WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

A State's Perspective on WET Methods

Randall Marshall
WET Coordinator
WA State Dept. of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600
360-407-6445
rmar461@ecy.wa.gov
WA WET webpage:
http://www.wa.gov/ecology/wq/wet

WET Test Review

Step 1 – Make expectations known.

Inform labs and permittees in advance of all of your requirements for sample handling, WET test conditions, and acceptable results. Referring to EPA test manuals is not sufficient communication.

Step 2 – Check for data errors.

Get the hand-written raw data sheet for each test submitted. Check all data entries and calculations. When you have the most accurate numbers possible, enter the data into a software package capable of performing EPA statistics and preserving an electronic record of the test results for future reference. Run the statistics contained in the flowcharts in the EPA manuals. Be alert for labs forcing a parametric hypothesis test when assumptions (normality and homogeneity of variance) have not been met by the data. Record all data related deficiencies for the test review report.

Step 3 – Decide if the test is valid.

Invalid WET tests occur when the lab does not follow the test method or when the results do not meet the validation criteria in the test method. Even though invalid tests shouldn't be submitted in the first place, some will arrive anyway. More will arrive if nobody checks for them. Use the EPA manuals supplemented by your own checklist (See Step 1 above) to check the test for validity. Invalid tests are rejected and repeated on a fresh sample.

Step 4 – Reducing type II errors

Sometimes variability across replicates will prevent a large difference in response (in other words, a toxic effluent) from being detected as statistically significant. The Department of Ecology uses an acute statistical power standard and a chronic statistical power standard to control false negatives. The acute statistical power standard says that the test must be able to detect a minimum of a 30% difference in survival between the ACEC and a control as statistically significant. The chronic statistical power standard says that the test must be able to detect a minimum of a 40% difference in response between the CCEC and a control as statistically significant.

These standards are not very restrictive, but the threat of test rejection has been sufficient to ensure statistical sensitivity much better than the power standards in most cases.

<u>**Step 5, part A** – Controlling type I errors</u>

To reduce the opportunity for WET limit violations due to statistically significant differences in response that are type I errors, choose *alpha* = 0.01 for small differences in response. If the difference in survival in an acute test is less than 10% or the difference in response in a chronic test is less than 20%, then the Department of Ecology chooses *alpha* to be 0.01 instead of the usual 0.05.

When everything lives in the control and everything dies in the effluent, the actual type I error rate is very much less than *alpha*. When everything lives in both the control and effluent, no hypothesis test will find a significant difference. Somewhere in between these two extremes, the type I error rate approaches *alpha* as the measured differences in response become smaller and more likely to be due to chance. Decreasing *alpha* for smaller differences in response keeps the type I error rate from ever being 1/20 tests.

<u>**Step 5, part B** – Spotting type I errors</u>

Type I errors can often be spotted and corrected by examining the concentration-response relationship after running statistics. The lower effluent concentrations in a WET test are typically nontoxic and have a flat concentration-response at generally the same level as the control. However, test organism response at any of these nontoxic concentrations rarely falls exactly on this level line. When the response at one of these concentrations falls below the line, then a hypothesis test might identify it as statistically significant. The flat concentration-response relationship in the vicinity of the failing concentration and a general absence of statistical significance in nearby concentrations allows a reviewer to discount this anomalous statistical significance and thereby lower the type I error rate.

<u>**Evidence in Support of Step 5, part B**</u> –

The Department of Ecology WET database was queried for NOECs for fathead minnow and *Ceriodaphnia dubia* survival and sublethal (growth, reproduction, and *Selenastrum* cell density) endpoints including an identification of those with an interrupted concentration-response. The standard *alpha* level for determining the NOECs was 0.05.

Forty-two (42) out of 724 (0.058) 7-day survival NOECs were identified as having an interrupted concentration-response. 52 out of 764 (0.068) sublethal endpoint NOECs were identified as having an interrupted concentration-response. These numbers are close to the *alpha* of 0.05. This indicates that the incidences of statistical significance with an interrupted concentration-response can be mostly explained as type I errors.

Step 6 – Decide if the test results are anomalous.

