Public Comment .(11/16/10 Wrkshp)
Policy for Toxicity Assessmnt
Deadline: 1/21/11 by 12 noon

Central Contra Costa Sanitary District

Protecting public health and the environment — 5019 Imhoff Place, Martinez, CA 94553-4392

January 21, 2011

Charles R. Hoppin, Chairman and Members
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

c/o Jeanine Townsend, Clerk to the Board
commentletters@waterboards.ca.gov

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SWRCB EXECUTIVE

RE: Comment Letter Preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment and Control

Dear Chairman Hoppin and Members:

Central Contra Costa Sanitary District (CCCSD) would like to thank the State Water Resources Control Board (SWRCB) for the opportunity to comment on the Preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment and Control. This letter, coupled with specific comments in the attachments to this letter, constitutes CCCSD's comments. By reference, this letter, in general, supports and includes technical rule related comments by the California Association of Sanitation Agencies (CASA, Sacramento, CA).

Who we are: CCCSD provides wastewater collection and secondary wastewater treatment for approximately 460,000 people in Contra Costa County, California. The wastewater treatment facility, located in Martinez, California, has a permitted average dry weather flow (ADWF) capacity of 53.8 million gallons per day. CCCSD has been recognized many times for our excellence in the cost effective collection and treatment of wastewater. In fact, CCCSD has recorded 13 years without a violation of our National Pollutant Discharge Elimination System permit.

CCCSD has spent considerable time and effort reviewing the preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment and Control. CCCSD was a key player working with Region 2 implementing their WET procedure over 20 years ago, so we have considerable experience in developing, implementing, and complying with a similar WET procedure. Based on our review, we the following comments regarding the WET policy as proposed.

Comment 1. San Francisco Regional Water Quality Control Board (Region 2) sets the standard for toxicity testing in the State of California. For two decades now, toxicity testing has been in place and working to protect the beneficial uses in the San Francisco Bay. The SWRCB should model state policy after Region 2 permits or declare Region 2's program to be equal to the state policy.

One of our success stories is CCCSD experienced measured toxicity in its effluent (using *Ceriodaphnia dubia* test species) in the early 1990s shortly after the Region 2 implemented the toxicity monitoring and control program. After conducting a Toxicity Identification Evaluation (TIE), organophosphate pesticides (Chlorpyrifos and Diazinon) were identified to cause the measured toxicity. A Toxicity Reduction Evaluation (TRE) program was initiated that involved extensive public outreach regarding controlling potential sources of these particular pesticides and practicing Integrated Pest Management (IPM) techniques in general. This program was expanded to the greater SF Bay Area under the "Our Water, Our World" campaign. The measured toxicity was abated through these efforts and IPM has become a standard within California because of Region 2 being strategic and thoughtful in using fully peer reviewed science to protect beneficial uses within the San Francisco Bay. The cost to complete this historic TIE and initiate the TRE was hundreds of thousands of dollars. The expenditure of these funds was justified because it addressed a true toxicity condition. This TIE/TRE was the start of a series of events that lead to chlorpyrifos to no longer be allowed for individual use.

Another success story is that the RMP stopped testing for toxicity because none was being found.

<u>Comment 2.</u> The statistical policy being suggested will erroneously designate water as toxic from 5-58% of the time depending upon the test species used. This level of false positives is unacceptable.

A "test run" of the TST by Dr. Jeff Miller at Aquascience Toxicity Laboratory indicates that non-toxic effluents will be deemed toxic (false positives) per the percentages shown below:

- CCCSD – 30%

Dr. Milller did not have large quantities of data to evaluate so the full effect of the TST method is masked, because the sample sizes are so low.

CCCSD engaged Daniel Gallagher, PhD, PE a Professor at Virginia Polytechnic Institute & State University to provide the SWRCB a peer review and evaluation of the TST method using 1000 sample points (Attachment 1). Figure 1 is profound in that it indicates the probability of improperly classifying an effluent as toxic using the TST test when there is **no difference** between the population means and standard deviations of the control versus the final plant effluent 5-58% of the time. To not have a false positive using the TST method, dischargers may need to run as many as 20 toxicity samples to overcome the statistics as compared to the standard Welch t-test requirement of 3 to 5 toxicity samples

(Figure 2). Furthermore, **both** statistical methods detect increasing toxicity of the effluent and lessen the chance of a false negative conclusion (Figure 3). In fact, the EPA standard Welch t-test is actually more protective of water quality when the variability of the samples is low (Figure 3). Dr. Gallagher, PE indicates that the TST has the potential to be more protective of the environment but it is not always more conservative than the traditional method and will frequently require an additional burden on the dischargers through increased testing (Attachment 1). For CCCSD, the current cost for chronic toxicity testing ranges from $2,200 to $2,500 per test or $13,200 - $15,000 annually. Utilizing the TST method the cost is $1,800 to $2,000 per test or $43,200 - $48,000 annually. Thus, there is little cost savings per test due to more frequent testing and the required increased monitoring due to the false positive rate. Thus, there is no cost saving by moving to one point test because of the increased variability of the TST statistics. When false positives occur with the TST, money will be wasted on unnecessary TIE and TRE which would be inconclusive because the water was deemed toxic by the math.

<u>Comment 3.</u> The SWRCB has not provided sufficient information that the current approach is not sufficiently protective of water quality and is effectively cancelling a 20-year program in Region 2 that has been highly successful.

CCCSD engaged Susan L. Anderson, PhD to review the successes of the whole effluent toxicity testing program in Region 2 and how experiences from the existing program may provide a practical perspective on the pros and cons of the proposed policy (Attachment 2). Dr. Anderson indicates that the need for statewide consistency and for detection of false negatives are significant, but they need to be weighed against potential for loss of important information when only two concentrations are tested (instead of an entire dilution curve of five concentrations) and for loss of continuity in the well established program in Region 2. Dr. Anderson suggests:

- A statewide standard of $IWC<IC_{25}$ be proposed initially and that a complete dilution series accompany all tests.

<u>Comment 4.</u> The SWRCB seems to have already reached a conclusion concerning the TST method prior to close of the comment period. A training session has been slated for February 7 and 8, 2011 on using the TST method. The training is not open to technical experts for peer review but only to lab personnel expected to implement the method. This type of approach only creates a forum for legal action instead of consensus building that occurs through the traditional sequence for developing new regulations. CCCSD is disappointed in this action by the SWRCB (Attachment 3).

<u>Comment 5.</u> The high rate of false positives likely will undermine public perception and reduce the use of recycled water, a major new water source for the State of California. It could also lead to unwarranted 303(d) listings.

Detailed Comments Attachments 1-3: Please see CCCSD's additional specific comments that are attached.

ATTACHMENT 1: TECHNICAL LETTER REPORT FROM DR. DANIEL GALLAGHER, PE

ATTACHMENT 2: TECHNICAL LETTER REPORT FROM DR. SUSAN ANDERSON

ATTACHMENT 3: TST TRAINING ANNOUNCEMENT AND NO PEER REVIEWERS ALLOWED TO ATTEND

In summary, for the reasons stated above and in the attached documents, the Preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment requires justification, further scientific peer review, and testing before statewide implementation.

Again, we appreciate the opportunity to comment on the proposed rule. Please do not hesitate to contact me (925-229-7386) with any questions.

Sincerely,

James M. Kelly, P.E.
General Manager

cc: Ann Farrell, P.E., Director of Engineering
Margaret P. Orr, P.E., Director of Plant Operations
Daniel Gallagher, PhD, P.E., Associate Professor, Virginia Tech
Susan Anderson, PhD, Retired Adjunct Professor UC Davis
Bhupinder Dhaliwal, Lab Superintendent

Attachments

January 20, 2011

Mr. Paul Hann
Chief Planning Standards and Implementation
State Water Resources Control Board
Division of Water Quality
1001 I Street, 15th Floor
Sacramento, CA 95814

Re: Preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment and Control

Dear Mr. Hann:

Central Contra Costa Sanitary District (CCCSD) has requested that I review the statistical implications of the proposed Whole Effluent Toxicity (WET) implementation. I reviewed the USEPA draft document *An Additional Whole Effluent Toxicity Statistical Approach for Analyzing Acute and Chronic Test Data* dated 09/14/09.

The proposed TST approach switches the typical null and alternative hypotheses to move the burden of proof to the discharger in order to be more protective of water quality. It also recommends the use of a bioequivalence approach for statistical testing, which introduces an additional parameter b into the analysis and makes recommendations for different α values depending on the nature of the test.

