NJ Drinking Water Quality Institute
Testing Subcommittee

Report on the Development of a Practical Quantitation Level for 1,4-Dioxane in Drinking Water

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Testing Subcommittee Report on PQL Development for 1,4-Dioxane in Drinking Water

Summary and Recommendations

This report presents the Drinking Water Quality Institute Testing Subcommittee's recommendation for an analytical Practical Quantitation Level (PQL) for 1,4-dioxane in drinking water. This PQL will then be used in conjunction with the information generated by the Health Effects Subcommittee and Treatment Subcommittee in recommending the MCL.

Several approaches were used by the Testing Subcommittee to derive a PQL, and the resulting PQLs from those approaches were considered in the final determination of the PQL. The value of 0.1 µg/L (microgram per liter) was recommended as the PQL by the Testing Subcommittee. The background and the specific approaches used to derive the PQL are presented below.

Background

Data from the national USEPA Unregulated Contaminant Monitoring Rule 3 (UCMR3) shows that 1,4-dioxane occurs more frequently in public water systems in New Jersey than nationally. In UCMR3, finished water from all U.S. large public water systems (serving more than 10,000 people) and a subset of smaller systems were analyzed for 1,4-dioxane. 1,4-dioxane was detected in 341 of 933 drinking water samples from 174 New Jersey public water systems included in UCMR3. These samples were analyzed using the published USEPA Method 522 with a reporting level of 0.07 µg/L (equivalent to parts per billion, ppb). In UCMR3, 1,4-dioxane was detected in 44.9% (80/174) of the New Jersey systems (at concentrations up to 5.83 µg/L) as compared to 22.0% (997/4741) of U.S. water systems outside of New Jersey. The concentration of 1,4-dioxane was at or above the USEPA Health Reference Level (USEPA, 2017) for a 1-in-1 million lifetime cancer risk of 0.35 µg/L in 17.2% (30/174) New Jersey systems as compared to 6.6% (315/4741) of non-New Jersey systems.

The New Jersey Department of Environmental Protection (NJDEP) has regulated 1,4-dioxane in ground water since 2008. As discussed in the Health Effects Subcommittee report, NJDEP (2008) established an Interim Specific Ground Water Quality Standard (ISGWQS) of 3 µg/L for 1,4-dioxane in 2008. In 2010, the ISGWQS was revised to 0.35 µg/L to reflect an update in the USEPA cancer slope factor for 1,4-dioxane. In 2018, NJDEP adopted a final Ground Water Quality Standard (GWQS) of 0.4 µg/L for 1,4-dioxane into the Ground Water Quality Standards regulations in January 2018. The earlier ISGWQS value of 0.35 µg/L was rounded to one significant figure (0.4 µg/L), as specified in the NJDEP Ground Water Quality Standards regulations. Regulations and guidance values for 1,4-dioxane in drinking water and ground water that have been developed by other states and countries are discussed in the Health Effects Subcommittee report on 1,4-dioxane.

The development of the PQL of 0.1 µg/L that supports the ISGWQS and GWQS is described in NJDEP (2014). The published minimum detection level (MDL) was multiplied by a factor of five (5) which resulted in a PQL value of 0.1 µg/L.

In 2018, the DWQI began its work on development of a recommended MCL for 1,4-dioxane. This advisory panel, which is comprised of 15 members from academia, regulated water systems, governmental agencies, and public health experts, is responsible for providing MCL recommendations to the Commissioner of NJDEP as part of the regulatory process in setting an MCL specific to New Jersey. The DWQI recommendations are a result of the collaboration of three DWQI Subcommittees: The Health Effects Subcommittee, the Testing Subcommittee and the Treatment Subcommittee. The Health Effects Subcommittee is responsible for recommending Health-based MCLs[1] for contaminants. The Testing Subcommittee is responsible for developing PQL for the contaminants. A PQL is the minimum concentration for which the contaminant under review can be reliably quantitated within acceptable limits of uncertainty. The Treatment Subcommittee is responsible for evaluating the best available treatment technologies for removal of the contaminant from drinking water supplies.

