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Total Coliform Rule Issue Paper

Analysis of Compliance and Characterization of Violations of the Total Coliform Rule

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Background and Disclaimer

The USEPA is revising the Total Coliform Rule (TCR) and is considering collecting data on distribution as part of these revisions. As part of this process, the USEPA is publishing a series of issue papers to present available information on topics relevant to possible TCR revisions. This paper was developed as part of that effort.

The objectives of the issue papers are to review the available data, information and research regarding the potential public health risks associated with the distribution system issues, and where relevant identify areas in which additional research may be warranted. The issue papers will serve as background material for EPA, expert and stakeholder discussions. The papers only present available information and do not represent Agency policy. Some of the papers were prepared by parties outside of EPA; EPA does not endorse those papers, but is providing them for information and review.

Additional Information

The paper is available at the TCR web site at:

http://www.epa.gov/safewater/disinfection/tcr/regulation_revisions.html

Questions or comments regarding this paper may be directed to **TCR@epa.gov**.

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Analysis of Compliance and Characterization of Violations of the Total Coliform Rule

1. Overview

Total coliforms have long been used in drinking water regulations as an indicator of the adequacy of water treatment and the integrity of the distribution system. Total coliforms are a group of closely related bacteria that are generally harmless. In drinking water systems, total coliforms react to treatment in a manner similar to most bacterial pathogens and many viral pathogens. Thus, the presence of total coliforms in the distribution system can indicate that the system is also vulnerable to the presence of pathogens in the system. (EPA, June 2001, page 7) Total coliforms are the indicators used in the existing Total Coliform Rule (TCR).

EPA is undertaking “a rulemaking process to initiate possible revisions to the TCR. As part of this process, EPA believes it may be appropriate to include this rulemaking in a wider effort to review and address broader issues associated with drinking water distribution systems.” (see *Federal Register* 68 FR 19030 and 68 FR 42907). Since the promulgation of the TCR, EPA has received stakeholder feedback suggesting modifications to the TCR to reduce the implementation burden.

The purpose of this paper is to provide information on the number and frequency of violations of the TCR and to further characterize the frequency with which different types and sizes of systems incur violations. Although EPA explores some statistical testing in this paper, the paper concentrates on presenting the data, as it is, in SDWIS/FED. Information on these frequencies will be useful in supporting several EPA initiatives, particularly the effort to review and possibly revise the TCR. This paper has been undertaken as part of the review of the TCR.

Despite potential data quality concerns, this report uses TCR violations data *as reported in SDWIS/FED* as the primary source due to the lack of an alternative source of national data. See Section 3 for more information on the data used for this report and the associated data quality.

The data on TCR violations presented in this paper can serve as a foundation for further analysis and research. For example, while this paper presents comparisons of violations across system sizes, categories, and sources, no attempt is made to explain reasons for any differences. Next steps could include research on the impact of factors such as water quality, system performance, and Monitoring & Reporting practices to explain the implications of differences in violation rates.

The Total Coliform Rule (TCR), which applies to all public water systems¹, was promulgated (i.e., published in the *Federal Register*) by the U.S. Environmental Protection Agency in 1989, and became effective in 1991 (54 FR 27544-27568). The TCR requires systems to monitor for total coliforms at points within the distribution system according to a State-approved sample siting plan. The minimum Monitoring & Reporting frequency depends upon the number of people a system serves and whether the system is a community water system (CWS) or a noncommunity water system (NCWS)². The required Monitoring & Reporting frequency ranges from 480 samples per month for the largest CWSs to one sample per year for certain small NCWSs.

If any routine sample is total coliform-positive, the system must test that positive culture for the presence of either fecal coliforms or *E. coli*, both of which are a subgroup of the total coliform group that, unlike total coliforms, are closely linked to fecal contamination. Fecal coliforms are a subgroup of total coliforms that are likely to have come from sewage or a fecal source. Hence, the presence of fecal coliforms in the distribution system is a more direct indication of possible fecal contamination and the possible attendant health impacts. *E. coli* is a subset of fecal coliforms that is commonly found in the intestines of warm blooded animals. Most strains of *E. coli* are harmless, but some strains such as O157:H7 are pathogenic and can cause mild to serious health threats to humans (EPA, February 2002, page 8, 54 FR 27544-27568).

After a total coliform-positive sample, the system must also take a set of three repeat samples (four repeat samples for systems that take one sample per month or fewer) within five service connections of the routine sample, and at least five routine samples the next month of operation. Both routine and repeat samples count toward compliance with the maximum contaminant levels (MCLs) for total coliforms. If a system normally takes fewer than five routine samples per month (normally systems serving 4,100 or fewer), it must undergo an on-site sanitary survey every five years (ten years for a noncommunity water system that uses protected and disinfected ground water). This analysis does not address compliance with disinfection residual monitoring requirements because such requirements do not fall under the TCR. The TCR Monitoring & Reporting requirements are summarized in Exhibit 1.

¹A public water system (PWS) is a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. (Federal Register: August 5, 1998 (Volume 63, Number 150))

² *Community Water System (CWS)*: A public water system that supplies water to the same population year-round. *Non-Transient Non-Community Water System (NTNCWS)*: A public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. *Transient Non-Community Water System (TNCWS)*: A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time. (<http://www.epa.gov/ogwdw/pws/factoids.html>)

Exhibit 1: Summary of TCR Sampling Requirements

Routine Sampling Requirements
<ul style="list-style-type: none">• Total coliform samples must be collected at sites which are representative of water quality throughout the distribution system according to a written sample siting plan subject to state review and revision.• Samples must be collected at regular time intervals throughout the month except groundwater systems serving 4,900 persons or fewer, that may collect them on the same day.• Monthly sampling requirements are based on population served• A reduced Monitoring & Reporting frequency may be available for systems serving 1,000 persons or fewer and using only ground water if a sanitary survey within the past 5 years shows the system is free of sanitary defects (the frequency may be no less than 1 sample/quarter for community and 1 sample/year for non-community systems).• Each total coliform-positive routine sample must be tested for the presence of fecal coliforms or <i>E. coli</i>.• If any routine sample is total coliform-positive, repeat samples are required.
Repeat Sampling Requirements
<ul style="list-style-type: none">• Within 24 hours of learning of a total coliform-positive ROUTINE sample result, at least 3 REPEAT samples must be collected and analyzed for total coliforms:<ul style="list-style-type: none">○ One REPEAT sample must be collected from the same tap as the original sample.○ One REPEAT sample must be collected within five service connections upstream.○ One REPEAT sample must be collected within five service connections downstream.• Systems that collect 1 ROUTINE sample per month or fewer must collect a 4th REPEAT sample.• If any REPEAT sample is total coliform-positive:<ul style="list-style-type: none">○ The system must analyze that total coliform-positive culture for fecal coliforms or <i>E. coli</i>.○ The system must collect another set of REPEAT samples, as before, unless the MCL has been violated and the system has notified the state.
Additional Routine Sampling Requirements
<ul style="list-style-type: none">• A positive ROUTINE or REPEAT total coliform result requires a minimum of five ROUTINE samples be collected the following month the system provides water to the public unless waived by the state.

Source: EPA, November 2001.

Compliance with the TCR is determined by both the completion of Monitoring & Reporting requirements (determined by system size and type) and by the presence or absence of total coliforms in those required samples. Monthly MCL violations are incurred by the presence of TC only while Acute MCL Violations require the presence of either *E. coli* or fecal coliform. Incomplete Monitoring & Reporting or under-reporting triggers MR violations. The following paragraphs more fully define the different types of TCR violations:

- **An Acute MCL Violation:** If a system has a total coliform-positive routine sample, and at least one of the required repeat samples is *E. coli* or fecal coliform-positive *or* if a system has an *E. coli* or fecal-positive routine sample and at least one of the required

repeat samples is total-coliform-positive, the system has an acute MCL violation.³ When an acute MCL violation occurs, the system must notify the State by the end of the day that the system is notified of the test result (unless the system is notified of the result after the State office is closed, in which case the system must notify the State before the end of the next business day). The system must also notify the public no later than 24 hours after the violation occurs (revised from no later than 72 hours under the revised Public Notification Rule). An Acute MCL violation is considered to be indicative of a serious potential health risk.

- **A Monthly or Nonacute MCL Violation:** If a system takes fewer than forty routine samples per month (i.e., serves 33,000 people or fewer) to comply with the MCL for total coliforms, no more than one sample/month can be total coliform-positive. If a system takes at least 40 samples per month, no more than 5.0% of the samples collected during a month can be total coliform-positive. If a sample violates the nonacute MCL, the system must notify the State within 48 hours and the public no later than 30 days after the violation occurs (revised from no later than 14 days under the revised Public Notification Rule). A Monthly MCL Violation poses a less serious but still significant potential health risk.
- **A Monitoring & Reporting Violation** refers to a failure to take and properly report the required number and type of samples during a time period. A Monitoring & Reporting Violation does not per se represent a health risk, but failure to sample and report could result in a failure to detect contamination. (EPA, November 2001, page 1). The TCR establishes the following Monitoring & Reporting violations.

ROUTINE:

- Major: A failure to take all (takes no samples) of the required routine samples per compliance period.
- Minor: A failure to take some (but not all) of the required routine samples in a compliance period.

REPEAT:

- Major: A failure to conduct follow up Monitoring & Reporting after a total coliform-positive sample (i.e., takes no repeat samples and/or conducts no speciation for fecal/*E. coli*).
- Minor: A failure to take some of the required repeat samples and/or a failure to speciate at least one (but not all) total coliform-positive samples for fecal/*E. coli*.

³ States may invalidate total coliform positive repeat samples under certain conditions, detailed in CFR 141.21(c).

In addition, violations can be associated with: (1) failure to undergo sanitary survey within the specified time line, as required; (2) failure to report to the State within specified time lines after an MCL violation; and (3) failure to notify the public within specified time lines after an MCL violation.

2. Need For Analysis of TCR Violations

Analysis of TCR violations will assist EPA in gauging the magnitude of non-compliance with the TCR, patterns of non-compliance (if any), and possibly the implications of non-compliance. This information will be used in the current effort to review and possibly revise the TCR. Understanding the nature and frequency of existing violations to the TCR will help EPA assess the current TCR approach and will inform the development and consideration of alternatives. In this report, the following sections contain the analyses of TCR violation data from 1997 to 2003.

- In Section 5, the number of systems and the fraction of systems that have had TCR Acute, Monthly, and/or Monitoring & Reporting violations were examined. Information on the number of systems incurring violations will indicate the scope of non-compliance and possible health risks, and support analysis of compliance.
- The fraction of systems incurring violations is important when looking at comparisons between categories or over time. For example, one would expect a greater number of small systems to incur violations, simply because there are a greater number of small systems. Also, the inventory of systems is changing over time. Examining the percent of systems per category normalizes the data and puts it on a consistent basis.
- Also, the number of TCR Acute, Monthly, and/or Monitoring & Reporting violations and the distribution of the violations per system were examined. The number of violations is also important in indicating the scope of non-compliance and possible health risks and supporting analysis of compliance.
- Further, the Violations per system allow us to identify the extent to which systems incur multiple violations, perhaps indicating an ongoing health risk.
- In Section 6, the distribution of TCR violations by size of system⁴ is evaluated to identify trends or problems with compliance based on system size.
- In Section 7, the distribution of TCR violations by type of system (CWS, NTNCWSs, TNCWSs)⁵ is evaluated. The different types of systems serve different types of

⁴ Size categories: <=100; 101-500; 501-1,000; 1,001-3,300; 3,301-10,000; 10,001-50,000; 50,001-100,000; >100,000

populations over different time periods, thus making different types of health risks more important for those systems.

- In Section 8, the distribution of TCR violations by the source water that supplies the system (GW, SW, GU)⁶ is evaluated. Treatment requirements vary by the type of source water used by a system. Analysis of TCR violations by source type can support analysis for other rules and indicate possible differences based on treatment requirements and water quality.
- In Section 9, analyses conducted to assess the degree to which systems incur violations repeatedly over a number of years are described.
- In Section 10, the trends over time are analyzed for the changes with respect to inventory characteristics and violations, and to determine if compliance is improving.
- In Section 11, more recent SDWIS/FED data that became available during the development of this paper is considered.
- In Section 12, potential issues and questions related to an analysis relating TCR violations to treatment technologies are addressed.
- In Section 13, analyses of variations in TCR violations across seasons are described.
- In Section 14, whether the systems that have experienced an outbreak also incurred a TCR violation for the outbreak incidence is examined. This information would facilitate the examination of the ability of TCR Monitoring & Reporting to serve as an indicator or predictor of outbreak risk.

3. Sources of Data

The primary source of data on TCR violations used for this analysis is the Safe Drinking Water Information System/Federal Version (SDWIS/FED). This national database stores basic information for every public water system in the United States supplied by primacy agencies (States, Territories, Tribes, and EPA Regions).

In SDWIS/FED, EPA maintains basic identifying information for all public water systems, including:

⁵ Community Water Systems, Nontransient Noncommunity Water Systems, Transient Noncommunity Water Systems

⁶ Groundwater, Surface Water, Groundwater under the Influence of Surface Water,

- The nine character PWS ID number that uniquely identifies each public water system
- Whether the system is: a Community (year-round, residential population – e.g. a city); Non-Transient Non-Community (serves the same population for at least six months a year, although the system is not the primary water supplier – e.g. many businesses or schools); or Transient Non-Community (varying population – e.g. a rest area) water system
- The number of people regularly served by the water system
- The number of service connections for each water system (defined as the number of households or businesses connected to the water system)
- Basic information on a water system's source of water
- Water system owner type (local, state or federal government, private, etc.)

SDWIS/FED also contains information on violations, including TCR MCL and Monitoring & Reporting violations. Violation information contained in SDWIS/FED include:

- A violation ID number which uniquely identifies the violation
- The type of violation that has occurred (MCL Acute, MCL Monthly, treatment technique, or Monitoring & Reporting Routine: Major, Routine: Minor, Repeat: Major, Repeat: Minor)
- The time period during which the violation occurred
- The date the state or EPA region became aware of the violation (for certain contaminants)
- For Monitoring & Reporting violations, whether it is a major or minor violation, depending on the contaminant and the number of samples taken (EPA, October 1998, pages 1-5)

States report violations data to SDWIS/FED every quarter. The data used in this analysis represents the contents of SDWIS/FED as of January 1, 2004, which means that the information is current through end of the 2003 federal fiscal year (Sept 30, 2003). The analyses contain information from FY 1997 through FY 2003. The version of SDWIS/FED inventory data used in this analysis was provided in data warehouse tables created by OGWDW in July 2004.

The quality of data stored in SDWIS/FED varies by data item. In 2000 and 2003, EPA prepared reports on the reliability of state reported public water system data in SDWIS/FED. These reports are based on EPA's data verification audits conducted from FY 1999 through FY 2001. During the data verification audit:

...personnel (EPA and contractor staff) review data submitted by public water systems, state files and databases and SDWIS/FED [i.e., state versions of SDWIS/FED], and compile results on errors (unreported, undetected, and incorrect violations) and discrepancies (wrong information) in the data as compared to the data in SDWIS/FED [i.e., the federal version of SDWIS/FED].⁷

The results of the audit are expressed as the percentage of data without any discrepancies or errors. Overall, the data quality of inventory data elements is high quality as rated in the data verification report and shown in Exhibit 2.

Exhibit 2: SDWIS/FED Inventory Data Quality

Data Element	Data Quality (% Data W/O Discrepancies or Errors)	
	2003	2000
PWS ID	100%	100%
Water System Type	98%	97%
Primary Source	98%	98%
Population Served	88%	91%
Overall Inventory	95%	96%

Source: EPA, March 2004, page 12

In general, the data quality value calculated in the data reliability report is a combination of a measure of completeness (i.e., the percent of actual violations reported to SDWIS) and accuracy (i.e., of the violations that were reported to SDWIS, the percent that were reported without errors) under a certain assumption. For example, if 50% of actual violations were reported to SDWIS (completeness measure) and 75% of the reported violations were error-free (accuracy), the overall data quality score would be 37.5%⁸ given that there is no false-positive error in reporting to SDWIS/FED. The data reliability report characterizes a data element as being of low quality if the overall data quality score is from 0% to 70%, of moderate quality if the overall score is between 71% to 90%, and of high quality if the score is from 91% to 100%.

Using this characterization, the data quality for the TCR violations data has been moderate for the more important TCR MCL violations and low quality for Monitoring and Reporting violations. The TCR MCL violations data has the highest quality of any MCL violations data (compared with other rules), at 75% overall score, up from 68% in the previous data verification report (EPA, October 2000). The overall data quality score of 75% for TCR

⁷ EPA, March 2004, pages 5-6.

⁸ 50% x 75% = 37.5%

MCL violations is a combination of a score of 81% for completeness and 93% for accuracy (Exhibit 3) and is therefore classified as being of moderate quality. Thus, one can conclude that the TCR MCL violations are under-reported to SDWIS/FED and the analyses conducted for this report probably understate the actual occurrence of TCR MCL violations.

The data quality for all Monitoring & Reporting violations is low at 23%, which is combination of the data completeness measure at 27% and accuracy at 89% (Exhibit 3).⁹ The data quality specifically for TCR Monitoring & Reporting violation is the highest of any of the Monitoring & Reporting categories for other rules at 41% (not shown in Exhibit 3), but is still considered of low quality by the report. Based on the low data quality, it is likely that the occurrence of TCR Monitoring & Reporting Violations may be underestimated by the data (EPA, October 2000; EPA, March 2004).

Data quality varies slightly by the type of system. Data quality estimates for TCR MCL violations are slightly higher for NTNCWSs and slightly lower for TNCWSs. For all Monitoring & Reporting violations, data quality is better for TNCWSs. Exhibit 3 summarizes information on data quality estimates by system type.

Exhibit 3: Data Quality Estimates for SDWIS-Reported Violations by PWS Type

Type of PWS	Year	TCR MCL Violation	Monitoring & Reporting Violation (ALL)
Overall Data Quality Score			
CWS	2003	78%	18%
	2000	69%	9%
NTNCWS	2003	81%	20%
	2000	67%	7%
TNCWS	2003	65%	39%
	2000	68%	14%
All Systems	2003	75%	23%
	2000	68%	9%
Completeness Score			
All Systems	2003	81%	27%
	2000	68%	10%
Accuracy Score			
All Systems	2003	93%	89%
	2000	99%	95%

Source: EPA, March 2004, page 18

⁹ Exhibit 3 displays information for ALL Monitoring & Reporting violations. The referenced source document does not provide equivalent information on TCR Monitoring & Reporting violations only.

Despite potential data quality concerns, this report uses TCR violations data as reported in SDWIS/FED as the primary source due to the lack of an alternative source of national data. For inventory (e.g., system type, population served, etc.) and TCR MCL violations data, the overall data quality is moderate to good. In addition, the accuracy of the TCR MCL data reported in SDWIS/FED is excellent. For example, TCR MCL violations data were found to be 99% accurate in 2000 and 93% accurate in 2003 (Exhibit 3); thus we can have a fair degree of confidence that the data in SDWIS/FED is correctly reported. The TCR MCL violations data is less complete (81% in 2003), leading one to conclude that our analyses may under-estimate overall rates of violations by as much as 20%. However, since 81% of the data represents a large majority of the data and because that 81% is highly accurate, the sample may be large enough to be useful in revealing possible trends and might not be strongly influenced by the remaining 19% of the data. Thus, the comparisons made using the MCL violations data (say among size categories or over time) should be valid, assuming no reporting bias.

The TCR Monitoring & Reporting violations data is of lesser data quality and therefore has more uncertainty involved in using and interpreting the data. In general, the accuracy of all Monitoring & Reporting data in SDWIS/FED is good (95% in 2000 and 89% in 2003 for ALL M&R violations)¹⁰. The completeness, however, is quite low for all M&R violations at 27% for 2003. The completeness for the TCR M&R violations, while not reported in the reference document, is likely better than for all M&R violations, estimated at about 43% (assuming the same level of accuracy as the overall M&R violations)¹¹. Thus, the results reported in this paper may under-estimate actual incidence of M&R violations by a fair degree.

The validity of the comparisons made in this paper using SDWIS data hinges on whether the violations that are not reported to SDIWS vary in a substantial manner from the data that is reported to SDWIS. For example, if the violations that are not reported to SDWIS tend to be more heavily weighted to small systems, then the comparisons of violations rates among system size categories may not accurately reflect actual differences. Subsequent analyses are underway to characterize the composition of the under-reported TCR violations would be useful in interpreting and validating the results presented in this paper.

In summary, although the data collected in SDWIS are not complete, particularly for Monitoring and Reporting violations, analysis of this available data is a necessary first step in evaluating potential revisions to the TCR.

The violation rates derived from SDWIS data and presented in the paper may also be under-reported due to the actions of systems. For example, systems may be incurring a Monitoring & Reporting violation in order to avoid an MCL violation. This issue is analyzed to

¹⁰ Data on the accuracy and completeness of TCR M&R violations is not available in the source document.

¹¹ Assumes an overall data quality of 41% for TCR M&R violations as reported and an accuracy of 95%.

a limited extent in the analysis of repeat violators, but it is impossible to determine the full extent of this practice solely from the SDWIS data. In addition, systems could be using the invalidation criteria to avoid violations. A further discussion of this issue can be found in the paper: *Invalidation of Total Coliform Positive Samples*. Also, States may have different reporting requirements which may impact the number and nature of violations that are included in SDWIS. The differences in State requirements are beyond the scope of this paper and could be the subject of future research.

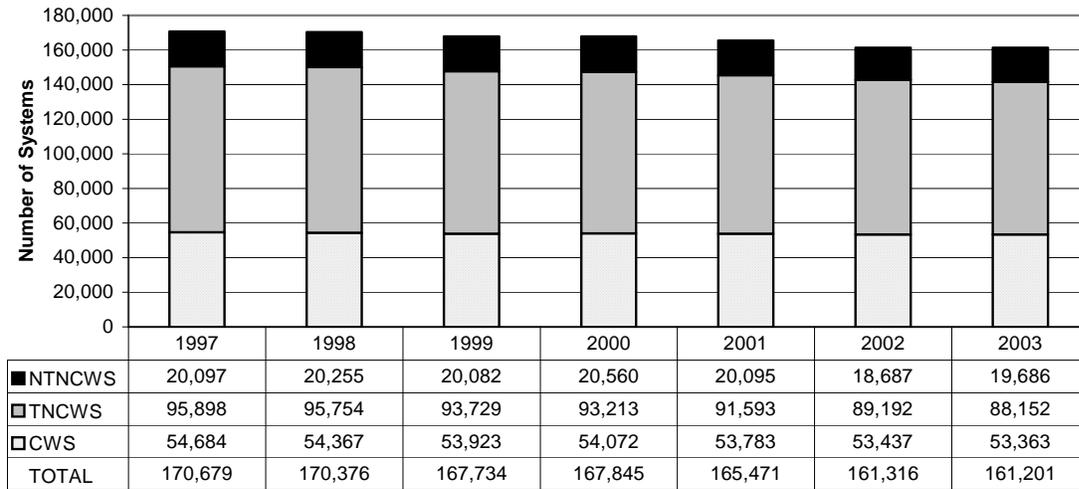
4. Characterization of the Inventory of Public Water Systems

The first series of data analyses presented in this paper contain information on the inventory of public water systems from 1997 through 2003. Inventory data is important to understanding the characteristics of water systems and how those characteristics may have changed over the period of analysis. Also, trends in these characteristics provide important contexts for interpreting the violations data presented in later chapters.

For each of the data elements examined, this report presents a graphical representation of the data, a table containing the values, and a few key points summarizing the data and implications.

Exhibit 4: Number of Public Water Systems By Type: 1997-2003

Source: Data extracted from SDWIS/FED in January 2004.

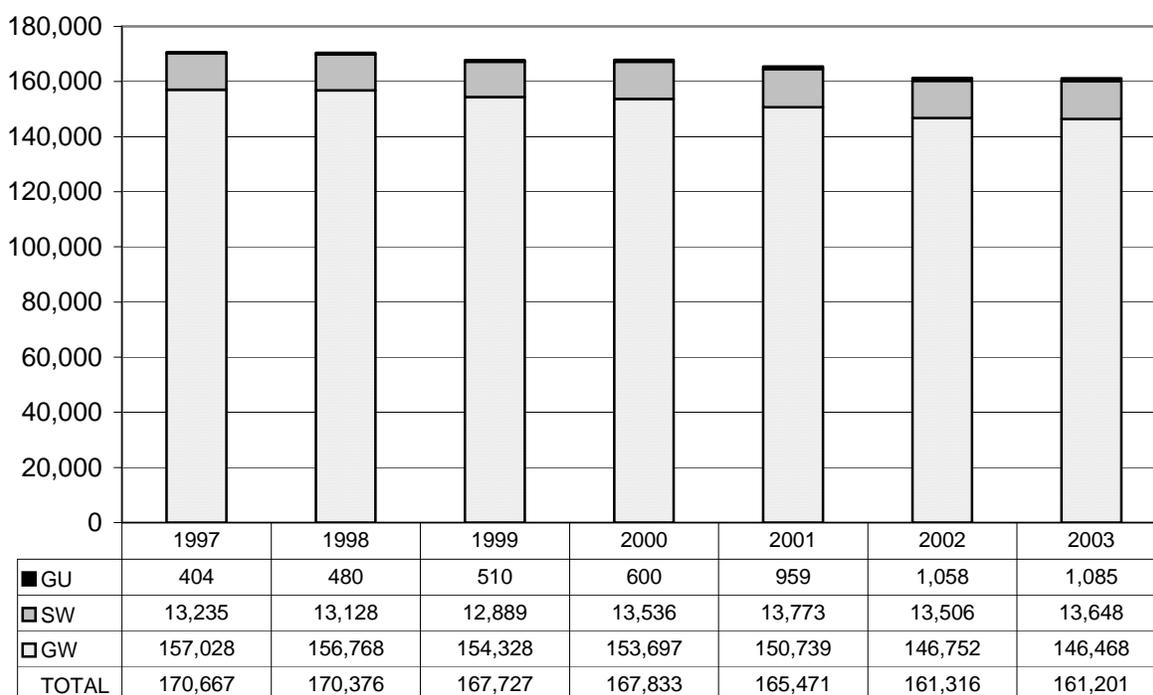


Note: Inactive, closed, and “unclassified” PWSs not included in counts

Key Points:

During the period of 1997 to 2003, the total number of active Public Water Systems (PWSs) has exhibited an overall slight downward trend, decreasing about 5.55% (170,679 - 161,201)/170,679. The number of systems in all three categories also showed a downward trend: CWSs had the smallest decline at 2.5% (54,684 – 53,363)/53,363. TNCWS had the largest decline at 8.1% (95,898 – 88,152)/88,152. With respect to the distribution among the system types, in 2003, 55% of PWSs were TNCWS, 12% were NTNCWS, and 33% were CWSs. This distribution has remained steady since 1997, with a shift of 1% fewer TNCWS systems (56% in 1997 and 55% in 2003) and of 1% more CWSs (32% in 1997 and 33% in 2003).

Exhibit 5: Number of Systems by Source Water Type: 1997 – 2003



Source: Data extracted from SDWIS/FED in January 2004.