Swapping the null and alternative hypotheses is an accepted method to shift where the burden of proof lies, and in general this proposed switch is more conservative. Thus, in general, additional tests with associated costs will be required to indicate that a discharge is safe. Nowhere in the document, however, is there an indication that the current approach is not sufficiently protective of water quality. The justification of the need for being more conservative is lacking.

More importantly, the document fails to adequately justify is recommendations for choices of b and α. The document indicates that over 2000 existing data sets were analyzed with both methods and that over one million computer simulations using Monte Carlo analysis was performed. But the analysis of the existing data is simply a sensitivity analysis of the change in methods. It does not qualify as a validation because whether or not the effluents tested were actually toxic was not known. Thus we can't use this analysis to determine which test method is more accurate.

Monte Carlo simulations can be used to address the accuracy of the test method, because the "true" value of the effluent toxicity is set beforehand. The "one million simulations" count is not meaningful either. Enough simulations need to be conducted so that the statistic of interest stabilizes. There is no discussion of stability (or even statistic of interest). For comparison, Figures 1 and 2 below are based on one million simulation of TST and Welch tests respectively. With even standard desktop computers, it is easy to drive up the number of simulations. More critical, however, is the nature of the simulations. Unfortunately, there is no description of how the Monte Carlo analysis was conducted, what parameters were varied, how many simulations for each scenario were conducted, and what the actual results of the simulations were.

Figures 1 and 2 below are based on a parametric bootstrap analysis of the TST method and existing Welch test conducted in R version 2.12.1 (www.r-project.org). The source code for the simulation is provided in an Appendix. For this simulation, the control and the test sample were drawn from the same statistical population. In other words, there was no statistical difference between the control and the test sample distributions. Random samples were drawn from these distributions and tested with the TST methodology (Figure 1) and the standard one-side Welch t-test (Figure 2). Note that these 2 figures use the exact same data. The plotted data indicate the probability of incorrectly classifying a known "safe" effluent as toxic as the sample variability changes (given as the standard deviation).

Figure 1 shows many situations where the false positive rate is unacceptably high. This will require that the dischargers run the WET tests with large numbers of replicates to ensure that false positives are guarded against.

Figure 2, on the other hand, illustrates that the false positive rate is fixed and controlled by the α value. All the curves quickly plateau at a 5% false positive, the same α value used for the test.

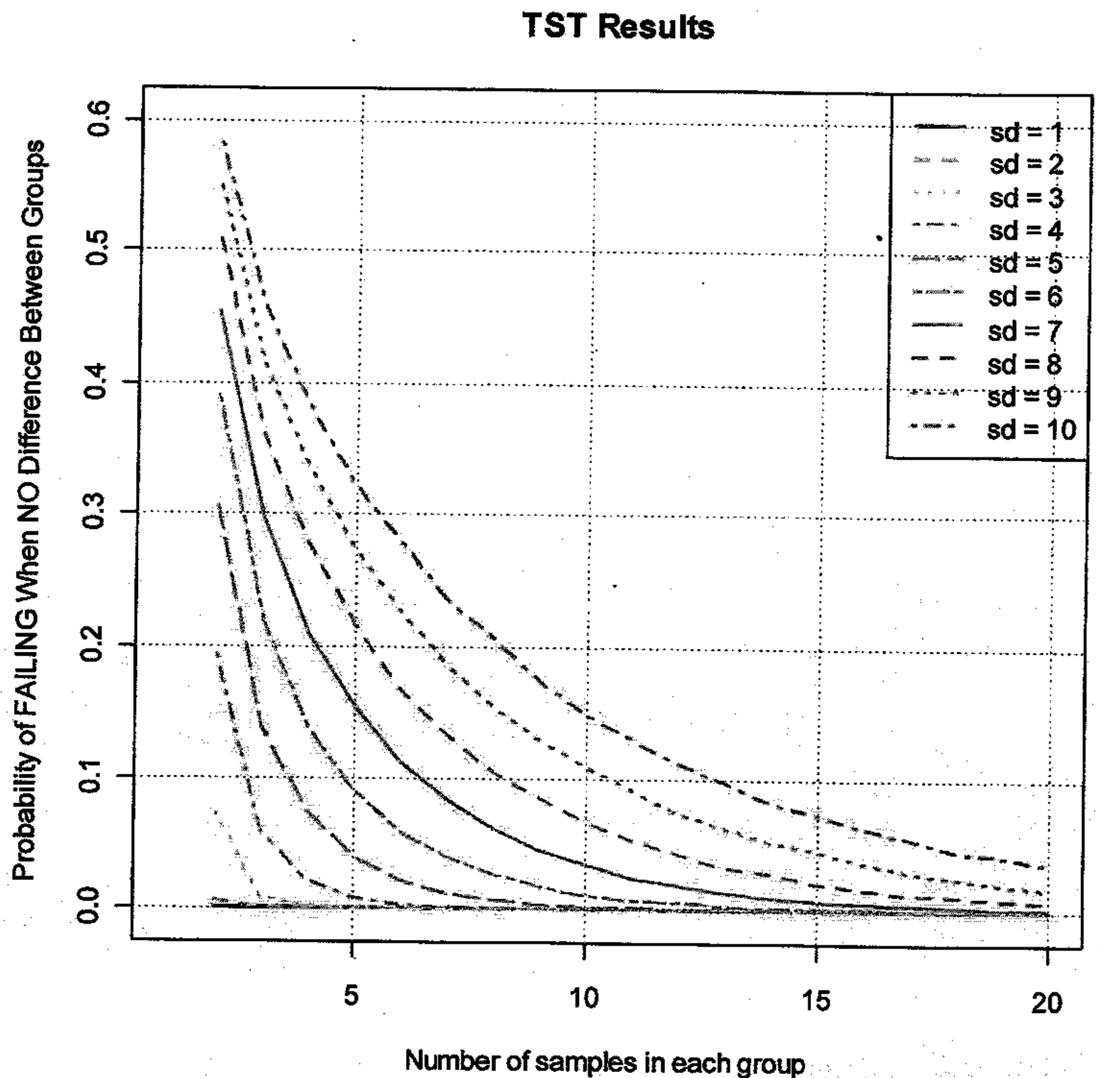

Figure 1. Probability of improperly classifying an effluent as toxic using the TST test when there is no different between the population means and standard deviations of the control versus the effluent. Based on mean of 30, b=0.75, α=0.2 and 100,000 simulations per bootstrap. sd = standard deviation