Developing a PQL involves researching analytical methods that are reliable and have the sensitivity to detect the contaminant at or as close as possible to the Health-based MCL developed by the Health Effects Subcommittee. When developing a PQL, the Testing Subcommittee considers available analytical methods and laboratory performance. 1,4-dioxane appears as a listed parameter in a published USEPA Method 522 entitled; "Determination of 1,4-dioxane In Drinking Water by Solid Phase Extraction (SPE) and Gas Chromatography/ Mass Spectrometry (GC/MS) With Selected Ion Monitoring (SIM)." Although published and required for the analysis of UCMR3 samples by the USEPA (2013-2015), this method has not been promulgated in federal regulation. The PQL recommended by the Testing Subcommittee in this document was based solely on the performance data of a group of drinking water laboratories that meet certain criteria established by the Testing Subcommittee.

If the Health-based MCL for a contaminant is known, the Testing Subcommittee will attempt to establish a PQL at a level lower than that Health-based MCL. This is not always feasible, and ultimately it is the performance data from robust analytical methods and accredited laboratories that determine the PQL. In the current process of developing an MCL recommendation, the Health-based MCL and the PQL were being developed simultaneously.

As mentioned above, the reporting level for 1,4-dioxane in USEPA UCMR3 was 0.070 µg/L, meaning that laboratories performing the 1,4-dioxane analysis for this rule could reliably quantitate at and above 0.070 µg/L. Through conversations with laboratories certified by NJDEP, average and median detection levels were found to be 0.02 µg/L and median and average reporting limits (MRL) were 0.07 µg/L and 0.10 µg/L, respectively. The above information further corroborates that the reporting limits for 1,4-dioxane are generally driven by the USEPA UCMR3 MRL.

[1] Health-based MCLs are goals, not enforceable standards, similar to USEPA Maximum Contaminant Level Goals (MCLG). For carcinogens, Health-based MCLS are set at levels that are not expected to result in cancer in more than one in one million persons ingesting the contaminant for a lifetime, and for non-carcinogens, at levels not expected to result in "any adverse physiological effects from ingestion" for a lifetime. The enforceable MCLs consider other factors such as analytical quantitation limits and availability of treatment removal technology and may be set higher than the MCLGs.

Data Sources for PQL Determination:

As a first step in the PQL development process, data from drinking water laboratories with adequate sensitivity for reliably analyzing 1,4-dioxane were compiled from the following sources:

1) Laboratories that are certified for the analysis of 1,4-dioxane by the NJDEP Office of Quality Assurance (OQA), NELAP or EPA; and
2) The laboratories must be EPA UCMR3 approved and reported capability of reporting lower than the UCMR3 MRL of 0.070 μg/L using EPA 522 currently or in the future.

On behalf of the Testing Subcommittee, the NJDEP conducted a phone inquiry of those USEPA laboratories approved for 1,4-dioxane analysis for the UCMR3 and laboratories certified for 1,4-dioxane drinking water analysis by NJDEP Office of Quality Assurance. The intention of this inquiry was to determine if any of these laboratories with experience analyzing 1,4-dioxane are also reporting lower than 0.070 μg/L for purposes other than the UCMR3. Of the eight laboratories participating in UCMR3 that were solicited for information, three stated that they are reporting lower than 0.070 μg/L and five stated that they do not report lower than 0.070 μg/L. Of the remaining eight drinking water labs that are certified by the NJDEP Office of Quality Assurance for 1,4-dioxane analysis but did not participate in UCMR3, five stated either that they were in the process of lowering the reporting limit or were confident that they could achieve lower reporting limits if requested by the client, and three actually conducted low level calibrations or MRL confirmations in response to the NJDEP inquiry.

The PQL for 1,4-dioxane has been determined as a result of performance data compiled from these two data sources.

Laboratories and Method Approved by USEPA for UCMR3 1,4-Dioxane Analysis

The UCMR3 is a national monitoring program administered every five years by the EPA in which all community water systems serving 10,000 people and over, and a representative sample of smaller water systems, throughout the country are required to test their drinking water for a specific set of 30 unregulated contaminants. The UCMR analytes are usually chosen from the corresponding EPA Candidate Contaminant List (CCL), as was the case with the selection of most of the UCMR3 analytes from the CCL3.