Anomalous test results happen when WET tests produce results that appear unreliable. The regulator should decide whether a test result is anomalous based upon concentration-response relationship. Factors such as disease, contaminated glassware, or accidents produce adverse effects on test organisms, but don't tend to produce a concentration-response relationship. Excluding tests without concentration-response makes WET testing more fair and enforceable. A concentration-response relationship where response increases with concentration is a good identifier of toxicity as opposed to other sources of organism stress.

The following anomalous test criteria should be taken at face value and are not intended to have defined statistical confidence levels or rely on curve-fitting models. The anomalous test criteria are used during test review to intervene with human judgment when statistics seem to be reaching the wrong conclusion about effluent toxicity. Their underlying principle is the definition of the NOEC as the highest effluent concentration showing no statistically significant difference from the control along with an expectation for a concentration-response relationship typical for toxicity under the conditions of the test.

Different toxicity tests have different expectations for a good concentration-response relationship. The proportional endpoints (survival, echinoderm fertilization, bivalve development) often have steeper concentration-response relationships than do the nonproportional endpoints such as growth or neonate production. Water chemistry gradients (i.e. hardness) will sometimes modify the expected concentration-response relationship.

Step 7 – Report the Test Review and Conclusion

Permittee comfort level for WET can be raised considerably by a report which demonstrates that the regulator is willing to assess test quality before making decisions. WET test results and jargon are baffling to many permittees. A report evaluating a WET test result and explaining its regulatory consequences will be appreciated especially if a name and telephone number are included for getting questions answered. Remember that labs tend to not ignore or argue with their clients' requests.

Labs deserve feedback and respond to fair and consistent criticism. Good labs appreciate that the playing field is being leveled by having standards applied equally. Labs also deserve fair warning of any changes in the standards and an opportunity for input.

Final Tally

Of 605 acute WET tests reviewed by the Department of Ecology, 72 (12%) were rejected and 14 (2%) were conditionally accepted but with a serious criticism. 519 (86%) of the acute WET tests were accepted without reservation.

Of 322 chronic WET tests reviewed by the Department of Ecology, 19 (6%) were rejected and 12 (4%) were conditionally accepted but with a serious criticism. 291 (90%) of the chronic WET tests were accepted without reservation.

Criteria for Identifying Anomalous Test Results and Anomalous Test Examples

Criterion 1

A WET test result is anomalous if it shows a statistically significant difference in response between the control and the IWC, but no statistically significant difference in response at one or more higher effluent concentrations. The lack of statistical significance must be associated with a lower toxic effect at the higher effluent concentration

Criterion 2

A WET test is anomalous if there is a statistically significant difference in response between the control and the IWC and the slope of the line fitted to the concentration-response plot of all test concentrations is zero, unless the zero slope is due to a complete effect (no survival, no fertilization, no normal development, etc.) at every effluent concentration.

Criterion 3

A WET test is anomalous if there is a statistically significant difference in response between the control and the IWC which together with other nearby concentrations of effluent have a zero slope and appear to be nontoxic (performance is typical of healthy test organisms). Another description of this criterion is a test with a control that seems to not belong to the concentration-response relationship because of exceptionally good performance.

Criterion 4

A WET test is anomalous if the overall slope of the line fitted to the concentration-response plot is opposite of normal expectations and there is a statistically significant difference in response at the IWC. A test might be considered acceptable if the slope is opposite over only part of the concentration series.

Criterion 5

A WET test is anomalous if the standard deviation for proportion alive equals or exceeds 0.3 in any test concentration unless the partial mortality fits a good concentration-response relationship. A WET test is anomalous if mortalities occur in any test concentration in excess of the control performance criterion for survival when the concentration-response relationship indicates that the effluent concentration is nontoxic (sporadic mortalities).

More about Sporadic Mortalities

Sporadic mortalities are deaths of test organisms that do not fit a good concentration-response relationship and seem unrelated to toxicity. These sporadic mortalities sometimes cause a flat concentration-response relationship with nearly equal proportions alive (criterion 2) which resemble an infection rate not toxicity. At other times, sporadic mortalities are confined to a few test chambers scattered throughout the test as if susceptible test organisms were becoming infected and concentrating a pathogen within their test chambers causing large standard deviations in proportion alive at those concentrations (criterion 5). Pathogens which will infect test organisms can come from inside a lab, from a composite sampler, or from the sample itself.

See also:

Grothe, D.R. and D.E. Johnson. 1996. Bacterial interference in whole effluent toxicity tests. *Environ. Toxicol. and Chem.* **15**:761-764.