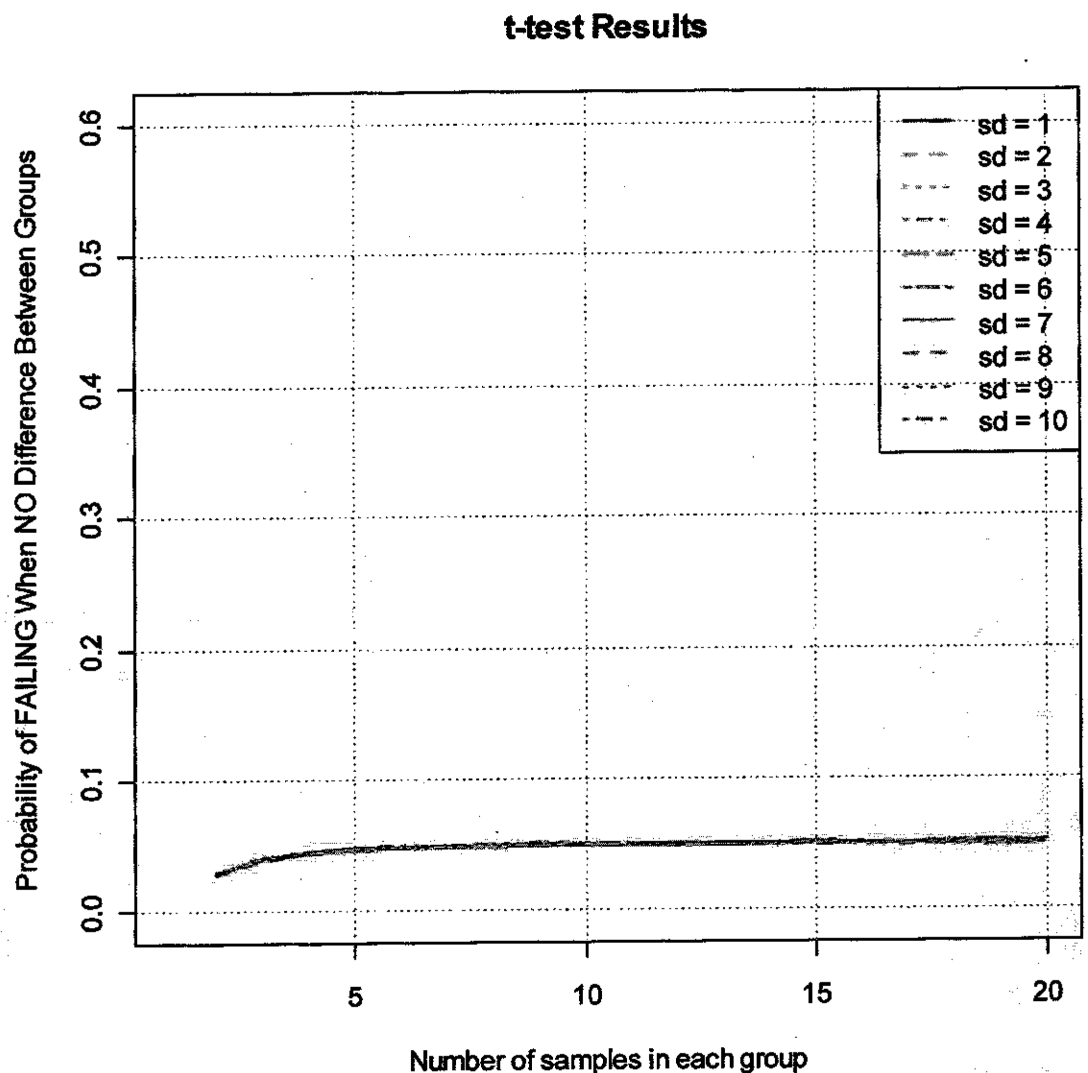

Figure 2. Probability of improperly classifying an effluent as toxic using the t-test when there is no different between the population means and standard deviations of the control versus the effluent. Based on mean of 30, α=0.05 and 100,000 bootstrap simulations for each point. sd = standard deviation.

The previous figures were based on simulations where the control and effluent were not different. Figure 3 illustrates 1 case where there are differences between the control and the effluent. The x axis is the difference in the mean of the populations (control mean – effluent mean). The effluent becomes more toxic at higher deltas. The y axis is the probability of passing the effluent, i.e. improperly concluding that the effluent is not different from the control when in fact it is different.

Both the TST test and the Welch t-test are compared on Figure 3 for 2 scenarios: a low variability (standard deviation = 5) and a high variability (standard deviation = 10). All curves show a decrease as delta increases. Both methods detect the increasing toxicity of the effluent and lessen the chance of a false negative conclusion. For the higher variability scenario (dotted lines), the TST result is always lower than the t-test result. This indicates that the TST method is less likely to have false negatives and is thus more protective of the environment. The opposite result occurs for the lower variability scenario (solid lines). The t-test approach has lower false negative rates throughout and therefore the t-test is actually the more conservative and protective approach.

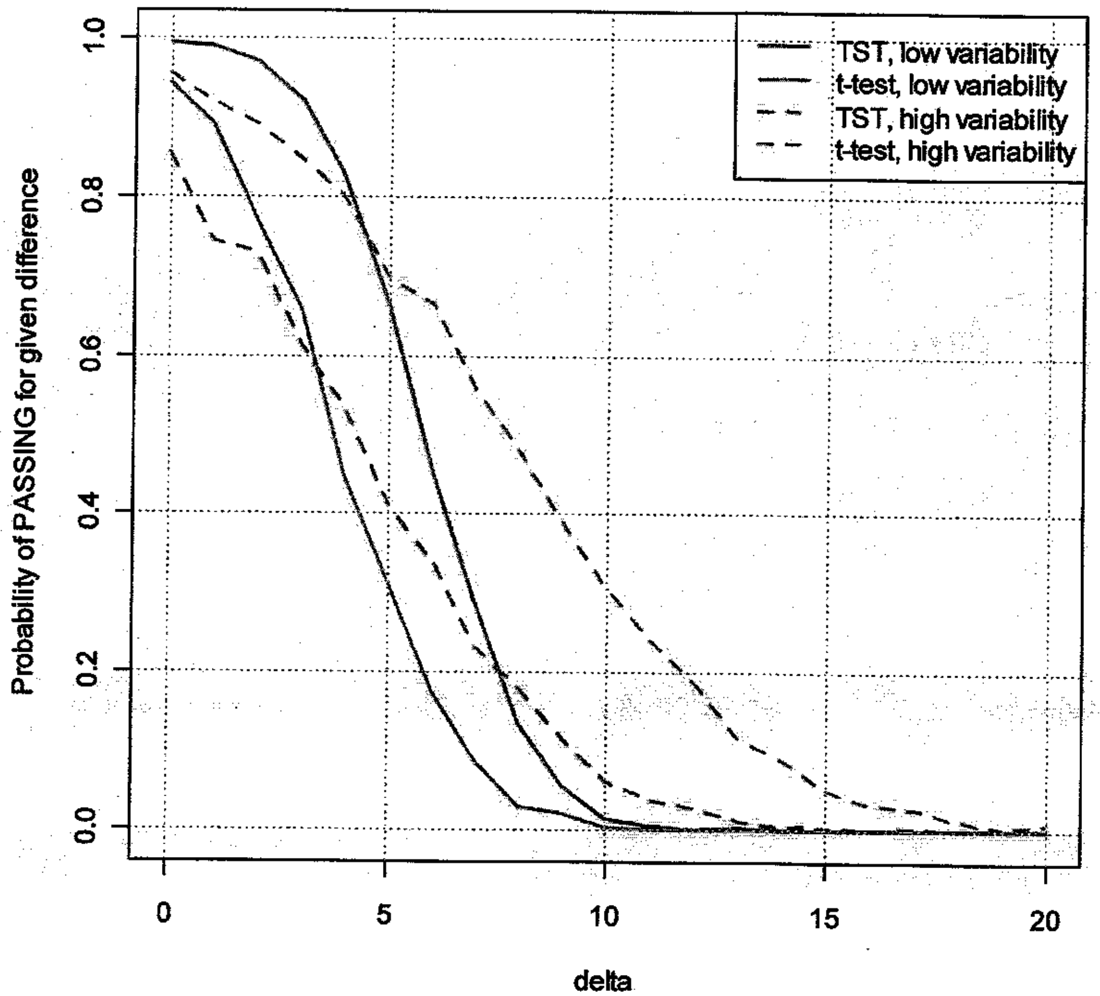

Figure 3. Mean = 30, standard deviation for low variability =5 and for high variability = 10, and number of samples in each of the control and effluent samples = 10. For the TST test, b=0.75 and α = 0.2 . For the one-sided Welch t-test, α = 0.05. Graphs based on 1000 bootstrap simulations for each point. Delta is the difference between the control population mean and the effluent population mean.

The TST methodology has the potential to be more protective of the environment. But by introducing additional parameters (b) and changing α for different tests, the test is much more complex statistically than the standard Welch t-test. It is not always more conservative than the traditional method, and will frequently require an additional burden on the dischargers through increased testing. The TST methodology may offer an improvement in safeguarding receiving waters, but my analysis and the provided documentation suggests that, at this time, the method has not been adequately studied and its impact analyzed. Further evaluation is recommended before this approach is implemented at a regulatory level.

Sincerely,

Daniel Gallagher

Daniel Gallagher, PhD, PE
Associate Professor
Civil & Environmental Engineering
Virginia Tech
Blacksburg, VA

