was temporarily increased from quarterly to weekly, the effluent was nontoxic during the first week and was very toxic continuously for the next three weeks. Neither quarterly nor monthly testing could have discovered the duration of this toxic episode. Quarterly monitoring might have missed the toxic episode all together. An effluent that is toxic 10 percent of the time would have a 66 percent chance of passing all four quarterly tests in one year. An effluent that is toxic 20 percent of the time would have a 41 percent chance of passing all four quarterly tests in one year. Sampling every other week (26 samples per year) would give a 95 percent chance of catching toxicity occurring 10 percent of the time. Effluents in this state are toxic 10 percent of the time on average.

Increasing monitoring frequency with the current WET tests would be considered too expensive. Labs usually charge from $500 to $1,500 per test depending on the type of test requested. Some tests can cost as much as $2,000. Increasing the demand for tests would tend to increase the cost of toxicity testing. An average of $10,800 was spent to find each occurrence of chronic toxicity in the database based on a cost of $1,200 per test estimated by a recent survey of five labs.

The state's waters could be better protected if we used rapid screening tests to establish the pattern of occurrence of episodes of effluent toxicity before testing with the more expensive WET tests. The cost of higher monitoring frequencies would be acceptable with rapid screening tests. Permittees with lower risk could stay at quarterly or monthly testing and save money with rapid screening tests. Using rapid screening tests to better assess the pattern of occurrence of effluent toxicity would make TI/REs more efficient by allowing sampling to better coincide with peak toxicity and perhaps providing suggestions as to the cause of toxicity based on its relationship to facility activities and other circumstances.

Rapid screening tests would be an excellent bottom layer in a tiered approach. EPA would not object as long as the WET tests were also included in the next layer of a tiered approach and all significant dischargers had at least some WET testing. A good selection of rapid screening tests is likely to be available in the near future for effluent monitoring.

## VI. GENERAL CONCLUSION

Controversy over WET testing arises from the attempt to unite two incompatible goals. One goal is the detection and elimination of effluent toxicity. The other goal is the evaluation of the toxicological health of the state's waters. Both are worthy goals, but the techniques necessary for each are not readily interchangeable. In addition, the proper use of the information gained in pursuit of each goal is specific to that goal. Pursuing each goal separately avoids conflicts between regulators and dischargers over the proper use of WET test results.

Monitoring effluents for toxicity is necessary in order to detect, identify, and eliminate toxic substances or combinations of toxic substances that would otherwise be missed. Effluents thoroughly characterized chemically and considered safe can still be toxic due to unknown constituents. Low stream flows do occasionally occur, and unless a discharge is expected to cease during low flow events, toxicity must be detected and controlled. The WET tests do this by creating effluent concentrations in the lab that occur only occasionally in the receiving water.

A regulatory program to control effluent toxicity needs standardized tests, which are reasonably available, affordable, and consistent. The current WET tests were developed to meet these requirements not to reflect receiving water conditions. These considerations in establishing test conditions have produced a suite of standard toxicity tests which are practical for monitoring effluents when testing is done quarterly or sometimes monthly. These standard tests have also been shown by EPA and North Carolina to have some ecological relevance.

On the other hand, if a toxicity test is to be used for assessing the health of a body of water, then the test should be performed on an ambient water sample using the most ecologically relevant test species available in order to reflect conditions in that water body as much as possible. *In situ* toxicity testing moves another step closer to a direct assessment of the health of receiving water organisms by exposing test organisms under environmental conditions while retaining some of the control of a lab test. Ambient and *in situ* toxicity tests detect toxicity from all sources: point sources (industries and POTWs), nonpoint sources (stormwater and agriculture), and natural (toxic phytoplankton). Bioassessments are the most direct measure available of ecosystem health. Bioassessments, and to a lessor extent *in situ* toxicity testing, also detect adverse effects that are not related to toxicity such as

siltation, scouring by floods, diseases, or natural population cycles. As the assessment of toxicity moves from the lab to environment, the information becomes more ecologically relevant, but loss of controlled condition makes drawing conclusions more complicated.

The regulatory program for WET gets into trouble when it implies unnecessary wider scientific significance through the use of "water quality-based" WET limits and the policy of independent application. WET testing is not a water quality assessment, but it is a measure of the potency of effluent toxicity. Fathead minnows, *Ceriodaphnia*, and the other established tests are the standard yardsticks against which toxicity is compared in both effluent monitoring and TIEs. The assessment and control of effluent toxicity is mostly based on the performance of these standard tests and need not be completely water quality-based in order to be justified.

WET testing should be done to discover unknown toxicants and to detect effluent toxicity at levels of concern for future low flow events. Any WET detected could be investigated as to cause and potential solution. A reasonable and flexible approach to finding a solution could be applied that combines both environmental (fate of toxicant, results of bioassessments, etc.) and economic factors before choosing reduction of effluent toxicity, improved dilution, or increased monitoring during low flows. Such a regulatory system acknowledges the importance of WET testing and control without making it out to be something it is not.

The lesson learned in Washington State during the years of accumulating a database of WET test results is that discharges meeting current technology-based requirements also tend to pass the standardized EPA WET tests at or near the end-of-pipe much of the time. The only major improvement needed for regulating WET is rapid screening tests to catch the toxicity that is being missed and sometimes reduce monitoring cost. Otherwise, additional efforts in evaluating whole effluent toxicity are not justified especially if these efforts increase the cost or complexity of the program. More emphasis should be placed on evaluating state waters and finding other sources of water quality impairment.