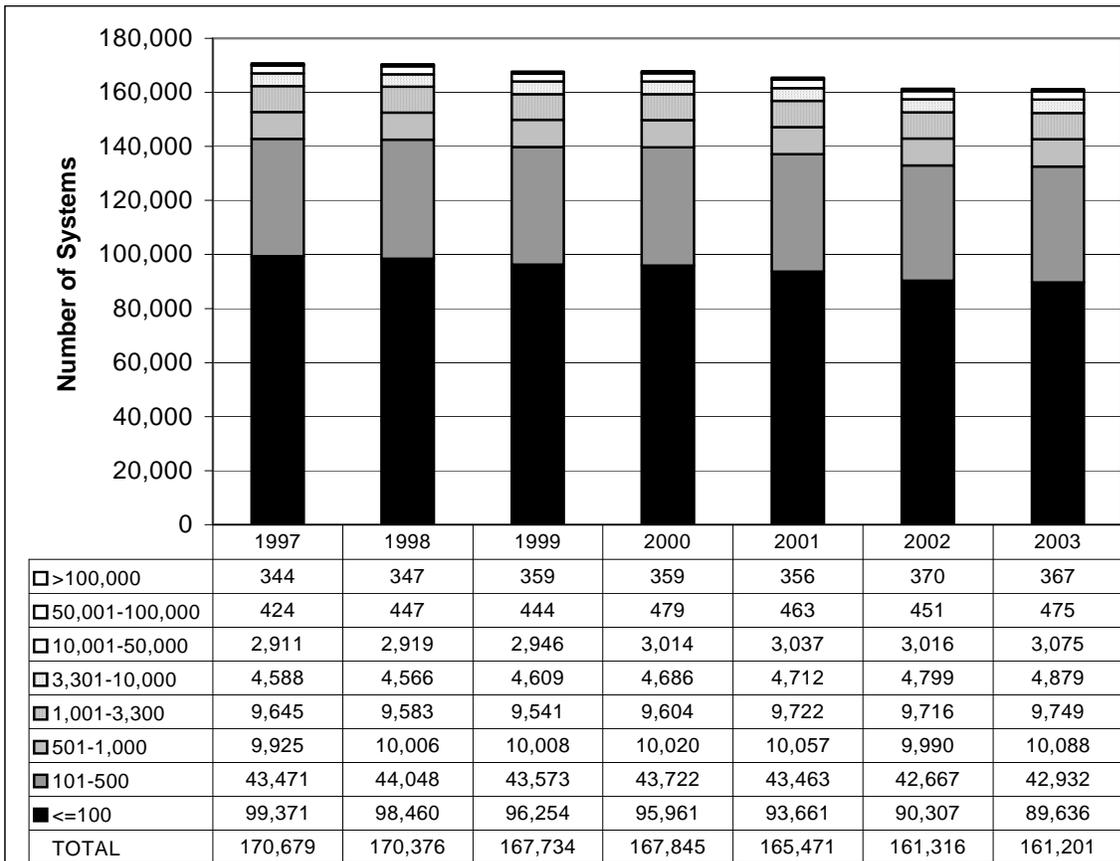
Note: Inactive, closed, unknown source and “unclassified” PWSs are not included in counts. Mixed systems are re-classified into other categories (i.e., GU, GW, SW).

GU: Groundwater under the influence of surface water and purchased groundwater under the influence of surface water
 GW: Groundwater and purchased groundwater
 SW: Surface water and purchased surface water

Key Points:

In 2003, the large majority (90.9%) of systems used groundwater as a source, with 0.7% using groundwater under the influence and 8.5% using surface water. Although a small fraction of systems, the number of systems that use groundwater under the influence has more than doubled from 1997 to 2003, both in terms of actual numbers (404 to 1,085) and as a percent of systems (0.2% to 0.7%) (404/170,667 to 1,085/161,201). The increase in systems using groundwater under the influence may be due to reclassification of existing systems or the use of new sources. The percent of systems using surface water has increased slightly from 1997 to 2003 (7.8% to 8.5%) (12,235/170,667 to 13,648/161,201) while the percent of systems using groundwater has decreased slightly (92.0% to 90.9%) (157,028/170,667 to 146,468/161,201).

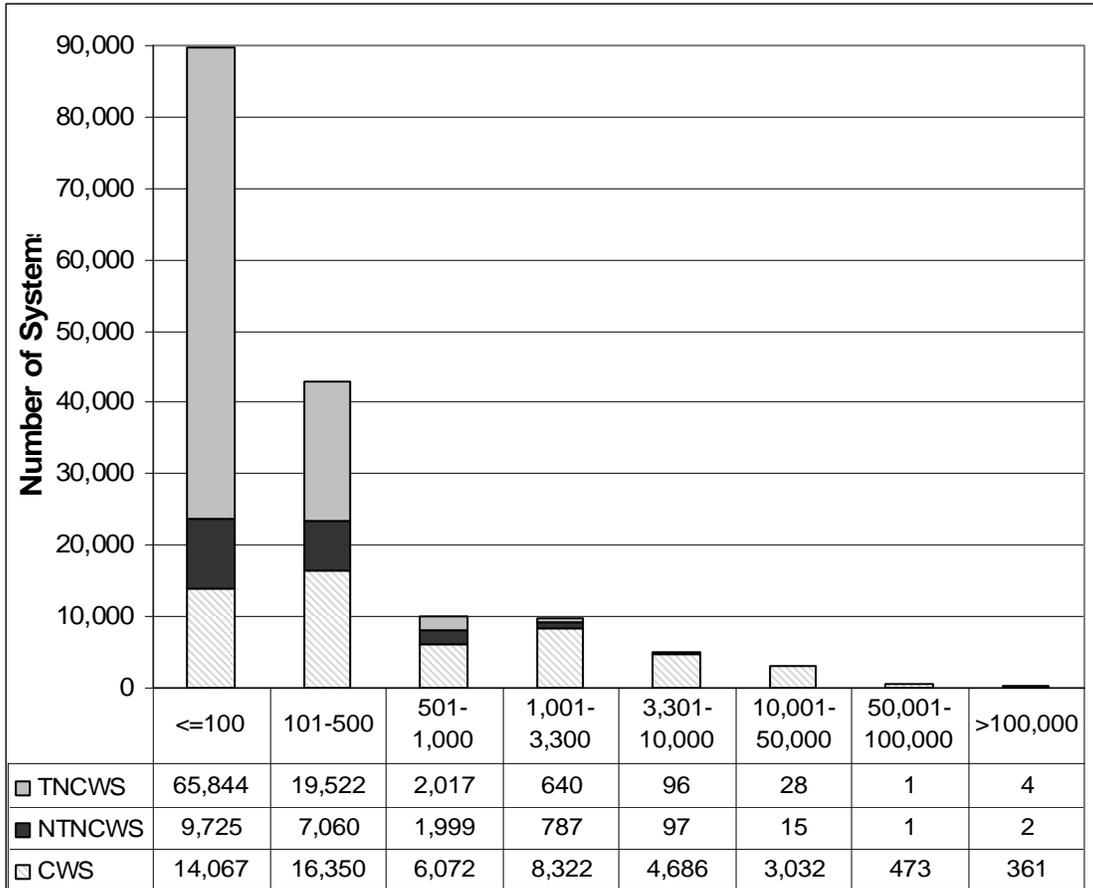
Exhibit 6: Number of Systems by Size: 1997 - 2003
 Source: Data extracted from SDWIS/FED in January 2004.



Key Points:

In 2003, of the total of 161,201 systems, 157,284 systems were systems serving fewer than 10,000, a size category that accounts for 97.6% of all systems. Medium and large systems make up a small fraction of the total number of systems: 2.4% $(367+475+3,075)/161,201$. The number of systems in the two smallest size categories (<100 and 101-500) declined from 1997 to 2003. All other size categories experienced an increase in the number and percent of systems, although the amount of change was small.

Exhibit 7: Number of Systems by Size and Type: 2003

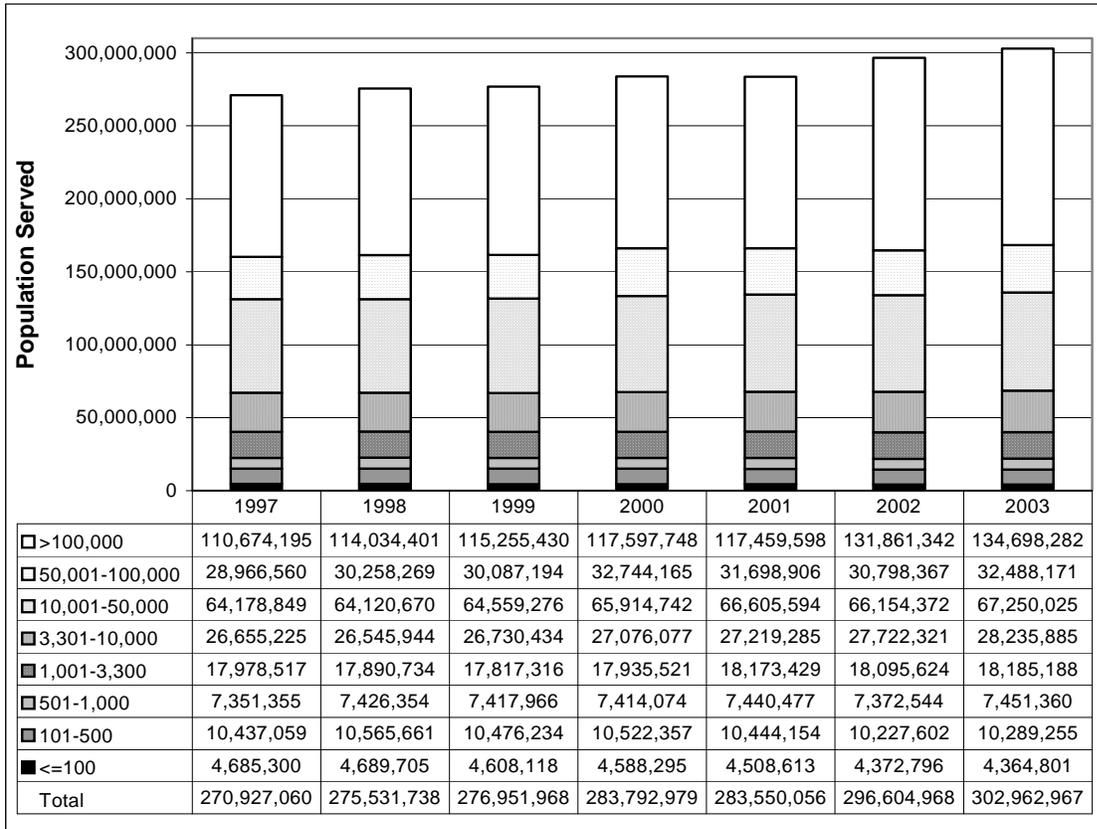


Source: Data extracted from SDWIS/FED in January 2004.

Key Points:

There are substantial differences in the distribution of system types across the size categories. Overall, there are far more systems in the small size category than in the larger categories. Also, the larger the size category, the greater the fraction of CWSs and the smaller the fraction of TNCWSs. For example, CWSs make up 15.7% (14,067/89,636) of systems <=100, but 96% (4,686/4,879) in the 3,301-10,000 category. A very small portion (around 1% (28+1+4+15+1+2)/(3,032+473+361)) of medium and large systems are noncommunity water systems (NTNCWSs or TNCWSs). There are two TNCWSs that serve greater than 1,000,000: Griffith Park in Los Angeles that has 10,000,000 visitors per year and the New York State Fair, which is listed as serving 2,000,000 visitors. Both systems use purchased surface water.

Exhibit 8: Population Served by System Size: 1997 - 2003



Source: Data extracted from SDWIS/FED in January 2004.

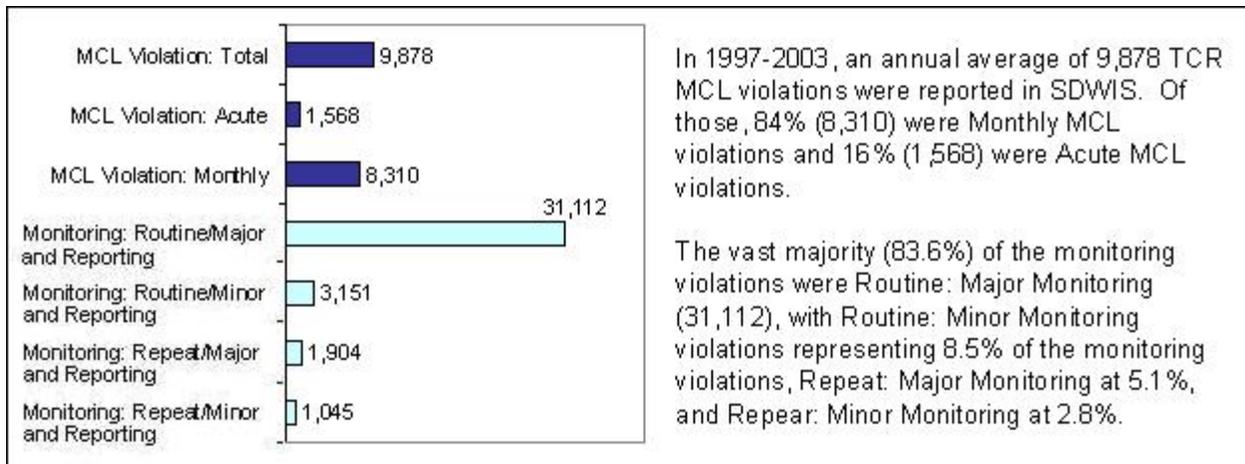
Key Points:

Although small systems make up the majority of the total number of systems, they serve a small fraction of the population. For example, in 2003, systems in the smallest size category (≤ 100) make up 56% of the total number of systems, but serve only 1.4% (4,364,801/302,962,967) of the population. The fraction of the population served has decreased slightly across all system categories serving fewer than 50,000. The fraction of the population served has remained the same in the 50,001-100,000 category and has increased in the >100,000 category.

5. Average of Annual TCR Violations Per Year from 1997 to 2003

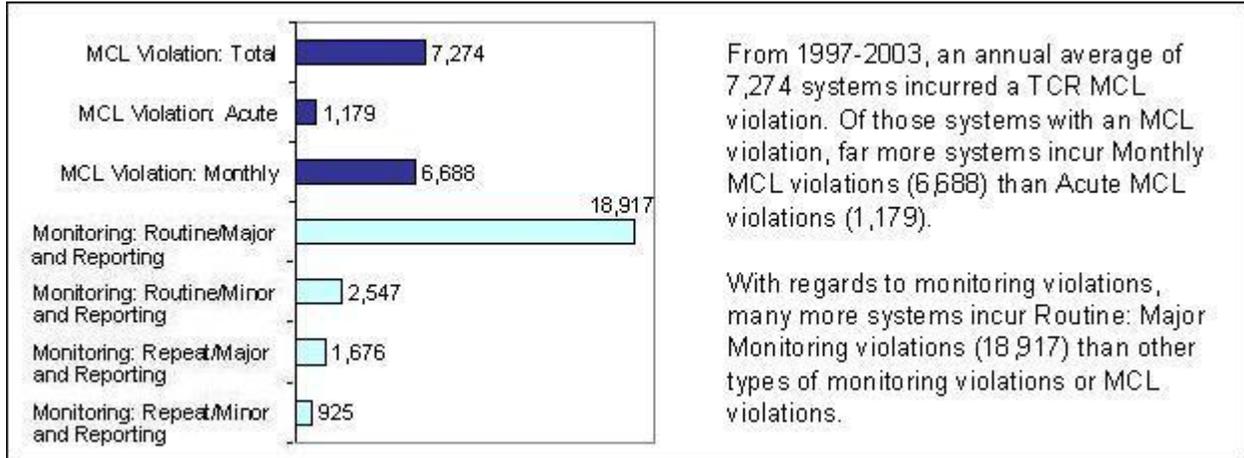
The series of data presented in this section and following sections contains information on the averages of TCR violations during the period of 1997-2003 where annual average is calculated as the total violations incurred from 1997 until 2003 divided by 7 years. Additionally, the number of violations, number of systems with violations, average number of violations per system, and the percent of systems with violations are presented for three TCR MCL violations (Total MCL violations, Acute MCL violations, and Monthly MCL violations) and four Monitoring & Reporting violations (Routine: Major Monitoring & Reporting Violations, Routine: Minor Monitoring & Reporting Violations, Repeat: Major Monitoring & Reporting Violations, and Repeat: Minor Monitoring & Reporting Violations) in Exhibits 9-12.

Exhibit 9: Average¹ of Annual Numbers of Violations per Year



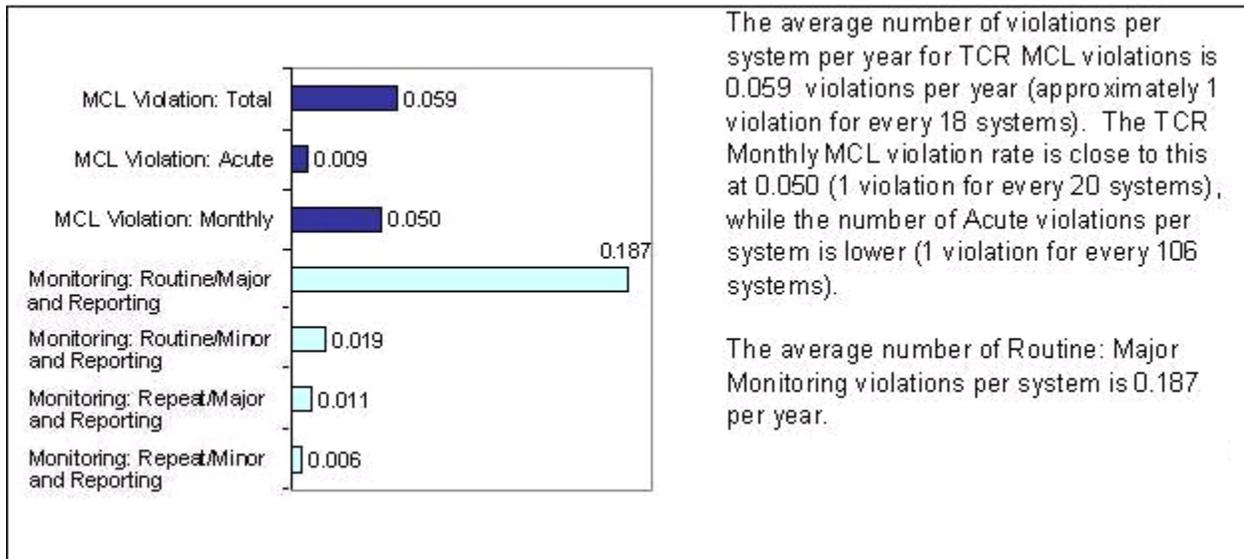
¹Standard Deviations are as follows: 925.7 for MCL Violation: Total; 737.8 for MCL Violation: Acute; 245.2 for MCL Violation: Monthly; 1953.9 for Monitoring and Reporting: Routine Major; 549.6 for Monitoring and Reporting: Routine Minor; 193.1 for Monitoring and Reporting: Repeat Major; and 339.7 for Monitoring and Reporting: Repeat Minor.

Exhibit 10: Average¹ of Annual Numbers of Systems With Violations



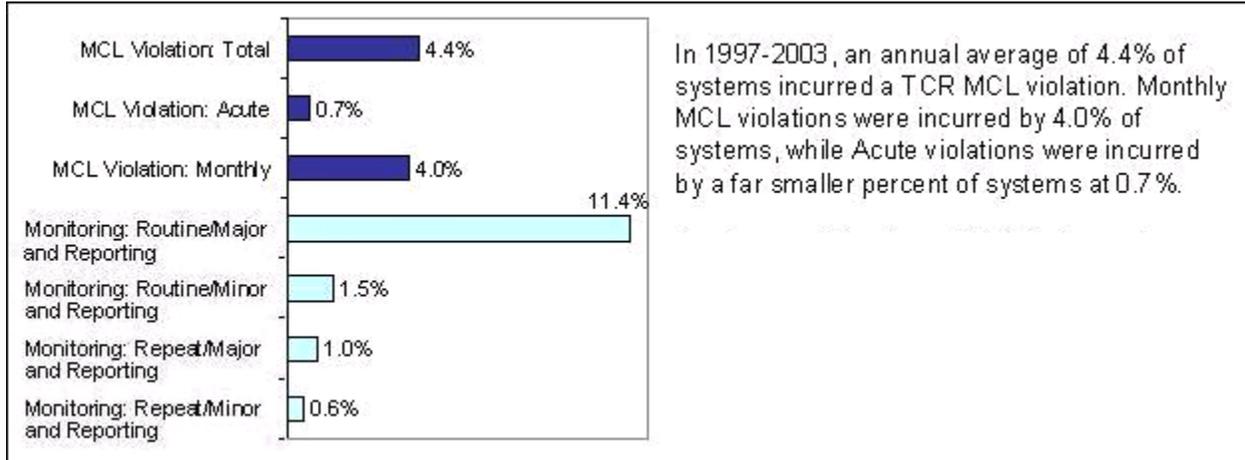
¹Standard Deviations are as follows: 316.6 for MCL Violation: Total; 486.2 for MCL Violation: Acute; 149.5 for MCL Violation: Monthly; 1238.3 for Monitoring and Reporting: Routine Major; 391.0 for Monitoring and Reporting: Routine Minor; 127.1 for Monitoring and Reporting: Repeat Major; 262.0 and for Monitoring and Reporting: Repeat Minor.

Exhibit 11: Average¹ of Annual Numbers of Violations Per System



¹Standard Deviations are as follows: 0.0044 for MCL Violation: Total; 0.004 for MCL Violation: Acute; 0.0014 for MCL Violation: Monthly; 0.0121 for Monitoring and Reporting: Routine Major; 0.0030 for Monitoring and Reporting: Routine Minor; 0.0008 for Monitoring and Reporting: Repeat Major; and 0.0019 for Monitoring and Reporting: Repeat Minor.

Exhibit 12: Average¹ of Annual Percentages of Systems with Violations



¹Standard Deviations are as follows: 0.12% for MCL Violation: Total; 0.26% for MCL Violation: Acute; 0.098% for MCL Violation: Monthly; 0.74% for Monitoring and Reporting: Routine Major; 0.21% for Monitoring and Reporting: Routine Minor; 0.038% for Monitoring and Reporting: Repeat Major; and 0.15% for Monitoring and Reporting: Repeat Minor.

The next three sections compare the TCR violations data across three characterizations: system size, system type, and source water. As evidenced by the previously reported inventory data, the number of systems can vary substantially across system size, type and source water. Therefore, only the percent of systems with violations (also referred to as the violation rate) is used to directly compare across categories, although the other data elements are included in the appendices. Each section contains a graphic representation of the percent of systems with each type of violation averaged over the period of 1997-2003, by system size, type, or source for a visual comparison. The section also includes the results of a more formal, but basic, statistical comparison of the data to determine if any differences among categories are statistically significant. The methodology used to develop these results is described in Appendix K.

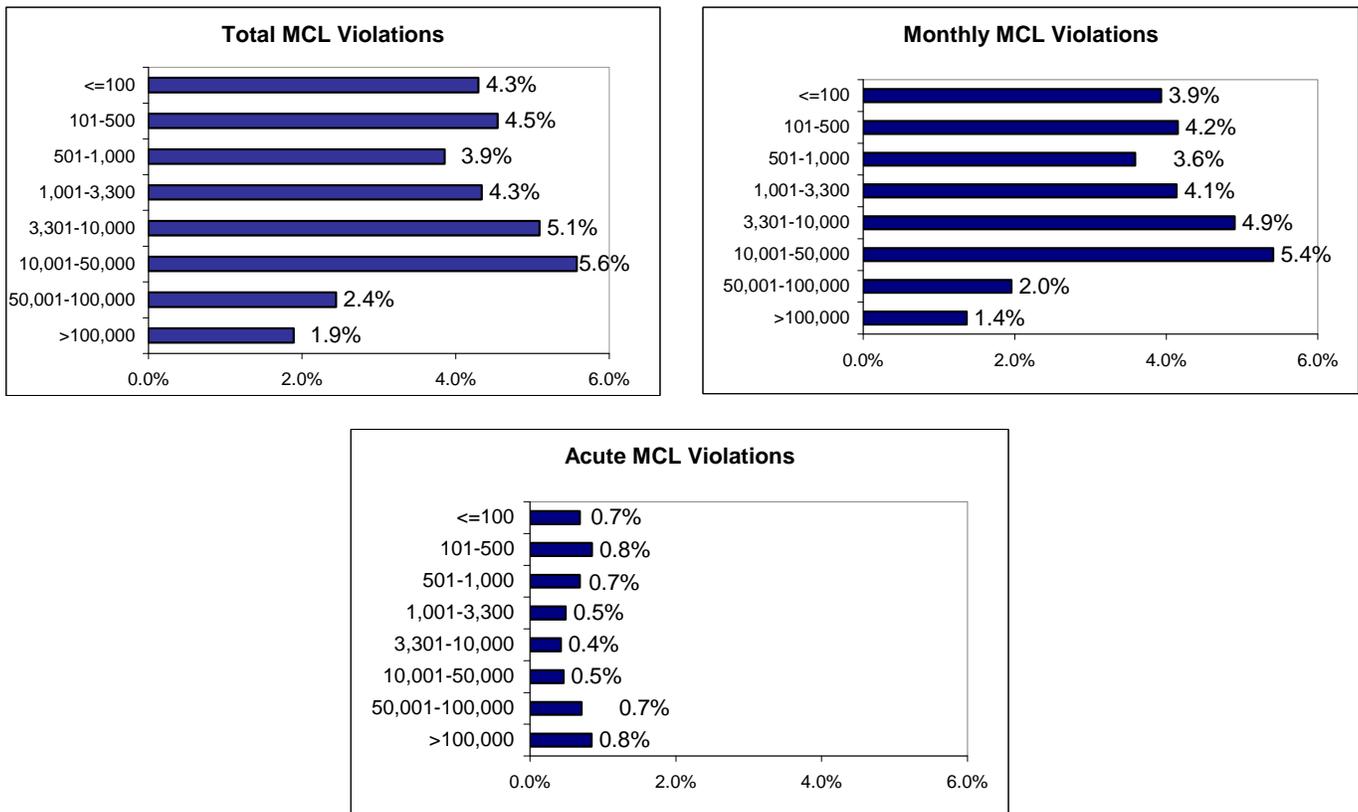
The following sections only present the violations rates by system size, system type, or source. There is no attempt made to interpret the data or to posit explanations for differences among categories. Important considerations, such as confounding among the classifications (i.e., the apparent relationship that one or more variables may or may not be making towards a single observed effect) and the impact of Monitoring & Reporting frequencies and violation triggers, could be the subject of future analyses. In addition, there may be a connection between Monitoring & Reporting violations and MCL violations: namely, when a system fails to monitor the water quality or report the results, MCL violations could be under-reported. We analyze this issue to a limited extent in Exhibits X, but the impacts are not considered further.

6. TCR Violations by System Size

This section provides an analysis of the percent of systems incurring TCR violations categorized by system size. Exhibit 13 presents the average of annual percentage of systems incurring MCL violations from 1997-2003, categorized by size and Exhibit 14 presents the average of annual percentage of system incurring Monitoring & Reporting violations from 1997-2003. Appendix A contains information by size for the number of violations, number of systems with violations, and the average number of violations per system.

Exhibit 13: Average¹ of Annual Percentages of Systems with TCR MCL Violations from 1997-2003, By System Size

(See Appendix A for Detail)



¹Standard Deviations are as follows:

	Total MCL Violations	Monthly MCL Violations	Acute MCL Violations
<=100:	0.13%	0.21%	0.26%
101-500:	0.22%	0.14%	0.36%
501-1,000:	0.28%	0.24%	0.29%
1,001-3,300:	0.37%	0.35%	0.15%
3,301-10,000:	0.48%	0.49%	0.14%
10,001-50,000:	0.65%	0.67%	0.19%
50,001-100,000:	1.18%	0.74%	0.76%
>100,000:	0.89%	0.83%	0.46%

As the above exhibit illustrates, the percent of systems incurring TCR MCL violations does vary across systems size categories, but not in a consistent pattern. For Total MCL violations and Monthly MCL violations, the largest percent of systems incurring violations is in the small and medium size categories: 5.1% and 4.9% for the 3,301-10,000 category and 5.6% and 5.4% for the 10,001-50,000 category. Total MCL Violations and Monthly MCL violations are expected to be similar, since most of the MCL violations are monthly. The smallest percentage of systems with violations is in the largest size categories at 1.9% and 1.4% for systems serving >100,000. The pattern is different for Acute MCL violations, with slight, although sometimes significant, variation between 0.4% to 0.8% for all size categories. The smallest percentage of systems with violations is in the medium size classes: 0.5% for the 1,001-3,000 category, 0.4% for the 3,001- 10,000 category, and 0.5% for the 10,001 to 50,000 category. The largest percentage of systems with violations is in the largest size category.