Appendix A: R source code for simulations
Appendix B: Validation of R function

APPENDIX A: R Code for Simulations

```
WET <- function(control, iwc, b=0.75, alpha=0.05, percent.data=FALSE) {
    # assumes no NAs in the input data
    if (percent.data) {
        control <- asin(sqrt(control))
        iwc <- asin(sqrt(iwc))
    }
    mean.control <- mean(control)
    mean.iwc <- mean(iwc)
    var.control <- var(control)
    var.iwc <- var(iwc)
    n.control <- length(control)
    n.iwc <- length(iwc)
    varest <- var.iwc/n.iwc + b^2*var.control/n.control
    t.stat <- (mean.iwc - b*mean.control) / sqrt(varest)
    denom.1 <- (var.iwc/n.iwc)^2 / (n.iwc-1)
    denom.2 <- (b^2 * var.control / n.control)^2 / (n.control-1)
    dof <- varest^2 / (denom.1 + denom.2)
    dof <- round(dof, digits=0)
    t.crit <- qt(1-alpha, dof)
    result <- ifelse(t.stat < t.crit, "fail", "pass")
    return(list("t.stat" = t.stat,
                "t.crit" = t.crit,
                "dof" = dof,
                "result" = result))
}


######################################################################
### comparison to standard unequal variance t-test when no difference
### between groups
### boot strap simulations used to generate Figures 1 and 2
### No difference in populatiosn parameters between control and
### treatment
######################################################################
s <- seq(1, 10, by=1)
mu <- 30
nsims <- 100000
maxn <- 10
alpha <- 0.05
fpass.wet <- matrix(data=NA, nrow=maxn, ncol=length(s))
fpass.t   <- matrix(data=NA, nrow=maxn, ncol=length(s))
for (isd in 1:length(s)) {
    for (nsamples in 2:maxn) {
        np.wet <- 0
        np.t <- 0
        for (isim in 1:nsims) {
            ctrl.boot <- rnorm(nsamples, mu, s[isd])
            trtm.boot <- rnorm(nsamples, mu, s[isd])
            res <- WET(ctrl.boot, trtm.boot, b=0.75, alpha=0.2)
            if (res$result == "pass") np.wet <- np.wet+1
            t.res <- t.test(ctrl.boot, trtm.boot, alt="greater")
            if(t.res$p.value >= alpha) np.t <- np.t + 1
        }
        fpass.wet[nsamples, isd] <- np.wet/nsims
```

```
        fpass.t [nsamples, isd] <- np.t/nsims
    }
}
fpass.wet
fpass.t

########################################################################
### Figure 1
########################################################################
matplot(1:maxn, 1-fpass.wet, typ="l",
       xlab="Number of samples in each group",
       ylab="Probability of FAILING When NO Difference Between Groups",
       main="TST Results", lty=1:length(s), lwd=2,
       col=rainbow(ncol(fpass.wet)), ylim=c(0,0.6))
grid()
legend("topright", legend=paste("sd =",s), lty=1:length(s), lwd=2,
col=rainbow(ncol(fpass.wet)))

########################################################################
### Figure 2
########################################################################
matplot(1:maxn, 1-fpass.t, typ="l",
      xlab="Number of samples in each group",
      ylab="Probability of FAILING When NO Difference Between Groups",
      main="t-test Results", lty=1:length(s), lwd=2,
      col=rainbow(ncol(fpass.t)), ylim=c(0,0.6))
grid()
legend("topright", legend=paste("sd =",s), lty=1:length(s), lwd=2,
      col=rainbow(ncol(fpass.t)))


########################################################################
### comparison to standard unequal variance t-test when
### there is a difference between groups
### boot strap simulations used to generate Figure 3
########################################################################
mu <- 30
nsamples <- 10
s.low <- 5
s.high <- 10
alpha <- 0.05
delta <- seq(0,20,1)
ndelta <- length(delta)
nsims <- 1000
fpass.wet.low <- double(ndelta)
fpass.t.low <- double(ndelta)
fpass.wet.high <- double(ndelta)
fpass.t.high <- double(ndelta)
for (idelta in 1:ndelta) {
        np.wet.low <- 0
        np.t.low <- 0
        np.wet.high <- 0
        np.t.high <- 0
        for (isim in 1:nsims) {
            ctrl.boot.low <- rnorm(nsamples, mu, s.low)
            trtm.boot.low <- rnorm(nsamples, mu-delta[idelta], s.low)
            res <- WET(ctrl.boot.low, trtm.boot.low, b=0.75, alpha=0.2)
```

```
            if (res$result == "pass") np.wet.low <- np.wet.low + 1
            t.res <- t.test(ctrl.boot.low, trtm.boot.low,
alt="greater")
            if(t.res$p.value >= alpha) np.t.low <- np.t.low + 1

            ctrl.boot.high <- rnorm(nsamples, mu, s.high)
            trtm.boot.high <- rnorm(nsamples, mu-delta[idelta], s.high)
            res <- WET(ctrl.boot.high, trtm.boot.high, b=0.75,
alpha=0.2)
            if (res$result == "pass") np.wet.high <- np.wet.high + 1
            t.res <- t.test(ctrl.boot.high, trtm.boot.high,
alt="greater")
            if(t.res$p.value >= alpha) np.t.high <- np.t.high + 1
        }
        fpass.wet.low[idelta] <- np.wet.low/nsims
        fpass.t.low[idelta]   <- np.t.low/nsims
        fpass.wet.high[idelta] <- np.wet.high/nsims
        fpass.t.high[idelta]   <- np.t.high/nsims
}
fpass.wet.low
fpass.t.low
fpass.wet.high
fpass.t.high

######################################################################
### Figure 3
######################################################################
plot(delta,  fpass.wet.low,  typ="l", lty=1, lwd=2, col="red",
     ylab="Probability of PASSING for given difference")
lines(delta, fpass.t.low,    typ="l", lty=1, lwd=2, col="blue")
lines(delta, fpass.wet.high, typ="l", lty=2, lwd=2, col="red")
lines(delta, fpass.t.high,   typ="l", lty=2, lwd=2, col="blue")
grid()
legend("topright", legend=c("TST, low variability", "t-test, low
variability",
            "TST, high variability", "t-test, high variability"),
            col=c("red","blue","red", "blue"), lty=c(1,1,2,2), lwd=2)


#################################################################
### check function against EPA examples
#################################################################
# Case Example 1
ctrl <- c(27, 38, 27, 34, 37, 35, 30, 31, 36, 39)
trtm <- c(32, 28, 25, 28, 20, 15, 27, 31, 31, 30)
mean(ctrl); sd(ctrl)
mean(trtm); sd(trtm)
WET(ctrl, trtm, b=0.75, alpha=0.2)

# Case Example 2
ctrl <- c(29, 38, 31, 34, 36, 35, 30, 31, 36, 34)
trtm <- c(31, 28, 25, 28, 22, 21, 27, 26, 29, 30)
mean(ctrl); sd(ctrl)
mean(trtm); sd(trtm)
WET(ctrl, trtm, b=0.75, alpha=0.2)

# Case 3 small
```

```
ctrl <- c(0.366, 0.399, 0.354, 0.422)
trtm <- c(0.303, 0.379, 0.311, 0.236)
mean(ctrl); sd(ctrl)
mean(trtm); sd(trtm)
WET(ctrl, trtm, b=0.75, alpha=0.25)

# Case 3 large
ctrl <- c(0.366, 0.399, 0.354, 0.422, 0.343, 0.407)
trtm <- c(0.303, 0.379, 0.311, 0.236, 0.364, 0.247)
mean(ctrl); sd(ctrl)
mean(trtm); sd(trtm)
WET(ctrl, trtm, b=0.75, alpha=0.25)

# Case 4
# NOTE EPA DOCUMENT HAS ORDER OF MAGNITUDE TYPO FOR TABULAR T
ctrl <- c(10, 10, 10, 10)
trtm <- c(10,  8,  9,  8)
mean(ctrl); sd(ctrl)
mean(trtm); sd(trtm)
WET(ctrl/ctrl, trtm/ctrl, b=0.8, alpha=0.1, percent.data=TRUE)
```

Appendix B: Validation of R function for WET Testing

Each of the 4 examples I the USEPA document were run using the WET() function given above. In each case, the intermediate calculations and the final results matched ththose in the USEPA document.

```
>#######################################################################
> ### check function against EPA examples
>#######################################################################
> # Case Example 1
> ctrl <- c(27, 38, 27, 34, 37, 35, 30, 31, 36, 39)
> trtm <- c(32, 28, 25, 28, 20, 15, 27, 31, 31, 30)
> mean(ctrl); sd(ctrl)
[1] 33.4
[1] 4.40202
> mean(trtm); sd(trtm)
[1] 26.7
[1] 5.417051
> WET(ctrl, trtm, b=0.75, alpha=0.2)
$t.stat
[1] 0.8224907

$t.crit
[1] 0.866245

$dof
[1] 15

$result
[1] "fail"

>
> # Case Example 2
> ctrl <- c(29, 38, 31, 34, 36, 35, 30, 31, 36, 34)
> trtm <- c(31, 28, 25, 28, 22, 21, 27, 26, 29, 30)
> mean(ctrl); sd(ctrl)
[1] 33.4
[1] 2.988868
> mean(trtm); sd(trtm)
[1] 26.7
[1] 3.267687
> WET(ctrl, trtm, b=0.75, alpha=0.2)
$t.stat
[1] 1.316727

$t.crit
[1] 0.864667

$dof
[1] 16

$result
```

```
[1] "pass"

>
> # Case 3 small
> ctrl <- c(0.366, 0.399, 0.354, 0.422)
> trtm <- c(0.303, 0.379, 0.311, 0.236)
> mean(ctrl); sd(ctrl)
[1] 0.38525
[1] 0.03102015
> mean(trtm); sd(trtm)
[1] 0.30725
[1] 0.0584715
> WET(ctrl, trtm, b=0.75, alpha=0.25)
$t.stat
[1] 0.5819961

$t.crit
[1] 0.7406971

$dof
[1] 4

$result
[1] "fail"

>
> # Case 3 large
> ctrl <- c(0.366, 0.399, 0.354, 0.422, 0.343, 0.407)
> trtm <- c(0.303, 0.379, 0.311, 0.236, 0.364, 0.247)
> mean(ctrl); sd(ctrl)
[1] 0.3818333
[1] 0.03185854
> mean(trtm); sd(trtm)
[1] 0.3066667
[1] 0.05848989
> WET(ctrl, trtm, b=0.75, alpha=0.25)
$t.stat
[1] 0.7866814

$t.crit
[1] 0.7111418

$dof
[1] 7

$result
[1] "pass"

>
> # Case 4
> # NOTE EPA DOCUMENT HAS ORDER OF MAGNITUDE TYPO FOR TABULAR T
> ctrl <- c(10, 10, 10, 10)
> trtm <- c(10,  8,  9,  8)
> mean(ctrl); sd(ctrl)
[1] 10
[1] 0
> mean(trtm); sd(trtm)
```

```
[1] 8.75
[1] 0.9574271
> WET(ctrl/ctrl, trtm/ctrl, b=0.8, alpha=0.1, percent.data=TRUE)
$t.stat
[1] 0.01735889

$t.crit
[1] 1.637744

$dof
[1] 3

$result
[1] "fail"

>
```