As part of the UCMR3 rule, laboratories performing analyses for any of the UCMR3 contaminants were required to obtain approval from USEPA. Among other requirements, this approval included proficiency testing and on-site audits. However, the laboratories that applied for UCMR3 analyses were not required to have National Environmental Laboratory Accreditation Program (NELAP) or state certification for the analytical methods used for the UCMR3. The Testing Subcommittee identified the laboratories that participated in UCMR3 as potential sources of data for the PQL determination. MRLs and/or lowest calibration standards from those laboratories in this group that can currently or expect in the future to be able to achieve higher sensitivity than was required for UCMR3, were considered in development of the PQL.

The USEPA established the specific analytical methods to be used for analyzing the UCMR3 contaminants. The USEPA developed two standardized analytical methods for analyzing 1,4-dioxane in drinking water, namely USEPA Method 522 (US EPA, 2008), and USEPA Method 541 (USEPA 2015). However, only Method 522 version 1.0 (Determination of 1,4-Dioxane in Drinking Water By Solid Phase Extraction [SPE] And Gas Chromatography/ Mass Spectrometry [GC/MS] with Selected Ion Monitoring [SIM]) was used for UCMR3 analysis of 1,4-dioxane.

In USEPA Method 522, the sample is spiked with an isotopically labeled surrogate followed by extraction using solid phase extraction (SPE). The sample is eluted using dichloromethane, the extract volume is adjusted and an isotopically labeled internal standard is added to the extract. The final extract is dried with anhydrous sodium sulfate and injected onto a high-resolution gas chromatography (GC) column interfaced with a mass spectrometer (MS) operated in selected ion monitoring (SIM) mode. The MDL for this method is 0.020 µg/L. Two single laboratory LCMRLs of 0.036 µg/L and 0.047 µg/L were determined using this method and reagent water (U.S. EPA, 2008). The USEPA UCMR3 stipulates that laboratories using Method 522 for UCMR3 analysis must achieve an MRL of 0.07 µg/L (U.S. EPA, 2012a). This MRL value was determined by using the lowest concentration minimum reporting level (LCMRL) data from multiple laboratories (U.S. EPA, 2012b).

In current certified methods including USEPA Method 522, the quantitation level term, Minimum Reporting Level (MRL) was defined as "the minimum concentration that can be reported as a quantitated value for a method analyte in a sample following analysis." The MRL could be no lower than the concentration of the lowest calibration standard for that analyte and could only be used if acceptable quality control (QC) criteria for this standard were met. The MRL used in USEPA 522 is a term that is more specific than a RL due to the additional requirement of meeting the verification criteria with a one-time demonstration of capability step in Section 1.2 of USEPA 522. Laboratories using USEPA 522 could not report results to a specific MRL unless it was verified within this level.

The USEPA MRL of 0.070 µg/L for was statistically determined from three laboratories' Lowest Concentration MRLs (LCMRLs) which were generated using the procedure described by Winslow et al. (2006). The LCMRL is defined as the lowest spiking concentration at which recovery of between 50 and 150% is expected 99% of the time by a single analyst. The USEPA determines an MRL using a Bayesian bootstrap of the LCMRL estimator using the LCMRL study data from each of several experienced drinking water laboratories. The Bayesian bootstrap replicates that were generated from each laboratory's data, serve to estimate the distribution of estimated LCMRL values that each laboratory might generate on repeated performance of the LCMRL study. The distribution of pooled Bayesian bootstrap replicates, generated from the LCMRL study data from a sample of experienced drinking water laboratories, approximates the distribution of estimated LCMRL values which might be generated from the *population* of experienced drinking water laboratories. The EPA statistical software, the LCMRL Calculator, performing this process was designed such that the MRL would be an estimate of the LCMRL that is achievable with 95% confidence by a capable analyst/laboratory at least 75% of the time.[2]

[2] Technical Basis for the Lowest Concentration Minimum Reporting Level (LCMRL) Calculator (EPA 815-R-11-001). http://water.epa.gov/scitech/drinkingwater/labcert/analyticalmethods_ogwdw.cfm

The USEPA's goal in developing this MRL was to establish a reporting concentration at which laboratories across the nation would be able to reliably analyze 1,4-dioxane for the UCMR3.

