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Environmental Protection
Agency

Economic Analysis
for the
Final Revised Total Coliform Rule

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List of Acronyms

A/CA	Assessment and corrective action if necessary
AGI	Acute Gastrointestinal Illness
AIDS	Acquired Immune Deficiency Syndrome
AIP	Agreement in Principle
ASDWA	Association of State Drinking Water Administrators
BMPs	Best Management Practices
CAs	Corrective Actions
CCR	Consumer Confidence Report
CDC	Centers for Disease Control and Prevention
CEA	Cost Effectiveness Analysis
COI	Cost of Illness
CWS	Community Water System
DBP	Disinfection Byproduct
DBPR	Disinfection Byproducts Rule
DisGW	Disinfected Ground Water
DisinfSW	Disinfected Surface Water
DV	Data Verification
EA	Economic Analysis
EC	*E. coli* bacteria
EC+	*E. coli*-positive
ECI	Employee Cost Index
EO	Executive Order
EPA	United States Environmental Protection Agency
ERS	Economic Research Service
FAC	Federal Advisory Committee
FACA	Federal Advisory Committee Act
FC	Fecal coliform bacteria
FC+	Fecal Coliform-positive
FDA	U.S. Food and Drug Administration
FR	*Federal Register*
GW	Ground Water
GWR	Ground Water Rule
GWUDI	Ground Water Under the Direct Influence of Surface Water
HAA5	Five Haloacetic Acids
HAV	Hepatitis A Virus
HEV	Hepatitis E Virus
HHS	U.S. Department of Health and Human Services
HUS	Hemolytic Uremic Syndrome
ICR	Information Collection Rule
ICR	Information Collection Request
IDSEs	Initial Distribution System Evaluations
IESWTR	Interim Enhanced Surface Water Treatment Rule
KRPEC	Number of repeat TC-positive samples assayed that tested positive for EC
KRPTC	Number positive repeat samples during year

KRTEC	Number of routine TC-positive samples assayed that tested positive for EC
KRTTC	Number positive routine samples during year
LRAAs	Locational Running Annual Averages
LT1ESWTR	Long Term 1 Enhanced Surface Water Treatment Rule
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
M/DBP	Microbial/Disinfection By-Product
M/Q/A	Monthly, Quarterly, and Annual
MAC	*Mycobacterium avium* Complex
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCMC	Bayesian Markov Chain Monte Carlo
MLEs	Maximum Likelihood Estimates
MRDLGs	Maximum Residual Disinfectant Level Goals
MRDLs	Maximum Residual Disinfectant Levels
NAICS	North American Industry Classification System
NCWS	Non-Community Water System
NDPWR	National Primary Drinking Water Regulation
NondisGW	Nondisinfected ground water
NPDWRs	National Primary Drinking Water Regulations
NRPEC	Number of repeat TC-positive samples that were assayed for EC
NRPTC	Total number repeat samples assayed
NRTEC	Number of routine TC-positive samples that were assayed for EC
NRTTC	Number routine samples assayed
NTNC	Nontransient Noncommunity
NTNCWS	Nontransient Noncommunity Water System
NTTAA	National Technology Transfer and Advancement Act
NTUs	Nephelometric Turbidity Units
O&M	Operations and Maintenance
OMB	Office of Management and Budget
PAM	Primary Amoebic Meningioencephalitis
PN	Public Notification
POU	Point of Use
pRPEC	Repeat probability that a TC-positive repeat sample will also test EC-positive
pRPTC	Probability that a repeat sample will test positive
pRTEC	Probability that a TC-positive routine sample will also test EC-positive
pRTTC	Probability that a routine sample will test positive
PWSs	Public Water Systems
RAA	Running Annual Average
RFA	Regulatory Flexibility Act
RPEC	Repeat *E. coli*
RPTC	Repeat TC
RTCR	Revised Total Coliform Rule
RTEC	Routine *E. coli*
RTTC	Routine TC

SAB	Science Advisory Board
SBA	Small Business Administration
SBREFA	Small Business Regulatory Enforcement Fairness Act
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SDWIS/FED	Safe Drinking Water Information System Federal Version
Six Year Review	Six Year Review of National Primary Drinking Water Regulations
SS	Sanitary survey
STEC	Shiga toxin-producing *E. coli*
SW	Surface Water
SWTR	Surface Water Treatment Rule
TC	Total Coliform bacteria
TC+	Total Coliform-positive
TCR	Total Coliform Rule
TCRDSAC	Total Coliform Rule/Distribution System Advisory Committee
TMF	Technical, Managerial, and Financial
TNC	Transient Noncommunity
TNCWS	Transient Noncommunity Water Systems
TTHM	Total Trihalomethane
TWG	Technical Work Group
UMRA	Unfunded Mandates Reform Act
UV	Ultraviolet light
VSL	Value of a Statistical Life

Health Risk Reduction and Cost Analysis

Under the Safe Drinking Water Act (SDWA) Amendments of 1996, when promulgating a national primary drinking water regulation that includes a maximum contaminant level (MCL), the U.S. Environmental Protection Agency (EPA) must conduct a health risk reduction and cost analysis (HRRCA). A HRRCA addresses seven requirements, all of which are addressed in this economic analysis (EA) for the final Revised Total Coliform Rule (RTCR).

HRRCA Crosswalk Summary

HRRCA Requirement	Addressed in Economic Analysis
Quantifiable and nonquantifiable health risk reduction benefits	Chapter 6 (all sections) Chapter 8 (sections 8.8) Chapter 9 (sections 9.1.1, 9.2.2, and 9.3)
Quantifiable and nonquantifiable health risk reduction benefits from co-occurring contaminants	Chapter 6 (section 6.5.1, 6.5.4) Chapter 9 (section 9.2.2)
Quantifiable and nonquantifiable costs	Chapter 7 (all sections) Chapter 8 (sections 8.3–8.5, and 8.14) Chapter 9 (sections 9.1.2, 9.1.3, 9.2.2, and 9.3)
Incremental costs and benefits associated with regulatory options	Chapter 6 (sections 6.2 and 6.3) Chapter 7 (sections 7.4, 7.5, and 7.8) Chapter 9 (sections 9.1 and 9.3)
Effects of the contaminants on the general population and sensitive subpopulations	Chapter 2 (section 2.2) Chapter 6 (all sections) Chapter 8 (section 8.13) Chapter 9 (sections 9.1.1, 9.2.2, and 9.3)
Increased health risk that may occur as a result of compliance	Chapter 6 (section 6.2) Chapter 9 (section 9.1.1)
Other relevant factors (quality and uncertainty of information)	Chapter 4 (sections 4.2 and 4.3) Chapter 5 (section 5.3.3.1) Chapter 6 (section 6.4) Chapter 7 (section 7.7) Chapter 9 (section 9.2.1)

Executive Summary

This economic analysis (EA) presents the evaluation of the benefits and costs of the Revised Total Coliform Rule (RTCR). The analysis is performed in compliance with Executive Order 12866, *Regulatory Planning and Review* (58 *Federal Register* (FR) 51735, September 1993), which requires the United States Environmental Protection Agency (EPA or Agency) to estimate the economic impact of rules that have an annual effect on the economy of over $100 million. The Order further requires agencies to make the analysis for an "economically significant" rule available to the public in conjunction with publication of the proposed rule. Although EPA's analysis of the RTCR has determined that its annual costs are below this threshold, EPA has chosen to publish a complete EA for this rule.

The revisions to the 1989 Total Coliform Rule (1989 TCR) are in accordance with the Safe Drinking Water Act (SDWA) as amended, which requires EPA to review and revise, as appropriate, each national primary drinking water regulation (NPDWR) promulgated under the SDWA at least every six years. In the Six-Year Review determination published in July 2003, EPA gave notice of its intent to review the 1989 TCR. EPA has since developed the proposed RTCR in collaboration with states, other interested stakeholders, and the Total Coliform Rule/Distribution System Advisory Committee (TCRDSAC), and then developed the final rule after assessing the comments received on the proposal. The Agency's primary reasons for revising the 1989 TCR are implementation-related issues. The RTCR offers a meaningful opportunity for greater public health protection against fecal contamination and waterborne pathogens in the distribution systems of public water systems (PWSs) beyond the 1989 TCR. As with the 1989 TCR, the RTCR applies to all PWSs.

ES.1 Need for the Rule

EPA promulgated the 1989 TCR to decrease the risk of waterborne illness. Among all SDWA rules promulgated for preventing waterborne illness, only the 1989 TCR applies to all PWSs, making the rule an essential component of the multi-barrier approach in public health protection against endemic (and epidemic) disease. The objectives of the 1989 TCR are: (1) to evaluate the effectiveness of treatment, (2) to determine the integrity of the distribution system, and (3) to signal the possible presence of fecal contamination.

In recent years, the number of violations under the 1989 TCR has remained relatively steady, as shown in Exhibit 4.11 and discussed in Appendix G of the RTCR EA. EPA believes that this is reflective of a steady state among PWSs complying with the 1989 TCR; improvements likely to occur under that rule have largely been achieved. In outlining recommendations for further reductions in occurrence, in September 2008 EPA and the TCRDSAC developed the Agreement in Principle (AIP), which has become the basis for the structure of the RTCR. EPA published a proposed RTCR which was consistent with the recommendations in the AIP. As a result of public comments received some provisions of the RTCR were changed from the proposal. However, the final RTCR remains largely consistent with the recommendations in the AIP.

In combination with the other SDWA rules, the RTCR will better address the 1989 TCR objectives and enhance the multi-barrier approach to protecting public health, especially with

respect to small ground water PWSs. The RTCR maintains the three objectives of the 1989 TCR, but better addresses these objectives by requiring systems that may be vulnerable to fecal contamination (as indicated by their monitoring results) to do an assessment, to identify whether any sanitary defect(s) is (are) present, and to correct the defects. Therefore, greater public health protection is anticipated under the RTCR compared to the 1989 TCR because of its more preventive approach to identifying and fixing problems that affect or may affect public health. The key provisions of the rule are summarized in Section ES.3.

Public health concerns, fecal contamination, and waterborne pathogens

SDWA section 1412(b)(9) requires that any revision to an NPDWR "shall maintain, or provide greater, protection of the health of persons." The RTCR aims to increase public health protection through the reduction of potential pathways of entry for fecal contamination into the distribution system. Since these potential pathways represent vulnerabilities in the distribution system whereby fecal contamination and/or waterborne pathogens, including bacteria, viruses, and parasitic protozoa could possibly enter the system, the reduction of these pathways in general should lead to reduced exposure and associated risk from the contaminants. Fecal contamination and waterborne pathogens can cause a variety of illnesses, including acute gastrointestinal illness (AGI) with diarrhea, abdominal discomfort, nausea, vomiting, and other symptoms. Most AGI cases are of short duration and result in mild illness. Other more severe illnesses caused by waterborne pathogens include hemolytic uremic syndrome (HUS) (kidney failure), hepatitis, and bloody diarrhea (WHO, 2004). Chronic disease such as irritable bowel syndrome, reduced kidney function, hypertension and reactive arthritis can result from infection by a waterborne agent (Clark et al., 2008).

When humans are exposed to and infected by an enteric pathogen, the pathogen becomes capable of reproducing in the gastrointestinal tract. As a result, healthy humans shed pathogens in their feces for a period ranging from days to weeks. This shedding of pathogens often occurs in the absence of any signs of clinical illness. Regardless of whether a pathogen causes clinical illness in the person who sheds it in his or her feces, the pathogen being shed may infect other people directly by person-to-person spread, contact with contaminated surfaces, and other means which are referred to as secondary spread. As a result, pathogens that are initially waterborne may subsequently infect other people through a variety of routes (WHO, 2004). Sensitive subpopulations are at greater risk from waterborne disease than the general population (Gerba et al., 1996).

Indicators

Total coliforms (TC) are a group of closely related bacteria that, with few exceptions, are not harmful to humans. Coliforms are abundant in the feces of warm-blooded animals, but can also be found in aquatic environments, in soil, and on vegetation. Coliform bacteria may be transported to surface water by runoff or to ground water by infiltration. TC bacteria are common in ambient water and may be injured by environmental stresses such as lack of nutrients, and water treatments such as chlorine disinfection, in a manner similar to most bacterial pathogens and many viral enteric pathogens (including fecal pathogens). EPA considers TC to be a useful indicator that a potential pathway exists through which fecal contamination can enter the distribution system. The absence (versus the presence) of TC in the distribution system indicates

a reduced likelihood that fecal contamination and/or waterborne pathogens are occurring in the distribution system.

Under the 1989 TCR, each total coliform-positive (TC+) sample is assayed for either fecal coliforms or *E. coli*. Fecal coliform bacteria are a subgroup of TCs that traditionally have been associated with fecal contamination. Since the promulgation of the 1989 TCR, more information and understanding of the suitability of fecal coliform and *E. coli* as indicators have become available. Study has shown that the fecal coliform assay is imprecise and too often captures bacteria that do not originate in the human or mammal gut (Edberg et al., 2000). On the other hand, *E. coli* is a more restricted group of coliform bacteria that almost always originate in the human or animal gut (Edberg et al., 2000). Thus, *E. coli* is a better indicator of fecal contamination than fecal coliforms.

Presence of fecal contamination

EPA believes that *E. coli* is a meaningful indicator for fecal contamination and the potential presence of associated pathogen occurrence. Fecal contamination is a very general term that includes all of the organisms found in feces, both pathogenic and nonpathogenic. Fecal contamination can occur in drinking water both through use of contaminated source water as well as direct intrusion of fecal contamination into the drinking water distribution system. Biofilms in distribution systems may harbor waterborne bacterial pathogens and accumulate enteric viruses and parasitic protozoa (Skraber et al., 2005; Helmi et al., 2008). Waterborne pathogens in biofilms may have entered the distribution system as fecal contamination from humans or animals.

Co-occurrence of indicators and waterborne pathogens is difficult to measure. The analytical methods approved by EPA to assay for *E. coli* do not specifically identify most of the pathogenic *E. coli* strains. There are at least 700 recognized *E. coli* strains (Kaper et al., 2004). About 10 percent of recognized *E. coli* strains are pathogenic to humans (Feng, 1995; Hussein, 2007; Kaper et al., 2004). Pathogenic *E. coli* include *E. coli* O157:H7, which is the primary cause of HUS in the United States (Rangel et al., 2005). The US Centers for Disease Control and Prevention (CDC) estimates that there are 73,000 cases of illness each year in the US due to *E. coli* O157:H7 (Mead et al., 1999). The CDC estimates that about 15 percent of all *reported E. coli* O157:H7 cases are due to water contamination (Rangel et al., 2005). Active surveillance by CDC shows that 6.3 percent of *E. coli* O157:H7 cases progress to HUS (Griffin and Tauxe, 1991; Gould et al., 2009) and about 12 percent of HUS cases result in death within four years (Garg et al., 2003). About 4 to 15 percent of cases are transmitted within households by secondary transmission (Parry and Salmon, 1998).

Because EPA-approved standard methods for *E. coli* do not typically identify the presence of the pathogenic *E. coli* strains, an *E. coli*-positive monitoring result is an indicator of fecal contamination but is not necessarily a measure of waterborne pathogen occurrence. Specialized assays and methods are used to identify waterborne pathogens, including pathogenic *E. coli*.

One notable exception is the data reported by Cooley et al. (2007), which showed high concentrations of pathogenic *E. coli* strains in samples containing high concentrations of fecal

indicator *E. coli*. These data are from streams and other poor quality surface waters surrounding California spinach fields associated with the 2006 *E. coli* O157:H7 foodborne outbreak. Data equivalent to these samples are not available from drinking water samples collected under the TCR.

Waterborne disease outbreaks

The CDC defines a waterborne disease outbreak as occurring when at least two persons (or one with amoebic meningoencephalitis) experience a similar illness after ingesting a specific drinking water contaminated with pathogens (or chemicals) (Kramer et al., 1996). The CDC maintains a database on waterborne disease outbreaks in the United States. The database is based upon responses to a voluntary and confidential survey form that is completed by state and local public health officials.

The National Research Council strongly suggests that the number of identified and reported outbreaks in the CDC database for surface and ground waters represents a small percentage of actual number of waterborne disease outbreaks (NRC, 1997; Bennett et al., 1987; Hopkins et al., 1985 for Colorado data). Underreporting occurs because most waterborne outbreaks in community water systems are not recognized until a sizable proportion of the population is ill (Perz et al., 1998; Craun, 1996), perhaps 1 percent to 2 percent of the population (Craun, 1996).

EPA drinking water regulations are designed to protect against endemic waterborne disease and to minimize waterborne outbreaks. In contrast to outbreaks, endemic disease refers to the persistent low to moderate level or the unusual ongoing occurrence of illness in a given population or geographic area (Craun, et al. 2006).

ES.2 Consideration of Regulatory Options

EPA evaluated the following three regulatory options as part of the regulatory development process: (1) 1989 TCR, (2) RTCR, and (3) Alternative option. EPA discusses the three regulatory options briefly in this executive summary and in greater detail in Chapter 3.

The first regulatory option, the 1989 TCR, reflects EPA's understanding of how the 1989 TCR (USEPA, 1989, 54 FR 27544, June 29, 1989) is currently being implemented. That is, the 1989 TCR is assumed to include "status quo" PWS and state implementation practices. The second regulatory option, which is the preferred regulatory option, is the RTCR. The RTCR is a revision of the 1989 TCR based on the recommendations of the advisory committee. The provisions of the preferred regulatory option are based on the AIP and are described in detail in section III of the preamble of the rule. The third regulatory option, the Alternative option, parallels the RTCR in most ways but includes variations of some of the provisions that were discussed by the advisory committee before consensus was reached on the AIP. Under the Alternative option, at the compliance date all PWSs are required to sample monthly for an initial period until they meet the eligibility criteria for reduced monitoring. EPA assumes that eligibility for reduced monitoring is determined during the next sanitary survey following the RTCR compliance date (corresponding to year 11 of the model runs presented later on in this EA). This more stringent approach differs from the RTCR that allows PWSs to continue to monitor at their

current frequencies (with an additional annual site visit or voluntary Level 2 assessment requirement for PWSs wishing to remain on annual monitoring) until they are triggered into an increased sampling frequency. Under the Alternative option, no PWSs are allowed to reduce monitoring to an annual basis. EPA defined the Alternative option this way and included it in this EA to assess the relative impacts of a more stringent rule and to better understand the balance between costs and public health protection.

To understand the relative impacts of the options, EPA gathered available data and information to develop and provide input into an occurrence and predictive model. EPA estimated both baseline conditions and changes to these conditions anticipated to occur over time as a result of these revised rule options. The analysis is described in more detail in the remainder of this EA.

ES.3 Summary of the RTCR Requirements

The RTCR maintains and strengthens the objectives of the 1989 TCR and is largely consistent with the recommendations in the AIP. The objectives are: (1) to evaluate the effectiveness of treatment, (2) to determine the integrity of the distribution system, and (3) to signal the possible presence of fecal contamination. The revised rule better addresses these objectives by requiring systems that may be vulnerable to fecal contamination (as indicated by their monitoring results) to do an assessment, to identify whether any sanitary defect(s) is (are) present, and to correct the defects. Therefore, greater public health protection is anticipated under the RTCR compared to the 1989 TCR because of its more preventive approach to identifying and fixing problems that affect or may affect public health. The following is an overview of the key provisions of the RTCR:

MCLG and MCL for E. coli and coliform treatment technique for protection against potential fecal contamination

The RTCR establishes a maximum contaminant level goal (MCLG) and maximum contaminant level (MCL) for *E. coli*. Under the RTCR there is no longer an MCL violation for multiple TC detections. The RTCR takes a preventive approach to protecting public health by establishing a coliform treatment technique for protection against potential fecal contamination. The treatment technique uses both TC and *E. coli* monitoring results to start an evaluation process that, where necessary, will require the PWS to conduct follow-up and corrective action that could prevent further incidences of contamination and exposure to fecal contamination and/or waterborne pathogens. See section III.B of the RTCR preamble (USEPA, 2010c) for a detailed discussion on the MCLG, MCL, and coliform treatment technique requirements.

Monitoring

As with the 1989 TCR, PWSs will continue to monitor for TC and *E. coli* according to a sample siting plan and schedule specific to the system.

Sample siting plans under the RTCR must continue to be representative of the water throughout the distribution system. Under the RTCR, systems will have the flexibility to propose repeat sample locations that will best verify and determine the extent of potential contamination of the distribution system rather than having to sample within five connections upstream and

downstream of the TC+ sample location. For some systems, most likely those that have limited or no distribution systems, the repeat samples may satisfy the requirement for source water samples. State approval is required because this constitutes a reduction in monitoring (no separate triggered source water samples), relative to requiring separate samples for compliance with the two rules. EPA believes that this reduction in monitoring is appropriate only if the state determines that the dual purpose sample provides public health protection equivalent to that provided by separate repeat and source water samples. On the other hand, EPA believes that dual purpose samples may not be appropriate for systems with extensive distribution systems because the reduction in monitoring (i.e., one less repeat sample in a distribution system that extends far from the source water sample site) may not provide public health protection equivalent to taking separate samples.

As with the 1989 TCR, the RTCR allows reduced monitoring for some small ground water systems. The RTCR is expected to improve public health protection compared to the 1989 TCR by requiring small ground water systems that are on or wish to move to reduced monitoring to meet certain eligibility criteria. Examples of the criteria include a sanitary survey showing that the system is free of sanitary defects, a clean compliance history for a minimum of 12 months, and a recurring annual site visit by the state and/or a voluntary Level 2 assessment by a party approved by the state, or meeting criteria established by the state.

For small ground water systems, the RTCR requires increased monitoring for higher-risk systems that meet certain criteria such as unacceptable compliance history under the RTCR. The RTCR specifies conditions under which systems will no longer be eligible for reduced monitoring and will therefore be required to return to routine monitoring or to monitor at an increased frequency.

The RTCR requires systems on a quarterly or annual monitoring frequency (applicable only to ground water systems serving 1,000 or fewer people) to conduct additional routine monitoring the month following one or more TC+ samples. Under the RTCR, systems must collect at least three routine samples during the next month, unless the state waives the additional routine monitoring. This is a reduction in the required number of additional routine samples from the 1989 TCR, which requires at least five routine samples in the month following a TC+ sample for all systems serving 4,100 or fewer people.

The 1989 TCR requires all systems serving 1,000 or fewer people to collect at least four repeat samples while PWSs serving greater than 1,000 people to collect three repeat samples. The revised rule requires three repeat samples after a routine TC+ sample, regardless of the system type and size.

Sections III.C and III.D of the RTCR preamble provide detailed discussions of the routine monitoring and repeat sampling requirements of the RTCR.

Seasonal systems

The RTCR establishes special monitoring requirements for seasonal systems for the first time. Seasonal systems represent a special case in that the shutdown and start-up of these water systems present additional opportunities for contamination to enter or spread through the

distribution system. Seasonal systems must demonstrate completion of a state-approved start-up procedure. In addition, they must designate the time period(s) for monitoring based on site-specific considerations (such as during periods of highest demand or highest vulnerability to contamination) in their state-reviewed sample siting plan. Section III.C.1.f of the RTCR preamble provides a detailed discussion of seasonal systems.

Assessment and corrective action

As part of a treatment technique, all PWSs are required to assess their systems when monitoring results show that the system may be vulnerable to contamination. Systems must conduct a simple self-assessment (Level 1) or a more detailed assessment (Level 2) depending on the level of concern raised by the results of the indicator sampling. The system is responsible for correcting any sanitary defect(s) found through either a Level 1 or Level 2 assessment. Section III.E of the RTCR preamble provides more discussion of the treatment technique requirement of the RTCR.

Violations and public notification

The RTCR establishes an *E. coli* MCL violation, a treatment technique violation, a monitoring violation, and a reporting violation. Public notification (PN) is required for each type of violation, depending on the degree of potential public health concern consistent with EPA's current PN requirements under 40 CFR part 141, subpart Q. The RTCR also modifies the PN and consumer confidence report language to reflect the construct of the revised rule and the role of TC as an indicator of a potential pathway for the contamination of the distribution system. Sections III.F and III.G of the RTCR preamble provide detailed discussions of violations and PN under the RTCR.

Transition to the RTCR

The RTCR allows all systems to transition to the revised rule at their 1989 TCR monitoring frequency, including systems on reduced monitoring under the 1989 TCR. States will then evaluate whether the system is on an appropriate monitoring schedule by performing a special monitoring evaluation during each sanitary survey to review the status of the system, including the distribution system. The first such evaluation will be conducted during the first scheduled sanitary survey after the effective date of the rule; a system may remain on its 1989 TCR monitoring schedule until this time unless it is triggered into more frequent monitoring. After its first evaluation, the state may allow the system to remain on its 1989 TCR monitoring schedule as long as the system meets the conditions for doing so. Initial grandfathering of monitoring frequencies reduces state burden by not requiring the state to determine appropriate monitoring frequency at the same time the state is working to adopt primacy, develop policies, and train their own staff and the PWSs in the state.

Exhibit ES.1 shows the implementation schedule, from year 1 through year 10, for the RTCR. PWSs will begin sampling under the RTCR in the fourth year after RTCR promulgation.[1]

ES.4 Systems Subject to the RTCR

The RTCR will apply to all PWSs in the United States. The baseline inventory for the EA is derived from EPA's Safe Drinking Water Information System (SDWIS), fourth quarter 2007 data (USEPA, 2007b),[2] which contains information reported by primacy agencies on the approximately 155,000 active PWSs. The systems are subdivided by water source (ground water or surface water), type (community water systems (CWS), nontransient noncommunity water systems (NTNCWS), and transient noncommunity water systems (TNCWS)), and size (nine size categories ranging from those serving 100 or fewer people to those serving more than 1 million people).

EPA developed the baseline water quality used in the RTCR EA from the Six-Year Review 2 data collected between 1998 and 2005, which include coliform monitoring data voluntarily provided to EPA by 37 primacy agencies (35 states and 2 tribes). The database consists of over nine million 1989 TCR records collected between 1998 and 2005. In addition, EPA incorporated information from the GWR, the U.S. Census, and the 1989 TCR to develop assumptions for the model.

EPA used the available data and the requirements of the regulatory options considered to develop a model that predicts the number of systems in each category that experience TC+ and *E. coli*+ assays over the 25-year period of analysis. The results of the occurrence model and cost model indicate the number of systems that conduct the various activities under three regulatory options (1989 TCR, RTCR, and Alternative option). These results are discussed in terms of benefits of the current rule (changes in *E. coli* MCL violations incurred and corrective actions to be implemented) and rule costs in Section ES.5 below.

ES.5 National Benefits and Costs of the RTCR

The consensus resulting from TCRDSAC deliberations was that an RTCR consistent with the AIP would achieve a net risk reduction compared to the 1989 TCR. The committee applied best professional judgment in determining that the increased protection provided by the new requirements for implementing focused assessments and appropriate corrective actions would more than offset any potential increase in risk introduced by the reduction in samples or other changes resulting from the RTCR.

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[1] Chapter 4 of the RTCR EA describes the baseline schedule under which systems would begin sampling following the RTCR effective date; Chapter 5 describes how the baseline schedule is adjusted, based on acute and non-acute violations incurred during an initial assessment period, to determine the steady state distribution of systems on monthly, quarterly, and annual sampling.

[2] SDWIS/Federal Version (SDWIS/FED) is a database created by EPA containing data submitted by States and regions regarding inventory as well as compliance with SDWA regulations.

Exhibit ES.1 Implementation Schedule

	Year									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
State	Implementation									
		Revising Sample Siting Plan								
				Routine Monitoring, Additional Routine Monitoring, Repeat Monitoring						
				Annual Site Visits						
				Level 1 and Level 2 Assessments						
				Correction Actions Based on Level 1 and Level 2 Assessments						
				Public Notification						
PWS	Implementation									
		Revising Sample Siting Plan								
				Routine Monitoring, Additional Routine Monitoring, Repeat Monitoring						
				Annual Site Visits						
				Level 1 and Level 2 Assessments						
				Correction Actions Based on Level 1 and Level 2 Assessments						
				Public Notification						

Source: Final Information Collection Request for the Revised Total Coliform Rule, Figure 4.1.
Note: Activities occurring in Year 10 continue throughout the remaining years of analysis

Based on limitations in available data (described further in Chapter 6, Section 6.4), EPA determined that benefits could not be calculated in terms of avoided cases of (or costs related to) morbidity or mortality. Since *E. coli* is an indicator of fecal contamination, EPA assumed that a decrease in *E. coli* occurrence in the distribution system would be associated with a decrease in fecal contamination in the distribution system. In general, this decrease in fecal contamination should reduce the potential risk to human health for PWS customers. Thus, any reduction in *E. coli* occurrence is considered a benefit of the RTCR. EPA's qualitative analysis in Section 6.2 of this EA considers the overall changes in occurrence of contaminant indicators under the RTCR as compared to the 1989 TCR, and predicts a net decrease in risk. As discussed in Chapter 6, this reduction in risk is an indicator of the benefits of the RTCR.

Sections ES.5.1 and ES.5.2 summarize the qualitative benefits analysis and the methods used to derive the costs of the rule, respectively. Section ES.5.1 describes the qualitative analyses of net changes in TC and *E. coli* occurrence anticipated to occur under the RTCR compared to the 1989 TCR. As found in Section ES.5.2, EPA's national cost estimates include cost to implement the rule; revise sample siting plans; conduct routine monitoring, additional routine monitoring, and repeat monitoring; perform Level 1 and Level 2 assessments; implement corrective actions; and provide PN in the case of violations. Estimates for present value and annualized national costs are presented using a 3 percent and 7 percent discount rate.[3] Chapters 6 (benefits), 7 (costs), and 9 (comparison of benefits and costs), as well as the appendices, provide a more detailed discussion of all the analyses discussed in the sections below.

Changes in risk associated with RTCR activities are characterized by their anticipated effects on potential pathways of contamination into PWS, as indicated by their effects on such pathways for TC/*E. coli*. These activities are considered under each rule component presented in Exhibit ES.3.

ES.5.1 Derivation of Benefits

In promulgating the RTCR, EPA expects to further reduce the risk of contamination of public drinking water from the current baseline risk under the 1989 TCR. The RTCR and Alternative option considered during development of this rule and analyzed as part of this EA (see Chapters 6, 7, and 9) are designed to achieve this reduction while maintaining public health protection in a cost-effective manner.

The EA examines the benefits in terms of tradeoffs between compliance with the 1989 TCR and the other options considered (RTCR and Alternative option). Because there are insufficient data reporting the co-occurrence in a single sample of fecal indicator *E. coli* and pathogenic organisms and because the available fecal indicator *E. coli* data from the Six-Year Review 2 dataset were limited to presence-absence data, EPA was unable to quantify health benefits for the RTCR. EPA used several methods to qualitatively evaluate the benefits of the

[3] There is much discussion among economists of the proper social discount rate to use for policy analysis. For RTCR cost analyses, calculations are made using two social discount rates (3 and 7 percent) thought to best represent current policy evaluation methodologies. Historically, the use of 3 percent is based on rates of return on relatively risk-free investments, as described in the *Guidelines for Preparing Economic Analyses* (USEPA, 2000b). The rate of 7 percent is a recommendation of the Office of Management and Budget (OMB) as an estimate of "before-tax rate of return to incremental private investment" (OMB, 1996).

RTCR and Alternative option. The qualitative evaluation uses both the judgment of EPA as informed by the TCRDSAC deliberations as well as quantitative estimates of changes in TC occurrence and counts of systems implementing corrective actions. The evaluation characterizes, in relative terms, the reduction in risk for each regulatory option as compared to baseline conditions.

As presented in the description of the baseline (see Chapter 4), the percentages of samples that are positive TC and *E. coli* are generally higher for PWSs serving 4,100 or fewer people than those serving more than 4,100 people. PWSs with higher TC and *E. coli* occurrence are more likely to be triggered into assessments and corrective action. As discussed previously, EPA believes that the assessments and corrective action will lead to a decrease in TC and *E. coli* occurrence. Because the PWSs serving 4,100 or fewer people have a higher initial *E. coli* occurrence and will be triggered into more assessments and corrective actions than larger PWSs, the increase in benefits for these small systems will likely be more evident as compared to the larger systems. In particular, model results suggest that customers of small ground water TNCWSs serving 100 or fewer people, which constitute approximately 40 percent of PWSs, experience the most improvement in water quality under the RTCR. That is, the occurrence of *E. coli* is predicted to decrease more for these systems that for other systems types.

When revising an existing drinking water regulation, one of the main concerns is to ensure that backsliding on water quality and public health protection does not occur. SDWA requires that EPA at least maintain or improve public health protection for any rule revision. EPA believes that the RTCR is more stringent than the 1989 TCR with regard to protecting public health. The basis for this perspective is provided in chapters 6 and 9 of this EA.

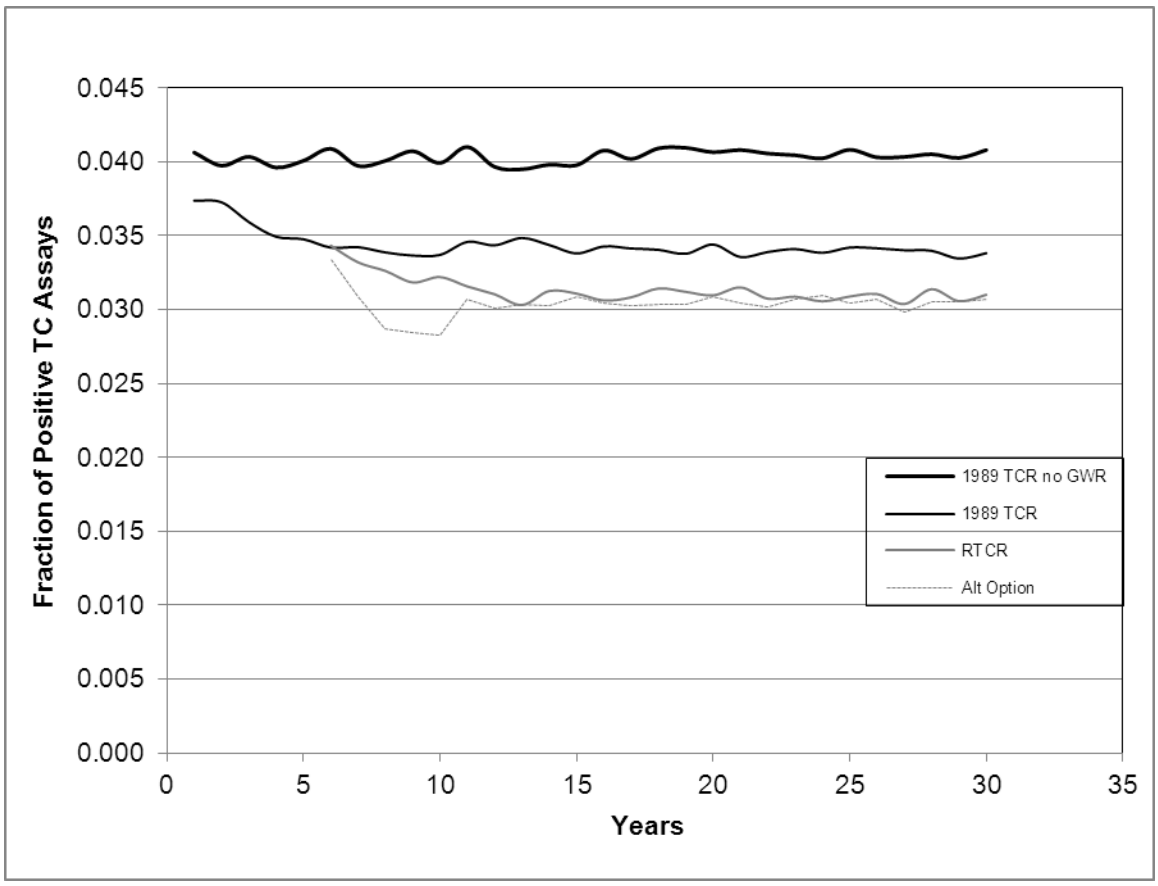
Risk reduction for the RTCR is characterized by the activities performed that are presumed to reduce risk of exposing the public to contaminated water. These activities are considered under each rule component presented in Exhibit ES.3.

More frequent monitoring has the potential to decrease the risk of contamination in PWSs based on an enhanced ability to diagnose and mitigate system issues in a more timely fashion. Conversely, less frequent monitoring has the potential to increase risk. Real-time continuous sampling would mitigate the most risk possible based on sampling schedule; however, it would cost prohibitively more than the periodic sampling practiced under the 1989 TCR and included in the RTCR and the Alternative option. EPA's objective in revising the sampling schedules included in the RTCR and Alternative option was to find an appropriate balance between the factors of risk mitigation and cost management.

Under the RTCR and Alternative option, the reduction in the number of repeat samples and additional routine samples for some PWSs has the potential to contribute to increased risk for PWS customers. However, this increase in risk is expected to be more than offset by potential decreases in risk from increased routine samples and the addition of the assessments and corrective action provisions that find and fix problems indicated by monitoring. Exhibit ES.2 illustrates the predicted reduced frequency at which TC occur subsequent to the implementation of the RTCR and Alternative option. As discussed previously, the RTCR uses TC and *E. coli* occurrence as an indicator of potential pathways for possible contamination to enter the distribution system. Exhibit ES.2 illustrates the combined effects on TC occurrence resulting

from changes in monitoring and the effects of assessments and corrective actions for the different rule options illustrated. The relative trends indicated in Exhibit ES.2 for small transient noncommunity ground water systems also pertain to other PWS categories as illustrated in Chapter 5. EPA chose to include the characterization for this set of TNCWSs because they represent the system category of largest influence on the national impacts.

Exhibit ES.2 Modeled TC+ Occurrence in Transient Noncommunity Ground Water Systems Serving ≤ 4,100



Notes:
1) Six Year 2005 TC+ occurrence is representative of all GW TNCWS. The rate presented may underestimate the occurrence for systems serving 25–4,100 individuals.
2) Graph shows the 30-year modeled period discussed in Ch. 5. Model years 3–27 represent the 25-year period of analysis for this EA. Model year 11 begins the steady state, during which systems that qualified for reduced monitoring are now sampling on their reduced schedules. The criteria and timing of this monitoring adjustment is discussed in Section 5.3.2.2 of this EA.
3) The results represented by the curves for 1989 TCR and RTCR and Alternative options all incorporate the effects of the GWR.

Exhibit ES.3 Potential Changes in Risk under the RTCR and Alternative Option Relative to the 1989 TCR

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	Alternative option	RTCR	Alternative option	RTCR	Alternative option
Implementation Activities	None	None	None	None	No change	No change
Routine Monitoring (Including Reduced Monitoring)	None	None	Increased stringency in requirements to qualify for reduced monitoring along with requirement to return to baseline monitoring upon loss of these criteria is expected to result in decreased risk (i.e., PWSs that qualify for reduced monitoring will be better operated, PWSs that no longer qualify will monitor more frequently).	PWSs all monitor monthly in the first few years of implementation of the RTCR, which is an increase in sampling frequency for systems that monitor quarterly or annually under the 1989 TCR. After the first few years, systems may reduce to quarterly, but none may reduce to annual monitoring, creating a decrease in risk for systems on annual monitoring under the 1989 TCR.	Decrease	Decrease
Repeat Monitoring	Required repeat samples reduced from 4 to 3 for systems serving ≤1,000 people	Required repeat samples reduced from 4 to 3 for systems serving ≤1,000 people	None	None	Increase	Increase
Additional Routine Monitoring	Additional routine samples are no longer required for PWSs monitoring monthly.	Additional routine samples are no longer required for PWSs monitoring monthly.	None	None	Increase	Increase

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	**Alternative option**	**RTCR**	**Alternative option**	**RTCR**	**Alternative option**
	GW PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.	GW PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.				
Annual Site Visits	None (only states currently performing annual site visits are expected to continue)	Annual monitoring is not permitted under the Alternative option so annual site visits will no longer be conducted.	None (only states currently performing annual site visits are expected to continue)	None	No change	Increase
Assessments	None	None	Mandatory assessments are a new requirement.	Mandatory assessments are a new requirement.	Decrease	Decrease
Corrective Actions	None	None	Mandatory corrective actions are a new requirement.	Mandatory corrective actions are a new requirement.	Decrease	Decrease
Public Notification—Monthly/Non-Acute MCL Violations	Reduction in available public information Possible PWS complacency	Reduction in available public information Possible PWS complacency	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Unknown	Unknown
Public Notification—Monitoring and Reporting Violations	None	None	Improved focus of required PN for rule aspects with potential adverse health consequences, notably *E. coli* MCL	Improved focus of required PN for rule aspects with potential adverse health consequences, notably *E. coli* MCL violations and	Decrease	Decrease

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	**Alternative option**	**RTCR**	**Alternative option**	**RTCR**	**Alternative option**
			violations and failure to conduct assessments and corrective actions, will motivate PWSs to conduct sampling and other treatment technique requirements.	failure to conduct assessments and corrective actions, will motivate PWSs to conduct sampling and other treatment technique requirements.		
Overall					Decrease	Decrease

Note:

1) Detailed discussion of the rationale for determinations of potential risk for each rule component is presented in Ch. 6 (Section 6.2) of this EA. Implementation activities consist of administrative activities by PWSs and states to implement the rule.
2) Assessment of potential changes in risk for monitoring components is an *overall* assessment. Potential changes (or static state) of risk for particular system sizes and types differ according to individual regulatory requirements and are discussed in Section 6.2. Chapter 3 provides a detailed description of the regulatory components for all three regulatory options, and the preamble to the RTCR provides additional discussion of the TCRDSAC process and the rationale underlying the structure of the regulatory options considered.

The effect that the changes to PN requirements under the 1989 TCR for monthly/non-acute MCL violations have on risk is difficult to predict. Some factors, such as reduction in available public information and possible PWS complacency, lead to a potential increase in risk and other factors, such as less confusion (PN more in line with potential health risks) and PWSs resources used more efficiently, lead to a potential decrease, as discussed in Chapter 9. This change to PN is addressing a key concern expressed by various stakeholders in the advisory committee and during the Six-Year Review 1 comment solicitation process. By eliminating the requirement and replacing it with assessment and corrective action requirements, the Agency expects less public confusion, more effective use of resources, increased transparency, and increased public health protection. Other rule components are expected to have a negligible effect on risk. However, the overall effect of the RTCR is expected to be a further reduction in risk from the current baseline risk under the 1989 TCR. Chapter 6 presents a detailed discussion of the potential influence on health risk for each rule component.

Although a qualitative analysis is the primary method employed for analyzing potential changes in risk, some quantitative measures are considered in the overall assessment of the RTCR, as presented in Chapter 9 of the RTCR EA. In particular, EPA developed a model to describe TC and *E. coli* occurrence in water systems for the 1989 TCR (baseline for this EA) and the RTCR and Alternative option. The model generates estimates of reduced TC and *E. coli* occurrence based on requirements of the RTCR and Alternative option to perform assessments and corrective actions not explicitly required in the 1989 TCR. In addition, the model takes into account in the baseline for the 1989 TCR the reductions attributable to the implementation of the GWR, which was effective as of December 2009. The predictive occurrence model and analyses results are discussed further in Chapters 5, 6, and 9.

Exhibit ES.4 presents the annual number of acute violations (1989 TCR) and *E. coli* MCL violations (RTCR and Alternative option) as predicted by the RTCR occurrence model in Year 9. By Year 9, PWSs that are expected to meet the criteria for reduced monitoring begin reduced monitoring, and the distribution of PWSs that monitor monthly, quarterly, and annually is assumed to remain relatively constant. EPA did not quantify changes in violation or trigger rates for systems serving more than 4,100 people among the 1989 TCR, RTCR, and Alternative option because of: (1) limited Six-Year Review data to characterize these systems, (2) the essentially unchanged monitoring requirements across options for these systems, and (3) the level of effort already occurring to implement the 1989 TCR.

The estimates of *E. coli* MCL violations have two major drivers: the total number of samples taken over time (including routine, additional routine, and repeat) and the impact of corrective actions taken. When looking at the comparisons between the 1989 TCR with the RTCR across all PWSs, the overall impact of the total numbers of samples taken is negligible because the total number of samples predicted to be taken throughout the period of analysis is almost the same (approximately 82 million samples) under both the 1989 TCR and the RTCR. For the Alternative option, the analysis predicts that 88 million total samples will be taken over the period of analysis.

The changes in the steady state estimates of annual *E. coli* MCL violations from the 1989 TCR to the RTCR and Alternative option are shown in Exhibit 6.5. The steady state in the model refers to the period beginning in years 7 (CWSs) and 9 (NCWSs) following promulgation, after

the proportions of systems sampling on monthly, quarterly, or annual regimens are adjusted following a period of assessment.[4] Systems that qualify for reduced monitoring will begin their new regimens in years 7 and 9 after promulgation, respectively, for CWSs and NCWSs. The annual number of acute violations (1989 TCR) and *E. coli* MCL violations (RTCR and Alternative option) shown in Exhibit ES.4 for small systems are from the predictive model and reflect the estimates for Year 9 of the 25-year period of analysis.