January 20, 2011

Mr. Paul Hann
Chief Planning Standards and Implementation
State Water Resources Control Board
Division of Water Quality
1001 I Street, 15th Floor
Sacramento, CA 95814

Re: Preliminary Draft Policy for Whole Effluent Toxicity (WET) Assessment and Control

Dear Mr. Hann:

Central Contra Costa Sanitary District (CCCSD) has requested my opinion on the proposed Whole Effluent Toxicity (WET) policy and its implementation, and this letter contains my comments to them. Let me say at the outset, that EPA Region 9 staff, who developed the statistical method used in this proposal, are widely acknowledged for their work in the field of aquatic toxicology; and in addition, there are many aspects of the proposed policy that are well conceived. Nevertheless, the use of a new statistical technique (the Test of Significant Toxicity or TST) to assess whole effluent toxicity permit compliance represents a more significant shift in both approach and philosophy then might be immediately obvious.

Below, I have outlined items regarding the TST method and its implementation that merit further consideration. Please note, that my perspective is based primarily on knowledge of the extensive track record with whole effluent toxicity testing in Region 2. Of course, this focus may not capture a complete statewide view. Nevertheless, the whole effluent toxicity testing program in Region 2 is viewed as a success, and experiences from this program may provide a practical perspective on the pros and cons of the proposed policy.

Overview of the proposed policy change

The proposed policy would dramatically affect both how compliance testing is conducted for effluents as well as the manner in which data are analyzed. First, most major dischargers in Region 2 assess the toxicity of their effluent using a chronic toxicity test with a control water and five levels of effluent dilution. Therefore, compliance is determined at a critical concentration such as the Instream Waste Concentration (IWC), but it is also feasible for the discharger to track their performance at lower concentrations---and make corrections before toxicity reaches critical values. In addition, abrupt changes in the dose response curve of a toxicity test, when compared to the same test over time, may signal a change in the types of effluent constituents driving toxicity. This would suggest the need for rapid assessment of the changes and perhaps, further intervention.

Another important aspect of the existing approach to effluent toxicity assessment is that compliance is determined using a point estimation method, the IC_{25}. This method of statistical analysis is a standard used in many areas across the nation and has been in place in Region 2 for approximately two decades.

The new policy differs from the existing one in that not only is a new statistical method employed to assess compliance, but only a control water and a *single* concentration of effluent are used in the toxicity test. Hence, the discharger will only know whether the test passed or failed, and they will have no warning when the toxicity of the discharge is approaching the level required for compliance. In contrast to the high level of validation and experience that exists for the current approach, the level of validation of the new statistical model is growing significantly (USEPA, 2010), but it still remains low by comparison. I have not heard of another area of the country where the new toxicity test approach has been implemented.

Scientific dialogue strengthens implementation of new programs

The WET testing program in Region 2 was founded on a strong scientific platform as well as extensive dialogue with the regulated community. As a member of San Francisco Bay Regional Board staff from 1986-1990, I was scientific lead on implementation of the first regional WET project in California. My opinion is that dialogue undertaken in that effort created a strong technical community and that this improved implementation of the program-- promoting broader stewardship.

In 1986, the original program in Region 2 involved several steps to build a scientific foundation and to encourage stepwise implementation. All efforts were based on peer-reviewed guidance (USEPA, 1985) that had been published, accepted for nationwide implementation, and supported by EPA research laboratories. Furthermore, preliminary effluent testing, based on these guidelines, was conducted by three EPA laboratories, the Regional Board policies (Anderson *et al.*, 1985) based on the guidelines were discussed in numerous workshops, and a quality assurance round robin testing was conducted and accepted for publication (Anderson, 1988; Anderson and Norberg, 1991). All of these activities established a strong science-based community. Revisions to the program in 1991, after I left the Regional Board staff, further strengthened implementation, testing, and statistical analyses (Suer, 1991; Anderson et al., 1991). To my knowledge, this has been a widely successful program. A key concern is that a move to a methodology with no track record would result in the loss of both a successful program as well as the historical benchmarks created by continuity in methods and data analysis. A pilot study would be useful in creating a firmer foundation to assess the pros and cons of the new approach in the real world.

Motivations remain unclear for the proposed policy change

Substantial changes in a well functioning program are more justifiable when the need for a new approach is clear. To our knowledge, evidence of ambient toxicity caused by major discharges in Region 2 has not been demonstrated in the Regional Monitoring Program or other, albeit limited, monitoring efforts. An important historical note is that an original intention for the whole effluent toxicity program in Region 2 was to evaluate receiving water toxicity, after major dischargers were in compliance, to determine whether the ongoing program was protective. Perhaps more instream testing should be implemented, but it is not clear why the method for compliance assessment should be changed.

The stated rationale for the new policy (USEPA, 2010) is to decrease the frequency of false negatives in effluent toxicity testing and to generate higher quality data. It is of course true that some instances of false negatives might be prevented with this approach. However, it is also true that many more incidences of toxicity violations could occur, because increases in wastewater treatment plant toxicity will not be detected until permit limits are exceeded. How does this improve water quality? Public perception of the municipalities and their ongoing efforts to control sources and treat wastewater could be unduly harmed. Policies promoting partnership and proactive management seem more sensible.

In a recent telephone conversation with Dr. Debra Denton, I learned that both regulatory agencies and many dischargers have asked for improved approaches to statistical analysis of WET data and that there is a need for statewide consistency in this matter. Evidently, this is one of the secondary motivations for the policy change. In particular, some discharges calculate a No Observed Effect Concentration (NOEC; e.g. limit expressed as IWC < NOEC), a hypothesis testing approach, while others use the IC_{25}, a point estimation method. I agree that perhaps all discharges could be switched to a single method but argue that use of the IWC < IC_{25} may be a better standard initially since it is more widely accepted (USEPA, 1991). I also support the use of IC_{25} because point estimate analyses are less affected by variance in the data than are the TST analyses. Review of Examples 1 and 2 in the USEPA Technical Report (2010; pp.A7 and A8) indicates that increased variance significantly increases the likelihood of failing a test. While all laboratories must aspire to the highest standards, some aspects of bioassay testing are difficult to control. For example, the embryo tests are dependent on spawning stock, and the quality of this stock varies greatly among seasons.

If statewide consistency is a highlighted goal, then it is critical to note that the statewide policy regarding allowable dilution, or the IWC portion of the equation, may be vastly more inconsistent than any detail of the statistical analysis. The 1987 Basin Plan in Region 2 established a conservative cap of 10:1 dilution credit for all major dischargers north of the Dumbarton Bridge, irrespective of the actual dilution achieved at the edge of the mixing zone. This means the IWC aspect of the equation can never be less than 10% effluent. This is obviously a source of conservatism in establishing compliance with an effluent toxicity limit. Hence, it is difficult to understand the bigger picture regarding statewide consistency.

Dr. Denton also mentioned critiques that the IC_{25} is not considered sufficiently protective and that more appropriate levels may be difficult to determine because they may vary among species. Again, this is an interesting point that merits exploration, but references to this effect must be examined critically before a well established benchmark is changed, especially given the conservative mixing zone policies and the strength of the existing programs in some regions.

