United States Environmental Protection Agency | Office of Water 4305T | EPA-823-F-06-013 August 2006

Water Quality Standards for Coastal Recreation Waters:
Using Single Sample Maximum Values in State Water Quality Standards

This fact sheet addresses common questions regarding the appropriate use of the single sample maximum (SSM) values component of EPA's 1986 bacteria criteria in coastal recreation waters. States monitor their Great Lakes and marine coastal recreation waters for the presence of fecal contamination, specifically for the indicator organisms E. coli and enterococci. States typically collect water samples and analyze them for bacteria content at regular intervals. States then evaluate these bacteria levels against the applicable water quality standards.

What are coastal recreation waters?
Coastal recreation waters are those Great Lakes and marine waters (including coastal estuaries) that are designated under section 303(c) of the Clean Water Act for use for swimming, bathing, surfing, or similar water contact activities. Inland waters or waters upstream from the mouth of a river or stream having an unimpaired natural connection with the open sea are not considered coastal recreation waters. (See CWA Section 502(21) and 40 CFR 131.41(b)).

What is EPA's current position on using the SSM in BEACH Act Waters?
EPA's current position is the same as it was in the November 2004 *Water Quality Standards for Coastal and Great Lakes Recreation Waters* rule (69 FR 67217, November 16, 2004), commonly referred to as the BEACH Act rule. In the preamble to the BEACH Act rule, EPA clarified its expectations with regard to how the single sample maximum (SSM) values could be used in the context of beach notification and closure decisions, and in the context of the implementation of other Clean Water Act programs. EPA indicated that it expected that the single sample maximum values would be used for making beach notification and closure decisions. EPA recognized, however, that States and Territories also use criteria in their water quality standards for other purposes under the Clean Water Act in order to protect and improve water quality. Other than in the beach notification and closure decision context, the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality. The geometric mean is generally more relevant because it is usually a more reliable measure of long term water quality, being less subject to random variation, and more directly linked to the underlying studies upon which the 1986 bacteria criteria were based. States, however, retain the discretion to determine whether and how to use the SSM in other Clean Water Act programs.

Why did EPA choose to address the SSM in the 2004 BEACH Act rule?
The 1986 EPA *Ambient Water Quality Criteria for Bacteria* document clearly identifies the SSM values and the geometric mean values as part of the criteria. Therefore, consistent with section 303(i)(2)(A) of the Clean Water Act, EPA included both components of the criteria in the BEACH Act rule. However, the SSM discussion in the 1986 bacteria criteria document refers

only to beach monitoring, and does not discuss how or whether the SSM should be implemented for other Clean Water Act applications, such as establishing Total Maximum Daily Loads or National Pollutant Discharge Elimination System permit limitations.

EPA continues to believe that the SSM values in the criteria are very useful for making beach notification and closure decisions. Beach managers frequently need to make beach notification and closure decisions based on as little as one single grab sample. Of the 2,823 beaches reporting information to EPA in 2002, 65% reported that pathogen levels were monitored at least once per week (*EPA's Beach Watch Program: 2002 Swimming Season*, EPA 823-F-03-007, May 2003, http://www.epa.gov/waterscience/beaches/beachwatch2003-newformat.pdf). This means that at 35% of the beaches, the beach managers had fewer than four samples each month for making decisions to open or close the beach. Indeed, in numerous cases, managers had only one sample in any given 30-day period. Thus, having a trigger level against which just one lone sample value can be compared is quite helpful. Furthermore, beach management programs need to be able to respond rapidly to short-term changes in water quality.

This does not mean the single sample maximum has no value outside of the beach monitoring and notification context. Using an SSM is especially important for beaches and other recreational waters that are infrequently monitored or prone to short-term spikes in bacteria concentrations, e.g., waters that may be affected by combined sewer overflow outfalls. The BEACH Act rule preamble recognized that States and Territories, having identified that a water is prone to short-term spikes in bacteria concentrations due to pollution episodes, have significant flexibility in how they address those episodes in permitting and assessments consistent with the Clean Water Act and implementing regulations. For States and Territories that are subject to the rule, they have the flexibility to determine how they choose to apply the SSM outside the beach monitoring and notification context. States that have already adopted their own water quality standards as protective of human health as EPA's 1986 bacteria criteria should consider in their water quality assessment methodology the applicability of the SSM to assessment of waters where fewer than five samples are available during the time over which the samples would normally be averaged if the states specify a minimum number of samples for calculating a geometric mean.