The steady state reductions in the number of annual *E. coli* MCL violations found under the RTCR and Alternative option primarily reflect the benefits of corrective actions under these two options in preventing many of the *E. coli* MCL violations that would otherwise occur over this period. Under the RTCR, reductions (or no increases) are predicted for all PWS sizes and types, while under the Alternative option, reductions (or no increases) are predicted for all PWSs except TNCWSs serving ≤1,000 people. For these small TNCWSs under the Alternative option, increased monitoring is expected to lead to an overall increase in annual *E. coli* MCL violations (and is also the driver of the greater total number of annual *E. coli* MCL violations predicted). The interplay of the reducing effect on *E. coli* MCL violations that required corrective actions induce and the increasing effect from reductions in some monitoring requirements are explored in Section 6.4 of this EA. The step-wise analysis presented in Section 6.4 shows how *E. coli* MCL violations could increase under the Alternative option and concludes that, on balance, more *E. coli* MCL events are prevented than are missed.

[4] The effective date of the RTCR occurs after 3 years of implementation, at the start of year 4 post-promulgation. For CWSs, years 4–6 post-promulgation are the period of assessment for considering potential to move to reduced monitoring for systems; for NCWSs, years 4–8 are the period of assessment.

Exhibit ES.4 Predicted Annual Number of Acute (1989 TCR) or *E. coli* MCL (RTCR and Alternative Option) Violations by Regulatory Option and System Type (Year 9)[1]

PWS Size (Population Served)	Number of Systems	1989 TCR	RTCR	Alternative Option
	A	B	C	D
Community Water Systems (CWSs) - SW				
≤100	1,170	7	5	5
101 - 500	2,150	7	8	8
501-1,000	1,173	5	4	4
1,001-4,100	2,938	8	7	7
4,101-33,000	3,164	9	9	9
33,001-96,000	720	3	3	3
96,001-500,000	308	1	1	1
500,001-1 Million	31	-	-	-
> 1 Million	17	-	-	-
Totals	**11,671**	**39**	**36**	**36**
Community Water Systems (CWSs) - GW				
≤100	11,938	58	41	40
101 - 500	13,892	40	35	36
501-1,000	4,467	13	7	8
1,001-4,100	6,443	26	15	15
4,101-33,000	3,156	12	12	12
33,001-96,000	335	2	2	2
96,001-500,000	63	0	0	0
500,001-1 Million	4	-	-	-
> 1 Million	3	-	-	-
Totals	**40,301**	**151**	**113**	**114**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW				
≤100	250	2	1	1
101 - 500	253	2	1	1
501-1,000	88	0	0	0
1,001-4,100	72	1	1	1
4,101-33,000	22	-	-	-
33,001-96,000	2	-	-	-
96,001-500,000	1	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Totals	**688**	**5**	**3**	**3**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW				
≤100	8,826	43	25	22
101 - 500	6,613	19	13	16
501-1,000	1,718	4	3	4
1,001-4,100	812	8	4	4
4,101-33,000	70	0	0	0
33,001-96,000	2	-	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Totals	**18,041**	**74**	**46**	**47**
Transient Noncommunity Water Systems (TNCWSs) - SW				
≤100	1,339	18	11	11
101 - 500	497	7	3	3
501-1,000	88	1	1	1
1,001-4,100	67	2	1	1
4,101-33,000	18	-	-	-
33,001-96,000	-	-	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	1	-	-	-
Totals	**2,010**	**29**	**16**	**16**
Transient Noncommunity Water Systems (TNCWSs) - GW				
≤100	60,200	339	237	279
101 - 500	19,275	96	69	95
501-1,000	1,963	11	9	8
1,001-4,100	617	8	5	5
4,101-33,000	67	0	0	0
33,001-96,000	2	-	-	-
96,001-500,000	1	-	-	-
500,001-1 Million	1	-	-	-
> 1 Million	-	-	-	-
Totals	**82,126**	**454**	**321**	**388**
Grand Total	**154,837**	**751**	**535**	**605**

Source: Output from RTCR models (described in Sections 5.3 and 5.4 of this EA).
Notes:
1) For modeling purposes, additional routine sample counts include regular routine samples taken in the same month.
2) Detail may not add due to independent rounding.

ES.5.2 Derivation of Costs

Costs are estimated for different PWS types and size categories (nine size categories are used based on population served) using unit costs obtained from the advisory committee technical work group and vendors and presented in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d). Cost analyses for PWSs include estimates to implement the rule; to revise sample siting plans; to conduct routine monitoring, additional routine monitoring, and repeat monitoring; to perform Level 1 and Level 2 assessments and implement corrective actions; and to provide PN in the case of violations. State cost analyses include estimates of the labor burdens that states would incur, including staff training on RTCR requirements, conducting annual administration, reviewing monitoring reports, reviewing and approving corrective action plans, and for recordkeeping. Chapter 7 of this EA provides detailed discussion on the underlying cost-buildup for each rule component included in the cost model.

National costs are estimated using a cost model specifically developed for the RTCR. The model builds on the occurrence model described in Chapter 5. Within the modeling structure, costs for PWSs serving more than 4,100 retail customers are analyzed differently from smaller PWSs to capture differing baseline structures and to account for differences in available occurrence data as described in Chapter 4 of this EA. The resulting national cost estimates for the RTCR regulatory options considered are shown in Exhibit ES.5. To evaluate the impact of costs under the RTCR, emphasis in this EA is placed on the net changes in costs of the RTCR or Alternative option compared to the 1989 TCR (i.e., incremental costs over the 1989 TCR), also shown in Exhibit ES.5.

As noted throughout the RTCR EA, there is variability among many of the input parameters to the cost model and several rule compliance assumptions based on PWS size and type (e.g., population served, labor rates, TC hit rates, and occurrence distributions are different for different sizes and types of PWSs). However, there is insufficient information to fully characterize the distribution of variability (i.e., calculating confidence bounds) within each of these PWS classifications on a national scale; therefore, EPA uses mean values for these input parameters.

EPA also recognizes that there is uncertainty in the national cost estimates. Many of the uncertainties have the same impact on both the 1989 TCR and RTCR and Alternative options (e.g., baseline assumptions and effects of GWR implementation). Because the EA analyses focus on net changes between the 1989 TCR and the RTCR and Alternative option, these common sources of uncertainty do not impact conclusions based on the net change analyses. For assumptions that are major drivers of the analyses and differ between the 1989 TCR and RTCR and Alternative option (e.g., corrective action compliance forecast), EPA has evaluated uncertainty and performed sensitivity analyses to qualitatively and quantitatively characterize the potential impacts of alternative input parameters. Chapters 4 and 5 present a comprehensive discussion of factors contributing uncertainty to the occurrence analysis. Chapter 5 presents a sensitivity analysis pertaining to the predictive occurrence model results, which also impact the cost calculations. Section 7.7 of the EA discusses uncertainty and provides sensitivity analysis results as they specifically pertain to the cost analyses.

Exhibit ES.5 Comparison of Total and Net Change from 1989 TCR in Annualized Present Value Costs ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ 185	$ 0.9	$ 186	$ 178	$ 0.9	$ 179
RTCR - Total	$ 199	$ 1.1	$ 200	$ 192	$ 1.3	$ 193
RTCR - Net Change	**$ 14**	**$ 0.1**	**$ 14**	**$ 14**	**$ 0.4**	**$ 14**
RTCR - Percent Change	**8%**	**16%**	**8%**	**8%**	**48%**	**8%**
Alternative Option - Total	$ 214	$ 1.2	$ 216	$ 209	$ 1.5	$ 210
Alternative Option - Net Change	**$ 29**	**$ 0.3**	**$ 30**	**$ 31**	**$ 0.6**	**$ 32**
Alternative Option - Percent Change	**16%**	**34%**	**16%**	**17%**	**69%**	**18%**

Source: RTCR cost model.
Notes:
1) Detail may not add due to independent rounding.
2) Annualized costs for the state are greater using the 7% than 3% discount rate for the RTCR and Alternative option. This occurs because the costs under the RTCR and Alternative option are frontloaded in the 25-year time period due to the all-monthly sampling requirement (which doesn't occur under the 1989 TCR). Discounting a given stream using 3% and 7% will always result in a higher present value using 3%; annualization of an identical value (any value) using 3% and 7% would result in a higher value under 7%. Depending on how costs accrue over the period, and how long the period is, one effect will be stronger than the other. Generally, the discounting effect is stronger, resulting in the pattern commonly seen where the 3% annualized amount is greater than the 7% one. However, in cases like the Alternative option where the costs accrue faster early in the time period, the annualization effect can more than compensate for the discounting effect, resulting in a higher annualized value under 7% compared to 3%.

ES.6 Projected Impacts on Household Costs

The household cost analysis considers the impact that the costs incurred by CWSs have on the households they serve. This analysis considers the potential increase in a household's annual water bill if a CWS passed the entire cost increase resulting from the rule on to their customers. This analysis is a tool to gauge potential impacts and should not be construed as a precise estimate of potential changes to household water bills. State costs and costs to TNCWSs and NTNCWSs are not included in this analysis since their costs are not typically passed through directly to households. Exhibit ES.6 presents the mean expected increases in annual household costs for all CWSs, including those systems that do not have to take corrective action. Exhibit ES.6 also presents the same information for CWSs that must take corrective action. Household costs tend to decrease as system size increases, due mainly to the economies of scale for the corrective actions.

The first section of Exhibit ES.6 presents net costs per household under the RTCR and Alternative option for all rule components spread across all CWSs. In this scenario, comparison to the 1989 TCR shows a cost savings for households in the largest size category. For those households that are expected to see a cost increase, the average annual water bill would be expected to increase by less than ten cents on average.

While the average increase in annual household water bills to implement the RTCR is less than a dollar, customers served by a small CWS that have to take corrective actions as a result of the rule would incur slightly larger increases in their water bills. The subsequent sections of the exhibit present net costs per household for three different subsets of CWSs (CWSs that perform assessments but no corrective actions, CWSs that do perform corrective

actions, and CWSs that do not perform assessments or corrective actions). As shown in the second section of Exhibit ES.6, approximately 67% of households are served by CWSs that would perform assessments but would not perform corrective actions (because no sanitary defects are found). The 9% of households belonging to CWSs that would perform corrective actions would experience an increase in annual net household costs of less than $1 on average for CWSs serving >4,100 people to approximately $26 for CWSs serving 100 people or fewer.

The final section of Exhibit ES.6 presents the 24% of households belonging to CWSs that would not perform assessments or corrective actions. Households of this category would experience an increase in cost savings when compared to those performing corrective actions, and a decrease in cost savings when compared to those performing assessments but no corrective actions. This decrease in costs savings is because no PN costs are associated with systems not performing assessments. Overall, the main driver of additional household costs under the RTCR is whether or not additional corrective actions are performed.

Exhibit ES.6 Summary of Net Annual Per-Household Costs for the RTCR (2007$)

PWS Size (Population Served)	Number of Households (RTCR)	Number of Households (Alternative Option)	3% Discount Rate				7% Discount Rate			
			RTCR Net	RTCR Net Cost per Household	Alternative Option Net	Alternative Option Net Cost per Household	RTCR Net	RTCR Net Cost per Household	Alternative Option Net	Alternative Option Net Cost per Household
	A	B	C	D=C/A	E	F=E/B	G	H=G/A	I	J=I/B
All Community Water Systems (CWSs)										
≤100	307,243	307,243	$ 111,694	$ 0.364	$ 225,693	$ 0.735	$ 207,140	$ 0.674	$ 348,782	$ 1.135
101-500	1,589,510	1,589,510	$ 371,004	$ 0.233	$ 464,207	$ 0.292	$ 471,664	$ 0.297	$ 598,244	$ 0.376
501-1,000	1,624,853	1,624,853	$ 46,687	$ 0.029	$ 87,294	$ 0.054	$ 96,473	$ 0.059	$ 148,274	$ 0.091
1,001-4,100	7,816,592	7,816,592	$ 371,294	$ 0.048	$ 371,294	$ 0.048	$ 418,935	$ 0.054	$ 418,935	$ 0.054
4,101-33,000	27,997,647	27,997,647	$ 2,385,056	$ 0.085	$ 2,385,056	$ 0.085	$ 2,083,266	$ 0.074	$ 2,083,266	$ 0.074
33,001-96,000	21,933,438	21,933,438	$ 1,532,410	$ 0.070	$ 1,532,410	$ 0.070	$ 1,273,202	$ 0.058	$ 1,273,202	$ 0.058
96,001-500,000	26,770,609	26,770,609	$ 1,479,280	$ 0.055	$ 1,479,280	$ 0.055	$ 1,214,316	$ 0.045	$ 1,214,316	$ 0.045
500,001-1 Million	9,764,979	9,764,979	$ 157,138	$ 0.016	$ 157,138	$ 0.016	$ 125,671	$ 0.013	$ 125,671	$ 0.013
> 1 Million	16,309,853	16,309,853	$ (2,223)	$ (0.000)	$ (2,223)	$ (0.000)	$ (1,479)	$ (0.000)	$ (1,479)	$ (0.000)
Total	**114,114,724**	**114,114,724**	**$ 6,452,342**	**$ 0.057**	**$ 6,700,151**	**$ 0.059**	**$ 5,889,190**	**$ 0.052**	**$ 6,209,211**	**$ 0.054**
Community Water Systems (CWSs) performing Level 1/Level 2 Assessments (and no Corrective Actions)										
≤100	125,340	124,920	$ (185,923)	$ (1.483)	$ (149,283)	$ (1.195)	$ (125,037)	$ (0.998)	$ (75,885)	$ (0.607)
101-500	460,577	464,568	$ (137,193)	$ (0.298)	$ (103,168)	$ (0.222)	$ (82,657)	$ (0.179)	$ (40,057)	$ (0.086)
501-1,000	394,643	401,009	$ (133,453)	$ (0.338)	$ (123,890)	$ (0.309)	$ (111,147)	$ (0.282)	$ (98,598)	$ (0.246)
1,001-4,100	2,341,578	2,341,578	$ (262,222)	$ (0.112)	$ (262,222)	$ (0.112)	$ (213,247)	$ (0.091)	$ (213,247)	$ (0.091)
4,101-33,000	24,827,588	24,827,588	$ (195,108)	$ (0.008)	$ (195,108)	$ (0.008)	$ (76,420)	$ (0.003)	$ (76,420)	$ (0.003)
33,001-96,000	19,232,570	19,232,570	$ (173,238)	$ (0.009)	$ (173,238)	$ (0.009)	$ (142,573)	$ (0.007)	$ (142,573)	$ (0.007)
96,001-500,000	23,912,325	23,912,325	$ (146,682)	$ (0.006)	$ (146,682)	$ (0.006)	$ (131,967)	$ (0.006)	$ (131,967)	$ (0.006)
500,001-1 Million	5,524,188	5,524,188	$ (40,160)	$ (0.007)	$ (40,160)	$ (0.007)	$ (36,993)	$ (0.007)	$ (36,993)	$ (0.007)
> 1 Million	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**76,818,809**	**76,828,746**	**$ (1,273,980)**	**$ (0.017)**	**$ (1,193,752)**	**$ (0.016)**	**$ (920,040)**	**$ (0.012)**	**$ (815,739)**	**$ (0.011)**
Community Water Systems (CWSs) performing Corrective Actions										
≤100	13,927	13,880	$ 365,576	$ 26.250	$ 388,703	$ 28.004	$ 330,235	$ 23.712	$ 353,002	$ 25.432
101-500	51,175	51,619	$ 516,102	$ 10.085	$ 508,146	$ 9.844	$ 452,342	$ 8.839	$ 450,070	$ 8.719
501-1,000	43,849	44,557	$ 178,205	$ 4.064	$ 181,189	$ 4.066	$ 155,596	$ 3.548	$ 158,538	$ 3.558
1,001-4,100	260,175	260,175	$ 590,719	$ 2.270	$ 590,719	$ 2.270	$ 512,568	$ 1.970	$ 512,568	$ 1.970
4,101-33,000	3,170,059	3,170,059	$ 2,605,551	$ 0.822	$ 2,605,551	$ 0.822	$ 2,198,499	$ 0.694	$ 2,198,499	$ 0.694
33,001-96,000	2,700,868	2,700,868	$ 1,709,801	$ 0.633	$ 1,709,801	$ 0.633	$ 1,424,758	$ 0.528	$ 1,424,758	$ 0.528
96,001-500,000	2,858,284	2,858,284	$ 1,625,742	$ 0.569	$ 1,625,742	$ 0.569	$ 1,346,704	$ 0.471	$ 1,346,704	$ 0.471
500,001-1 Million	613,799	613,799	$ 195,076	$ 0.318	$ 195,076	$ 0.318	$ 161,185	$ 0.263	$ 161,185	$ 0.263
> 1 Million	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**9,712,136**	**9,713,240**	**$ 7,786,773**	**$ 0.802**	**$ 7,804,928**	**$ 0.804**	**$ 6,581,888**	**$ 0.678**	**$ 6,605,324**	**$ 0.680**
Community Water Systems (CWSs) not performing Level 1/Level 2 Assessments, or Corrective Actions										
≤100	167,976	168,442	(67,959)	$ (0.405)	(13,728)	$ (0.081)	1,943	$ 0.012	71,665	$ 0.425
101-500	1,077,758	1,073,324	(7,905)	$ (0.007)	59,230	$ 0.055	101,979	$ 0.095	188,231	$ 0.175
501-1,000	1,186,361	1,179,288	1,936	$ 0.002	29,995	$ 0.025	52,024	$ 0.044	88,334	$ 0.075
1,001-4,100	5,214,839	5,214,839	42,797	$ 0.008	42,797	$ 0.008	119,614	$ 0.023	119,614	$ 0.023
4,101-33,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
33,001-96,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
96,001-500,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
500,001-1 Million	3,626,992	3,626,992	-	$ -	-	$ -	-	$ -	-	$ -
> 1 Million	16,309,853	16,309,853	-	$ -	-	$ -	-	$ -	-	$ -
Total	**27,583,779**	**27,572,738**	**$ (31,132)**	**$ (0.001)**	**$ 118,294**	**$ 0.004**	**$ 275,560**	**$ 0.010**	**$ 467,844**	**$ 0.017**

Sources: (C), (E), (G), (I) Exhibit 7.28.

ES.7 Comparison of Benefits and Costs, and Regulatory Options of the RTCR

As required by the SDWA, EPA has determined that the benefits of the RTCR justify the costs. In making this determination, EPA considered quantified and non-quantified benefits and costs as well as the other components of the HRRCA outlined in section 1412 (b)(3)(C) of the SDWA.

Additionally, EPA used several other techniques to compare benefits and costs including a break-even analysis and a cost effectiveness analysis. The break-even analysis (see Chapter 9 of the RTCR EA) was conducted using two example pathogens responsible for some (unknown) proportion of waterborne illness in the United States. The analysis shows that a relatively small number of cases (based on STEC O157 or *Salmonella*) would need to be avoided for the rule to break-even with the best estimates of net costs.

Under the RTCR, approximately two deaths would need to be avoided annually using a 3% discount rate based on consideration of the bacterial pathogen STEC O157. Alternatively, approximately 3,000 or 8,000 non-fatal cases, using the enhanced or traditional benefits valuations approaches,[5] respectively, would need to be avoided to break even with the RTCR costs. As expected based on its costs, the Alternative option would require that a higher number of cases be avoided annually for that option to break even (between 100% and 113% more than the RTCR under the enhanced and traditional approaches, respectively).

As Exhibit ES.8 shows, approximately 2 deaths would need to be avoided annually from a *Salmonella* infection for the rule to break even. The estimated number of non-fatal *Salmonella* cases that would need to be avoided to break even is approximately 10,000 or 68,000 cases under the enhanced and traditional benefits valuations approaches, respectively. As expected based on its costs, the Alternative option would require that a higher number of *Salmonella* cases be avoided annually for that option to break even (approximately 110% more than the RTCR under either the enhanced or traditional approaches).

As the discussion presented in Chapter 2 of this EA describes, disease and deaths are attributable to drinking water contamination across the country. The CDC estimates that there are 73,000 cases of illness each year in the U.S. due to STEC O157 (Mead et al., 1999). The CDC has found that 15% of outbreak cases of STEC O157 are waterborne (Rangel et al., 2005); if that rate applies as well to endemic cases, then approximately 11,000 cases would be due to waterborne exposure to STEC O157 and could be mitigated. Based on that assumption, up to 11,000 cases annually may be avoided by measures that mitigate pathways of contamination into PWSs for just this one potential contaminant. That amount of reduction in terms of STEC O157 would be enough for the rule to break even based on either the enhanced or traditional cost of illness approaches. If more than one contaminant was reduced or prevented from occurring in PWSs, the rule would be that much more likely to break even. Avoided illness and death from secondary transmission of infection could also be significant. Additionally, fewer cases would need to be avoided if all the benefits of the rule as described in chapter 6 were included in the analysis. If increased assessments and corrective actions result in a level of knowledge of the system that enables earlier mitigation of potential pathways of contamination, then additional illnesses or deaths may be avoided beyond those suggested by the decrease in acute events that the model predicts.

Chapter 9 of the RTCR EA has a complete discussion of the break-even analysis and how costs per case were calculated.

[5] Both traditional and enhanced COI approaches count the value of the direct medical costs and of time lost that would been spent working for a wage, but differ in their assessment of the value of time lost that would be spent in nonmarket work (e.g. housework, yardwork, and raising children) and leisure (e.g. recreation, family time, and sleep). They also differ in their valuation of (other) disutility, which encompasses a range of factors of well-being, including both inconvenience and any pain and suffering. A complete discussion of the traditional and enhanced COI approaches can be found in Appendix E.

Exhibit ES.7 Estimated Annual Breakeven Threshold for Avoided Cases of STEC O157

COI Methodology	Discount Rate	RTCR		Alternative Option	
		Non-fatal cases only	Fatal cases only[1]	Non-fatal cases only	Fatal cases only[1]
Traditional COI	3%	8,000	1.6	17,000	3.4
	7%	8,000	1.6	18,000	3.6
Enhanced COI	3%	3,000	1.6	6,000	3.4
	7%	3,000	1.6	6,000	3.6

[1] Calculations for fatal cases include the non-fatal COI component for the underlying illness prior to death.

Notes:

1) The number of cases needed to reach break-even threshold calculated by dividing the net change in costs for the RTCR (Exhibit 9.11) by the average estimated value of avoided cases (Exhibit 9.18). Threshold estimates based on a weighted average of the cost of "all cases" that includes both fatal and non-fatal cases is shown in Appendix E. STEC O157 is only an example of a pathogenic endpoint that could have been used for this analysis. Use of additional pathogenic contaminants in addition to this single endpoint would result in lower threshold values. Detail may not add due to independent rounding.
2) The break-even threshold is higher using a 7% discount rate than a 3% discount rate under the Alternative option. This result is consistent with the annualized costs of the Alternative option being higher using the 7% discount rate, which is caused by the frontloading of costs in the period of analysis, as explained further in Chapter 7 of the EA.

Exhibit ES.8 Estimated Annual Breakeven Threshold for Avoided Cases of *Salmonella*

COI Methodology	Discount Rate	RTCR		Alternative Option	
		Non-fatal cases only	Fatal cases only[1]	Non-fatal cases only	Fatal cases only[1]
Traditional COI	3%	68,000	1.6	141,000	3.4
	7%	68,000	1.6	151,000	3.6
Enhanced COI	3%	10,000	1.6	21,000	3.4
	7%	10,000	1.6	23,000	3.6

[1]Note: Calculations for fatal cases include the non-fatal COI component for the underlying illness prior to death.

Notes:

1) The number of cases needed to reach break-even threshold calculated by dividing the net change in costs for the RTCR (Exhibit 9.11) by the average estimated value of avoided cases (Exhibit 9.19). Threshold estimates based on a weighted average of the cost of "all cases" that includes both fatal and non-fatal cases is shown in Appendix E. *Salmonella* is only an example of a pathogenic endpoint that could have been used for this analysis. Use of additional pathogenic contaminants in addition to this single endpoint would result in lower threshold values. Detail may not add due to independent rounding.
2) The break-even threshold is higher using a 7% discount rate than a 3% discount rate under the Alternative option. This result is consistent with the annualized costs of the Alternative option being higher using the 7% discount rate, which is caused by the frontloading of costs in the period of analysis, as explained further in Chapter 7 of the EA.

Cost effectiveness is another way of examining the benefits and costs of the rule. ES.9 shows the cost of the rule per corrective action implemented. The cost effectiveness analysis, as with the net benefits, is limited because EPA was able to only partially quantify and monetize the benefits of the RTCR. The RTCR achieves the lowest cost per corrective action implemented among the options considered.

Exhibit ES.9 Total Net Annual Cost Per Corrective Action Implemented under the RTCR and Alternative Option, Annualized Using 3% and 7% Discount Rates ($Millions, $2007)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 14.3	$ 14.2
RTCR - Incremental Number of Corrective Actions (L1 & L2)	616	594
RTCR - Cost Effectiveness Analysis[1]	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change	$ 29.6	$ 31.7
Alternative Option - Incremental Number of Corrective Actions (L1 & L2)	808	819
Alternative Option - Cost Effectiveness Analysis[1]	**$ 0.04**	**$ 0.04**

Notes:
[1]CEA = (Net Change)/(Incremental Number of corrective actions).
[2]Detailed cost information is provided in Appendix C.

EPA also considered the net cost effectiveness of the RTCR as compared to the Alternative option to determine the additional benefit associated with that portion of cost for the Alternative option that exceeds the cost of the RTCR. Exhibit ES.9 shows that in terms of net rule cost for all PWSs, the RTCR has a far lower unit cost per unit benefit than the Alternative option. EPA further considered the group of 60,200 TNCWSs using GW and serving ≤100 people, which is the largest subset of systems by size and type, and is expected to bear the highest burden under the RTCR. Exhibit ES.10 shows that in terms of net rule cost, the cost effectiveness of the RTCR far exceeds that of the Alternative option using either a 3% or 7% discount rate. The two net cost analyses (ES.9 and ES.10) together indicate that the RTCR is significantly more cost effective than the Alternative option for the most burdened subset of systems and for all the PWSs together. Additional information about this analysis and other methods used to compare benefits and costs can be found in Chapter 9 of the RTCR EA.

Exhibit ES.10 Annualized Net Change in Costs Per Corrective Action (CA) Implemented for All PWSs under the RTCR and Alternative Option ($Millions, 2007$)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 14.30	$ 14.17
RTCR - Incremental Number of Corrective Actions (L1 & L2)[1]	615.82	593.71
RTCR - Incremental Cost per Corrective Action ($)	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change (over RTCR)[2]	$ 15.29	$ 17.52
Alternative Option - Incremental Number of Corrective Actions (L1 & L2) (over RTCR)[2]	192.23	224.93
Alternative Option - Incremental Cost per Corrective Action ($)	**$ 0.08**	**$ 0.08**

Notes:
[1]Exhibit includes the number of corrective actions predicted by the RTCR occurrence model to be implemented in addition to those implemented under the 1989 TCR.
[2]Add net values for Alternative option to net values for RTCR to calculate total net values of Alternative option over the 1989 TCR.
[3]Detailed cost information is provided in Appendix C.

Exhibit ES.11 Annualized Net Change in Costs per CA Implemented for TNCWSs (Serving <100 people) under the RTCR and Alternative Option ($Millions, 2007$)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 5.3	$ 5.3
RTCR - Incremental Corrective Actions (L1 & L2)[1]	287	275
RTCR - Incremental Cost per Corrective Action ($)	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change (over RTCR)[2]	$ 9.4	$ 10.8
Alternative Option - Incremental Corrective Actions (L1 & L2) (over RTCR)[2]	132	155
Alternative Option - Incremental Cost per Corrective Action ($)	**$ 0.07**	**$ 0.07**

Notes:
[1]Derived by dividing incremental rule costs applicable to TNCWS <100 by the incremental number of corrective actions to be implemented under the RTCR (relative to the 1989 TCR) and the Alternative option (relative to the RTCR) by TNCWSs using GW.
[2]Add net values for Alternative option to net values for the RTCR to calculate total net values of Alternative option over the 1989 TCR.
[3]Detailed cost information is provided in Appendix C.

ES.8 Conclusion

The RTCR aims to further reduce occurrence of TC and *E. coli* (and any waterborne pathogens that may co-occur) beyond the reductions achieved under the 1989 TCR. EPA's goal is to increase public health protection from potential fecal contamination and/or waterborne pathogen exposure, while continuing to pursue the objectives of the 1989 TCR. Although EPA's analysis of the RTCR has determined that its annual costs are most likely below the threshold stated in Executive Order 12866 of $100 million, EPA has chosen to publish a complete EA for this rule.

EPA has developed the final RTCR to be consistent with the majority of the AIP recommendations, with consideration of the comments received on the proposed rule, because it will not allow for backsliding from current levels of protection of public health and will likely

reduce risk from waterborne disease further while costing relatively little on a net basis. This conclusion is consistent with the conclusion of the TCRDSAC regarding the likely impact of the rule provisions. As required by the SDWA, EPA has determined that the benefits of the RTCR justify the costs. In making this determination, EPA considered quantified and non-quantified benefits and costs as well as the other components of the HRRCA outlined in section 1412 (b)(3)(C) of the SDWA.

As shown in the uncertainty analysis presented in Chapter 6 (section 6.4), reducing repeat samples and additional samples both have the potential to increase risk for some PWSs (see also sections III.C and III.D of the RTCR preamble for discussions on the additional routine sample and repeat sample provisions respectively). However, this increase in risk is expected to be more than offset by potential decreases in risk from increased routine monitoring and the addition of the assessments and corrective action provisions that find and fix problems indicated by monitoring. That is, based on the analyses presented in this EA, EPA concludes that the effect of the corrective actions outweighs that of reduced sampling; both the RTCR and the Alternative option are expected to result in a net decrease in risk as compared to the 1989 TCR. Although the Alternative option decreases risk to a greater degree than the RTCR, this additional reduction is achieved at a higher cost, both in absolute terms and in terms of cost-effectiveness. The estimated net cost of the RTCR is not only small relative to the 1989 TCR (approximately $14 million annually using either a 3% or 7% discount rate), but it is also small compared to net cost increase of the Alternative option relative to the 1989 TCR (approximately $30–$32 million using a 3% and 7% discount rate, respectively). This cost differential is especially important considering the potential concentration of impacts on the smallest TNCWSs and the potential frontloading of costs during the first few years of implementation under the Alternative option. In addition, no backsliding in overall risk is predicted.

The analyses performed as part of this EA support the collective judgment and consensus of the TCRDSAC that the RTCR requirements provide for effective and efficient revisions to 1989 TCR regulatory requirements.

1 Introduction

This economic analysis (EA) presents the evaluation of the benefits and costs of the Revised Total Coliform Rule (RTCR). The analysis is performed in compliance with Executive Order 12866, Regulatory Planning and Review (58 FR 51735), which requires the United States Environmental Protection Agency (EPA) to estimate the economic impact of rules that have an annual effect on the economy of over $100 million and make that analysis available to the public in conjunction with publication of the final rule. Although EPA's analysis of the RTCR has determined that its annual costs are most likely below this threshold, EPA has chosen to publish a complete EA for this rule.

EPA developed the RTCR in collaboration with states, other interested stakeholders, and the Total Coliform Rule/Distribution System Advisory Committee (TCRDSAC). In July 2003, as part of the Agency's Six Year Review of existing national primary drinking water regulations, EPA published its intent to revise the 1989 Total Coliform Rule (TCR). The Agency's primary reasons for revising the 1989 TCR are implementation-related issues. The RTCR offers a meaningful opportunity for greater public health protection against waterborne pathogens in the distribution systems of public water systems (PWSs) beyond the 1989 TCR.

This chapter provides a summary of the RTCR in Section 1.1. Section 1.2 outlines the organization of this EA, and Section 1.3 provides information regarding supporting calculations and citations.

1.1 Summary of the Revised Total Coliform Rule (RTCR)

The RTCR applies to all community and noncommunity PWSs. The RTCR takes a proactive approach to protect public health, maintaining a maximum contaminant level goal (MCLG) and maximum contaminant level (MCL) for *E. coli* and using both *E. coli* and total coliform (TC) monitoring to establish a framework for PWSs to assess for sanitary defects and to correct them as appropriate.

Like the requirements of the 1989 TCR, the requirements of the RTCR ensure that PWSs address the following objectives:

- Evaluate the effectiveness of treatment;
- Determine the integrity of the distribution system; and
- Signal the possible presence of fecal contamination.

To accomplish the above objectives, the RTCR uses TC as an indicator to start an evaluation process that, where necessary, requires the PWS to correct sanitary defects, defined in the RTCR as:

> A defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure in a barrier that is already in place.

Under the RTCR, *E. coli* remains a regulated contaminant with an MCLG of zero and an MCL of zero. All fecal coliform provisions (including the MCLG and MCL) are removed in the RTCR. There is no longer an MCL for TC: instead, TC is used as an indicator as part of a coliform treatment technique.

For all PWSs serving >4,100 people, monitoring requirements under the RTCR remain essentially unchanged from 1989 TCR requirements. However, PWSs serving ≤4,100 people may experience changes in their required monitoring schemes depending on specific size, type, and source water categorizations. Changes for these PWSs may be for routine, additional routine or repeat monitoring as summarized in Exhibit 1.1 below.

Under the RTCR, PWSs must complete Level 1 or Level 2 assessments to identify the presence of "sanitary defects" and defects in distribution system coliform monitoring practices if sampling results in one of the following triggers listed below.

Level 1 Assessment Triggers

- For PWSs taking 40 or more samples per month, the PWS exceeds 5.0 percent TC-positive samples for the month; or
- For PWSs taking fewer than 40 samples per month, the PWS has two or more TC-positive samples in the same month; or
- Failure to take every required repeat sample after a single routine TC-positive sample.

Level 2 Assessment Triggers

- The PWS has an *E. coli* violation (See Section III.B.1.a of the RTCR preamble for a description of what constitutes an *E. coli* MCL violation.); or
- The PWS has a second Level 1 treatment trigger within a rolling 12-month period, unless the first Level 1 treatment trigger was based on exceeding the allowable number of TC+ samples, the state has determined a likely reason for the TC+ samples that caused the initial Level 1 treatment trigger, and the state establishes that the system has fully corrected the problem;
- For PWSs with approved reduced annual monitoring, a Level 1 treatment technique trigger in two consecutive years.

Exhibit 1.1 RTCR Monitoring Frequency Requirements

PWS Type	Source	Population Served	Monitoring Requirements
Routine Monitoring[1]			
Noncommunity (NCWS)	Ground water	≤ 1,000 people	Quarterly monitoring for TC[2] Additional requirements to qualify for reduced monitoring apply[3]
Community (CWS)	Ground water	≤ 1,000 people	Monthly monitoring for TC Additional requirements to qualify for reduced monitoring apply[4]
All (CWS & NCWS)	Surface water	All	Same requirements as under 1989 TCR (Monthly monitoring for TC)
	Ground water	>1,000 people	Same requirements as under 1989 TCR (Monthly monitoring for TC)
Additional Routine Monitoring			
All (CWS & NCWS)	Ground water	≤ 1,000 people	Additional routine monitoring no longer required if monitoring monthly Number of additional routine samples required reduced from five to three if monitoring quarterly or annually
	Ground water	1,101–4,100 people	Additional routine monitoring no longer required
	Surface water	≤4,100 people	Additional routine monitoring no longer required
	Ground and surface water	>4,100 people	Same requirements as under 1989 TCR (Additional routine monitoring not required)
Repeat Monitoring			
All (CWS & NCWS)	Ground and surface water	≤1,000 people	Number of repeat samples required reduced from four to three
	Ground and surface water	>1,000 people	Same requirements as under 1989 TCR (Three repeat samples required)

[1] Seasonal PWSs serving ≤ 1,000 people are required to sample monthly while in service but may qualify for reduced monitoring.
[2] PWSs may be increased to monthly monitoring based on compliance with rule. Examples include system with Level 2 assessment violation, an *E. coli* MCL violation, an RTCR treatment technique violation, and /or two monitoring violations in a rolling 12-month period.
[3] PWSs may qualify for annual monitoring based on compliance record, the existence of enhancements to water system barriers to contamination, and completion of an initial and recurring annual site visit conducted by the state or an annual voluntary Level 2 assessment by a party approved by the state.
[4] PWSs may qualify for quarterly monitoring based on compliance record and either the existence of enhancements to water system barriers to contamination or the completion of an annual site visit conducted by the state or an annual voluntary Level 2 assessment by a party approved by the state.

The PWS shall be responsible for correcting sanitary defects found through either Level 1 or Level 2 assessments as defined above by implementing appropriate corrective actions. Failure to complete a required assessment or take necessary corrective action constitutes a Treatment Technique violation under the RTCR.

The RTCR requires public notification for three events that are tiered as follows:

- Tier 1. *E. coli* MCL violation
- Tier 2. Treatment technique violation
- Tier 3. Routine monitoring and reporting violations

The RTCR also provides the primacy agency with the discretion to reduce the monitoring frequency for well-operated ground water PWSs serving ≤1,000 people, if the PWS can demonstrate that it meets the criteria for reduced monitoring stipulated in the rule. The specific criteria to qualify for reduced monitoring are described in Chapter 3.

Ground Water Rule (GWR) implementation began in December of 2009 prior to the transition from the 1989 TCR to the RTCR. Compliance with the GWR requirements, including sanitary surveys and site visits, can be used to help determine the level of monitoring required for ground water PWSs serving ≤1,000 people.

1.2 Document Organization

The remainder of this EA is organized into the following chapters:

- **Chapter 2** summarizes the technical, regulatory, and public health issues addressed by the RTCR. It also explains the statutory authority for the RTCR and the economic rationale for the regulatory approach.
- **Chapter 3** reviews various regulatory options that EPA considered during the development of the rule and presents the rationale for selecting the RTCR requirements.
- **Chapter 4** characterizes baseline conditions that exist (including PWS inventory, treatment, and water quality data) before PWSs make changes to meet the RTCR requirements.
- **Chapter 5** summarizes TC and EC occurrence analysis, providing a description of the occurrence model, the sources used, and the limitations or constraints to the analysis based on the nature of the data provided by those sources.
- **Chapter 6** presents the relative risk evaluation performed to estimate the potential benefits of the RTCR relative to the baseline and other regulatory options considered.

- **Chapter 7** presents an estimate of the net costs of implementing the RTCR to industry, households, and states. The net costs of all regulatory options considered are compared.

- **Chapter 8** discusses distributional analyses performed to evaluate the effects of the rule on different segments of the population, and considers various executive orders and requirements, including the Regulatory Flexibility Act and Unfunded Mandates Reform Act.

- **Chapter 9** compares the benefits and costs of the RTCR to evaluate the potential net benefits and cost-effectiveness. The results are discussed and compared to other regulatory options considered.

- **Chapter 10** includes a detailed list of references.

1.3 Calculations and Citations

This EA involves detailed and complex analyses, and the following are provided to help the reader:

- The detailed reference section provided in Chapter 10.

- Appendices containing supporting spreadsheets and analyses:

  – Appendix A—Detailed Predictive Model Results

  – Appendix B—Graphs of Predicted Hit Rates Over Time

  – Appendix C—Detailed Cost Model Results

  – Appendix D—Detailed Compliance Forecast and Unit Costs Estimates

  – Appendix E—Supporting information for Value of Statistical Life and Cost of Illness estimates used in break-even analyses

  – Appendix F—Detailed analysis of potential uncertainty and variability in occurrence estimates

  – Appendix G—Evaluation of representativeness of Six Year Review data

  – Appendix H—Analysis of potential impacts of reduced repeat sampling

  – Appendix I—Supporting Information for Regulatory Flexibility Act Screening Analysis

- Exhibits. Most tabular exhibits include a row that provides the formulas used to compute the contents of each column.

- Sources for values used if they were not calculated within the exhibits.

- Supporting electronic file outputs (i.e., RTCR occurrence and cost model output).
- Flowcharts that illustrate methodologies of analyses as well as RTCR requirements.

2 Statement of Need for the Rule

2.1 Introduction

The United States Environmental Protection Agency (EPA) is revising the 1989 Total Coliform Rule (TCR) to better protect public health. EPA noticed its intent to revise the 1989 TCR as part of its Six-Year Review determination published in 2003 (USEPA 2003b, 68 FR 42907, July 18, 2003). In July 2007 EPA convened a Total Coliform Rule/Distribution System Federal Advisory Committee (TCRDSAC or advisory committee) charged with evaluating how well the objectives of the TCR are met and recommending possible revisions to the rule. The TCRDSAC completed its analysis and provided recommendations for revising the 1989 TCR in an Agreement in Principle (AIP) (USEPA, 2009, 74 FR 1683, January 13, 2009) that was signed by advisory committee members in September 2008. In July 2010, EPA proposed a rule that was consistent with the recommendations in the AIP (see Chapter 3 of this economic analysis (EA) for more details on the TCRDSAC). The final RTCR provisions were created by also taking into consideration comments received on the RTCR proposal.

The RTCR maintains and strengthens the objectives of the 1989 TCR. The objectives are: (1) to evaluate the effectiveness of treatment, (2) to determine the integrity of the distribution system, and (3) to signal the possible presence of fecal contamination. The RTCR better addresses these objectives by requiring systems that may be vulnerable to fecal contamination (as indicated by their monitoring results) to do an assessment, to identify whether any sanitary defect(s) is (are) present, and to correct the defects. Therefore, greater public health protection is anticipated under the RTCR compared to the 1989 TCR because of its more preventive approach to identifying and fixing problems that affect or may affect public health (see Chapter 3 of this EA for more details on the provisions of the RTCR).

This chapter summarizes the technical, regulatory, and public health issues addressed by the final rule. It also explains the statutory authority for the final RTCR and the economic rationale for choosing a regulatory approach rather than non-regulatory options.

2.1.1 Description of the Issue

EPA is required to review each existing national primary drinking water regulation (NPDWR) every six years. In 2003, EPA completed its review of the 1989 TCR and 68 NPDWRs for chemicals that were established prior to 1997. The purpose of the review was to identify current health risk assessments, changes in technology, and other factors that would provide a health or technological basis to support a regulatory revision that will maintain or improve public health protection. In the 2003 announcement of the completion of the Six Year Review, EPA provided public notice of its intent to revise the 1989 TCR (USEPA 2003b, 68 FR 42907, July 18, 2003). Implementation-related issues are the primary reason for EPA's decision to revise the 1989 TCR. Since promulgation of the 1989 TCR, EPA has received comments from a number of stakeholders suggesting modifications to reduce the burden of implementing the 1989 TCR. These comments included, among others, suggestions to modify the 1989 TCR's monitoring requirements (e.g., with regards to sampling locations and repeat samples) (USEPA 2002b, 67 FR 19030, April 17, 2002 and USEPA 2003b, 68 FR 42907, July 18, 2003).

The 1989 TCR was promulgated to decrease the risk of waterborne illness. Among all rules promulgated for preventing waterborne illness, only the 1989 TCR applies to all PWSs, so the rule is an essential component of the multiple barrier approach in public health protection against endemic and epidemic disease. However, improvements to the 1989 TCR construct and requirements can better protect public health as shown in the following discussions.

In recent years, violation rates under the 1989 TCR have remained relatively steady (see Chapter 4, Exhibit 4.11 of this EA). EPA believes that this is reflective of a steady state among PWSs complying with the 1989 TCR, suggesting the possibility that improvements likely to occur under the 1989 TCR have largely been achieved. Potential exposure to waterborne pathogens continues to be a health risk. Within the United States, disease is caused by a relatively small variety of bacterial, viral, and parasitic protozoan pathogens in drinking water. Nevertheless, the number of potential waterborne pathogens and the number of potential waterborne illnesses are significant. Humans can be exposed via fecal-oral, inhalation or dermal exposure, with fecal-oral exposure being the most significant and prevalent pathway.

The 1989 TCR established a maximum contaminant level goal (MCLG) and a maximum contaminant level (MCL) for total coliforms (TC) (including fecal coliforms (FC) and *E. coli*). Under the 1989 TCR, a TC MCL violation required public notification. However, many of the organisms detected by TC and FC methods are not of fecal origin and do not have any direct public health implication. Information has also become available since promulgation of the 1989 TCR that indicates that measurement of FC sometimes detects organisms that may not have any connection to fecal contamination (Edberg et al., 2000). Attributing greater public health significance to the presence of TC or FC could result in public confusion. On the other hand, EPA continues to believe that *E. coli* is a meaningful indicator of fecal contamination and of the potential presence of associated pathogens (see Section 2.2.4.1 of this chapter).