Box 6.1: Statistically Significant Relationships for Total and Monthly MCL Violations with Respect to Size

Statistically Significant Relationships for Total and Monthly MCL Violations with Respect to Size:

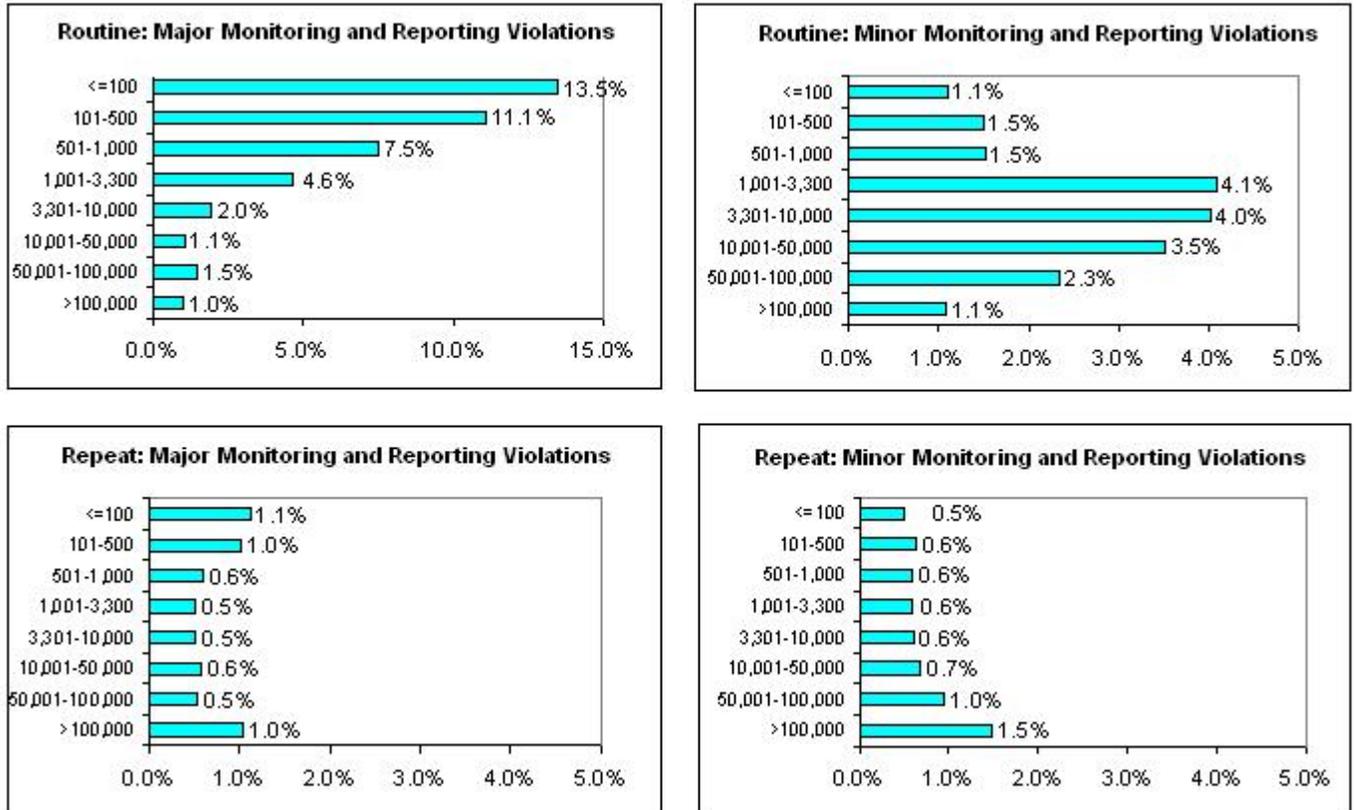
- *Middle size classes (3,301-50,000) have a violation rate **greater** than that for other size classes.*
- *Larger size classes (>50,001) have a violation rate **less** than that for other size classes*

Statistically Significant Relationships for Acute Violations with Respect to Size:

- *Very large size classes (>100,000) and Small size classes (101-500) have a violation rate **greater** than that for other size classes.*
- *Middle size classes (1,001-10,000) have a violation rate **less** than that for other size classes.*

See Appendix K for discussion on Statistical Analysis of TCR Violation Data

Exhibit 14: Average¹ of Annual Percentages of Systems with TCR Monitoring & Reporting Violations from 1997- 2003, By System Size



¹Standard Deviations are as follows:

	Routine: Major MR Violations	Routine: Minor MR Violations	Repeat: Major MR Violations	Repeat: Minor MR Violations
<=100:	1.18%	0.16%	0.05%	0.12%
101-500:	0.68%	0.31%	0.11%	0.19%
501-1,000:	0.55%	0.28%	0.12%	0.19%
1,001-3,300:	0.69%	0.38%	0.15%	0.19%
3,301-10,000:	0.44%	0.52%	0.12%	0.31%
10,001-50,000:	0.22%	0.89%	0.16%	0.31%
50,001-100,000:	0.76%	1.30%	0.41%	0.66%
>100,000:	0.69%	0.71%	0.74%	0.43%

As the above exhibit illustrates, average of annual percentages of systems with TCR Monitoring & Reporting violations does vary across systems size categories and, in the cases of Routine: Major violations and Repeat: Minor violations, shows visible trends with increasing population. For Routine: Major violations, the largest percent of systems incurring violations is in the smallest size category (<100) with 13.5%, or nearly one in 7 systems, incurring a violation. As shown in Appendix G-1, the trend for systems serving <100 has been relatively steady over time, with 13.4% (13,343/99,575) having Routine: Major violations in 1997 and 14.0%

(12,521/89,436) in 2003, with a low of 11.1% (10,970/98,829) in 1998 and a high of 14.9% (13,363/96,396) in 1999.

The percent of systems incurring Routine: Major violations declines as the size category increases with only an average of 1.0% of the largest systems incurring violations (with a slight exception between 50,001-100,000). The trend in Routine: Major violations for the largest systems has been decreasing, from 1.7% (6/353) in 1997 to 0.3% (1/333) in 2003. For Routine: Minor violations, the highest percent of systems incurring violations is in the mid-range categories at 4.1% of systems 1,001-3,000 and 4.0% of systems 3,001-10,000.

Box 6.2: Statistically Significant Relationships for Total Monitoring & Reporting Violations with Respect to Size

Statistically Significant Relationships for Monitoring & Reporting Violations with Respect to Size:

Routine: Major and Repeat: Major violations:

- *Smallest size class (<100) has a violation rate **greater** than other size classes for Routine: Major Monitoring & Reporting Violations and **slightly greater** for Repeat: Major Monitoring & Reporting Violations..*
- *Middle and large size classes (>501) have a violation rate **less** than other size classes (except the largest size class for Repeat: Minor violations).*

Routine: Minor and Repeat: Minor violations:

- *Smallest size class (<100) has a violation rate **less** than other size classes.*

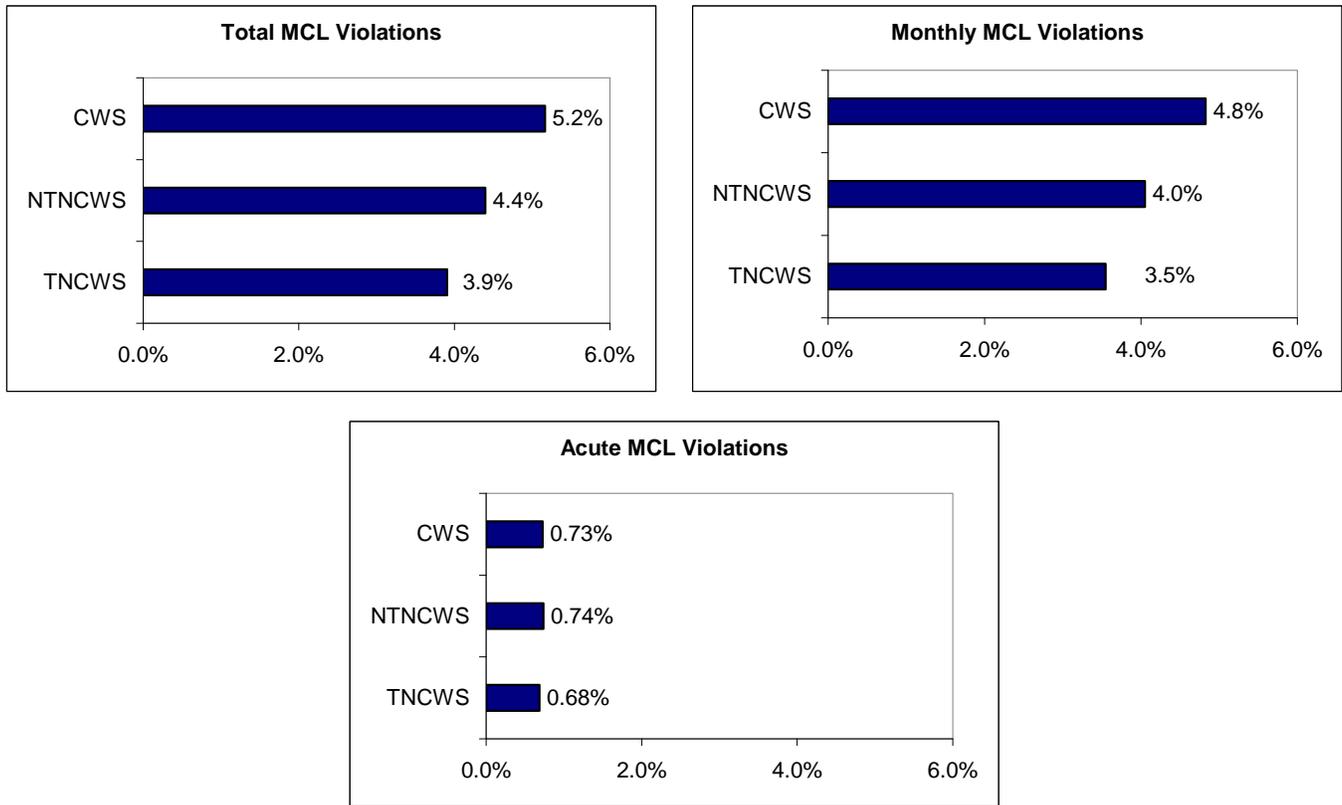
See Appendix K for discussion on Statistical Analysis of TCR Violation Data

The trend of violations as population size increases is inconsistent for Repeat: Major violations, but consistent for Repeat: Minor violations. For Repeat: Major violations, the percent of systems with violations is highest in the smallest two categories (1.1% for <100 and 1.0% for 101-500) and the largest category (1.0% for >100,000). The smallest percent of systems incurring Repeat: Major violations is in the middle categories. For Repeat: Minor violations, the highest percent of systems with violations is found in the largest category (1.5% in the >100,000 category). The percent of systems incurring Repeat: Minor violations declines as the size category decreases with only 0.5% of the smallest systems incurring violations.

7. TCR Violations by System Type

This section provides an analysis of the percent of systems incurring TCR violations categorized by type of system. Exhibit 15 presents the average of annual percentages of systems with TCR MCL violations from 1997-2003 by type of system and Exhibit 16 presents the average of annual percentages of systems with TCR Monitoring & Reporting violations by type of system. Appendix B contains information by type of system for the number of violations, number of systems with violations, and the average number of violations per system from 1997 to 2003.

Exhibit 15: Average¹ of Annual Percentages of Systems with TCR MCL Violations from 1997- 2003, By System Type



¹Standard Deviations are as follows:

	Total MCL Violations	Monthly MCL Violations	Acute MCL Violations
CWS:	0.51%	0.43%	0.28%
NTNCWS:	0.21%	0.21%	0.24%
TNCWS:	0.22%	0.28%	0.31%

The percent of systems with Acute and Monthly MCL violations is similar across the three types of systems (CWS, NTNCWS, TNCWS) with small (but in some cases,

significant) differences. Acute MCL violations ranged from 0.68 - 0.74%, with the lowest percent of systems occurring in the TNCWS category. This difference, however, is not statistically significant for Acute MCL violations. For Monthly MCL violations, the TNCWS category has the lowest percent of systems with violations at 3.5%, with CWSs at 4.8% and NTNCWSs at 4.0%.

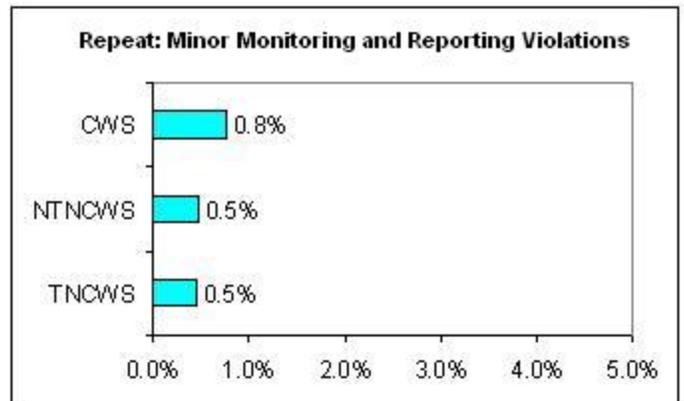
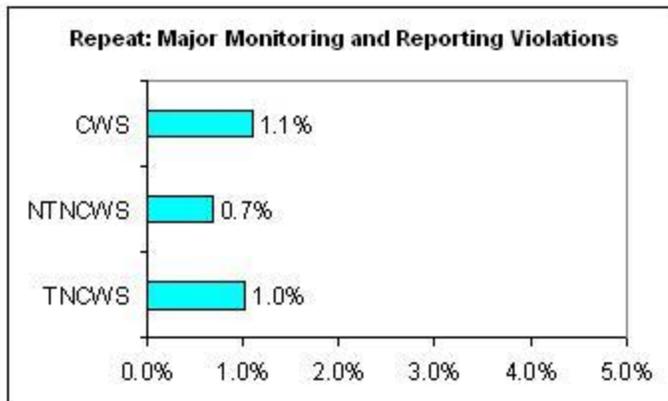
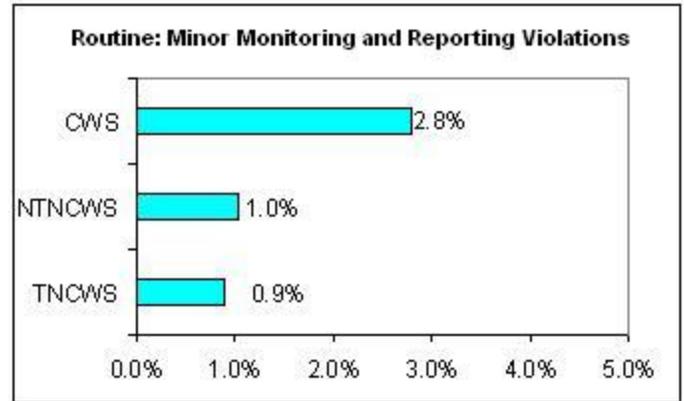
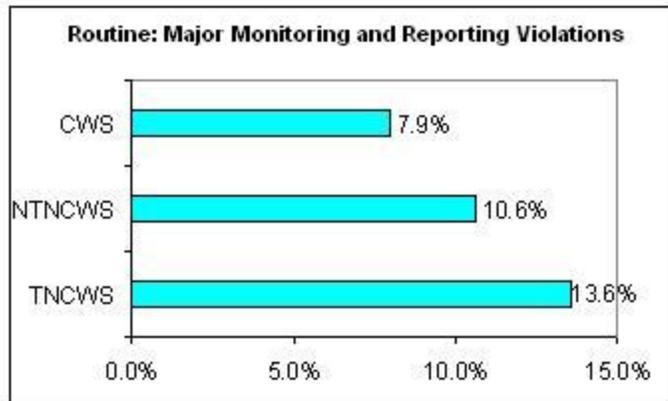
**Box 7.1: Statistically Significant Relationships for TCR MCL Violations from 1997- 2003,
By System Type**

Statistically Significant Relationships for Total and Monthly MCL Violations with Respect to Type:

- *CWSs have a violation rate **greater** than other system types.*
- *TNCWSs have a violation rate **less** than other system types.*

See Appendix K for discussion on Statistical Analysis of TCR Violation Data

Exhibit 16: Average¹ of Annual Percentages of Systems with TCR Monitoring & Reporting Violations from 1997- 2003, By System Type



¹Standard Deviations are as follows:

	Routine: Major MR Violations	Routine: Minor MR Violations	Repeat: Major MR Violations	Repeat: Minor MR Violations
CWS:	0.93%	0.46%	0.24%	0.24%
NTNCWS:	1.5%	0.15%	0.090%	0.11%
TNCWS:	1.6%	0.11%	0.058%	0.11%

The percent of systems with Routine: Major Monitoring & Reporting violations is greater for TNCWSs (13.6%) than for CWSs (7.9%) or NTNCWSs (10.6%). The percent of systems with Routine: Minor violations is much lower for all types of systems than Routine: Major, with 2.8% of CWSs having violations and 1.0% and 0.9% of NTNCWSs and TNCWSs, respectively.

A relatively small percentage of systems incur a Repeat Monitoring & Reporting violation: on average, between 0.7% and 1.1% incur Repeat: Major violations and between 0.5% and 0.8% incur Repeat: Minor violations. A slightly greater percent of all systems types incur Repeat: Major violations than Repeat: Minor violations.

Box 7.2: Statistically Significant Relationships for TCR Monitoring & Reporting Violations from 1997- 2003, By System Type

Statistically Significant Relationships for Monitoring & Reporting Violations with Respect to Type:

Routine: Major violations:

- CWSs have a violation rate **less** than other system types.
- TNCWSs have a violation rate **greater** than other system types.

Routine: Minor and Repeat: Minor violations:

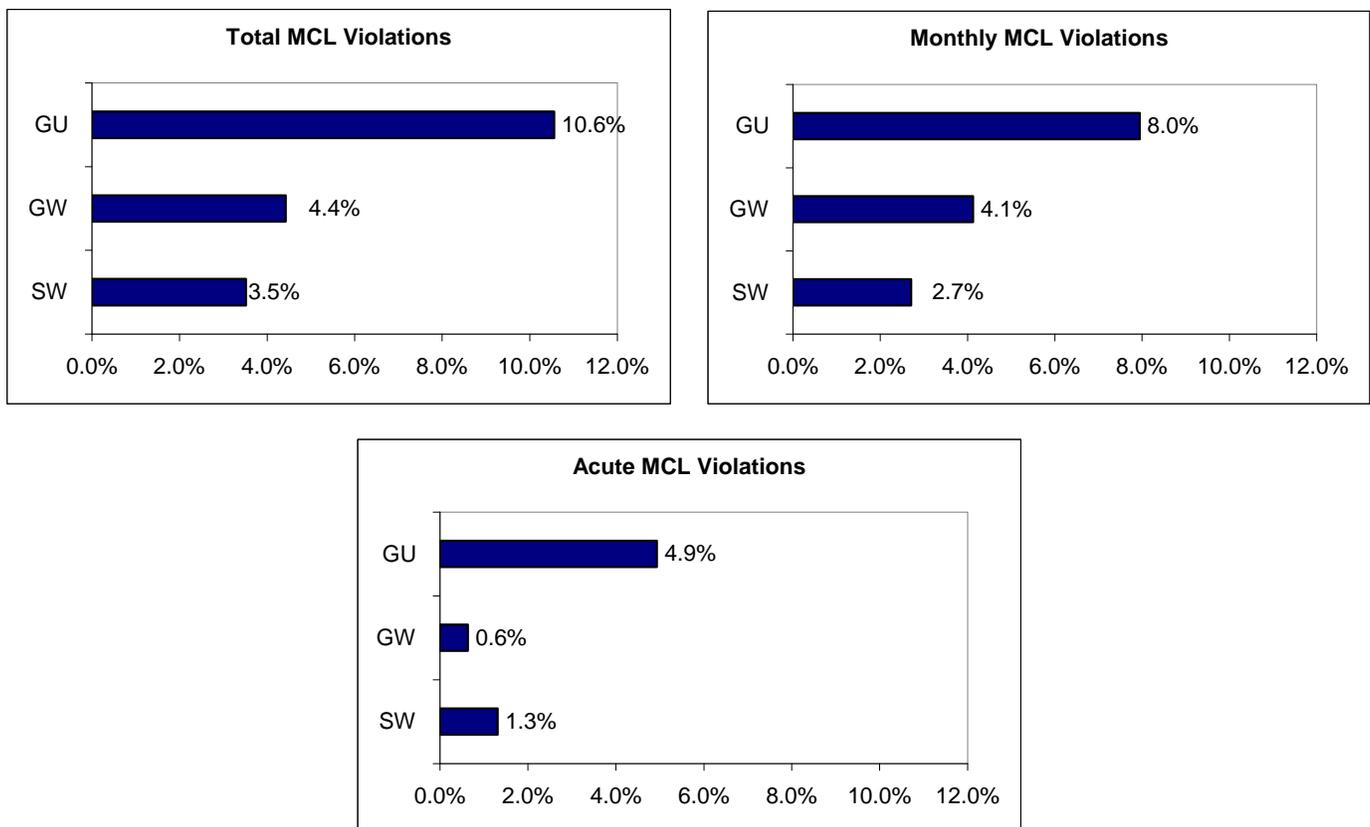
- CWS have a violation rate **greater** than other system types.
- NTNCWSs and TNCWSs have a violation rate **less** than CWSs.

See Appendix K for discussion on Statistical Analysis of TCR Violation Data

8. Analysis of TCR Violations By Source Water

The following section provides an analysis of TCR violations broken out by source water used. Exhibit 17 presents the average of annual percentages of systems with TCR MCL violations from 1997-2003, by source water, and Exhibit 18 presents the average of annual percentages of systems with TCR Monitoring & Reporting violations, by source water. Appendix C contains information by source water for the number of violations, number of systems with violations, and the average number of violations per system.

Exhibit 17: Average¹ of Annual Percentages of Systems with TCR MCL Violations from 1997- 2003, By Source Water



¹Standard Deviations are as follows:

	Total MCL Violations	Monthly MCL Violations	Acute MCL Violations
GU:	5.8%	4.1%	3.7%
GW:	0.13%	0.11%	0.25%
SW:	3.5%	0.43%	0.51%

The highest percent of systems with MCL violations is among systems that use Groundwater Under the Direct Influence of Surface Water (GU)¹². This relationship holds true across all of the violations types, including 4.9% of GU systems incurring Acute MCL violations and 8.0% incurring Monthly MCL violations. The percent of systems incurring Acute MCL violations is 0.6% for GW and 1.3% for SW systems, while a greater percent of groundwater systems incur monthly MCL violations (4.1%) than surface water systems (2.7%), on average from 1997-2003. As displayed in Appendix E-3, in each year from 1997-2003, SW and GU have consistently higher Acute violations rates than GW systems, and this relationship is statistically significant.

Box 8.1: Statistically Significant Relationships for TCR MCL Violations from 1997- 2003, By Source Type

Statistically Significant Relationships for Total and Monthly MCL Violations with Respect to Source:

- *Systems using GU have a violation rate **greater** than other water sources.*
- *Systems using SW have a violation rate **less** than other water sources.*

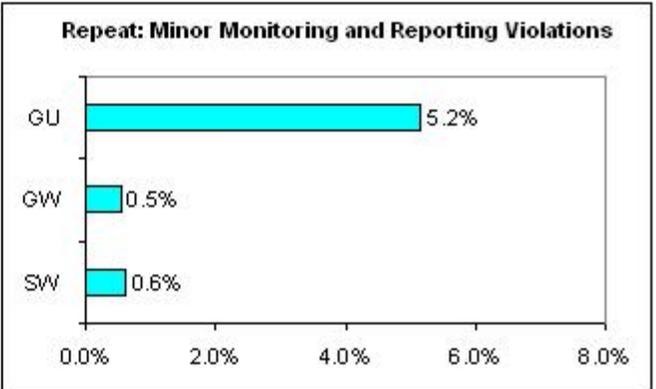
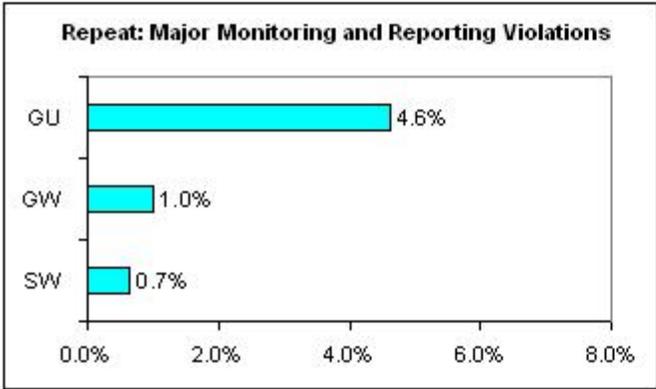
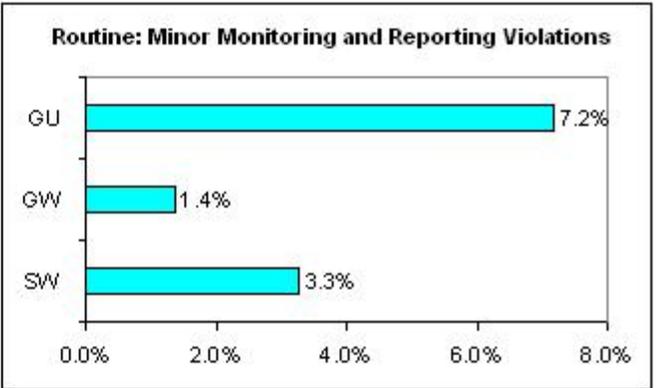
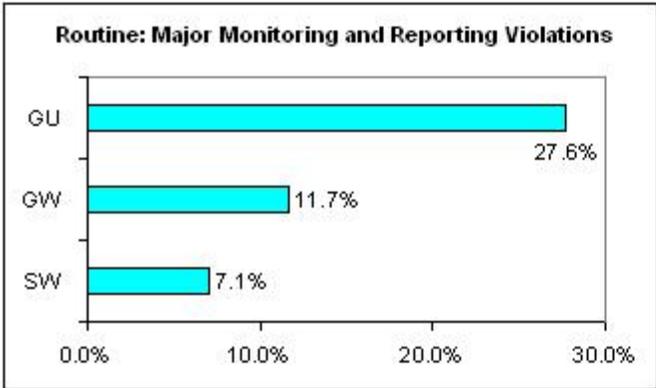
Statistically Significant Relationships for Acute MCL Violations with Respect to Source:

- *Systems using GU have a violation rate **greater** than GW and SW systems.*
- *Systems using SW have a violation rate **greater** than GW systems.*
- *Systems using GW have a violation rate **less** than other water sources.*

See Appendix K for discussion on Statistical Analysis of TCR Violation Data

¹² It is important to note that the total number of violations attributable to GU systems is quite low because of the relatively small number of systems in this category.

Exhibit 18: Average¹ of Annual Percentages of Systems with TCR Monitoring & Reporting Violations from 1997- 2003, By Source Water



¹Standard Deviations are as follows:

	Routine: Major MR Violations	Routine: Minor MR Violations	Repeat: Major MR Violations	Repeat: Minor MR Violations
GU:	11.6%	2.8%	2.1%	4.2%
GW:	0.81%	0.18%	0.038%	0.13%
SW:	0.74%	0.67%	0.14%	0.27%

A larger fraction of systems using groundwater under the influence incur all four types of Monitoring & Reporting violations than systems using either surface water or groundwater (Routine: Major at 27.6%; Routine: Minor at 7.2%, Repeat: Major at 4.6%; and Repeat: Minor at 5.2%). On average, a larger fraction of systems using groundwater (11.7%) incur Routine: Major violations than surface water systems (7.1%). The percent of systems incurring Repeat: Major violations is higher for those using groundwater (1.0%) than surface water (0.7%), although a slightly greater fraction of surface water systems (0.6%) incur Routine: Minor violations than groundwater (0.5%).

