

April 24, 2009  
Project No. 200919W

Ms. Helen M. Perry  
Storm Water Program Manager  
City of Santee  
10601 Magnolia Avenue  
Santee, CA 92107-1266

**Re: Updating Action Levels for Total Coliform, Fecal Coliform and  
*Enterococcus* for the Dry Weather Monitoring Program: Draft Report**

Dear Ms. Perry:

Per request of the San Diego Copermittees Dry Weather Monitoring Sub-Workgroup (Dry Weather Workgroup), D-MAX Engineering, Inc. (D-MAX) conducted a study to update the existing action levels for three constituents: total coliform, fecal coliform, and *Enterococcus* bacteria. The results of the study were presented during the Dry Weather Workgroup meeting on April 22, 2009. This report also summarizes our approach in data collection, data analyses, and statistical methodologies; and it presents the results of the analyses. A copy of the April 22 presentation is attached to this report.

**Background**

The existing action levels used by the Copermittees are based on the 2003 action level study conducted by D-MAX using the dry weather sampling data collected in 2002. Since that time, the Copermittees have completed six more years of dry weather monitoring from 2003 through 2008. The aim of this study was to reassess the existing action levels for the above constituents based on this larger dataset. Each year the Copermittees send standardized dry weather data files to the County of San Diego's regional monitoring contractor, Weston Solutions, to be compiled into one large dataset. Since the 2008 data have not been reported to Weston Solutions yet, this study is based on data collected from 2002 to 2007.

**Data Organization**

Data used in this study were compiled from the following sources:

- 2002 data are from D-MAX archives (this data was compiled in 2003 when the previous action level study was conducted)
- 2003 data are based on two sources:
  - D-MAX's databases, based on past work D-MAX has completed
  - Data sent to D-MAX from jurisdictions for which D-MAX did not already have data



- 2004-2007 data were acquired from Weston Solutions. These data are from the regional data sharing program requiring Copermittees to annually submit data to Weston Solutions.

The collected data for all six years were combined into one file and converted to a single format. Initially, there were records for 2,852 sampling events. Samples that were noted as being duplicates, follow-ups, or confirmations were excluded. Samples that were taken as part of additional studies rather than normal dry weather sampling were also excluded.

**Quality Control**

For the majority of the laboratories conducting analyses, the maximum detection limit for total coliform is 1,600,000 MPN/100 mL, and the maximum detection limit for fecal coliform and *Enterococcus* is 160,000 MPN/100 mL. After filtering out the samples described above, there were still many values at or above these levels. Since these values were in the range of feasible results, they were not immediately removed from the dataset.

To determine whether it was appropriate to include these samples in our analysis, the specific data points at or above the maximum detection levels were discussed with the relevant Copermittees. Each jurisdiction provided us with information about which of these samples, if any, were known to be from illegal discharges or other abnormal conditions that would make them not representative of typical dry weather conditions. Based on this information, 26 sample results were removed from the dataset.

The final data used for analysis for each constituent are presented in Table 1. Since not all samples reported a value for all three constituents, there was minor variation in sample size among constituents. Table 1 presents the current action levels, number of samples used in the analyses, and number and percentage of exceedances when compared to the existing action levels.

**Table 1. Existing Action Levels and Sample Sizes used in Current Study**

	<b>Total Coliform (MPN/100 mL)</b>	<b>Fecal Coliform (MPN/100 mL)</b>	<b><i>Enterococcus</i> (MPN/100 mL)</b>
Existing Action Level	50,000	20,000	10,000
Sample Size	2,328	2,333	2,293
Samples ≥ Existing Action Level	814	325	369
Percentage of Samples ≥ Existing Action Level	34.97%	13.93%	16.09%

**Methodologies**

In 2002, the action levels were developed using a 90 percent upper limit confidence interval. Since that time, the California State Water Resources Control Board organized a Storm Water Panel (Blue Ribbon Panel) to evaluate the issues of numeric effluent limits and action levels. The Blue Ribbon Panel produced a report titled “The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial, and Construction Activities” dated June 19, 2006. The Blue Ribbon Panel’s report recommended three potential approaches for developing action levels:



- Consensus Based Approach
- Ranked Percentile Distribution
- Statistically-Based Population Parameters

The consensus based approach requires that all stakeholders agree on a certain numeric limit. Because such a large dataset exists for the dry weather monitoring programs, it did not seem appropriate to pursue a consensus based approach instead of the other approaches. For the purposes of this study, three approaches were used: ranked percentile and statistically-based population parameters, both based on the Blue Ribbon Panel report, and confidence intervals since that approach had also been used in the past. The results of analyses based on each of these three approaches are presented below.