The RTCR aims to maintain and strengthen the objectives of the 1989 TCR more effectively and efficiently. *E. coli* remains a regulated contaminant with a defined MCLG and MCL while TC (including FC) no longer has an MCLG and an MCL. Instead, the final RTCR uses TC as an indicator as part of a coliform treatment technique. The treatment technique uses both TC and *E. coli* monitoring results to start an evaluation process that, where necessary, will require the PWS to conduct assessments and corrective actions. The final rule also takes into account the capacity of small systems (especially for PWSs serving 1,000 or fewer people) and primacy agencies to effectively implement the final rule requirements.

Modeling results show that the assessment and corrective action provisions of the RTCR will result in a decrease in *E. coli* occurrence (see Exhibits 5.16–5.21) which is anticipated to lead to a decrease in the potential exposure of the public to fecal contamination and its associated pathogens. In general, this decrease in fecal contamination should reduce the potential risk to human health of PWS customers. Thus, any reduction in *E. coli* occurrence is considered a benefit of the RTCR. Also, since fecal contamination can contain waterborne pathogens including bacteria, viruses, and parasitic protozoa, in general a reduction in fecal contamination should also reduce the potential risk from these other contaminants.

2.2 Public Health Concerns, Fecal Contamination, and Waterborne Pathogens

2.2.1 Rule Objectives and Public Health Concerns

The RTCR aims to increase public health protection through a reduction of potential pathways of entry for fecal contamination into the distribution system. Since these potential pathways represent vulnerabilities in the distribution system whereby fecal contamination and/or waterborne pathogens, including bacteria, viruses, and parasitic protozoa can enter the system, the reduction of these pathways in general should lead to reduced exposure and associated risk from these contaminants. Waterborne pathogens that can be associated with fecal contamination may cause a variety of illnesses, including acute gastrointestinal illness (AGI) with diarrhea, abdominal discomfort, nausea, vomiting, and other symptoms. Most AGI cases are of short duration and result in mild illness. Consuming water contaminated with waterborne pathogens can also result in acute illnesses such as hepatitis, hemolytic uremic syndrome (kidney failure), and bloody diarrhea; milder, acute illnesses such as conjunctivitis; and severe chronic illnesses such as diabetes and dilated cardiomyopathy. Other examples of potential chronic diseases resulting from infection by a waterborne agent include irritable bowel syndrome, hypertension, and reactive arthritis; chronic illnesses are generally costly to treat.[6]

Sensitive subpopulations are at greater risk from waterborne disease than the general population. These sensitive subpopulations include children (especially the very young); the elderly; the malnourished; pregnant women; chronically ill patients (e.g., those with diabetes or cystic fibrosis); and a broad category of those with compromised immune systems, such as Acquired Immunodeficiency Syndrome (AIDS) patients, those with autoimmune disorders (e.g., rheumatoid arthritis, lupus erythematosus, and multiple sclerosis), organ transplant recipients, and those receiving chemotherapy (Rose, 1997). Sensitive subpopulations represent almost 20 percent of the population in the United States (Gerba et al., 1996). The severity and duration of illness is often greater in sensitive subpopulations than in healthy individuals, and may occasionally result in death.

When humans are exposed to and infected by an enteric pathogen (pathogens that most commonly occur in the gut of humans and other animals), the pathogen becomes capable of reproducing in the gastrointestinal tract. As a result, healthy humans shed pathogens in their feces for a period ranging from days to weeks. This shedding of pathogens often occurs in the absence of any signs of clinical illness. Regardless of whether a pathogen causes clinical illness in the person who sheds it in his or her feces, the pathogen being shed may infect other people directly by person-to-person spread, contact with contaminated surfaces, and other means which are referred to as secondary spread. As a result, waterborne pathogens that are initially waterborne may subsequently infect other people through a variety of routes (WHO, 2004).

Waterborne pathogens include pathogens of both fecal and non-fecal origin. Non-fecal pathogens are found in the soil and soil water interface and include *Legionella, Naegleria fowleri*

[6] Lifetime costs associated with a new case of diabetes, for example, assuming an average illness duration of 30 years, are estimated at $255,833 using a three percent discount rate and $161,967 using a seven percent discount rate (year 2007 dollars). For dilated cardiomyopathy, the lifetime (21-year average) cost is $68,870 (seven percent discount rate, year 2007 dollars).

and probably *Helicobacter pylori*, or are components of the distribution system environment and can include *Mycobacterium avium* complex (MAC). Examples of common fecal bacterial pathogens include pathogenic *E. coli*, *Salmonella*, *Shigella*, and *Campylobacter jejuni*. Some waterborne bacterial pathogens cause disease by rapid growth and dissemination (e.g., *Salmonella*) while others primarily cause disease via toxin production (e.g., *Shigella*, *E. coli* O157, *Campylobacter jejuni*). *Campylobacter jejuni*, *E. coli*, and *Salmonella* have a host range that includes both animals and humans; *Shigella* is associated only with humans (Geldreich, 1996). Unlike viruses, bacteria are able to reproduce outside of the host.

Because a positive TC assay is an indicator of ambient water entry into or growth within the distribution system, it represents an indication of potential for both fecal and non-fecal contamination. Because *E. coli* originates in the gut of warm-blooded animals, it is an indication of fecal contamination. Together, the TC/*E. coli* indicator system can be used in monitoring to identify the potential for fecal contamination. Since fecal contamination can contain waterborne pathogens including bacteria, viruses, and parasitic protozoa, in general a reduction in fecal contamination should also reduce the potential risk from these other contaminants.

The group of bacteria known as *E. coli* contains both pathogenic and non-pathogenic isolates. The methods approved by EPA to assay for *E. coli* do not identify most of the pathogenic *E. coli* strains. The most dangerous *E. coli* bacteria contain the gene for producing shiga-toxins. *E. coli* O157:H7 is the most widespread shiga-toxin producing *E. coli* but at least 81 serotypes have been identified (Prager et al., 2005). Release of toxins in the body can result in kidney failure, shock and death in otherwise healthy individuals, especially small children. Typically, kidney failure occurs in 2–7 percent of illnesses. Death or end-stage renal disease occurs in about 12 percent of patients four years after diarrhea-associated kidney failure (Garg et al., 2003). Twenty five percent of kidney failure survivors demonstrate long-term renal consequences (Garg et al., 2003). For patients with moderate and severe gastroenteritis caused by *E. coli*, long-term study shows that they have an increased risk of irritable bowel syndrome, hypertension and reduced kidney function (Garg et al., 2005).

The Centers for Disease Control and Prevention (CDC) indicates that drinking water is responsible for a portion of the 73,000 illnesses each year from *E. coli* O157:H7 (Mead et al., 1999). The CDC estimates that about 15 percent of all reported *E. coli* O157:H7 cases are due to water contamination (Rangel et al., 2005). *E. coli* O157:H7 is the primary cause of hemolytic uremic syndrome (HUS) in the United States (Rangel et al., 2005). Active surveillance by CDC shows that 6.3 percent of *E. coli* O157:H7 cases progress to HUS (Griffin and Tauxe, 1991; Gould et al., 2009) and about 12 percent of HUS cases result in death within four years (Garg et al., 2003). About 4 to 15 percent of STEC O157 cases are transmitted within households by secondary transmission (Parry and Salmon, 1998).

Ground water outbreaks due to *E. coli* O157:H7 are prominent because of the fatal outcomes associated with those outbreaks. In Walkerton, Ontario, 6 individuals died and 27 developed kidney failure from ground water contaminated with *E. coli* O157:H7 (and *Campylobacter jejuni*) (Health Canada, 2000). The outbreak coincided with a reduction in chlorination treatment coincident with a large fecal contamination event. In Washington County, NY, two individuals (including an otherwise healthy two year old child) died from *E. coli* O157:H7 contamination of a county fair water supply system. (The fairground's water supply

system was not recognized as a PWS because it was used for less than 60 days each year.) Four individuals died in Cabool, MO due to *E. coli* O157:H7 (Swerdlow et al., 1992) in an outbreak that was likely due to source water contamination.

Although manure is often considered to be the source of shiga-toxin producing *E. coli*, these bacteria have also been isolated from municipal sewage (Holler et al., 1999). *E. coli* O157:H7 was found to survive on a pasture surface for almost 4 months. About 4–15 percent of cases are acquired via secondary transmission (Parry and Salmon, 1998). In addition to the shiga-toxin producing *E. coli*, there are a substantial number of other *E. coli* bacteria that are pathogenic, mostly through production of other toxins. Little data are available on the hazard associated with waterborne transmission for most of the pathogenic *E. coli* other than *E. coli* O157:H7.

As the result of a seven-year-long study of individuals infected or ill during the Walkerton, Ontario waterborne disease outbreak due to *E. coli O157*:H7 and *Campylobacter jejuni*, researchers noted an increased incidence in chronic disease sequellae. Within a few years after the outbreak, irritable bowel syndrome, hypertension, reactive arthritis and reduced kidney function increased 33–38 percent (Clark et al., 2008).

Shigella bacteria are distinct because they are often associated with bloody diarrhea (bacillary dysentery). The enterohemorraghic *E. coli* bacteria acquired the capability to produce toxins by exchanging plasmids with *Shigella* (Murray et al., 2007). Thus, *Shigella* often also causes kidney failure and chronic kidney disease. *Shigella* contamination only results from human fecal contamination and thus it is probably less common than *E. coli* contamination, which has both human and animal sources.

Campylobacter bacteria (like *Salmonella*) are very common contaminants of food and water, and result in a large number of illnesses. *Campylobacter* is commonly associated with animal manure, especially cow and chicken manure. More deaths may be associated with *Campylobacter* and *Salmonella* than with viruses. Uniquely, *Campylobacter* is often associated with Guillain-Barre paralysis that can last for weeks or months. About one paralysis case occurs for every 1,000 cases of campylobacteriosis (Altekruse et al., 1999). About 20 percent of paralysis patients are left with some disability and approximately 5 percent die. Campylobacterosis is also associated with Reiter syndrome (reactive arthritis). Approximately 1 percent of patients with camplybacterosis have arthritis onset in one or more joints (especially the knee) in the 7 to 10 days after diarrheal onset (Altekruse et al., 1999). *Arcobacter* (now a separate genus from *Campylobacter*) was responsible for a ground water outbreak at a camp in Coeur d'Alene, Idaho (McMillan, 1996).

Salmonella causes typhoid fever, once a common and dangerous waterborne disease. Typhoid is no longer a problem in the United States, and in recent years, *Salmonella* has become increasingly less common as a common source outbreak agent while campylobacterosis outbreaks have correspondingly increased. The reasons for this change are unclear. Seven deaths that occurred due to *Salmonella* contamination in a ground water PWS in Gideon, Missouri were due to bird entry into a storage tank (Angulo et al., 1997). *Salmonella* resulted in a very large outbreak in a ground water utility in Riverside, California during the 1960s (16,000 illnesses, 70 hospitalizations and 3 deaths) prior to the promulgation of the 1989 TCR (Boring et al., 1971). A

2008 waterborne outbreak in Alamosa, Colorado was due *to Salmonella*. *Salmonella*-positive samples were collected from the distribution system but no *E. coli* was identified in other distribution samples collected on the same day (CDPHE, 2009).

Legionella are opportunistic bacterial pathogens that colonize water distributions systems. An estimated 8,000–18,000 cases of Legionnaires disease and Pontiac fever occur in the U.S. each year due to *Legionella* (CDC, 2011). Twenty-one of 48 known species are able to infect humans.

Helicobacter pylori is often associated with ground water (Hegarty et al.,1999; Rolle-Kampzczyk et al., 2004) and is known to cause gastric ulcers. However, *Helicobacter* is not culturable and so occurrence data are fairly uncertain. Improved hygiene and water treatment have together reduced the number of ulcers caused by this organism over the last few decades but it is impossible to quantify that decrease.

Most of the waterborne bacterial pathogens cause gastrointestinal illness, but some can cause other severe illnesses as well. For example, *Legionella* causes Legionnaires Disease, a form of pneumonia that has a fatality rate of about 15 percent. It can also cause Pontiac Fever, which is a milder respiratory infection form of Legionnaires Disease. Several strains of *E. coli* can cause severe disease, including kidney failure. Some bacterial pathogens are opportunistic (i.e., they are only infectious in the presence of another, preexisting condition or weakness). Opportunistic pathogens usually cause illness only in immunocompromised persons or in other sensitive subpopulations, such as the very young or the elderly. Other pathogens, such as *Salmonella*, *Shigella*, *and Campylobacter jejuni*, are not entirely opportunistic but result in certain diseases with greater frequency and severity in immunocompromised persons (Framm and Soave, 1997).

Examples of common viral pathogens include norovirus and the enteroviruses (coxsackievirus, echovirus, poliovirus, enterovirus 70 and 71). Viruses can cause a spectrum of mild to severe clinical illness, including paralytic disease and death. There is considerable information that Type 1 diabetes may be associated with enterovirus infection, including infection with coxsackievirus and echoviruses (Maria et al., 2005; Vreugdenhil et al., 2000). Dilated cardiomyopathy can follow myocarditis caused by echovirus and other enterovirus infection.

Mild enteroviral illness includes nonspecific febrile illness, respiratory illness, photophobia or sensitivity, stiff neck, and gastrointestinal illness. Aseptic meningitis may or may not require a doctor's visit, but more severe illnesses such as viral encephalitis, myocarditis, and non-polio flaccid paralysis are likely to require hospitalization. Most likely to be hospitalized are infants less than 3 months old with non-specific febrile illnesses that require treatment to rule out and expectantly treat serious bacterial illness. Dilated cardiomyopathy can follow myocarditis caused by echovirus and other enterovirus infection.

The health effects of norovirus illness include acute onset of nausea, vomiting, abdominal cramps and diarrhea. Vomiting is more prevalent among children. However, many adults also experience vomiting, as well as diarrhea. Constitutional symptoms (e.g., headache, fever, chills, and myalgia) are frequently reported. Although rare, severe dehydration caused by norovirus

gastroenteritis can be fatal, with this outcome occurring among susceptible persons (e.g., older persons with debilitating health conditions). No long-term sequelae of norovirus infection have been reported (CDC, 2001a). Duration of illness is typically 12–60 hours.

Hepatitis A (HAV) virus is the only waterborne virus that is reportable to CDC. About 28,000 HAV cases are reported to CDC each year; however, that number is expected to decline with time because children are currently vaccinated for HAV in high risk states, and newer recommendations are for increased vaccination coverage. Mead et al. (1999) estimate about 83,000 HAV cases each year (nearly three times the number of cases reported yearly to CDC), with a hospitalization rate of 13 percent and a mortality rate of 0.3 percent. Because HAV is more severe as an adult disease, an aging U.S. population may have greater disease burden.

Hepatitis E (HEV) virus is another fecal oral virus that is potentially waterborne. Serology and case histories of individual patients indicate that HEV is established as endemic within the United States (Tsang et al., 2000). However, the data suggest that only one or a few percent of the population has been infected. Unlike HAV, no waterborne outbreaks of HEV have occurred in the United Sates, although they have occurred in China and Somalia. The disease is severe, with up to 20 percent mortality among pregnant women in developing countries.

The adenoviruses are a large group of viruses that produce diverse symptoms. Two adenovirus serotypes, adenovirus 40 and 41, produce primarily enteric symptoms, but several other adenoviruses are also capable of producing such symptoms. Additionally, some adenoviruses cause conjunctivitis. Most significantly, adenoviruses caused a fatal outcome in otherwise healthy young males in military settings (CDC, 2001b). All adenoviruses, no matter the infection site and characteristic illness, are shed copiously through the gut. Thus, the adenoviruses are fecal-oral viruses (Carter, 2005) potentially transmissible via water to infection sites in the gut or, for the respiratory adenoviruses, in the lung, via waterborne aerosol drops.

Most children are exposed to astroviruses at an early age. Astrovirus is commonly acquired in child care settings and causes mild disease in children. However, a small percentage of exposed children may suffer more significant health effects and may require in-patient care. The disease burden in older children and adult populations is underestimated because the disease is mild (Carter, 2005). Astroviruses are shed in stool in large numbers. In France, prospective epidemiology studies have implicated water as a route of astrovirus infection (Gofti-Laroche, et al., 2003).

The CDC has determined that the incidence of rotavirus diarrhea can reach 0.30 episodes/child/year by age two, with a cumulative incidence approaching 0.80 episodes/child by age five (Glass et al., 1996). Hospitalizations for rotavirus diarrhea are most common in children 6 months to 3 years of age (Parashar et al., 1998), while self-limiting norovirus infections are prevalent in school-age children (LeBaron et al., 1990). Although deaths from infectious diarrhea have generally declined among U.S. children since 1965 because of re-hydration therapy, newborn children, especially infants born prematurely, remain at risk of death from severe diarrheal illness (Kilgore et al., 1995). Common strain rotaviruses typically affect young children, particularly those less than 3 years old, but other strains (G1, G2 and G9) have been found to be common in adults and the elderly in nursing homes, and found to be responsible for more severe illness in children (Griffin et al., 2000). In 2006, the U.S. Food and Drug

Administration (FDA) approved a new pentavalent vaccine for rotavirus (Vesikari et al., 2006) in children. The vaccine protects against the most common rotaviruses now found in the U.S. (serotypes G1, G2, G3, G4, and G9) but does not protect against all rotaviruses.

Reovirus is commonly found co-occurring with the enteroviruses in PWS wells. Carducci et al. (2002) found that in some cases enterovirus detection was limited because reovirus reproduction was so highly favored. Reovirus is more closely related to rotavirus and thus has some similar characteristics. Reovirus is now recognized as a human pathogen in children (Tyler et al., 2004).

Cryptosporidium is of particular concern to EPA because, unlike pathogens such as viruses and bacteria, *Cryptosporidium* oocysts are resistant to inactivation by many common disinfection methods. Since the oocysts are especially resistant to chlorine disinfection, simply increasing existing chlorination dosage levels or contact time above those most commonly practiced in the United States is not effective. Emerging disinfectant-resistant pathogens, such as *Microsporidia*, *Cyclospora*, and *Toxoplasma*, are also a concern for similar reasons.

Cryptosporidiosis is a protozoal infection that usually causes 7 to14 days of diarrhea, possibly accompanied by low-grade fever, nausea, and abdominal cramps in individuals with healthy immune systems (Juranek, 1998). It is caused by the ingestion of infectious *Cryptosporidium* oocysts, which are readily carried in water. The most common source of oocysts in water is the feces of infected hosts (Perz et al.,1998; Rose, 1997). Although cryptosporidiosis often occurs through ingestion of contaminated food or water, it may also result from direct or indirect contact with infected people or animals (Casemore, 1990; Juranek, 1998; Rose, 1997). Infected humans and other animals excrete oocysts, which can then be transmitted to others. Cryptosporidiosis can also cause non-gastrointestinal symptoms, such as eye and joint pain, headaches, dizziness, and fatigue (Hunter et al., 2004). There is no treatment that can eliminate a *Cryptosporidium* infection, and only a few antiparasite or antimicrobial agents have shown even a slight ability to reduce a patient's parasite load (Guerrant, 1997).

In some occurrences, cryptosporidiosis can be fatal, particularly among subpopulations such as AIDS patients, the elderly with other underlying illnesses, and other immuno-compromised individuals. In a *Cryptosporidium* outbreak in Milwaukee in 1994, which had an estimated 403,000 cases of illness (Kramer et al., 1996), 54 people died who had cryptosporidiosis listed on their death certificate. Of those 54 people, 46 also had AIDS listed as an underlying cause of death (Hoxie et al., 1997).

Giardiasis is a protozoal infection that usually causes diarrhea, possibly accompanied by fever, nausea and abdominal cramps in individuals with healthy immune systems. It is caused by ingestion of *Giardia* cysts.

In 2003, two 5-year-old boys living in the same water service area near Phoenix, AZ died in the same week from Primary Amoebic Meningioencephalitis (PAM) (Marciano-Cabral et al., 2003). Both boys lived in homes supplied by untreated PWS wells. Atypically, the wells in that area provide water at elevated temperatures as a result of the elevated geothermal gradient in the subsurface. Seventeen samples taken from the boys homes were positive for *Naegleria fowleri*, and *N. fowleri* was also responsible for the boys' deaths from PAM. It is likely that the elevated

ground water temperature provided a suitable habitat for *N. fowleri* colonization and growth either in the aquifer, the well, the distribution system, or the household plumbing.

2.2.2 Total Coliforms as Indicators of Treatment Effectiveness and Integrity of the Distribution System

TC is a group of closely related bacteria that, with a few exceptions, are not harmful to humans. Many bacteria in the TC group are soil bacteria but some, such as *E. coli*, originate in the gut of warm-blooded animals. Coliform bacteria may be transported to surface water by runoff or to ground water by infiltration. TCs are common in ambient water and may be injured by environmental stresses such as lack of nutrients, and water treatment, such as chlorine disinfection, in a manner similar to most bacterial pathogens and many viral enteric pathogens (including fecal pathogens). EPA considers TC to be a useful indicator of a potential pathway through which fecal contamination can enter the distribution system. The absence (versus the presence) of TC in the distribution system indicates a reduced likelihood that fecal contamination and/or waterborne pathogens are occurring in the distribution system.

Under the 1989 TCR, each TC-positive sample is assayed for either FC or *E. coli*. Fecal coliform bacteria are a subgroup of TC that traditionally has been associated with fecal contamination. Since the promulgation of the TCR, more information and understanding of the suitability of FC and *E. coli* as indicators have become available. Study has shown that the FC assay is imprecise and too often captures bacteria that do not originate in the human or mammal gut (Edberg et al., 2000). On the other hand, *E. coli* is a more restricted group of coliform bacteria that almost always originate in the human or animal gut (Edberg et al., 2000). Thus, *E. coli* is a better indicator of fecal contamination than FC.

2.2.3 Sanitary Defects

As part of the RTCR, TC is used as an indicator to start an evaluation process that, where necessary, will require the PWS to correct sanitary defects, which are defined as “a defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure in a barrier that is already in place.” “Sanitary defect” is a term specific to the TCR assessment and correction provisions. Sanitary defects are not intended to be linked directly to the “significant deficiencies” under the SWTR and GWR, although some problems could meet either definition. The RTCR is not intended to limit the existing authorities of primacy agencies under other regulations. Primacy agencies may allow for integrated assessments meeting the requirements of multiple rules, where appropriate (see Chapter 3 of this EA for more details on the provisions of the RTCR).

2.2.4 Occurrence of Fecal Contamination and/or Waterborne Pathogens

2.2.4.1 Presence of Fecal Contamination

Fecal contamination is a very general term that includes all of the organisms found in feces, both pathogenic and nonpathogenic. Fecal contamination can occur in drinking water both through use of contaminated source water as well as direct intrusion into the drinking water distribution system. Biofilms in distribution systems may harbor waterborne pathogens and accumulate enteric viruses and parasitic protozoa (Skraber et al., 2005; Helmi et al., 2008).

Waterborne pathogens harbored and accumulated in biofilms may have originally entered the distribution system as fecal contamination from humans or animals.

EPA believes that *E. coli* is a meaningful indicator for fecal contamination and the potential presence of associated pathogen occurrence. However, co-occurrence of indicators and waterborne pathogens is difficult to measure. The analytical methods approved by EPA to assay for *E. coli* do not specifically identify most of the pathogenic *E. coli* strains. There are at least 700 recognized *E. coli* strains. About 10 percent of the recognized *E. coli* strains are pathogenic to humans (Feng, 1995; Hussein, 2007; Kaper et al., 2004). Because EPA-approved standard methods for *E. coli* do not typically identify the presence of the pathogenic *E. coli* strains, an *E. coli*-positive monitoring result is an indicator of fecal contamination but is not necessarily a definitive measure of waterborne pathogen occurrence. Specialized assays and methods must be used to identify waterborne pathogens, including pathogenic *E. coli*. These specialized assays and methods are generally considered too costly and time consuming to be effective for routine monitoring of drinking water distribution systems.

One notable exception is the data reported by Cooley et al. (2007), which showed high concentrations of pathogenic *E. coli* strains in samples containing high concentrations of fecal indicator *E. coli*. These data are from streams and other poor quality surface waters surrounding California spinach fields associated with the recent *E. coli* O157:H7 foodborne outbreak. Data equivalent to these are not available from drinking water samples collected under the 1989 TCR.

2.2.4.2 Waterborne Disease Outbreaks

The CDC defines a waterborne disease outbreak as occurring when at least two persons experience a similar illness, or one person is ill with amoebic meningioencephalitis, after the ingestion of drinking water or following exposure to water used for recreational purposes, in cases where the epidemiologic evidence implicates water as the probable source of the illness (Kramer et al., 1996). The CDC maintains a database on waterborne disease outbreaks in the United States. The database is based upon responses to a voluntary and confidential survey form that is completed by state and local public health officials.

The National Research Council strongly suggests that the number of identified and reported outbreaks in the CDC database for surface and ground waters represents only a small percentage of the actual number of waterborne disease outbreaks (NRC, 1997; Bennett et al., 1987, Hopkins et al.,1985 for Colorado data). Underreporting occurs because most waterborne outbreaks in community water systems are not recognized until a sizable proportion of the population is ill (Perz et al., 1998; Craun, 1996), perhaps 1 to 2 percent of the population (Craun, 1996).

EPA drinking water regulations are designed to protect against endemic waterborne disease and to minimize waterborne outbreaks. Endemic waterborne disease may be defined as any waterborne disease not associated with an outbreak.

2.3 Statutory Authority for Promulgating the Rule

As mentioned previously, SDWA requires EPA to review and revise, as appropriate, each existing NPDWR at least once every six years (SDWA section 1412(b)(9), 42 U.S.C. § 300g-1(b)(9)). Section 1412(b)(9) of SDWA states:

> The Administrator shall, not less often than every 6 years, review and revise, as appropriate, each national primary drinking water regulation promulgated under this title. Any revision of a national primary drinking water regulation shall be promulgated in accordance with this section, except that each revision shall maintain, or provide for greater, protection of the health of persons.

In 2003, EPA completed its review of the 1989 TCR and 68 NPDWRs for chemicals that were established prior to 1997 (USEPA 2002b, 67 FR 19030, April 17, 2002). In the Six-Year Review determination published in July 2003, EPA stated its intent to revise the 1989 TCR (USEPA 2003b, 68 FR 42907, July 18, 2003).

2.4 Economic Rationale

As a revision to an existing regulation, the primary goal of the RTCR is to achieve the objectives of the 1989 TCR more effectively and efficiently, taking into account the changes in regulatory framework for implementing the SDWA over the past 20 years and experience with the 1989 TCR since promulgation. In this context, the overall *economic rationale* behind the promulgation of the RTCR is the same as the rationale for the promulgation of the 1989 TCR. This section addresses the economic rationale for choosing a regulatory approach under the RTCR (and 1989 TCR) rather than non-regulatory options.

An economic rationale for the rule is required by Executive Order 12866, Regulatory Planning and Review (58 FR 51735, October 1993), which states:

> "[E]ach agency shall identify the problem that it intends to address (including, where applicable, the failures of the private markets or public institutions that warrant new agency action) as well as assess the significance of that problem." (Section 1, b(1))

In addition, Office of Management and Budget (OMB) guidance, dated January 11, 1996, states that "in order to establish the need for the proposed action, the analysis should discuss whether the problem constitutes a significant market failure" (OMB, 1996).

In a perfectly competitive market, prices and quantities are determined solely by the aggregated decisions of buyers and sellers. Such a market occurs when many producers of a product are selling to many buyers, and where both producers and consumers have perfect information on the characteristics and prices of each firm's products. Barriers to entry in the industry cannot exist, and individual buyers and sellers must be "price takers" (i.e., their individual decisions cannot affect the price). Several properties of the public water supply do not satisfy the conditions for a perfectly competitive market and thus lead to market failures that require regulation.

Many PWSs are natural monopolies. A natural monopoly exists when it is impossible for more than one firm in each area to recover the costs of production and survive. There are high fixed costs associated with reservoirs and wells, transmission and distribution systems, treatment plants, and other facilities. For other potential suppliers to enter the market, they would have to provide the same extensive infrastructure to realize similar economies of scale and be competitive. A splitting of the market with increased fixed costs (e.g., two supplier networks in a single market) usually makes this situation unprofitable. The result is a market suitable for a single supplier and hostile to alternative suppliers. In such natural monopolies, suppliers have fewer incentives for providing quality services or maintaining competitive prices. In these situations, governments often intervene to help protect the public interest.

For example, because PWSs are legal, as well as natural, monopolies, they are often subject to price controls, if not outright public ownership. While customers may demand improvements in water quality, the regulatory structure may not facilitate the transmission of that demand to the water supplier or allow the supplier to raise its price to recover the cost of the improvements. If consumers do not believe that their drinking water is safe enough, they cannot simply switch to another water utility. Other options for obtaining safe drinking water (e.g., buying bottled water or installing point of use filtration) most often represent a higher water cost to consumers than the purchase from PWSs. Therefore, the water supplier may have little incentive to improve water quality.

The public may also not understand the health and safety issues associated with poor drinking water quality. Understanding the health risks posed by trace quantities of drinking water contaminants involves analysis and synthesis of complex toxicological and health sciences data. Therefore, the public may not be aware of the risks it faces. EPA has implemented a Consumer Confidence Reports (CCR) Rule (USEPA, 1998b, 63 FR 44512, August 1998) that makes water quality information more easily available to consumers. This rule requires CWSs to publish an annual report on local drinking water quality. Consumers, however, still have to analyze this information for its health risk implications. Furthermore, even if informed consumers are able to engage PWSs in a dialogue about health issues, the transaction costs of such interaction (measured in personal time and monetary outlays) present another significant impediment to consumer expression of risk reduction preferences.

SDWA regulations are intended to provide a level of protection from exposure to drinking water contaminants. The regulations set minimum performance requirements to protect consumers from exposure to contaminants. SDWA regulations are not intended to restructure market mechanisms or to establish competition in supply; rather, they establish the level of service to be provided that best reflects public preference for safety. The federal regulations reduce the high information and transaction costs by acting on behalf of consumers in balancing risk reduction and the social costs of achieving this risk reduction.

3 Consideration of Regulatory Options

3.1 Introduction

This chapter describes the regulatory options considered during the development of the Revised Total Coliform Rule (RTCR) and evaluated as part of this economic analysis (EA).

3.2 Total Coliform Rule/Distribution System Advisory Committee

In the July 2003 NPDWR review decision, EPA provided public notice of its intent to revise the 1989 TCR. In 2007, EPA decided to establish a committee under the Federal Advisory Committee Act (FACA) called the Total Coliform Rule/Distribution System Advisory Committee (TCRDSAC) (USEPA, 2007a). The advisory committee was charged with developing an Agreement in Principle (AIP) [7] with recommendations for the revision of the 1989 TCR. The advisory committee was to also provide EPA with recommendations needed to understand and address possible public health impacts from potential degradation of drinking water quality in distribution systems. Specifically, the major objectives of the advisory committee were to provide advice and recommendations on:

- Revisions to the 1989 TCR that would improve implementation while maintaining or improving public health protection and distribution system water quality. Examples of the issues the TCRDSAC considered include: the 1989 TCR monitoring framework, sanitary survey provisions, definition of maximum contaminant level (MCL) violations and potential follow-up corrective actions, and public notification of violations.

- What data should be collected, research conducted, and/or risk management strategies evaluated to better project distribution system contaminant occurrence and associated public health risks in the distribution systems. This was intended to "initiate a process for addressing cross connection control and backflow prevention requirements and consider additional distribution system requirements related to significant health risks" as recommended by the M/DBP Federal Advisory Committee.

EPA held a series of 13 meetings of the advisory committee between July 2007 and September 2008. The 15 committee members, along with other stakeholders, discussed options for revising the 1989 TCR and began the process of developing the RTCR by discussing the purpose, efficacy and applicability of the 1989 TCR, as well as data collection and research needed to better understand potential distribution system risks. The advisory committee formed a Technical Work Group (TWG) to provide data analysis and information to inform the advisory committee's discussions. The advisory committee also discussed the relevant provisions of the Ground Water Rule (GWR) and discussed the extent to which other rules contribute to the objectives of the 1989 TCR. All advisory committee members signed the AIP in September 2008. All of the recommendations of the AIP, on which all the members of the committee

[7] Under the proposed rule, the preferred regulatory option was called Agreement in Principle (AIP). Under the final rule, the preferred regulatory option is called the RTCR.

agreed, are found in the signed AIP (USEPA 2009, 74 FR 1683, January 13, 2009). The AIP and details about the advisory committee can be found at EPA's website at: http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/regulation_revisions_tcrdsac.cfm.

3.3 Regulatory Options Considered

EPA evaluated three regulatory options as part of the development of the RTCR—the 1989 TCR, the RTCR, and the Alternative option. The following discussion provides an overview of the three regulatory options considered followed by a detailed table comparing specific regulatory components. A detailed evaluation and comparison of the benefits and costs of each of the three regulatory options for the RTCR is found in later chapters of this EA.

Baseline Option: 1989 Total Coliform Rule

The baseline option for the EA is the 1989 TCR as written, with adjustments made to reflect the requirements of the GWR that PWSs must comply with beginning December 1, 2009. Analysis of this option is primarily based on data collected under the 1989 TCR, as described in Chapter 4 (Baseline Conditions) of this EA.

The 1989 TCR requires public water systems (PWSs) to monitor routinely for total coliforms (TC) and fecal coliforms (FC) or *E. coli.* Monitoring requirements are based on system type, population served by the PWS and source water type. Each PWS must sample according to a written sample siting plan. Plans are subject to state review and revision.

The 1989 TCR specifies a maximum contaminant level goal (MCLG) of zero for TC (including FC and *E. coli)* as well as an MCL where compliance is based on the presence or absence of TC and/or FC or *E. coli* in the samples. A PWS is required to take repeat samples following a total coliform-positive (TC+) sample and to test the TC+ sample for *E. coli*. A monthly MCL violation is triggered if: (1) a PWS collecting fewer than 40 samples per month has >1 TC+ sample per month; or (2) a PWS collecting at least 40 samples per month has >5.0% TC+ samples per month. An acute MCL violation is triggered if any PWS has any fecal coliform- or *E. coli* -positive (FC+ / EC+) repeat sample or has a FC+ or EC+ routine sample followed by a TC+ repeat sample. A PWS must demonstrate compliance with the MCL for TC each month it serves water to the public (or each calendar month that sampling occurs for PWSs on reduced monitoring). MCL violations must be reported to the state no later than the end of the next business day after the PWS learns of the violation. The public must also be notified depending on the severity of the MCL violation (within 30 days for monthly MCL violations and within 24 hours for acute MCL violations).

RTCR

The RTCR is designed to trigger PWSs that exceed specified levels of TC/*E. coli* in their finished water to do an assessment, to identify whether sanitary defects are present, and to correct such defects accordingly. EPA believes that the RTCR is an improvement over the 1989 TCR framework because it takes a more preventive approach to identifying and fixing problems with public health implications. Under the RTCR, EPA establishes an MCLG of zero for *E. coli*, an MCL for *E. coli* based on TC and *E. coli* monitoring results, and a coliform treatment technique for protection against potential fecal contamination.

On July 14, 2010, EPA proposed a RTCR that had the same elements and effect as the recommendations in the advisory committee AIP (USEPA 2010b, 75 FR 40926, July 14, 2010). The final RTCR was developed based on the proposed rule and the comments received on it. The RTCR maintains the 1989 TCR requirement for all PWSs to monitor for TC and *E. coli* according to a sample siting plan and schedule specific to the PWS. PWSs are required to take repeat samples and to test for *E. coli* following a TC+ sample.

Under the RTCR, the PWS monitoring frequencies take into account the unique characteristics of various PWS types and sizes. Small, well-operated PWSs using ground water may be able to reduce monitoring frequencies by meeting specific criteria, thus reducing their monitoring and reporting burden. Criteria for reduced monitoring includes monitoring results that reflect a clean compliance history for a minimum of 12 months as well as preventive practices designed to continue to maintain the integrity of the distribution system.

The RTCR requires PWSs to complete either Level 1 or Level 2 assessments following certain triggers (see Exhibit 3.1). The purpose of Level 1 and 2 assessments is to identify the presence of sanitary defects and deficiencies in distribution system coliform monitoring practices. The minimum elements of both Level 1 and 2 assessments include review and identification of:

- Atypical events that may affect distributed water quality or indicate that distributed water quality was impaired;
- Changes in distribution system maintenance and operation that may affect distributed water quality (including water storage);
- Source and treatment considerations that bear on distributed water quality, where appropriate (e.g., whether a ground water system is disinfected)
- Existing water quality monitoring data; and
- Inadequacies in sample sites, sampling protocol, and sample processing.

A Level 1 assessment (completed by the PWS) consists of a simple examination of the system and relevant operational practices. The PWS must complete the assessment form and submit it to the state for review within 30 days after determination that the PWS has exceeded the Level 1 trigger. The completed assessment form must include assessments conducted, all sanitary defects identified (or indicate if no sanitary defects were found), corrective actions completed, and a timetable for any corrective actions not already completed. Upon completion and submission of the assessment form by the PWS, the state will determine if the PWS has identified a likely cause for the Level 1 trigger and determine whether the PWS has corrected the problem, or has included a schedule acceptable to the state for correcting the problem. Whether or not the system has identified any sanitary defects or a likely cause for the Level 1 trigger, the state may determine whether or not the Level 1 assessment is sufficient, and if it is not the state must discuss its concerns with the system. The state may require revisions to the assessment after the consultation. If the state requires revision after consultation, the PWS must submit a revised assessment form to the state on an agreed-upon schedule not to exceed 30 days from the date of consultation. Upon completion and submission of the assessment form by the PWS, the state

must determine if the PWS has identified a likely cause for the Level 1 trigger and, if so, establish that the PWS has corrected the problem, or has included a schedule acceptable to the state for correcting the problem.

The Level 2 assessment must be conducted either by the state, a third party approved by the state, or the PWS where the PWS has the staff or management with the required certification or qualifications specified by the state. A Level 2 assessment is a more detailed examination of the system's monitoring and operational practices than a Level 1 assessment. As with the Level 1 assessment, the completed assessment form for a Level 2 assessment must also be submitted to the state for review within 30 days after determination that the PWS has exceeded the Level 2 trigger. The PWS must also indicate in the completed assessment form the sanitary defects detected (or indicate if no sanitary defects were found), corrective actions completed, and a timetable for any corrective actions not already completed. Upon completion and submission of the assessment form by the PWS, the state will determine if the PWS has identified a likely cause for the Level 2 trigger and determine whether the PWS has corrected the problem, or has included a schedule acceptable to the state for correcting the problem. Whether or not the system has identified any sanitary defects or a likely cause for the Level 2 trigger, the state may determine whether or not the Level 2 assessment is sufficient, and if it is not the state must discuss its concerns with the system. The state may require revisions to the assessment after the consultation. If the state requires revision after consultation, the PWS must submit a revised assessment form to the state on an agreed-upon schedule not to exceed 30 days from the date of consultation. Upon completion and submission of the assessment form by the PWS, the state must determine if the PWS has identified a likely cause for the Level 2 trigger and, if so, establish that the PWS has corrected the problem, or has included a schedule acceptable to the state for correcting the problem.

The RTCR requires PWSs to correct sanitary defects found through either a Level 1 or Level 2 assessment. The 1989 TCR does not require PWSs that have TC MCL violations to perform corrective actions. For corrections that are not completed by the time the PWS submits the completed assessment form to the state, the PWS must complete the corrective action(s) on a schedule determined by the state in consultation with the PWS. The PWS must notify the state when each scheduled corrective action is completed.

The RTCR specifies violations corresponding to different degrees of potential public health concern and public notification. A violation of an *E. coli* MCL occurs when:

- A routine sample is TC+ and one of its associated repeat samples is EC+; or
- A routine sample is EC+ and one of its associated repeat samples is TC+ or EC+; or
- A system fails to test for *E. coli* when any repeat sample is TC+; or
- A system fails to take all required repeat samples following a routine sample that is EC+.

An *E. coli* MCL violation requires a Tier 1 public notification. A coliform treatment technique violation occurs when the PWS exceeds a treatment technique trigger (see Exhibit 3.1) and then fails to conduct the required assessment or corrective action within the required

timeframes. A coliform treatment technique violation requires a Tier 2 public notification. If the system does conduct the assessment and satisfies the requirements of the coliform treatment technique (including corrective action when a sanitary defect is identified), no public notification is required. A monitoring violation occurs when a PWS fails (1) to take every required routine or additional routine sample in a compliance period, or (2) to analyze for *E. coli* following a TC+ sample. A reporting violation occurs when (1) a PWS properly conducts monitoring or an assessment but fails to submit a monitoring report or a completed assessment form, or (2) a PWS fails to notify the state following an EC+ sample. Both monitoring violations and reporting violations require a Tier 3 public notification, but community water systems can use their annual consumer confidence report to complete the notification.

The provisions of the RTCR consider the implication and linkages to other rules promulgated by EPA under SDWA (e.g., GWR, Surface Water Treatment Rules (SWTRs), and the Disinfectant/ Disinfection Byproduct (DBP) Rules (USEPA, 1998c)). Compliance activities for other rules, such as the sanitary survey, are used under the RTCR as criteria to assess the integrity of the PWS and to implement the reduced monitoring provisions in a cost-effective manner. By January 2015 ground water PWSs will have completed at least one round of the sanitary survey component of the GWR. Therefore, sanitary survey findings can be used by states in the determination of the monitoring frequency.

Alternative Option: All PWSs Initially Sample for TC/EC on Monthly Basis

The third option is the Alternative option which parallels the RTCR in most ways but includes variations of some of the provisions that were discussed by the advisory committee before consensus was reached on the RTCR. Under the Alternative option, at the compliance date, all PWSs would be required to sample monthly for an initial period until they meet the eligibility criteria for reduced monitoring. This more stringent approach differs from the RTCR. Under the RTCR PWSs are allowed to continue to monitor at their current frequencies (with an additional annual site visit / voluntary Level 2 assessment for PWSs wishing to remain on annual monitoring) until they are triggered into an increased sampling frequency. Under the Alternative option, however, no PWSs would be allowed to reduce monitoring to an annual basis. EPA defined the Alternative option this way and included it in the economic analysis to assess the relative impacts of a more stringent rule and to better understand the balance between costs and public health protection.

3.3.1 Comparative Summary of Regulatory Options

Exhibit 3.1 below summarizes the components of each regulatory option considered for the RTCR.

Exhibit 3.1 Comparison of RTCR Regulatory Options

Element	1989 TCR	RTCR	Alternative option
Rule construct	• MCLG of zero for TC (including FC and EC). • TC monthly MCL based on the number/percent of TC+ samples in a month. • FC/EC acute MCL based on FC+/EC+ samples. • Public Notification required for MCL violations, including the TC monthly MCL violation based only on TC occurrence.	• No MCLG/MCL for TC, FC no longer used. • EC MCLG of zero, and an EC MCL and a coliform treatment technique based on TC and/or EC results. • Assessment (and corrective action if necessary) required if PWS has a coliform treatment technique trigger. • Public Notification not required for only TC occurrence.	Same as RTCR.
Transition to the New Rule	N/A	• PWSs continue on their 1989 TCR monitoring schedule provided they meet criteria. • Noncommunity Water Systems (NCWSs) on quarterly/annual monitoring remain on that schedule unless/until they have an event that triggers increased monitoring. • Community Water Systems (CWSs) on reduced monitoring remain on that schedule unless/until they have an event that triggers return to routine monitoring. • Monitoring schedules will be evaluated during the “special monitoring evaluation” conducted by the state as part of the periodic sanitary survey to determine if the monitoring frequency is appropriate. The first such evaluation must be conducted during the first scheduled sanitary survey after the effective date of the rule; a system may remain on its 1989 TCR monitoring schedule until this time unless it is triggered into more frequent monitoring.	No transition. PWSs start new requirements as soon as the rule is effective.

Element	1989 TCR	RTCR	Alternative option
Routine Monitoring	• 1 sample per quarter for NCWS ≤1,000 Ground Water (GW). • 1 sample per month for NCWS ≤1,000 Surface Water (SW) and all CWS ≤1,000. • For all PWS >1,000, the number of samples per month is based on population served and specified in the rule.	• 1 sample per month for seasonal NCWS ≤1,000 (GW)[8] with criteria to qualify for reduced monitoring. Seasonal systems must also demonstrate completion of a state-approved start-up procedure. • For all others, same as 1989 TCR, with more explicit criteria to qualify for reduced monitoring (see "Reduced Monitoring" in this exhibit).	A minimum frequency of monthly monitoring for all PWSs.
Reduced Monitoring	• NCWS ≤1,000 (GW) can reduce to 1 sample per year if system is free of sanitary defects. • CWS ≤1,000 (GW) can reduce to 1 sample per quarter if no history of TC contamination, no sanitary defects, and protected GW source. • No other systems are eligible for reduced monitoring.	• NCWS ≤ 1,000 (GW)—same as in 1989 TCR, but more criteria to qualify and remain on reduced annual monitoring. ○ Most recent sanitary survey shows that system is free of sanitary defects,[9] has a protected water source, and meets approved construction standards; ○ Clean compliance history for a minimum of 12 months; ○ Level 2 assessment by party approved by state within the last 12 months and correction of all identified sanitary defects. System must also have an annual site visit every year thereafter to remain on annual monitoring. • Seasonal NCWS ≤ 1,000 (GW) can be eligible for reduced monitoring by having an approved sample site plan that designates the time period for monitoring based on site-specific considerations (e.g., during periods of highest demand or highest vulnerability to contamination). The system must collect compliance samples during this time. ○ For reduced quarterly monitoring the seasonal system must have a sanitary survey or site visit or Level 2 assessment within last 12 months; a protected water source; a clean	• NCWS ≤ 1,000 (GW) (including seasonal systems)—reduced quarterly monitoring (criteria same as RTCR). Reduced annual monitoring is not allowed. • CWS ≤ 1,000 (GW)—same as RTCR. • No other systems are eligible for reduced monitoring.