Box 8.2: Statistically Significant Relationships for TCR Monitoring & Reporting Violations from 1997- 2003, By Source Type

Statistically Significant Relationships for Monitoring & Reporting Violations with Respect to Source:

Routine Major and Repeat Major violations:

- *GU systems have a violation rate **greater** than other water sources.*
- *SW systems have a violation rate **less** than other water sources.*

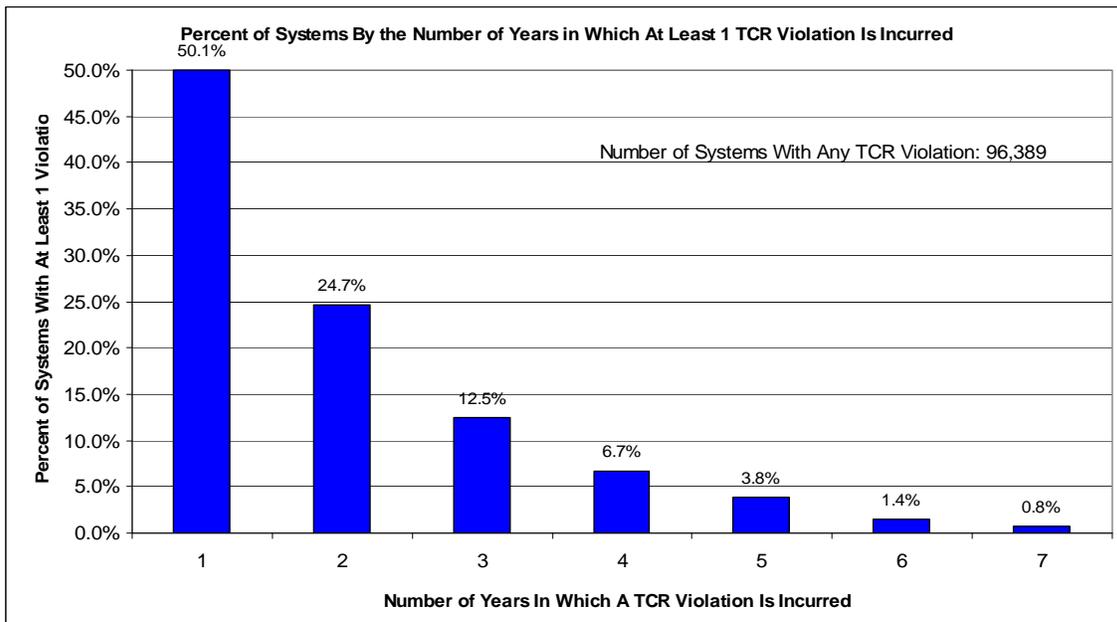
Routine Minor and Repeat Minor violations:

- *GU systems have a violation rate **greater** than other water sources.*
- *GW systems have a violation rate **less** than other water sources for Routine Minor.*

9. Analysis of Repeat Violators

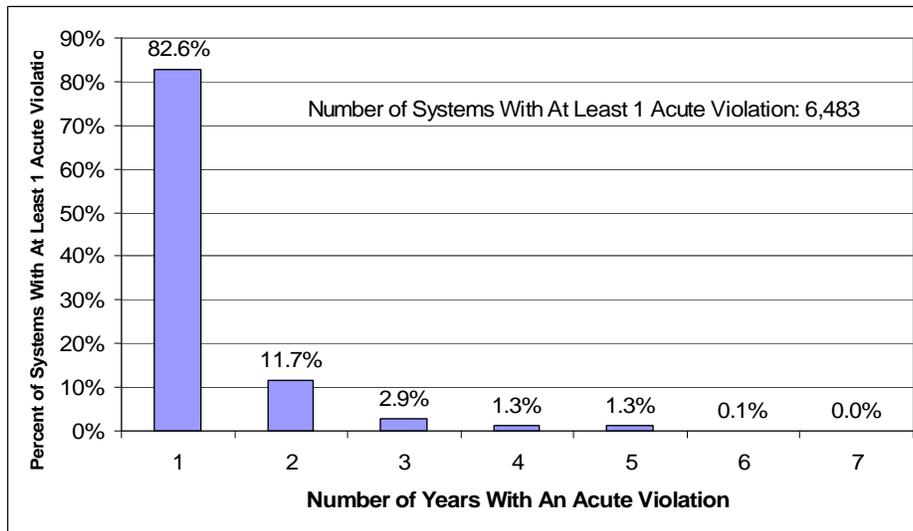
This section describes analyses conducted to assess the degree to which systems incur violations repeatedly over a number of years. Basically, the next set of exhibits present, for systems that had at least 1 TCR violation over the 1997 to 2003, the percentage of systems that incurred a violation in only 1 year, 2 years, and up to all seven years. This means at least one violation in any one of the years between 1997 to 2003.

Exhibit 19: Percent of Systems With Violations In A Given Number of Years – All TCR Violations



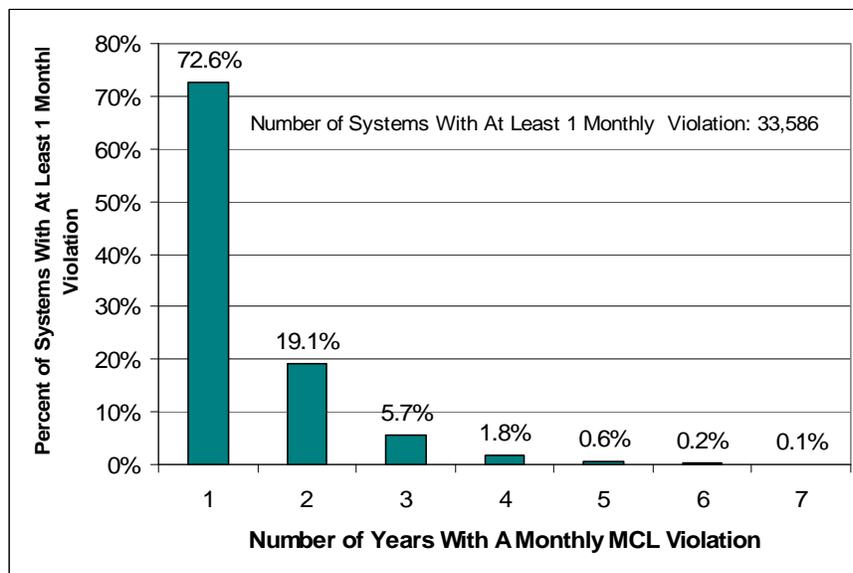
During the period of 1997 to 2003, 96,389 systems had at least 1 TCR violation of any kind, out of a possible universe of systems ranging in number from 170,679 to 161,201. Roughly 55% to 60% of all systems had at least 1 TCR violation during 1997 to 2003. Of these systems, about half (50.1%) incurred at least 1 violation in only 1 year, with another 24.7% incurring at least 1 violation in 2 of the 7 years. A small fraction of systems (0.8%) incurred at least 1 violation in all 7 years and 1.4% incurred at least 1 violation in 6 of 7 years.

Exhibit 20: Percent of Systems With Violations In A Given Number of Years – Acute MCL Violations



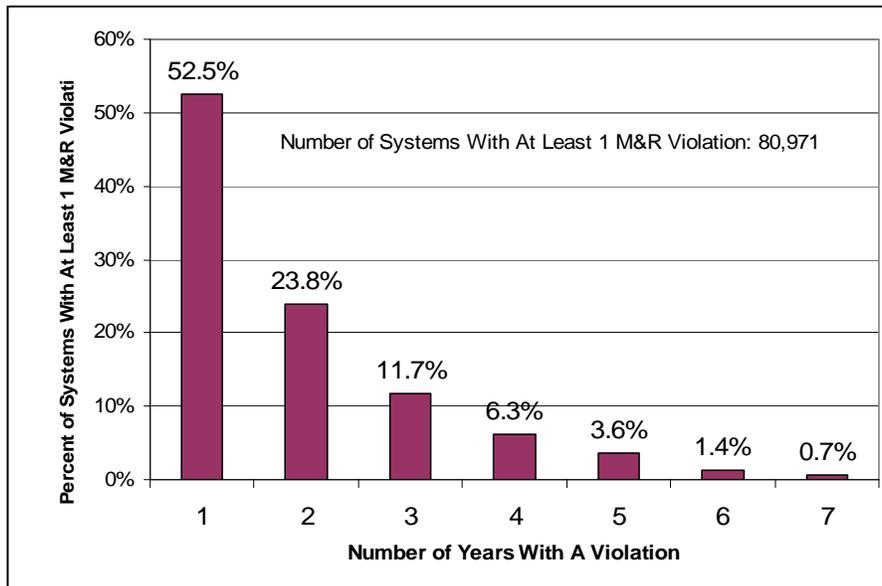
During the period of 1997 to 2003, 6,483 systems had at least 1 Acute MCL violation. Of those, the vast majority (82.6%) incurred at least 1 Acute MCL violation in only 1 of the 7 years. No systems incurred at least 1 Acute MCL violation in all 7 years and only a handful (0.1% or 7 systems) incurred at least 1 Acute MCL violation in 6 of 7 years. A small, but not necessarily inconsequential, fraction of systems (between 5% and 6%) appear to have chronic problems as indicated by incurring at least 1 Acute MCL violation in 3 or more years out of 7.

Exhibit 21: Percent of Systems With Violations In A Given Number of Years – Monthly MCL Violations



During the period of 1997 to 2003, 33,586 systems had at least 1 Monthly MCL violation. Of those, the vast majority (72.6%) incurred at least 1 Monthly MCL violation in only 1 of the 7 years. A small fraction incurred at least 1 Monthly MCL violation in all 7 years (0.1% or 21 systems) with another 0.2% (52 systems) incurring at least 1 Monthly MCL violation in 6 of 7 years. Approximately 8.3% (2,793 systems) appear to have chronic problems as indicated by incurring at least 1 Monthly MCL violation is 3 or more years out of 7.

Exhibit 22: Percent of Systems With Violations In A Given Number of Years – Monitoring & Reporting Violations

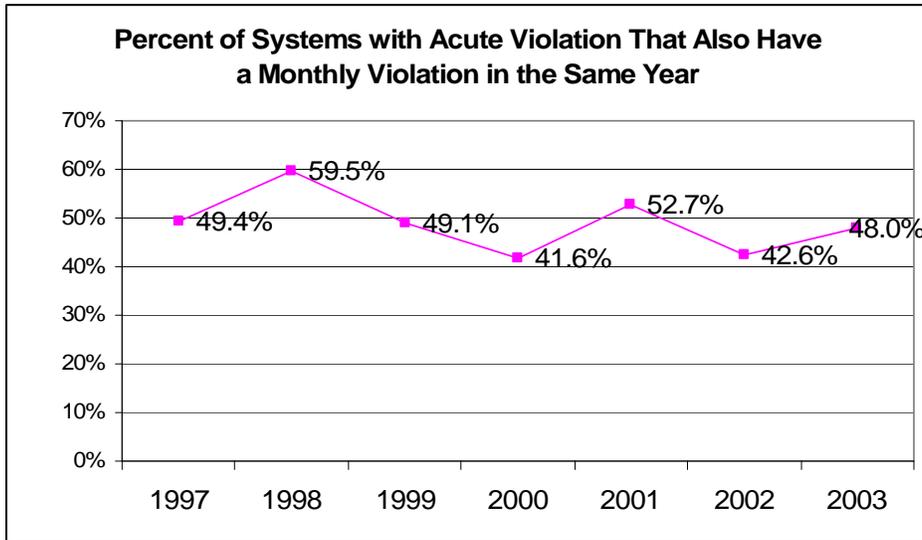


During 1997 to 2003, 80,971 systems had at least 1 Monitoring & Reporting violation. Of those, the about half (52.5%) incurred at least 1 Monitoring & Reporting violation in only 1 of the 7 years. A small fraction incurred at least 1 Monitoring & Reporting violation in all 7 years (0.7% or 593 systems) with another 1.4% (1,098 systems) incurring at least 1 Monitoring & Reporting violation in 6 of 7 years. Approximately one quarter of systems (23.7% or 19,169 systems) appear to have chronic problems as indicated by incurring at least 1 Monitoring & Reporting violation is 3 or more years out of 7.

The breakdown of repeat violators by system type, source water, and system size can be found in Appendix L.

An additional set of analyses was conducted to assess whether certain types of violations were more likely to co-occur. One analysis quantified the extent that systems with an Acute MCL violation also had a Monthly MCL violation. Exhibit 23 displays the percent of systems with an Acute MCL violation that also had a Monthly MCL violation within the same fiscal year.

Exhibit 23: Percent of Systems with Acute Violations that Also Have a Monthly Violation in the Same Year



Roughly half of the systems that have an Acute MCL violation also have at least 1 Monthly MCL violation in the same fiscal year. The data does not show trend over time, with a high of 59.5% in 1998, a low of 41.6% in 2000, and 48.0% in the most recent year (2003).

To attempt to determine the extent that systems may be incurring a Monitoring & Reporting violation to avoid an MCL violation, the following analysis compares the rate of previous MCL violations in systems with and without Monitoring & Reporting violations. The analysis first separates out the universe of systems that had *any* Monitoring violation¹³ in 2003: 21,282 systems had at least 1 Monitoring & Reporting violation (of any type) in 2003 and 139,919 did not have Monitoring & Reporting violation in 2003. The analysis then looked at whether a system had at least 1 MCL violation in the previous year (2002). Exhibit 24 summarizes the results of the analysis.

¹³ The analysis does not distinguish between the four Monitoring & Reporting violations.

Exhibit 24: How do subsequent monitoring violation rates compare among systems with previous MCL violations?

	Number of Systems	Number of Systems With MCL in Previous Year	Percent
Systems with M&R Violation in 2003	21,282	1,460	6.9%
Systems w/o M&R in 2003	139,919	5,580	4.0%
Total	161,201	7,040	4.4%

Of the 21,282 systems that incurred at least 1 Monitoring & Reporting violation in 2003, 1,460 (6.9%) had at least 1 MCL violation in the previous year (2002). Of the 139,919 systems that did not have a Monitoring & Reporting violation in 2003, 5,580 had an MCL violation in the previous year, a rate of 4.0%. Based on this analysis, systems with at least 1 Monitoring & Reporting violation in 2003 had a higher rate of previous MCL violation in 2002, 6.9% vs. 4.0%. Expressing it another way, systems with a Monitoring & Reporting violation in 2003 made up 13.2% of all systems, but had 20.7% of the MCL violations in the previous year. These data show that it is 1.72 times as likely to observe a Monitoring & Reporting violation in a system that had an MCL violation the previous year than in a system without an MCL violation in the previous year with the 95% confidence interval of the odds ratio as follows:

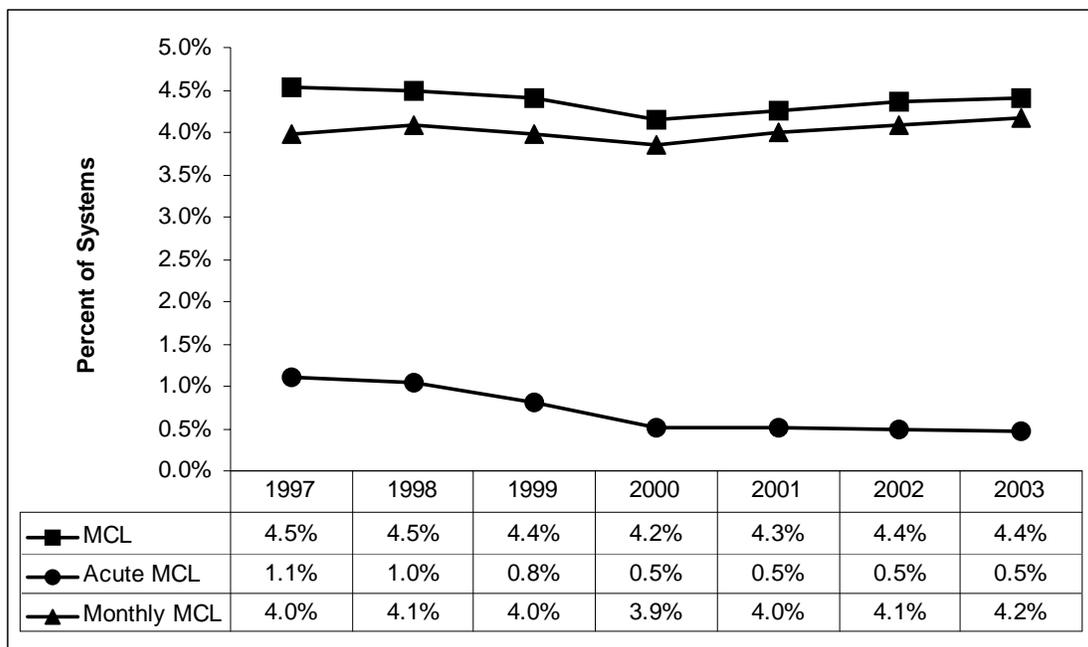
$$RR\left(\frac{MCL\ violation}{No\ MCL\ violation}\right) = [1.638, 1.801]$$

The difference in rates of previous MCL violation may indicate the extent to which systems could be incurring a Monitoring & Reporting violation instead of an MCL violation. It is important to note that the vast majority (93%) of systems with a Monitoring & Reporting violation in 2003 did not have an MCL violation in the previous year.

10. Analysis of TCR Violations Over Time

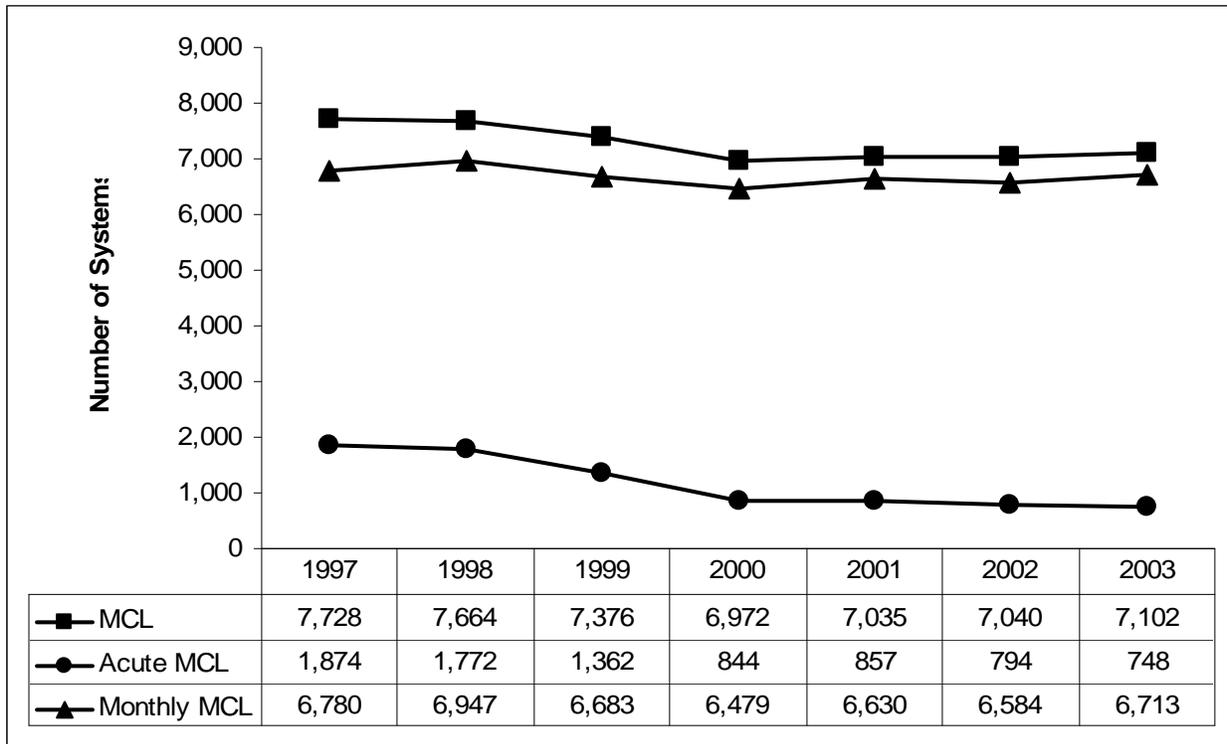
This section provides analysis of percent of systems with TCR violations and the number of systems with TCR violations each year over the period of 1997 to 2003. Exhibit 25 contains information on the percent of systems incurring MCL violations over the time period and Exhibit 26 presents the number of systems incurring MCL violations. Exhibit 27 contains information on the percent of systems incurring Monitoring & Reporting violations over the time period and Exhibit 28 presents the number of systems incurring Monitoring & Reporting violations. Appendices D-I contain information broken down by size, type, and source water over time.

Exhibit 25: Percent of Systems Incurring TCR MCL Violations from 1997 to 2003



Over the period of 1997 to 2003, the fraction of systems reporting a TCR MCL violation has remained relatively steady for overall MCL violations (i.e., either an Acute MCL or a monthly MCL violation). The percent of systems experiencing an Acute MCL violation has decreased by over half from 1.1% in 1997 to 0.5% in 2003. The fraction of systems incurring Monthly MCL violations has increased, although very slightly from 4.0% to 4.2%. For all three MCL violations, the lowest percent of systems incurring a violation occurred in the year 2000.

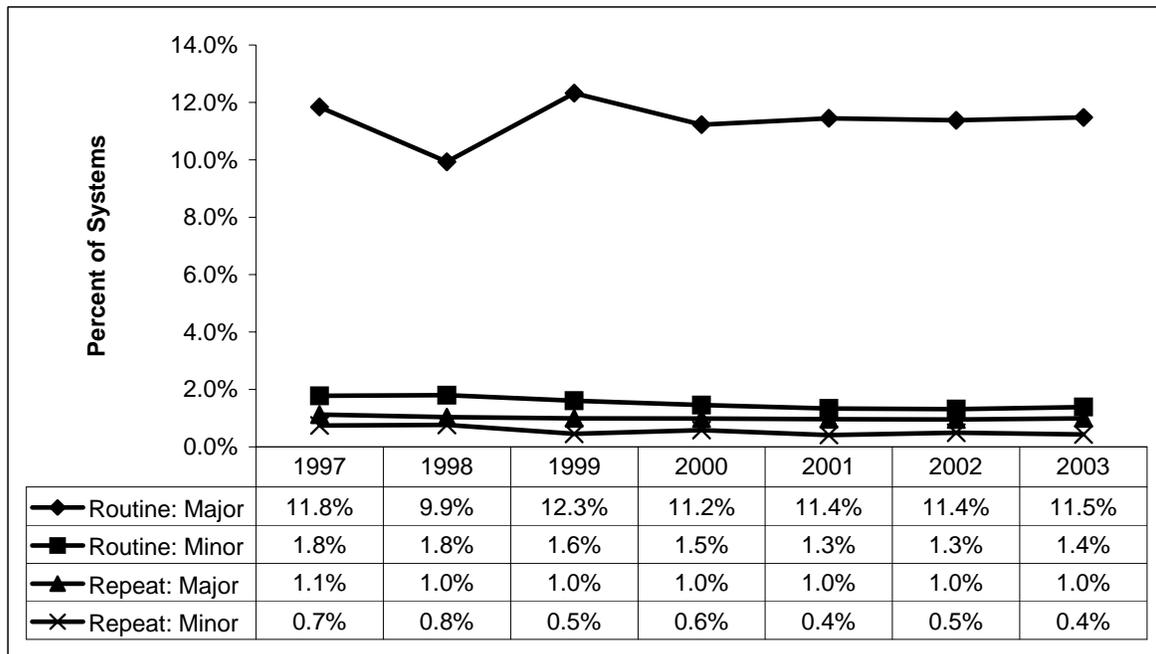
Exhibit 26: Number of Systems Incurring TCR MCL Violations from 1997 to 2003



Note: The total number of systems has decreased over time.

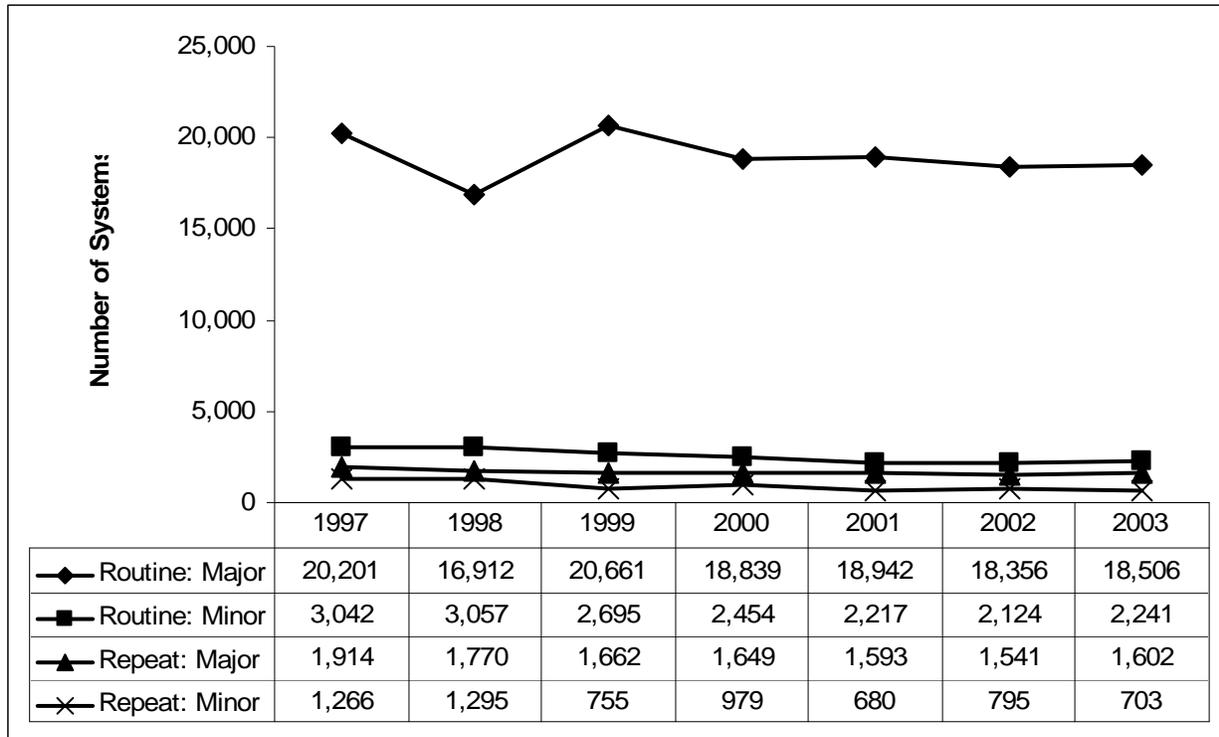
Over the period of 1997 to 2003, number of systems experiencing an Acute MCL violation has steadily declined in each year, with the number of systems with an Acute MCL in 2003 less than half of the number of systems in 1997. The number of systems incurring Monthly MCL violations has remained relatively steady, with slight year to year changes (+ or - 4%).

Exhibit 27: Percent of Systems with TCR Monitoring & Reporting Violations from 1997 to 2003



The percent of systems incurring Routine: Major Monitoring & Reporting violations did not change to a great extent from 1997 to 2003 (11.8% vs. 11.5%), but did decrease substantially in 1998 and rebound in 1999 before stabilizing. The percent of systems with Routine: Minor Monitoring & Reporting violations decreased slightly from 1997 (1.8%) to 2003 (1.4%). The percent of systems with Repeat: Major Monitoring & Reporting violations remained steady over the time period, while the percent with Repeat: Minor Monitoring & Reporting decreased overall, with a small increase in 1998.

Exhibit 28: Number of Systems with TCR Monitoring & Reporting Violations from 1997 to 2003



Note: The total number of systems has decreased over time.

The number of systems incurring Routine: Major Monitoring & Reporting violations did not change to a great extent from 1997 to 2003, but did decrease substantially in 1998 and rebound in 1999 before stabilizing. The number of systems with Routine: Minor Monitoring & Reporting violations decreased from 1997 to 2003. The number of systems with Repeat: Major Monitoring & Reporting violations decreased slightly over the time period, while the number with Repeat: Minor Monitoring & Reporting decreased overall, although with increases and decreases from year to year.