As noted above, the SSM may, but need not, also play a role in implementing other Clean Water Act programs. Except in the beach notification and closure context, EPA expects that States will determine whether and how to use the SSM criteria in the context of their other programs implementing the Clean Water Act.

Was the SSM developed to serve as an acute criterion to protect swimmers against short term exposures?

No. The SSM values in the 1986 EPA *Ambient Water Quality Criteria for Bacteria* were not developed as acute criteria; rather, they were developed as statistical constructs to allow decision makers to make informed decisions to open or close beaches based on small data sets. This does not mean the SSM values serve no purpose outside of beach notification decisions. For example, they may give States and Territories the ability to make waterbody assessments where they have limited data for a waterbody. However, the SSMs were not designed to provide any more protection of health than provided by the geometric mean criterion.

In developing the 1986 EPA *Ambient Water Quality Criteria for Bacteria*, EPA derived the SSM as upper percentiles of the frequency distributions around the geometric mean. The 1986 bacteria criteria document recognizes that there will be instances where the concentration of bacteria in one or more individual samples will be higher than the acceptable geometric mean concentration. This is to be expected when dealing with water quality criteria expressed as average concentrations over a period of time. For example, in a waterbody with a 30-day average concentration exactly at the water quality criterion, it can be expected that approximately half the time the waterbody concentration will be above the criteria level. Hence, half of the samples collected will have a concentration above the criterion concentration (*e.g.*, 126/100 ml for *E. coli*). Thus, that the value of any one individual sample is greater than the numerical value of the geometric mean criterion, or even the numerical value of the SSM, does not necessarily indicate that the geometric mean criterion has actually been exceeded. Likewise, the fact that one sample out of a set of samples has a concentration lower than the criteria level does not necessarily mean that the actual average concentration is lower than the criteria level.

Can a beach meet the geometric mean without always meeting the SSM?
Yes. Based on the derivation of the SSM as percentiles of a distribution of bacterial concentrations around the 30-day geometric mean, using the SSM as values not to be surpassed at any time for all Clean Water Act applications could impart a level of protection much more stringent than intended by the 1986 bacteria criteria document. For example, in marine waters the geometric mean criterion for enterococci is 35/100 ml, and the SSM is 104/100 ml at designated bathing beach waters based on the 75th percentile of the distribution of individual values around the mean. If that SSM were used as a value-not-to-be-surpassed, it would become a maximum value and all other values in the statistical distribution of individual measurements would have to be less than the maximum. EPA typically uses the 99^{th} percentile of a distribution to derive regulatory maximums. Assuming a waterbody had the same standard deviation in concentration of bacteria employed in deriving the SSM (*e.g.*, 0.7 for marine waters), then the waterbody geometric mean needed to keep the waterbody concentration below 104/100 ml 99% of the time would need to be 2/100 ml. This would be far more stringent than the level of protection provided by the actual geometric mean criterion for enterococci of 35/100 ml.

Treating the SSM as equivalent to acute criteria (*i.e.*, with a specified duration of exposure of just one second) for purposes of complying with Section 303(d) of the Clean Water Act would result in a large number of waters being listed as impaired even though the waters may not have exceeded the applicable geometric mean criteria. Therefore, EPA intends that States and Territories covered by the BEACH Act rule retain the discretion to use SSM values as they deem

appropriate in the context of Clean Water Act implementation programs other than beach notification and closure, consistent with the Clean Water Act and its implementing regulations.

Can states establish more stringent water quality criteria than that recommended by EPA?
Of course, states are always free to establish water quality criteria more protective of human health and aquatic ecosystems than those required or recommended by EPA. Hence, though EPA is pointing out the effects of using the SSMs in the ways described in the answer to the previous question - ways the Agency had not envisioned when it published the 1986 bacteria criteria document - states, territories, and authorized tribes retain the discretion to be more stringent and use an SSM in such a fashion.