[8] A seasonal system is a non-community water system that is not operated as a public water system on a year-round basis and starts up and shuts down the system at the beginning and end of each operating season (§141.851 of the RTCR).

[9] The RTCR defines a sanitary defect as "a defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure in a barrier that is already in place"

Element	1989 TCR	RTCR	Alternative option
		compliance history for a minimum of 12 months, and be free of sanitary defects. ○ To reduce to 1 sample per year, the seasonal system must meet the criteria specified above for quarterly monitoring and have in place or adopt one or more additional enhancements to barriers to contamination (cross connection control, certified operator, meet disinfection criteria, maintenance of at least 4-log removal or inactivation of viruses, other equivalent enhancements). • CWS ≤ 1,000 (GW)—same as in 1989 TCR, but more criteria to qualify and remain on reduced quarterly monitoring. ○ State certified operator; ○ Most recent sanitary survey shows that system is free of sanitary defects (or has an approved plan and schedule to correct them), has a protected water source, and meets approved construction standards; ○ Clean compliance history for a minimum of 12 months; ○ Meets at least one of the following criteria: annual site visit by the state or a voluntary Level 2 assessment by a party approved by the state or meeting criteria established by the state; cross connection control; meet disinfection criteria; maintenance of at least 4-log removal or inactivation of viruses; other equivalent enhancements to water systems as approved by the state. • No other systems are eligible for reduced monitoring.	
Increased Monitoring (NCWS) and Return to Routine Monitoring (CWS)	• N/A (none specified)—NCWS. • N/A (none specified)—CWS	• NCWS ≤ 1,000 (GW only) increases from quarterly or annual monitoring to monthly monitoring if one of the following occurs: ○ Triggered Level 2 assessment or a 2nd Level 1 assessment in 12 months; ○ EC MCL violation; ○ Treatment technique violation; ○ Two monitoring violations within 12 months if on quarterly	Same as RTCR with the exception that reduced annual monitoring is not allowed under this option.

Element	1989 TCR	RTCR	Alternative option
		monitoring; or ○ One monitoring violation and one Level 1 assessment within 12 months if on quarterly monitoring. • NCWS ≤ 1,000 (GW only) increases from quarterly monitoring to monthly monitoring if it has one monitoring violation and one Level 1 assessment within 12 months. • NCWS ≤ 1,000 (GW only) increases from annual monitoring to quarterly monitoring if it has one monitoring violation. • CWS ≤ 1,000 (GW only) on quarterly monitoring return to monthly monitoring based on the first four criteria that trigger a NCWS ≤ 1,000 (GW only) to increased its monitoring to monthly, as listed above.	
Return to Reduced Monitoring (After Being Triggered to Increased Monitoring)	N/A	• NCWS ≤ 1,000 (GW) must meet the following criteria to return to routine quarterly monitoring after being triggered to increased monitoring: ○ Within the last 12 months, system must have completed a sanitary survey or a site visit by the state or a voluntary Level 2 assessment, must be free of sanitary defects, and must have a protected water source; and ○ Clean compliance history for a minimum of 12 months. • NCWS ≤ 1,000 (GW) must meet the following criteria to return to reduced annual monitoring in addition to meeting the criteria for returning to routine quarterly monitoring: ○ An annual site visit by the state or a voluntary Level 2 assessment and correction of all identified sanitary defects; and ○ Adoption of one or more additional enhancements to the water system barriers to contamination (cross connection control, certified operator, meet disinfection criteria, maintenance of at least 4-log removal or inactivation of viruses, other equivalent enhancements). • CWS ≤ 1,000 (GW) must meet the same criteria for qualifying for reduced quarterly monitoring.	Same as RTCR with the exception that reduced annual monitoring is not allowed under this option.

Element	1989 TCR	RTCR	Alternative option
Repeat Monitoring	• PWS serving >1,000 people must take 3 repeat samples after a TC+ sample. • PWS serving ≤1,000 must take 4 repeat samples after a TC+ sample. ○ For ground water systems, 1 sample can be a source water sample to comply with the GWR.	• All PWSs must take 3 repeat samples after a TC+ sample. ○ PWS ≤ 1,000, the number of repeat samples is reduced from 4 samples to 3. • GW PWS must still take an additional source sample to comply with the GWR. • For GW PWS ≤ 1,000, a single sample can meet both the triggered source water requirements of the GWR and the repeat sample requirements of the RTCR, but only if the state approves the use of the single sample to meet both rule requirements and the use of EC as the fecal indicator.	Same as RTCR.
Additional Routine Monitoring	PWS taking <5 routine samples per month (PWS serving ≤ 4,100) must take at least 5 routine samples the month after a TC+ sample.	• For PWS taking samples less than monthly, the number of samples required after a TC+ is reduced from 5 to 3. • For PWS taking at least 1 sample per month, the additional routine sample requirement is eliminated (they take their usual number of samples the following month).	Same as RTCR.
Sample Siting Plan	• Sampling must occur at sites representative of water quality in the distribution system. • Sample siting plans are subject to state review/ revision. • Special purpose samples are not used for determining compliance. • Take at least one repeat sample within 5 connections up- and downstream of the TC+ site.	Same as 1989 TCR except: • Specifically allows for dedicated sampling stations. • Provides more flexibility for systems in determining the locations for taking repeat samples. For systems that want to establish repeat sampling locations other than the within-five-connections-upstream-and-downstream of the TC-positive sample, the system must submit the sample siting plan for review and the state may modify the sampling locations as needed. • States may allow entry point sampling at ground water systems if the overall plan remains representative of water quality in the distribution system.	Same as RTCR.
Assessment	N/A—none required under the 1989 TCR.	• The PWS must conduct a Level 1 (self-assessment) if it exceeds any of the following triggers: ○ For systems taking ≥40 samples per month, the PWS	Same as RTCR.

Element	1989 TCR	RTCR	Alternative option
		exceeds 5.0% TC+ samples for the month; or ○ For systems taking <40 samples per month, the PWS has ≥ 2 TC+ samples for the month; or ○ The PWS fails to take every required repeat sample after any single routine TC+ sample. • The PWS must ensure that a Level 2 assessment is conducted either by the state or a state-approved 3rd party (including qualified PWS employee) if it exceeds any of the following triggers: ○ The PWS has an *E. coli* MCL violation. ○ The PWS has a second Level 1 trigger within a rolling 12-month period, or in 2 consecutive years for systems on annual monitoring. • Assessment results and description of corrective action taken will be submitted to the state within 30 days.	
Corrective Action	N/A—none required under the 1989 TCR.	• System must correct all sanitary defects found in the assessment. • State must be satisfied with the assessment. • For corrections not completed by the time the assessment form is submitted, the systems must be in compliance with a state determined schedule and must notify the state when completed.	Same as RTCR.

Element	1989 TCR	RTCR	Alternative option
Violations and Public Notification	• EC/FC MCL violation—acute violation, Tier 1 Public Notification. • Monthly TC MCL violation—Tier 2 Public Notification. • Monitoring or reporting violation—Tier 3 Public Notification. • PWS must notify state regarding single EC+/FC+ result.	• EC MCL violation—Tier 1 Public Notification. Failure to take repeat samples following an EC+ is also an EC MCL violation. • Monthly TC MCL violation is dropped—conditions that trigger a monthly TC MCL violation under the TCR trigger assessment and corrective action instead. • Coliform treatment technique violation occurs when a PWS fails to conduct required assessment and corrective action—Tier 2 Public Notification. • Monitoring and reporting violations will be tracked separately—Tier 3 Public Notification.	Same as RTCR.

3.4 Final Rule Requirements

Based on the recommendations in the AIP, as well as the comments received on the proposed RTCR during the public comment period, EPA selected the RTCR as the preferred regulatory option. The RTCR was developed by the EPA with the primary goal of achieving the objectives of the 1989 TCR more effectively and efficiently, taking into account the changes in regulatory framework for implementing the SDWA over the past 20 years and experience with the TCR since it was promulgated in 1989. Additional discussion supporting the selection of the RTCR as the preferred regulatory option in terms of benefits and costs is provided in Chapters 6 (benefits), 7 (costs), and 9 (benefits and costs). For a detailed discussion of the requirements of the RTCR, see section III of the RTCR preamble and subpart Y of 40 CFR part 141.

4 Baseline Conditions

4.1 Introduction

A primary step in the development of the economic analysis (EA) for the Revised Total Coliform Rule (RTCR) was to estimate the baseline conditions. The U.S. Environmental Protection Agency (EPA) used available data to develop an occurrence and predictive model for public water systems (PWSs) serving 4,100 people or fewer based primarily on the 2005 Six-Year Review 2 data to predict total coliform (TC) and *E. coli* occurrence, Level 1 and Level 2 assessment triggers, corrective actions, and violations, both in the baseline and over time. EPA developed another, simpler, predictive model for PWSs serving more than 4,100 people based primarily on the 2005 Safe Drinking Water Information System/Federal Version (SDWIS/FED) violation data (USEPA, 2005) that predicts triggers, assessments, corrective actions, and violations both in the baseline and over time, but not TC and *E. coli* occurrence. Because five years of Ground Water Rule (GWR) implementation prior to the effective date of the RTCR are expected to cause changes to ground water systems, the baseline conditions that EPA developed for the EA account for the effects of the GWR, as described in this chapter and Chapter 5. The remainder of this chapter describes the data sources used to develop the baselines and how the data were used. The resulting estimate of baseline conditions serves as a reference point for understanding net impacts of the RTCR, as discussed in Chapters 6, 7, and 9 of this EA.

4.1.1 Background and Purpose

The baseline analysis is a characterization of the water industry and its current operations in effect before systems make changes to meet requirements of the RTCR. This chapter presents estimates of the number of systems, the population affected, water quality measures, and subpopulations affected. The data collected for this profile serves as the baseline in the RTCR EA. The development of the baseline analysis consisted of the following steps:

- Compilation of a profile of water systems—identifying and collecting information on all PWSs.
- Characterization of current monitoring requirements, including testing requirements, sample siting plans, routine and repeat sampling requirements, and sanitary surveys.
- Characterization of current PWS compliance information, including acute and monthly maximum contaminant level (MCL) violations, triggered monitoring, and public notification reporting.

4.1.2 Chapter Organization

The remainder of this document is organized into four general sections:

- **Section 4.2** describes general information on data sources.
- **Section 4.3** describes the baseline conditions.

- **Section 4.4** estimates baseline impact on sensitive populations.
- **Section 4.5** presents a summary of assumptions used to develop baseline estimates, associated uncertainty and variability, and potential impacts on the results of the RTCR EA.

4.2 Data Sources

Several primary data sources were used for the EA to characterize the RTCR baseline to create system and population baselines, including the SDWIS/FED (USEPA, 2007b), the 2005 Six-Year Review of National Primary Drinking Water Regulations (Six-Year Review 2), the GWR EA, and the U.S. Census. Each of these data sources is further explained in Sections 4.2.1–4.2.3 below.

4.2.1 Background on SDWIS/FED Data

SDWIS/FED[10] is EPA's national regulatory compliance database for the drinking water program and is the main source of PWS inventory and violation data for the RTCR baseline. SDWIS/FED contains information on each of the approximately 155,000 active PWSs as reported by primacy agencies,[11] EPA Regions, and EPA headquarters personnel. SDWIS/FED does not include sample results, but does include identification of MCL violations and monitoring and reporting violations (both routine and repeat, and minor and major).[12] It also contains information to characterize the U.S. inventory of PWSs, namely: system name and location; retail population served; source water type (i.e., ground water (GW), surface water (SW), or ground water under the direct influence of surface water (GWUDI)); whether or not systems disinfect the water; and PWS type, as described below.

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[10] Further information on SDWIS/FED can be found on EPA's website: http://www.epa.gov/safewater/databases/sdwis/index.html.

[11] States and Indian Tribes are given primary enforcement responsibility (primacy) for regulations pertaining to PWSs in their State/jurisdiction if they meet certain requirements specified under the primacy regulations at 40CFR142, Subpart B.

[12] Under the 1989 Total Coliform Rule, violation categories are defined as follows (category names in bold). A **non-acute (monthly) MCL violation** occurs when >1 routine and/or repeat sample are total coliform-positive (TC+) for PWSs that take fewer than 40 samples monthly, or greater than 5.0% of monthly samples are TC+ for PWSs that take at least 40 samples. An **acute MCL violation** is triggered if a PWS has a fecal coliform-positive (FC+) or *E. coli*-positive repeat sample following a TC+ or has a FC+/EC+ routine sample followed by a TC+ repeat sample. A **monitoring violation** occurs when a PWS 1) does not satisfy the sample siting plan requirement; 2) does not sample in accordance with its required schedule; 3) does not analyze a TC+ routine sample for FC or *E. coli*; 4) does not collect repeat samples within 24 hours and analyze for TC following a routine TC+; or 5) does not test repeat samples that are TC+ for FC or *E. coli*. If a PWS fails to conduct some of the required routine samples in a compliance period, the PWS incurs a **minor routine monitoring violation**. Equivalently, a PWS that fails to conduct some or all of its required repeat samples following a TC+ routine sample incurs a **minor repeat monitoring violation** or a **major repeat monitoring violation**, respectively. Reporting violations occur when a PWS does not report to the state or to the public according to the schedule for each violation type. For acute MCL violations, a PWS must report to the state by end of day and to the public within 24 hours (by posting, hand delivery, or mass media subject to primacy agency approval). For monthly MCL violations, a PWS must report to the state by end of next day, and to the public within 30 days by mail, hand delivery, or other methods approved by the primacy agency. For monitoring violations, a PWS must notify the public with 1 year in accordance with general public notification requirements approved by the primacy agency.

EPA defines a PWS as a system that provides water for human consumption through pipes or other constructed conveyances if such a system has at least 15 service connections or regularly serves an average of at least 25 individuals per day for at least 60 days per year. PWSs are categorized as follows:

- **Community water systems (CWS)** are PWSs that supply water to the same population year-round.
- **Noncommunity water systems (NCWS)** are PWSs that supply water to a varying population or one that is served less than year-round. They are sub-categorized as follows:
  - Nontransient noncommunity water systems (NTNCWS) are PWSs that are not CWSs and that regularly supply water to at least 25 of the same people at least six months per year, for example, schools.
  - Transient noncommunity water systems (TNCWS) are NCWSs that provide water in places such as gas stations or campgrounds where people do not remain for long periods of time.

Additionally, PWS are analyzed in this EA according to categories defined by the number of people they serve. The following nine categories of populations served by PWSs are used throughout this document:

- ≤100
- 101–500
- 501–1,000
- 1,001–4,100
- 4,101–33,000
- 33,001–96,000
- 96,001–500,000
- 501,001–1 Million
- Over 1 Million

These population categories are mostly consistent with those analyzed for other rules and consider the distinctions in cost and system operation that are meaningful when considering the economic effects of rule requirements. In particular, under the 1989 TCR, PWSs serving more than 1,000 people all test for TC monthly; PWSs serving fewer than 1,000 people may monitor quarterly or even annually and (assuming that they collect fewer than 5 samples per month) must have a sanitary survey every 5 years. The 33,000 threshold is significant as it corresponds with sampling requirements (at least 40 samples per month are taken) that affects how compliance with the rule is calculated. (PWSs serving >33,000 persons must take 40 or more samples in a month, and may trigger an MCL violation based on the percentage of total coliform-positive (TC+) samples, in this case, >5.0 percent.) Finally, the size category thresholds of 1,000; 4,100; 33,000; and 96,000 are consistent with the size categories used in the 1989 TCR to determine the monitoring regimen.

4.2.1.1 Data Used from SDWIS/FED

To create the system and population baseline, EPA obtained the most current PWS inventory data by downloading data from the 4th quarter of 2007 from SDWIS/FED (USEPA, 2007b). These data represented all current, active PWSs and the population served by these systems at the time of the download. This information comprises the PWS inventory baseline for this EA, and is summarized in Section 4.3.

EPA also used MCL violations data from SDWIS/FED to validate model predictions for systems serving ≤4,100 people as described in Section 5.3.3.2, and to predict *E. coli* (acute) MCL violations (1989 TCR, RTCR, and Alternative option), TC (non-acute or monthly) MCL violations (1989 TCR) and Level 1 and Level 2 assessment triggers (RTCR and Alternative option) for systems serving more than 4,100 people, as described in Section 4.3.4.2.

4.2.1.2 Data Cleaning

Data obtained from SDWIS/FED comprised PWS inventory data for the 4th quarter of 2007 and violations data from 3rd quarter 2005. The 4th quarter inventory data included the number of each type of PWS and the retail population served by each system for all active PWSs, and was used from SDWIS/FED without manipulation for the purpose of this analysis. For the SDWIS/FED violations dataset, EPA excluded some data representing OH, tribes, and territories as described in Section 4.3.4.2. The data set taken from the 2005 Six-Year Review 2 database was cleaned as described in Section 4.2.2 of this EA.

4.2.1.3 Representativeness and Quality of SDWIS/FED Data

As noted above, SDWIS/FED is the source of PWS inventory data, and includes information on all of the approximately 155,000 PWSs to the extent that such data was entered by primacy agencies, EPA Regions, and EPA headquarters personnel. In 1998, EPA began a major effort to assess the quality of the drinking water data in SDWIS, including performance of a data quality assessment that has been published triennially since 2002. The most recent report from this periodic assessment, the 2006 Drinking Water Data Reliability Analysis and Action Plan (2006 report) (USEPA, 2008a), evaluated data for 2002–2004 and found the PWS inventory data quality to be high (87 percent) and the 1989 TCR violations data quality to be moderately high (81 percent). For the PWS inventory data used in this analysis, EPA found specifically that:

> "…The overall data quality of the eight inventory (water system identification) parameters assessed was 87%. In other words, 87% of PWSs from data verification (DV) [13] states between 2002 and 2004 had consistent data for all eight inventory data elements between their state files and SDWIS/FED database, or 13% of PWSs had at least one data element reported with a discrepancy. The highest discrepancy rate was for the administrative contact address element."

[13] EPA routinely evaluates state programs by conducting DV audits, which evaluate the accuracy of a state's decisions regarding PWS compliance with SDWA regulations and the accuracy with which inventory and compliance data is reported (entered or uploaded into) SDWIS/FED.

The report's assessment indicates a high degree of completeness and accuracy in inventory data submitted by states to SDWIS/FED, and suggests that the information is largely representative of the PWSs in the United States. Although the RTCR EA uses inventory data from 2007, the assessment above applies to the most recent period analyzed in this report (2002–2004). EPA believes that the inventory data from SDWIS/FED in 2007 is also likely to be representative of the approximately 155,000 PWSs and that there is low uncertainty in the data with respect to numbers of systems, source water type, size classification, and disinfection status.[14]

For the 1989 TCR MCL violations data, the overall data quality estimate was 81 percent, based on a rating of 84 percent for completeness of data and 97 percent accuracy of the data in SDWIS/FED as compared to data observed in states' databases during the verification process.[15] As described in the report, the 84 percent completeness assessment indicates that for approximately 16 percent of those systems found by EPA to have 1989 TCR MCL violations, states did not report the data in SDWIS/FED. Additionally, data completeness for monitoring and reporting violations as a whole for all Safe Drinking Water Act (SDWA) rules in SDWIS/FED is low at 29 percent, although this metric specific to the 1989 TCR is not provided in the report. Low compliance with monitoring and reporting may occur if systems would rather incur a Monitoring/Reporting violation rather than risk an MCL violation by sampling. These factors together suggest that violation rates would likely be higher if systems were fully in compliance with monitoring and reporting requirements, and if states were fully reporting those results to SDWIS/FED. Despite this potential downward bias in the MCL violations data, the Total Coliform Rule Distribution System Advisory Committee (TCRDSAC) was still able to note systematic trends in the data (across time and among PWS types and sizes) and informed its decisions and recommendations based on key observations:

- Most systems with violations were NCWSs.
- Lower violation rates were observed among larger systems.
- Higher violation rates were observed among GW systems than SW systems.
- Lower violation rates were observed among disinfecting GW systems than other GW systems.

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[14] In particular, in the 2006 report the disinfection status (disinfecting, nondisinfecting, or status unknown) inventory item was assessed at 99.3%, indicating that less than 1% of systems from DV states analyzed between 2002 and 2004 had a discrepancy in this information between State files and SDWIS/FED. For the purpose of the RTCR EA, systems with status listed as "unknown" were included in the nondisinfecting group.

[15] The Overall Data Quality Estimate in SDWIS/FED measures how many noncompliance determinations are correctly reported in SDWIS/FED among all noncompliance determinations (that are either violations or false-positive violations). This quantity is estimated based on the violations confirmed by EPA and correctly reported to SDWIS/FED out of all violations found by EPA or in the state files and SDWIS/FED. When the false positive rate is 0%, this measure is the product of Completeness and Accuracy. The False Positive rate of the violation data in SDWIS/FED describes how much of the reported violation data in SDWIS are, in fact, false violations, expressed as a percentage. Further description can be found in the 2006 Drinking Water Data Reliability Analysis and Action Plan (2006 report) (USEPA, 2008a).

An additional concern with the representativeness of the violations data in SDWIS/FED that would not be accounted for in the data quality estimate from the 2006 report is the potential bias introduced by oversampling. In a recent paper by (Bennear et al., 2009), the authors attempt to determine how often oversampling is an effort to "sample out" of a potential violation versus just over compliance—taking additional samples to increase the PWS's diagnostic power is assessing the quality of the water. The authors suggested that strategic oversampling was occurring in the one state included in their analysis[16] and suggested that some systems were reducing their probability of incurring monthly violations (on the basis of TC positives as a percent of total monthly samples taken) by increasing the total number of samples taken. Although the study was not broad enough in scope to warrant adjusting the data used from SDWIS/FED, the issue is included in the discussion of net benefits in Chapter 9 of this EA.

4.2.2 Background on 2005 Six-Year Review 2 Data

Through an information collection request (USEPA, 2006b), EPA requested that states voluntarily submit monitoring data (sample results) that were collected between January 1998 and December 2005 that were available electronically for specified chemical, radiological, and microbiological contaminants. This request included data collected in compliance with the 1989 TCR regarding the presence/absence of TC, *E. coli*, and/or fecal coliforms (FC) and any disinfection data collected at 1989 TCR monitoring sites. (SW systems are required to monitor for the presence of a disinfectant residual when collecting coliform samples in the distribution system.)

These data are an important component in supporting EPA's second Six-Year Review of national primary drinking water regulations (NPDWRs). EPA encouraged each primacy agency to submit its contaminant occurrence information because these data directly contribute to EPA's understanding of national contaminant occurrence, populations exposed to regulated contaminants, and exposure reductions associated with the current regulations.

EPA requested the 1989 TCR monitoring results with the intent of conducting analyses and developing models to assess the potential impacts of changes to the rule. Models of the occurrence of TC and *E. coli* were developed using the 1989 TCR data to assess revisions to monitoring requirements and compliance decisions for different types of PWSs as suggested by the stakeholders during the TCRDSAC process, described further in Chapter 3 of this EA.

For the RTCR EA, EPA used the 2005 Six Year Review data to develop the key parameters used in the RTCR predictive model to forecast water quality (in terms of TC and *E. coli* occurrence) under the 1989 TCR, the RTCR, and the Alternative option. Additionally, 2005 Six Year Review data was used to inform EPA's assumptions regarding the proportion of GW systems serving 1,000 or fewer people that sample monthly, quarterly, or annually (presented in Exhibit 4.4).

[16] Bennear et al. found that violations in the state of Massachusetts may have been approximately 30% greater had the oversampling not taken place.

4.2.2.1 2005 Six-Year Review 2 Data Used

As described in the Total Coliform Rule Compliance Monitoring Data Quality and Completion Report (USEPA, 2010e) (Data Quality Report) prepared during the TCRDSAC process prior to this EA, the 2005 Six-Year Review 2 data is based on coliform monitoring data voluntarily provided to EPA by 37 primacy agencies (35 states and 2 tribes). The data consist of over nine million TCR records collected between 1998 and 2005. The data elements include the following:

- PWS information—system type, population, source water type.
- Sampling types—routine, repeat, special, unknown.
- Sampling locations—entry point to the distribution system, distribution system, and for repeat samples, original location, downstream, upstream, and other.
- Methods—for testing for TC and *E. coli*.
- Monitoring results—presence/absence for TC, FC, and *E. coli*.

EPA prepared a tool that states using the SDWIS/State database system could use to easily extract data from their databases and submit it to EPA. The data extraction tool was a query that collected the data elements requested in the letter to the states. The states that used this extraction tool are categorized as Tier 1 states. States submitting data in formats not compatible with the EPA extraction tool are categorized as Tier 2 states. States that submitted incomplete or problematic data are categorized as Tier 3, and states that did not provide data are categorized as Tier 4 (e.g., California and Pennsylvania). The complete lists of states included in each of the Tiers 1–4 are provided in the Data Quality Report.

EPA used 2005 data exclusively in developing this EA. This decision was made for several reasons:

- The 2005 data, being the most recent in the Six-Year Review, were judged to be more representative of present conditions than the less recent data, especially in terms of the percent of TC records that were positive.
- There were fewer data in the years before 2005, especially 2001 and earlier, and therefore data in earlier years were judged to be too sparse to be comparable with the 2005 data. The difference in the base of PWSs studied year-to-year might have introduced an unknown bias.
- As noted earlier, the 2005 data had more records than other years, and enough to represent the full spectrum of PWSs within states that provided the data.
- Using only a single year of data was beneficial in that it simplified the analysis to include a fairly static set of PWSs, and did not require interpretation of the meaning of differences in occurrence data observed across multiple years. Understanding these types of differences would involve analysis of changing environmental

factors, program participation and administration factors, and possibly other factors before the data could be used as a baseline in the model. Additionally, a full year (and not less) of observed data was required for consistency with the basic unit of time in occurrence estimates, which is one year; and a period of 12 consecutive months is assumed to capture seasonal variation normally experienced in water quality.

- A single year of data would allow for use of a single database to store all the data for easier analysis.

4.2.2.2 Data Cleaning of 2005 Six-Year Review 2 Data

The Data Quality Report (USEPA, 2010e) describes how TCR monitoring data were obtained, evaluated, and modified where necessary to make the database internally consistent and usable for analysis. Exhibit 2.1 in the Data Quality Report provides a complete list of states or territories that submitted data and a description of the use of these data.

To determine whether a PWS's sampling data were complete in the 2005 Six-Year Review 2 dataset, a representative month for a system was defined as having at least 50 percent of the number of samples expected based on the size of system and 1989 TCR requirements. Using this 50 percent criterion, months that were not representative of a PWS were excluded; this cleaning resulted in a decrease of only 2 percent of submitted data, and is unlikely to have skewed occurrence results, as shown by Exhibits 3.1 and 3.2, respectively, of the Data Quality Report. EPA determined that a 50 percent criterion systematically eliminated systems that were only reporting positive results or otherwise not reporting many of its samples, while retaining data for systems that had increased from one size category to the next (and were therefore expected to have, for example, 15 samples per month instead of 10). The TCRDSAC agreed with this approach, which is explained further in Section 3.2 of the Data Quality Report.

4.2.2.3 Representativeness of 2005 Six-Year Review 2 Data

In the course of cleaning the 2005 Six-Year Review 2 data, EPA examined data from the 10 largest PWSs in each state and found, by matching with SDWIS inventory information, that many larger systems were not included in the data submitted by the states. For the largest systems that are represented in the 2005 Six-Year Review 2 data, EPA also compared the expected number of samples based on population served (i.e., the 1989 TCR requires a system serving a million people to sample 300 times per month) to the number of samples in the actual data to evaluate completeness. In some cases it was found that only data from the state laboratory were included. Since many large PWSs have their own laboratory and do not use the state laboratories, data for these large systems were not available. In many cases, states handled large PWSs with negative samples in a special way, and those data were not captured by the data extraction tool. The end result was that large PWSs had a lower percentage of samples included in the data than did smaller systems; therefore, data for systems serving more than 4,100 were not used from this database. Instead, as described in Section 4.3.4.2, EPA used SDWIS/FED violations data to model changes in the number of corrective actions to be implemented and the net change in costs under the RTCR (i.e., incremental costs over the 1989 TCR) for PWSs serving greater than 4,100 people.

Based on the number of smaller PWSs (serving fewer than 4,101 people) in states whose data were excluded for data quality/quantity issues or for non-submittal of data, approximately 39 percent of systems were excluded from the analysis. Specifically, the following states or territories submitted data but were excluded because of issues with the quality or quantity of data submitted: AL, American Somoa, DC, ME, MD, NJ, SC, SD, TN, and the Navajo Nation. Additionally, the following states/territories did not submit data: CA, Guam, HI, LA, MA, MS, Northern Mariana Islands, PA, Puerto Rico, TX, Virgin Islands, and WA. The remaining 70 percent of PWSs' data were used to simulate occurrence of TC and *E. coli* under the 1989 TCR, the RTCR and the Alternative option and to develop parameters for use in the RTCR predictive model, described in Chapter 5 of this EA.

Although approximately 61 percent of the systems are represented in the analysis, only an estimated 32 percent of the population served by PWSs is represented due to the omission of some large population states (i.e., CA, PA, and TX).[17] However, since EPA is not predicting changes in occurrence for the largest systems (i.e., the majority of the population is served by very large CWSs) the underrepresentation of population served in the data is not expected to have a significant impact on the analyses performed.

4.2.3 Background on Other Data and Information Used

SDWIS/FED data and 2005 Six-Year Review 2 data represent the largest portion of information used for the RTCR baseline analysis. In addition, EPA incorporated information from the GWR, the U.S. Census, and the 1989 TCR to develop assumptions for the model. EPA also relied upon the knowledge and experience of stakeholders representing industry, states, small systems, and the public to inform the process throughout development of the RTCR.

4.2.3.1 1989 TCR

Under the 1989 TCR, PWSs experienced reduced occurrence of fecal indicator contamination after the effective date as a result of increased sampling, reporting, and to some degree corrective actions. In recent years under the 1989 TCR, the occurrence of fecal indicators has reached a steady state, as reflected in SDWIS/FED violation data (see Section 4.3.4.2 for discussion). Additional reductions in occurrence are expected prior to RTCR implementation that reflect water quality improvements due to implementation of the GWR. Because the water quality data used in this analysis is the Six-Year Review 2 data for 2005, adjustments are made to the 2005 data in the modeling to reflect this GWR impact. Further reductions in occurrence of fecal indicators under the RTCR can then be properly modeled based on more focused assessments and corrective actions in response to TC+ or *E. coli*-positive (EC+) samples.

4.2.3.2 GWR data

The GWR was promulgated to address microbial contamination of ground water sources used to supply drinking water and, specifically, to address the concern about potential adverse health risks that may be associated with fecal contamination. Before the GWR was promulgated,

[17] As described further in the Data Quality Report, submission of the data was voluntary; CA, PA, and TX did not submit data.

there were no federal regulations to require filtration or disinfection of ground water sources to remove microbial contaminants. The GWR requirements include sanitary surveys, triggered monitoring in response to TCR samples testing positive for contaminant indicators, source water monitoring for indicators of fecal contamination such as *E. coli*,[18] and corrective actions that may include disinfection.

Both the GWR and the RTCR seek to decrease the level of fecal contamination in drinking water. Since the RTCR applies to all PWSs including systems that use ground water sources, the implementation of the GWR (requiring compliance beginning December 1, 2009) in advance of the RTCR is expected to modify the TCR baseline (see Sections 4.3.1–4.3.2) taken from the 2007 SDWIS/FED (4th quarter) and 2005 Six Year Review data (see Sections 4.2.1 and 4.2.2 for discussion of SDWIS/FED and 2005 Six Year Review data, respectively). The number of disinfecting and nondisinfecting public ground water systems prior to the start of GWR implementation (based on 4th quarter 2007 SDWIS/FED data) is 54,469 and 85,999, respectively. By October 2012 when the GWR is fully implemented, EPA predicts that the number of systems disinfecting will have increased from the 2007 4th quarter baseline. The RTCR occurrence model incorporates the estimated change in the number of systems with disinfection into this EA baseline (Section 5.3.1).

The RTCR occurrence model (described in further detail in Section 5.3 of this EA) accounts for GWR implementation in the following ways:

- The baseline number of disinfecting systems in the 4th quarter 2007 data of SDWIS/FED will be increased to account for the additional systems that are estimated to begin disinfecting under the GWR.

- Sanitary surveys, as required by the GWR, will be phased in for applicable PWSs in the model (over five years for systems on a five year sanitary survey cycle; and over three years for systems on a three year cycle), resulting in reduced occurrence for these systems indefinitely to represent that systems are correcting deficiencies identified in the survey. Further detail on this component of the model is provided in Chapter 5 of this EA.

- GWR compliance monitoring will be incorporated with an additional decrease in probability of occurrence to represent anticipated efforts by systems to identify and correct problems.

- The baseline estimates will account for the decreased levels of TC occurrence and fecal contamination achieved under the GWR. This decrease will be reflected in model output for the following RTCR rule components:

    - Repeat monitoring
    - Additional routine monitoring
    - Triggers for level 1 and 2 assessments

[18] Standridge, J. (2008) discusses the use of *E. coli* as an indicator of drinking water quality.

- Corrective actions
- Public notification

- Under the GWR, if a PWS experiences a TC+ while conducting TCR monitoring, the system must sample the source water for the presence of a fecal indicator (*E. coli*, enterococci, or coliphage, as determined by the state). GW systems that have a positive initial fecal indicator sample from the source are required to take five repeat fecal indicator samples if they are not required by the state to take corrective action. Under the RTCR, PWSs having less than 4-log treatment and serving 1,000 people or fewer would only be required to take 3 repeat samples. To meet GWR requirements, these systems would need to take one additional sample at the source.

- Under the RTCR, PWSs having less than 4-log treatment and serving 1,000 people or fewer would be required to take 3 repeat samples after a TC+ routine sample as opposed to the 4 repeat samples required under the 1989 TCR. To meet GWR requirements, these systems would need to take one additional sample (i.e., a fourth repeat sample) at the source. Under the RTCR, the PWS may, with written state approval, take one of its repeat RTCR samples at the location required for triggered source water monitoring under the GWR if the PWS demonstrates that the repeat sample sites in the sample siting plan remain representative of water quality in the distribution system.

4.2.3.3 U.S. Census Data

The baseline analysis incorporates data from the U.S. Census that are publically available and include surveys of the U.S. population, economics, industry, and geography. Census 2000 data were used in the baseline analyses to estimate the sensitive subpopulations in the U.S. who may be more susceptible to illness as a result of poor drinking water quality, as explained in Section 4.4 of this EA. Additionally, the Census 2008 Annual Social and Economic Supplement was used in the estimates of household size as described in Section 4.3.3.

4.3 Baseline Profile

The RTCR applies to all PWSs, regardless of their size, water source (GW or SW), or type (CWS, NTNCWS, or TNCWS). This section estimates the baseline number of PWSs and the size of the population subject to the RTCR in each of these subcategories. EPA used 4th quarter 2007 data from SDWIS to develop this inventory baseline because at the time when the TCRDSAC began discussing the RTCR and its analysis, 2007 data were the most recent inventory data available. As described in Section 4.2, the best available occurrence data for smaller PWSs were collected in 2005. For larger systems (serving >4,100 people) as Section 4.3.4.2 describes, EPA used SDWIS/FED violations data for modeling benefits and costs for PWSs serving more than 4,100 people because the 2005 Six-Year Review 2 dataset (containing sampling data) for larger systems was not as robust. Third quarter 2005 SDWIS/FED data is used for the violation baseline since EPA compiles violation data in the 3rd quarter every year (as opposed to the 4th quarter freeze used for annual compilation inventory data) and was the most recently available data at the time that this analysis was begun. Use of the 2005 data was deemed

to be equivalent to an average of multiple years due to the steady numbers of violations seen in the data over the past several years.

The baseline described in the following sections is used as a reference point for informing net costs and benefits as described in Chapters 6 and 7 of this EA.

4.3.1 Pre-GWR Baseline

Estimates of the number of GW systems subject to the RTCR are presented in Exhibit 4.1 below. These numbers reflect SDWIS/FED inventory from the fourth quarter of 2007, prior to implementation of the GWR. Ground water system inventories indicate disinfection status as disinfecting or unreported; since reporting is voluntary, the status of a system that did not report disinfection is actually unknown, although EPA assumes in this EA that the system is not disinfecting. The number of disinfecting PWSs includes those achieving less than 4-log disinfection, which matches the categorization of systems used to estimate the underlying distributions of occurrence of TC and *E. coli* modeled, as described in Chapter 5.

Exhibit 4.2 presents the number of SW systems subject to the RTCR, also derived from the SDWIS/FED database. GWR implementation does not affect the disinfection status of SW systems.

Exhibit 4.3 presents the population associated with each PWS category of system size and type prior to incorporating the effects of the GWR into the model; this is the pre-GWR baseline affected population. After incorporating GWR effects, some systems shift into the disinfecting category and some of the population shifts accordingly.

Lastly, Exhibit 4.4 presents the distribution of PWSs by frequency of sampling—monthly, quarterly, or annually—under the 1989 TCR for those systems that qualify for reduced monitoring (all other systems are required to sample monthly). This is the baseline distribution of sampling frequencies used for analyses in this EA. This distribution was derived as part of the work done by the Technical Workgroup (TWG) supporting the TCRDSAC, and validated by the Association of State Drinking Water Administrators (ASDWA). Workgroup members analyzed 2005 Six Year Review and other readily available state data to derive the estimates shown in Exhibit 4.4.

Exhibit 4.1 Pre-GWR Baseline Number of GW Systems

PWS Size	Number of GW PWSs (Pre-GWR)					
	CWS		NTNCWS		TNCWS	
	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting
≤100	6,132	5,806	2,907	5,919	13,558	46,642
101-500	9,260	4,632	2,753	3,860	5,341	13,934
501-1,000	3,502	965	868	850	673	1,290
1,001-4,100	5,405	1,038	542	270	269	348
4,101-33,000	2,798	358	56	14	27	40
33,001-96,000	307	28	2	-	-	2
96,001-500,000	62	1	-	-	-	1
500,001-1 Million	4	-	-	-	-	1
> 1 Million	3	-	-	-	-	-
Total	**27,473**	**12,828**	**7,128**	**10,913**	**19,868**	**62,258**
Combined Total	**40,301**		**18,041**		**82,126**	

Source: Data extracted from SDWIS/FED PWS Inventory, 2007 4th Quarter Data based on listed disinfection status. PWSs listed as "unknown" disinfection status in SDWIS/FED are counted as non-disinfecting.

Exhibit 4.2 Baseline Number of SW Systems

PWS Size	Number of SW PWSs		
	CWS	NTNCWS	TNCWS
≤100	1,170	250	1,339
101-500	2,150	253	497
501-1,000	1,173	88	88
1,001-4,100	2,938	72	67
4,101-33,000	3,164	22	18
33,001-96,000	720	2	-
96,001-500,000	308	1	-
500,001-1 Million	31	-	-
> 1 Million	17	-	1
Total	**11,671**	**688**	**2,010**

Source: Data extracted from SDWIS/FED PWS Inventory, 2007 4th Quarter Data. SW count includes GWUDI systems.

Exhibit 4.3 Pre-GWR Baseline Population Served by GW Systems

PWS Size	Population Served by GW PWSs (Pre-GWR)					
	CWS		NTNCWS		TNCWS	
	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting
≤100	387,558	342,243	168,482	326,342	645,949	2,139,529
101-500	2,375,507	1,085,555	708,424	948,500	1,231,077	3,005,703
501-1,000	2,570,662	703,562	630,071	600,643	516,707	956,781
1,001-4,100	11,307,740	2,074,139	991,971	456,985	449,757	599,171
4,101-33,000	29,346,057	3,627,365	418,368	122,865	194,136	353,290
33,001-96,000	15,587,186	1,527,861	89,405	-	-	119,700
96,001-500,000	9,935,500	107,323	-	-	-	100,000
500,001-1 Million	2,670,841	-	-	-	-	725,000
> 1 Million	4,389,948	-	-	-	-	-
Total	**78,570,999**	**9,468,048**	**3,006,721**	**2,455,335**	**3,037,626**	**7,999,174**
Combined Total	**88,039,047**		**5,462,056**		**11,036,800**	

Source: Data extracted from SDWIS/FED PWS Inventory, 2007 4th Quarter Data based on listed disinfection status. Populations for PWSs listed as "unknown" disinfection status in SDWIS/FED are counted as non-disinfecting.

Exhibit 4.4 Percent Distribution of GW System Monitoring Frequencies by PWS Size and Type for 1989 TCR

Size	Number of Systems	Monthly	Quarterly	Annual
Community Water Systems (CWSs), Disinfecting				
≤100	6,132	86.6%	13.4%	0.0%
101-1000	12,762	88.5%	11.5%	0.0%
1001-4100	5,405	100.0%	0.0%	0.0%
Community Water Systems (CWSs), Non-Disinfecting				
≤100	5,806	86.6%	13.4%	0.0%
101-1000	5,597	88.6%	11.4%	0.0%
1001-4100	1,038	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Disinfecting				
≤100	2,904	19.3%	64.7%	16.0%
101-1000	3,621	18.5%	66.7%	14.7%
1001-4100	542	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Non-Disinfecting				
≤100	5,913	19.3%	64.7%	16.0%
101-1000	4,710	18.5%	66.7%	14.8%
1001-4100	270	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Disinfecting				
≤100	13,558	4.8%	62.9%	32.3%
101-1000	6,014	7.9%	66.9%	25.2%
1001-4100	269	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Non-Disinfecting				
≤100	46,642	4.8%	62.9%	32.3%
101-1000	15,224	7.8%	66.8%	25.3%
1001-4100	348	100.0%	0.0%	0.0%

Source: Based on EPA and TWG analysis of 2005 Six-Year data and individual state statutes during the TCRDSAC and review by ASDWA.
Note: All other system sizes and types are required to sample monthly.

4.3.2 Post-GWR Baseline

PWSs must comply with requirements of the GWR beginning December 1, 2009, which will be approximately five years prior to the effective date of the RTCR. To account for the impact of the GWR on baseline occurrence for those PWSs using a GW source, EPA performed a number of adjustments to the 2005 data prior to its use in this EA.

Using 2007 SDWIS inventory data (as explained in Section 4.3.1) as a pre-GWR inventory baseline, EPA applied probabilities of P_{sample} and P_{well}[19] to determine the probability of a positive sample for a fecal indicator in nondisinfecting PWSs. A fraction of those systems with

[19] The term "P_{well}" refers to the probability that a randomly selected well across the United States will ever test positive in its source water for a virus or indicator species, such as TC; "P_{sample}" is the probability that given a contaminated well, a random sample at the well will test positive for a virus or indicator. The GWR EA (November 2006) (USEPA, 2006a), and in particular the Baseline Chapter of that document, provides a detailed explanation of the analysis used to generate these P_{well} and P_{sample} estimates.

a positive sample is expected to move to a disinfecting status in the five years prior to RTCR implementation. This modification ensured that systems in the analysis that disinfect drew from the probability distribution for TC+ and EC+ for disinfecting systems, which is different from the distribution for those that do not disinfect. The model continues to apply P_{well} and P_{sample} throughout the RTCR period of analysis (the 25 years following promulgation). The application of this model parameter, as it is applied in the context of other aspects of the predictive occurrence model, is explained in further detail in Chapter 5 of this EA. Exhibit 4.5 shows the baseline inventory of GW systems by disinfection status in model year 5, which is the year immediately prior to the effective date of the RTCR. The estimates in Exhibit 4.5 of nondisinfecting PWSs include a number of systems that selected a corrective action other than converting to a disinfecting system in response to fecal contamination at the source.