Additional Analytical Methods for 1,4-Dioxane

USEPA Method 541 is another method for analysis of 1,4-dioxane in drinking water. It also analyzes three additional compounds that are oxidation products of 1,4-dioxane (1-butanol, 2-methoxyethanol and 2-propen-1-ol). In this method, the sample is spiked with two isotopically labeled surrogates and extracted using SPE. The SPE cartridges are dried to remove adsorbed water using a controlled stream of nitrogen followed by elution with 5% methanol in dichloromethane. The eluted sample is spiked with two isotopically labeled internal standards and further dried with anhydrous sodium sulfate. The final extract is analyzed by GC/MS in SIM mode of detection. The extraction process in USEPA method 541 involves an additional SPE cartridge drying step using compressed nitrogen gas. Prior to conducting the method, the cartridge drying parameters need to be optimized for each extraction format to maximize sample recovery. Optimization involves careful control of gas flow and calibration of rotameter flow rate based on actual measured values. This step is critical as over drying the cartridge will result in reduced sample recovery particularly for 2-propen-1-ol. Insufficient drying will result in residual water in the final extract causing a retention time shift, suppression/enhancement of signals and column degradation. The single laboratory LCMRL for this method is 0.074 µg/L (USEPA, 2015b).

It should be noted that the USEPA has also developed several standardized methods for the analysis of volatile and semi-volatile organics, including 1,4-dioxane, in various matrices. However, these methods are not certified for drinking water analysis. USEPA Methods 8015C and 8260B determine the concentration of 1,4-dioxane in surface water or groundwater using either direct injection of aqueous samples or sample preparation using azeotropic distillation (USEPA Method 5031) followed by analysis using GC/Flame Ionization Detection (GC/FID) (USEPA Method 8015C) or GC/MS (USEPA Method 8260B). The MDLs are 15 µg/L and 12 µg/L for methods 8015C and 8260B, respectively, when azeotropic distillation is used for sample preparation. No MRL data were reported for either method (USEPA, 1996, 2000b). An advantage of these methods is that they can be used for a broad list of volatile organic compounds (VOCs) as well as 1,4-dioxane, which may be useful for sites where co-contaminants are present. Although 1,4-dioxane is not listed as an analyte, other USEPA methods such as 8270D (based on liquid-liquid extraction) and GC/MS have been modified and used to analyze 1,4-dioxane in source water.

PQL Determination

In developing the PQL, the Testing Subcommittee considered the RLs, lowest calibration standards and MDLs from laboratories that meet at least one of the criteria below:

1) Laboratories that are certified for the analysis of 1,4-dioxane by the NJDEP Office of Quality Assurance (OQA), NELAP or EPA; and
2) The laboratories must be EPA UCMR3 approved and reported capability of reporting lower than the UCMR3 MRL of 0.070 µg/L using EPA 522 currently or in the future.

Determination of the PQL using MDLs

The determination of the PQL using MDLs requires a sample size of at least five MDLs from which to obtain an inter-laboratory MDL value. The individual MDL value from each laboratory for a given method is used to obtain a median MDL value as a representative inter-laboratory MDL. This inter-laboratory MDL is then multiplied by a factor of five. In 1993, a research project was conducted by NJDEP to determine if the MDL multiplied by a certain factor could yield a supportable PQL value. The outcome of this research concluded that a factor of 4, 5 or 6 could be used to derive a PQL (Eaton et al., 1993). In 1994, the Testing Subcommittee chose to use a multiplier of five to determine the PQLs generated as part of the NJ DWQI MCL contaminant recommendations. This multiplier approach for determination of a PQL is also consistent with that outlined in the Ground Water Quality Standards (N.J.A.C. 7:9-6).