**Ranked Percentile Analyses**

Data for each constituent were numerically ranked, and 80<sup>th</sup>, 85<sup>th</sup>, 90<sup>th</sup>, and 95<sup>th</sup> percentiles were calculated. The results are tabulated in Table 2. For interpretation purposes, the 80<sup>th</sup> percentile is the number that 80 percent of the data falls below and 20 percent of the data is at or above. This means that if the 80<sup>th</sup> percentile value was used, 20 percent of the sites in the evaluated dataset would exceed the action level.

Because these calculations are based on rank rather than value, this method provides an effective way to assess highly skewed data and ensure that outliers do not affect the results. The results indicate that the 80<sup>th</sup> percentile action level values are higher than the current action levels for total coliform but lower than existing levels for fecal coliform and *Enterococcus*. The 85<sup>th</sup> percentile values are higher for total coliform and *Enterococcus* but lower for fecal coliform. The 90<sup>th</sup> and 95<sup>th</sup> percentile values are all higher than the existing action levels.

**Table 2. Percentiles Analyses Results**

	<b>Total Coliform (MPN/100 mL)</b>	<b>Fecal Coliform (MPN/100 mL)</b>	<b><i>Enterococcus</i> (MPN/100 mL)</b>
80th Percentile	<b><i>130,000</i></b>	<i>13,000</i>	<i>7,000</i>
85th Percentile	<b><i>160,000</i></b>	<i>17,000</i>	<b><i>11,000</i></b>
90th Percentile	<b><i>240,000</i></b>	<b><i>30,000</i></b>	<b><i>17,000</i></b>
95th Percentile	<b><i>500,000</i></b>	<b><i>90,000</i></b>	<b><i>35,000</i></b>
Existing Action Levels	50,000	20,000	10,000

Note: Numbers in ***bold, italics*** are higher than existing action levels. Numbers in *italics* are lower than existing action levels.

**Statistically-Based Population Parameters**

Two different approaches were used to conduct the statistically-based population parameters method. In the first approach, the standard dataset also used to calculate the percentiles was used in the analyses. In the second approach, all total coliform data greater than 1,600,000 MPN/100 mL and all fecal coliform and *Enterococcus* values greater than 160,000 MPN/100mL were capped at 1,600,000 MPN/100mL and 160,000 MPN/100 mL, respectively. The second approach was used based on comments received from Dry Weather Workgroup members that a similar “capping” approach is used to evaluate data for the coastal outfall monitoring program.



To properly apply the statistically-based population parameters approach, the underlying dataset should follow a normal distribution. Three transformations were performed to convert the original data to a normal distribution: the natural log transformation, log base 10 transformation (log transformation), and square-root transformation. Among the three transformations, the log transformation resulted in the dataset closest to a normal distribution and thus was selected to transform the data.

After log transformation, the normality of distribution for total coliform, fecal coliform, and *Enterococcus* datasets were each further evaluated. The log transformed total coliform data was slightly negatively skewed, so it was adjusted by excluding log values below 2 (below 100 MPN/100 mL before transformation) and above 6.5 (above 3,162,277 MPN/100 mL before transformation). These data constituted the extreme tails of the distribution. This resulted in the removal of 53 total coliform data points, only two of which came from the high end of the distribution (log value above 6.5). This resulted in the log of total coliform values being normally distributed.