Kszos, L.A., A.J. Stewart, and J.R. Sumner. 1997. Evidence that variability in ambient fathead minnow short-term chronic tests is due to pathogenic infection. *Environ. Toxicol. and Chem.* **16**:351-356.

The Washington State Regulatory System for WET

Step 1 - The process begins with a National Pollutant Discharge Elimination System (NPDES) permit application. The application can be for a new NPDES permit or for renewal of an existing permit. NPDES permits are required for point source discharges to surface waters. Other types of permit are not covered by the WET rule and do not need to have WET testing.

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. These circumstances define discharges with a risk for aquatic toxicity. Permits for discharges which fit any of these circumstances will contain requirements for WET characterization. Permits for discharges which do not fit any of these circumstances will not contain any WET testing requirements.

Step 3 - WET testing usually begins with an effluent characterization in the first year of the permit term. Effluent characterization establishes the baseline toxicity level and determines the need for WET limits. Every sample during effluent characterization will be tested with all of the WET tests listed in the permit (multiple species testing).

Step 4 - The permit will require that the permittee determines 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. Those permittees who meet the performance standards will not get WET limits or compliance monitoring (will go straight to Step 7).

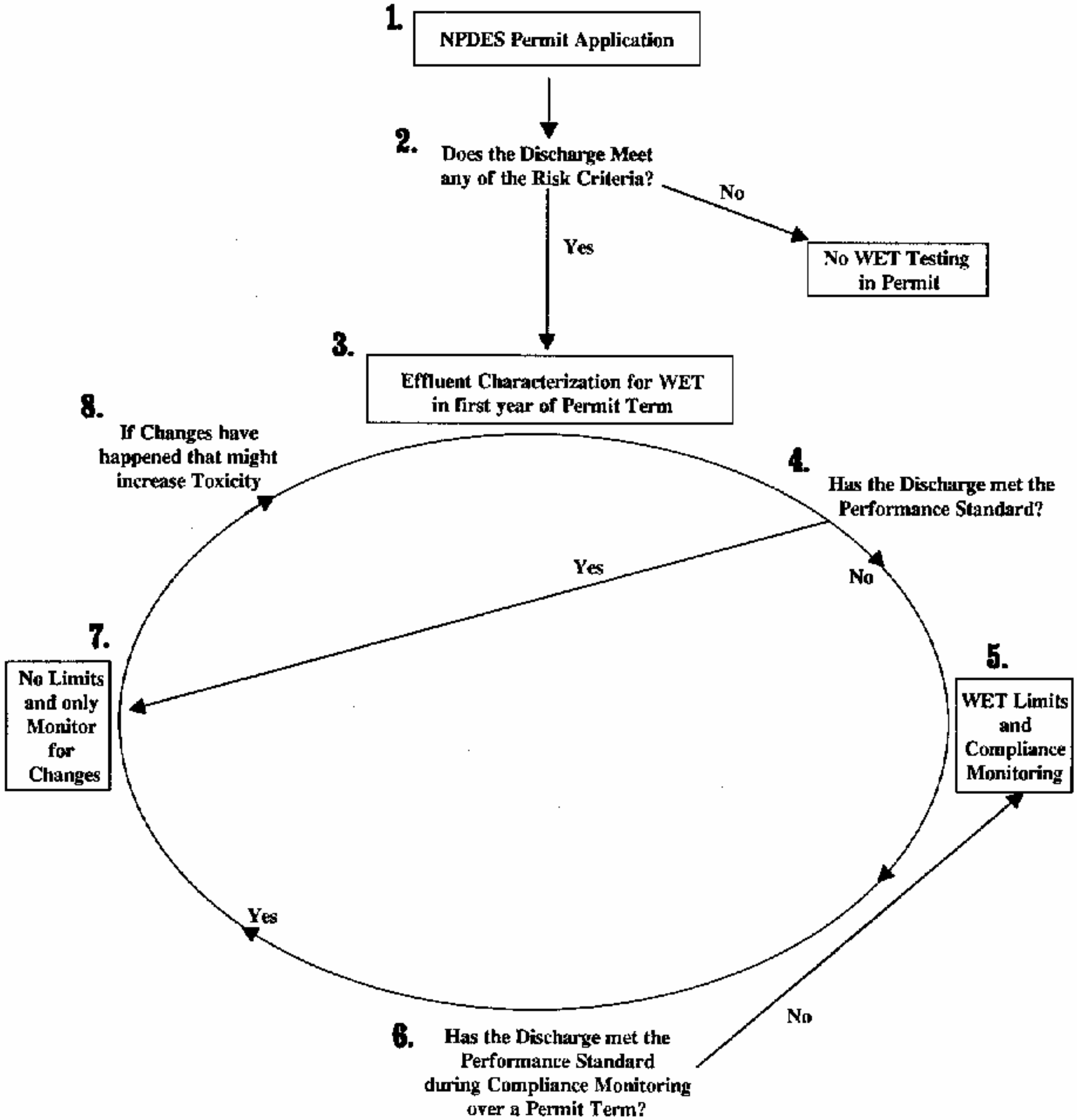
Step 5 - Those permittees who do not meet a performance standard during effluent characterization will receive WET limits. WET limits are the same as other permit limits. The permit will require routine monitoring to determine compliance with the WET limit. Failing a compliance test for a WET limit will trigger additional WET testing and possibly other enforcement actions.