Finally, Dr. Denton suggested that more frequent testing could be conducted if the two-concentration TST approach is implemented. The rationale being, that if each test costs less money, then testing could be conducted more frequently. If this is one of the goals of the policy, perhaps it should be stated. In some regions it may be a good idea; but in Region 2, the loss of an historical benchmark and of information obtained by running a full dose curve seems to outweigh the benefits. It might be wise to consider the larger picture when it comes to cost savings as well. If false positives occur with the TST, then money could be wasted on unnecessary Toxicity Identification Evaluations (TIE), which would be difficult to conduct (because of the low toxicity) and possibly inconclusive.

Validation of the TST statistical approach is not quite complete

It has been difficult to critically review selected aspects of the Test of Significant Toxicity (TST) and to assess the level of acceptance for this approach in the scientific community. My two main questions are discussed below.

First, the TST uses test-specific alpha values, which are the false negative error rates in this case. These values are critical to the use of the statistical model. Exactly how were these values determined? The EPA Technical report provides some explanation, principally on pages 6-7. However, the description is not sufficiently detailed for the approach to be analyzed critically. I learned from Dr. Denton that some of this information was recently accepted for journal publication. This provides further indication of the general validity of the approach, but broad implementation is not warranted until more complete material is available for broader review.

Finally, many people have noted that implementation of the TST is only listed as a suggested alternative in the EPA technical report. Why is California moving so quickly to make it mandatory? Why have the EPA Office of Research and Development (ORD) staff not promoted this implementation and published case studies with real world data? This is a departure from the manner in which previous aspects of the WET program were implemented. A bit of clarification on this would be very helpful.

In closing, absent the demonstration of either ambient toxicity or unacceptable false negative toxicity, a change in the existing policy (IWC<IC25) seems unwarranted at this time, especially given the success of the current program and the need for further validation of the TST. I hope my comments will be useful. I appreciate the opportunity to comment on this important topic. Thank you for your time and consideration in this matter.

Sincerely,

Susan L. Anderson, Ph.D, Independent Consultant
Retired Adjunct Professor UC Davis Department of Environmental Toxicology and
Director of the Pacific Estuarine Ecosystem Indicator Research Consortium

APPENDIX A – REFERENCES

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Anderson, S.L. 1988. Memo to Effluent Toxicity Characterization mailing list regarding results of Quality Assurance Testing. (File 1539). California Regional Water Quality Control Board, San Francisco Bay Region.

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Resume of

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EDUCATION

Ph.D. in Environmental Science & Engineering, University of North Carolina at Chapel Hill, NC. May, 1986. Thesis: *Application of Data Based Transformations to Parameter Estimation in Water Quality Models.*

M.S. in Environmental Engineering, Drexel University, Philadelphia, PA, June 1981. Thesis: *Nutritional Stimulation of Methanogenic Bacteria.*

B.S. in Civil Engineering, Drexel University, Philadelphia, PA, June 1979. Graduated with Highest Honors. Senior Project: *Pilot Study of Deep U-Tube Aerator.*

AWARDS and HONORS

2001 Risk Policy Fellow / American Association for the Advancement of Science
1989 National Science Foundation Presidential Young Investigator Award
1988 Environmental Science and Engineering Fellow / American Association for the Advancement of Science

EMPLOYMENT

Associate Professor — June 1993 to present
Assistant Professor — September 1987 to June 1993
Dept. of Civil Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Developed and taught numerous courses in environmental engineering and science. Conducted sponsored research dealing with environmental statistics, risk assessment, water treatment, and contaminant fate and transport. Recent projects include the evaluation and modeling of sampling plans for food safety, characteristics of small water utilities, and consumer complaints as early warnings for water utilities. Other major projects included the development of an ecosystem restoration plan for acid-mine impacted streams, evaluation of pesticide runoff to aquaculture facilities, and modeling ground water/surface water interactions.

Courses Taught

Undergraduate		Graduate	
EF 1024	Pascal For Engineers	CE 5714	Surface Water Quality Modeling
CE 3104	Intro. to Environmental Engineering	CE 5724	Environmental Sampling and Monitoring
CE 3804	Computer Applications for Civil Engineers	CE 5984	Environmental Systems Optimization
CE 4184	Environmental Hydraulics		
CE 4594	Soil and Groundwater Pollution		

Risk Policy Fellow — August 2001 to August 2002
American Association for the Advancement of Science, Washington, D.C.

Worked with the U.S Department of Agriculture's Food safety and Inspection Service to develop and implement risk assessments for *Listeria monocytogenes* and bovine spongiform encephalopathy, and to evaluate trends in the data from the chemical residue monitoring program. The *Listeria* risk assessment resulted in a USDA directive estimated to save over 25 lives per year.

Environmental Science & Engineering Fellow — June 1988 to August 1988
American Association for the Advancement of Science, Washington, D.C.

Worked with the Environmental Protection Agency's Office of Pesticides and Toxic Substances to integrate water quality modeling with a geographical information system. Results used to evaluate potential population exposure to new chemicals under the premanufacturing notice requirements of RCRA.

Research Associate — January 1986 to September 1987
Water Resources Research Institute, Univ. of North Carolina, Raleigh, NC.

Implemented geographical information system and water quality monitoring program for Haywood County, NC, as part of a study on drinking water source protection in mountainous watersheds. Responsible for development of preventive maintenance and inventory database for consortium of local water and sewer utilities. Conducted and analyzed survey of over 300 utilities in 9 southeastern states to determine financial practices for water and sewer line extensions.

Instructor — August 1986 to January 1987
School of Forestry & Environmental Studies, Duke University, Durham, NC.

Developed and taught a graduate course in water quality management. Topics included water chemistry, water quality modeling, statistics, and treatment plant design.

Research Assistant — August 1981 to January 1986
Dept. of Environmental Science & Engineering, Univ. of North Carolina, Chapel Hill, NC.

Investigated improved methods of parameter estimation for water quality models. Developed a robust statistical estimation method which more accurately predicts concentrations of trace contaminants and biological species. Responsible for development and programming of water quality and optimization models with subsequent statistical evaluation.

Research Specialist — June 1979 to August 1981
Environmental Studies Institute, Drexel University, Philadelphia, PA.

Directed research in anaerobic digestion. Responsibilities included supervising four laboratory technicians, designing experiments, analyzing data, and writing technical reports. Supervised construction and testing of pilot scale low energy aeration equipment.

SPONSORED RESEARCH

Principal or Co-Principal Investigator on the following projects:

2010. Evaluating Bacterial Cross Contamination Potential In Retail Deli Environments. USDA. (~$105,000)

2010. Identification, Evaluation, and Mitigation of Health Risks from Elevated Lead in School Drinking Water. NSF (~$360,000)

2010 Response to Public comments on the "Draft FSIS Comparative Risk Assessment for Listeria monocytogenes in Ready-To-Eat Meat and Poultry Deli Meats". USDA (~$5,000)

2009. ICTAS Grand Challenge "Water for Health". Virginia Tech ICTAS. (~$300,000)

2008. Development of a Retail Bacterial Cross Contamination Model for Foodborne Pathogens. USDA (~$225,000)

2008. Adaptation of *L. monocytogenes* Risk Assessment to a 2-Dimensional Model For Development of Acceptable Levels of Protection. USDA. (~$90,000)

2007. Integration of Dynamic Water and Sewer Distribution Models with Water Quality and Flow Sensor for Real-Time Control. EDD. (~$130,000)

2007. A Comparative Risk Assessment For *Listeria Monocytogenes* In Ready To Eat Meat And Poultry Products: Sliced And Packaged In-Plant Versus Sliced And Packaged At Retail. USDA, (~$50,000)

2005. Pilot Study on the Integration of Customer Complaint Data with On-Line Water Quality Data as an Early Warning System. AWWA. (~$50,000)

2004. A Comparative Risk Assessment for *Listeria monocytogenes* in Deli Meat: Sliced in-plant versus sliced at retail. USDA/SAIC. (~$50,000)

2003. Risk-based Verification Sampling for Listeria. USDA/SAIC. (~$37,000)

2002. Risk Assessment and Food Safety. Interagency Personnel Agreement with U.S. Department of Agriculture (~$54,000)

2002. Natural Resources and Environment Fellowships, U.S. Department of Agriculture (~$269,000)

1999. Assessment of Regulations and Other Factors Pertaining to the Availability of Operators for Small Water Systems, Virginia Department of Health (~$60,000)