What additional flexibility do states have with regard to using the SSM?
Although EPA promulgated default SSM values based on the 75, 82, 90, and 95% confidence levels, the BEACH Act rule also includes the equation that can be used to calculate site-specific SSM values. EPA calculated the values for the SSM included in the rule using the standard deviations observed during the EPA epidemiological studies. The Agency recognizes that the log standard deviations observed in EPA's epidemiological studies may not coincide with that for a particular waterbody. EPA encourages states to collect data to calculate site-specific standard deviations. To compute a site-specific log standard deviation in a statistically meaningful way, the rule requires that States and Territories collect at least 30 bacterial samples in a single recreation season (see 40 CFR 131.41(c)(3)). EPA recognizes the difficulty in collecting the required number of samples over a single recreation season, but the Agency nonetheless concluded that collecting this much data during a single season is necessary in order to capture the variability inherent in bacteria concentrations at a site over the period of a single season without introducing additional variability from extreme weather conditions such as drought or El Niño conditions. Using 30 samples over more than one recreation season could affect the outcome of the SSM such that it may not be as protective of human health as EPA's 1986 bacteria criteria. If this requirement is met, the state may use the resulting site-specific standard deviation to calculate a corresponding SSM or set of SSMs.

EPA considers that the calculation of site-specific SSM values, as specified in 40 CFR 131.41(c)(3), provides enough detail on the calculation that states included in the BEACH Act rule can implement this provision of the rule without needing to adopt it as a site-specific water quality criterion. As a result, states included in the BEACH Act rule do not need EPA review and approval under 40 CFR Part 131 in their application of 40 CFR 131.41(c)(3).

Should states included in the BEACH Act rule use the SSM in implementing all of their Clean Water Act programs, such as the TMDL and NPDES permitting programs?
The BEACH Act rule was not intended to constrain the states included in the rule in how they could use single sample maximum values in the context of Clean Water Act implementation programs such as the Total Maximum Daily Load program and the National Pollutant Discharge Elimination System (NPDES) program.

Normally, states use all applicable water quality criteria included in their water quality standards for all purposes specified under the Clean Water Act and implementing EPA regulations, including water quality assessments, establishment of TMDLs, and setting of water quality-based effluent limits (WQBELs) under the NPDES program. However, the BEACH Act rule presented a unique situation in that it promulgated both the geometric mean component – without establishing a minimum number of samples – and an SSM component. This leads to some special considerations in CWA section 303(d) assessments and NPDES permits.

CWA 303(d) listing
In making CWA 303(d) listing decisions, the geometric mean is generally more relevant than the SSM because it is usually a more reliable measure of long term water quality, as discussed above. However, because EPA did not include a minimum sample size in expressing the geometric mean criterion when EPA promulgated criteria for coastal recreation waters, if there is only a single measurement (sample) of a waterbody, a state could use the SSM instead of the geometric mean to determine whether to include that waterbody on the CWA 303(d) list. This is because the state could not calculate a statistically reliable geometric mean without more than a single grab sample. It would not be appropriate for a state to use the SSM *as a substitute* for the geometric mean if there is more than one measurement (sample) because a geometric mean could be calculated with more than one grab sample.

When developing TMDLs, states should consider the availability of additional pathogen data besides that used for the original listing in developing their estimates of loading capacity, load allocations and wasteload allocations needed to meet their specific water quality standards. For a more detailed discussion of pathogen TMDLs, see EPA's January 2001 "Protocol for Developing Pathogen TMDLs" (US EPA 841-R-00-002).

NPDES Permitting
Although states have flexibility in deciding whether and how to apply SSM values in the NPDES permitting program, this does not mean that maximum daily or seven-day average permit limits for bacteria are inappropriate for National Pollutant Discharge Elimination System permits. EPA's *Technical Support Document for Water Quality-based Toxics Control* describes how maximum daily and 7-day average effluent limits can be calculated based on 30-day average conditions and an understanding of effluent variability (EPA-505-2-90-001, March 1991). The procedures in Section 5.4.4 of the *Technical Support Document* are based on statistical methodologies similar to those employed in deriving the SSM in the 1986 water quality criteria for bacteria. EPA's decision to promulgate criteria that include SSM values does not address the question of how States' should establish maximum daily permit limits.

For a state now adopting water quality standards for coastal recreation waters to be as protective of human health as EPA's 1986 bacteria criteria and seeking EPA approval, would a state need to adopt into its water quality standards for coastal recreation waters *both* the geometric mean and SSM components of the criteria?
Yes. As stated in the preamble to the BEACH Act rule, one of the considerations EPA uses in reviewing state water quality standards submissions related to bacteria criteria for coastal

recreation waters is whether or not those standards include not only a geometric mean, but also appropriate SSMs for all coastal recreation waters.