Step 6 - The period of effluent characterization is not the only time for a permittee to demonstrate that WET limits are not needed. The WET rule does not intend that WET limits are permanent. 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. By attaining the higher level of toxicity control necessary to meet the performance standard, the permittee has allowed the WET limit and compliance monitoring to be removed from the permit. The permittee's cost and liability are lower. 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 one set of WET tests submitted with each permit application. Some permittees will be 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.

WET PERMITTING SYSTEM DIAGRAM



Monitoring to Detect Toxic Episodes

Industrial effluents can be highly variable within small time intervals. Bleckmann *et al* reported that the toxicity of an oil refinery effluent varied by more than a factor of 16 to the most sensitive of 5 species tested on 11 effluent samples collected within a 35-day sampling interval. Reference toxicant (SDS) testing was used to measure the inherent variability of the toxicity tests within the lab, and this information was used to demonstrate that the toxicity of the effluent was much more variable than can be accounted for by test variability.

Sherry *et al* found that 8 samples within 4 months from 3 oil refineries (2 refineries sampled twice and the 3rd sampled 4 times) were inadequate to determine if apparent differences in toxicity between the refinery effluents were real or due to the temporal variability of the individual effluents.

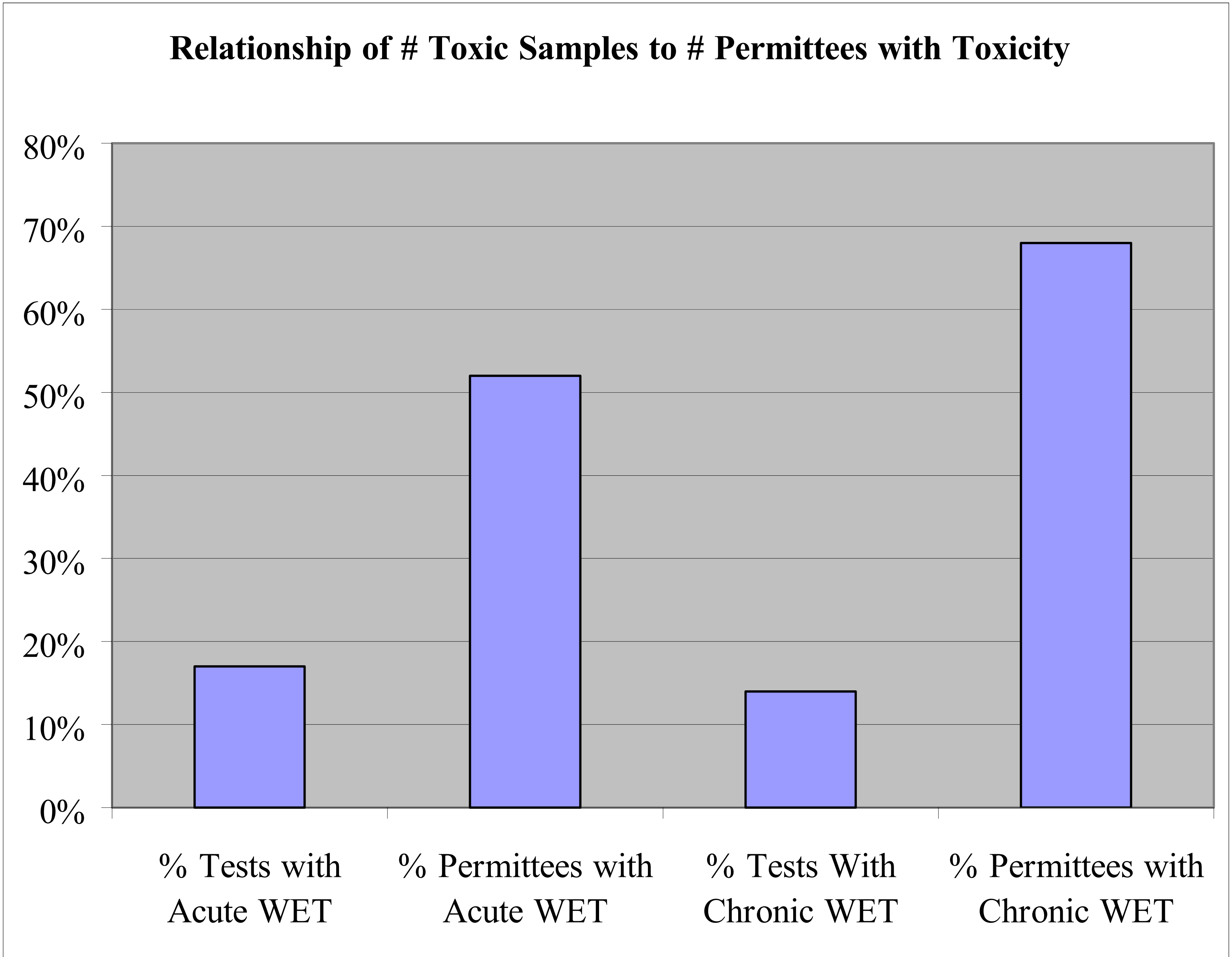
Stormwater toxicity can be episodic and vary greatly from storm event to storm event. Fisher *et al* reported toxicity in storm water samples from 4 storm events at a site at an airport that ranged from completely nontoxic to an LC_{50} of 1.1% effluent.

Episodic toxicity also occurs in ambient waters and may be the result of point source or nonpoint source discharges. Lewis *et al*, Mount *et al*, and Stewart *et al* have assessed episodic toxicity in ambient waters.