1998. Ecological Risk Reduction for Copper-Based Crop Protectants: A Comparison of Plasticulture Without and Without Sedimentation Control. Virginia Department of Agriculture and Consumer Services (~$93,000)

1998. Interactive Web-based Learning for Ground Water Transport and Contamination. Virginia Tech Center for Excellence in Undergraduate Teaching (~$30,000)

1997. Treatment Technologies for the Removal of Excess Copper from Process Water Used for Shellfish Aquaculture. CFAST (Commercial Fish and Seafood Technologies) (~$6,000)

1997. Investigation of Toxicity to Shellfish in Aquaculture Facilities on the Eastern Shore of Virginia From Water Quality and Hydrological Impacts. Virginia Sea Grant (~$120,000)

1996. Evaluation of Pollutants in Source and Process Waters Used in Shellfish Aquaculture. Virginia Sea Grant (~$10,000)

1995. The Investigation of Mined Land and Abandoned Mined Land Influences on Aquatic Ecotoxicology and Water Quality. American Electric Power (~$250,000)

1995. Groundwater Nitrogen Movement and Distribution of Discharge in a Coastal Plain Watershed. Virginia Division of Soil and Water Conservation. (~$45,000)

1994. A Screening Model for Contaminant Transport in Ground Water/Surface Water Systems. New Jersey Department of Environmental Protection. (~$40,000)

1994. Identification of High-Risk Groundwater Discharge Regions in a Coastal Plain Watershed: A Geographical Information System Approach. Virginia Department of Soil and Water Conservation. (~$44,000)

1994. Tidal Modeling of Copper Concentrations in the Occoquan River. Virginia Tech Core Research. (~$4,000)

1994. Tidal Modeling of Copper Concentrations in the Occoquan River. Black and Veatch. (~$22,000)

1993. Water Quality Screening Model for Development in Coastal Areas. Virginia Tech Core Research. (~$5,000)

1993. Field Verification: Fluctuating Groundwater Tables and Septic Field Contamination of Shellfish Waters. Virginia Council on the Environment. (~$26,000)

1993. Screening Model Development for Water Quality Impacts and Carrying Capacity of Small Tidal Creeks and Inlets. Virginia Marine Resources Commission. (~$15,000)

1992. The Effects of Water Table Elevation on Nonpoint Source Pollution from Onsite Sewage Disposal Systems. Virginia Council on the Environment. (~$15,000)

1992. Development and Field Verification of Sorption/Oxidation Models for Soluble Manganese Removal by Oxide-Coated Filtration Systems. National Science Foundation. (~$138,000)

1992. Dynamic Measurement of Submarine Groundwater Discharge. Virginia Tech Core Research. (~$5,000)

1992. Leachate Treatment and Groundwater Assessment with Recharge. Stearns and Wheler. (~$17,000)

1992. Pesticide Transport by Submarine Groundwater Discharge. Virginia Department of Agriculture and Consumer Services. (~$38,000)

1992. Submarine Groundwater Discharge Coupling Land/Water Ecosystems. Virginia Division of Soil and Water Conservation and NSF PYI. (~$122,500).

1991. Pesticide Transport by Submarine Groundwater Discharge. Virginia Tech Core Research. (~$7,000)

1991. Submarine Groundwater Discharge Coupling Land/Water Ecosystems. Virginia Division of Soil and Water Conservation and NSF PYI. (~$112,500).

1991. Physical Transport of Interstitial Solutes in Relation to Seawater Cycling within Carbonate Coastal Margin Sediments. NOAA / UNC - Wilmington National Undersea Research Program (~$8,000).

1990. Water Quality Modeling with Cellular Automata. Virginia Tech Core Research. (~$8,000).

1990. Submarine Groundwater Discharge Coupling Land/Water Ecosystems. Virginia Division of Soil and Water Conservation and NSF PYI. (~$100,000).

1990. Control of Chlorine Dioxide Residuals Through Generator Optimization, Use of Reducing Agents, and/or Activated Carbon. American Water Works Association Research Foundation and NSF PYI. (~$168,000).

1990. The Influence of Groundwater Discharge and Land-Uses on Sediment Nutrient Flux and Primary Productivity within Nearshore Chesapeake Bay Environments. Virginia Water Resources Research Center. (~$23,000).

1989. Development in a Conservative Substance, Plug Flow Model of the Occoquan Reservoir. CH2M-Hill and NSF PYI. (~35,000).

1989. Treatment of J.C. Miles Clam Processing Wastewater Utilizing the Upflow Anaerobic Sludge Blanket System: A Demonstration Project. Virginia Seafood Council and NSF PYI. (~5,000).

1989. Novel Approaches to Environmental Systems. National Science Foundation Presidential Young Investigator. (~$125,000 plus $187,500 potential matching).

1989. Optimization of Water Distribution Network Sampling. Virginia Tech Core Research. (~$9,000)
1988. Preventive Maintenance and Inventory Database for Water Utilities. Water Resources Research Institute of the University of North Carolina. (~$3,000)

1988. Use of Groundwater Models for Risk Assessment of Virginia's Superfund Sites. Virginia Department of Waste Management. (~$21,000).

1988. Optimal Sampling Strategies for Water Distribution Systems. Virginia Tech Core Research. (~$9,000).

1988. Exposure Assessment with Geographical Information Systems: Water Quality Modeling. Environmental Science and Engineering Fellows Program. American Association for the Advancement of Science and Environmental Protection Agency. (~$7,000)

1988. Classroom Demonstration Development for Geographic Information Systems. Virginia Tech Teaching Learning Grant. (~$1,000)

CONSULTING

CSC — December 2005 – February 2007
Statistical analysis of customer complaint data under USEPA Water Sentinel program.

SAIC — December 2004-January 2005
Washington, D.C.
Review of USDA Residue Testing in Food Products

Huggins, Faulkner, and Flynn — June 2003 – July 2003
Roanoke, VA
Development of statistically sound and cost efficient sampling plant for mine seeps.

Huggins, Faulkner, and Flynn — March 2000 – May 2002
Roanoke, VA
Designed statistical sampling plans for hazardous waste site remediation.

Camp, Dresser, & McKee September 2001
Arlington, VA
Statistical analysis of water quality data from distribution system.

Glenbard Wastewater Authority September, 2000
Chicago, IL
Conducted statistical analysis of pollutant loading patterns.

Biological Monitoring, Inc. January, 1998 to May, 1999
Blacksburg, VA
Developed sediment transport model for release of coal fines to streams in western Virginia.

Glenbard Wastewater Authority September, 1997
Chicago, IL
Developed statistical sewage flow prediction model for cost allocation among the Authority's members.

Management Systems International May, 1996
Washington, DC
Developed and taught short course on design and operation of water distribution systems for Palestinian Water Authority under the auspices of USAID and UNDP.

Burns and McDonnell January, 1995
Evaluation of sludge characteristics and hydraulic analysis for pumping station.

City of Danville, VA September, 1987 to June, 1988
Aided water utility in analysis and design of water quality modeling project for permitting purposes.

Pan American Health Organization, Washington, D.C. February 1987 to June 1988
Developed software for evaluation of design standards used in constructing water distribution and sewer collection networks.

The World Bank, Washington, D.C. January 1985 to March 1985
Developed a series of computer programs on the IBM-PC using a structured programming format. The series included programs for statistical analysis and experimental design, mathematical optimization, and the design of water and sewer networks. These were distributed to planning agencies in developing countries.

Water for Sanitation and Health, October 1984
AID, Washington, D.C.
Traveled to Quito, Ecuador, to implement water distribution computer programs on local minicomputer system. Taught a workshop to the design engineers on the use of these programs.

PROFESSIONAL AFFILIATIONS

Registered Professional Engineer, North Carolina
American Society of Civil Engineers, Member
International Association for Food Protection, member
Chi Epsilon Civil Engineering Fraternity

PUBLICATIONS and PRESENTATIONS

Refereed Journal Papers and Book Chapters

Ömür-Özbek P, Gallagher DL, Dietrich AM. "Determining Human Exposure and Sensory Detection of Odorous Compounds Released During Showering", *Environmental Science & Technology.* In press

Benson AS, Dietrich AM, Gallagher DL. "Evaluation of Iron Release Models for Water Distribution Systems", *Critical Reviews in Environmental Science and Technology.* In press.

Whelton A, Dietrich AM, Gallagher DL. "Contaminant Diffusion, Solubility, and Material Property Differences between HDPE and PEX Potable Water Pipes", *ASCE Journal of Environmental Engineering.* 136(2):227-237 2010.