As explained in Chapter 5 of this EA, a number of PWSs will undertake sanitary surveys (for all GW systems) and compliance monitoring (for disinfecting GW systems) prior to implementation of the RTCR; although the costs are not considered in this EA (they were considered in the GWR EA), the systems are assigned a reduced occurrence, which is reflected in the RTCR baseline. The predictive model incorporates the contribution of sanitary survey results to the qualification of systems for reduced monitoring by assuming a 10 percent reduction in the number of systems finding a TC+, which is applied to a portion of systems each year and retained throughout the period of analysis. For NCWSs, the reduction is applied to one-fifth of systems per year for the five years of GWR implementation prior to the RTCR effective date; for CWSs, it is applied to one-third of systems in each of the first three years of the GWR implementation period. Similarly, the system incorporates the effect of compliance monitoring by disinfecting GW systems by applying an additional 10 percent reduction for systems that are disinfecting as of the RTCR effective date, and additionally to those determined in the model to select disinfection as a corrective action; the compliance monitoring reduction in occurrence is assumed to apply in all remaining years of the analysis once a system qualifies for the reduction.

As described in Section 5.3.2.2 of this EA, model output was generated for a 30-year period to encompass 5 years of the effects of GWR implementation and 25 years of the effects of RTCR implementation. Chapter 5 presents this output for the 30-year period. For the purpose of the benefit-cost analysis, years 3 through 27 of this period are included in the calculations and presented in the results shown in Chapter 6 (Benefits Analysis), Chapter 7 (Cost Analysis), and Chapter 9 (Comparison of Benefits and Costs). Initially in the modeled period, all systems under the 1989 TCR and the RTCR are assumed to sample based on the sampling regimen applicable to their system type, size, type of water source, and whether or not the system disinfects (Exhibit 4.4).[20] Under the Alternative option, all systems are assumed to sample monthly for the first five years after the RTCR effective date. Following an assessment period as described in Section 5.3.2.2, monitoring frequencies are adjusted from the baseline for GW systems serving fewer than 1,000 people. All other systems remain on monthly monitoring.

The estimates for distribution of PWSs across the M/Q/A monitoring schedules as adjusted from the baseline distribution are presented in Chapter 5 for the 1989 TCR, RTCR, and Alternative option (Exhibits 5.9a–5.9c).

[20] Based on EPA and TWG analysis of Six-Year data and individual state statutes during the TCRDSAC and review by ASDWA.

Exhibit 4.5 Baseline Number of GW Systems Post-Implementation of the GWR (Model Year 5)

PWS Size	Number of GW PWSs (Post-GWR)					
	CWS		NTNCWS		TNCWS	
	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting
≤100	6,190	5,748	2,938	5,888	13,753	46,447
101 - 500	9,311	4,581	2,776	3,837	5,451	13,824
501-1,000	3,512	955	873	845	684	1,279
1,001-4,100	5,422	1,021	547	265	274	343
4,101-33,000	2,798	358	56	14	27	40
33,001-96,000	307	28	2	-	-	2
96,001-500,000	62	1	-	-	-	1
500,001-1 Million	4	-	-	-	-	1
> 1 Million	3	-	-	-	-	-
Total	**27,610**	**12,691**	**7,191**	**10,850**	**20,189**	**61,937**
Combined Total	**40,301**		**18,041**		**82,126**	

Source: Estimates calculated based on the proportion of PWSs changing disinfection status, which is an output from the predictive occurrence model, as described in Chapter 5 of this EA.

4.3.3 Baseline Population Served

PWS population characteristics are important to this analysis for determining the number of people, both prior to and following implementation of the GWR, for which risk changes under each component of the RTCR, as discussed in Chapter 6 of this EA. These population estimates are based on SDWIS/FED 2007 4th quarter data as described in Section 4.2.1, and stratified by PWS size, type, whether the system disinfects or not and whether the system uses GW or SW sources. The estimates represent the number of systems which disinfect water and their populations served; both estimates are adjusted upward based on predicted impacts of the GWR in the five years prior to the effective date of RTCR requirements, as shown in Exhibits 4.6 and 4.7 below. (See Exhibits 4.1 and 4.3 for PWS counts and population served by disinfection status prior to effects of GWR.)

Exhibit 4.6 Baseline Population Served by GW Systems Post-Implementation of the GWR (Model Year 5)

PWS Size	Population Served by Post-GWR PWSs					
	CWS		NTNCWS		TNCWS	
	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting	Disinfecting	Non-Disinfecting
≤100	390,986	338,815	170,177	324,647	654,897	2,130,581
101 - 500	2,387,462	1,073,600	713,960	942,964	1,254,805	2,981,975
501-1,000	2,578,316	695,908	633,744	596,970	524,599	948,889
1,001-4,100	11,341,403	2,040,476	999,913	449,043	458,242	590,686
4,101-33,000	29,346,057	3,627,365	418,368	122,865	194,136	353,290
33,001-96,000	15,587,186	1,527,861	89,405	-	-	119,700
96,001-500,000	9,935,500	107,323	-	-	-	100,000
500,001-1 Million	2,670,841	-	-	-	-	725,000
> 1 Million	4,389,948	-	-	-	-	-
Total	**78,627,698**	**9,411,349**	**3,025,567**	**2,436,489**	**3,086,679**	**7,950,121**
Combined Total	**88,039,047**		**5,462,056**		**11,036,800**	

Note:
Estimates calculated based on the proportion of PWSs changing disinfection status, which is an output from the predictive occurrence model, as described in Chapter 5 of this EA.

Exhibit 4.7 Baseline Population Served by SW Systems

PWS Size	Population Served by SW PWSs		
	CWS	NTNCWS	TNCWS
≤100	56,740	13,297	57,454
101-500	608,084	68,083	116,529
501-1,000	885,400	67,958	70,147
1,001-4,100	6,628,597	140,168	143,347
4,101-33,000	38,700,554	174,408	147,423
33,001-96,000	39,034,554	121,446	-
96,001-500,000	58,489,936	203,000	-
500,001-1 Million	22,327,506	-	-
> 1 Million	37,363,275	-	2,000,000
Total	**204,094,646**	**788,360**	**2,534,900**

Source: Data extracted from SDWIS/FED PWS Inventory, 2007 4th Quarter Data.
Population figures for SW systems include GWUDI systems.

Number of Households Served

Because PWS costs are often passed onto customers in the form of water rate increases, the RTCR EA also includes analyses to assess the impact of the rule provisions at a household level. The number of households served by CWSs expected to be subject to the RTCR is estimated by dividing the population for each PWS size category (Exhibits 4.6 and 4.7 above) by the average number of people per household, which was estimated as 2.56 for the year 2007

(U.S. Census Bureau, 2008). Exhibit 4.8 below shows the number of households served by ground water and surface water systems, respectively.

Exhibit 4.8 Household Baseline

PWS Size	Number of Households		
	GW CWSs		SW CWSs
	Disinfecting	Non-Disinfecting	Disinfecting
≤100	151,390	133,689	22,164
101-500	927,932	424,045	237,533
501-1,000	1,004,165	274,829	345,859
1,001-4,100	4,417,086	810,211	2,589,296
4,101-33,000	11,463,304	1,416,939	15,117,404
33,001-96,000	6,088,745	596,821	15,247,873
96,001-500,000	3,881,055	41,923	22,847,631
500,001-1 Million	1,043,297	-	8,721,682
> 1 Million	1,714,823	-	14,595,029
Total	**30,691,796**	**3,698,456**	**79,724,471**

Sources: U.S. Census Bureau, Current Population Survey, 2008 Annual Social and Economic Supplement; SDWIS/FED PWS Inventory, 2007 4th Quarter Data.

4.3.4 Baseline Water Quality

The following sections provide an overview of summary statistics relating to baseline water quality. The source data from which these summary statistics are derived form the basis of further analysis in the RTCR occurrence and risk assessment models as described in later chapters of the EA.

4.3.4.1 Percent of TC and EC-Positive Samples Based on 2005 Six-Year Review 2 Data

Exhibit 4.9 below shows the percent of TC+ and EC+, samples based on PWS type and size. As described in Section 4.2.2.2, the 2005 Six-Year Review 2 data was cleaned using a criterion that a given system-month of data should include a minimum of 50 percent of the expected number of samples based on the system's population served and water system category.

The "TC+ samples" column was calculated by taking the total number of routine TC+ samples and dividing by the number of routine TC samples. For small PWSs, additional routine TC samples in the month following a TC+ were included in the denominator. To calculate the EC+ rate, the total number of EC+ samples was divided by the total number of TC- samples[21] plus the number of TC+ samples that were tested for *E. coli*. This EC+ computation did not include additional routine samples taken in the month following a TC+ because a significant

[21] EPA assumes that a PWS will not test for EC if the TC assay is negative.

number of PWSs did not provide data on EC+ or *E. coli*-negative samples, and some systems tested for FC and not *E. coli*.

Exhibit 4.9 Total Coliform and *E. coli* Percent Positive by System Size and Type

PWS Type	Source Water	Population Served	TC (# Samples)	TC (+ Samples)	TC (% Positive)	EC (# Samples) [1]	EC (+ Samples)	EC (% Positive)[2]
CWS	GW	≤100	93,105	2,479	2.66%	1,172	72	0.08%
		101 - 500	125,490	2,500	1.99%	1,639	61	0.05%
		501-1,000	48,265	736	1.52%	483	20	0.04%
		1,001-4,100	110,391	1,176	1.07%	732	21	0.02%
		4,101-33,000	183,721	877	0.48%	458	22	0.01%
		33,001-100,000	96,361	214	0.22%	44	2	0.00%
		>100,000	64,965	289	0.44%	34	1	0.00%
		Total GW	**722,298**	**8,271**	**1.15%**	**4,562**	**199**	**0.03%**
	SW	≤100	6,735	95	1.41%	64	6	0.09%
		101 - 500	19,716	227	1.15%	159	10	0.05%
		501-1,000	12,828	90	0.70%	70	7	0.05%
		1,001-4,100	55,310	314	0.57%	233	17	0.03%
		4,101-33,000	175,758	525	0.30%	399	41	0.02%
		33,001-100,000	112,894	157	0.14%	106	5	0.00%
		>100,000	112,143	235	0.21%	99	2	0.00%
		Total SW	495,384	1,643	0.33%	1,130	88	0.02%
	GW & SW	**Total CWS**	**1,217,682**	**9,914**	**0.81%**	**5,692**	**287**	**0.02%**
TNCWS	GW	≤100	163,730	7,820	4.78%	5,820	316	0.20%
		101 - 500	52,891	2,418	4.57%	1,869	99	0.19%
		501-1,000	6,952	299	4.30%	217	4	0.06%
		>1,000	7,062	143	2.02%	85	2	0.03%
		Total GW	230,635	10,680	4.63%	7,991	421	0.18%
	SW	≤100	6,723	150	2.23%	141	17	0.25%
		101 - 500	2,854	75	2.63%	69	13	0.46%
		501-1,000	523	19	3.63%	19	-	0.00%
		>1,000	988	6	0.61%	37	-	0.00%
		Total SW	11,088	250	2.25%	266	30	0.27%
	GW & SW	**Total TNCWS**	**241,723**	**10,930**	**4.52%**	**8,257**	**451**	**0.19%**
NTNCWS	GW	≤100	46,505	1,476	3.17%	1,061	34	0.07%
		101 - 500	33,084	893	2.70%	628	19	0.06%
		501-1,000	9,531	166	1.74%	103	2	0.02%
		>1,000	13,138	177	1.35%	103	5	0.04%
		Total GW	102,258	2,712	2.65%	1,895	60	0.06%
	SW	≤100	1,668	32	1.92%	30	4	0.24%
		101 - 500	2,304	9	0.39%	9	2	0.09%
		501-1,000	932	6	0.64%	5	-	0.00%
		>1,000	1,316	1	0.08%	1	-	0.00%
		Total SW	6,220	48	0.77%	45	6	0.10%
	GW & SW	**Total NTNCWS**	**108,478**	**2,760**	**2.54%**	**1,940**	**66**	**0.06%**

Source: Derived using 2005 Six-Year Review 2 Data, which was filtered by including a month of data for a given system (system-month) only if it represented at least 50% of the expected number of samples for a month based on the system's size. The Total Coliform Rule Compliance Monitoring Data Quality and Completion Report (USEPA, 2010e) includes a detailed description of this data cleaning process.

Notes:

1) Number of samples that were specifically tested for *E. coli*. The denominator of the *E. coli* percent positive calculation includes this number plus the number of total coliform negative samples (TC #samples – TC +samples).

2) Percent EC+ was calculated as (# EC+ samples)/(# EC samples).

4.3.4.2 Violation Levels Based on SDWIS/FED Data

Non-acute violations are triggered under the 1989 TCR by water quality violations. They are defined as >1 routine or repeat monitoring sample testing positive for TC in a given compliance period (month, quarter, or year) for PWSs serving fewer than 33,001 people, or by >5.0 percent of samples being positive for systems taking >40 samples per month (typically those systems serving greater than 33,000 people). Acute violations are triggered when any PWS has a repeat sample with an EC+ or FC-positive (FC+) or has an FC+ or EC+ routine sample followed by a TC+ repeat sample in a given month.

Exhibit 4.10 below presents an assessment of water quality prior to the RTCR promulgation in terms of the number of acute and non-acute violations incurred by PWSs. The number of violations from this data is directly input into the cost model for PWSs serving more than 4,100 people to derive estimates of the number of assessments and corrective actions that will be undertaken under the RTCR. As noted in Exhibit 4.10, the data used is from 2005 3rd quarter. Exhibit 4.11 presents the seven years of PWS violation data[22] evaluated by the TWG. Appendix G presents further detail on this assessment, including queries used in SDWIS/FED and the resulting datasets downloaded.

In addition to the acute and non-acute system violation data, Exhibit 4.11 also presents data on the numbers of PWSs with monitoring and reporting violations (minor and major for routine and repeat monitoring and reporting). Although PWS monitoring and reporting violation data is not used directly in the quantitative analyses performed for the EA, the TCRDSAC did consider the data in its deliberations on the impact of the regulation. In particular, the TCRDSAC determined that the revisions to the RTCR may significantly reduce the high numbers of monitoring and reporting violations by: a) reducing the numbers of additional routine and repeat samples required; b) providing more flexibility in development of sampling site plans; and c) adding consequences for missed monitoring (possible triggering to increased monitoring for missed samples).

The data verification process was used to review individual states' data in comparison to SDWIS/FED data and to compare violations rates across states. This process revealed many differences between states in their implementation of the 1989 TCR, and allowed EPA to identify and review outliers in the national database. Specifically, EPA did not include violation data from Ohio, U.S. territories, or tribal PWSs in the summaries presented in Exhibits 4.10 and 4.11. Review of the data verification information revealed that Ohio's broad interpretation of what constitutes a violation led to abnormally high violation counts compared (on average) to other states. For U.S. territories and tribal systems, it was established that unique environmental factors and operating conditions contribute to abnormally high TC+ results and associated violations. Thus, inclusion of these results would skew the national averages used for analysis, and were therefore excluded.

[22] Exhibit 4.11 presents PWS counts (PWSs with at least one violation during the year) to be consistent with the metric evaluated by the TCRDSAC TWG. Exhibit 4.10 presents total violation counts, which are used as inputs to the predictive modeling for the EA.

Exhibit 4.10 Baseline Number of 1989 TCR Violations by System Size and Type (2005)

	Number of Violations in GW PWSs		Number of Violations in SW PWSs		Total Number of GW PWSs (without OH & PR)	Total Number of SW PWSs (without OH & PR)
	Non-Acute	Acute	Non-Acute	Acute		
	A	B	C	D	E	F
CWSs						
≤100	905	52	16	3	11,709	1,133
101-500	809	34	50	7	13,508	2,067
501-1,000	203	13	16	3	4,299	1,112
1,001-3,300	272	8	55	7	5,490	2,406
3,301-10,000	171	8	75	3	2,628	2,015
10,001-50,000	125	8	78	4	1,247	1,752
50,001-100,000	11	2	5	4	147	362
100,001-250,000	1	1	3	1		
250,001-500,000	-	-	-	-	61	306
500,001-1 Million	-	-	1	-		
> 1 Million	-	-	-	-	3	15
Total CWSs	**2,497**	**126**	**299**	**32**	**39,092**	**11,168**
NTNCWSs						
≤100	514	34	7	2	8,392	249
101-500	346	20	4	-	6,294	246
501-1,000	57	6	2	-	1,622	87
1,001-3,300	58	4	-	-	726	66
3,301-10,000	9	2	1	-	102	23
10,001-50,000	1	-	-	-	11	4
50,001-100,000	-	-	-	-	-	1
100,001-250,000	-	-	-	-	-	
250,001-500,000	-	-	-	-	-	1
500,001-1 Million	-	-	-	-	-	
> 1 Million	-	-	-	-	-	-
Total NTNCWSs	**985**	**66**	**14**	**2**	**17,147**	**677**
TNCWSs						
≤100	2,665	278	19	5	58,396	1,334
101-500	833	76	11	1	18,184	492
501-1,000	133	11	4	-	1,868	85
1,001-3,300	58	2	1	-	578	57
3,301-10,000	5	-	1	-	77	22
10,001-50,000	-	-	-	-	11	3
50,001-100,000	-	-	-	-	3	-
100,001-250,000	-	-	-	-		
250,001-500,000	-	-	-	-		
500,001-1 Million	-	-	-	-	1	-
> 1 Million	-	-	-	-	-	1
Total TNCWSs	**3,694**	**367**	**36**	**6**	**79,118**	**1,994**

Sources:
(A) - (D) Acute/Non-Acute Violations from SDWIS/FED annual data for period ending 3rd quarter 2001 – 2007 (only 2005 data is presented in this exhibit). OH, U.S. territories, tribal PWS data excluded.
(E), (F) 2007 4th Quarter SDWIS Data, Total Number of PWSs.

Exhibit 4.11 Number of PWSs with Violations by System Type (2001–2007)

PWS Type	Year						
	2001	2002	2003	2004	2005	2006	2007
Acute MCL Violations							
CWS	143	144	185	171	151	171	171
NTNCWS	51	53	70	58	65	68	45
TNCWS	261	278	322	351	349	361	295
All	455	475	577	580	565	600	511
Non-Acute MCL Violations							
CWS	2,074	2,110	2,204	2,314	2,196	2,095	1,996
NTNCWS	601	679	725	750	753	735	655
TNCWS	2,707	2,934	3,036	3,132	3,039	3,244	3,209
All	5,382	5,723	5,965	6,196	5,988	6,074	5,860
Major Monitoring and Reporting Violations (Routine and Repeat)							
CWS	3,312	3,327	3,900	3,924	3,760	3,659	3,415
NTNCWS	1,503	1,561	1,676	1,679	1,588	1,468	1,377
TNCWS	10,360	10,531	11,230	11,043	10,426	10,630	10,389
All	15,175	15,419	16,806	16,646	15,774	15,757	15,181
Minor Monitoring and Reporting Violations (Routine and Repeat)							
CWS	1,218	1,257	1,389	1,445	1,302	1,285	1,244
NTNCWS	187	182	200	233	194	214	183
TNCWS	701	842	883	903	875	843	839
All	2,106	2,281	2,472	2,581	2,371	2,342	2,266

Note: PWSs counts are of systems that had at least one violation during the year.
Source: SDWIS/FED annual data for period ending 3rd quarter 2001 – 2007. OH, U.S. territories, tribal PWS data excluded.

4.4 Sensitive Sub-Populations

Under the 1996 Amendments to the Safe Drinking Water Act (SDWA) (PL 104-182), EPA must analyze health impacts of rulemaking on sensitive subpopulations. Sensitive populations include "infants, children, pregnant women, the elderly, individuals with a history of serious illness, and other subpopulations that are identified as likely to be at a greater risk of adverse health effects due to exposure to contaminants in drinking water than the general population." (1996 Amendments to the Safe Drinking Water Act).

Exhibit 4.12 presents EPA's estimates of the number of U.S. individuals who are at increased risk of developing more severe symptoms from illnesses caused by waterborne pathogens. Persons suffering from certain diseases and/or conditions are believed to be sensitive to microbes and chemicals in drinking water. These subgroups of the population include pregnant women, the very young, the elderly, and the immunocompromised. In total, these subgroups represent approximately 20 percent of the current population of the U.S.

Exhibit 4.12 Estimates of Sensitive Subpopulations in the United States

Sensitive Population	Individuals	Approximate Percent of U.S. Population[1]	Citation/Notes
Pregnant women and neonates			
Pregnant Women	6,240,000	2.2	Vital and Health Statistics, CDC (Ventura et al., 2000)
Neonates (under one month)[2]	317,137	0.1	U.S. 2000 Census (US Census Bureau, 2001a)
Age-based sensitive populations			
Children (<5 years old)	19,175,798	6.8	U.S. 2000 Census (US Census Bureau, 2001a)
Elderly (>65 years old)	34,991,753	12.4	U.S. 2000 Census (US Census Bureau, 2001a)
Compromised immune status			
Bone marrow transplant Recipients	20,000	0.01	National Marrow Donor Program http://.marrow.org/MEDIA/facts_figures.pdf
AIDS Patients	816,149	0.3	HIV/AIDS Surveillance Report, cases through 2001 (CDC, 2002)
Organ transplant recipients	23,143	0.01	U.S. Census Bureau, Statistical Abstract of the U.S., based on 1998 data (2001b)
Total	61,583,980	21.8	

[1] Based on U.S. Census estimate (July 2000).
[2] 1/12 of the 2000 census population for age <1 year.

4.5 Summary of Baseline Assumptions

In Section 4.2 (Data Sources), EPA discusses the representativeness and quality of the data used from the 2005 Six-Year Review 2 data and SDWIS/FED. An additional source of uncertainty is introduced into the baseline in the monitoring frequencies estimated for systems, shown in Exhibit 4.4. As described in that section, to arrive at this distribution EPA and the Technical Workgroup conducted an analysis of 2005 Six-Year Data and individual state statutes, and had the results validated by ASDWA during the TCRDSAC deliberations.

Exhibit 4.13 below presents a summary of the assumptions made in developing the RTCR EA baseline. These assumptions may introduce uncertainty into the predictive model and its outcomes in terms of benefits and costs. However, all of the assumptions influencing the EA baseline (1989 TCR) do so in the same way as for the RTCR and Alternative option. Therefore, EPA does not expect the net results of the analyses presented in this EA to be significantly influenced by the uncertainty in the assumptions applied in developing the RTCR EA baseline.

Exhibit 4.13 Summary of Baseline Assumptions Influencing RTCR Estimates

Uncertainty Factor	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Pre-GWR baseline distribution of systems across sampling frequency categories (M/Q/A)	Varies per system category as shown in Ex. 4.4	4.3.1	Variability, Uncertainty			X			X
Selection of 2005 data from Six Year Review 2 for use as baseline	Data are adequately representative of U.S. PWSs and of sufficient quality.[2]	4.2.2	Variability, Uncertainty			X			X
Use of SDWIS/FED for inventory data (2007 Q3) and violations data (2001–2007 Q3)	Data are adequately representative of U.S. PWSs and of sufficient quality.	4.2.1	Variability, Uncertainty			X			X
Distribution of systems across sampling frequency categories (M/Q/A) following	Varies per system category as shown in Ex. 5.9a	5.3.2.2	Variability, Uncertainty			X			X

Uncertainty Factor	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
implementation of GWR sanitary surveys prior to RTCR implementation									
Pwell—the portion of GW Systems having viral pathogens in their source waters (adopted from GWR EA)	21.58 percent	5.3.1	Constant, Uncertainty			X			X
Psample—the probability that a random sample will test positive for viral pathogens given a contaminated source water (adopted from GWR EA)	Variable drawn from a beta distribution with a range of alpha and beta estimates having a median value of 5.8 percent and an expected value of 12.4 percent.	5.3.1	Variability, Uncertainty			X			X

Uncertainty Factor	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Reduced occurrence for sanitary surveys performed under the GWR	90 percent of baseline occurrence; applied to equal number of systems annually over the sanitary survey cycle (20 percent each year of 5 years for CWSs; 33.3 percent each year for 3 years for NCWSs)	5.3.1	Constant, Uncertainty			X			X
Reduced occurrence for GWR compliance monitoring (applies to subset of GW Systems that disinfect).	90 percent of baseline occurrence	5.3.1	Constant, Uncertainty			X			X
Percentage of nondisinfecting GW Systems choosing disinfection corrective action vs. non-disinfection	Range: High end is the percentage of CWS entry points employing disinfection by system size,	5.3.1	Constant, Uncertainty			X			X

Uncertainty Factor	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
corrective action in response to source water quality issue (adopted from GWR)	low end assumed to be 10 percent based on discussions with State representatives.								
Population and sensitive sub population estimates	Varies by category	4.2.3.3 and 4.4	Variability, Uncertainty			X			X

Notes:
1) All baseline variables or factors were incorporated into the predictive model in the same way for the 1989 TCR (baseline option) and the other two regulatory options considered in this EA (RTCR and Alternative Option), therefore EPA expects that any under- or overestimation would affect the baseline and other options similarly, resulting in no net effect on the results of the analysis.
2) A complete discussion of the data cleaning and assumption used in preparing Six-Year Review data for use in the RTCR baseline is provided in the Total Coliform Rule Compliance Monitoring Data Quality and Completion Report (USEPA, 2010e).

5 Occurrence and Predictive Model

5.1 Introduction

Based on evaluation of the Safe Drinking Water Information System/Federal Version (SDWIS/FED) violation data, the U.S. Environmental Protection Agency (EPA) assumes that the national occurrence of total coliform (TC) and *E. coli* (EC) has reached a steady state in recent years under the 1989 Total Coliform Rule (TCR). Cycles of normal deterioration and repair/replacement appear to be occurring at the individual system level, while the numbers of violations at the national level remain relatively unchanged. Chapter 4 (Exhibit 4.11) presents the number of public water systems (PWSs) with TCR violations from 2001–2007, which shows that national violation rates have remained relatively steady. Revisions to the 1989 TCR would affect this steady state, likely resulting in a reduction of the underlying occurrence and associated violations. However, prior to the Revised Total Coliform Rule (RTCR) implementation, the Ground Water Rule (GWR), which became effective December 2009, would also have an effect on the steady state. This chapter explains the development of a model that both reproduces the steady-state occurrence conditions under the 1989 TCR and predicts the effects of both the RTCR and the GWR in further reducing occurrence from current estimated levels.

The occurrence and predictive model developed for the RTCR was used for PWSs serving 4,100 people or fewer, and it has two components. Occurrence and predictive modeling focuses on PWSs serving ≤4,100 people because (a) there are adequate data to support development of the occurrence distributions that are needed for the predictive components of the model, (b) these systems are known to have higher occurrence levels than systems serving >4,100 people, and (c) these systems, in particular, are subject to changes in the monitoring requirements under the RTCR. The first component of the model characterizes how the presence or positive rates of TC and EC detections vary across the population of PWSs serving ≤4,100 people in the U.S. These rates vary by the type of sample (routine or repeat), by analyte (TC or EC), by system type (community water system (CWS), nontransient noncommunity water system (NTNCWS), or transient noncommunity water systems (TNCWS)), and by system size. EPA determined from the Six-Year Review data[23] that systems differ considerably with respect to the observed occurrence of TC and EC in both routine and repeat sampling. Some of this variability can be explained by the type, size, water source, and disinfection practices of the systems. However, even among systems having the same characteristics, some systems were found to rarely experience positive assays, while others often did experience positive assays. The second component of the model uses the TC and EC occurrence distributions, together with the various sampling and response requirements, to simulate a set of nationally-representative systems within the context of the three regulatory options (1989 TCR, RTCR, and Alternative option) to predict changes in TC and EC occurrence, triggers, assessments, corrective actions over time, and violations. The model generates estimates of reduced TC and EC occurrence based on requirements of the RTCR to perform assessments and corrective actions not explicitly required in the 1989 TCR. Additionally, the occurrence model takes into account reductions attributable to the implementation of the GWR.

[23] A discussion of the use of data from the Six-Year Review of SDWA regulations is presented in Chapter 4 of this EA.

The occurrence model produces outputs over a 30-year time horizon[24] that include national estimates of TC and EC occurrence in PWSs across the U.S., and the resulting Level 1 and Level 2 assessments[25] and corrective actions performed. These outputs are used to characterize reduced exposure to the potential contamination under each regulatory option considered, as presented in Chapter 6 of this economic analysis (EA), and to estimate the net change in costs (i.e., incremental costs over the 1989 TCR) for PWSs across the U.S., as described in Chapter 7 of this EA.

The two major components of the occurrence and predictive model used for systems serving ≤4,100 people are described in Sections 5.2 and 5.3 of this chapter.

For systems serving more than 4,100 people, EPA estimated violation and trigger rates using SDWIS/FED (USEPA, 2005) because the Six-Year Review data for PWSs serving more than 4,100 people were not as robust as the Six-Year Review data for systems serving 4,100 or fewer people. EPA did not quantify changes in violation or trigger rates for systems serving more than 4,100 people among the 1989 TCR, RTCR, and Alternative option for the following reasons: (1) limited Six-Year Review data to characterize these systems, (2) essentially unchanged monitoring requirements across the regulatory options for these systems, and (3) level of effort already occurring to implement the 1989 TCR. A complete description of the methods for developing the occurrence estimates as described above is found in the remaining sections of this chapter:

- **Section 5.2** describes development of occurrence models to describe the occurrence of TC and EC for systems serving less than or equal to 4,100 people.
- **Section 5.3** describes how the occurrence model developed for systems serving less than or equal to 4,100 people (Sections 5.3.1–5.3.2) is used to predict occurrence following assessments and corrective actions (5.3.3) and includes a comprehensive list of assumptions contributing to uncertainty, a sensitivity analysis, and a discussion of model validation (5.3.3.1–5.3.3.2).
- **Section 5.4** describes how outcomes were predicted for systems serving more than 4,100 people.

[24] The occurrence model includes an additional 5 years prior to the promulgation of the RTCR monitoring to account for effects of the GWR after it is fully implemented, plus 25 years of RTCR analysis, for a total of 30 modeled years.

[25] The RTCR and Alternative option require PWSs to complete either a Level 1 or Level 2 assessment following triggers specified in Exhibit 3.1 of this EA. The purpose of Level 1 and 2 assessments is to identify the presence of sanitary defects and deficiencies in distribution system coliform monitoring practices, similar to an annual inspection but more focused on determining the cause of a contamination event. In order to complete a Level 2 assessment the PWS must perform a more detailed examination of the system than for a Level 1 assessment, including its monitoring and operational practices.

5.2 Modeling of Current Total Coliform and *E. coli* Occurrence for Systems Serving ≤4,100 People

This section describes the development of parameters used to define variability across and within groups of similar PWSs with regard to occurrence of TC and EC. Details related to this section are provided in Appendix F to this EA.

5.2.1 Distributional Model and Notation

The Six-Year Review data demonstrate that, even among systems of similar size and type, there are some PWSs that rarely find routine samples to be TC-positive and others that often find TC-positive samples. For example, among the TNCWSs serving ≤101 people that are using nondisinfected ground water, 47 systems reported ten or more routine TC positives while assaying 40 or fewer samples during 2005. Among the same set of TNCWSs with nondisinfected ground water are 60 that assayed 20 or more routine samples, finding all of them TC-negative. Clearly, routine TC-positive rates vary considerably within this set of systems. Different fractions of positives can be found among any basic subset of systems (defined by system type, water type, and population served, as described in Section 5.2.2 of this EA) and for any type of assay (both routine and repeat TC and both routine and repeat EC).

Within a group of similar systems, $pRTTC_i$, which is defined as the probability that a routine sample taken from system i will test positive, is assumed to vary as a beta random variable. The beta distribution is commonly used to model varying probabilities because it is limited to values between 0 and 1 and can assume a wide variety of shapes. EPA used a beta distribution to describe how probabilities of virus-positive samples vary among virus-contaminated wells in the EA for the Ground Water Rule (USEPA, 2006a).

Samples that test negative for TC are generally not tested further for the presence of EC, unlike TC-positive samples. The probability that a TC-positive routine sample taken from system i will also test EC-positive (EC+), $pRTEC_i$, is assumed to vary among similar systems as another beta random variable, but with parameters that can be quite different from those of the routine TC samples. Although systems with frequent routine TC positives necessarily generated more EC assays, the EC+ rates for these systems did not appear to be significantly different than the EC+ rates of systems with rare TC positives. The variables pRTTC and pRTEC are therefore modeled as independent beta-distributions.

Similar assumptions are extended to the repeat positive probabilities, $pRPTC_i$ and $pRPEC_i$. Like $pRTTC_i$ and $pRTEC_i$, these are assumed to be independently beta-distributed among sets of similar systems. A process for determining "sets of similar systems" is described in Sections 5.2.3 and 5.2.4. The process is informed by system-specific data that are reduced from the sample-specific data described in Chapter 4 of this EA, as discussed in the following section.

5.2.2 Data Reduction

The occurrence model assumes that positive routine TC measurements for system i result from some unobserved probability ($pRTTC_i$). This probability may vary from month-to-month and season-to-season. However, in this model each result, whether positive or negative, is

assumed to be an independent trial with positive probability $pRTTC_i$. Each of these is called a Bernoulli trial. The total number of positives observed for system i during a year ($KRTTC_i$) is therefore a binomial random variable, whose parameters are the system's positive probability ($pRTTC_i$) and the total number of samples assayed ($NRTTC_i$). Data for the system can be reduced to the number of positive samples ($KRTTC_i$) and the number of samples assayed ($NRTTC_i$). The leading character "N" designates the number of samples tested and "K" designates the number positive.

Similarly, the routine EC data for system i can be reduced to the number of routine TC-positive samples that were assayed for EC ($NRTEC_i$) and, of those, the number testing positive ($KRTEC_i$). For many systems, both NRTEC and KRTEC will be zero because they encountered no routine TC positives during 2005 (KRTTC = 0), and EPA assumes that in the case of a TC-negative, no EC assay is performed.

Finally, the data for repeat samples for system i can be reduced to four numbers: NRPTC, $KRPTC_i$, $NRPEC_i$, and $KRPEC_i$. Again, the leading characters, "N" and "K", designate numbers of samples assayed and numbers positive, respectively. "RP" designates that these are repeat samples, while "TC" and "EC" designate assays for TC and EC, respectively. For many systems, all four of these numbers are zero because no routine samples were TC positive.

It is important to note that only TC-positive samples are assayed for EC. The positive probabilities for EC are therefore conditional, that is, they apply only to samples that have tested TC positive. All TC-negative samples are assumed to be EC negative. The overall (unconditional) probability that a routine sample from system i will be EC+ is the product $pRTTC_i$*$pRTEC_i$ and the overall (unconditional) probability that a repeat sample from the system will be EC+ is the product $pRPTC_i$*$pRPEC_i$.

The reduced dataset includes eight integer values (for NRTTC, KRTTC, NRTEC, KRTEC, NRPTC, KRPTC, NRPEC, KRPEC) for each of approximately 93,000 systems. Although none of the NRTTC is zero (all systems assayed at least one routine TC sample during 2005), the great majority of the other values are zeros.

5.2.3 Basic Subsets of Systems

The 92,747 systems serving ≤4,100 people in the Six-Year Review dataset (which represent the approximately 147,000 total systems that exist in this size range) can be classified by system type, source water type and disinfection status, and population served. The three types of systems are CWS, NTNCWS and TNCWS. The three source water types are surface water (SW), which is always disinfected, nondisinfected ground water (NondisGW) and disinfected ground water (DisGW). Three important size categories are systems serving ≤100 people, systems serving 101 to 1,000 people, and systems serving 1,001 to 4,100 people. Systems serving more than 4,100 people are not included here, for reasons discussed in Chapter 4 of this EA and earlier in this chapter. In total, there are 27 possible categories that each PWS may belong to (3 system types x 3 source water types x 3 population served sizes). Each PWS may only be in one of the 27 categories. Exhibit 5.1 lists the 27 basic subsets and corresponding numbers of systems in the dataset.

Exhibit 5.1 Basic Classifications of PWSs Used for Occurrence Modeling

System Type	Water Type	Population Served Group	Number of Systems in 6-Year Review Data
CWS	SW	≤100	484
CWS	SW	101-1,000	2,034
CWS	SW	1,001-4,100	1,699
CWS	DisGW	≤100	3,662
CWS	DisGW	101-1,000	7,678
CWS	DisGW	1,001-4,100	2,707
CWS	NondisGW	≤100	3,788
CWS	NondisGW	101-1,000	3,755
CWS	NondisGW	1,001-4,100	644
NTNCWS	SW	≤100	114
NTNCWS	SW	101-1,000	172
NTNCWS	SW	1,001-4,100	33
NTNCWS	DisGW	≤100	1,577
NTNCWS	DisGW	101-1,000	1,780
NTNCWS	DisGW	1,001-4,100	252
NTNCWS	NondisGW	≤100	4,026
NTNCWS	NondisGW	101-1,000	3,264
NTNCWS	NondisGW	1,001-4,100	152
TNCWS	SW	≤100	838
TNCWS	SW	101-1,000	358
TNCWS	SW	1,001-4,100	30
TNCWS	DisGW	≤100	8,112
TNCWS	DisGW	101-1,000	3,007
TNCWS	DisGW	1,001-4,100	119
TNCWS	NondisGW	≤100	32,028
TNCWS	NondisGW	101-1,000	10,217
TNCWS	NondisGW	1,001-4,100	217
		TOTAL	**92,747**

Source: Derived using 2005 Six-Year Review 2 Data.
Note: Water Type includes disinfection status, as informed by information from SDWIS/FED. Systems with no indication of disinfection status in SDWIS/FED were assumed to not disinfect (Nondis).

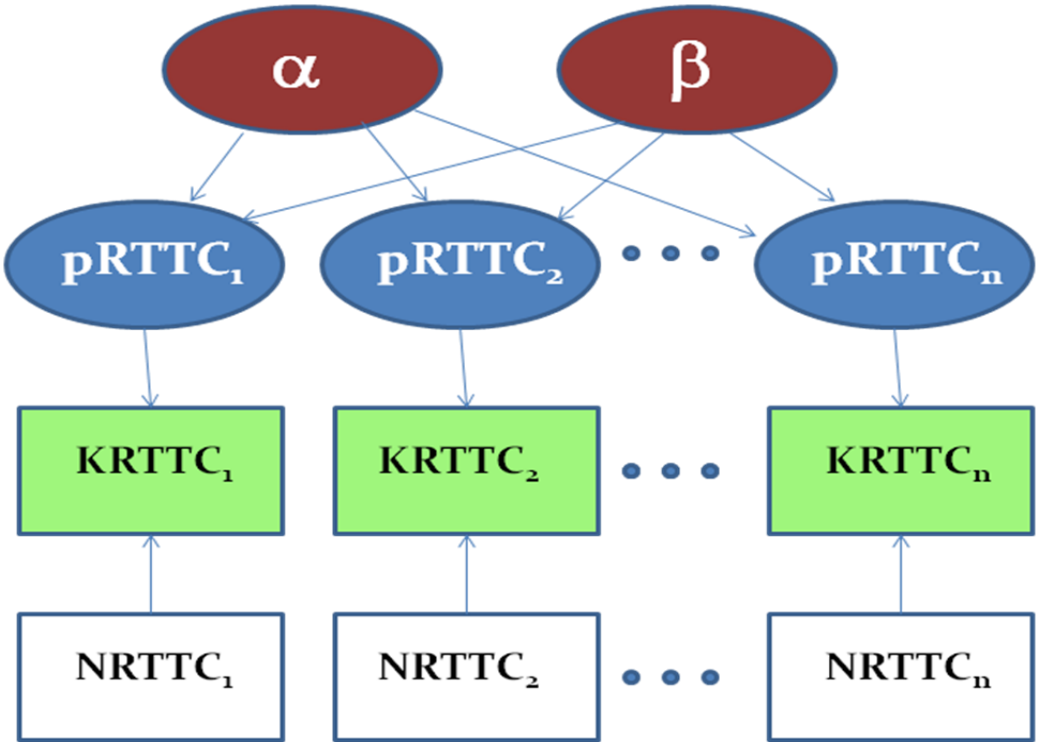
5.2.4 Estimation Methodology

The methodology described in this section applies to all four kinds of measurements, routine TC (RTTC), routine EC (RTEC), repeat TC (RPTC) and repeat EC (RPEC). However, to simplify the presentation, the description will be expressed only in terms of RTTC. Results presented in Section 5.2.5 show that the final system classifications used to model TC (both routine and repeat) are quite different from the final subsets used to model EC occurrence.

For any individual subset of systems from Exhibit 5.1 or grouping of these subsets, two methods were used to estimate parameters of the beta-distributed RTTC: maximum likelihood estimation and Bayesian Markov Chain Monte Carlo (MCMC) sampling. The MCMC samples are used to test whether two basic subsets have equal average positive rates and to check the maximum likelihood estimates (MLEs). This check was conducted to ensure that the algorithm used to find the MLE had not stopped running too soon.

Both the MLE and MCMC methodologies require computation of the likelihood function, L(data | α,β), where α and β are parameters of beta-distributed pRTTC. For a specific system in a set of similar systems, the number of positive RTTC samples is a binomial random variable with parameters NRTTC and pRTTC, which are the numbers of RTTC samples assayed by the system and the system's unobserved probability of a positive, respectively. The probability of a positive, pRTTC, is a beta random variable, whose parameters are α and β. Exhibit 5.2 is a directed graph showing the model structure. At the top are the two high-level parameters (α and β) and arrows from them showing their influence on the distribution of the system-specific parameters, the positive probabilities or pRTTCs. Finally, the exhibit shows how the pRTTCs, together with the numbers of samples assayed (NRTTCs), influenced the numbers estimated to be positive (KRTTCs).

Exhibit 5.2 Directed Graph of Model Used for RTTC Occurrence



This same model could have been equally well represented with all of the arrows pointing up to show the direction of inference, starting with the data (NRTTCs and KRTTCs), which inform estimates of the unobserved positive probabilities (pRTTCs), and then those informing estimates of the high level parameters (α and β).

5.2.4.1 Maximum Likelihood Estimation

From this point through the end of this chapter, the approach for estimating parameters for routine TC occurrence (RTTC) is the same approach used for repeat TC (RPTC) and both routine and repeat EC occurrence (RTEC and RPEC). To simplify the notation, the designation of measurement type (e.g., RTTC) will be dropped. For example, KRTTC is reduced to K, NRTTC is reduced to N, and pRTTC is reduced to p. Subscript i is used to denote a particular system in a basic subset of systems.

For a single system in a subset, if pi were known, the likelihood of the system's RTTC data (Ki positives observed among Ni routine samples) would be given by the binomial probability mass function:

$$\text{dbinom}(K_i, N_i, p_i) = \left[\frac{N_i!}{K_i!(N_i - K_i)!}\right] \times p_i^{K_i}(1-p_i)^{N_i - K_i}$$

But p_i is not known, nor can it be observed explicitly. It is, therefore, treated as a beta random variable. The expected value of the likelihood function is obtained by integrating the product of the beta probability density function and the binomial probability mass function. The beta probability density function is:

$$\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\cdot\Gamma(\beta)}\cdot\left(p_i\right)^{\alpha-1}\cdot\left(1-p_i\right)^{\beta-1}$$

And the expected likelihood is:

$$\int_0^1 \frac{N_i!}{K_i!\cdot\left(N_i-K_i\right)!}\cdot\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\cdot\Gamma(\beta)}\cdot(p)^{\alpha-1+K_i}\cdot(1-p)^{\beta-1+N_i-K_i}\,dp$$

Because both N_i and K_i are constant (observed data), the function only depends on the factors involving p, α, and β, so the factorial terms in the above may be ignored when seeking to maximize the likelihood function. This simplifies the computation considerably, and the resulting integral has a closed-form solution, which is:

$$\frac{\Gamma(\alpha+\beta)\cdot\Gamma\left(\alpha+K_i\right)\cdot\Gamma\left(\beta+N_i-K_i\right)}{\Gamma(\alpha)\cdot\Gamma(\beta)\cdot\Gamma\left(\alpha+\beta+N_i\right)}=\frac{\mathrm{Beta}\left(\alpha+K_i,\beta+N_i-K_i\right)}{\mathrm{Beta}(\alpha,\beta)}$$

The total likelihood for a set of systems is the product of the system-specific likelihoods:

$$\mathrm{Likelihood}(\alpha,\beta)=\prod_i\frac{\mathrm{Beta}\left(\alpha+K_i,\beta+N_i-K_i\right)}{\mathrm{Beta}(\alpha+\beta)}$$

In order to find maximum likelihood estimates of parameters α and β, some additional steps were taken:

1. Log likelihood, rather than likelihood, was computed to avoid the problems of numerical overflow and underflow. Because the log transformation is positive and monotonic, parameters found to maximize the log likelihood function will also maximize the untransformed likelihood function:

$$\mathrm{LogLikelihood}(\alpha,\beta)=\sum_i\ln\left(\frac{\mathrm{Beta}\left(\alpha+K_i,\beta+N_i-K_i\right)}{\mathrm{Beta}(\alpha+\beta)}\right)$$

2. Parameters of the Beta distribution were expressed in terms of the mean (a=α/(α+β)) and dispersion (b=1/sqrt(α+β)). In terms of these new parameters, the log likelihood function is:

$$\text{LogLikelihood}(a,b) = \sum_i \ln\left(\frac{\text{Beta}\left(\frac{a}{b^2} + K_i, \frac{1-a}{b^2} + N_i - K_i\right)}{\text{Beta}\left(\frac{a}{b^2} + \frac{1-a}{b^2}\right)}\right)$$

3. Bayesian MCMC estimation, as described in Appendix F was used to check the MLEs and to support decisions about combining (pooling) different categories or subsets of systems.