An important conclusion from examining the occurrence of acute and chronic toxicity in effluents in Washington State is that the technology-based permitting program was fairly successful in controlling toxicity. Treatment plants may not be designed to control toxicity, but they often do a very good job of removing toxicity anyway. The only problem is that these treatment plants are not consistent, and many produce episodes of toxicity.

Forty-seven percent of 1,853 acute tests had 100% survival in 100% effluent, and 72% had 90% survival or better in 100% effluent. (A fair number of chronic tests also show no toxicity at end-of-pipe. 59% of chronic NOECs were 100% effluent.) Eighty-three percent of these tests met the state's acute toxicity performance standard of at least 65% survival in 100% effluent with a median percent survival of at least 80%. However, the 17% of acute tests which failed to meet the performance standard were distributed throughout 52% of permittees.

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% of permittees have never shown acute WET at levels of regulatory concern, and only 32% have never reported chronic WET test results at levels of regulatory concern. The 11% of chronic tests with toxicity of regulatory concern were distributed across 68% of the permittees in the database. These occasional excursions have unknown duration and pattern because of inadequate monitoring frequencies.


Relationship of # Toxic Samples to # Permittees with Toxicity
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Tests with Acute WET
% Permittees with Acute WET
% Tests With Chronic WET
% Permittees with Chronic WET

Five (5) labs were surveyed as to the price of their chronic WET tests. The estimate of average cost is $1,200/7-day freshwater chronic test. Saltwater 7-day tests are slightly more expensive and all other chronic tests are slightly less expensive than $1,200. Echinoderm fertilization tests are the least expensive chronic tests and can be as low as $600.

These 7-day chronic tests are labor intensive and this accounts for most of the cost. MEC Analytical Systems, Inc. in Carlsbad, CA has recently estimated that 20 person-hours are devoted to every 7-day chronic test with fathead minnow or *Ceriodaphnia dubia*. The MEC time estimate is close to that produced by Stewart *et al* in 1988 for the same tests.