The Testing Subcommittee was able to derive a PQL from a sample size of 6 MDLs, from six laboratories using Method 522 identified through a phone survey. All six laboratories were certified by the NJDEP Office of Quality Assurance. As seen in Table 1 the median value of these MDLs is 0.02 µg/L. This median value when multiplied by 5 is 0.10 µg/L.

Table 1. MDLs Determined by Phone Survey of Six (6) Certified Laboratories

Lab ID	Laboratory Name	MDL (µg/L, ppb)
CT003	PHOENIX ENVIRONMENTAL LABORATORY	0.02
IL457	AMERICAN WATER CENTRAL LABORATORY	0.04
IN598	EUROFINS EATON ANALYTICAL, LLC (SOUTH BEND)	0.02
MA015	ALPHA ANALYTICAL	0.03
NY158	PACE ANALYTICAL SERVICES, LLC - LONG ISLAND NY	0.007
PA010	ALS ENVIRONMENTAL - MIDDLETOWN	0.02
	Median	**0.02**
	Average	**0.02**
	Median Interlaboratory MDL x 5	**0.10**

Determination of PQL Using Reporting Limits or Lowest Calibration Standards

USEPA regulations (40 CFR Part 136 Appendix B) specifies the approach to be used in determining the MDL for a specific laboratory. The MRL in current certified methods including USEPA Method 522 differs from an MDL in that it accounts for both accuracy and precision as a quantitation level that is within specific tolerance levels. Laboratories using current USEPA Method 522 report results to an MRL which is a concentration equal to or greater than the lowest calibration standard but must also meet the QC criteria at Section 9.2.5 of EPA Method 522. This criterion is a verification of laboratory proficiency at the laboratory's designated MRL. USEPA Method 522 does not require laboratories to perform the previously discussed LCMRL procedure but does require this less rigorous MRL confirmation. Both the LCMRL procedure and the confirmation MRL procedure account for the combined effect accuracy and precision have on these quantitation levels.

An MRL can be established either by the laboratory for their own specific purpose or by a regulatory agency as with the required MRL of 0.070 µg/L for the USEPA UCMR3 program. Since USEPA Method 522 describes the MRL as the lowest analyte concentration that meets the Data Quality Objectives developed for the intended use of this method, the MRL would be an important factor in determining the PQL for 1,4-dioxane. It would follow that, in addition to using inter-laboratory MDLs, the PQL should be assessed by considering the MRLs used by these laboratories.

If different than the MRL or reporting limit, the laboratories' lowest calibration standard was considered in the PQL assessment. As previously stated, since the RLs are mostly client driven, it is not obvious whether greater sensitivity can be achieved. For this reason, in cases where the lowest calibration standard was lower than the reporting limit, the lowest calibration standard was used in lieu of the reporting limit when deriving the PQL. Alpha Analytical laboratory reported 11 different reporting limits while the other laboratories only reported one. A such, 11 reporting limits were considered for Alpha Analytical laboratory since the data were generated during the duration of UCMR3 sampling and analysis.

Two spreadsheets provided by the NJDEP Bureau of Safe Drinking Water on February 19, 2019 indicated laboratories with MRL performance levels for 1,4-dioxane. The detection level that is published in USEPA Method 522 is 0.02 µg/L as was stated in the NJDEP (2014) PQL determination for the ISGWQS for 1,4-dioxane. A phone survey was conducted of the six (6) NJDEP/OQA certified laboratories that confirmed the mean and median MDL values of 0.02 µg/L in Table 1. This exceeds the minimum number of laboratories required to generate a PQL as published in Sanders et al. (1996). Only one laboratory, ALS Environmental-Middletown, reported a low-point calibration value below their reporting limit. MDL and MRL data are the preferred method for recommending a PQL for use in developing a drinking water MCL.

Bootstrap Analysis using MRLs or Reporting Limits

One hundred and twenty-three (123) MRL values were reported nationwide over the duration of UCMR3 from seven (7) laboratories. The number of NJ UCMR3 samples analyzed by each of these laboratories are listed in Table 2, and Table 3 shows low calibration standards and minimum reporting limits reported by these laboratories. Mean and median statistics are also included in Table 3.