An observed overall tendency does not necessarily represent the tendency for each specific category of systems. For example, the percent of systems serving fewer than 100 incurring an Acute MCL violation is observed to decrease over time, while the percent of systems serving greater than 100,000 incurring an Acute MCL violation seems to remain steady between 1997 and 2003.

When an overall tendency was not observed, it was still possible that specific categories of systems may have observable tendencies. For example, the percent of GU and SW systems with a monthly MCL violation decreased, but the percent of GW systems with a monthly MCL violation increased slightly. In this case, the two opposing trends negate one another, resulting in

an net result of no overall change. To examine how well overall trends represent the individual trends for each category of systems, the following table summarizes overall trends in comparison with individual trends for each TCR violation type. This table does not reflect changes from year to year, which can show some variation. Especially for categories with few systems, very small differences in the number of violations may result in wider and inconsistent variations in the rate of violations from year to year. These year to year variations can be observed from the detailed data in the appendices.

Exhibit 29: Observed Overall Change in Violation Rate from 1997 to 2003
(+ indicates an increase, - indicates a decrease)

	TCR MCL Violations			TCR Monitoring & Reporting Violations			
	MCL: Total	MCL: Acute	MCL: Monthly	Routine: Major	Routine: Minor	Repeat: Major	Repeat: Minor
Overall Trend (Change from 1997 to 2003)	-	-	+	-	-	-	-
By System Size							
<=100	+	-	+	+	-	+	-
101-500	-	-	-	-	-	-	-
501-1,000	-	-	-	-	-	-	-
1,001-3,300	-	-	-	-	-	-	-
3,301-10,000	-	-	-	-	-	+	-
10,001-50,000	-	-	-	-	-	-	-
50,001-100,000	-	-	-	-	-	-	-
>100,000	-	-	-	-	-	+	-
By System Type							
CWS	-	-	-	-	-	-	-
NTNCWS	+	-	+	-	-	+	-
TNCWS	+	-	+	+	-	+	-
By Source Water							
GU	-	-	-	-	-	-	-
GW	+	-	+	-	-	-	-
SW	-	-	-	-	-	-	-

Acute MCL Violations:

The percent of systems experiencing an Acute MCL violation decreased by over half from 1.1% in 1997 to 0.5% in 2003. When examining individual trends for each size class, the percent of systems with violations decreased over time, except for the largest size class. In the largest size class (>100,000), Acute MCL violations remained relatively steady (1.2% in 1997 and 1.1% in 2003). Because of the relatively small number of systems in this size class and the relatively infrequent incurrence of Acute MCL violations, very small differences in the number of violations from year to year may result in wider and inconsistent variations in the rate of violations. The percent of systems with violations for all system types and water sources decreased with time.

Monthly MCL Violations:

The fraction of systems incurring Monthly MCL violations has increased, although very slightly from 4.0% to 4.2%. Not all types of systems follow this slight increasing trend. For example, the percent of medium and large systems (501-50,000 and >100,000) with violations

showed an overall decrease over time. Monthly MCL violations decreased for CWS whereas violations increased for NTNCWS and TNCWS. The percent of systems with monthly MCL violations decreased for GU and SW, but increased for GW.

Routine: Major Monitoring & Reporting

The percent of systems incurring routine major violations did not change to a great extent from 1997 to 2003 (11.8% vs. 11.5%). The percent of systems with violations decreased for all size classes in 1998, except for the (50,001-100,000) system, which followed the opposite pattern by substantially increasing in 1998 and decreasing in 1999. There was an overall decrease in the percent of systems with routine major violations for moderately small and medium sized systems (101-3,330) and for the two largest system categories (>50,001). The percent of CWS and NTNCWS systems with routine major violations decreased while the percent of TNCWS systems with violations increased. The percent of GU and SW systems with violations decreased substantially from 1997-2003, with the percent of GW systems also decreasing but by a small amount.

Routine: Minor Monitoring & Reporting

The percent of systems with Routine: Minor Monitoring & Reporting violations significantly decreased from 1997 (1.8%) to 2003 (1.4%). All categories of systems follow this overall decreasing trend between 1997 and 2003 (although the trend does not necessarily hold true for every year over this period).

Repeat: Major Monitoring & Reporting

The percent of systems with Repeat: Major Monitoring & Reporting violations remained steady over the time period. There was a slight decrease for moderately small-medium systems (101-3,330) and the largest systems (>100,000). The percent of systems with violations decreased for CWS and slightly increased for TNCWS. The percent of GU and SW systems with violations decreased. The percent of GW systems also decreased, but only by a small amount.

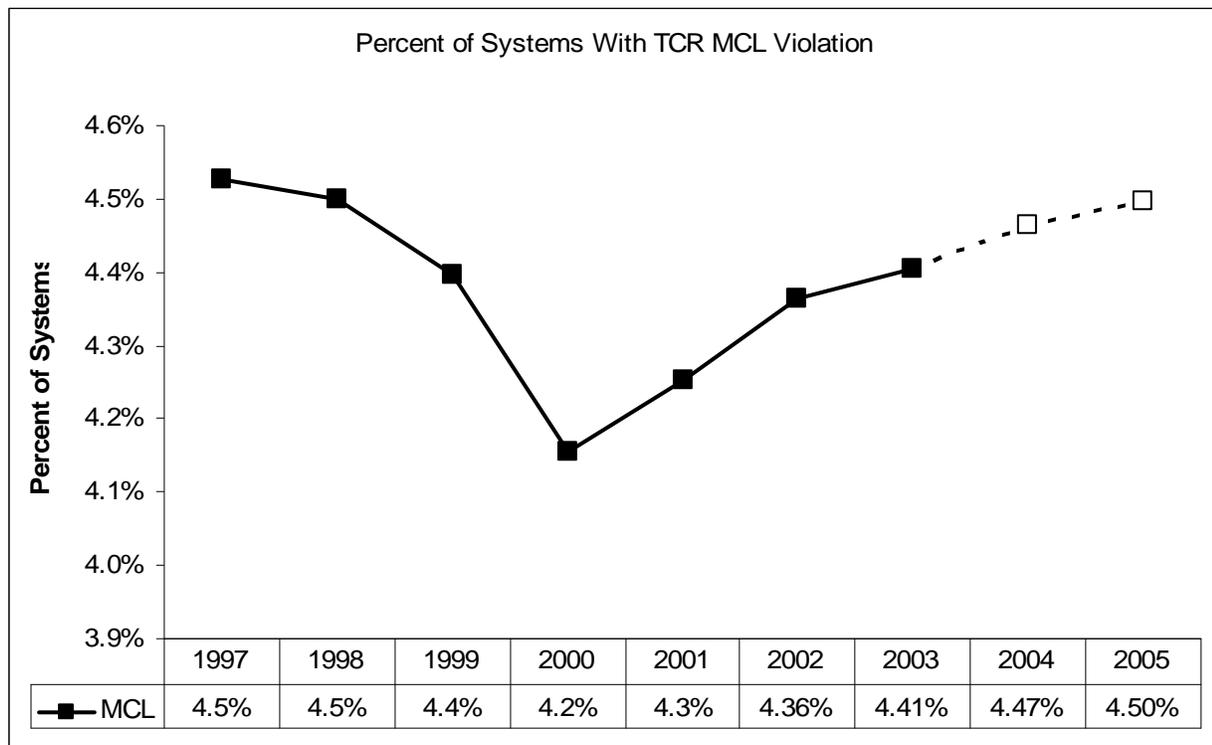
Repeat: Minor Monitoring & Reporting

The percent of systems with Repeat: Minor Monitoring & Reporting violations significantly decreased overall, with an increase in 1998. All categories of systems followed this overall decrease, although some system categories decreased more than others. Largest decreases were seen in CWS, GU, 50,001-100,000 and 3,301-10,000 categories.

11. More Recent TCR Violation Data

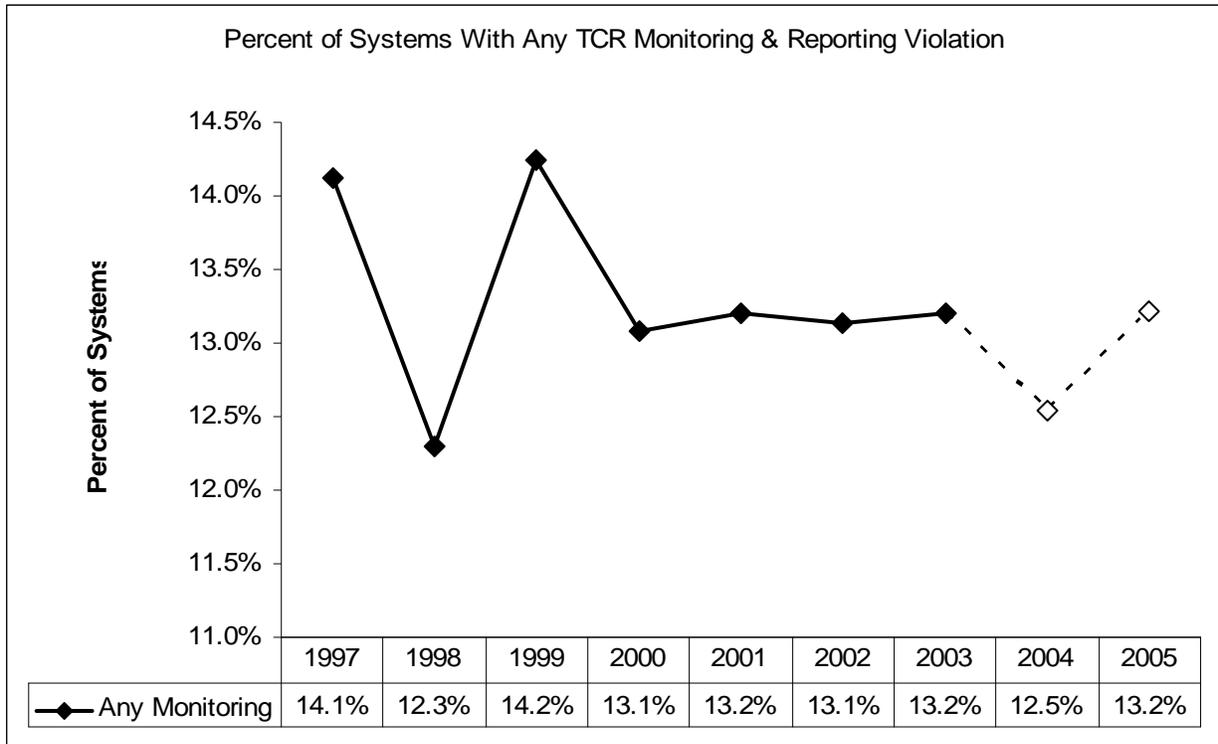
The SDWIS data used for the analyses detailed in this paper originated from a January 2004 data query and contained information on violations through Fiscal Year 2003. Additional data is now available that covers Fiscal Year 2004 and 2005. The following exhibits display the overall violation rates for MCL, Monthly, Acute and Monitoring & Reporting violations for FY 2004 and 2005.

Exhibit 30: Recent Observations in TCR MCL Violations Data (FY 2004 & 2005)



The percent of systems with a TCR MCL violation continued a slight upward trend during 2004 and 2005 (from 4.41% in 2003 to 4.47% in 2004 to 4.50% in 2005).

Exhibit 31: Recent Observations in TCR Monitoring & Reporting Violations Data (FY 2004 & 2005)



The percent of systems with TCR Monitoring & Reporting violations decreased from 2003 to 2004 (13.2% to 12.5%) and then rebounded back to 2003 levels in 2005.

12. Analysis of TCR Violations by Treatment Technology

SDWIS contains a data field that identifies the treatment technology used at a system, including whether a disinfection treatment is applied. As part of this paper, consideration was given to comparing TCR violation rates of disinfecting systems with those where no disinfection treatment(s) were applied. The treatment data was not consistently reported or of adequate quality for this analysis.

13. Analysis of TCR Violations by Season

An analysis of variations in TCR violations across seasons was conducted. To ensure consistency across this report, analysis of seasonal variability has been conducted on data from FY 1997 - FY 2003. Analysis has also been limited to Acute MCL violations as these pose the greatest health risk. Exhibit 32 depicts the total number of Acute MCL Violations reported by month of the year (for All PWSs).

Exhibit 32: Total Number of Acute MCL Violations By Month, 1997-2003

Month	Acute MCL
January	1,160
February	495
March	383
April	1,515
May	559
June	758
July	2,800
August	947
September	744
October	2,152
November	603
December	520

It can be noted that there are high numbers of violations in months January, April, July, and October. These spikes are attributed to PWSs that are on quarterly or annual monitoring & reporting. However, there is no EPA requirement pertaining to which month a quarter must commence with (e.g. a quarter in some state may commence in February even though most states appear to use the standard January, April, July, and October as the beginning months).

While it does appear that in the warmer months there are more Acute MCL violations reported than in the cooler months, sufficient analysis has not been completed to confirm these conclusions. For example, during the summer months many “vacation” communities increase the number of samples required (and may increase Monitoring & Reporting to monthly rather than quarterly) to account for those seasonal fluctuations; increasing sampling frequency and number of samples increase the “opportunity” to have a TCR Acute MCL Violation. So the fact that there are more violations reported may be attributed to the warmer weather which creates better opportunity for those violations to occur, or it may be attributed to more frequent Monitoring & Reporting which may create more opportunities for the violations to be discovered.

Exhibit 33 categorized these violations by PWS Type.

Exhibit 33: Number of Acute MCL Violations By Month and System Type, 1997-2003

Month	CWS	NTNCWS	TNCWS
January	398	128	634
February	373	47	75
March	272	37	74
April	313	155	1,047
May	345	50	164
June	415	56	287
July	632	310	1,857
August	595	85	267
September	465	76	203
October	616	287	1,248
November	438	60	105
December	357	65	98

Looking exclusively at CWSs, and not including the months of January, April, July, and October (because of the mix of Quarterly and Monthly Monitoring & Reporting variability); it appears that in the warmest months the greatest number of violations are incurred, with August and September having the greatest number of Acute MCL violations reported.

Exhibit 34 provides information on the percent of violations that occur with the months grouped into four seasons: Winter includes December, January, and February; Spring includes March, April, and May; Summer includes June, July, and August; and Fall includes September, October, and December.

Exhibit 34: Percent of Acute MCL Violations By Season and System Type, 1997-2003

Season	CWS	NTNCWS	TNCWS
Winter (Dec, Jan, Feb)	21.6%	17.7%	13.3%
Spring (Mar, Apr, May)	17.8%	17.8%	21.2%
Summer (Jun, Jul, Aug)	31.5%	33.3%	39.8%
Fall (Sep, Oct, Nov)	29.1%	31.2%	25.7%

For all types of systems, the greatest percentage of Acute MCL violations occur during the Summer season. The second most violations occur in the Fall, with only a few percentage points difference between Summer and Fall for CWSs and NTNCWSs, with a larger difference for TNCWSs. For CWSs, the season with the lowest percent of violations is Spring, while the

season with the lowest percent of violations is Winter for NTNCWSs and TNCWSs. With regards to TNCWSs, the high occurrence of violations in the Summer season may be related to increased use of facilities and increased frequency of testing during this season.

14. Analysis of TCR Violations Associated with Outbreak Events

Another question of interest is whether systems that experience reported waterborne disease outbreaks also experience TCR violations. The analysis of this question is limited by the relatively small number of waterborne disease outbreaks and, more importantly, the inability to determine the public water system involved in an outbreak given currently available information on the outbreaks. Annual published reports on waterborne disease outbreaks include only the State in which the outbreak occurred, but do not identify the town or water system (see for example CDC, 2002). Without this information, we are unable to match the outbreak incidence with corresponding TCR violations data for all but a handful of outbreaks and systems.

Through secondary sources such as incidence investigation reports and media reports, we were able to identify the public water systems associated with 10 waterborne disease outbreaks – 4 related to distribution system causes and 6 related to other causes (such as source water contamination or treatment failure). Exhibit 35 presents a summary of the outbreaks and the TCR violations for those public water systems. None of the 4 systems with a distribution system outbreak had a TCR MCL violation around the time of the outbreak. One of the systems does not have any reported TCR violations; one has only minor reporting violations (although several of them); one has a bacteria violation pre-dating the TCR; and one system has 2 consecutive Monthly MCL violations and a major Monitoring & Reporting violation several years after the outbreak. It is important to note that it is uncertain when and where these systems take their total coliform samples. Sampling may have taken place in areas of the distribution system that weren't impacted by a contamination event.

A further discussion of the detection of total coliforms during outbreak investigations can be found in the paper: *Causes of Total Coliform-Positive Samples and Contamination Events in Distribution Systems*.

Exhibit 35: Summary of Outbreak and TCR Violation Information for Select Systems

Date	State	System ID	System Name	Outbreak Description	TCR Violations
Oct-84	MO	MO3024084	Callaway Co PWSID #1	The suspected cause of the outbreak was sewage contaminated public drinking water supplied to an airport and a nearby national guard facility. Subsequent sampling indicated coliforms in the part of the distribution system serving the airport and national guard facility. Of the 119 persons interviewed, 107 experienced gastrointestinal symptoms. Inspection of the distribution system found 23 cross connections between the water distribution system and sewage sources. (Source: Missouri Division of Health, 1984)	The only violation found occurred prior to the existing TCR in 1989: a bacteria Monitoring & Reporting violation for the period of 2/1/1989 - 2/28/1989.
Sep-95	WI	WI4360364	Manitowoc Waterworks	The suspected cause of the outbreak was the backsiphonage of contaminated water through a hose at a high school. Subsequent sampling did not indicate the presence of coliforms, perhaps because the time delay in taking samples allowed the chlorine residual to cleanse the system. Approximately 100 persons experienced gastrointestinal symptoms. The outbreak was caused by a virus (probably calicivirus). (Source: Haupt, 1996)	This system does not have any TCR violations in the database.
May-94	TN	TN0000479	Mountain City Water Department	The suspected cause of the outbreak was a cross-connection between waste water and potable water. The presence of high levels of <i>Giardia</i> was detected in concurrent samples. Approximately 300 persons experienced diarrhea. (Source: Sterling, et al., 1994)	The system incurred Routine: Minor TCR Monitoring & Reporting violations for the period of: 11/1/89 - 11/30/89; 12/1/89 - 12/31/89; and 10/1/91-10/31/91.
Dec-93	MO	MO4010304	Gideon	The suspected cause of the outbreak was bird contamination in a storage tank. Fecal coliforms were detected in samples taken shortly after the outbreak. Approximately 1100 residents were affected by gastroenteritis caused by <i>S. typhimurium</i> . Seven residents of a nursing home died. (Source: Clark, et al., 1996).	This system incurred Monthly MCL violation for the period of: 1/1/03-1/31/03; 12/1/02-12/31/02; and a Routine: Major Monitoring & Reporting violation for the period of 8/1/98-8/31/98.

15. TCR Sanitary Survey Violations

Another type of violation under the TCR is a violation associated with the failure to conduct the required sanitary survey. There is little data in SDWIS on Sanitary Survey TCR violations (type 27). The data has only been reported in FY 2003 and only by a few (13) states, totaling 90 Sanitary Survey violations. Moreover, some PWS have many TCR Sanitary Survey Violations during the same year, thus raising further questions about the reliability, representativeness, and value of the data (Exhibit 36). Therefore, this type of violation will not be addressed further in this paper.

Exhibit 36: TCR Sanitary Survey Violations, 2003

Number of Violations Per System	Number of Systems
1	33
2	15
3	2
4	1
7	1
10	1

16. Small System Issues

In general, small systems incur the greatest number of all types of violations, largely because there are a greater number of small systems. As a percent of systems, however, small systems do not incur MCL violations more frequently than other systems. In fact, the greatest frequency seems to be in large systems for Acute MCL violations and medium systems for Monthly MCL violations.

By contrast, small systems incur Monitoring & Reporting violations at a much greater frequency. Small systems incur the most Routine: Major Monitoring & Reporting violations, both in terms of the total number of violations and the percent of systems incurring violations. For example, in 2003, systems in the smallest size category (≤ 100) account for 67% of these violations but only comprise 56% of systems. Close to 1 in 7 (14%) of systems in the smallest size category incur Routine: Major Monitoring & Reporting violations, by far the highest frequency for any of the violations and size categories. In the next smallest size category (101-500), 10.8% (1 in 10) systems incur Routine: Major Monitoring & Reporting violations. In contrast, only 1.5% of the systems in the 50,001-100,000 incur these violations. With respect to the Routine: Major Monitoring & Reporting violations, there is a relatively consistent trend across the system size categories of a greater frequency of violation for smaller system sizes.

See Appendices G – J for numbers and frequencies of Monitoring and Reporting Violations.

17. Summary

This paper presents data on the number of systems with the different types of TCR violations, the number of TCR violations, the average number of TCR violations per system, and the percent of systems with TCR violations for the time period of 1997 to 2003. Overall, Routine: Major Monitoring & Reporting violations occur the most frequently by far – with one in every 9 systems (11.5%) incurring a Routine: Major Monitoring & Reporting violation in 2003. By contrast, only 4.2% of systems incurred a Monthly MCL violation and only 0.5% incurred an Acute MCL violation in 2003. The paper then compares the percent of systems with violations across system size categories, systems types, and source waters, and over time.

The data on TCR violations presented in this paper can serve as a foundation for further analysis and research. For example, while this paper presents comparisons of violations across system sizes, categories, and sources, no attempt is made to explain reasons for any differences. Next steps could include research on the impact of factors such as water quality, system performance, and Monitoring & Reporting practices to explain the implications of differences in violation rates.

Exhibit 37: Summary of Statistically Significant Relationships

TCR Total and Monthly MCL Violations
<ul style="list-style-type: none"> • Middle size classes (3,301-50,000) have a violation rate greater than other size classes. • Larger size classes (>50,001) have a violation rate less than other size classes. • CWSs have a violation rate greater than other system types. • TNCWSs have a violation rate less than other system types. • Systems using SW have a violation rate less than other water sources.
TCR Acute MCL Violations
<ul style="list-style-type: none"> • Smaller size classes (101-500) have a violation rate greater than other size classes. • Middle size classes (1,001-10,000) have a violation rate less than other size classes. • Systems using GU and SW have a violation rate greater than other water sources. • Systems using GW have a violation rate less than other water sources.
Routine: Major Monitoring & Reporting Violations
<ul style="list-style-type: none"> • Smallest size class (<100) has a violation rate greater than other size classes. • Middle and large size classes (>501) have a violation rate less than other size classes. • CWSs have a violation rate less than other system types. • TNCWSs have a violation rate greater than other system types. • GU systems have a violation rate greater than SW sources. • SW systems have a violation rate less than other water sources.
Routine: Minor Monitoring & Reporting Violations
<ul style="list-style-type: none"> • Smallest size class (<100) has a violation rate less than other size classes. • CWS have a violation rate greater than other system types. . • GU systems have a violation rate greater than other water sources. • GW systems have a violation rate less than other water sources.
Repeat: Major Monitoring & Reporting Violations
<ul style="list-style-type: none"> • Smallest size class (<100) has a violation rate greater than other size classes. • Middle and large size classes (>501) have a violation rate less than other size classes. • GU systems have a violation rate greater than other water sources. • SW systems have a violation rate less than other water sources.
Repeat: Minor Monitoring & Reporting Violations
<ul style="list-style-type: none"> • Smallest size class (<100) has a violation rate less than other size classes. • CWS have a violation rate greater than other system types. • GU systems have a violation rate greater than other water sources. • GW systems have a violation rate less than other water sources.

REFERENCES

Clark, et al., *A Waterborne Salmonella typhimurium Outbreak in Gideon, Missouri: Results from a Field Investigation*, International Journal of Environmental Health Research, 1996, 6: 187-193.

Federal Register 54 FR 27544-27568

Federal Register 68 FR 19030

Federal Register 68 FR 42907

Haupt, Thomas, *Gastrointestinal Illness at Roncalli High School, Manitowoc, WI, September 1995*, Communicable Disease Epidemiology Unit, Memorandum dated 7/24/96.

Missouri Division of Health, *Water-borne Gastrointestinal Illness in Callaway County*, 1984.

Sterling, et al., *A Public Health Laboratory's Handling of a Parasitic Outbreak*, Tennessee Department of Health, Nashville, TN, 1994.

U.S. Environmental Protection Agency, June 2001, Office of Water, *A Small Systems Guide to the Total Coliform Rule: Monitoring & Reporting Drinking Water to Protect Public Health*, EPA 816-R-02-017A.

U.S. Environmental Protection Agency, February 2002, Office of Water, *Drinking Water Academy: Total Coliform Rule*.

U.S. Environmental Protection Agency, November 2001, Office of Water, *Total Coliform Rule: A Quick Reference Guide*, EPA 816-F-01-035.

U.S. Environmental Protection Agency, October 1998, Office of Water, *Information Available from the Safe Drinking Water Information System*, EPA 816-F-98-006.

U.S. Environmental Protection Agency, March 2004, Office of Water, *Drinking Water Data Reliability Analysis and Action Plan (2003): For State Reported Public Water System Data in the EPA Safe Drinking Water Information System/Federal Version (SDWIS/FED)*, EPA 816-R-03-021.

U.S. Environmental Protection Agency, October 2000, Office of Water, *Data Reliability Analysis of the EPA Safe Drinking Water Information System/Federal Version (SDWIS/FED)*, EPA 816-R-00-020.