The State of Washington's Department of Ecology has assembled the data and results from over 5,000 acute and chronic WET tests into a database. The results of 792 chronic tests conducted on samples from 53 NPDES permittees were evaluated for toxicity at concentrations of regulatory concern (IWC or instream waste concentration at edge of mixing zone during critical conditions). The total number of permittees with chronic WET test results that were evaluated for this study was 105, but only 53 of these had established mixing zones and IWCs. The results of this evaluation were used to determine the average cost for detection of one episode of regulatorily significant toxicity.

5 of the accredited labs doing the most testing on effluents from Washington State were surveyed by telephone to determine an average cost for chronic tests. The 7-day fathead minnow and *Ceriodaphnia dubia* tests are 75% of the chronic tests in the database. The average cost for these tests is $1,200/test and was selected for use in the evaluation of the testing program because it represents 75% of the data and the costs of the less common chronic tests range about equally to both sides. The results of this evaluation were used to determine the average cost for detection of one episode of regulatorily significant toxicity.

The compliance failure rate at the IWC for the 53 permittees with a known IWC is 8% of chronic WET tests. The mean of the IWCs from these 53 NPDES permittees is 11% effluent. This mean was compared to the NOECs from 105 permittees with chronic WET tests in order to estimate a compliance rate that accounted for all data. The compliance failure rate estimated by comparing NOECs from all 105 permittees to an average IWC is 11% of chronic WET tests. For the purpose of this evaluation, a 10% compliance failure rate represents both of these numbers well.

With toxicity occurring at the IWC 10% of the time, a permittee has a 66% chance of passing all chronic WET tests in a year with quarterly sampling. The same typical permittee has a 28% chance of passing all tests from monthly sampling. It should also be noted that this means that the above compliance failure rates are under-estimated since 90% of the permittees did quarterly sampling and the highest monitoring frequency recorded was monthly.

The following table only addresses the chance of finding effluent toxicity occurring 10% of the time with a random distribution. Detecting effluent toxicity and determining its pattern of occurrence (including duration) over a year would likely require more samples. Exactly how many more could not be determined because quarterly and monthly monitoring provided insufficient data to make an estimation.

The number of chronic WET tests for each of the 53 permittees was multiplied by the average cost estimate of $1,200 in order to estimate the total testing cost for each permittee. The number of toxicity detections was determined for each permittee by counting failures at the IWC. The total chronic testing cost for each permittee was divided by the number of failures at the IWC. The result is the cost per toxicity detection at meaningful levels. This cost ranged from a low of $1,300/toxicity detection to a high of $40,000/toxicity detection. The average is $11,000/toxicity detection.

Common effluent monitoring frequencies are often inadequate for both regulatory and scientific purposes. Episodic effluent toxicity cannot be adequately characterized as to frequency or duration with quarterly or monthly sampling. One permittee having trouble complying with a chronic WET limit decided to try to prove the *Ceriodaphnia* test to be unreliable. This permittee split samples between two labs for weekly testing in May and June 1995. The testing demonstrated instead that the effluent was toxic at all effluent concentrations down to the IWC of 5% effluent constantly for about 3 weeks. Mortality was sometimes complete at all test concentrations within 24 hours of test initiation. The labs were in exact agreement on the results of these tests. Neither quarterly nor monthly testing could have determined the duration of this toxic episode. Effluent toxicity disappeared when a TIE was begun. The TIE took longer to complete and was more expensive because the pattern of toxicity was unknown and many samples taken for the TIE had little or no toxicity.

The standard WET tests, especially the 7-day chronic WET tests, are relatively expensive. The expense of the tests discourages realistic monitoring frequencies and reduces the cost-effectiveness of toxicity detection. In order to allow adequate effluent monitoring frequencies and improve the cost-effectiveness and efficiency of the regulation of effluent toxicity, a selection of rapid screening toxicity tests that are quicker and cheaper than standard toxicity tests needs to be established. In one evaluation, Toussaint *et al* compared the response of 5 rapid screening tests to the response of 5 standard acute toxicity tests using 11 chemicals. 3 of the rapid screening tests performed similarly to the standard tests.