4. Where subsets of systems were found to have insufficient data to support maximum likelihood estimation, engineering judgment was used to decide if combining with other subsets made sense, for the purpose of parameter estimation. Rationale and strategies for this are described in Appendix F.

5.2.5 Results

Appendix F of this EA describes how systems and their data were combined, or pooled, for the purpose of RTTC, RTEC, RPTC, and RPEC modeling. Section 5.2.5.1 and 5.2.5.2 report the resulting MLEs in terms of *a*, *b* and α, β.

RTTC data were addressed first because: a) so much more data were available for RTTC than for the other three measurement types (RTEC, RPTC, and RPEC); and b) summary statistics suggested that systematic differences due to system size and other factors were larger for TC than for EC measurements.

When evaluating data for any one type of measurement, system size was evaluated first because it was expected to be important for a number of reasons, primarily: a) larger systems have more resources and are more likely to employ full-time professional operators than smaller systems; and b) having more resources, the larger systems may provide better treatment and distribution systems. System type and water type were evaluated after system size, but the order in which these were evaluated does not appear to have been important.

5.2.5.1 Maximum Likelihood Estimates (MLEs)

Exhibit 5.3 provides MLEs for routine and repeat TC, while Exhibit 5.4 provides MLEs for routine and repeat EC. Note that both of these exhibits present the *a* and *b* parameters as defined in Section 5.2.4.1.

Exhibit 5.3 Maximum Likelihood *a* and *b* Parameter Estimates for RTTC and RPTC

Size	No. Systems	aRTTC	bRTTC	aRPTC	bRPTC
Community Water Systems (CWSs), Surface Water (SW), Disinfecting					
≤100	484	0.01502	0.2090	0.06464	0.6107
101-1,000	2,034	0.009458	0.1490	0.06464	0.6107
1,001-4,100	1,699	0.005864	0.1275	0.03430	0.2721
Community Water Systems (CWSs), Ground Water (GW), Disinfecting					
≤100	3,662	0.01592	0.2243	0.09415	0.8493
101-1,000	7,678	0.01243	0.2142	0.09415	0.8493
1,001-4,100	2,707	0.007767	0.1841	0.05221	0.4916
Community Water Systems (CWSs), Ground Water (GW), Non-Disinfecting					
≤100	3,788	0.03147	0.2680	0.1898	0.8407
101-1,000	3,755	0.02690	0.2840	0.1898	0.8407
1,001-4,100	644	0.02690	0.2840	0.1312	0.6938
Nontransient, Noncommunity Water Systems (NTNCWSs), Surface Water (SW), Disinfecting					
≤100	114	0.01584	0.3576	0.1064	1.078
101-1,000	172	0.01127	0.2458	0.1064	1.078
1,001-4,100	33	0.01127	0.2458	0.1064	1.078
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Disinfecting					
≤100	1,577	0.01584	0.3576	0.1064	1.078
101-1,000	1,780	0.01127	0.2458	0.1064	1.078
1,001-4,100	252	0.01127	0.2458	0.1064	1.078
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	4,026	0.03658	0.4044	0.2575	0.9319
101-1,000	3,264	0.02690	0.2840	0.2575	0.9319
1,001-4,100	152	0.02690	0.2840	0.2575	0.9319
Transient, Noncommunity Water Systems (TNCWSs), Surface Water (SW), Disinfecting					
≤100	838	0.02312	0.2992	0.1439	1.108
101-1,000	358	0.02312	0.2992	0.1439	1.108
1,001-4,100	30	0.02312	0.2992	0.1439	1.108
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Disinfecting					
≤100	8,112	0.02312	0.2992	0.1439	1.108
101-1,000	3,007	0.02312	0.2992	0.1439	1.108
1,001-4,100	119	0.02312	0.2992	0.1439	1.108
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	32,028	0.04758	0.3990	0.2788	1.068
101-1,000	10,217	0.04758	0.3990	0.2487	0.9359
1,001-4,100	217	0.02467	0.3121	0.1694	0.4052

Note: Disinfection status ("Disinf?") is from information downloaded from SDWIS/FED. Systems with no indication of disinfection status in SDWIS/FED are assumed to not disinfect.

Exhibit 5.4 Maximum Likelihood *a* and *b* Parameter Estimates for RTEC and RPEC

Size	No. Systems	aRTEC	bRTEC	aRPEC	bRPEC
Community Water Systems (CWSs), Surface Water (SW), Disinfecting					
≤100	484	0.1291	0.6287	0.05175	1.153
101-1,000	2,034	0.1291	0.6287	0.05175	1.153
1,001-4,100	1,699	0.07514	0.8767	0.05175	1.153
Community Water Systems (CWSs), Ground Water (GW), Disinfecting					
≤100	3,662	0.05449	0.6387	0.03950	1.168
101-1,000	7,678	0.05449	0.6387	0.03950	1.168
1,001-4,100	2,707	0.05449	0.6387	0.03950	1.168
Community Water Systems (CWSs), Ground Water (GW), Non-Disinfecting					
≤100	3,788	0.04223	0.8129	0.03569	1.059
101-1,000	3,755	0.04223	0.8129	0.03569	1.059
1,001-4,100	644	0.04223	0.8129	0.03569	1.059
Nontransient, Noncommunity Water Systems (NTNCWSs), Surface Water (SW), Disinfecting					
≤100	114	0.1291	0.6287	0.05175	1.153
101-1,000	172	0.1291	0.6287	0.05175	1.153
1,001-4,100	33	0.1291	0.6287	0.05175	1.153
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Disinfecting					
≤100	1,577	0.08599	0.8796	0.07063	1.196
101-1,000	1,780	0.08599	0.8796	0.07063	1.196
1,001-4,100	252	0.08599	0.8796	0.07063	1.196
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	4,026	0.04223	0.8129	0.03569	1.059
101-1,000	3,264	0.04223	0.8129	0.03569	1.059
1,001-4,100	152	0.04223	0.8129	0.03569	1.059
Transient, Noncommunity Water Systems (TNCWSs), Surface Water (SW), Disinfecting					
≤100	838	0.1291	0.6287	0.05175	1.153
101-1,000	358	0.1291	0.6287	0.05175	1.153
1,001-4,100	30	0.1291	0.6287	0.05175	1.153
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Disinfecting					
≤100	8,112	0.08599	0.8796	0.07063	1.196
101-1,000	3,007	0.08599	0.8796	0.07063	1.196
1,001-4,100	119	0.08599	0.8796	0.07063	1.196
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	32,028	0.04223	0.8129	0.03569	1.059
101-1,000	10,217	0.04223	0.8129	0.03569	1.059
1,001-4,100	217	0.04223	0.8129	0.03569	1.059

Note: Disinfection status ("Disinf?") is from information downloaded from SDWIS/FED. Systems with no indication of disinfection status in SDWIS/FED are assumed to not disinfect.

5.2.5.2 Derivation of *α, β* from Maximum Likelihood Estimates

Using the estimates of *a* and *b* presented in Exhibits 5.3 and 5.4, EPA derived *α, β* estimates of the variation in PWSs within groups of systems, and incorporated these into the occurrence model as described in Section 5.2.4.1.

These parameters are derived from a and b as follows:

$$\alpha = a / b^2$$

$$\beta = (1- a) / b^2$$

Exhibits 5.5 and 5.6 present the estimates of *α, β* corresponding to estimates of *a* and *b* in exhibits 5.3 and 5.4.

Exhibit 5.5 *α* and *β* Parameter Estimates for RTTC and RPTC

Size	No. Systems	αRTTC	βRTTC	αRPTC	βRPTC
Community Water Systems (CWSs), Surface Water (SW), Disinfecting					
≤100	484	0.3438	22.54	0.173	2.508
101-1,000	2,034	0.4262	44.63	0.173	2.508
1,001-4,100	1,699	0.3608	61.17	0.463	13.04
Community Water Systems (CWSs), Ground Water (GW), Disinfecting					
≤100	3,662	0.3166	19.57	0.1305	1.256
101-1,000	7,678	0.2709	21.53	0.1305	1.256
1,001-4,100	2,707	0.2291	29.26	0.2160	3.922
Community Water Systems (CWSs), Ground Water (GW), Non-Disinfecting					
≤100	3,788	0.4381	13.49	0.2685	1.146
101-1,000	3,755	0.3336	12.07	0.2685	1.146
1,001-4,100	644	0.3336	12.07	0.2726	1.805
Nontransient, Noncommunity Water Systems (NTNCWSs), Surface Water (SW), Disinfecting					
≤100	114	0.1239	7.697	0.092	0.7697
101-1,000	172	0.1866	16.37	0.092	0.7697
1,001-4,100	33	0.1866	16.37	0.092	0.7697
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Disinfecting					
≤100	1,577	0.1239	7.697	0.09164	0.7697
101-1,000	1,780	0.1866	16.37	0.09164	0.7697
1,001-4,100	252	0.1866	16.37	0.09164	0.7697
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	4,026	0.2236	5.890	0.2965	0.8550
101-1,000	3,264	0.3336	12.07	0.2965	0.8550
1,001-4,100	152	0.3336	12.07	0.2965	0.8550
Transient, Noncommunity Water Systems (TNCWSs), Surface Water (SW), Disinfecting					
≤100	838	0.2584	10.92	0.117	0.6972
101-1,000	358	0.2584	10.92	0.117	0.6972
1,001-4,100	30	0.2584	10.92	0.117	0.6972
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Disinfecting					
≤100	8,112	0.2584	10.92	0.1172	0.6972
101-1,000	3,007	0.2584	10.92	0.1172	0.6972
1,001-4,100	119	0.2584	10.92	0.1172	0.6972
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	32,028	0.2989	5.983	0.2444	0.6323
101-1,000	10,217	0.2989	5.983	0.2839	0.8577
1,001-4,100	217	0.2532	10.01	1.03175	5.059

Note: Disinfection status ("Disinf?") is from information downloaded from SDWIS/FED. Systems with no indication of disinfection status in SDWIS/FED are assumed to not disinfect.

Exhibit 5.6 *α* and *β* Parameter Estimates for RTEC and RPEC

Size	No. Systems	αRTEC	βRTEC	αRPEC	βRPEC
Community Water Systems (CWSs), Surface Water (SW), Disinfecting					
≤100	484	0.3266	2.203	0.03891	0.7129
101-1,000	2,034	0.3266	2.203	0.03891	0.7129
1,001-4,100	1,699	0.0978	1.203	0.03891	0.7129
Community Water Systems (CWSs), Ground Water (GW), Disinfecting					
≤100	3,662	0.1336	2.318	0.02896	0.7041
101-1,000	7,678	0.1336	2.318	0.02896	0.7041
1,001-4,100	2,707	0.1336	2.318	0.02896	0.7041
Community Water Systems (CWSs), Ground Water (GW), Non-Disinfecting					
≤100	3,788	0.0639	1.449	0.03184	0.8602
101-1,000	3,755	0.0639	1.449	0.03184	0.8602
1,001-4,100	644	0.0639	1.449	0.03184	0.8602
Nontransient, Noncommunity Water Systems (NTNCWSs), Surface Water (SW), Disinfecting					
≤100	114	0.3266	2.203	0.03891	0.7129
101-1,000	172	0.3266	2.203	0.03891	0.7129
1,001-4,100	33	0.3266	2.203	0.03891	0.7129
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Disinfecting					
≤100	1,577	0.1112	1.181	0.04936	0.6496
101-1,000	1,780	0.1112	1.181	0.04936	0.6496
1,001-4,100	252	0.1112	1.181	0.04936	0.6496
Nontransient, Noncommunity Water Systems (NTNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	4,026	0.0639	1.449	0.03184	0.8602
101-1,000	3,264	0.0639	1.449	0.03184	0.8602
1,001-4,100	152	0.0639	1.449	0.03184	0.8602
Transient, Noncommunity Water Systems (TNCWSs), Surface Water (SW), Disinfecting					
≤100	838	0.3266	2.203	0.03891	0.7129
101-1,000	358	0.3266	2.203	0.03891	0.7129
1,001-4,100	30	0.3266	2.203	0.03891	0.7129
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Disinfecting					
≤100	8,112	0.1112	1.181	0.04936	0.6496
101-1,000	3,007	0.1112	1.181	0.04936	0.6496
1,001-4,100	119	0.1112	1.181	0.04936	0.6496
Transient, Noncommunity Water Systems (TNCWSs), Ground Water (GW), Non-Disinfecting					
≤100	32,028	0.0639	1.449	0.03184	0.8602
101-1,000	10,217	0.0639	1.449	0.03184	0.8602
1,001-4,100	217	0.0639	1.449	0.03184	0.8602

Note: Disinfection status ("Disinf?") is from information downloaded from SDWIS/FED. Systems with no indication of disinfection status in SDWIS/FED are assumed to not disinfect.

5.3 Predictive Modeling of Occurrence for Systems Serving Up to 4,100 People

For the purpose of understanding both the potential to reduce exposure to potential contamination and for estimating the net change in costs that may be incurred under the RTCR, EPA developed a model to predict the changes in TC and EC occurrence over the modeled period with respect to requirements of the RTCR regulatory options. This predictive occurrence model takes into account the requirements of existing regulations (1989 TCR and GWR) and develops estimates of changes in occurrence (as well as the frequency of the new Level 1 and Level 2 assessments and corrective actions) based on requirements of the regulatory options considered under the RTCR. The resulting estimates are used to generate cost estimates that can be compared across the three regulatory options[26]—the 1989 TCR, the RTCR, and the Alternative option, as described in Chapter 7 of this EA. Potential benefits are compared in terms of changes in the level of occurrence associated with each regulatory option, as presented in Chapter 6 of this EA.

The occurrence model focuses on a 30-year period beginning with full implementation of the GWR and covering a 25-year period of analysis from the anticipated RTCR effective date of 2015. The predictive model is implemented as a Monte Carlo simulation and currently uses 10,000 iterations (simulated systems) within each of the 27 type, source and size categories to predict the effects of changes to the current rule over the modeling period.

The PWSs included in this model are those serving ≤4,100 people primarily because these are the systems that will experience the major changes in monitoring frequency and other requirements that will affect their TC and EC occurrence. For systems serving more than 4,100 people, which will not have significant monitoring frequency changes, a separate analysis was performed based on historical violations rates instead of occurrence rates, as explained in Section 5.4 of this EA. The characteristics of all systems are described in Section 4.3 of this EA.

5.3.1 Summary of GWR factors and timing affecting the 1989 TCR and RTCR

The triggered and compliance monitoring requirements of the GWR must be implemented beginning December 2009, which will be approximately five years prior to the anticipated compliance date of the RTCR. Sanitary survey requirements must be implemented by states by December 2012 for most CWSs and not until December 2014 for higher performing CWSs and noncommunity water systems (NCWSs). To account for the impact of the GWR requirements on baseline occurrence for those PWSs using a ground water source (and serving ≤4,100 people), the model performs a number of adjustments to the existing data prior to its application in the model as a baseline.

[26] The three regulatory options considered in the RTCR EA (1989 TCR, RTCR, and Alternative option) are described in detail in Chapter 3 of this EA. Briefly, the RTCR and Alternative option both differ from the 1989 TCR primarily in the requirements for Level 1 and Level 2 assessments and corrective actions and for reduced monitoring eligibility. The RTCR allows a continuation of current monitoring frequency while the Alternative option requires systems to sample monthly for an initial period. Both allow reduced monitoring for qualified systems, but only the RTCR allows annual monitoring. Systems on annual monitoring would require an annual site visit or an annual voluntary Level 2 assessment.

Using 2005 SDWIS data (as explained in Section 4.3.1 of this EA) as a pre-GWR inventory baseline, EPA applies probabilities of P_{sample} and P_{well}[27] to determine the number of nondisinfecting systems that are expected to move to a disinfecting status in the five years prior to RTCR implementation. EPA derived P_{sample} and P_{well} [28] in the GWR EA (USEPA, 2006a); P_{well} is a fixed value of 21.58 percent, and P_{sample} is drawn from a beta distribution with a range of alpha and beta estimates having a median value for each system of 5.8 percent and an expected value of 12.4 percent. Incorporation of these factors into the model ensures that the corrective actions anticipated to be performed under the GWR are reflected in reduced occurrence for systems implementing them. In the predictive model, simulated nondisinfecting ground water systems having a TC-positive (TC+) take one or more source water samples per the GWR triggered monitoring requirement and test the samples for fecal indicator presence (EC is assumed to be the fecal indicator used).[29] The probability of observing an EC-positive (EC+) is based on the product of P_{well} and the P_{sample} value drawn for that system. If positive, a second assessment is done to determine if that system implements disinfection or a nondisinfection corrective action based on the estimated proportion choosing those options as defined in the GWR EA for the various types and sizes of systems.[30]

The simulation model keeps track of systems that begin as nondisinfecting ground water systems at the start of the analysis period and elect disinfection at some point during the 30-year period from the effective date of the GWR (December 2009) through the end of the analysis period for the RTCR. The inventory for disinfecting and nondisinfecting ground water systems are then adjusted accordingly for subsequent stages of the analysis.

Exhibit 4.5 in Chapter 4 of this EA presents the baseline inventory of ground water systems (GW systems) by disinfection status at the beginning of RTCR implementation. Those GW systems achieving <4 log disinfection must sample at their source when they have a TC+ sample in their distribution system monitoring under the 1989 TCR and the RTCR. Sampling costs were accounted for in the GWR EA (USEPA, 2006a).

Throughout the modeling period, GW systems that do not currently disinfect or add disinfection may have EC+ source water samples and implement a nondisinfection corrective action. Modeling in the GWR EA did not incorporate estimates of the effectiveness of implementing GWR requirements because the GWR was only effective as of December 2009. Absent this data, EPA applied best professional judgment in assuming that these corrective

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[27] The term "P_{well}" refers to the probability that a randomly selected well across the United States will test positive for a virus or fecal indicator species, such as EC, in its source water; "P_{sample}" is the probability that given a contaminated well, a random sample at the well will eventually test positive for a virus or fecal indicator. The GWR EA (USEPA, 2006a), and in particular the Baseline Chapter of that document, provide a detailed explanation of the analysis used to generate these P_{well} and P_{sample} estimates.

[28] Under the GWR, GW systems with less than 4 log of treatment for viruses must sample their source for a fecal indicator (e.g., *E. coli*) when they incur a TC+ under the 1989 TCR (or RTCR). If sample water is fecal indicator positive, the system may be required to implement remedial actions at the source, one of which achieves disinfection to 4 log for viruses.

[29] Edberg, R. (2000) discusses the use of *E. coli* as an indicator of drinking water quality.

[30] Costs for compliance with the GWR were considered in the GWR EA (USEPA, 2006a) and are not included in the RTCR EA.

actions would have approximately the same effectiveness as a Level 2 corrective action since they are similar in nature to an acute violation under the 1989 TCR. As shown in Exhibit 5.8, if a nondisinfecting system performs a nondisinfecting corrective action, the model assumes that occurrence is 0 percent for the remainder of that year and 2 full years after that. As a result of this assumption, baseline occurrence will be significantly reduced as a function of movement from nondisinfecting to disinfecting status. The modeling then assumes the P values are only 25 percent of baseline values for an additional five years. The model assumes the system returns to baseline P values after that (approximately) seven year period.

Additionally, the model incorporates the effect of SSs performed under the GWR as of January 2010, which is estimated by EPA to reduce TC and EC occurrence by 10 percent for the remainder of the period of analysis. For TNCWSs, which are on a 5-year SS cycle under the GWR, this reduction is initially applied to 20 percent of qualifying systems for each of the 5 years from 2010 to 2015. For CWSs, which are on a 3-year cycle, this reduction is initially applied to 1/3 of systems annually from 2010 to 2012. EPA considers the estimate of 10 percent in reduction of occurrence to be a conservative estimate of the effectiveness of the SS provision of the GWR based on best professional judgment of the TCRDSAC. However, absent empirical information to assume otherwise and because the factor is similarly incorporated by the model into the estimates of occurrence for all three regulatory options, EPA assumes that this conservatism does not significantly affect the net results for the RTCR or Alternative option, which are calculated by comparison to the 1989 TCR (baseline).

A third GWR requirement that the model incorporates is compliance monitoring by the subset of GW systems that disinfect, for which the model assigns a 10 percent reduction in occurrence in effect throughout the period of analysis. Again, this GWR effectiveness estimate may be conservative, but EPA assumes that because it is incorporated by the model into occurrence estimates for all three regulatory options, the net effect on results of the RTCR and Alternative option (in comparison to the 1989 TCR) is unlikely to be significant. Taking into account the effect of both SS and compliance reductions, the disinfecting GW systems are expected to ultimately have TC and EC occurrence rates that are 81 percent of the values derived from the occurrence distributions (from 90 percent for sanitary surveys x 90 percent for compliance monitoring).

A fourth and last GWR requirement that the model incorporates concerns the repeat number of samples following a TC positive. For GW systems serving ≤1,000 people, the GWR allows the PWS to use of one of the four repeat samples required under the 1989 TCR following a TC+ sample to meet the requirement for source water testing under the GWR. By comparison, under the RTCR, Alternative option, and the 1989 TCR scenarios for systems serving >1,000 people, only 3 repeat samples are required following a TC+ and in these cases an additional, separate sample is used for the GWR source water fecal indicator assay.

As mentioned above with regard to SS and disinfecting system GWR compliance, the actual reductions in occurrence that will result from implementation of GWR requirements may differ from those predicted based on assumptions used in this model. EPA believes this would affect neither the net analysis nor how the RTCR or Alternative option compare to each other, since both would be affected similarly. Section 5.3.3.1 describes the various sources of uncertainty and variability considered in this EA and presents an analysis of key variables.

5.3.2 Summary of Predictive Model

As the following Sections 5.3.2.1–5.3.2.2 describe, EPA modeled the expected trend in occurrence of TC and EC+ assays over a pre-RTCR monitoring period of 5 years (to capture applicable GWR effects), and a subsequent 25-year period of analysis for the three regulatory options: continuation of the 1989 TCR, RTCR, and Alternative option.[31] EPA sought to capture the changes in occurrence from the implementation of the GWR requirements, and in turn, the implementation of requirements of the RTCR and the Alternative option. Along with changes in TC and EC occurrence, the model predicts behavioral changes: the number of Level 1 and Level 2 assessments (and associated number of Level 1 or Level 2 corrective actions) to be performed and further resulting adjustments to occurrence, and changes in sampling regimens as systems qualify for reduced monitoring requirements.

5.3.2.1 Approach to Estimating Parameters

As described in Section 5.2 of this chapter, EPA derived Beta distributions, characterized by their α, β parameters, based on analyses of the variation in TC and EC+ assays that occurred both between and within 27 groupings of systems (as defined in Section 5.2.3); the resulting α, β parameter estimates are presented in Exhibits 5.5 and 5.6. Based on an initial analysis, the 27 groups were condensed into the groups presented in Appendix F of this EA. The final Beta distributions were based on these groupings to make the best use of the available data, combining groups of systems when their occurrence levels were similar to avoid having small sample size in any of the final groups.

5.3.2.2 Description of Predictive Model

Model output in this chapter (Exhibits 5.10–5.21) was generated for a 30-year period to encompass 5 years of the effects of GWR implementation and 25 years of the effects of RTCR implementation. For the purpose of the benefit-cost analysis, years 3 through 27 of this period are included in the calculations and presented in the results shown in Chapter 6 (Benefits Analysis), Chapter 7 (Cost Analysis), and Chapter 9 (Comparison of Benefits and Costs). Initially in the modeled period, all systems under the 1989 TCR and the RTCR are assumed to sample based on the sampling regimen applicable to their system type, size, type of water source, and whether or not the system disinfects on the effective date of the RTCR.[32] Under the Alternative option, all systems are assumed to sample monthly for the first five years after the RTCR effective date.

For the RTCR, the model adjusts these monitoring frequencies for GW systems serving fewer than 1,000 people in years 9 and 11 of the 30-year period, or following 3 and 5 years after of implementation of the RTCR, respectively, for CWSs and NCWSs. The adjustments are made based on the acute and non-acute violations modeled during these 3- and 5-year periods,[33] and

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[31] Footnote 4 briefly describes the three regulatory options, which are described in detail in Chapter 3 of this EA.

[32] Based on EPA and TWG analysis of Six-Year data and individual state statutes during the TCRDSAC and review by ASDWA.

[33] Systems modeled to incur one or more acute or non-acute violations in this period are assumed to be on monthly monitoring. For the RTCR, the remaining systems (incurring no acute or non-acute violations) are distributed

the period of assessment coincides with the sanitary survey for CWSs and NCWSs. The adjusted monitoring frequencies then apply from years 9–30 and years 11–30 of the analysis for CWSs and NCWSs, respectively.

For the Alternative option, the model adjusts the monitoring frequencies from the all-monthly regimen based on the acute and non-acute violations[34] predicted during the assessment period, which is the first five years after the RTCR effective date, during which all systems sample monthly. The model applies the schedule thus adjusted in years 11–30 of the analysis.

The timing for the adjustments made to the monitoring frequency schedules is consistent with the length of time of the respective sanitary survey cycles. Although EPA uses the sanitary cycle to define the period of assessment for updating the schedule, the results of the surveys are not predicted in this model and are not directly incorporated into the calculations in any way. Assumptions for the percentage of systems on monthly, quarterly, or annual monitoring upon RTCR implementation are shown in Exhibit 5.9a–5.9c.

Using the monitoring frequencies described above, the model applies the baseline occurrence associated with each category of PWS at the start of each modeled year (i.e., the level of occurrence in 2005 under the 1989 TCR updated to reflect GWR implementation, as described in Section 5.3.1), as described in Exhibits 5.7 and 5.8 for SW and GW systems, respectively. The TC and EC occurrence (both from routine and repeat samples) are modeled by combining the Beta distributions described previously with the binomial distribution to simulate TC+ and EC+ results (i.e., successes) given the number of samples (i.e., trials) each month.

For each simulated system in the model, a probability (P) is drawn randomly for each of the RTTC, RPTC, RTEC, and RPEC types of samples from their corresponding Beta distributions. These P values are used in the binomial distribution, together with the number of samples taken each month, to predict the number of TC+ and EC+ results. In the absence of any corrective actions being performed under the RTCR, those P values remain the same for that system for the entire modeling period. If TC or EC occurrence is found that results in a specific corrective action under the RTCR, temporary reductions in these P values are made as described further below. In addition, when a system has a TC+ in a particular month that does not result in a specific corrective action, it is assumed (for both the 1989 TCR and the RTCR) that the RTTC rate in the following month will change to reflect either some worsening of the problem or an improvement based on some other actions taken that are not part of the specific corrective actions being considered. This was carried out by selecting at random a different RTTC P value

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between quarterly and annual monitoring according to the percentage distribution from the initial M/Q/A estimates prior to GWR implementation (Exhibit 4.4). Constraints to these adjustments include: 1) the final estimates of the proportion of disinfecting CWSs on monthly monitoring should not decrease from the current baseline estimate; and 2) for the disinfecting NCWSs, there are caps on the percent that move to annual monitoring under the RTCR (TNCWS <500: 13.8 percent, TNCWS 501-1,000: 8.6 percent, NTNCWS <500: 7.3 percent, NTNCWS 501-1,000: 3.0 percent).

[34] Systems incurring one or more acute or non-acute violations in this period are assumed to be on monthly monitoring. For the Alternative option, all of the remaining systems (incurring no acute or non-acute violations) move to quarterly monitoring.

in those months following a TC+ for which explicit corrective actions were not initiated. In the second month following a TC+ that does not result in a corrective action, the RTTC rate reverts to the rate applicable in the month in which the TC+ occurred. EPA determined that this approach provided overall results for the 1989 TCR that approximated what was observed in the 6-Year Review data and SDWIS data as discussed in the Section 5.3.3.2 (model validation) below.

Based on the frequency of sampling and the occurrence probabilities for each system, the model determines what percentage of these systems will be required to take an action (i.e., perform a Level 1 or Level 2 assessment in response to exceeding the threshold of multiple TC positive assays or one EC+ assay, and, in some cases, implement a corrective action).

For the percentage of systems predicted to require a Level 1 assessment following the requisite number of TC positives, the model assumes that 10 percent will find and address the exact source of the problem under the RTCR and Alternative option. This represents a net increase over the number expected to implement such a corrective action under the 1989 TCR. The model assumes that systems that successfully identify and correct the problem will not have a positive assay for the remainder of that year and also 1 additional full year after the assessment, after which the probability of a TC+ or EC+ will be 50 percent that of the baseline P value for 3 additional years.[35] After this period of reduced occurrence, the model assumes that occurrence probabilities for this subset of systems return to those that were initially assigned. Because the Level 1 and Level 2 assessments are a new requirement, empirical data on their effectiveness in determining an appropriate corrective action is not available. Absent this evidence, EPA has applied best professional judgment in choosing what it believes to be a significant but conservative success rate—10 percent of Level 1 assessments will result in determining the root of the problem and effectively implementing an appropriate corrective action. The assumptions about the success rates of assessments and corrective actions, and the length of time before and likelihood of subsequent positive samples, are assumptions made for modeling purposes and do not reflect the expectation for any particular system.

Similarly, based on observing the requisite number of TC+ and/or EC+ results for systems predicted to require a Level 2 assessment under the RTCR and Alternative option, a 10 percent increase in the number of systems from the 1989 TCR are assumed to implement a corrective action that addresses the cause of the problem. For those systems, the model assumes that occurrence is 0 percent for the remainder of that year and then for 2 full years after that. The modeling then assumes the P values are only 25 percent of baseline values for an additional 5 years. The model assumes the system returns to baseline P values after that (approximately) 7-year period.

For nondisinfecting GW systems, a percentage of positive samples is estimated (from the P_{well} and P_{sample} parameters) to be related to a source water problem. All nondisinfecting GW

[35]Using best professional judgment informed by deliberations within the TCRDSAC, EPA assumes that some systems will have 0 percent occurrence for some number of years longer than one year, and some will have occurrence levels that are >0 percent within the first year. The assumption used in the analysis (systems will have 1 year with 0 percent occurrence, plus 2 to 3 years of reduced occurrence from their baseline occurrence) is meant to represent an average system that experiences occurrence that is between these two scenarios.

systems having source water EC+ results[36] will implement disinfection or nondisinfecting corrective action. Those adding disinfection essentially get removed from the nondisinfecting category and are reassigned to the disinfecting category for the remainder of the modeling period. The portion of systems in this subset that are assumed to implement a nondisinfecting corrective action[37] are assumed to experience the same reduced occurrence levels as those addressing Level 2 Assessments (i.e., 0 percent occurrence for 2 years, then occurrence at 25 percent of baseline for an additional 5 years). As Chapter 7 of this EA explains, no costs are attributed to the RTCR for any corrective action related to source water EC occurrence since such costs have already been considered in the GWR EA (USEPA, 2006a).

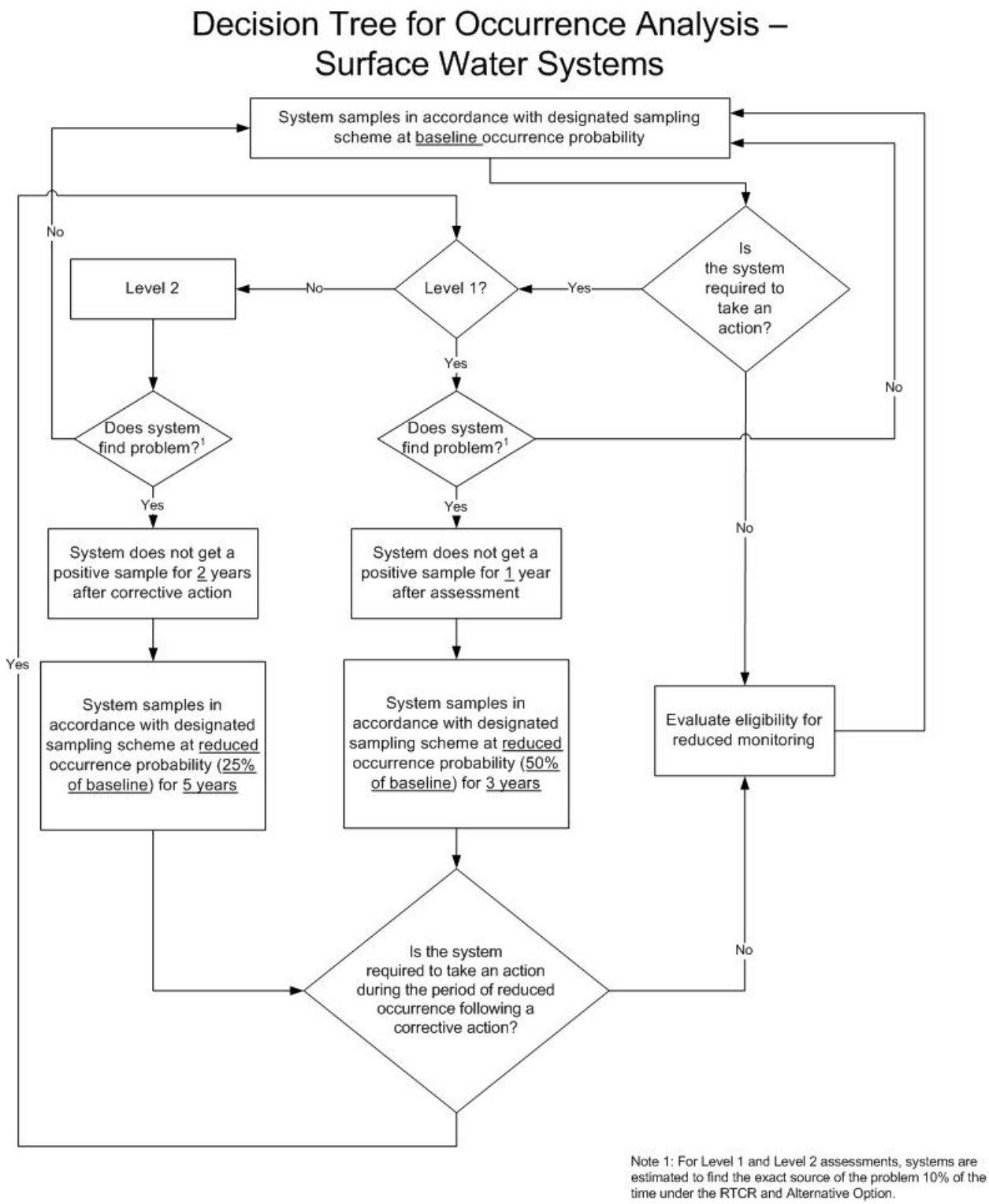
Outputs generated from this predictive simulation model (for PWSs serving 4,100 or fewer people) include the following for each modeled year: occurrence of TC+ and EC+ assays, the number of Level 1 and Level 2 assessments conducted, and the number of Level 1 and Level 2 corrective actions implemented. Based on these model outputs and the criteria for reduced monitoring, the model also provides estimates of the number of systems on monthly, quarterly, and annual sampling regimes (and by implication the number of routine, repeat, and additional routine samples taken annually) under the RTCR and Alternative option. These requirements are detailed in Chapter 3 of this EA.

The results of the RTCR predictive occurrence model are presented in the following section, Section 5.3.3.

[36] The model determines source water occurrence separately based on the subset of nondisinfecting GW systems, as described in Section 5.3.1 (2nd paragraph) of this chapter.

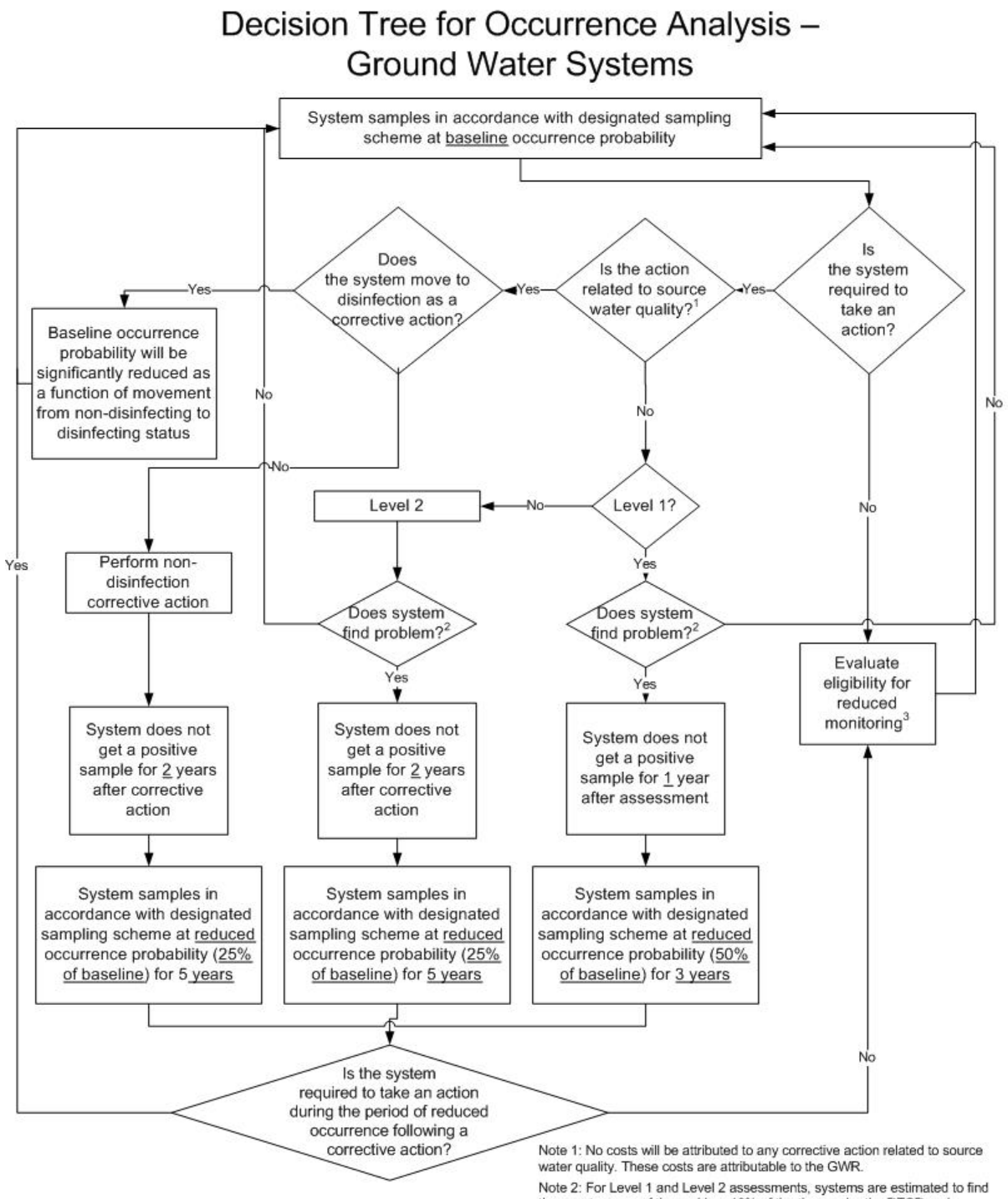
[37] Estimates of the number of systems implementing a nondisinfection corrective action are taken from Exhibit 6.21b ("Estimated Distribution of Source Water Contamination Corrective Actions") of the GWR EA (USEPA, 2006a). The GWR EA estimated the number of systems choosing a nondisinfection corrective action based on a range; the high end was the percentage of CWS entry points employing disinfection at that time by system size, and the low end was assumed to be 10 percent based on discussions with state representatives.

Exhibit 5.7 Simulated Impact of the RTCR and Alternative Option on Systems Serving ≤4,100 People—Surface Water Systems



Note 1: For Level 1 and Level 2 assessments, systems are estimated to find the exact source of the problem 10% of the time under the RTCR and Alternative Option.

Exhibit 5.8 Simulated Impact of the RTCR and Alternative Option on Systems Serving ≤4,100 People—Ground Water Systems



Note 1: No costs will be attributed to any corrective action related to source water quality. These costs are attributable to the GWR.

Note 2: For Level 1 and Level 2 assessments, systems are estimated to find the exact source of the problem 10% of the time under the RTCR and Alternative Option.

Note 3: For modeling purposes, adjustments to a new steady state distribution between monthly, quarterly, and annual monitoring regimens are made once in the period of analysis - after 5 years for noncommunity water systems and 3 years for community water systems. This time frame is meant to correspond with a full sanitary survey cycle for these systems based on the Agency's assumption that States may want to coordinate their evaluation of PWS eligibility for reduced monitoring with the sanitary survey cycle.

Exhibit 5.9a Percent of GW Systems Assumed to be on Monthly, Quarterly, and Annual (M/Q/A) Monitoring by System Category under 1989 TCR (Baseline)—Initial Estimates (Post-GWR Implementation)

Size	Number of Systems	Monthly	Quarterly	Annual
Community Water Systems (CWSs), Disinfecting				
≤100	6,132	86.6%	13.4%	0.0%
101-1,000	12,762	88.5%	11.5%	0.0%
1,001-4,100	5,405	100.0%	0.0%	0.0%
Community Water Systems (CWSs), Non-Disinfecting				
≤100	5,806	86.6%	13.4%	0.0%
101-1,000	5,597	88.6%	11.4%	0.0%
1,001-4,100	1,038	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Disinfecting				
≤100	2,904	19.3%	64.7%	16.0%
101-1,000	3,621	18.5%	66.7%	14.7%
1,001-4,100	542	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Non-Disinfecting				
≤100	5,913	19.3%	64.7%	16.0%
101-1,000	4,710	18.5%	66.7%	14.8%
1,001-4,100	270	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Disinfecting				
≤100	13,558	4.8%	62.9%	32.3%
101-1,000	6,014	7.9%	66.9%	25.2%
1,001-4,100	269	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Non-Disinfecting				
≤100	46,642	4.8%	62.9%	32.3%
101-1,000	15,224	7.8%	66.8%	25.3%
1,001-4,100	348	100.0%	0.0%	0.0%

Notes:

1) EPA assumes that the frequencies noted in this exhibit for the 1989 TCR would also apply under the RTCR in the first 10 years of the analysis period. Under the Alternative option, all systems would monitor monthly for the first 5 years after the RTCR effective date.

2) Estimates for the size categories presented in this exhibit are produced from weighted averages from the following size categories (and corresponding estimates of proportion sampling monthly, quarterly, or annually): ≤100; 101-500; 501-1,000; 1,001-2,500; 2,501-3,300; and 3,301-4,100. Water Type includes disinfection status, as informed by information from SDWIS/FED.

3) Systems with no indication of disinfection ("Disinf?") status in SDWIS/FED were assumed to not disinfect.

4) Some figures may not add due to rounding in the model.

Exhibit 5.9b Percent of GW Systems Predicted to be on M/Q/A Monitoring by System Category under RTCR—Adjusted Estimates (Post-RTCR Implementation)

Size	Number of Systems	Monthly	Quarterly	Annual
Community Water Systems (CWSs), Disinfecting				
≤100	6,132	86.6%	13.4%	0.0%
101-1,000	12,762	88.5%	11.5%	0.0%
1,001-4,100	5,405	100.0%	0.0%	0.0%
Community Water Systems (CWSs), Non-Disinfecting				
≤100	5,806	86.6%	13.4%	0.0%
101-1,000	5,597	88.6%	11.4%	0.0%
1,001-4,100	1,038	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Disinfecting				
≤100	2,907	2.8%	89.9%	7.3%
101-1,000	3,621	2.6%	91.2%	6.3%
1,001-4,100	542	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Non-Disinfecting				
≤100	5,919	14.7%	78.0%	7.3%
101-1,000	4,710	13.5%	79.9%	6.5%
1,001-4,100	270	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Disinfecting				
≤100	13,558	5.2%	81.0%	13.7%
101-1,000	6,014	5.1%	81.7%	13.2%
1,001-4,100	269	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Non-Disinfecting				
≤100	46,642	16.9%	71.0%	12.0%
101-1,000	15,224	16.7%	71.2%	12.1%
1,001-4,100	348	100.0%	0.0%	0.0%

Notes:

1) M/Q/A percentage estimates are based on model predictions of acute and non-acute violations from years 6 – 10 (NCWSs) and 6 – 8 (CWSs) of the 30-year modeled period. Systems incurring 1 or more acutes or non-acutes in this period are assumed to be on monthly monitoring for years 11 – 25 of the analysis; the remaining systems are distributed between quarterly and annual monitoring according to the percentage distribution from the initial M/Q/A estimates (Exhibit 5.9a). Other constraints apply to the determination of the M/Q/A distribution of systems as described in Section 5.3.2 above.

2) Estimates for the size categories presented in this exhibit are produced from weighted averages from the following size categories (and corresponding estimates of proportion sampling monthly, quarterly, or annually): ≤100; 101-500; 501-1,000; 1,001-2,500; 2,501-3,300; and 3,301-4,100.