APPENDIX A: TCR VIOLATIONS: AVERAGES FOR 1997-2003, BY SYSTEM SIZE

	MCL Violations			Monitoring & Reporting Violations			
	Total	Acute	Monthly	Routine		Repeat	
				Major	Minor	Major	Minor
AVERAGE OF ANNUAL NUMBERS OF SYSTEMS WITH VIOLATIONS							
<=100	4,071	655	3,721	12,767	1,044	1,076	477
101-500	1,975	369	1,803	4,818	650	443	273
501-1,000	386	68	359	752	152	59	60
1,001-3,300	419	47	399	447	395	50	56
3,301-10,000	239	20	230	92	188	24	28
10,001-50,000	166	14	161	32	104	17	20
50,001-100,000	11	3	9	7	11	2	4
>100,000	7	3	5	4	4	4	5
All Sizes	7,274	1,179	6,688	18,917	2,547	1,676	925
AVERAGE OF ANNUAL NUMBERS OF VIOLATIONS							
<=100	5,335	792	4,543	21,111	1,240	1,226	530
101-500	2,854	557	2,298	8,014	799	510	307
501-1,000	577	110	467	1,165	186	64	67
1,001-3,300	574	65	508	646	534	53	68
3,301-10,000	298	23	275	120	246	26	32
10,001-50,000	216	14	202	42	127	18	25
50,001-100,000	14	3	10	8	13	3	6
>100,000	10	3	6	5	5	4	10
All Sizes	9,878	1,568	8,310	31,112	3,151	1,904	1,045
AVERAGE OF ANNUAL NUMBERS OF VIOLATIONS PER SYSTEM							
<=100	0.056	0.008	0.048	0.185	0.018	0.012	0.006
101-500	0.066	0.013	0.053	0.116	0.019	0.006	0.007
501-1,000	0.058	0.011	0.047	0.067	0.055	0.006	0.007
1,001-3,300	0.059	0.007	0.053	0.026	0.053	0.005	0.007
3,301-10,000	0.064	0.005	0.059	0.014	0.043	0.006	0.007
10,001-50,000	0.072	0.005	0.068	0.017	0.029	0.006	0.008
50,001-100,000	0.031	0.007	0.023	0.015	0.014	0.012	0.014
>100,000	0.027	0.010	0.017	0.187	0.019	0.011	0.028
All Sizes	0.059	0.009	0.050	0.187	0.019	0.011	0.006
AVERAGE OF ANNUAL PERCENTAGE OF SYSTEMS WITH VIOLATIONS							
<=100	4.3%	0.7%	3.9%	13.5%	1.1%	1.1%	0.5%
101-500	4.5%	0.8%	4.2%	11.1%	1.5%	1.0%	0.6%
501-1,000	3.9%	0.7%	3.6%	7.5%	1.5%	0.6%	0.6%
1,001-3,300	4.3%	0.5%	4.1%	4.6%	4.1%	0.5%	0.6%
3,301-10,000	5.1%	0.4%	4.9%	2.0%	4.0%	0.5%	0.6%
10,001-50,000	5.6%	0.5%	5.4%	1.1%	3.5%	0.6%	0.7%
50,001-100,000	2.4%	0.7%	2.0%	1.5%	2.3%	0.5%	1.0%
>100,000	1.9%	0.8%	1.4%	1.0%	1.1%	1.0%	1.5%
All Sizes	4.4%	0.7%	4.0%	11.4%	1.5%	1.0%	0.6%

APPENDIX B: TCR VIOLATIONS: AVERAGES FOR 1997-2003, BY SYSTEM TYPE

	MCL Violations			Monitoring & Reporting Violations			
	Total	Acute	Monthly	Routine		Repeat	
				Major	Minor	Major	Minor
AVERAGE OF ANNUAL NUMBERS OF SYSTEMS WITH VIOLATIONS							
CWS	2,787	393	2,606	4,292	1,504	592	413
NTNCWS	876	147	806	2,110	207	137	93
TNCWS	3,611	639	3,276	12,515	837	947	418
All Types	4,243	1,179	6,688	18,917	2,547	1,676	925
AVERAGE OF ANNUAL NUMBERS OF VIOLATIONS							
CWS	4,109	651	3,458	8,460	1,918	700	477
NTNCWS	1,172	168	1,004	2,934	253	148	106
TNCWS	4,596	749	3,848	19,718	980	1,056	461
All Types	9,878	1,568	8,310	31,112	3,151	1,904	1,045
AVERAGE OF ANNUAL NUMBER OF VIOLATIONS PER SYSTEM							
CWS	0.076	0.012	0.064	0.157	0.036	0.013	0.009
NTNCWS	0.059	0.008	0.050	0.147	0.013	0.007	0.005
TNCWS	0.050	0.008	0.042	0.214	0.011	0.011	0.005
All Types	0.059	0.009	0.050	0.187	0.019	0.011	0.006
AVERAGE OF ANNUAL PERCENTAGE OF SYSTEMS WITH VIOLATIONS							
CWS	5.2%	0.7%	4.8%	7.9%	2.8%	1.1%	0.8%
NTNCWS	4.4%	0.7%	4.0%	10.6%	1.0%	0.7%	0.5%
TNCWS	3.9%	0.7%	3.5%	13.6%	0.9%	1.0%	0.5%
All Types	4.4%	0.7%	4.0%	11.4%	1.5%	1.0%	0.6%

APPENDIX C: TCR VIOLATIONS: AVERAGES FOR 1997-2003, BY SOURCE WATER

	MCL Violations			Monitoring & Reporting Violations			
	Total	Acute	Monthly	Routine		Repeat	
				Major	Minor	Major	Minor
AVERAGE OF ANNUAL NUMBERS OF SYSTEMS WITH VIOLATIONS							
GU	65	28	50	176	46	29	30
GW	6,739	976	6,276	17,792	2,066	1,558	814
SW	469	174	361	949	434	89	80
All Source Types	7,274	1,179	6,688	18,917	2,547	1,676	925
AVERAGE OF ANNUAL NUMBERS OF VIOLATIONS							
GU	101	37	64	370	63	36	40
GW	8,902	1,166	7,736	28,555	2,500	1,751	908
SW	873	365	509	2,187	588	117	97
All Source Types	9,878	1,568	8,310	31,112	3,151	1,904	1,045
AVERAGE OF ANNUAL NUMBER OF VIOLATIONS PER SYSTEM							
GU	0.167	0.025	0.100	0.566	0.095	0.058	0.069
GW	0.058	0.027	0.051	0.188	0.016	0.011	0.006
SW	0.066	0.009	0.038	0.163	0.044	0.009	0.007
All Source Types	0.059	0.009	0.050	0.187	0.019	0.011	0.006
AVERAGE OF ANNUAL PERCENTAGE OF SYSTEMS WITH VIOLATIONS							
GU	10.6%	4.9%	8.0%	27.6%	7.2%	4.6%	5.2%
GW	4.4%	0.6%	4.1%	11.7%	1.4%	1.0%	0.5%
SW	3.5%	1.3%	2.7%	7.1%	3.3%	0.7%	0.6%
All Source Types	4.4%	0.7%	4.0%	11.4%	1.5%	1.0%	0.6%

APPENDIX D

TCR MCL VIOLATIONS OVER TIME, BY PARAMETER

Exhibit D-1: TCR MCL Violations by System Size: 1997 - 2003

Number of Systems With TCR MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	4,278	4,215	4,144	3,923	3,914	3,952	4,072	28,498
101-500	2,061	2,165	2,049	1,893	1,896	1,890	1,869	13,823
501-1,000	413	389	410	363	403	388	338	2,704
1,001-3,300	477	456	386	397	421	409	386	2,932
3,301-10,000	274	242	214	233	235	221	252	1,671
10,001-50,000	196	178	153	145	155	173	165	1,165
50,001-100,000	19	14	10	9	6	5	14	77
>100,000	10	5	10	9	5	2	6	47
TOTALS	7,728	7,664	7,376	6,972	7,035	7,040	7,102	50,917

Number of TCR MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	5,721	5,858	5,433	4,900	5,150	5,106	5,177	37,345
101-500	3,075	3,549	3,145	2,544	2,782	2,453	2,433	19,981
501-1,000	626	668	671	503	630	510	434	4,042
1,001-3,300	650	675	558	549	569	536	479	4,016
3,301-10,000	345	299	292	283	296	280	289	2,084
10,001-50,000	268	242	203	187	201	207	204	1,512
50,001-100,000	22	18	16	9	9	7	15	96
>100,000	12	8	17	11	7	2	10	67
TOTALS	10,719	11,317	10,335	8,986	9,644	9,101	9,041	69,143

Average Number of TCR MCL Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.058	0.059	0.056	0.051	0.055	0.057	0.058	0.056
101-500	0.071	0.081	0.072	0.058	0.064	0.057	0.057	0.066
501-1,000	0.063	0.067	0.067	0.050	0.063	0.051	0.043	0.058
1,001-3,300	0.067	0.070	0.058	0.057	0.059	0.055	0.049	0.059
3,301-10,000	0.075	0.065	0.063	0.060	0.063	0.058	0.059	0.064
10,001-50,000	0.092	0.083	0.069	0.062	0.066	0.069	0.066	0.072
50,001-100,000	0.052	0.040	0.036	0.019	0.019	0.016	0.032	0.031
>100,000	0.035	0.023	0.047	0.031	0.020	0.005	0.027	0.027
TOTALS	0.063	0.066	0.062	0.054	0.058	0.056	0.056	0.059

Percent of Systems With TCR MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	4.3%	4.3%	4.3%	4.1%	4.2%	4.4%	4.5%	4.3%
101-500	4.7%	4.9%	4.7%	4.3%	4.4%	4.4%	4.4%	4.5%
501-1,000	4.2%	3.9%	4.1%	3.6%	4.0%	3.9%	3.4%	3.9%
1,001-3,300	4.9%	4.8%	4.0%	4.1%	4.3%	4.2%	4.0%	4.3%
3,301-10,000	6.0%	5.3%	4.6%	5.0%	5.0%	4.6%	5.2%	5.1%
10,001-50,000	6.7%	6.1%	5.2%	4.8%	5.1%	5.7%	5.4%	5.6%
50,001-100,000	4.5%	3.1%	2.3%	1.9%	1.3%	1.1%	2.9%	2.4%
>100,000	2.9%	1.4%	2.8%	2.5%	1.4%	0.5%	1.6%	1.9%
TOTALS	4.5%	4.5%	4.4%	4.2%	4.3%	4.4%	4.4%	4.4%

Exhibit D-2: Number and Frequency of TCR MCL Violations by System Type: 1997 - 2003

Number of Systems With TCR MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	3,142	3,217	2,850	2,714	2,696	2,515	2,378	19,512
NTNCWS	888	857	911	854	836	866	917	6,129
TNCWS	3,698	3,590	3,615	3,404	3,503	3,659	3,807	25,276
TOTALS	7,728	7,664	7,376	6,972	7,035	7,040	7,102	50,917

Number of TCR MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	4,611	5,185	4,500	3,783	4,157	3,402	3,127	28,765
NTNCWS	1,202	1,183	1,237	1,121	1,121	1,138	1,202	8,204
TNCWS	4,906	4,949	4,598	4,082	4,366	4,561	4,712	32,174
TOTALS	10,719	11,317	10,335	8,986	9,644	9,101	9,041	69,143

Average Number of TCR MCL Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.084	0.095	0.083	0.070	0.077	0.064	0.059	0.076
NTNCWS	0.060	0.058	0.062	0.055	0.056	0.061	0.061	0.059
TNCWS	0.051	0.052	0.049	0.044	0.048	0.051	0.053	0.050
TOTALS	0.063	0.066	0.062	0.054	0.058	0.056	0.056	0.059

Percent of Systems With TCR MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	5.7%	5.9%	5.3%	5.0%	5.0%	4.7%	4.5%	5.2%
NTNCWS	4.4%	4.2%	4.5%	4.2%	4.2%	4.6%	4.7%	4.4%
TNCWS	3.9%	3.7%	3.9%	3.7%	3.8%	4.1%	4.3%	3.9%
TOTALS	4.5%	4.5%	4.4%	4.2%	4.3%	4.4%	4.4%	4.4%

Exhibit D-3: Number and Frequency of TCR MCL Violations by Source: 1997 – 2003

Number of Systems With TCR MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	77	85	61	42	57	69	62	453
GW	7,097	7,016	6,773	6,462	6,578	6,576	6,669	47,171
SW	549	561	541	468	400	395	371	3,285
TOTALS	7,728	7,664	7,376	6,972	7,035	7,040	7,102	50,917

Number of TCR MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	119	147	101	58	93	94	95	707
GW	9,600	9,920	9,117	8,164	8,653	8,395	8,462	62,311
SW	992	1,248	1,116	764	898	612	484	6,114
TOTALS	10,719	11,317	10,335	8,986	9,644	9,101	9,041	69,143

Average Number of TCR MCL Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.295	0.306	0.198	0.097	0.097	0.089	0.088	0.167
GW	0.061	0.063	0.059	0.053	0.057	0.057	0.058	0.058
SW	0.075	0.095	0.087	0.056	0.065	0.045	0.035	0.066
TOTALS	0.063	0.066	0.062	0.054	0.058	0.056	0.056	0.059

Percent of Systems With TCR MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	19.1%	17.7%	12.0%	7.0%	5.9%	6.5%	5.7%	10.6%
GW	4.5%	4.5%	4.4%	4.2%	4.4%	4.5%	4.6%	4.4%
SW	4.1%	4.3%	4.2%	3.5%	2.9%	2.9%	2.7%	3.5%
TOTALS	4.5%	4.5%	4.4%	4.2%	4.3%	4.4%	4.4%	4.4%

APPENDIX E

TCR ACUTE MCL VIOLATIONS OVER TIME, BY PARAMETER

Exhibit E-1: TCR Acute MCL Violations by System Size: 1997 - 2003

Number of Systems With TCR Acute MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,106	987	725	433	427	471	434	4,583
101-500	545	581	441	284	305	212	215	2,583
501-1,000	107	93	90	53	54	47	34	478
1,001-3,300	59	67	57	42	41	37	27	330
3,301-10,000	23	18	32	19	13	17	16	138
10,001-50,000	20	21	12	6	12	9	16	96
50,001-100,000	10	2	2	2	3	1	2	22
>100,000	4	3	3	5	2	0	4	21
TOTALS	1,874	1,772	1,362	844	857	794	748	8,251

Number of TCR Acute MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,319	1,283	904	494	542	537	462	5,541
101-500	810	989	696	377	520	269	236	3,897
501-1,000	163	174	154	78	102	64	38	773
1,001-3,300	88	99	83	60	53	45	29	457
3,301-10,000	26	20	39	24	18	17	16	160
10,001-50,000	20	23	12	6	13	9	17	100
50,001-100,000	11	2	2	2	3	1	2	23
>100,000	4	3	5	5	3	0	4	24
TOTALS	2,441	2,593	1,895	1,046	1,254	942	804	10,975

Average Number of TCR Acute MCL Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.013	0.013	0.009	0.005	0.006	0.006	0.005	0.008
101-500	0.019	0.022	0.016	0.009	0.012	0.006	0.005	0.013
501-1,000	0.016	0.017	0.015	0.008	0.010	0.006	0.004	0.011
1,001-3,300	0.009	0.010	0.009	0.006	0.005	0.005	0.003	0.007
3,301-10,000	0.006	0.004	0.008	0.005	0.004	0.004	0.003	0.005
10,001-50,000	0.007	0.008	0.004	0.002	0.004	0.003	0.006	0.005
50,001-100,000	0.026	0.004	0.005	0.004	0.006	0.002	0.004	0.007
>100,000	0.012	0.009	0.014	0.014	0.008	0.000	0.011	0.010
TOTALS	0.014	0.015	0.011	0.006	0.008	0.006	0.005	0.009

Percent of Systems With TCR Acute MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	1.1%	1.0%	0.8%	0.5%	0.5%	0.5%	0.5%	0.7%
101-500	1.3%	1.3%	1.0%	0.6%	0.7%	0.5%	0.5%	0.8%
501-1,000	1.1%	0.9%	0.9%	0.5%	0.5%	0.5%	0.3%	0.7%
1,001-3,300	0.6%	0.7%	0.6%	0.4%	0.4%	0.4%	0.3%	0.5%
3,301-10,000	0.5%	0.4%	0.7%	0.4%	0.3%	0.4%	0.3%	0.4%
10,001-50,000	0.7%	0.7%	0.4%	0.2%	0.4%	0.3%	0.5%	0.5%
50,001-100,000	2.4%	0.4%	0.5%	0.4%	0.6%	0.2%	0.4%	0.7%
>100,000	1.2%	0.9%	0.8%	1.4%	0.6%	0.0%	1.1%	0.8%
TOTALS	1.1%	1.0%	0.8%	0.5%	0.5%	0.5%	0.5%	0.7%

**Exhibit E-2: Number and Frequency of TCR Acute MCL Violations by System Type:
1997 - 2003**

Number of Systems With TCR Acute MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	547	580	466	384	357	224	191	2,749
NTNCWS	203	208	199	115	96	105	104	1,030
TNCWS	1,124	984	697	345	404	465	453	4,472
TOTALS	1,874	1,772	1,362	844	857	794	748	8,251

Number of TCR Acute MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	874	1,096	850	530	698	310	202	4,560
NTNCWS	225	241	225	148	103	118	114	1,174
TNCWS	1,342	1,256	820	368	453	514	488	5,241
TOTALS	2,441	2,593	1,895	1,046	1,254	942	804	10,975

Average Number of TCR Acute MCL Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.016	0.020	0.016	0.010	0.013	0.006	0.004	0.012
NTNCWS	0.011	0.012	0.011	0.007	0.005	0.006	0.006	0.008
TNCWS	0.014	0.013	0.009	0.004	0.005	0.006	0.006	0.008
TOTALS	0.014	0.015	0.011	0.006	0.008	0.006	0.005	0.009

Percent of Systems With TCR Acute MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	1.0%	1.1%	0.9%	0.7%	0.7%	0.4%	0.4%	0.7%
NTNCWS	1.0%	1.0%	1.0%	0.6%	0.5%	0.6%	0.5%	0.7%
TNCWS	1.2%	1.0%	0.7%	0.4%	0.4%	0.5%	0.5%	0.7%
TOTALS	1.1%	1.0%	0.8%	0.5%	0.5%	0.5%	0.5%	0.7%

Exhibit E-3: Number and Frequency of TCR Acute MCL Violations by Source: 1997 - 2003

Number of Systems With TCR Acute MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	41	45	34	15	23	19	18	195
GW	1,615	1,480	1,072	632	686	685	664	6,834
SW	217	247	256	197	148	90	66	1,221
TOTALS	1,874	1,772	1,362	844	857	794	748	8,251

Number of TCR Acute MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	54	70	49	17	24	24	22	260
GW	1,941	1,920	1,315	704	837	742	703	8,162
SW	445	603	531	325	393	176	79	2,552
TOTALS	2,441	2,593	1,895	1,046	1,254	942	804	10,975

Average Number of TCR Acute MCL Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.134	0.012	0.009	0.005	0.006	0.005	0.005	0.025
GW	0.034	0.046	0.041	0.024	0.029	0.013	0.006	0.027
SW	0.014	0.015	0.011	0.006	0.008	0.006	0.005	0.009
TOTALS	0.014	0.015	0.011	0.006	0.008	0.006	0.005	0.009

Percent of Systems With TCR Acute MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	10.1%	9.4%	6.7%	2.5%	2.4%	1.8%	1.7%	4.9%
GW	1.0%	0.9%	0.7%	0.4%	0.5%	0.5%	0.45%	0.6%
SW	1.6%	1.9%	2.0%	1.5%	1.1%	0.7%	0.48%	1.3%
TOTALS	1.1%	1.0%	0.8%	0.5%	0.5%	0.5%	0.46%	0.7%

APPENDIX F

TCR MONTHLY MCL VIOLATIONS OVER TIME, BY PARAMETER

Exhibit F-1: TCR Monthly MCL Violations by System Size: 1997 – 2003

Number of Systems With TCR Monthly MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	3,674	3,772	3,736	3,650	3,692	3,673	3,853	26,050
101-500	1,812	1,954	1,838	1,735	1,756	1,772	1,755	12,622
501-1,000	365	365	376	338	389	360	323	2,516
1,001-3,300	452	432	365	378	404	391	371	2,793
3,301-10,000	267	236	202	222	230	211	241	1,609
10,001-50,000	192	172	147	143	151	170	155	1,130
50,001-100,000	11	13	9	7	5	5	12	62
>100,000	7	3	10	6	3	2	3	34
TOTALS	6,780	6,947	6,683	6,479	6,630	6,584	6,713	46,816

Number of TCR Monthly MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	4,402	4,575	4,529	4,406	4,608	4,569	4,715	31,804
101-500	2,265	2,560	2,449	2,167	2,262	2,184	2,197	16,084
501-1,000	463	494	517	425	528	446	396	3,269
1,001-3,300	562	576	475	489	516	491	450	3,559
3,301-10,000	319	279	253	259	278	263	273	1,924
10,001-50,000	248	219	191	181	188	198	187	1,412
50,001-100,000	11	16	14	7	6	6	13	73
>100,000	8	5	12	6	4	2	6	43
TOTALS	8,278	8,724	8,440	7,940	8,390	8,159	8,237	58,168

Average Number of TCR Monthly MCL Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.044	0.046	0.047	0.046	0.049	0.051	0.053	0.048
101-500	0.052	0.058	0.056	0.050	0.052	0.051	0.051	0.053
501-1,000	0.047	0.049	0.052	0.042	0.053	0.045	0.039	0.047
1,001-3,300	0.058	0.060	0.050	0.051	0.053	0.051	0.046	0.053
3,301-10,000	0.070	0.061	0.055	0.055	0.059	0.055	0.056	0.059
10,001-50,000	0.085	0.075	0.065	0.060	0.062	0.066	0.061	0.068
50,001-100,000	0.026	0.036	0.032	0.015	0.013	0.013	0.027	0.023
>100,000	0.023	0.014	0.033	0.017	0.011	0.005	0.016	0.017
TOTALS	0.049	0.051	0.050	0.047	0.051	0.051	0.051	0.050

Percent of Systems With TCR Monthly MCL Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	3.7%	3.8%	3.9%	3.8%	3.9%	4.1%	4.3%	3.9%
101-500	4.2%	4.4%	4.2%	4.0%	4.0%	4.2%	4.1%	4.2%
501-1,000	3.7%	3.6%	3.8%	3.4%	3.9%	3.6%	3.2%	3.6%
1,001-3,300	4.7%	4.5%	3.8%	3.9%	4.2%	4.0%	3.8%	4.1%
3,301-10,000	5.8%	5.2%	4.4%	4.7%	4.9%	4.4%	4.9%	4.9%
10,001-50,000	6.6%	5.9%	5.0%	4.7%	5.0%	5.6%	5.0%	5.4%
50,001-100,000	2.6%	2.9%	2.0%	1.5%	1.1%	1.1%	2.5%	2.0%
>100,000	2.0%	0.9%	2.8%	1.7%	0.8%	0.5%	0.8%	1.4%
TOTALS	4.0%	4.1%	4.0%	3.9%	4.0%	4.1%	4.2%	4.0%

**Exhibit F-2: Number and Frequency of TCR Monthly MCL Violations by System Type:
1997 - 2003**

Number of Systems With TCR Monthly MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	2,878	2,991	2,648	2,503	2,548	2,398	2,277	18,243
NTNCWS	809	784	799	774	803	805	867	5,641
TNCWS	3,093	3,172	3,236	3,202	3,279	3,381	3,569	22,932
TOTALS	6,780	6,947	6,683	6,479	6,630	6,584	6,713	46,816

Number of TCR Monthly MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	3,737	4,089	3,650	3,253	3,459	3,092	2,925	24,205
NTNCWS	977	942	1,012	973	1,018	1,020	1,088	7,030
TNCWS	3,564	3,693	3,778	3,714	3,913	4,047	4,224	26,933
TOTALS	8,278	8,724	8,440	7,940	8,390	8,159	8,237	58,168

Average Number of TCR Monthly MCL Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.068	0.075	0.068	0.060	0.064	0.058	0.055	0.064
NTNCWS	0.049	0.047	0.050	0.047	0.051	0.055	0.055	0.050
TNCWS	0.037	0.039	0.040	0.040	0.043	0.045	0.048	0.042
TOTALS	0.049	0.051	0.050	0.047	0.051	0.051	0.051	0.050

Percent of Systems With TCR Monthly MCL Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	5.3%	5.5%	4.9%	4.6%	4.7%	4.5%	4.3%	4.8%
NTNCWS	4.0%	3.9%	4.0%	3.8%	4.0%	4.3%	4.4%	4.0%
TNCWS	3.2%	3.3%	3.5%	3.4%	3.6%	3.8%	4.0%	3.5%
TOTALS	4.0%	4.1%	4.0%	3.9%	4.0%	4.1%	4.2%	4.0%

Exhibit F-3: Number and Frequency of TCR Monthly MCL Violations by Source: 1997 - 2003

Number of Systems With TCR Monthly MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	57	64	42	30	46	56	53	348
GW	6,295	6,453	6,259	6,131	6,256	6,198	6,339	43,931
SW	424	428	381	318	328	330	321	2,530
TOTALS	6,780	6,947	6,683	6,479	6,630	6,584	6,713	46,816

Number of TCR Monthly MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	65	77	52	41	69	70	73	447
GW	7,659	8,000	7,802	7,460	7,816	7,653	7,759	54,149
SW	547	645	585	439	505	436	405	3,562
TOTALS	8,278	8,724	8,440	7,940	8,390	8,159	8,237	58,168

Average Number of TCR Monthly MCL Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.161	0.160	0.102	0.068	0.072	0.066	0.067	0.100
GW	0.049	0.051	0.051	0.049	0.052	0.052	0.053	0.051
SW	0.041	0.049	0.045	0.032	0.037	0.032	0.030	0.038
TOTALS	0.049	0.051	0.050	0.047	0.051	0.051	0.051	0.050

Percent of Systems With TCR Monthly MCL Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	14.1%	13.3%	8.2%	5.0%	4.8%	5.3%	4.9%	8.0%
GW	4.0%	4.1%	4.1%	4.0%	4.2%	4.2%	4.3%	4.1%
SW	3.2%	3.3%	3.0%	2.3%	2.4%	2.4%	2.4%	2.7%
TOTALS	4.0%	4.1%	4.0%	3.9%	4.0%	4.1%	4.2%	4.0%

APPENDIX G

**TCR ROUTINE: MAJOR MONITORING & REPORTING VIOLATIONS OVER TIME,
BY PARAMETER**

**Exhibit G-1: TCR Routine: Major Monitoring & Reporting Violations by System Size:
1997 - 2003**

**Number of Systems With TCR Routine: Major Monitoring & Reporting & Reporting & Reporting
Violations**

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	13,343	10,970	14,363	12,777	12,673	12,722	12,521	89,369
101-500	5,328	4,655	5,119	4,801	4,783	4,407	4,633	33,726
501-1,000	868	725	721	733	741	713	760	5,261
1,001-3,300	511	428	366	402	564	405	450	3,126
3,301-10,000	96	87	65	91	132	75	96	642
10,001-50,000	41	30	21	26	34	31	38	221
50,001-100,000	8	12	3	7	8	2	7	47
>100,000	6	5	3	2	7	1	1	25
TOTALS	20,201	16,912	20,661	18,839	18,942	18,356	18,506	132,417

Number of TCR Routine: Major Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	22,044	17,826	23,224	21,578	20,603	21,669	20,834	147,778
101-500	9,399	7,872	7,956	7,637	7,759	7,489	7,986	56,098
501-1,000	1,421	1,086	997	1,082	1,105	1,176	1,289	8,156
1,001-3,300	753	608	469	598	798	607	688	4,521
3,301-10,000	128	118	76	128	165	102	126	843
10,001-50,000	48	43	29	36	55	42	44	297
50,001-100,000	8	13	3	7	12	2	9	54
>100,000	12	8	3	2	9	3	1	38
TOTALS	33,813	27,574	32,757	31,068	30,506	31,090	30,977	217,785

Average Number of TCR Routine: Major Monitoring & Reporting Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.222	0.181	0.241	0.225	0.220	0.240	0.232	0.223
101-500	0.216	0.179	0.183	0.175	0.179	0.176	0.186	0.185
501-1,000	0.143	0.109	0.100	0.108	0.110	0.118	0.128	0.116
1,001-3,300	0.078	0.063	0.049	0.062	0.082	0.062	0.071	0.067
3,301-10,000	0.028	0.026	0.016	0.027	0.035	0.021	0.026	0.026
10,001-50,000	0.016	0.015	0.010	0.012	0.018	0.014	0.014	0.014
50,001-100,000	0.019	0.029	0.007	0.015	0.026	0.004	0.019	0.017
>100,000	0.035	0.023	0.008	0.006	0.025	0.008	0.003	0.015
TOTALS	0.198	0.162	0.195	0.185	0.184	0.193	0.192	0.187

Percent of Systems With TCR Routine: Major Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	13.4%	11.1%	14.9%	13.3%	13.5%	14.1%	14.0%	13.5%
101-500	12.3%	10.6%	11.7%	11.0%	11.0%	10.3%	10.8%	11.1%
501-1,000	8.7%	7.2%	7.2%	7.3%	7.4%	7.1%	7.5%	7.5%
1,001-3,300	5.3%	4.5%	3.8%	4.2%	5.8%	4.2%	4.6%	4.6%
3,301-10,000	2.1%	1.9%	1.4%	1.9%	2.8%	1.6%	2.0%	2.0%
10,001-50,000	1.4%	1.0%	0.7%	0.9%	1.1%	1.0%	1.2%	1.1%
50,001-100,000	1.9%	2.7%	0.7%	1.5%	1.7%	0.4%	1.5%	1.5%
>100,000	1.7%	1.4%	0.8%	0.6%	2.0%	0.3%	0.3%	1.0%
TOTALS	11.8%	9.9%	12.3%	11.2%	11.4%	11.4%	11.5%	11.4%

Exhibit G-2: Number and Frequency of TCR Routine: Major Monitoring & Reporting Violations by System Type: 1997 - 2003

Number of Systems With TCR Routine: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	5,251	4,776	4,124	4,224	4,107	3,669	3,893	30,044
NTNCWS	2,783	2,144	2,042	2,086	2,002	1,890	1,822	14,769
TNCWS	12,167	9,992	14,495	12,529	12,833	12,797	12,791	87,604
TOTALS	20,201	16,912	20,661	18,839	18,942	18,356	18,506	132,417

Number of TCR Routine: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	10,851	9,291	7,228	7,758	7,822	7,810	8,461	59,221
NTNCWS	3,988	3,067	2,769	2,944	2,739	2,563	2,471	20,541
TNCWS	18,974	15,216	22,760	20,366	19,945	20,717	20,045	138,023
TOTALS	33,813	27,574	32,757	31,068	30,506	31,090	30,977	217,785