<u>REFERENCES</u>:

Bleckmann, C.A., B. Rabe, S.J. Edgmon, and D. Fillingame. 1995. Aquatic toxicity variability for fresh- and saltwater species in refinery wastewater effluent. *Environ. Toxicol. Chem.* **14**:1219-1223.

Sherry, James, Brian Scott and Bernard Dutka. 1997. Use of various acute, sublethal and early life-stage tests to evaluate the toxicity of refinery effluents. *Environ. Toxicol. Chem.* **16**:2249-2257.

Fisher, D.J., M.H. Knott, S.D. Turley, B.S. Turley, L.T. Yonkos and G.P. Ziegler. 1995. The acute whole effluent toxicity of storm water from an international airport. *Environ. Toxicol. Chem.* **14**:1103-1111.

Lewis, M.A., W.S. Eckhoff and J.D. Cooney. 1989. Impact of an episodic event on the toxicity evaluation of a treated municipal effluent. *Environ. Toxicol. Chem.* **8**:825-830

Mount, D.I., N.A. Thomas, T.J. Norberg, M.T. Barbour, T.H. Roush and W.F. Brandes. 1984. Effluent and ambient toxicity testing and instream community response on the Ottawa River, Lima, Ohio. EPA 600/3-84-080. U.S. Environmental Protection Agency, Duluth, MN.

Stewart, A.J., L.A. Kszos, B.C. Harvey, L.F. Wicker, G.J. Haynes and R.D. Bailey. 1990. Ambient toxicity dynamics: assessments using *Ceriodaphnia dubia* and fathead minnow (*Pimephales promelas*) larvae in short-term tests. *Environ. Toxicol. Chem.* **9**:367-379.

Toussaint, M.W., T.R. Shedd, W.H. van der Schalie and G.R. Leather. 1995. A comparison of standard acute toxicity tests with rapid-screening toxicity tests. *Environ. Toxicol. Chem.* **14**:907-915.

Samples and Chronic WET Tests as Related to Compliance at the IWC (ACEC or CCEC) and Testing Cost

Permit ID	ACEC	CCEC	Effluent Type	total # samples	usual # samples/year	toxicity tests performed	#statistical comparisons	fail ACEC	fail CCEC	total estimated cost	cost per toxicity detection
WA0000680	7	4.8	aluminum smelter	5	4	12	20	0	0	$14,400.00	
WA0029017	2.6	0.53	POTW	16	4	22	44	1	0	$26,400.00	$26,400.00
WA0022900	3.1	0.7	oil refinery effluent	6	4	12	17	0	0	$14,400.00	
WA0023744	3.03	1.43	POTW	6	4	12	25	0	0	$14,400.00	
WA0000264	20	2.9	pulp mill effluent	10	4	16	33	2	0	$19,200.00	$9,600.00
WA0003697	2.3	0.3	pulp mill effluent	4	4	8	16	0	0	$9,600.00	
WA0029289	4	1.45	POTW	6	6	11	23	0	0	$13,200.00	
WA0030520	2.4	1.5	POTW	15	4	19	40	0	0	$22,800.00	
WA0037338	100	100	coal mining & storm water	10	4	11	22	4	4	$13,200.00	$3,300.00
WA0003239	8.3	2.5	industry process & storm water	16	4	18	22	3	1	$21,600.00	$7,200.00
WA0002925	1	0.7	pulp mill effluent	11	4	15	24	0	0	$18,000.00	
WA0029513	11.2	1.25	POTW	9	4	13	27	4	0	$15,600.00	$3,900.00
WA0029581	0.68	0.32	POTW	14	4	18	37	0	0	$21,600.00	
WA0024058	2.17	0.26	POTW	22	4	33	71	1	0	$39,600.00	$39,600.00
WA0024341	85.5	32.6	POTW	5	4	15	29	2	1	$18,000.00	$9,000.00
WA0020575	67	16	POTW	6	2	12	22	2	1	$14,400.00	$7,200.00
WA0001091	1.7	0.7	pulp mill effluent	10	4	14	22	4	4	$16,800.00	$4,200.00
WA0000825	2.79	1.93	industry process water	1	1	2	4	0	0	$2,400.00	
WA0002950-01	2	1.6	aluminum smelter	9	4	15	25	0	0	$18,000.00	
WA0002950-02	11.1	4	industrial stormwater	9	4	15	25	1	0	$18,000.00	$18,000.00
WA0000795	2.1	0.3	pulp mill effluent	5	4	9	17	1	1	$10,800.00	$10,800.00
WA0000256	6.3	1.4	pulp mill effluent	4	4	8	16	0	0	$9,600.00	
WA0000876	100	100	aluminum smelter	7	4	13	22	3	3	$15,600.00	$5,200.00
WA0000931	10	4.3	aluminum smelter	5	4	12	20	0	0	$14,400.00	
WA0000281	12	5	noncontact cooling	16	12	24	60	1	1	$28,800.00	$28,800.00
WA0000621*	7	2.63	pulp mill effluent	10	4	36	60	8	8	$43,200.00	$5,400.00
* based on the average of the ACEC and CCEC for 3 similar discharges under the same permit #											
WA0000078	2.6	0.7	pulp mill effluent	5	4	10	20	0	0	$12,000.00	
WA0024031	1.25	0.57	POTW	15	4	19	38	0	0	$22,800.00	