Table 2: New Jersey UCMR3 Samples Analyzed by Laboratory

Lab Name	Number of Samples Analyzed in UCMR3
AMERICAN WATER WORKS SERVICE COMPANY	413
PACE ANALYTICAL	226
EUROFINS ANALYTICAL, INC*	133
ALPHA ANALYTICAL INC	129
YORK ANALYTICAL LABS INC	26
ANALYTICAL LAB SERVICES	6
*This includes analysis at two Eurofins Eaton laboratories that were UCMR3 certified	

Table 3: Low Calibration Standard and Minimum Reporting Limit Data from Phone Solicitation and UCMR3 for 8 Certified Laboratories

Laboratory	State	Method	Lowest Calibration Standard (μg/L)	Reporting Limit (μg/L)	Reporting Limit Source
Eurofins Eaton Analytical	IN	EPA 522	0.070	0.070	Phone
Phoenix Environmental Laboratory	CT	EPA 522	0.025	0.025	Phone
Alpha Analytical	MA	EPA 522	0.100	0.100	Phone
American Water Central Laboratory	IL	EPA 522	0.070	0.070	Phone
Pace Analytical Services	NY	EPA 522	0.020	0.020	Phone
ALS Environmental-Middletown	PA	EPA 522	0.040	0.070	Phone
York Analytical Labs Inc	NJ/NY	EPA 522	0.100	0.100	UCMR3
Eurofins Eaton Analytical, Inc	CA	EPA 522	0.070	0.070	UCMR3
Pace Analytical Services	NY	EPA 522	0.070	0.070	UCMR3
Alpha Analytical	MA	EPA 522	0.178	0.178	UCMR3
Alpha Analytical	MA	EPA 522	0.167	0.167	UCMR3
Alpha Analytical	MA	EPA 522	0.156	0.156	UCMR3
Alpha Analytical	MA	EPA 522	0.128	0.128	UCMR3
Alpha Analytical	MA	EPA 522	0.122	0.122	UCMR3
Alpha Analytical	MA	EPA 522	0.119	0.119	UCMR3
Alpha Analytical	MA	EPA 522	0.116	0.116	UCMR3
Alpha Analytical	MA	EPA 522	0.111	0.111	UCMR3
Alpha Analytical	MA	EPA 522	0.109	0.109	UCMR3
Alpha Analytical	MA	EPA 522	0.106	0.106	UCMR3
ALS Environmental-Middletown	PA	EPA 522	0.040	0.070	UCMR3
Mean			**0.096**	**0.103**	
Median			**0.103**	**0.099**	

Another approach that has been used most recently by the USEPA for LCMRL range calculation is a statistical technique called "Bootstrap Estimate of a Confidence Interval of the Mean." This technique was applied to generate a normal distribution and associated 95 % upper and lower confidence intervals from the inter-laboratory MDL values from Table 1 and the RLs and the lowest calibration standard from Table 3.

To incorporate more recent techniques of calculating quantification levels, the bootstrap technique can also be applied to evaluate the consistency of the 20 laboratory reporting limits (MRLs) found in Table 3. This generated distribution of 2000 randomly selected values produced an upper confidence limit of 0.085 μg/L as a reporting level that 95% of the laboratory community should be able to achieve. The data generated by this first iteration bootstrap analysis are shown in Table 4.

Table 4: First Iteration Bootstrap Estimate of Reporting Levels for All Data in Table 3

Lower Confidence Limit (μg/L)	Mean (μg/L)	Upper Confidence Limit (μg/L)	Confidence Level Range	Number of Randomly Selected Values
0.075	0.080	0.085	95%	2000

Twelve (12) of the 20 laboratory MRLs from Table 3 are above the upper confidence level of 0.085 μg/L. The remaining 8 laboratory MRLs indicate quantitative performance better than that required of the UCMR3. A second bootstrap iteration was conducted on the eight (8) remaining laboratory MRLs. The statistical analysis was rerun, producing the following information in Table 5.