Average Number of TCR Routine: Major Monitoring & Reporting Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.198	0.171	0.134	0.143	0.145	0.146	0.159	0.157
NTNCWS	0.198	0.151	0.138	0.143	0.136	0.137	0.126	0.147
TNCWS	0.198	0.159	0.243	0.218	0.218	0.232	0.227	0.214
TOTALS	0.198	0.162	0.195	0.185	0.184	0.193	0.192	0.187

Percent of Systems With TCR Routine: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	9.6%	8.8%	7.6%	7.8%	7.6%	6.9%	7.3%	7.9%
NTNCWS	13.8%	10.6%	10.2%	10.1%	10.0%	10.1%	9.3%	10.6%
TNCWS	12.7%	10.4%	15.5%	13.4%	14.0%	14.3%	14.5%	13.6%
TOTALS	11.8%	9.9%	12.3%	11.2%	11.4%	11.4%	11.5%	11.4%

Exhibit G-3: Number and Frequency of TCR Routine: Major Monitoring & Reporting Violations by Source: 1997 - 2003

Number of Systems With TCR Routine: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	189	190	141	155	175	209	170	1,229
GW	18,936	15,726	19,522	17,767	17,832	17,352	17,411	124,546
SW	1,075	995	998	917	935	795	925	6,640
TOTALS	20,201	16,912	20,661	18,839	18,942	18,356	18,506	132,417

Number of TCR Routine: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	366	386	273	297	386	461	419	2,588
GW	30,847	24,971	30,546	29,037	28,018	28,437	28,030	199,886
SW	2,598	2,215	1,938	1,734	2,102	2,192	2,528	15,307
TOTALS	33,813	27,574	32,757	31,068	30,506	31,090	30,977	217,785

Average Number of TCR Routine: Major Monitoring & Reporting Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.906	0.804	0.535	0.495	0.403	0.436	0.386	0.566
GW	0.196	0.159	0.198	0.189	0.186	0.194	0.191	0.188
SW	0.196	0.169	0.150	0.128	0.153	0.162	0.185	0.163
TOTALS	0.198	0.162	0.195	0.185	0.184	0.193	0.192	0.187

Percent of Systems With TCR Routine: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	46.8%	39.6%	27.6%	25.8%	18.2%	19.8%	15.7%	27.6%
GW	12.1%	10.0%	12.6%	11.6%	11.8%	11.8%	11.9%	11.7%
SW	8.1%	7.6%	7.7%	6.8%	6.8%	5.9%	6.8%	7.1%
TOTALS	11.8%	9.9%	12.3%	11.2%	11.4%	11.4%	11.5%	11.4%

APPENDIX H

**TCR ROUTINE: MINOR MONITORING & REPORTING VIOLATIONS OVER TIME,
BY PARAMETER**

**Exhibit H-1: TCR Routine: Minor Monitoring & Reporting Violations by System Size:
1997 – 2003**

Number of Systems With TCR Routine: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,289	1,273	1,108	988	875	905	868	7,306
101-500	809	774	759	651	497	517	544	4,551
501-1,000	181	192	167	143	117	133	129	1,062
1,001-3,300	449	434	358	381	386	347	409	2,764
3,301-10,000	191	220	171	194	198	150	191	1,315
10,001-50,000	112	136	116	88	126	64	89	731
50,001-100,000	6	20	15	8	14	5	6	74
>100,000	5	8	1	1	4	3	5	27
TOTALS	3,042	3,057	2,695	2,454	2,217	2,124	2,241	17,830

Number of TCR Routine: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,533	1,465	1,438	1,202	998	1,037	1,005	8,678
101-500	954	895	1,171	863	542	573	598	5,596
501-1,000	208	220	260	193	127	149	144	1,301
1,001-3,300	587	604	466	513	495	465	609	3,739
3,301-10,000	256	288	216	248	244	182	291	1,725
10,001-50,000	145	167	147	101	143	75	113	891
50,001-100,000	8	25	18	10	17	5	8	91
>100,000	5	14	1	1	5	3	6	35
TOTALS	3,696	3,678	3,717	3,131	2,571	2,489	2,774	22,056

Average Number of TCR Routine: Minor Monitoring & Reporting Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.015	0.015	0.015	0.013	0.011	0.011	0.011	0.013
101-500	0.022	0.020	0.027	0.020	0.012	0.013	0.014	0.018
501-1,000	0.021	0.022	0.026	0.019	0.013	0.015	0.014	0.019
1,001-3,300	0.061	0.063	0.049	0.053	0.051	0.048	0.062	0.055
3,301-10,000	0.056	0.063	0.047	0.053	0.052	0.038	0.060	0.053
10,001-50,000	0.050	0.057	0.050	0.034	0.047	0.025	0.037	0.043
50,001-100,000	0.019	0.056	0.041	0.021	0.037	0.011	0.017	0.029
>100,000	0.015	0.040	0.003	0.003	0.014	0.008	0.016	0.014
TOTALS	0.022	0.022	0.022	0.019	0.016	0.015	0.017	0.019

Percent of Systems With TCR Routine: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	1.3%	1.3%	1.2%	1.0%	0.9%	1.0%	1.0%	1.1%
101-500	1.9%	1.8%	1.7%	1.5%	1.1%	1.2%	1.3%	1.5%
501-1,000	1.8%	1.9%	1.7%	1.4%	1.2%	1.3%	1.3%	1.5%
1,001-3,300	4.7%	4.5%	3.8%	4.0%	4.0%	3.6%	4.2%	4.1%
3,301-10,000	4.2%	4.8%	3.7%	4.1%	4.2%	3.1%	3.9%	4.0%
10,001-50,000	3.8%	4.7%	3.9%	2.9%	4.1%	2.1%	2.9%	3.5%
50,001-100,000	1.4%	4.5%	3.4%	1.7%	3.0%	1.1%	1.3%	2.3%
>100,000	1.5%	2.3%	0.3%	0.3%	1.1%	0.8%	1.4%	1.1%
TOTALS	1.8%	1.8%	1.6%	1.5%	1.3%	1.3%	1.4%	1.5%

Exhibit H-2: Number and Frequency of TCR Routine: Minor Monitoring & Reporting Violations by System Type: 1997 - 2003

Number of Systems With TCR Routine: Minor Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	1,815	1,815	1,634	1,542	1,295	1,132	1,294	10,527
NTNCWS	253	226	216	185	183	205	178	1,446
TNCWS	974	1,016	845	727	739	787	769	5,857
TOTALS	3,042	3,057	2,695	2,454	2,217	2,124	2,241	17,830

Number of TCR Routine: Minor Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	2,247	2,222	2,452	2,066	1,505	1,305	1,629	13,426
NTNCWS	310	257	281	214	218	244	247	1,771
TNCWS	1,139	1,199	984	851	848	940	898	6,859
TOTALS	3,696	3,678	3,717	3,131	2,571	2,489	2,774	22,056

Average Number of TCR Routine: Minor Monitoring & Reporting Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.041	0.041	0.045	0.038	0.028	0.024	0.031	0.036
NTNCWS	0.015	0.013	0.014	0.010	0.011	0.013	0.013	0.013
TNCWS	0.012	0.013	0.010	0.009	0.009	0.011	0.010	0.011
TOTALS	0.022	0.022	0.022	0.019	0.016	0.015	0.017	0.019

Percent of Systems With TCR Routine: Minor Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	3.3%	3.3%	3.0%	2.9%	2.4%	2.1%	2.4%	2.8%
NTNCWS	1.3%	1.1%	1.1%	0.9%	0.9%	1.1%	0.9%	1.0%
TNCWS	1.0%	1.1%	0.9%	0.8%	0.8%	0.9%	0.9%	0.9%
TOTALS	1.8%	1.8%	1.6%	1.5%	1.3%	1.3%	1.4%	1.5%

Exhibit H-3: Number and Frequency of TCR Routine: Minor Monitoring & Reporting Violations by Source: 1997 - 2003

Number of Systems With TCR Routine: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	42	55	39	34	51	52	52	325
GW	2,501	2,484	2,162	1,967	1,794	1,786	1,768	14,462
SW	499	518	493	453	372	285	421	3,041
TOTALS	3,042	3,057	2,695	2,454	2,217	2,124	2,241	17,830

Number of TCR Routine: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	61	63	52	41	67	75	80	439
GW	3,039	2,973	2,768	2,425	2,063	2,086	2,147	17,501
SW	596	642	896	665	441	327	547	4,114
TOTALS	3,696	3,678	3,717	3,131	2,571	2,489	2,774	22,056

Average Number of TCR Routine: Minor Monitoring & Reporting Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.151	0.131	0.102	0.068	0.070	0.071	0.074	0.095
GW	0.019	0.019	0.018	0.016	0.014	0.014	0.015	0.016
SW	0.045	0.049	0.070	0.049	0.032	0.024	0.040	0.044
TOTALS	0.022	0.022	0.022	0.019	0.016	0.015	0.017	0.019

Percent of Systems With TCR Routine: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	10.4%	11.5%	7.6%	5.7%	5.3%	4.9%	4.8%	7.2%
GW	1.6%	1.6%	1.4%	1.3%	1.2%	1.2%	1.2%	1.4%
SW	3.8%	3.9%	3.8%	3.3%	2.7%	2.1%	3.1%	3.3%
TOTALS	1.8%	1.8%	1.6%	1.5%	1.3%	1.3%	1.4%	1.5%

APPENDIX I

**TCR REPEAT: MAJOR MONITORING & REPORTING VIOLATIONS OVER TIME,
BY PARAMETER**

Exhibit I-1: Frequency of TCR Repeat: Major Monitoring & Reporting Violations by System Size: 1997 - 2003

Number of Systems With TCR Repeat: Major Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,191	1,096	1,067	1,089	1,012	1,017	1,058	7,530
101-500	523	489	469	401	414	396	412	3,104
501-1,000	78	74	55	57	57	46	49	416
1,001-3,300	78	50	36	46	59	40	39	348
3,301-10,000	18	29	23	35	21	23	20	169
10,001-50,000	20	22	10	17	17	16	19	121
50,001-100,000	3	5	0	3	4	1	1	17
>100,000	3	5	2	1	9	2	4	26
TOTALS	1,914	1,770	1,662	1,649	1,593	1,541	1,602	11,731

Number of TCR Repeat: Major Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	1,406	1,301	1,196	1,234	1,143	1,140	1,163	8,583
101-500	621	588	533	452	479	437	462	3,572
501-1,000	85	82	56	64	58	50	52	447
1,001-3,300	86	58	37	50	61	41	41	374
3,301-10,000	18	30	26	40	22	23	20	179
10,001-50,000	22	23	10	18	17	16	20	126
50,001-100,000	3	5	0	5	4	1	1	19
>100,000	3	6	2	1	12	2	5	31
TOTALS	2,244	2,093	1,860	1,864	1,796	1,710	1,764	13,331

Average Number of TCR Repeat: Major Monitoring & Reporting Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.014	0.013	0.012	0.013	0.012	0.013	0.013	0.013
101-500	0.014	0.013	0.012	0.010	0.011	0.010	0.011	0.012
501-1,000	0.009	0.008	0.006	0.006	0.006	0.005	0.005	0.006
1,001-3,300	0.009	0.006	0.004	0.005	0.006	0.004	0.004	0.006
3,301-10,000	0.004	0.007	0.006	0.009	0.005	0.005	0.004	0.005
10,001-50,000	0.008	0.008	0.003	0.006	0.006	0.005	0.007	0.006
50,001-100,000	0.007	0.011	0.000	0.010	0.009	0.002	0.002	0.006
>100,000	0.009	0.017	0.006	0.003	0.034	0.005	0.014	0.012
TOTALS	0.013	0.012	0.011	0.011	0.011	0.011	0.011	0.011

Percent of Systems With TCR Repeat: Major Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.1%
101-500	1.2%	1.1%	1.1%	0.9%	1.0%	0.9%	1.0%	1.0%
501-1,000	0.8%	0.7%	0.5%	0.6%	0.6%	0.5%	0.5%	0.6%
1,001-3,300	0.8%	0.5%	0.4%	0.5%	0.6%	0.4%	0.4%	0.5%
3,301-10,000	0.4%	0.6%	0.5%	0.7%	0.4%	0.5%	0.4%	0.5%
10,001-50,000	0.7%	0.8%	0.3%	0.6%	0.6%	0.5%	0.6%	0.6%
50,001-100,000	0.7%	1.1%	0.0%	0.6%	0.9%	0.2%	0.2%	0.5%
>100,000	0.9%	1.4%	0.6%	0.3%	2.5%	0.5%	1.1%	1.0%
TOTALS	1.1%	1.0%						

Exhibit I-2: Number and Frequency of TCR Repeat: Major Monitoring & Reporting Violations by System Type: 1997 - 2003

Number of Systems With TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	808	750	578	569	551	451	439	4,146
NTNCWS	127	137	164	136	152	119	123	958
TNCWS	979	883	920	944	890	971	1,040	6,627
TOTALS	1,914	1,770	1,662	1,649	1,593	1,541	1,602	11,731

Number of TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	982	897	674	679	661	513	497	4,903
NTNCWS	140	152	179	143	163	127	133	1,037
TNCWS	1,122	1,044	1,007	1,042	972	1,070	1,134	7,391
TOTALS	2,244	2,093	1,860	1,864	1,796	1,710	1,764	13,331

Average Number of TCR Repeat: Major Monitoring & Reporting Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.018	0.016	0.012	0.013	0.012	0.010	0.009	0.013
NTNCWS	0.007	0.008	0.009	0.007	0.008	0.007	0.007	0.007
TNCWS	0.012	0.011	0.011	0.011	0.011	0.012	0.013	0.011
TOTALS	0.013	0.012	0.011	0.011	0.011	0.011	0.011	0.011

Percent of Systems With TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	1.5%	1.4%	1.1%	1.1%	1.0%	0.8%	0.8%	1.1%
NTNCWS	0.6%	0.7%	0.8%	0.7%	0.8%	0.6%	0.6%	0.7%
TNCWS	1.0%	0.9%	1.0%	1.0%	1.0%	1.1%	1.2%	1.0%
TOTALS	1.1%	1.0%						

Exhibit I-3: Number and Frequency of TCR Repeat: Major Monitoring & Reporting Violations by Source: 1997 - 2003

Number of Systems With TCR Repeat: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	24	37	32	24	37	26	23	203
GW	1,768	1,627	1,552	1,532	1,479	1,449	1,500	10,907
SW	122	106	78	93	77	66	79	621
TOTALS	1,914	1,770	1,662	1,649	1,593	1,541	1,602	11,731

Number of TCR Repeat: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	30	48	40	32	46	31	26	253
GW	2,042	1,893	1,709	1,718	1,651	1,601	1,642	12,256
SW	172	152	111	114	99	78	96	822
TOTALS	2,244	2,093	1,860	1,864	1,796	1,710	1,764	13,331

Average Number of TCR Repeat: Major Monitoring & Reporting Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.074	0.100	0.078	0.053	0.048	0.029	0.024	0.058
GW	0.013	0.012	0.011	0.011	0.011	0.011	0.011	0.011
SW	0.013	0.012	0.009	0.008	0.007	0.006	0.007	0.009
TOTALS	0.013	0.012	0.011	0.011	0.011	0.011	0.011	0.011

Percent of Systems With TCR Repeat: Major Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	5.9%	7.7%	6.3%	4.0%	3.9%	2.5%	2.1%	4.6%
GW	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
SW	0.9%	0.8%	0.6%	0.7%	0.6%	0.5%	0.6%	0.7%
TOTALS	1.1%	1.0%						

APPENDIX J

**TCR REPEAT: MINOR MONITORING & REPORTING VIOLATIONS OVER TIME, BY
PARAMETER**

Exhibit J-1: Number and Frequency of TCR Repeat: Minor MR Violations by Source: 1997 - 2003

Number of Systems With TCR Repeat: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	635	665	422	500	347	411	362	3,342
101-500	400	376	225	268	198	223	220	1,910
501-1,000	81	86	40	63	51	62	36	419
1,001-3,300	66	75	33	74	48	52	47	395
3,301-10,000	45	44	20	36	15	23	14	197
10,001-50,000	25	36	9	25	12	20	16	143
50,001-100,000	9	6	2	6	3	1	3	30
>100,000	5	7	4	7	6	3	5	37
TOTALS	1,266	1,295	755	979	680	795	703	6,473

Number of TCR Repeat: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	TOTALS
<=100	707	769	452	567	376	449	389	3,709
101-500	446	458	235	295	209	257	246	2,146
501-1,000	93	104	43	67	55	64	41	467
1,001-3,300	78	101	37	94	54	61	51	476
3,301-10,000	48	60	22	42	15	26	14	227
10,001-50,000	27	50	9	36	12	24	17	175
50,001-100,000	13	13	2	7	4	1	3	43
>100,000	13	21	4	16	6	4	5	69
TOTALS	1,425	1,576	804	1,124	731	886	766	7,312

Average Number of TCR Repeat: Minor Monitoring & Reporting Violations Per System

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.007	0.008	0.005	0.006	0.004	0.005	0.004	0.006
101-500	0.010	0.010	0.005	0.007	0.005	0.006	0.006	0.007
501-1,000	0.009	0.010	0.004	0.007	0.005	0.006	0.004	0.007
1,001-3,300	0.008	0.011	0.004	0.010	0.006	0.006	0.005	0.007
3,301-10,000	0.010	0.013	0.005	0.009	0.003	0.005	0.003	0.007
10,001-50,000	0.009	0.017	0.003	0.012	0.004	0.008	0.006	0.008
50,001-100,000	0.031	0.029	0.005	0.015	0.009	0.002	0.006	0.014
>100,000	0.038	0.061	0.011	0.045	0.017	0.011	0.014	0.028
TOTALS	0.008	0.009	0.005	0.007	0.004	0.005	0.005	0.006

Percent of Systems With TCR Repeat: Minor Monitoring & Reporting Violations

Size Category	1997	1998	1999	2000	2001	2002	2003	Avg
<=100	0.6%	0.7%	0.4%	0.5%	0.4%	0.5%	0.4%	0.5%
101-500	0.9%	0.9%	0.5%	0.6%	0.5%	0.5%	0.5%	0.6%
501-1,000	0.8%	0.9%	0.4%	0.6%	0.5%	0.6%	0.4%	0.6%
1,001-3,300	0.7%	0.8%	0.3%	0.8%	0.5%	0.5%	0.5%	0.6%
3,301-10,000	1.0%	1.0%	0.4%	0.8%	0.3%	0.5%	0.3%	0.6%
10,001-50,000	0.9%	1.2%	0.3%	0.8%	0.4%	0.7%	0.5%	0.7%
50,001-100,000	2.1%	1.3%	0.5%	1.3%	0.6%	0.2%	0.6%	1.0%
>100,000	1.5%	2.0%	1.1%	1.9%	1.7%	0.8%	1.4%	1.5%
TOTALS	0.7%	0.8%	0.5%	0.6%	0.4%	0.5%	0.4%	0.6%

**Exhibit J-2: Number and Frequency of TCR Repeat: Minor Monitoring & Reporting
Violations by System Type: 1997 - 2003**

Number of Systems With TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	563	608	304	476	332	328	280	2,891
NTNCWS	125	122	84	112	67	75	69	654
TNCWS	578	565	367	391	281	392	354	2,928
TOTALS	1,266	1,295	755	979	680	795	703	6,473

Number of TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	TOTALS
CWS	643	773	332	550	357	372	315	3,342
NTNCWS	139	141	87	141	75	84	75	742
TNCWS	643	662	385	433	299	430	376	3,228
TOTALS	1,425	1,576	804	1,124	731	886	766	7,312

Average Number of TCR Repeat: Minor Monitoring & Reporting Violations Per System

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	0.012	0.014	0.006	0.010	0.007	0.007	0.006	0.009
NTNCWS	0.007	0.007	0.004	0.007	0.004	0.004	0.004	0.005
TNCWS	0.007	0.007	0.004	0.005	0.003	0.005	0.004	0.005
TOTALS	0.008	0.009	0.005	0.007	0.004	0.005	0.005	0.006

Percent of Systems With TCR Repeat: Major Monitoring & Reporting Violations

System Type	1997	1998	1999	2000	2001	2002	2003	Avg
CWS	1.0%	1.1%	0.6%	0.9%	0.6%	0.6%	0.5%	0.8%
NTNCWS	0.6%	0.6%	0.4%	0.5%	0.3%	0.4%	0.4%	0.5%
TNCWS	0.6%	0.6%	0.4%	0.4%	0.3%	0.4%	0.4%	0.5%
TOTALS	0.7%	0.8%	0.5%	0.6%	0.4%	0.5%	0.4%	0.6%

**Exhibit J-3: Number and Frequency of TCR Repeat: Minor Monitoring & Reporting Violations
by Source: 1997 - 2003**

Number of Systems With TCR Repeat: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	39	59	11	30	16	38	19	212
GW	1,145	1,153	651	799	608	706	638	5,700
SW	82	83	93	150	56	51	46	561
TOTALS	1,266	1,295	755	979	680	795	703	6,473

Number of TCR Repeat: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	TOTALS
GU	53	85	12	38	18	46	26	278
GW	1,274	1,378	692	884	653	785	692	6,358
SW	98	113	100	202	60	55	48	676
TOTALS	1,425	1,576	804	1,124	731	886	766	7,312

Average Number of TCR Repeat: Minor Monitoring & Reporting Violations Per System

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	0.131	0.177	0.024	0.063	0.019	0.043	0.024	0.069
GW	0.008	0.009	0.004	0.006	0.004	0.005	0.005	0.006
SW	0.007	0.009	0.008	0.015	0.004	0.004	0.004	0.007
TOTALS	0.008	0.009	0.005	0.007	0.004	0.005	0.005	0.006

Percent of Systems With TCR Repeat: Minor Monitoring & Reporting Violations

Source	1997	1998	1999	2000	2001	2002	2003	Avg
GU	9.7%	12.3%	2.2%	5.0%	1.7%	3.6%	1.8%	5.2%
GW	0.7%	0.7%	0.4%	0.5%	0.4%	0.5%	0.4%	0.5%
SW	0.6%	0.6%	0.7%	1.1%	0.4%	0.4%	0.3%	0.6%
TOTALS	0.7%	0.8%	0.5%	0.6%	0.4%	0.5%	0.4%	0.6%

APPENDIX K

STATISTICAL ANALYSIS AND OBSERVATIONS OF TCR VIOLATION DATA

Initial Statistical Analysis of TCR Violations Data

Summary

Although EPA explores statistical testing in this paper, the paper concentrates on presenting the data, as it is, in SDWIS/FED. The statistical analysis of the TCR compliance data that are outlined in this appendix consists of comparisons of the data across categories using Chi-square tests on the relationships between the seven varieties of TCR violations and system size class, system type, and system source water. This resulted in 147 Chi-square tests, for 7 varieties of TCR violations x 3 ways of categorizing systems x 7 different years of data. Nearly all of these 147 tests indicated that system characteristics had a highly statistically significant impact on violations rate. However, these test results only indicate confidence that each system characteristic (size class, type, water source) has some impact on violation rates, but the results do not indicate what these specific impacts are.

Impact of system size class on violations rate:

Total and Monthly MCL violations:

- Middle size classes (3,301-50,000) > violations relative to other size classes.
- Larger size classes (>50,001) < violations relative to other size classes.

Acute MCL violations:

- Smaller size classes (101-500) > violations relative to other size classes.
- Middle size classes (1,001-10,000) < violations relative to other size classes.

Routine Major and Repeat Major violations:

- Smallest size class (<100) > violations relative to other size classes.
- Middle and large size classes (>501) < violations relative to other size classes.

Routine Minor and Repeat Minor violations:

- Smallest size class (<100) < violations relative to other size classes.

Impact of system type on violations rate:

Total and Monthly MCL violations:

- CWS > violations relative to other system types.
- TNCWS < violations relative to other system types.

Routine Major violations:

- CWS < violations relative to other system types.
- TNCWS > violations relative to other system types.

Routine Minor and Repeat Minor violations:

- CWS > violations relative to other system types.
- NTNCWS and TNCWS < violations relative to other system types.

Impact of water source on violations rate:

Total and Monthly MCL violations

- SW < violations relative to other water sources.

Acute MCL violations

- GU and SW > violations relative to other water sources.
- GW < violations relative to other water sources.

Routine Major and Repeat Major violations:

- GU > violations relative to other water sources.
- SW < violations relative to other water sources.

Routine Minor and Repeat Minor violations:

- GU > violations relative to other water sources.
- GW < violations relative to other water sources.

I. Chi-square test results

The following analyses have been performed on the percentage of systems that have had TCR violations of various sorts. This data:

- Covers seven varieties of TCR violations: 1) Total MCL violations; 2) Acute MCL violations; 3) Monthly MCL violations; 4) Routine Major Monitoring & Reporting/reporting violations; 5) Routine Minor Monitoring & Reporting/reporting violations; 6) Repeat Major Monitoring & Reporting/reporting violations; 7) Repeat Minor Monitoring & Reporting/reporting violations.
- Are available for each of the seven years from 1997 through 2003.
- Has been broken down in each of three ways: 1) By system size class; 2) By system type (i.e., CWS, NTNCWS, TNCWS); 3) By water source (e.g., GU, GW, SW).

In effect, then, there are 147 tables of data: one table for each of the seven varieties of TCR violations, for each of seven years, and for each of three ways to break out the data (7x7x3=147). Each table shows, for a given variety of TCR violation and year, the number and percentage of systems of different sorts that did and did not have this variety of violation. Please refer to Exhibit K-1 as an example.

**Exhibit K-1: TCR Violations Data for
Type of Violation: Total MCL
Year: 2003
Break-Out: By water source**

Water Source	# Systems w/MCL Violations	# Systems w/out MCL Violations	Total # Systems	% Systems w/MCL Violations
GU	62	1,023	1,085	5.7
GW	6,669	139,799	146,468	4.6
SW	371	13,277	13,648	2.7
All	7,102	154,099	161,201	4.4

The initial question to answer for this table of data is whether “Water Source” makes a difference in the likelihood of a system having an MCL violation. In 2003, 4.4 % of all systems had MCL violations. GU and GW systems had MCL violations more frequently than this average, while SW systems had MCL violations less frequently than this average. Are these differences statistically significant?

A Chi-square (χ^2) test was performed to answer this question. In formal terms, a Chi-square test allows one to assess the confidence with which one can reject a “null hypothesis” to the effect that there is no difference across the three water sources in the frequency with which systems have MCL violations. The Chi-square value calculated for this table of data is 104.24, resulting in at least 99.9% confidence that the MCL violation rate is not constant across the three sets of systems using the different water sources. In effect, the differences among the violation rates for systems using the three different sorts of source waters are statistically significant.

Note that the Chi-square test result indicates confidence that water source has an impact on violation rates, but the test tells nothing about what that specific impact is. One can't, for example, conclude that GU systems have a higher probability of incurring MCL violations than GW systems, and that GW systems in turn have a higher probability of incurring MCL violations than SW systems. To draw more specific conclusions, additional statistical tests are needed other than this initial Chi-square.

The results of the 147 Chi-square tests are shown in following three summary tables. Exhibit K-2 shows the Chi-square test results evaluating whether system size class has an impact on violation rates, Exhibit K-3 shows results evaluating the impact of system type on violation rates, and Exhibit K-4 shows results evaluating the impact of water source on violation rates. The tables show the χ^2 value and the probability that such a value could arise by chance given the null hypothesis that the variable under consideration (size class in Exhibit K-2, type of system in Exhibit K-3, and water source in Exhibit K-4) has no impact on the TCR violation rate. The probabilities (p values) less than 0.05 are considered statistically significant. In such a case, there is less than a 5% likelihood that the variable under consideration has no impact on the TCR violations rate and the observed variation in TCR violations rate across systems is due to chance alone. Or, from another perspective, when the p value is less than 0.05 there is more than a 95% likelihood that the variable under consideration does have some impact on the TCR violations rate. If the p-value is greater than 0.05, it is not considered statistically significant, and "n.s." (not significant) is recorded in the table.