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Dietrich AM, Gallagher DL. "Fate and Environmental Impact of Pesticides in Plastic Mulch Production Runoff: Field and Laboratory Studies", *Journal of Agricultural and Food Chemistry*, 50(15):4409-4416, 2002.

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Robinson M, Gallagher DL, "A Model of Ground Water Discharge from an Unconfined Coastal Aquifer", *Ground Water Monitoring and Remediation*, 37(1): 80-97, January-February, 1999.

Robinson M, Gallagher DL, Reay WR. "Field Observations of Tidal and Seasonal Variations in Ground Water Discharge to Tidal Estuarine Water", *Ground Water Monitoring and Remediation*, pp. 83-92, Winter, 1998.

Merkle PB, Knocke WR, Gallagher DL, Little J. "Dynamic Model for Soluble Mn^{2+} Removal by Oxide-Coated Filter Media", *J. Environmental Engineering Division, ASCE*, 123(7):650-658, July, 1997.

Merkle PB, Knocke WR, Gallagher DL. "Method for Coating Filter Media with Synthetic Manganese Oxide", *J. Environmental Engineering Division, ASCE*, 123(7):642-649, July, 1997.

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Rashash DMC, Gallagher DL. "An Evaluation of Algal Enumeration", *Journal of the American Water Works Association*, 87(4):127-132, April, 1995.

Reay W, Gallagher DL, Simmons Jr. GM. "Sediment-Water Column Oxygen and Nutrient Fluxes in Nearshore Environments of the Lower Delmarva Peninsula, USA", *Marine Ecology Progress Series* 118:215-227, 1995.

Boardman GD, Tissinger JL, Gallagher DL "Treatment of Clam Processing Wastewaters by Means of Upflow Anaerobic Sludge Blanket Technology", *Water Research*, 29(6):1483-1490, 1995.

Mastran TA, Dietrich AM, Gallagher DL, Grizzard TJ. "Distribution of Aqueous and Sediment Polyaromatic Hydrocarbons with respect to Boating Activity in a Reservoir", *Water Research*, 28(11): 2353-2366, 1994.

Coffey BM, Gallagher DL, Knocke WR. "Modeling Soluble Manganese Removal by Oxide-Coated Media Filtration", *Journal of the Environmental Engineering Division - ASCE*, 119(4), pp. 676-694, July/August, 1993.

Dietrich AM, Chesnutt SA, Alderman LA, Gallagher DL, "Determination of Organic Pollutants in Land-Applied Municipal Wastewater Sludges by Toxicity Characteristic Leaching Procedure (TCLP) and Extraction Procedure Toxicity Test (EP Tox)", *Research Journal of the Water Pollution Control Federation*, 65(5), pp. 612-619, July/August 1993.

Reay W, Gallagher DL, Simmons Jr. GW. "Groundwater Discharge and its Impact on Surface Water Quality in a Chesapeake Bay Inlet", *Water Resources Bulletin*, 28(6), pp. 1121-1134, December, 1992.

Dietrich AM, Ledder TD, Gallagher DL, Grabeel MN, Hoehn RC. "Determination of Chlorite and Chlorate in Chlorinated and Chloraminated Drinking Water by Flow Injection Analysis and Ion Chromatography", *Analytical Chemistry* Vol. 64(5), pp. 496-502, 1992.

Dietrich AM, Orr MP, Gallagher DL, Hoehn RC. "Tastes and Odors Associated with Chlorine Dioxide", *Journal of the American Water Works Association*. Vol. 84(6), pp. 82-88. 1992.

Dietrich AM, Gallagher DL, DeRosa P, Millington DS, DiGiano FA. "Enhancement of N-Nitrosamine Formation on Granular-Activated Carbon from N-Methylaniline and Nitrite", *Environmental Science & Technology*, Vol. 20, pp. 1050-1055, 1986.

Speece RE, Parkin G, Gallagher DL, "Nickel Stimulation of Anaerobic Digestion", *Water Research*, Vol. 17, pp. 677-683, 1983.

Speece RE, Gallagher DL, Krick C, Thompson R, "Pilot Performance of Deep U-Tubes", *Progress in Water Technology*, Vol. 12, Toronto, pp. 395-407, 1980.

Proceedings Papers

Gallagher OD, Gallagher DL. "Incorporating Uncertainty and Variability When Determining Ground Water Contamination Source Reductions", Virginia Water Research Conference. Richmond, VA October 15-16, 2009.

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From: "Amy Chastain" <achastain@bacwa.org>
To: MOakley@rmcwater.com; James.Ervin@sanjoseca.gov
Date: 1/18/2011 10:31:07 AM
Subject: FW: Training Opportunity - Test of Significant Toxicity

Just in case you haven't seen this - here is notice of the State Board workshops.

Amy

From: lyris@swrcb18.waterboards.ca.gov
[mailto:lyris@swrcb18.waterboards.ca.gov]
Sent: Friday, January 14, 2011 3:54 PM
To: Amy Chastain
Subject: Training Opportunity - Test of Significant Toxicity

State Water Resources Control Board
<http://www.waterboards.ca.gov/images/ca_department/waterboard_logo.jpg>
This is a message from the State Water Resources Control Board.

The State Water Resources Control Board and EPA Region 9 are jointly holding two one-day hands-on workshops to be held February 7 (at SCCWRP office) and February 8 (Sacramento area) that will present the statistical approach, Test of Significant Toxicity (TST). The course will include, a general overview of the TST, how to use it for analyzing effluent and ambient toxicity results, and how labs and permittees can obtain more confidence in toxicity test results using TST. Participants will learn to use the user-friendly TST analysis tool to help them analyze different types of WET data at the workshop. Participants must pre-register (no on-site registration will be allowed) and space is limited to 50 participants for each location. Only those conducting or analyzing effluent, storm water, or ambient toxicity tests will be eligible to attend the workshop. Contact Maggie.craig@tetratech.com if interested in pre-registering for one of these workshops, noting which day you prefer and your title and affiliation.

Please see the attached flyer for additional details

Paul Hann

Course Description:

The State Water Resources Control Board and EPA Region 9 are pleased to sponsor a one-day workshop on the theory and application of EPA's Test of Significant Toxicity (TST) for analyzing Whole Effluent Toxicity test data as part of California's draft Toxicity policy. Toxicity testing is specified in effluent discharge permits to monitor compliance with toxicity objectives. National policy requires that the "discharge of toxic pollutants in toxic amounts be prohibited". Toxicity tests have the advantage of directly assessing the biological effects of all effluent constituents, including the interactive effects of multiple chemicals.

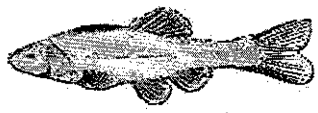
On November 2010, the State Board presented an overview of their new draft Toxicity policy, which includes the use of EPA's recently published TST approach, for analyzing effluent toxicity data as well as stormwater and ambient surface water toxicity data. This workshop will cover:

- Statistical approaches for analyzing toxicity data and the science behind TST
- How the TST analysis works
- Hands-on analysis of example datasets using the TST Excel tool
- What labs and permittees can do to increase confidence in their toxicity test results using TST

Instructors will discuss the applications of TST in toxicity testing for permits, other regulatory programs, and ambient toxicity testing with interested toxicity laboratory staff.

Target Audience: Only, laboratories or entities (to include regulators) conducting or analyzing effluent, storm water, and ambient toxicity testing are able to attend this course. This course is restricted to only those individuals as stated above.

Test of Significant Toxicity Analysis: Applications for stormwater, effluent, and ambient toxicity testing



Dates: **February 7, 2011, Southern California Coastal Water Research Project, Costa Mesa**

February 8, 2011, Sacramento

Hours: 9:00 am – 4 pm

Fees: No charge

WORKSHOP INSTUCTORS:

Debra L. Denton. Dr. Denton, Environmental Scientist with US EPA Region 9
Jerry Diamond. Dr. Diamond, Director, Ecotoxicology with Tetra Tech, Inc., MD
John Hunt, Brian Anderson and Bryn Phillips. Dr. Hunt, Mr. Anderson, and Mr. Phillips with UC Davis, Department of Environmental Toxicology
Steve Bay. Mr. Bay, Principal Scientist with Southern California Coastal Water Resources Project, Toxicology Department.

To Register. Class max is 50. **Participants must preregister (no on-site will be allowed)** by emailing a request to Maggie Craig at maggie.craig@tetratech.com.

If you have special accommodation or language needs, please contact Maggie Craig at (410)-356-8993 or maggie.craig@tetratech.com at least 5 working days prior to February 7. TTY/DD/Speech to Speech users may dial 7-1-1 for the California Relay Service.