Table 5: Second Iteration: Bootstrap Estimate of Reporting Levels, excluding Reporting Levels above the Upper Confidence Level of 0.085 μg/L, in Table 3

Lower Confidence Limit (μg/L)	Mean (μg/L)	Upper Confidence Limit (μg/L)	Confidence Level Range	Number of Randomly Selected Values
0.065	0.070	0.074	95.7%	2000

This bootstrap analysis generated an upper confidence limit of 0.074 μg/L. This distribution shows that 95% of the laboratory community can achieve a RL level of 0.074 μg/L. This value of 0.074 μg/L agrees closely with:

1) the PQL value of 0.100 μg/L derived from the median of the MDLs from six (6) NJDEP/OQA certified laboratories (Table 1),

2) the PQL value of 0.103 μg/L as the average (or mean) of the 20 reporting limits used by eight (8) laboratories (Table 3),

3) the PQL value of 0.099 μg/L derived from the median of 20 reporting limits used by eight (8) laboratories (Table 3),

4) the UCL PQL value of 0.085 μg/L derived from the bootstrap analysis of all the MRLs reported in Table 4, and

5) the UCL PQL value of 0.074 μg/L derived from the bootstrap analysis of the eight (8) MRLs below the UCL of 0.085 μg/L from Table 5.

Summary and Recommendations

The PQL developed by the Testing Subcommittee in this report can be used in conjunction with the information generated by the Health Effects and Treatment Subcommittees in recommending the MCL for 1,4-dioxane.

Because the Health-based MCL was being developed at the same time as the PQL, a Health-based MCL was unavailable to the Testing Subcommittee as a goal for determining analytical sensitivity requirements. As a result, several approaches were used to derive a PQL and the resulting PQLs from those approaches were considered in the final determination of the PQL.

MDLs from six (6) New Jersey Office of Quality Assurance certified laboratories that reported this information were used in the determination of the PQL. The median value of the interlaboratory MDL values (0.020 μg/L) multiplied by the factor of 5 resulted in a calculated PQL value of 0.100 μg/L.

Eight laboratories that analyzed samples from New Jersey PWS reported that they currently achieve MRL values lower than the UCMR3 MRL of 0.070 μg/L or believe that they can do so in the future. In addition to using the MDLs for determining the PQL, the median value of the lower of the MRLs or lowest calibration standards for these eight (8) laboratory performance data resulted in a PQL value of 0.099 μg/L. The "Bootstrap Estimate of a Confidence Interval of a Mean" was used to confirm that the calculated values were consistent with the statistically derived values for the recommended PQL.

The Testing Subcommittee is basing the PQL recommendation to the DWQI on the MRL or lowest calibration standard, whichever is lower. The Testing Subcommittee is not recommending a PQL based on the MDL because the MDL is a statistical value while the values mentioned above are actual concentrations verified within the analysis.

Although not used as the basis for the PQL, the MDL values are important as a regulatory trigger to determine if a contaminant is present in the New Jersey potable water supply. The RLs of the laboratories performing analysis, however, may be higher than what the laboratory is actually capable of achieving because they are largely client driven. For the parameter 1,4-dioxane, the Testing Subcommittee recommends that the PQL be derived using the median value of all the methods summarized in this document to account for the lack of NJDEP/OQA certified laboratory performance data for drinking water.

Table 6: Summary of the approaches for calculating the PQL

PQL Approach	**Value (μg/L)**
MDL data from phone solicitation (Table 1)	0.100
Mean of MRL (Table 3)	0.103
Median of MRL (Table 3)	0.099
Mean of Low-Point Calibration (Table 3)	0.096
Mean of Low-Point Calibration (Table 3)	0.103
Bootstrap Upper Confidence Limit of all RLs (Table 4)	0.085
Bootstrap Upper Confidence Limit of eight RLs (Table 5)	0.074
Median PQL	0.099

The median of the values in Table 6 above that summarizes the approaches used for the PQL derivation and the PQL values derived from each is 0.099 μg/L; when rounded to one significant figure, the value is 0.1 μg/L. Therefore, the Testing Subcommittee recommends a PQL of 0.1 μg/L for 1,4-dioxane to the Drinking Water Quality Institute.

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