Exhibit K-2. Results of χ^2 tests on violations data, by size of system, 1997-2003

	Total MCL		Acute MCL		Monthly MCL		Routine Major		Routine Minor		Repeat Major		Repeat Minor	
	χ^2	p value	χ^2	p value	χ^2	p value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value
2003	58.05	<0.001	18.25	p<0.025	59.99	p<0.001	2017.11	p<0.001	959.23	p<0.001	117.92	p<0.001	20.53	p<0.01
2002	45.23	<0.001	10.85	n.s.	48.40	p<0.001	2309.53	p<0.001	589.35	p<0.001	104.88	p<0.001	10.32	n.s
2001	32.86	<0.001	43.73	p<0.001	38.52	p<0.001	1622.03	p<0.001	1123.92	p<0.001	70.70	p<0.001	25.53	p<0.001
2000	31.37	<0.001	37.08	p<0.001	36.89	p<0.001	1871.4	p<0.001	824.55	p<0.001	78.02	p<0.001	34.41	p<0.001
1999	28.73	<0.001	39.71	p<0.001	26.37	p<0.001	2469.89	p<0.001	652.52	p<0.001	102.55	p<0.001	12.38	n.s
1998	72.55	<0.001	69.72	p<0.001	88.24	p<0.001	1224.10	p<0.001	940.02	p<0.001	51.23	p<0.001	36.29	p<0.001
1997	79.94	<0.001	56.74	p<0.001	138.29	p<0.001	1529.04	p<0.001	810.03	p<0.001	54.32	p<0.001	51.67	p<0.001

Exhibit K-3. Results of χ^2 tests on violations data, by type of system, 1997-2003

	Total MCL		Acute MCL		Monthly MCL		Routine Major		Routine Minor		Repeat Major		Repeat Minor	
	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value
2003	4.89	n.s.	19.51	p<0.001	7.20	p<0.05	1811.92	p<0.001	623.11	p<0.001	74.11	p<0.001	15.39	p<0.001
2002	32.91	p<0.001	9.23	p<0.01	44.21	p<0.001	1888.43	p<0.001	400.75	p<0.001	43.8	p<0.001	24.3	p<0.001
2001	117.99	p<0.001	33.33	p<0.001	118.06	p<0.001	1408.12	p<0.001	688.93	p<0.001	11.20	p<0.01	83.18	p<0.001
2000	160.71	p<0.001	80.58	p<0.001	132.01	p<0.001	1115.71	p<0.001	1071.00	p<0.001	25.36	p<0.001	125.93	p<0.001
1999	167.19	p<0.001	15.25	p<0.001	190.26	p<0.001	2034.14	p<0.001	1021.87	p<0.001	9.90	p<0.01	23.17	p<0.001
1998	383.23	p<0.001	0.56	n.s.	427.30	p<0.001	116.79	p<0.001	1080.75	p<0.001	99.93	p<0.001	135.88	p<0.001
1997	288.27	p<0.001	11.08	p<0.01	379.24	p<0.001	406.01	p<0.001	1091.17	p<0.001	114.73	p<0.001	90.61	p<0.001

Exhibit K-4. Results of χ^2 tests on violations data, by source, 1997-2003

	Total MCL		Acute MCL		Monthly MCL		Routine Major		Routine Minor		Repeat Major		Repeat Minor	
	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value
2003	104.24	p<0.001	34.02	p<0.001	123.55	p<0.001	339.61	p<0.001	413.31	p<0.001	39.23	p<0.001	46.30	p<0.001
2002	83.66	p<0.001	47.01	p<0.001	104.10	p<0.001	506.49	p<0.001	182.18	p<0.001	57.91	p<0.001	211.25	p<0.001
2001	72.83	p<0.001	160.20	p<0.001	104.21	p<0.001	360.38	p<0.001	333.40	p<0.001	108.40	p<0.001	37.27	p<0.001
2000	29.68	p<0.001	319.10	p<0.001	92.23	p<0.001	414.83	p<0.001	442.73	p<0.001	68.62	p<0.001	276.80	p<0.001
1999	70.65	p<0.001	464.10	p<0.001	61.78	p<0.001	376.44	p<0.001	560.41	p<0.001	165.01	p<0.001	57.10	p<0.001
1998	196.77	p<0.001	428.30	p<0.001	128.20	p<0.001	555.04	p<0.001	638.43	p<0.001	214.52	p<0.001	850.30	p<0.001
1997	201.90	p<0.001	347.60	p<0.001	129.94	p<0.001	655.21	p<0.001	502.25	p<0.001	89.40	p<0.001	438.79	p<0.001

It is apparent in virtually all cases that the differences in TCR violation rates across groups of systems are statistically significant – whether systems are broken out by size class, by type, or by water source. Of the 147 Chi-square tests shown in these three tables, 142 are significant at the 0.05 level or lower, and 135 are significant at the 0.001 level or lower. System size, type and source water clearly have some impact on violation rates. Again, though, these Chi-square tests serve only to demonstrate that there is a statistically significant relationship or relationships between system characteristics and TCR violations rate, but further investigation is needed to determine exactly what these relationships might be.

Although Chi-square tests make up the bulk of the statistical tests, EPA also explored the use of odds ratio as an alternate form of statistical testing. For example, based on RR, EPA cannot reject the notion that $\frac{\Pr\{viol | GU\}}{\Pr\{viol | GW\}} = 1$. A 95% confidence interval for RR is [0.984, 1.6]. Combining GU and GW, it is possible to reject that $\frac{\Pr\{viol | not SW\}}{\Pr\{viol | SW\}} = 1$. A 95% confidence interval is [1.514, 1.86]. EPA went with the Chi-square test because observed violation numbers seem sufficiently large to justify the test. Textbook examples and NIST's handbook often have smaller numbers (<http://www.itl.nist.gov/div898/handbook/>).

II. Observations regarding system characteristics and TCR violation rates that are consistent over time.

Observations Regarding Consistency over Time for relationship between Systems Size and Violation Rate:

- Total MCL and Monthly MCL violations: a higher proportion of systems in the middle size classes (3,301-50,000) incur violations relative to systems in other size classes. A smaller proportion of systems in the larger size classes (>50,000) incur violations than do systems in other size classes.
- Acute MCL violations: a higher proportion of systems in the small size class (101-500) incur violations relative to systems in other size classes. A smaller proportion of systems in the middle size classes (1,001-10,000) incur violations than do systems in other size classes.
- Routine Major and Repeat Major violations: systems in the smallest size class (<100) incur them with higher frequency relative to all other systems, while systems in the middle and large size classes (>500) incur them with relatively lower frequency.
- Routine Minor and Repeat Minor violations: systems in the smallest size class (<100) incur them with relatively lower frequency.

Observations Regarding Consistency over Time for relationship between System Type and Violation Rate:

- Total and Monthly MCL violations: a higher proportion of CWS incur violations relative to other systems. A smaller proportion of TNCWS incur violations relative to other systems.

- Routine Major violations: CWS incur violations with relatively lower frequency, and TNCWS incur them with relatively higher frequency.
- Routine Minor and Repeat Minor violations: CWS incur violations more frequently than do other systems, while NTNCWS and TNCWS incur them less frequently than do other systems.

Observations Regarding Consistency over Time for relationship between Systems Source and Violation Rate:

- Total and Monthly MCL violations: a higher proportion of GU systems incur violations relative to other systems. A smaller proportion of SW systems incur violations than do other systems.
- Acute MCL violations: a higher proportion of GU and SW systems incur violations relative to other systems. A smaller proportion of GW systems incur violations than do other systems.
- Routine Major and Repeat Major violations: GU and GW systems incur them with relatively higher frequency, and SW systems incur them with relatively lower frequency.
- Routine Minor and Repeat Minor violations: GU systems again incur these violations relatively frequently. GW system incur them relatively infrequently.

IV. Observations Regarding the relationship between season and the number of acute MCL violations for each system type.

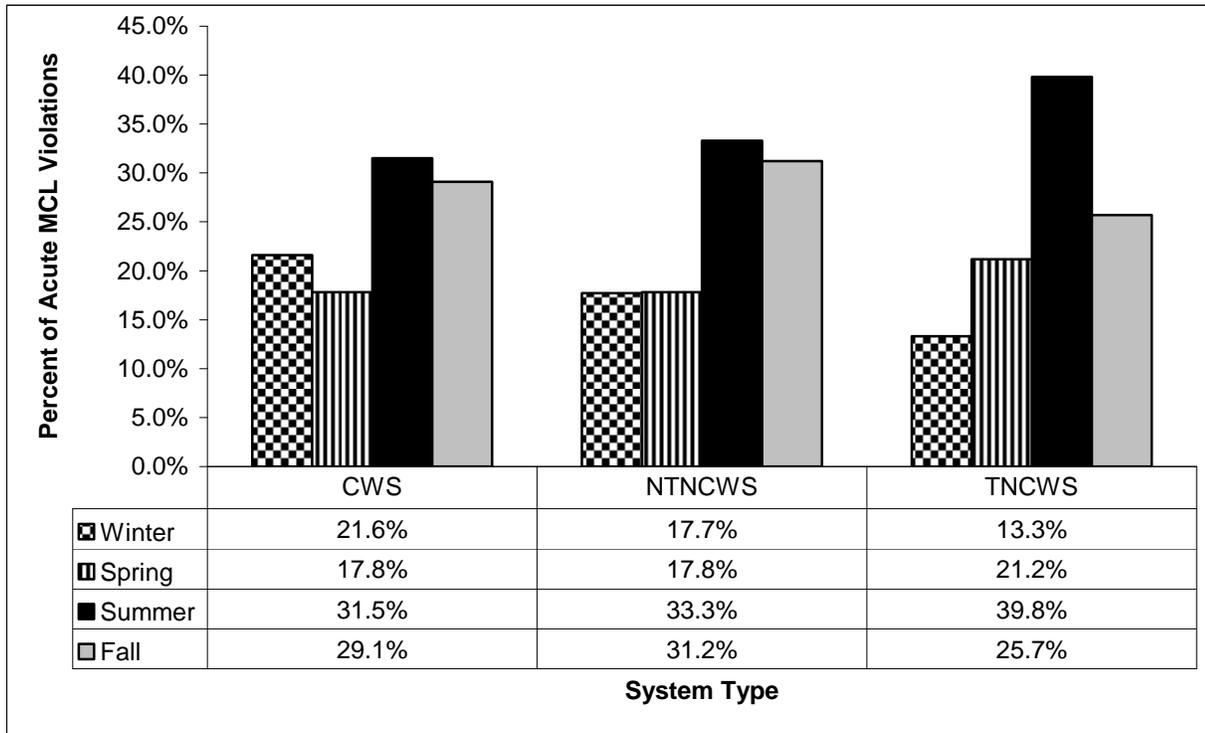
Climate can have a large impact on microbial growth and contamination. For example, warmer temperatures and an increase in precipitation events can lead to higher microbial growth rates. To determine whether seasonality has an effect on acute MCL violations, we examined the number of acute MCL violations for each month, FY 1997- FY 2003, as shown in Exhibit 22. Initial examination of the data suggested that the highest amount of acute MCL violations occurred during the months with the warmest weather.

While climate is one potential factor that could be driving this trend, water usage patterns may also influence the number of violations in a warm month. For example, TNCWS generally have higher use during the summer since they are typically associated with vacation areas. An increase in violations is more likely when there is greater water usage and sampling.

To examine the impact of seasonality in systems that have consistent usage (e.g. CWS), and those that have fluctuating usage (e.g. TNCWS), we examined the number of acute MCL violations by system type. Additionally, we defined four seasons: 1) Winter (December through February), 2) Spring (March through May), 3) Summer (June through August), and 4) Fall (September through November). For each season and each system type, we calculated the percent of violations that accrued during each season. For example, there were a total of 1129 acute violations during the winter season (December through February) for CWS. The total number of acute violations for CWS systems from FY 1997– FY 2003 was 5219. Therefore, for CWS systems, 21.6% (1129 / 5219) of all acute violations from 1997-2003 occurred

during the winter season. Exhibit-K10 describes the seasonal distribution of acute MCL Violations for CWS, NTNCWS, and TNCWS systems.

Exhibit K-5: Percent of Acute MCL Violations that Occur Each Season for Each System Type



Our preliminary assessment of the data revealed the following trends:

- Summer has the highest percentage of acute MCL violations for all system types.
- The difference between summer vs. spring and summer vs. winter is much more pronounced than the difference between summer vs. fall, especially for CWS and NTNCWS systems.

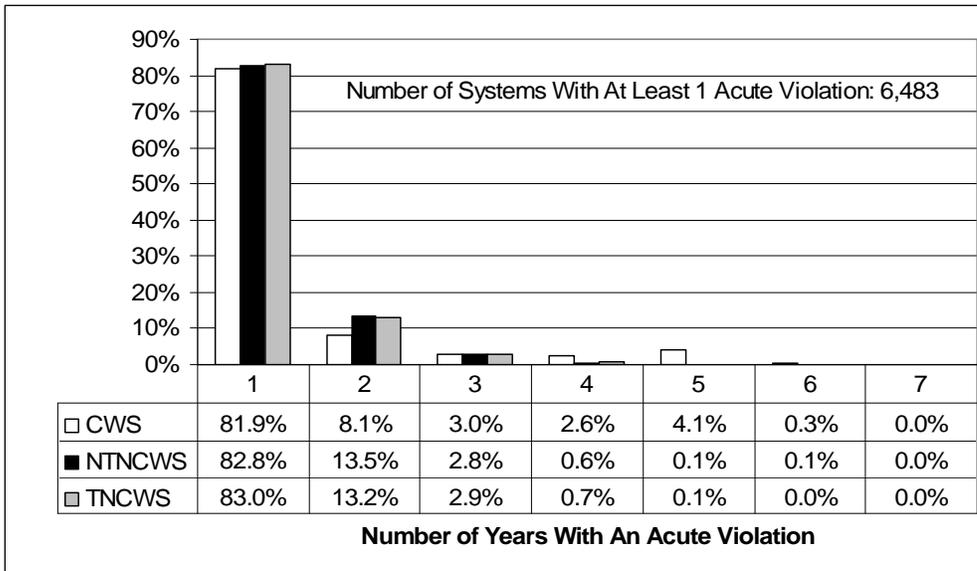
For all water systems, the percent of acute MCL violations in summer was greater than in spring or in winter. The percent of acute violations in summer was greater for TNCWS (39.8%) than for NTNCWS and CWS (33.3 and 31.5 %, respectively). This could in part be due to the fact that transient, non-community systems are typically associated with vacation areas, which has a higher proportion of use and water quality testing in summer than in other seasons. On the other hand, NTNCWS and CWS have a more uniform distribution of usage and testing among the seasons. Climate is another important variable that may be driving this patterns, as higher temperatures and precipitation rates generally occur from June-September. This climate effect is most strongly supported by the fact that NTNCWS and CWS have a higher percentage of violations in summer, but fairly consistent usage rates throughout the year, which removes the effect of increase usage in the summer that is associated with TNCWS systems.

The percent of acute violations was greater in summer than fall for all system types, however this difference was only statistically significant for TNCWS systems, which had a difference of 14.1%. For NTNCWS and CWS systems, there was only a difference of 2.1% and 2.4%, respectively.

APPENDIX L

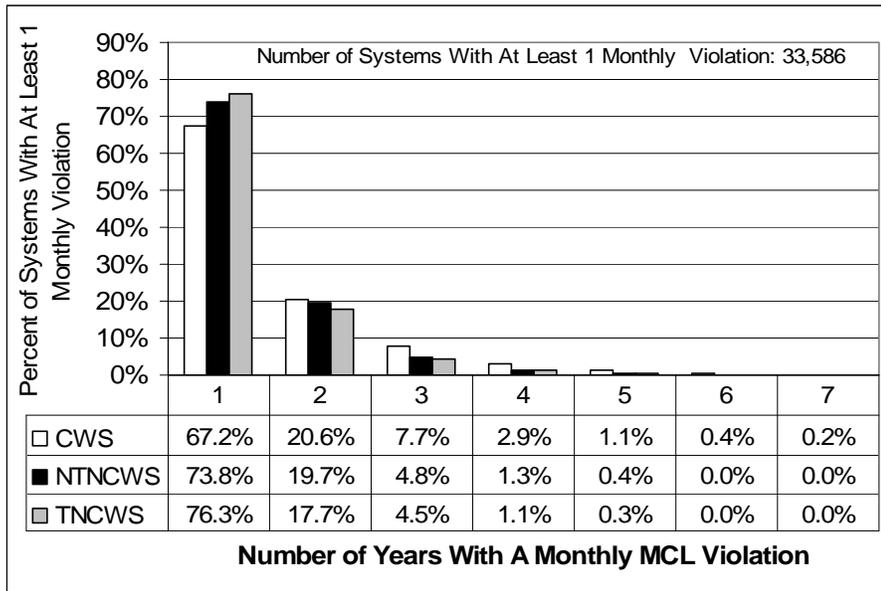
ANALYSIS OF REPEAT VIOLATIONS BY SYSTEM TYPE, SOURCE, AND SYSTEM SIZE

**Exhibit L-1: Percent of Systems With Acute Violations In A Given Number of Years
By Type of System**



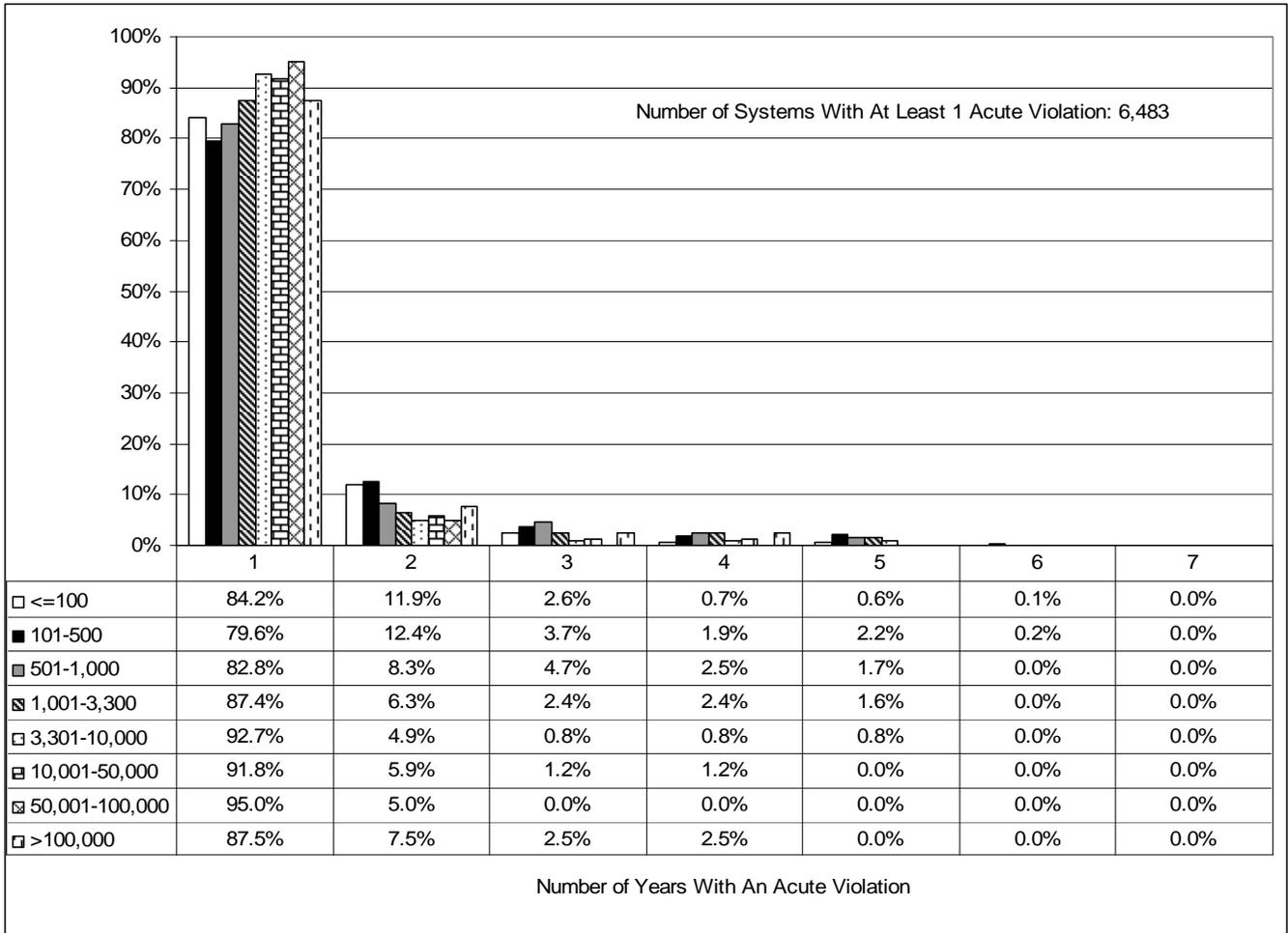
- A higher percentage of CWSs had Acute violations in 6 of 7 years.
- No TNCWSs had Acute violations in 6 of 7 years.
- Over twice as many CWSs have chronic Acute violations (violations in 3 or more years) than NTNCWSs and TNCWSs.

**Exhibit L-2: Percent of Systems With Monthly Violations In A Given Number of Years
By Type of System**



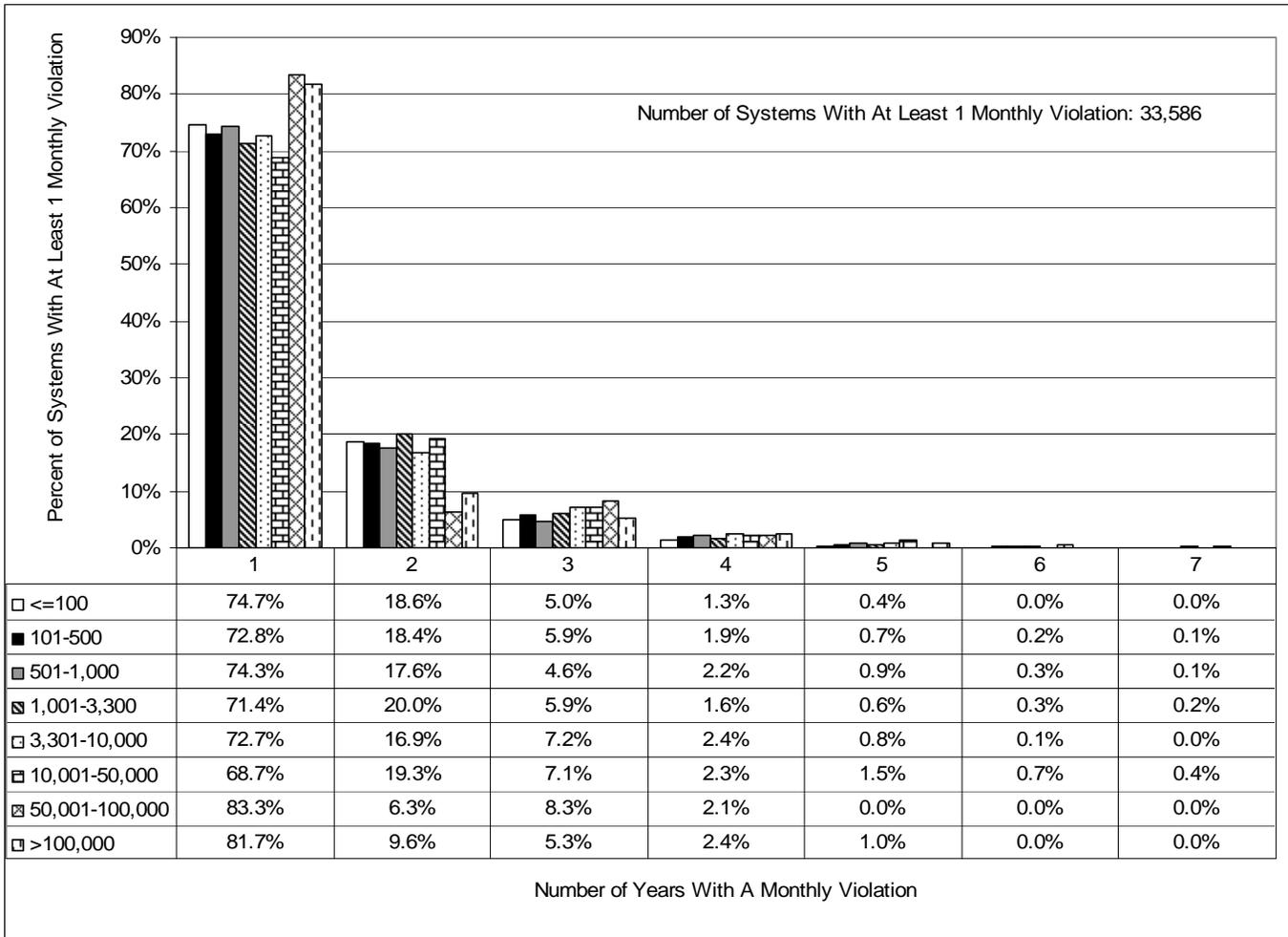
- A higher percentage of CWSs had Acute violations in 6 of 7 years or in all 7 years.
- No TNCWSs or NTNCWSs had Acute violations in 6 of 7 years or in all 7 years.
- Approximately twice as many CWSs have chronic Acute violations (violations in 3 or more years) than NTNCWSs and TNCWSs.

**Exhibit L-3: Percent of Systems With Acute Violations In A Given Number of Years
By System Size**

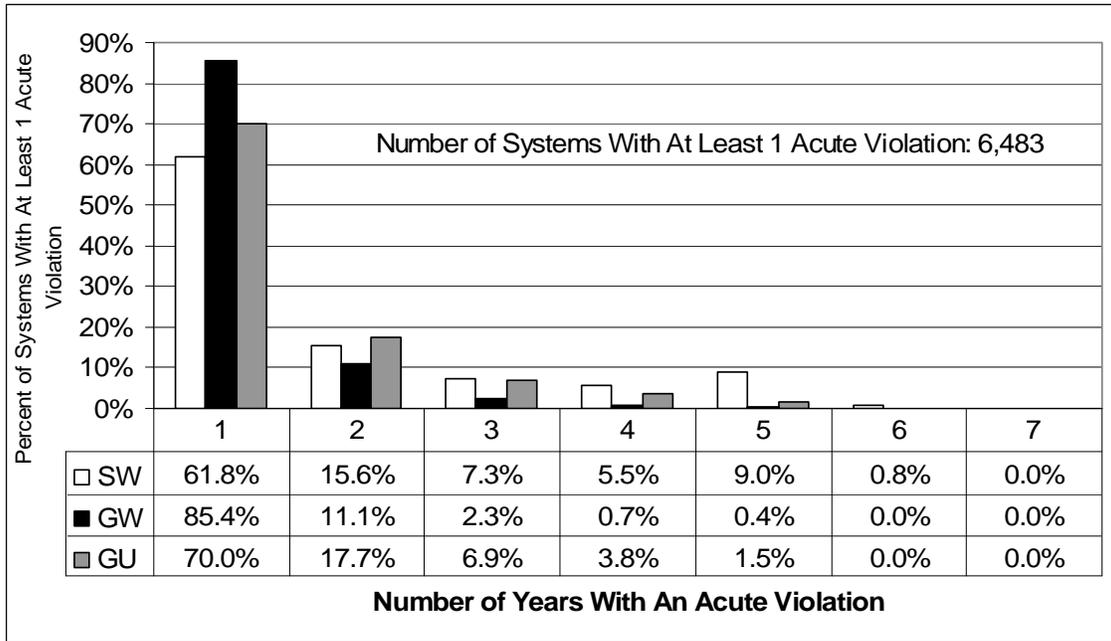


- Only systems in the two smallest size categories had Acute violations in 6 of 7 years.
- The highest rate of chronic violators (Acute violations in 3 or more years) are in the 101-500, 501-1,000 and 1,001-3,300 size categories.

**Exhibit L-4: Percent of Systems With Monthly Violations In A Given Number of Years
By System Size**



**Exhibit L-5: Percent of Systems With Acute Violations In A Given Number of Years
By Source**



**Exhibit L-6: Percent of Systems With Monthly Violations In A Given Number of Years
By Source**