Note that this adjustment had different results for the standard and capped total coliform datasets. For the standard dataset, the values above a log transformed value of 6.5 were completely removed from the dataset during the adjustment process. For the capped dataset, the values that had a log-transformed value above 6.5 in the standard dataset were capped at a log transformed value of 6.2 (1,600,000 MPN/100 mL before transformation). Because of this, in the capped dataset those values were not removed when the adjustment for normality was made because capping them brought them below the 6.5 threshold. This difference resulted in two additional data points at 6.2 being incorporated into the overall mean and standard deviation calculations for the capped dataset, whereas in the uncapped (standard) dataset those two data points were above 6.5 and thus not included in the mean and standard deviation calculations. Thus, paradoxically, the capped total coliform dataset mean and standard deviation were slightly higher than the mean and standard deviation for the uncapped dataset.

No adjustment was required for the transformed fecal coliform and *Enterococcus* datasets. Typical distributions before and after transformation for all three parameters are presented in the attached presentation slides.

Following normalization, values for the mean and median plus one standard deviation were calculated. This was performed on the log transformed data and then back-transformed to the original units. The resulting values were approximately 100,000 MPN/100 mL above the existing action level for total coliform, and slightly below existing action levels for fecal coliform and *Enterococcus*. The results of the analyses for both methods are presented in Tables 3 and 4 respectively.

**Table 3. Results of the Statistical Analyses Using Capped Dataset**

	<b>Total Coliform (MPN/100 mL)</b>	<b>Fecal Coliform (MPN/100 mL)</b>	<b><i>Enterococcus</i> (MPN/100 mL)</b>
Mean + One SD	<b><i>149,081</i></b>	<i>16,123</i>	<i>9,008</i>
Median + One SD	<b><i>167,303</i></b>	<i>15,785</i>	<i>9,123</i>
Existing Action Levels	50,000	20,000	10,000

Note: Numbers in ***bold, italics*** are higher than existing action levels. Numbers in *italics* are lower than existing action levels.



**Table 4. Results of the Statistical Analyses Using Standard Dataset**

	<b>Total Coliform (MPN/100 mL)</b>	<b>Fecal Coliform (MPN/100 mL)</b>	<b><i>Enterococcus</i> (MPN/100 mL)</b>
Mean + One SD	<b><i>149,517</i></b>	<i>15,552</i>	<i>8,997</i>
Median + One SD	<b><i>167,366</i></b>	<i>15,394</i>	<i>9,115</i>
Existing Action Levels	50,000	20,000	10,000

Note: Numbers in ***bold, italics*** are higher than existing action levels. Numbers in *italics* are lower than existing action levels.

Please note that the higher values for the capped total coliform data are the result of adjustments for normality as explained earlier in the discussion.

### **Confidence Interval**

The same normalized, uncapped dataset prepared for the assessment of population parameters described above was also used to calculate 90 and 95 percent confidence intervals for the mean. Primarily due to the very large sample size for the dataset, the confidence interval range for the 2002-2007 dataset is very narrow. That is, even the upper 90 and 95 percent confidence intervals are very close to the mean of the dataset. The results of these analyses are presented in Table 5 below.

**Table 5. Results of the Confidence Interval for the Mean**

	<b>Total Coliform (MPN/100 mL)</b>	<b>Fecal Coliform (MPN/100 mL)</b>	<b><i>Enterococcus</i> (MPN/100 mL)</b>
90% Upper Limit	<i>18,675</i>	<i>1,525</i>	<i>1,149</i>
95% Upper Limit	<i>18,993</i>	<i>1,553</i>	<i>1,1168</i>
Existing Action Levels	50,000	20,000	10,000

Note: Numbers in *italics* are lower than existing action levels.

### **Summary**

Different methods of calculating action levels have been examined and presented herein. The methods include Ranked Percentile Distribution, Statistically-Based Population Parameters, and Confidence Interval. These methods were discussed at the April 22, 2009, Dry Weather Workgroup meeting. Following the meeting the results of the study were distributed to all members of the Dry Weather Workgroup for a vote to determine which option should be used for the 2009 bacteria action levels.

It has been our pleasure working with you on this project. If you have any questions regarding this study, please contact me at (858) 586-6600, ext. 22.

Sincerely,  
D-MAX Engineering, Inc.

Arsalan Dadkhah, Ph.D., P.E.  
Principal