3) Systems with no indication of disinfection ("Disinf?") status in SDWIS/FED were assumed to not disinfect.

4) Some figures may not add due to rounding in the model.

Exhibit 5.9c Percent of GW Systems on M/Q/A Monitoring by System Category under Alternative option—Adjusted Estimates (Post-RTCR Implementation)

Size	Number of Systems	Monthly	Quarterly	Annual
Community Water Systems (CWSs), Disinfecting				
≤100	6,132	86.6%	13.4%	0.0%
101-1,000	12,762	88.5%	11.5%	0.0%
1,001-4,100	5,405	100.0%	0.0%	0.0%
Community Water Systems (CWSs), Non-Disinfecting				
≤100	5,806	86.6%	13.4%	0.0%
101-1,000	5,597	88.6%	11.4%	0.0%
1,001-4,100	1,038	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Disinfecting				
≤100	2,907	4.4%	95.6%	0.0%
101-1,000	3,621	4.5%	95.5%	0.0%
1,001-4,100	542	100.0%	0.0%	0.0%
Nontransient, Noncommunity Water Systems (NTNCWSs), Non-Disinfecting				
≤100	5,919	20.8%	79.2%	0.0%
101-1,000	4,710	21.5%	78.5%	0.0%
1,001-4,100	270	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Disinfecting				
≤100	13,558	9.9%	90.1%	0.0%
101-1,000	6,014	10.1%	89.9%	0.0%
1,001-4,100	269	100.0%	0.0%	0.0%
Transient, Noncommunity Water Systems (TNCWSs), Non-Disinfecting				
≤100	46,642	25.8%	74.2%	0.0%
101-1,000	15,224	25.4%	74.6%	0.0%
1,001-4,100	348	100.0%	0.0%	0.0%

Notes:

1) M/Q/A percentage estimates are based on model predictions from years 6 – 10 (NCWSs) and 6 – 8 (CWSs) of the period of analysis. Systems incurring 1 or more acutes or non-acutes in this period are assumed to be on monthly monitoring for years 11 – 25 of the analysis; the remaining systems are assumed to be on quarterly monitoring. Other constraints apply to the determination of the M/Q/A distribution of systems as described in Section 5.3.2 above. This is a modeling assumption that reflects an expected steady state of some systems that will regain and others that will lose reduced monitoring post RTCR implementation.

2) Estimates for the size categories presented in this exhibit are produced from weighted averages from the following size categories (and corresponding estimates of proportion sampling monthly, quarterly, or annually): ≤100; 101-500; 501-1,000; 1,001-2,500; 2,501-3,300; and 3,301-4,100.

3) Systems with no indication of disinfection ("Disinf?") status in SDWIS/FED were assumed to not disinfect.

4) Some figures may not add due to rounding in the model.

5.3.3 Predictive Model Results

As noted above, the predictive model produces output that includes national estimates of sampling and occurrence in PWSs across the United States, the resulting Level 1 and Level 2 assessments, corrective actions resulting from Level 1 and Level 2 assessments, and reductions in sampling and occurrence for these systems in accordance with requirements under the 1989 TCR, the RTCR, and the Alternative option. In Exhibits 5.10 through 5.15, output includes the model years 1–30 described in Section 5.3.2.2. Years 1–5 are summed for the 1989 TCR only and represent the period prior to the start of monitoring under the final RTCR, including 5 years after the GWR effective date. Year 5 in the analysis (also for just the 1989 TCR) is also shown separately because it represents the baseline year, reflecting conditions just prior to the start of monitoring under the RTCR. Model years 6 through 30 are summed for the 1989 TCR, the RTCR, and the Alternative option because they represent the 25-year period of analysis following promulgation of the RTCR.

For all types of PWSs, the model output is presented for the 1989 TCR, the RTCR, and the Alternative option. The 1989 TCR with the GWR effects incorporated serves as the appropriate baseline for comparisons with the RTCR.

EPA's general expectations for TC occurrence for GW systems shown in Exhibits 5.16–5.18 are as follows:

1. Years 1–5 show a decline in the TC+ rates due to GWR implementation effects. These include expected reductions in RTTC rates for all GW systems related to SSs, for disinfecting GW systems related to the compliance monitoring, and for nondisinfecting GW systems due to corrective actions taken following a source water EC+ sample.

2. Years 6–30 reflect additional reductions (beyond GWR effects) in TC+ rates due to the RTCR or Alternative option. The RTCR and Alternative option occurrence rates are generally lower than those for the 1989 TCR with the GWR primarily because of the additional corrective actions (Level 1 and Level 2). In some subgroups, some counts are higher under the Alternative option than under the 1989 TCR due to the increased sampling e.g., routine TC+ and routine EC+ results for GW NTNCWSs (Ex. 5.11). The balance of the two effects of reduced sampling (reduced additional and repeat samples) and the additional assessments and corrective actions, which move the counts in opposite directions, is explored in the sensitivity analysis in Section 5.3.3.1 of this chapter.

3. In Years 6 through 10 and years 11–30 differences in TC+ rates between the RTCR and Alternative option are due to different proportions of systems that are performing monthly, quarterly, or annual monitoring. In general, more monitoring (e.g., more systems doing monthly than quarterly, or more systems doing quarterly than annual)—*in conjunction with the corrective actions*—will push the TC occurrence levels down (more samples are expected to be taken and fewer samples are likely to be positive).

a. In years 6–10, the Alternative option has a lower TC+ rate than the RTCR because all systems under the Alternative option begin the 5-year period on monthly sampling. The increased sampling and resulting increase in corrective actions performed will together reduce the occurrence rate.

b. By year 11, the systems are sampling according to their "steady state" regimens, when all of the systems that qualified for reduced monitoring during their respective periods of assessment (as described in Section 5.3.2.2) are assigned to their reduced regimens in the model. For the RTCR, the proportions of systems on M/Q/A sampling is identical to those under the 1989 TCR; under the Alternative option, however, systems that would qualify under the 1989 TCR for annual monitoring can only reduce to quarterly monitoring.

The following paragraphs describe TC occurrence in PWSs serving less than or equal to 4,100 people (as shown in Exhibits 5.16 through 5.21). See Appendix B for detailed breakouts of TC occurrence by population category.

In Exhibit 5.16 (GW CWSs), the graph shows the expected drop in TC rates for years 1–5 as the GWR is implemented prior to RTCR. There are only very small differences between the RTCR and Alternative option, and these are not observable in this graph. A comparison of the estimates in Exhibit 5.10 clarifies these small differences. Most of these systems are already on monthly sampling, so there is no significant difference seen between the RTCR and Alternative option in years 6–8 for those few systems not on monthly sampling and it is assumed that the monthly/quarterly distribution after this period returns to that under the 1989 TCR. Therefore, the TC+ rates over the 25-year period for these systems show no difference between the RTCR and Alternative option.

In Exhibit 5.17 (GW NTNCWSs), the graph also shows the expected drop in TC+ rates for years 1–5 as the GWR is implemented prior to the RTCR. For years 6–10 the occurrence rates decrease under the RTCR and the Alternative option due to the implementation of corrective actions, and the rates for the Alternative option are lower than for the RTCR since all systems are on monthly sampling under the Alternative option for this period (having the effect of reducing the occurrence level as noted above). However, from year 11 to 30, the M/Q/A distributions for these two are essentially the same and therefore the TC occurrence levels are the same over this period.

In Exhibit 5.18 (GW TNCWS), the graph also shows the expected drop in TC+ rates for years 1–5 as the GWR is implemented prior to the RTCR. For years 6–10, the TC rates drop further as the corrective actions implemented in response to Level 1 and Level 2 assessments are begun for both the RTCR and Alternative option. TC occurrence is markedly lower during this period for the Alternative option where all systems are on monthly monitoring, whereas the majority of systems under the RTCR are on quarterly monitoring. Beginning in Year 11, there is a shift under the RTCR towards more systems on monthly monitoring than under the 1989 TCR, and more systems on quarterly monitoring than under the 1989 TCR, and hence the overall TC+ rate drops. For the Alternative option, beginning in Year 11, a substantial portion of systems move from the all monthly sampling during years 6–10 to quarterly sampling (but none on

annual sampling). Because there are slightly more systems under the Alternative option that end up on monthly and quarterly monitoring than under the RTCR for years 11–30, the TC+ rate for the RTCR is slightly higher than for the Alternative option.

EPA's general expectations for TC+ rates for SW systems shown in Exhibits 5.19–5.21 are as follows:

1. The 1989 TCR is provided as the baseline for comparison with the RTCR (the GWR does not apply to SW systems and therefore its effect is not included in these graphs).

2. Because all SW systems of all sizes do monthly monitoring (no systems are on quarterly or annual monitoring), the applicable provisions of the RTCR are identical for the RTCR and Alternative option.

3. The reductions in TC+ rates shown by the RTCR relative to the 1989 TCR therefore reflect solely the effects of the corrective actions implemented in response to Level 1 and Level 2 assessments.

In Exhibit 5.19 (SW CWSs), the graph shows little difference in TC+ rates between the 1989 TCR and RTCR. This is primarily because the current TC+ rate is very low for these systems, and therefore there are few corrective actions implemented over the 25-year period.

In Exhibit 5.20 (SW NTNCWSs), the graph shows that there is a slightly greater difference between the 1989 TCR and the RTCR for the SW NTNCWSs than for the SW CWSs shown in Exhibit 5.19. This is because the baseline TC+ rate is slightly higher and, therefore, more corrective actions are performed for SW NTNCWSs than SW CWSs.

In Exhibit 5.21 (SW TNCWSs), the graph indicates that this group exhibits the most significant difference between the 1989 TCR and RTCR since the baseline TC+ rate for these systems is approximately twice that of the SW NTNCWSs and SW CWSs.

A comparison of results for SW versus GW systems reveals a pattern of lower occurrence for SW systems; this is explained by the uniform requirement that SW systems disinfect. Many GW systems are not required to disinfect, and the result is a level of TC occurrence that is periodically elevated in some systems, raising the overall average TC occurrence in GW system categories. This difference is larger for the GW NCWSs than for the GW CWSs based on the relatively large proportion of GW NCWSs that do not disinfect. The difference is largest among the TNCWSs, a category in which the largest proportion of GW systems do not disinfect.

Complete results from the model (by year and system size) and additional graphs are shown in Appendix B. The implications of these results in terms of changes in the level of risk associated with contamination of PWS water supplies are discussed in Chapter 6 of this EA. Model results are used to calculate national estimates of the net change in costs for PWSs in Chapter 7 of this EA.

Exhibit 5.10 Ground Water Community Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR No GWR	12,712,859	1,052,957	816,079	0	215,787	111,640	10,267	4,344	0	55,639	5,773	34,556	30,657	0	0	0	0
	1989 TCR	12,761,616	864,605	588,252	93,331	176,379	66,797	7,236	2,106	872	39,769	3,335	26,947	18,545	0	0	714	158
	RTCR	12,984,469	19,027	488,523	83,140	162,841	48,053	6,438	1,347	816	30,271	2,362	22,112	11,667	2,220	1,155	665	151
	Alternative Option	13,073,297	16,686	490,683	83,299	163,561	47,829	6,562	1,595	781	29,955	2,511	21,917	11,660	2,242	1,175	622	160
Sum Years 1-5	1989 TCR No GWR	2,542,182	254,662	197,228	0	52,150	27,053	2,471	1,033	0	13,486	1,391	8,410	7,393	0	0	0	0
	1989 TCR	2,550,295	180,676	122,391	19,799	36,791	14,208	1,532	460	312	8,358	711	5,542	4,103	0	0	203	109
Year 5	1989 TCR No GWR	508,401	42,520	32,969	0	8,719	4,613	402	176	0	2,259	240	1,415	1,241	0	0	0	0
	1989 TCR	510,266	35,345	24,060	3,864	7,231	2,655	297	70	48	1,605	130	1,107	731	0	0	31	17

Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.11 Ground Water Nontransient Noncommunity Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR No GWR	2,661,114	328,889	264,574	0	68,232	59,455	3,484	2,338	0	24,614	2,723	14,759	14,021	0	0	0	0
	1989 TCR	2,668,723	271,756	178,204	42,339	55,965	34,716	2,534	1,269	446	17,922	1,778	11,658	8,991	0	0	351	95
	RTCR	2,564,440	90,884	145,401	37,384	48,467	25,164	2,115	841	435	13,642	1,213	10,157	5,088	1,015	499	350	85
	Alternative Option	3,345,137	71,729	185,814	48,181	61,938	31,758	2,628	1,089	496	17,403	1,547	11,996	7,585	1,194	761	389	107
Sum Years 1-5	1989 TCR No GWR	532,239	66,134	53,191	0	13,714	11,904	693	446	0	4,925	531	2,956	2,794	0	0	0	0
	1989 TCR	533,205	58,599	38,489	9,192	12,094	7,867	574	288	150	3,924	403	2,477	2,084	0	0	99	52
Year 5	1989 TCR No GWR	106,453	13,330	10,711	0	2,760	2,425	137	89	0	1,001	102	603	555	0	0	0	0
	1989 TCR	106,725	10,980	7,219	1,717	2,267	1,416	95	48	23	729	68	473	362	0	0	16	6

Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.12 Ground Water Transient Noncommunity Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR No GWR	7,508,835	1,766,220	1,489,330	0	374,523	373,849	17,881	14,195	0	143,238	15,757	87,899	79,745	0	0	0	0
	1989 TCR	7,524,239	1,458,180	966,919	253,032	305,814	213,958	12,859	7,416	2,651	105,646	10,326	70,031	51,552	0	0	2,134	517
	RTCR	9,780,374	674,328	981,521	283,807	327,174	191,401	13,121	5,792	2,993	99,961	8,421	71,817	39,668	7,188	4,039	2,455	538
	Alternative Option	14,651,904	528,324	1,379,719	398,642	459,906	258,975	18,354	7,963	3,622	135,781	11,760	87,063	66,458	8,498	6,564	3,012	610
Sum Years 1-5	1989 TCR No GWR	1,501,831	350,417	295,149	0	74,227	73,576	3,577	2,709	0	28,251	3,150	17,357	15,692	0	0	0	0
	1989 TCR	1,503,848	311,414	206,844	54,227	65,441	47,969	2,873	1,791	942	22,651	2,360	14,769	11,528	0	0	610	332
Year 5	1989 TCR No GWR	300,376	70,103	59,023	0	14,844	14,766	686	612	0	5,627	610	3,545	3,008	0	0	0	0
	1989 TCR	300,923	59,747	39,565	10,447	12,536	8,813	506	331	129	4,269	429	2,821	2,101	0	0	87	42

Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.13 Surface Water Community Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR	3,516,224	137,063	98,139	0	27,729	5,244	2,909	293	0	3,322	666	2,829	1,237	0	0	0	0
	RTCR	3,565,200	0	81,187	0	27,062	3,860	2,866	180	0	2,755	502	2,415	901	243	93	0	0
	Alternative Option	3,565,200	0	81,187	0	27,062	3,860	2,866	180	0	2,755	502	2,415	901	243	93	0	0
Sum Years 1-5	1989 TCR	703,236	27,458	19,651	0	5,550	1,066	584	57	0	675	137	573	255	0	0	0	0
Year 5	1989 TCR	140,622	5,559	3,956	0	1,117	224	119	13	0	138	29	115	55	0	0	0	0

Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.14 Surface Water Nontransient Noncommunity Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR	222,494	13,728	10,670	0	2,796	1,127	360	51	0	458	105	292	294	0	0	0	0
	RTCR	225,900	0	8,183	0	2,728	675	350	37	0	330	76	232	187	24	19	0	0
	Alternative Option	225,900	0	8,183	0	2,728	675	350	37	0	330	76	232	187	24	19	0	0
Sum Years 1-5	1989 TCR	44,500	2,740	2,131	0	558	221	72	10	0	90	21	57	59	0	0	0	0
Year 5	1989 TCR	8,898	554	429	0	113	43	15	2	0	17	4	11	12	0	0	0	0

Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.15 Surface Water Transient Noncommunity Water System Model Output Cumulative Endpoints

Period	Regulatory Scenario	Routine Samples	Additional Routine Samples	Repeat Samples	GWR Source Water Samples	Routine TC+ Samples	Repeat TC+ Samples	Routine *E. coli* + Samples	Repeat *E. coli* + Samples	GWR *E. coli* + Samples	Non-Acute Events	Acute Events	Level 1 Assessments	Level 2 Assessments	Level 1 Corrective Actions	Level 2 Corrective Actions	GWR, Non-Disinfecting Systems[1]	GWR, Disinfecting Systems[2]
Sum Years 6-30	1989 TCR	609,514	71,280	57,424	0	14,612	8,365	1,855	398	0	3,148	765	1,893	2,214	0	0	0	0
	RTCR	625,200	0	39,905	0	13,302	4,311	1,679	218	0	2,037	437	1,357	1,200	130	118	0	0
	Alternative Option	625,200	0	39,905	0	13,302	4,311	1,679	218	0	2,037	437	1,357	1,200	130	118	0	0
Sum Years 1-5	1989 TCR	121,900	14,265	11,476	0	2,920	1,671	382	81	0	628	152	370	449	0	0	0	0
Year 5	1989 TCR	24,373	2,891	2,314	0	589	331	77	17	0	124	30	74	88	0	0	0	0

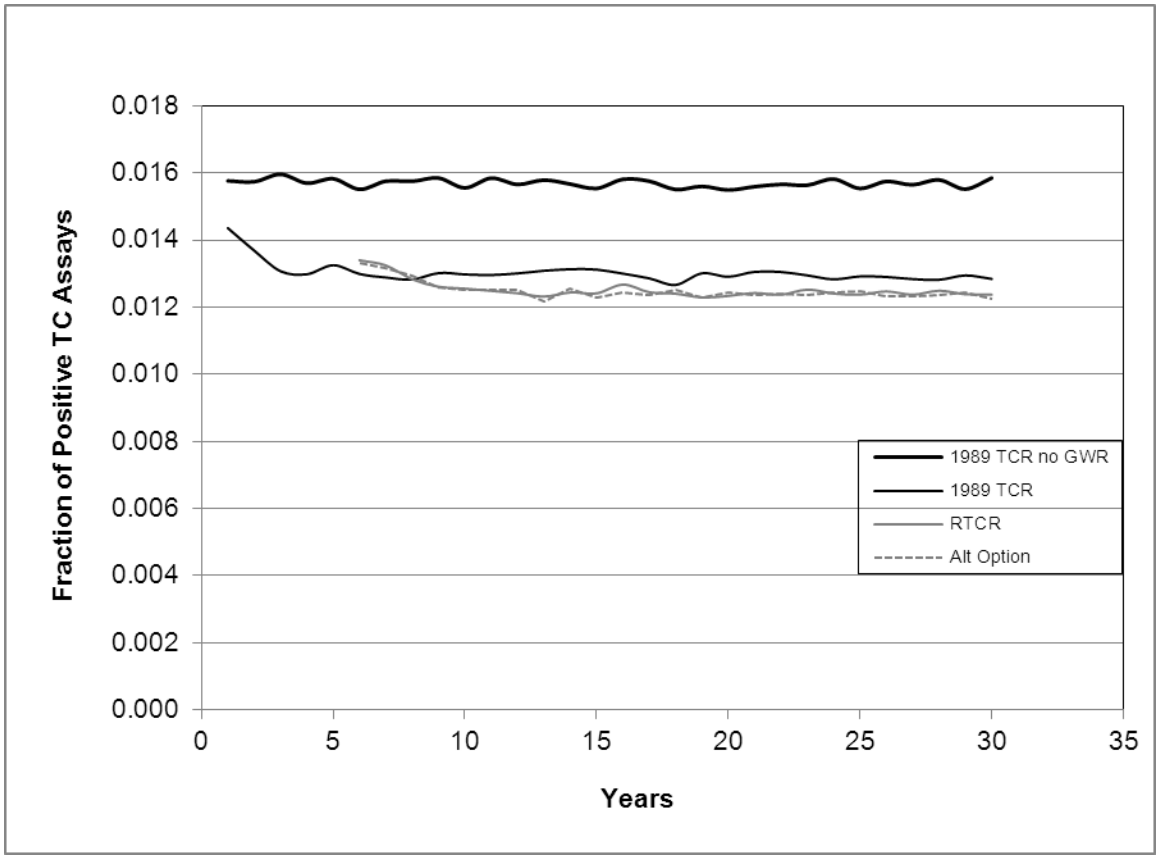
Source: RTCR predictive model.

Note: Years 1 – 5 in the model reflect incorporation of GWR effects (explained in Section 5.3.3) into pre-GWR baseline data; Year 5 in the model reflects baseline conditions immediately prior to the effective date of the RTCR; and Years 6 – 30 represent a period of 25 years after monitoring begins under the RTCR.

[1]Number of Non-Disinfecting GWR Systems with an *E. coli* + remaining as Non-Disinfecting Systems.

[2]Number of Non-Disinfecting GWR Systems with an *E. coli* + changing to Disinfecting Systems.

Exhibit 5.16 Ground Water Community Water System (Serving ≤ 4,100) TC Occurrence

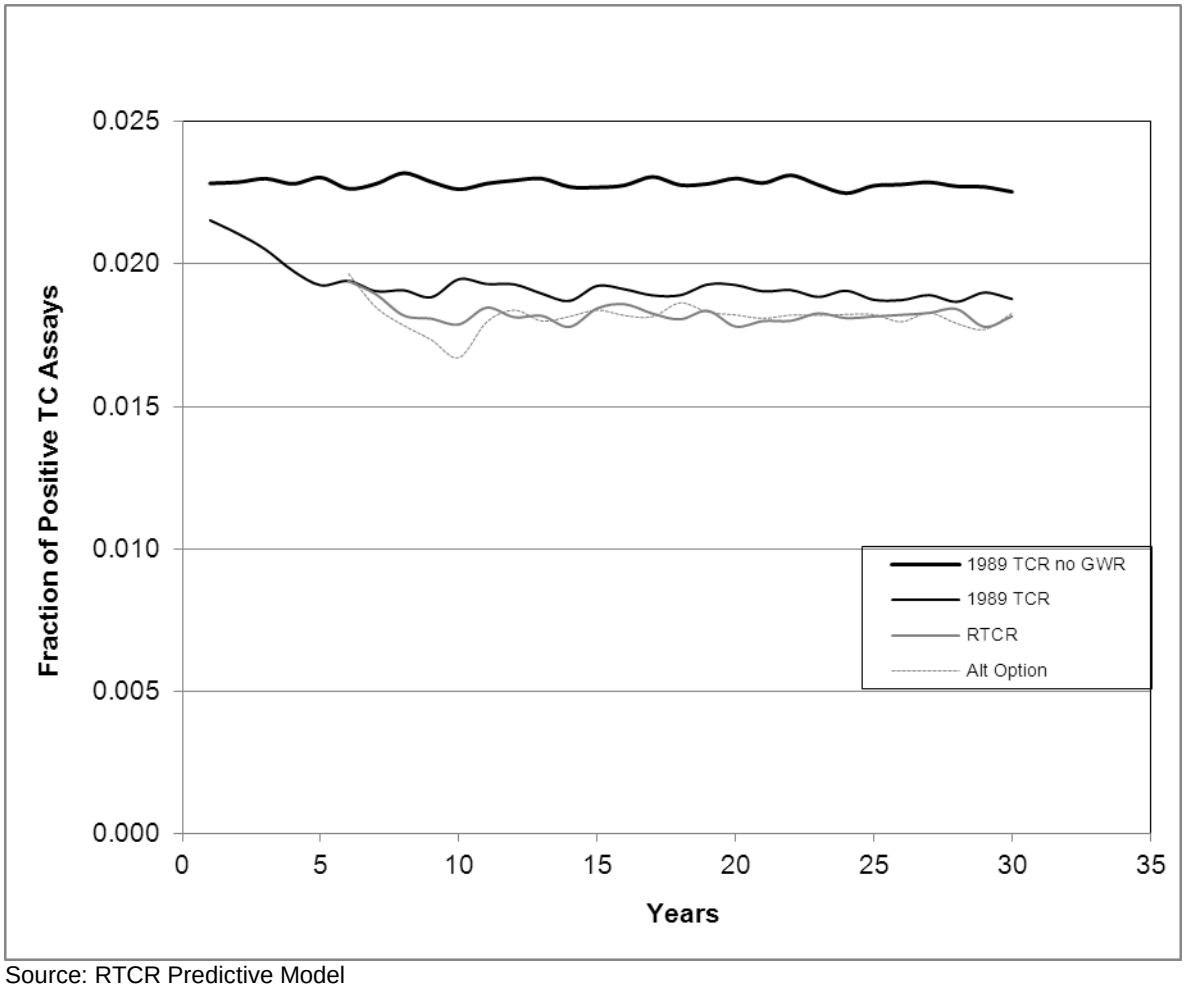


Source: RTCR Predictive Model

Notes:

1) 1989 TCR No GWR: Represents the predicted TC occurrence, absent the effects of GWR implementation, under the 1989 TCR requirements.
2) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements, including the effects of GWR implementation.
3) RTCR: Represents the projected TC occurrence under RTCR requirements, including the effects of GWR implementation.
4) Alt Option: Represents the projected TC occurrence under the Alternative option requirements, including the effects of GWR implementation.
5) Steady state: By Year 11, all systems that qualify for reduced monitoring during their assessment period (Section 5.3.2.2) have moved to their reduced sampling schedule under the RTCR and Alternative option. This period in the model (from years 11–30) reflects a steady state with regard to proportions of systems sampling on monthly, quarterly, or annual regimens.

Exhibit 5.17 Ground Water Nontransient Noncommunity Water System (Serving ≤ 4,100) TC Occurrence

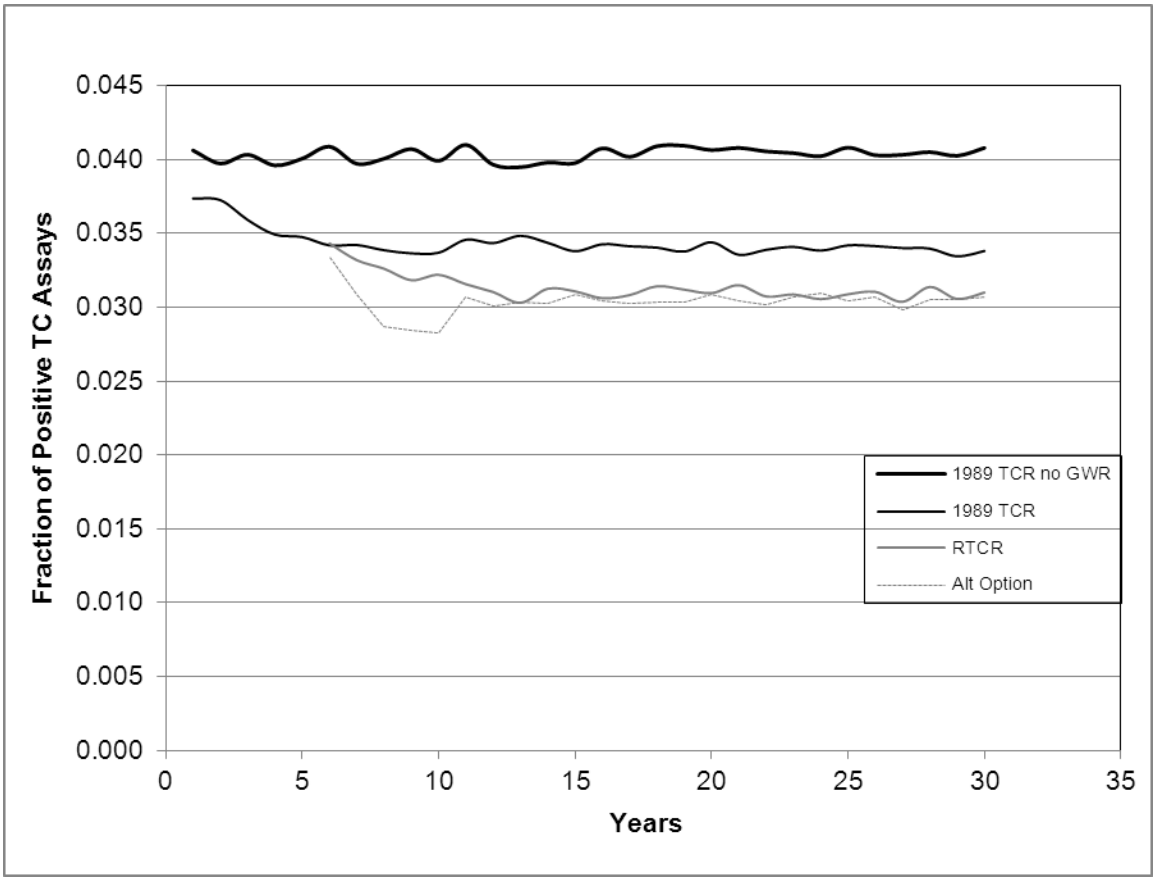


Source: RTCR Predictive Model

Notes:

1) 1989 TCR No GWR: Represents the predicted TC occurrence, absent the effects of GWR implementation, under the 1989 TCR requirements.
2) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements, including the effects of GWR implementation.
3) RTCR: Represents the projected TC occurrence under RTCR requirements, including the effects of GWR implementation.
4) Alt Option: Represents the projected TC occurrence under the Alternative option requirements, including the effects of GWR implementation.
5) Steady state: By Year 11, all systems that qualify for reduced monitoring during their assessment period (Section 5.3.2.2) have moved to their reduced sampling schedule under the RTCR and Alternative option. This period in the model (from years 11–30) reflects a steady state with regard to proportions of systems sampling on monthly, quarterly, or annual regimens.

Exhibit 5.18 Ground Water Transient Noncommunity Water System (Serving ≤ 4,100) TC Occurrence

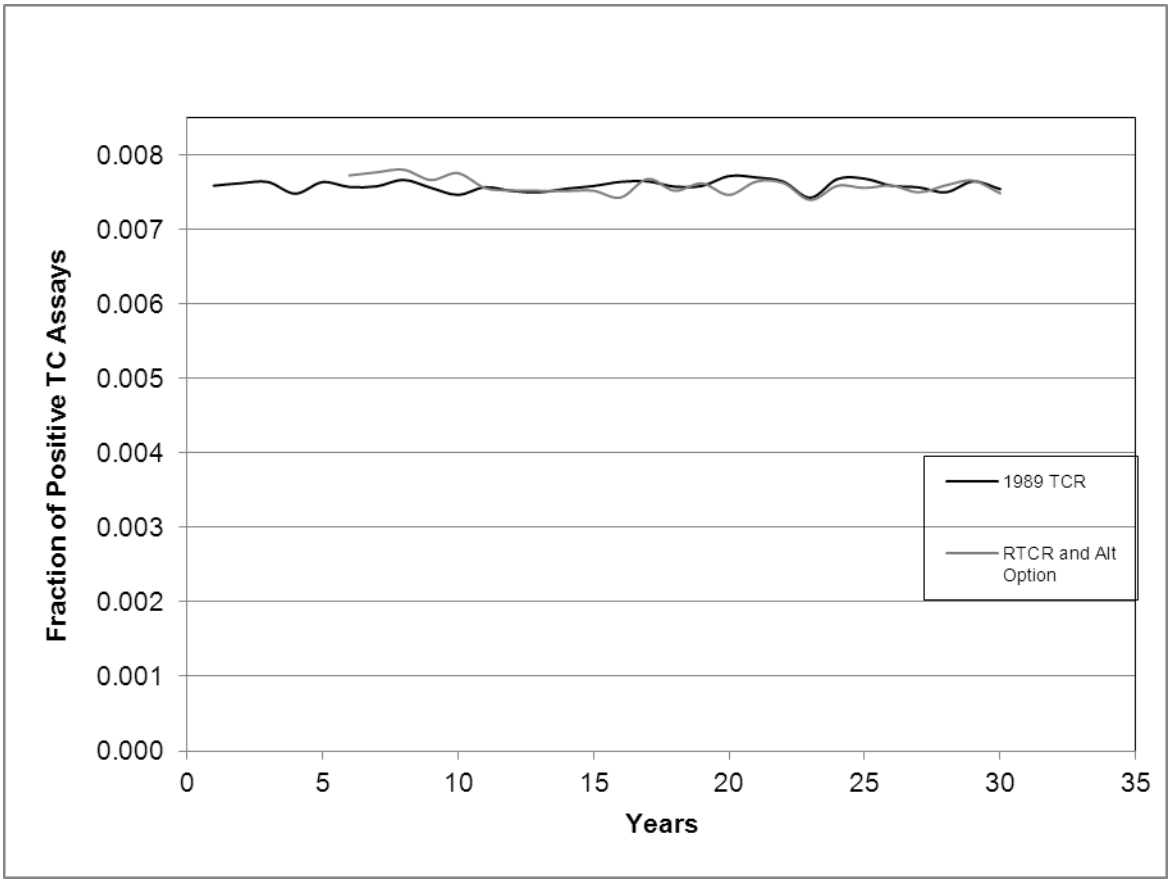


Source: RTCR Predictive Model

Notes:

1) 1989 TCR No GWR: Represents the predicted TC occurrence, absent the effects of GWR implementation, under the 1989 TCR requirements.
2) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements, including the effects of GWR implementation.
3) RTCR: Represents the projected TC occurrence under RTCR requirements, including the effects of GWR implementation.
4) Alt Option: Represents the projected TC occurrence under the Alternative option requirements, including the effects of GWR implementation.
5) Steady state: By Year 11, all systems that qualify for reduced monitoring during their assessment period (Section 5.3.2.2) have moved to their reduced sampling schedule under the RTCR and Alternative option. This period in the model (from years 11–30) reflects a steady state with regard to proportions of systems sampling on monthly, quarterly, or annual regimens.

Exhibit 5.19 Surface Water Community Water System (Serving ≤ 4,100) TC Occurrence

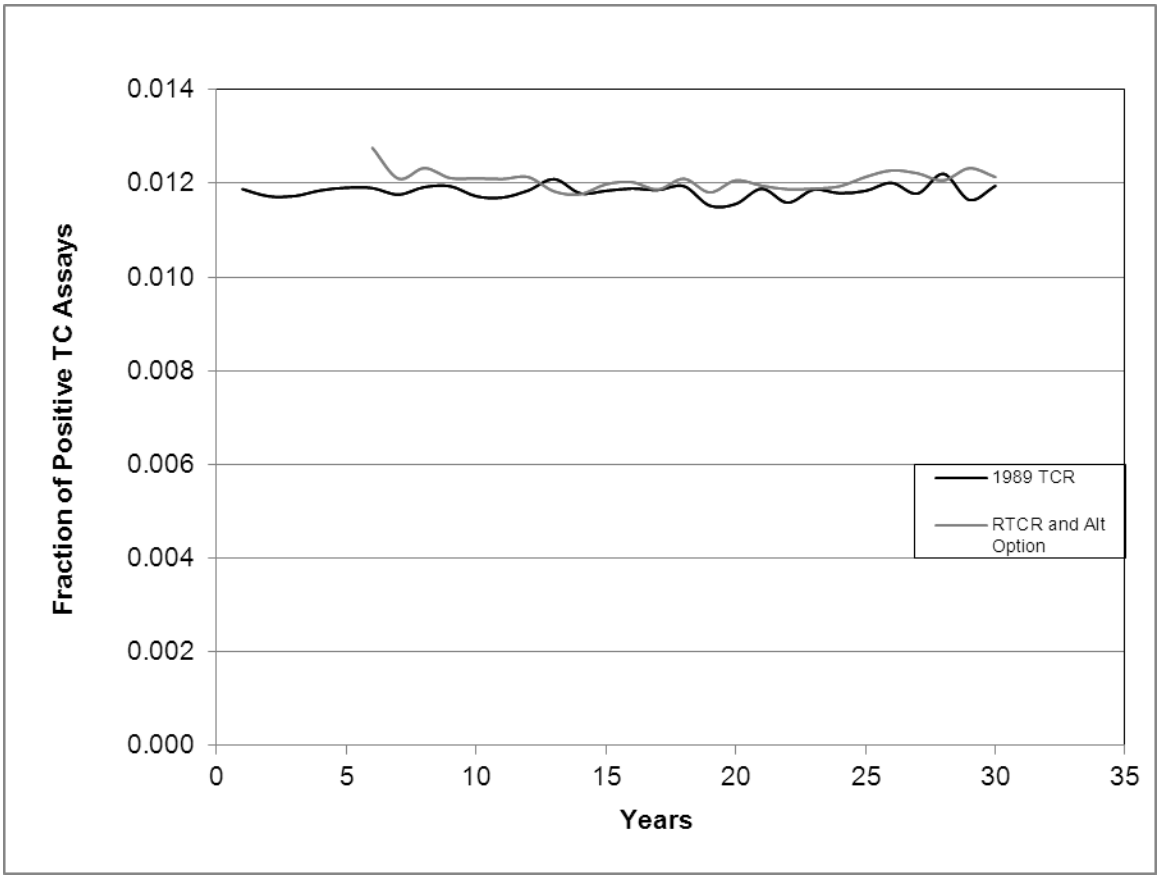


Source: RTCR Predictive Model

Notes:

1) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements.
2) RTCR and Alt Option: Represents the projected TC occurrence under the RTCR and Alternative option, which have the same requirements for SW systems, resulting in the same TC occurrence under the two options.

Exhibit 5.20 Surface Water Nontransient Noncommunity Water System (Serving ≤ 4,100) TC Occurrence

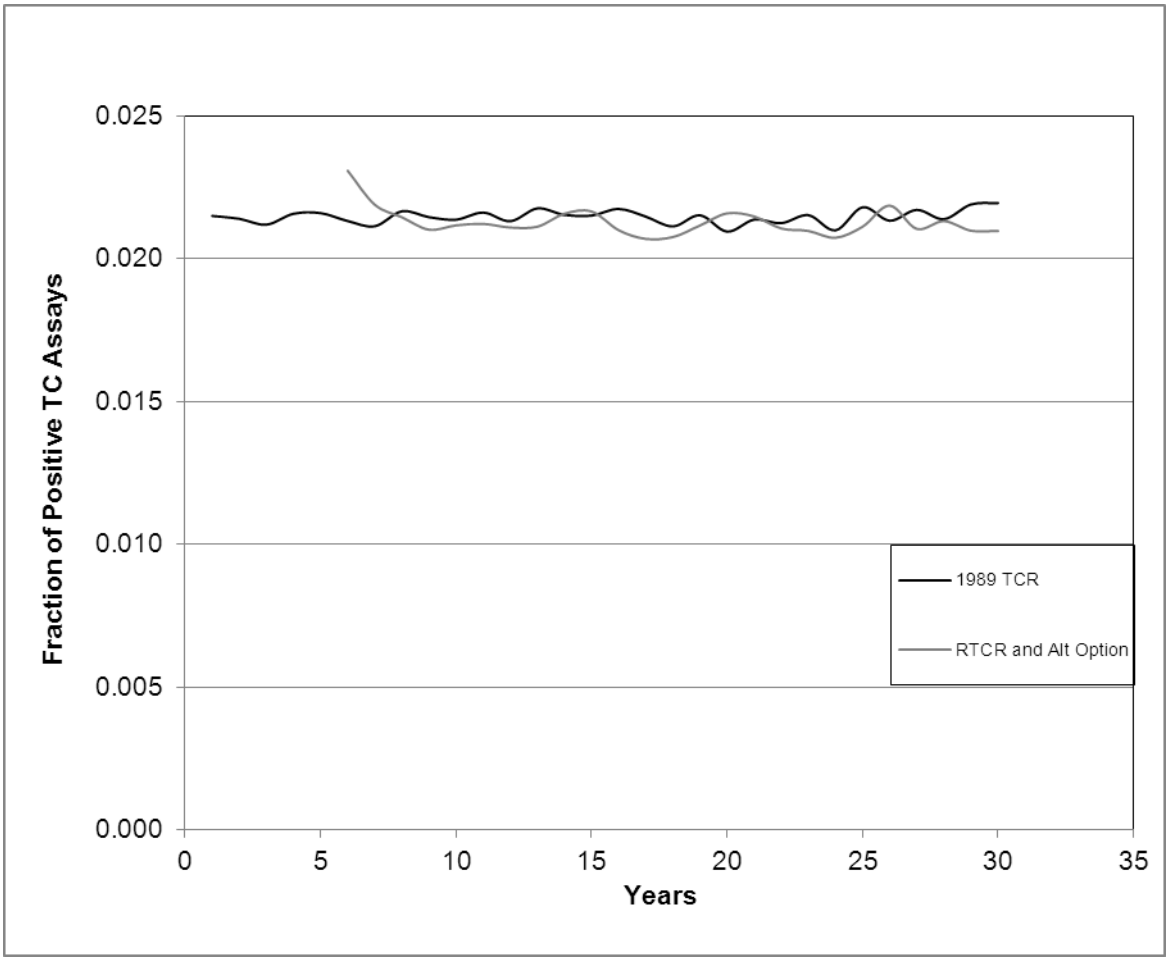


Source: RTCR Predictive Model

Notes:

1) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements, which compose the baseline regulatory option for the RTCR EA.
2) RTCR and Alt Option: Represents the projected TC occurrence under the RTCR and Alternative option, which have the same requirements for SW systems, resulting in the same TC occurrence under the two options.

Exhibit 5.21 Surface Water Transient Noncommunity Water System (Serving ≤ 4,100) TC Occurrence



Source: RTCR Predictive Model

Notes:

1) 1989 TCR: Represents the projected TC occurrence under the 1989 TCR requirements.
2) RTCR and Alt Option: Represents the projected TC occurrence under the RTCR and Alternative option, which have the same requirements for SW systems, resulting in the same TC occurrence under the two options.

5.3.3.1 Uncertainty and Sensitivity Analysis in Occurrence Modeling

There are two primary sources of uncertainty in the RTCR occurrence modeling: uncertainty related to the baseline occurrence model due to the limited data on which the model is based, and uncertainty regarding the frequency and effectiveness of corrective actions and their effects on subsequent TC and EC occurrence.

Data limitations in part derive from a lack of observed data on the effects of the requirements of the GWR, for which implementation began as of December 2009. In the absence of this data, EPA made assumptions regarding the effectiveness of each of the relevant requirements, as described in Section 5.3.1 of this chapter. Each of these assumptions affects the modeled 1989 TCR, which is the baseline for this EA. The predictive model uses this same baseline (1989 TCR) in determining the net influence of both the RTCR and Alternative option requirements on occurrence. Therefore, although the actual reductions in occurrence resulting from GWR implementation may differ from the assumptions used in this model, this difference would likely not affect the net results of the RTCR and Alternative option relative to the 1989 TCR, or their performance relative to each other. Other data limitations are discussed in Section 4.2 of this EA.

Many other assumptions incorporated into the predictive model also have no net effect on results. More generally, assumptions that contribute to uncertainty in the predictive model results can be separated into two categories: those that have no net effect on results and those that may bias results downward or upward. Exhibit 5.22a below presents assumptions that influence the baseline (1989 TCR) and the RTCR and Alternative option in the same way, and therefore are expected to have no significant effect on net results. Exhibit 5.22b presents those assumptions that may have a significant effect on net results because they influence only the RTCR and Alternative option, but not the 1989 TCR. Exhibits 5.22a and 5.22b also include EPA's best estimate of whether the assumption would tend to overestimate, underestimate, or have an unknown impact.

Based on a lack of empirical data, EPA did not include in the model an estimate for the number of systems that might be required to return to more frequent monitoring after having been operating on a reduced schedule. A result of more frequent monitoring when combined with assessments and corrective actions as required under the RTCR (or Alternative option), as described elsewhere in this chapter, is expected to be an increase in TC and EC hits, and a corresponding increase in assessments and corrective actions, resulting in improved water quality. EPA expects that the result of not accounting for movement of systems back to a more rigorous monitoring schedule will tend to underestimate benefits and costs for the RTCR and Alternative option relative to the 1989 TCR. It may have more of an impact on net results for the RTCR than for the Alternative option because the RTCR is expected to have a larger proportion of systems on more reduced monitoring.