Samples and Chronic WET Tests as Related to Compliance at the IWC (ACEC or CCEC) and Testing Cost

Permit ID	ACEC	CCEC	Effluent Type	total # samples	usual # samples/year	toxicity tests performed	#statistical comparisons	fail ACEC	fail CCEC	total estimated cost	cost per toxicity detection
WA0022497	11.4	5.88	POTW	5	2	8	18	1	1	$9,600.00	$9,600.00
WA0039578	38.5	5	industry process water	24	4	45	88	42	26	$54,000.00	$1,285.71
WA0020958	1.79	0.4	POTW	10	4	14	29	0	0	$16,800.00	
WA0022764	1.07	0.7	POTW	15	4	19	39	1	1	$22,800.00	$22,800.00
WA0020486	25.6	7.46	POTW	3	3	4	8	0	0	$4,800.00	
WA0024074	4.54	1.19	POTW	6	4	6	12	0	0	$7,200.00	
WA0045268	7.8	0.84	industry process water	8	4	13	27	1	1	$15,600.00	$15,600.00
WA0020346	1.6	0.071	POTW	2	2	4	9	0	0	$4,800.00	
WA0037168	38.5	5	POTW	7	4	10	21	3	0	$12,000.00	$4,000.00
WA0000086	10	3.3	aluminum smelter	4	4	12	20	0	0	$14,400.00	
WA0022772	1.67	0.7	POTW	15	4	18	37	0	0	$21,600.00	
WA0000761	4.8	0.6	oil refinery effluent	6	4	11	14	0	0	$13,200.00	
WA0000850	3.7	1.1	pulp mill effluent	14	4	29	31	10	3	$34,800.00	$3,480.00
WA0000884	6.3	0.8	pulp mill effluent	5	4	12	25	2	0	$14,400.00	$7,200.00
WA0024473	85.4	26.2	POTW	22	4	32	69	7	2	$38,400.00	$5,485.71
WA0001040	3.6	0.7	pulp mill effluent	9	4	13	21	0	0	$15,600.00	
WA0023353	50	5	POTW	13	3	14	31	1	0	$16,800.00	$16,800.00
WA0002941	1.4	0.6	oil refinery effluent	6	4	14	18	0	0	$16,800.00	
WA0002984	3.2	0.7	oil refinery effluent	4	4	12	16	0	0	$14,400.00	
WA0003671	10	2.7	industry process water	6	4	10	22	2	0	$12,000.00	$6,000.00
WA0001783	100	100	oil refinery effluent	8	4	9	12	3	3	$10,800.00	$3,600.00
WA0000299	20	1.4	aluminum smelter	5	4	12	20	1	0	$14,400.00	$14,400.00
WA0029181	1.3	0.64	POTW	15	4	23	51	0	0	$27,600.00	
WA0000809	10	1.3	pulp mill effluent	8	4	12	20	4	0	$14,400.00	$3,600.00
WA0000124	6.7	1.8	pulp mill effluent	4	4	7	14	0	0	$8,400.00	
WA0025151	9	2	noncontact cooling	2	3	5	10	0	0	$6,000.00	
AVE IWC:	17.351	8.6380	**TOTALS:**	483	214	792	1483	115	61	$950,400.00	$292,451.43
									average:	$17,600.00	$10,831.53