EPA expects those states adopting their own water quality standards as protective of human health as EPA's 1986 bacteria criteria to use the SSM to make short-term decisions in the beach monitoring and notification context. States adopting their own water quality standards have the flexibility to determine how to use the SSM in other Clean Water Act programs. In adopting new standards in coastal recreation waters, States may elect to include a minimum sample set size as part of its geometric mean criterion. If it does so, it would need to have another component of its criteria that would apply when there are fewer samples than the minimum sample set size. This is because the criteria have to be as protective of human health as EPA's 1986 bacteria criteria. If the geometric mean criterion does not apply for some specified condition, such as when there are fewer than five samples, then some other aspect of the criterion would need to apply, in this case the SSM. Alternatively, states may elect to apply the geometric mean criterion regardless of the number of samples used to calculate the geometric mean, which is the approach EPA envisioned when it promulgated the BEACH Act rule. In this case, the geometric mean criterion would apply in all instances, and a state could elect not to use the single sample maximum for Clean Water Act purposes as a substitute for the geometric mean, other than for beach monitoring and notification. This approach ensures a situation does not arise where there is no applicable criterion.

When states adopt the 1986 bacteria criteria into water quality standards for their coastal recreation waters, states should specify, in the water quality standards, how the SSM will be used in particular Clean Water Act applications. This helps make it clear to EPA, state regulators, dischargers, and the public how the SSM will be used in NPDES permits, assessment, TMDLs, and beach monitoring and notification. The flexibility afforded to states in deciding whether and how to apply SSM values in the National Pollutant Discharge Elimination System permitting program does not mean that maximum daily or seven-day average permit limits for bacteria are inappropriate for National Pollutant Discharge Elimination System permits. EPA's *Technical Support Document for Water Quality-based Toxics Control* describes how maximum daily and 7-day average effluent limits can be calculated based on 30-day average conditions and an understanding of effluent variability (EPA-505-2-90-001, March 1991). The procedures in Section 5.4.4 of the *Technical Support Document* are based on statistical methodologies similar to those employed in deriving the SSM in the 1986 water quality criteria for bacteria. EPA's decision to promulgate criteria that include SSM values does not address the question of how States' should establish maximum daily permit limits.

How should states that already have water quality standards that are as protective of human health as EPA's 1986 bacteria criteria apply the single sample maximum?
States that already have water quality standards as protective of human health as EPA's 1986 bacteria criteria should apply the single sample maximum in a manner consistent with their water quality standards.

Some states have included a provision in their water quality standards that limits the application of the geometric mean component of the criterion to situations only where five or more samples are available. EPA expects these states to use the single sample maximum for all Clean Water Act purposes if the geometric mean cannot be used because, for example, the sample set is fewer than the minimum number of samples required by the state's water quality standards. EPA has this expectation because the criteria have to be as protective of human health as EPA's 1986 bacteria criteria. If the geometric mean criterion does not apply for some specified condition, such as when there are fewer than five samples, then some other aspect of the criterion would need to apply, in this case the SSM. Alternatively, states may elect to apply the geometric mean criterion regardless of the number of samples used to calculate the geometric mean, which is the approach EPA envisioned when it promulgated the BEACH Act rule. In this case, the geometric mean criterion would apply in all instances, and a state could elect not to apply the single sample maximum for Clean Water Act purposes other than beach monitoring and notification, as is discussed in the preamble to the BEACH Act rule. This approach ensures a situation does not arise where there is no applicable criterion.

May states adopt a single sample maximum only for their beaches, rather than for all coastal recreation waters?

No. This is because EPA has interpreted CWA section 303(i)(1)(A) of the Clean Water Act to require states to adopt a geometric mean and at least one SSM for all of their coastal recreation waters, not just for their beaches. In determining whether or not a state's coastal recreation water quality standards for bacteria are as protective of human health as the 1986 bacteria criteria document, EPA will look to see if the water quality standards include, along with a geometric mean, at least one SSM for each of the state's coastal recreation waters. EPA will also look to see if criteria for designated bathing beaches include an SSM based on the 75% confidence level, because EPA considers this approach to be as protective of human health as the 1986 bacteria criteria. EPA included in the BEACH Act rule any state or territory that did not cover all coastal recreation waters with a SSM and that for designated bathing beaches did not have a SSM based on the 75% confidence level. EPA does not expect a state or territory to use all four of the use categories identified in the criteria document for its standards to be at least as protective as the 1986 bacteria criteria. For example, a State that applied the 75% confidence based maximum to all waters would clearly be as protective as the 1986 bacteria criteria, even though it would only have a single use category.

To get more information

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