Exhibit 5.22a Summary of Model Parameters Influencing 1989 TCR, RTCR, and Alternative Option

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Distribution of systems across sampling frequency categories (M/Q/A) following implementation of GWR sanitary surveys prior to RTCR implementation	Varies per system category as shown in Ex. 5.9a	5.3.2.2	Variability, Uncertainty			X			X
Alpha, beta parameters developed as model inputs describing distribution of occurrence based on Six Year Review 2 Data (conducted in 2005)	Varies per system category as shown in Ex. 5.5–5.6	Appendix F	Variability, Uncertainty			X			X
P_{well}—the portion of ground water systems having viral pathogens in their source waters (adopted from GWR EA)	21.58 percent	5.3.1	Constant, Uncertainty			X			X
P_{sample}—the probability that a random sample will test positive for viral pathogens given a contaminated source water (adopted from GWR EA)	Variable drawn from a beta distribution with a range of alpha and beta estimates having a median value of 5.8 percent and an expected value of 12.4 percent.	5.3.1	Variability, Uncertainty			X			X

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Reduced occurrence for sanitary surveys performed under the GWR.	90 percent of baseline occurrence; applied to equal number of systems annually over the sanitary survey cycle (20 percent each year of 5 years for CWSs; 33.3 percent each year for 3 years for NCWSs)	5.3.1	Constant, Uncertainty			X			X
Reduced occurrence for GWR compliance monitoring (applies to subset of GW systems that disinfect).	90 percent of baseline occurrence	5.3.1	Constant, Uncertainty			X			X
Percentage of nondisinfecting GW systems choosing disinfection corrective action vs. nondisinfection corrective action in response to source water quality issue (adopted from GWR)	Range: High end is the percentage of CWS entry points employing disinfection by system size, low end assumed to be 10 percent based on discussions with state representatives.	5.3.1	Constant, Uncertainty			X			X
Seasonal variation in TC occurrence.	TC occurrence is constant over the course of the year.	5.3.3.1	Variability, Uncertainty			X			X

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
RTTC rate in the months following TC+ not resulting in corrective action	RTTC rate will change to reflect either worsening of the problem or improvement based on actions taken (other than the corrective actions being considered). This was modeled by selecting at random a different pRTTC value.	5.3.2.2	Variability, Uncertainty			X			X

Note: For variables or factors that were incorporated into the predictive model in the same way for the 1989 TCR (baseline option) and the other two regulatory options considered in this EA (RTCR and Alternative Option), EPA expects that any under- or overestimation would affect the baseline and other options equally, resulting in no net effect on the results of the analysis.

Exhibit 5.22b Summary of Model Parameters Influencing RTCR and Alternative option Only

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Percentage of systems implementing an Effective corrective action after a Level 1 or Level 2 Assessment	10 percent	5.3.3.1	Constant, Uncertainty	X			X		
Occurrence immediately following corrective action implementation for period of 3 or 5 years (Level 1 and 2, respectively) (or nondisinfecting GW systems choosing a nondisinfection corrective action)	0 percent	5.3.3.1	Constant, Uncertainty		X		X		
Duration of initial phase of reduced occurrence (0 percent) following corrective action implementation	Remainder of year + 1 or 2 years (Level 1 and 2, respectively)	5.3.3.1	Constant, Uncertainty			X			X
Occurrence in second phase following corrective action implementation (after initial phase of 0 percent occurrence)	50 percent or 25 percent of baseline occurrence (Level 1 and 2, respectively)	5.3.3.1	Constant, Uncertainty			X			X
Duration of reduced occurrence in second phase following corrective action implementation	3 or 5 years (Level 1 and 2, respectively)	5.3.3.1	Constant, Uncertainty			X			X

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
Duration of reduced occurrence (0 percent) in initial phase following corrective action implementation (applies to nondisinfecting GW systems choosing nondisinfecting corrective action)	Remainder of year + 2 years	5.3.3.1	Constant, Uncertainty			X			X
Occurrence in second phase following corrective action implementation (after initial phase of 0 percent occurrence) (applies to nondisinfecting GW systems choosing nondisinfecting corrective action)	25 percent of baseline occurrence	5.3.1	Constant, Uncertainty			X			X
Duration of reduced occurrence in second phase following corrective action implementation (applies to nondisinfecting GW systems choosing nondisinfecting corrective action)	5 years	5.3.2.2	Constant, Uncertainty			X			X

Model Parameter	Current Assumption	Section with Full Discussion	Contributes Variability, Uncertainty, or Constant?	Most Likely Effect on Benefits[1]			Most Likely Effect on Costs[1]		
				Underestimate	Overestimate	Unknown Impact	Underestimate	Overestimate	Unknown Impact
For systems serving more than 4,100 people: Application of a rate that varies by type of system and water source but is held constant through time (does not change over the 25 years of analysis)	These groups incur the same number of violations annually throughout the analysis (i.e., no reduction in violations in the years immediately following corrective action). The number of violations is used to calculate the number of Level 1 and Level 2 assessments and corrective actions by PWS category that systems will implement under the 1989 TCR, RTCR, and Alternative option.	5.4.3	Variability, Uncertainty			X			X

Note: For variables and factors that affect the options considered (RTCR and Alternative option) but do not have a parallel influence on the 1989 TCR (baseline), EPA expects that any under- or over-estimation will have an effect as noted in the above exhibit on the net results for the RTCR or Alternative option.

Key Factors Driving Analysis Uncertainty

The remainder of this section focuses on those assumptions identified in Exhibit 5.22b as contributing the most uncertainty to the net results of the analysis: the frequency and effectiveness of corrective actions (i.e., percent reduction in occurrence and duration of reduction period resulting from corrective actions) applied in the predictive model. These are the key drivers in determining net results, that is, the difference between the RTCR or Alternative option and the 1989 TCR.

As described previously in Section 5.3, EPA incorporated the following assumptions for the frequency and effectiveness of the corrective actions that systems will implement following a Level 1 or a Level 2 assessment:

Level 1: Following a Level 1 Assessment in a particular year, 10 percent of the systems performing the assessment will implement corrective actions that will reduce the TC and EC occurrence levels to 0 percent for the remainder of that year and for 1 full year after that. Then, for an additional 3 full years, the TC and EC occurrence levels for each of these systems will be reduced to 50 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values.

Level 2: Following a Level 2 Assessment in a particular year, 10 percent of the systems performing the assessment will implement corrective actions that will reduce the TC and EC occurrence levels to 0 percent for the remainder of that year and for 2 full years after that. Then, for an additional 5 full years, the TC and EC occurrence levels for each of these systems will be reduced to 25 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values.

Also, for the nondisinfecting GW systems that are found in the simulation to have an EC+ in their source water but do not move to disinfection, the assumptions for the effectiveness of the nondisinfecting corrective actions are identical to those above for Level 2 corrective actions. (However, note that all nondisinfecting systems that discover EC+ source water that do not go to disinfection will implement these corrective actions (under GWR), not just 10 percent as assumed for systems that already disinfect.)

To assess the influence of these assumptions on the model results, EPA ran the model with alternative assumptions reflecting corrective actions that are less effective (50 percent of the assumption of efficacy in the primary analysis in this EA) and corrective actions that are more effective (2x the assumption of efficacy in the primary analysis). The assumptions made in the primary analysis, and the alternative assumptions made in this sensitivity analysis, do not represent a sum of the effectiveness of all individual corrective actions, but indicate the average frequency across all systems with which a given system will correctly diagnose and effectively implement a corrective action, mitigating the source of the problem. The alternative assumptions assume this frequency will be half or twice that used in the primary analysis. Using these alternative assumptions, key model outputs that can serve as proxy indicators of the costs and benefits of the RTCR were compared with those same outputs from the main model assumptions for the RTCR.

For the less effective corrective actions, the alternative assumptions for Level 1 and Level 2 are:

Level 1: Following a Level 1 Assessment in a particular year, 5 percent of the systems performing the assessment will implement corrective actions that reduce the TC and EC occurrence levels to 0 percent for the remainder of that year only. Then, for an additional 2 full years, the TC and EC occurrence levels for each of these systems will be reduced to 50 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values.

Level 2: Following a Level 2 Assessment in a particular year, 5 percent of the systems performing the assessment will implement a corrective action that will reduce the TC and EC occurrence levels to 0 percent for the remainder of that year and for 1 full year after that. Then, for an additional 3 full years, the TC and EC occurrence levels for that system will be reduced to 25 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values. (These alternative Level 2 durations were also applied to the nondisinfecting GWR corrective actions.)

For the more effective corrective actions, the alternative assumptions for Level 1 and Level 2 are:

Level 1: Following a Level 1 Assessment in a particular year, 20 percent of the systems performing the assessment will implement corrective actions that will reduce the TC and EC occurrence levels to 0 percent for the remainder of that year and for two full years after that. Then, for an additional 6 full years, the TC and EC occurrence levels for that system will be reduced to 50 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values.

Level 2: Following a Level 2 Assessment in a particular year, 20 percent of the systems performing the assessment will implement corrective actions that will reduce the TC and EC occurrence levels to 0 percent for the remainder of that year and for 4 full years after that. Then, for an additional 10 full years, the TC and EC occurrence levels for that system will be reduced to 25 percent of their initial values. After that, the TC and EC occurrence levels return to their initial values. (Again, these alternative Level 2 durations were also applied to the nondisinfecting GWR corrective actions.)

A summary of the assumptions used in these alternative sensitivity analyses is provided in Exhibit 5.23. The analyses were run in the predictive model for the RTCR for the approximately 60,000 nondisinfecting GW TNCWSs serving ≤500 people. This subgroup contains the largest number of systems and has on average the largest number of violations of all subgroups. This subgroup may experience the largest change in activity under the RTCR because, unlike the larger systems that have more resources at their disposal, these systems are not generally going beyond requirements of the 1989 TCR, and generally have less frequent requirements for sampling under the 1989 TCR than the larger systems. To conduct the sensitivity analysis described in this section, EPA applied to the predictive model the alternative assumptions that are presented in Exhibit 5.23 along with assumptions applied in the primary analysis for comparison.

Exhibit 5.23 Sensitivity Analysis Assumptions for Frequency and Effectiveness of Corrective Actions following Level 1 or 2 Assessments

	Type of Assessment	% Performing Corrective Action after a Level 1 or Level 2[1] Assessment	Reduced hit rate Immediately after Corrective Action	Period of time for reduced hit rate[2]	Additional period of reduced hit rate (yrs)	Reduction from initial hit rate in additional reduced period
Predictive Model	Level 1	10%	0%	Remainder + 1	3	50%
	Level 2	10%	0%	Remainder + 2	5	25%
Sensitivity 1 - Less Effective	Level 1	5%	0%	Remainder only	2	50%
	Level 2	5%	0%	Remainder + 1	3	25%
Sensitivity 2 - More effective	Level 1	20%	0%	Remainder + 2	6	50%
	Level 2	20%	0%	Remainder + 4	10	25%

Notes:
1. Level 2 assumptions for the predictive model and sensitivity analyses are also applied to 100% of nondisinfecting ground water systems that incur an EC+ in the source water and implement a nondisinfecting corrective action.
2. "Remainder" refers to the balance of the year following implementation of a corrective action.

Exhibit 5.24a Cumulative Effect of Alternative Assumptions for Corrective Action (CA) Effectiveness and Duration on RTCR Model Results (Nondisinfecting TNCWS Serving ≤500 People over 25 Years)

Corrective Actions Assumption	Model Output											
	RTTC+	RTTC+ as rate	RPTC+	RTEC+	RPEC+	GWR EC +	Nonacutes	Acutes	L1 Assmt	L2 Assmt	L1 CA	L2 CA
Low CAs[1]	300,209	3.81%	204,124	11,585	6,613	3,364	104,161	9,162	68,941	48,658	3,539	2,395
RTCR[2]	277,776	3.55%	174,200	9,937	5,038	2,906	90,389	7,170	64,275	36,090	6,448	3,671
High CAs[3]	240,248	3.11%	124,822	8,271	3,942	2,240	67,662	5,352	53,823	20,710	10,664	3,918
50% Option[4]	229,270	2.97%	110,839	7,887	3,225	2,641	61,424	4,534	53,896	12,506	27,227	6,288
	% Change from RTCR											
Low CAs[1]	8.1%	7.42%	17.2%	16.6%	31.2%	15.8%	15.2%	27.8%	7.3%	34.8%	-45.1%	-34.7%
High CAs[3]	-13.5%	-12.43%	-28.3%	-16.8%	-21.8%	-22.9%	-25.1%	-25.4%	-16.3%	-42.6%	65.4%	6.7%
50% Option[4]	-17.5%	-16.22%	-36.4%	-20.6%	-36.0%	-9.1%	-32.0%	-36.8%	-16.1%	-65.3%	322.3%	71.3%
	Relative Change											
Low CAs[1]	1.08	1.08	1.17	1.17	1.31	1.16	1.15	1.28	1.07	1.35	0.55	0.65
High CAs[3]	0.86	0.83	0.72	0.83	0.78	0.77	0.75	0.75	0.84	0.57	1.65	1.07
50% Option[4]	0.83	0.77	0.64	0.79	0.64	0.91	0.68	0.63	0.84	0.35	4.22	1.71

Notes:
1. "Low CAs" uses half of the primary analysis estimate, or 5% incremental increase in CAs beyond the 1989 TCR (50% decrease in the assumption).
2. "RTCR" refers to the RTCR under assumptions used in the primary analysis, which includes an assumption that 10% more CAs addressing the root cause of a TC/EC event will be implemented than under the 1989 TCR (0% change in the assumption).
3. "High CAs" doubles the primary analysis CAs estimate from 10% to 20% (100% increase in the assumption).
4. "50% option" uses a CAs estimate of 50% instead of the primary analysis assumption of 10% (500% increase in the assumption).
Cumulative effects shown in this exhibit are based on application in the predictive occurrence model of the alternative assumptions for frequency and effectiveness of corrective actions following Level 1 or 2 Assessments, as presented in Ex. 5.23. The effectiveness of corrective actions is based both on the effectiveness of the Level 1 or Level 2 assessments performed in diagnosing the correct system deficiency(ies) and upon the effectiveness of implementation of the intended corrective action.

As expected, the results of these runs indicate that the less frequent and less effective corrective action assumptions result in more TC+ and EC+ samples and having more non-acute and acute events than the main assumptions. In addition, more L1 and L2 assessments are conducted in response to those additional events, but fewer corrective actions are performed.

Conversely, the more frequent and more effective corrective action assumptions lead to fewer TC+, EC+, non-acute, and acute events occurring and more L1 and L2 corrective actions being performed.

The fewer number of TC+, EC+, non-acute and acute events occurring with the more effective corrective action assumptions relative to the main assumptions can be viewed as events that are prevented from occurring as a result of those more effective actions relative to the main assumptions. Similarly, the increased number of those events occurring with the less effective corrective actions can be viewed as those that would not be prevented relative to the main assumptions.

It is important to note that this sensitivity analysis is not intended as a rigorous, quantitative comparison of the regulatory options, but rather as a general indicator of the magnitude and direction of change in these outputs relative to inputs. Broadly speaking, since the sensitivity analysis input assumptions reflect changes that are approximately one half and two times the main analysis input assumptions, sensitivity analysis outputs that are substantially less than half or significantly greater than two times the main analysis outputs could be considered to be very sensitive to the changes in the input assumptions. Sensitivity analysis outputs that are between one half and twice the main analysis outputs can be considered to be much less sensitive to changes in the input assumptions. Note, if the ratio of the outputs from the sensitivity analysis to the main analysis is approximately one, it suggests that the outputs of the sensitivity analysis are not sensitive to changes in the input assumptions.

As indicated in Exhibit 5.24b, all of the ratios for outputs fall within the 0.5 to 2.0 range, indicating that these outputs do not appear to be highly sensitive to these alternative assumptions for corrective action effectiveness.

The outputs that could serve as indicators of the sensitivity of the benefits to these assumptions are the numbers of TC+ and EC+ results predicted as well as the number of non-acute and acute events predicted. These outputs have factors that generally fall well within the 0.5 to 2.0 range, indicating that these changes in the inputs assumptions appear to result in relatively small changes in these outputs. That is, the less effective corrective action assumptions do not appear to result in missing a disproportionately greater number of these events, and the more effective corrective actions appear to result in finding a disproportionately greater number of these events.

The outputs that could serve as indicators of the sensitivity of the costs on these assumptions are the Level 1 and Level 2 assessments and the Level 1 and Level 2 corrective actions. The assessments have ratios that, like those for the outputs like TC+ and EC+, are generally well within the 0.5 to 2.0 range. The ratios for the corrective actions are also within this range but tend to be close to the 0.5 and 2.0 values. The input assumptions used for the number of corrective actions done is directly proportional to the number of assessments

performed, so these changes would be expected to be more directly linear (closer to 0.5 or 2.0). For example, using the more effective corrective action assumptions, the number of TC+ samples predicted is reduced, as are the number of Level 1 assessments that are related to TC+ events. The ratio for Level 1 assessments under the more effective corrective action assumptions is 0.84, indicating that under these assumptions systems will only need to perform about 85 percent of the Level 1 assessments over the 25-year period (that is, the others are prevented by the more effective actions). However, this set of alternative assumptions includes a factor that 20 percent of those doing Level 1 assessments go on to do Level 1 corrective actions (which is twice the 10 percent assumption in the main model). Therefore, we see that almost twice as many of these Level 1 corrective actions are performed as under the main model. More specifically, the ratio for Level 1 corrective actions is 1.65 which is approximately two times the 0.84 ratio noted for Level 1 assessment predicted.

An additional analysis was run to test the model's sensitivity to the primary analysis assumption that 10 percent more corrective actions addressing the root cause of a TC/EC event will be implemented than under the 1989 TCR. The additional sensitivity analysis investigates the implications of a much greater rate of corrective action implementation—50 percent rather than 10 percent, or a 400 percent increase from the primary analysis assumption. All other parameters in this sensitivity test, including the effectiveness and duration of the corrective actions, are identical to those of the RTCR primary analysis.

Exhibit 5.24b Cumulative Effect of 50 percent Assumption for Corrective Action Implementation Rate on RTCR Model Results (Nondisinfecting TNCWS Serving ≤500 People over 25 Years)

Corrective Actions Assumption	Model Output											
	RTTC+	RTTC+ as rate	RPTC+	RTEC+	RPEC+	GWR EC +	Nonacutes	Acutes	L1 Assmt	L2 Assmt	L1 CA	L2 CA
RTCR[1]	277,776	3.55%	174,200	9,937	5,038	2,906	90,389	7,170	64,275	36,090	6,448	3,671
50% Option[2]	229,270	2.97%	110,839	7,887	3,225	2,641	61,424	4,534	53,896	12,506	27,227	6,288
% Change from RTCR												
50% Option[2]	-17.5%	-16.22%	-36.4%	-20.6%	-36.0%	-9.1%	-32.0%	-36.8%	-16.1%	-65.3%	322.3%	71.3%
Relative Change												
50% Option[2]	0.83	0.77	0.64	0.79	0.64	0.91	0.68	0.63	0.84	0.35	4.22	1.71

Notes:
1. "RTCR" refers to the RTCR under assumptions used in the primary analysis, which includes an assumption that 10% more CAs addressing the root cause of a TC/EC event will be implemented than under the 1989 TCR (0% change in the assumption).
2. "50% option" uses a CAs estimate of 50% instead of the primary analysis assumption of 10% (500% increase in the assumption).

As might be expected, this modification causes rates of Level 1 and Level 2 corrective actions to increase. This in turn decreases the RTTC+ rate and other levels of occurrence, including the number of Level 1 and Level 2 assessments. It is interesting to note that the rate of Level 1 corrective actions increases much more dramatically than the rate of Level 2 corrective actions. One possible explanation for this is that with the higher corrective action implementation rate, more systems move to a reduced TC occurrence level during the first years of RTCR. Thereafter these systems are more likely to trigger Level 1 assessments than Level 2 assessments, causing the ratio of Level 1 corrective actions to Level 2 corrective actions to shift substantially from that predicted in the primary analysis.

Since this analysis involves changing a parameter by a factor of five, changes in model output greater than a factor of five would indicate a high degree of sensitivity to the parameter.

In the table it is evident that no changes on that scale occur. Nonetheless, the analysis does indicate that an increase in the rate of implementation of corrective actions would reduce the long-run incidence of TC/EC events and that it would increase the number of Level 1 corrective actions more dramatically than it would increase the number of Level 2 corrective actions.

Additional Factors Assessed

As described in the introduction to this section, there were assumptions in addition to the frequency and effectiveness of corrective actions that EPA considered might influence the analysis. These assumptions were categorized as those that were unlikely to have an impact on net results (5.22a), and those that affected the RTCR and Alternative option differently than the 1989 TCR (5.22b), thus having the potential to impact net results.

Because the effect of seasonality on occurrence is commonly a concern when using annual average occurrence rates in an analysis, and because RTTC occurrence rates were found to be twice as high in the summer and fall as in the winter and spring, EPA ran a sensitivity analysis on the influence of seasonal trends. This analysis was performed on the subset including transient nondisinfecting ground water systems serving fewer than 101 people because of its relatively large number of systems and high occurrence rate. For simplicity, the sensitivity analysis was limited to only the RTCR.

EPA performed the sensitivity analysis through two runs of the RTCR model. The first run established a baseline, and the second multiplied the assigned baseline pRTTC values by a factor of 0.67 during December–May and by a factor of 1.33 during June–November. (No seasonality factors were applied for systems on annual sampling.)

Summary results in Table 5.25 show expected yearly averages for selected occurrence metrics during the first 25 years under full implementation of the RTCR. Overall the differences between the model results are small. Also, they are not consistently higher for one model (e.g., when accounting for seasonality, total TC occurrence is slightly lower but the number of acutes is slightly higher). These variations are likely within the range of Monte Carlo error. Therefore, EPA determined that not incorporating seasonality into the occurrence model is an acceptable simplification.

Exhibit 5.25 Effect of Seasonality on Occurrence Analysis Endpoints

RTCR Metric	No Seasonality	Seasonality
Total TC Positives	8,560	8,556
Total Level 1 Triggers	2,824	2,784
Total Acutes[1]	225	240
L1 Corrective Actions	201	194
L2 Corrective Actions	113	104

Notes:
Estimates represent a yearly average during the first 25 years under full implementation of the RTCR.
1. Includes those Level 2 Triggers resulting from an EC+ (does not include those resulting from a second Level 1 trigger occurring within a 12-month rolling period).

5.3.3.2 Model Validation

There are a limited number of ways in which outputs from the predictive model for the systems serving ≤4,100 people can be compared to observed data. EPA has identified two types of analyses where comparisons can be made. One of these is to compare the model's predictions of average annual TC and EC occurrence levels for various types and sizes of systems under the 1989 TCR against the observations from the 2005 Six-Year Review data used to parameterize the model. The other is to compare the model's predictions for the 1989 TCR against those reported in SDWIS/FED.

It is necessary to keep in mind that the primary purpose of the modeling effort for the systems serving ≤4,100 people was not to exactly match observed results but to provide a framework for comparing relative changes across regulatory options. Nevertheless, it is important that, to the extent possible, the model outputs for conditions that can be checked against observed data compare reasonably well. This provides assurance that the model is operating in a manner that is a reasonable simulation of how the 1989 TCR currently operates and provides some measure of confidence that the relative changes seen for the regulatory options are meaningful.

Exhibit 5.26 provides a comparison of the model results for average annual TC+ assays under the 1989 TCR with those observed in the 2005 Six-Year Review data.

Exhibit 5.26 Comparison of TC+ Occurrence Predicted as a 25-Year Annual Average under the 1989 TCR with 2005 Six-Year Review Data

Population Served	Six Year review		Predictive Model	
	TC (% Positive)	EC (% Positive)	TC (% Positive)	EC (% Positive)
Community Water Systems (CWSs) - SW				
≤100	1.41%	0.09%	1.43%	0.18%
101-500	1.15%	0.05%	0.92%	0.12%
501-1,000	0.70%	0.05%	0.95%	0.13%
1,001-4,100	0.57%	0.03%	0.57%	0.04%
Community Water Systems (CWSs) - GW				
≤100	2.66%	0.08%	2.23%	0.10%
101-500	1.99%	0.05%	1.69%	0.08%
501-1,000	1.52%	0.04%	1.49%	0.07%
1,001-4,100	1.07%	0.02%	0.99%	0.05%
Nontransient, Noncommunity Water Systems (NTNCWSs) - SW				
≤100	1.92%	0.24%	1.43%	0.18%
101-500	0.39%	0.09%	1.08%	0.14%
501-1,000	0.64%	0.00%	1.06%	0.14%
1,001-4,100	0.08%	0.00%	1.03%	0.12%
Nontransient, Noncommunity Water Systems (NTNCWSs) - GW				
≤100	3.17%	0.07%	2.91%	0.14%
101-500	2.70%	0.06%	2.00%	0.10%
501-1,000	1.74%	0.02%	1.86%	0.11%
1,001-4,100	1.35%	0.04%	1.49%	0.09%
Transient, Noncommunity Water Systems (TNCWSs) - SW				
≤100	2.23%	0.25%	2.15%	0.27%
101-500	2.63%	0.46%	2.18%	0.29%
501-1,000	3.63%	0.00%	2.17%	0.29%
1,001-4,100	0.61%	0.00%	2.04%	0.27%
Transient, Noncommunity Water Systems (TNCWSs) - GW				
≤100	4.78%	0.20%	4.17%	0.19%
101-500	4.57%	0.19%	4.04%	0.20%
501-1,000	4.30%	0.06%	3.86%	0.20%
1,001-4,100	2.02%	0.03%	2.09%	0.12%

Source: Derived using 2005 Six-Year Review 2 Data. 1989 TCR data from model output.

The comparison of the predictive model output with the Six-Year data for TC and EC occurrence levels (based on number of TC routine samples taken) shows a reasonable concordance for all types and sizes of systems. With respect to the differences, the model does not appear to be either systematically overestimating or underestimating the occurrence levels compared with the Six-Year Review data (except where the Six-Year Review data show 0 percent observed, the model does show a low level of occurrence).

Exhibit 5.27 provides a comparison of the model results of the average annual non-acute and acute violations for the 1989 TCR with the same metric from SDWIS data for 2005 3rd

quarter. (Violations data are downloaded from SDWIS on an annual basis in 3rd quarter only, and are not disaggregated by month.)

Exhibit 5.27 Comparison of SDWIS Data for Non-acute and Acute Violations with Predictive Model Annual Results for the 1989 TCR

System Size	Non-Acute Violations				Acute Violations			
	GW		SW		GW		SW	
	SDWIS	Predictive Model	SDWIS	Predictive Model	SDWIS	Predictive Model	SDWIS	Predictive Model
CWSs								
≤100	905	955	16	31	52	97	3	7
101-500	809	733	50	34	34	81	7	8
501-1,000	203	191	16	19	13	19	3	5
1,001-4,100	338	347	83	49	12	35	6	7
Total	**2,255**	**2,226**	**165**	**133**	**111**	**231**	**19**	**27**
NTNCWSs								
≤100	514	560	7	7	34	60	2	2
101-500	346	265	4	6	20	30	-	1
501-1,000	57	61	2	2	6	7	-	0
1,001-4,100	62	98	1	3	6	12	-	1
Total	**979**	**985**	**14**	**18**	**66**	**109**	**2**	**4**
TNCWSs								
≤100	2,665	4,109	19	81	278	445	5	19
101-500	833	1,371	11	31	76	156	1	8
501-1,000	133	144	4	5	11	16	-	1
1,001-4,100	58	105	2	9	2	13	-	2
Total	**3,689**	**5,730**	**36**	**126**	**367**	**630**	**6**	**31**
Grand Total	**6,923**	**8,940**	**215**	**277**	**544**	**970**	**27**	**61**

Source: SDWIS 2005 Q3 download and occurrence and predictive model results.
Note: Predictive Model reflects annual average results for model years 16 to 40 without inclusion of the GWR.

The comparison of the predictive model output with the SDWIS violations data also shows a reasonable concordance for all types and sizes of systems. EPA believes there is some under-counting of actual violations in SDWIS due to monitoring and reporting violations, which the model does not incorporate. Therefore, EPA generally expects that the model would generate results that are higher than the observed SDWIS data. While a comparison reveals that some of the model estimates are lower than the SDWIS statistics, the grand totals for the model are consistently higher than those observed in SDWIS.

5.4 Occurrence Analysis for Systems Serving More Than 4,100 People

Systems serving populations greater than 4,100 are similar in many ways. In particular, these systems generally have the resources and are managed in ways that lead to generally high expectations for the integrity of the distribution systems and the ability of the systems to identify and correct problems. Some of these similarities may include:

- Most of these systems operate with certified operators, are staffed at all operating times, and usually operate continuously.
- Most of these systems have operators for whom producing water is their primary activity, and most are owned by communities rather than run as ancillary businesses.
- As a result of the professional operations, these systems have a much lower incidence of monitoring and reporting violations.
- Many of these systems have their own laboratory for analyzing samples.
- Many more of these systems disinfect their water.
- These systems take at least five samples per month. The largest of these systems take hundreds of samples per month. There is no requirement for "additional next month samples" as there is for systems serving ≤4,100 people because systems serving >4,100 people already take at least five samples each month.
- The monitoring frequency changes under the RTCR mostly do not affect systems serving more than 4,100 people; all systems take at least five samples per month.

For systems serving more than 4,100 people, EPA assumes that occurrence may change based on the extra distribution system awareness created by: a) applying the Level 1 and Level 2 assessments in lieu of prior assessments that may, in some cases, have been less structured; and b) reporting the assessment results. Therefore, EPA developed a simple model to predict the effects of the RTCR and Alternative option on PWSs and to compare those data to the baseline data predicted for the 1989 TCR. EPA did not quantify changes in violation or trigger rates for systems serving more than 4,100 people among the 1989 TCR, the RTCR, and Alternative option because of: (1) limited Six-Year Review data to characterize these systems; (2) the essentially unchanged monitoring requirements across options for these systems; and (3) the level of effort already occurring to implement the 1989 TCR.

5.4.1 Model (for Systems Serving >4,100 People)

As input for this model, EPA first considered 2005 data for the 1989 TCR on sampling and positive assays that were compiled under the Six-Year Review, as was incorporated into the model for systems serving ≤4,100 people. However, as discussed in Section 4.2.2.3, detailed sampling results from the Six Year Review data were not representative of the universe of systems serving >4,100 people. EPA instead found that violations data were adequately representative of the universe of systems serving >4,100 people. This input to the model, based on 2005 SDWIS data (see Exhibit 4.10), was used to predict violations that systems serving more than 4,100 people will incur in the 25-year period of RTCR analysis, and the behavioral responses (Level 1 and Level 2 assessments and corrective actions) that would result.

The model uses the same stratification as the model for systems serving ≤4,100 people—by system type (CWS, TNCWS, or NTNCWS) and by water source (SW or GW). For each system in a given category the model applies the 2005 SDWIS violations rate for that category.

This rate is applied in each year of the analysis, that is, the violations rate is a constant in the model. For estimating the effects on violations under the RTCR and Alternative option, the model estimates that 10 percent of the assessments resulting from violations will result in corrective actions, the same value applied in the analysis of the systems serving ≤4,100 people. This 10 percent represents the net increase in efficacy of addressing the root cause of system contamination under the RTCR and Alternative option compared to the 1989 TCR.

Repeat samples are reduced in the model under the RTCR and Alternative option from the 1989 TCR. They are calculated by applying the ratios of repeat samples to routine samples from systems serving 1,001–4,100 people to the systems serving more than 4,100 people.

The model output, shown in Section 5.4.2, includes predictions of the annual number of violations (non-acute = Level 1, acute = Level 2), and the number of Level 1 and Level 2 assessments and corrective actions to be implemented.

5.4.2 Model Results (for Systems Serving >4,100 People)

Exhibits 5.28 through 5.30 present model results for systems serving more than 4,100 people by size category.

5.4.3 Model Uncertainty (for Systems Serving >4,100 People)

As explained in Section 5.4.1 of this chapter, EPA does not expect systems serving >4,100 people to experience changes in routine monitoring or repeat sample regimes under the regulatory options; furthermore, all systems in this size range are on monthly sampling. Therefore, the model for systems serving >4,100 people was relatively simple compared to that for the systems serving ≤4,100 people, and EPA did not develop an uncertainty analysis for this group of systems.

Exhibit 5.28 Results for Systems Serving more than 4,100 People—1989 TCR

PWS Size (Population Served)	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	PWSs Performing Additional Annual Site Inspections	Number of Non-Acute Violation Assessments (Single Violations)	Number of Corrective Actions (based on Single Non-Acute Violation Assessment)	Number of Acute Violation Assessments	Number of Non-Acute Violation Assessments (Multiple Violations)	Number of Corrective Actions (based on Acute and Multiple Non-Acute Violation Assessments)
	A	B	C	D	E	F	G	H	I
Community Water Systems (CWSs) - SW									
4,101-33,000	10,636,296	-	186,729	-	2,152	-	197	-	-
33,001-96,000	11,058,960	-	194,149	-	534	-	56	-	-
96,001-500,000	10,190,400	-	178,901	-	233	-	24	-	-
500,001-1 Million	2,019,600	-	35,456	-	22	-	-	-	-
> 1 Million	1,686,960	-	29,616	-	-	-	-	-	-
Community Water Systems (CWSs) - GW									
4,101-33,000	9,145,224	-	230,201	-	4,545	-	263	-	-
33,001-96,000	4,884,000	-	122,938	-	656	-	53	-	-
96,001-500,000	1,945,680	-	48,976	-	129	-	10	-	-
500,001-1 Million	253,440	-	6,380	-	-	-	-	-	-
> 1 Million	269,280	-	6,778	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - SW									
4,101-33,000	50,424	-	1,628	-	5	-	-	-	-
33,001-96,000	34,320	-	1,108	-	-	-	-	-	-
96,001-500,000	31,680	-	1,023	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - GW									
4,101-33,000	153,648	-	5,936	-	123	-	9	-	-
33,001-96,000	23,760	-	918	-	4	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - SW									
4,101-33,000	40,656	-	-	-	8	-	-	-	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	102,960	-	-	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - GW									
4,101-33,000	156,288	-	8,909	-	116	-	4	-	-
33,001-96,000	34,320	-	1,956	-	-	-	-	-	-
96,001-500,000	26,400	-	1,505	-	-	-	-	-	-
500,001-1 Million	63,360	-	3,612	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-

Source: Appendix A, Exhibit A.1.z.

Note: For modeling purposes, EPA estimated only the net change in the number of corrective actions performed under the RTCR and Alternative option compared to the 1989 TCR. Because only the net change in the number of corrective actions is estimated, no additional corrective actions are modeled for the 1989 TCR (it is assumed that PWSs are already performing some corrective actions under the 1989 TCR).

Exhibit 5.29 Results for Systems Serving more than 4,100 People—RTCR

PWS Size (Population Served)	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	PWSs Performing Additional Annual Site Inspections	Number of Level 1 Assessments	Number of Corrective Actions (based on Level 1 Assessments)	Number of Level 2 Assessments (based on Acute Violations)	Number of Level 2 Assessments (based on Non-Acute Violations)	Number of Corrective Actions (based on Level 2 Assessments)
	A	B	C	D	E	F	G	H	I
Community Water Systems (CWSs) - SW									
4,101-33,000	10,636,296	-	181,661	-	2,152	215	197	-	20
33,001-96,000	11,058,960	-	188,880	-	534	53	56	-	6
96,001-500,000	10,190,400	-	174,046	-	233	23	24	-	2
500,001-1 Million	2,019,600	-	34,493	-	22	2	-	-	-
> 1 Million	1,686,960	-	28,812	-	-	-	-	-	-
Community Water Systems (CWSs) - GW									
4,101-33,000	9,145,224	-	217,321	-	4,545	454	263	-	26
33,001-96,000	4,884,000	-	116,060	-	656	66	53	-	5
96,001-500,000	1,945,680	-	46,236	-	129	13	10	-	1
500,001-1 Million	253,440	-	6,023	-	-	-	-	-	-
> 1 Million	269,280	-	6,399	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - SW									
4,101-33,000	50,424	-	1,448	-	5	0	-	-	-
33,001-96,000	34,320	-	985	-	-	-	-	-	-
96,001-500,000	31,680	-	910	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - GW									
4,101-33,000	153,648	-	5,157	-	123	12	9	-	1
33,001-96,000	23,760	-	797	-	4	0	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - SW									
4,101-33,000	40,656	-	2,225	-	8	1	-	-	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	102,960	-	5,636	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - GW									
4,101-33,000	156,288	-	7,188	-	116	12	4	-	0
33,001-96,000	34,320	-	1,578	-	-	-	-	-	-
96,001-500,000	26,400	-	1,214	-	-	-	-	-	-
500,001-1 Million	63,360	-	2,914	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-

Source: Appendix A, Exhibit A.2.z.

Note: Estimates of the number of assessments and corrective actions are net increases in activity predicted to occur under the RTCR relative to the 1989 TCR; estimates of zero reflect that no additional such activity occurs as compared to baseline (the 1989 TCR).

Exhibit 5.30 Results for Systems Serving more than 4,100 People—Alternative Option

PWS Size (Population Served)	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	PWSs Performing Additional Annual Site Inspections	Number of Level 1 Assessments	Number of Corrective Actions (based on Level 1 Assessments)	Number of Level 2 Assessments (based on Acute Violations)	Number of Level 2 Assessments (based on Non-Acute Violations)	Number of Corrective Actions (based on Level 2 Assessments)
	A	B	C	D	E	F	G	H	I
Community Water Systems (CWSs) - SW									
4,101-33,000	10,636,296	-	181,661	-	2,152	215	197	-	20
33,001-96,000	11,058,960	-	188,880	-	534	53	56	-	6
96,001-500,000	10,190,400	-	174,046	-	233	23	24	-	2
500,001-1 Million	2,019,600	-	34,493	-	22	2	-	-	-
> 1 Million	1,686,960	-	28,812	-	-	-	-	-	-
Community Water Systems (CWSs) - GW									
4,101-33,000	9,145,224	-	217,321	-	4,545	454	263	-	26
33,001-96,000	4,884,000	-	116,060	-	656	66	53	-	5
96,001-500,000	1,945,680	-	46,236	-	129	13	10	-	1
500,001-1 Million	253,440	-	6,023	-	-	-	-	-	-
> 1 Million	269,280	-	6,399	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - SW									
4,101-33,000	50,424	-	1,448	-	5	0	-	-	-
33,001-96,000	34,320	-	985	-	-	-	-	-	-
96,001-500,000	31,680	-	910	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Nontransient Noncommunity Water Systems (NTNCWSs) - GW									
4,101-33,000	153,648	-	5,157	-	123	12	9	-	1
33,001-96,000	23,760	-	797	-	4	0	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - SW									
4,101-33,000	40,656	-	2,225	-	8	1	-	-	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	102,960	-	5,636	-	-	-	-	-	-
Transient Noncommunity Water Systems (TNCWSs) - GW									
4,101-33,000	156,288	-	7,188	-	116	12	4	-	0
33,001-96,000	34,320	-	1,578	-	-	-	-	-	-
96,001-500,000	26,400	-	1,214	-	-	-	-	-	-
500,001-1 Million	63,360	-	2,914	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-

Source: Appendix A, Exhibit A.3.z.

Note: Estimates of the number of assessments and corrective actions are net increases in activity predicted to occur under the Alternative option relative to the 1989 TCR; estimates of zero reflect that no additional such activity occurs as compared to baseline (the 1989 TCR).

5.5 Summary of Key Drivers for Benefit and Cost Analyses Output from the Predictive Model

As presented in Exhibits 5.10–5.15, the model for systems serving ≤4,100 people produces estimates of the number of samples, the number of Level 1 and Level 2 assessments, and the number of corrective actions implemented as a result of Level 1 and Level 2 assessments under each regulatory option. For the RTCR and Alternative option, the model calculates the corrective actions performed as a net increase from those performed under the 1989 TCR. Those corrective actions performed under the 1989 TCR are described in Chapter 7 in the discussion of 1989 TCR costs. The net change in each of the model outputs, in particular sampling regimens and implementation of assessments and corrective actions relative to the 1989 TCR and under the RTCR and Alternative option provides the basis for estimating the benefits in the rule,

described in Chapter 6 of this EA. Similarly, the cost model applies unit costs to the activities described by these outputs to produce net costs for each regulatory option considered, as described in Chapter 7.

As described in the uncertainty discussion and sensitivity analysis presented in Section 5.3.3.1, these key drivers represent the most significant source of uncertainty in the analysis. However, the sensitivity analysis showed that a doubling in the implementation and effectiveness assumptions for corrective actions (the proportional increase in the number of effective corrective actions implemented and the duration and extent of reduced occurrence) implemented under the RTCR would result in only approximately a 25 percent decrease in acute events. Conversely, a 50 percent reduction in corrective action implementation and effectiveness was estimated to induce less than a 28 percent increase in acute events. These results are expected to apply similarly to all categories of systems. Based on these results, EPA concludes that changing the assumptions within the likely range (a doubling or halving of current assumptions) would not have a significant effect on the conclusions drawn from this EA. Similarly, varying the assumptions by size and type of system within a likely range would not be expected to have a significant effect on the results.

For systems serving >4,100 people, the net change in costs is estimated for the additional reporting requirements under the rule, as well as the additional corrective actions implemented for these systems. However, as described in Section 5.4, the sampling regimens are not expected to change for these systems, and they likely would experience minimal changes in risk and cost, as described in Chapter 6 and Chapter 7 of this EA, respectively.

6 Benefits Analysis

6.1 Introduction

This chapter considers the overall change in risk of contamination to public water systems (PWSs), as indicated by the presence of total coliforms (TC) and *E. coli*, associated with compliance with the 1989 Total Coliform Rule (1989 TCR) and with the Revised Total Coliform Rule (RTCR) and the Alternative option. Since *E. coli* is an indicator of fecal contamination (Edberg et al., 2000), EPA assumes that a decrease in *E. coli* occurrence in the distribution system would be associated with a decrease in fecal contamination in the distribution system. In general, this decrease in fecal contamination should reduce the potential risk to human health for PWS customers. Thus, any reduction in *E. coli* occurrence is considered a benefit of the RTCR. Since fecal contamination may contain waterborne pathogens including bacteria, viruses, and parasitic protozoa, in general, a reduction in fecal contamination should reduce the risk from all of these contaminants.

Based on limitations in available data as described further in Section 6.4 of this chapter, EPA determined that benefits could not be calculated in terms of avoided costs or other quantified benefits related to avoided morbidity or mortality. Therefore, this economic analysis (EA) focuses on a qualitative analysis of risk, which is supported by quantitative analysis of predicted outcomes for each regulatory option. The quantitative discussion focuses on net changes in occurrence of contaminant indicators under both regulatory options (RTCR and Alternative option) considered as compared to the 1989 TCR option. The qualitative analysis considers the direction of anticipated changes in risk related to changes in sampling and corrective action regimens under each regulatory option (Section 6.2). EPA considered the results of the qualitative and quantified assessments to determine how the 1989 TCR compares to the RTCR and Alternative option in terms of overall change in risk to the population served by PWSs across the United States. The remainder of this chapter is organized into four sections, as follows:

- **Section 6.2** presents qualitative benefits analyses.
- **Section 6.3** presents an assessment of the predictive analysis results.
- **Section 6.4** presents uncertainty and sensitivity analyses.
- **Section 6.5** discusses other potential benefits.

6.2 Qualitative Benefits Analyses

When revising an existing drinking water regulation, one of the main concerns is to ensure that backsliding on water quality and public health protection does not occur. The Safe Drinking Water Act (SDWA) states that any revision to a regulation must "maintain, or provide for greater protection for the health of persons." Risk reduction for the RTCR is characterized by the activities performed that are presumed to reduce risk of exposing the public to contaminated water. These activities are considered under each rule component discussed in Sections 6.2.1–6.2.8 and summarized in Figure 6.1 below. The discussion in Section 6.2.9 considers how

expected overall increases in the risk for some rule components are offset by expected overall decreases resulting from other components, and provides a net assessment of the direction in change of risk for the regulatory options considered.

The qualitative analysis uses the best professional judgment of EPA as informed by Total Coliform Rule Distribution System Advisory Committee (TCRDSAC) deliberations,[38] as well as certain quantitative estimates, to predict the directional change in risk for each rule component of the RTCR and the Alternative option. Quantitative estimates considered include the changes in TC occurrence and counts of systems conducting assessments and implementing corrective actions shown in Exhibits 6.2–6.6. Exhibit 6.1 presents a summary of this evaluation for the RTCR and Alternative option as compared to the 1989 TCR. The qualitative analysis discusses the influence of the individual rule components under each regulatory option considered on the occurrence of TC-positive (TC+) and *E. coli*-positive (EC+) samples. Since a dose-response relationship between exposure to the fecal indicator *E. coli* and adverse health effects from waterborne pathogens that can be present with fecal contamination is not available, the resulting risk to human health is discussed only in terms of the anticipated change in direction of risk.

6.2.1 Implementation Activities

Rule implementation activities are expected to be similar under the RTCR and Alternative option. These activities are primarily administrative in nature and include items such as reading and understanding the rule, training, and development of reporting and recordkeeping protocols. Because of the similarities in expected implementation activities under the regulatory options, they are not expected to have an observably different effect on overall risk relative to the 1989 TCR. Both PWSs and states would incur additional burden and costs for transitioning to operations under the RTCR or Alternative option requirements. Because the activities undertaken to make the transition are primarily administrative, the additional activities are not expected to have any direct impact on risk.

6.2.2 Routine Monitoring

EPA expects that more frequent monitoring would decrease the risk of contamination in PWSs based on an enhanced ability to diagnose and mitigate system issues in a more timely fashion. Conversely, EPA assumes that a less frequent monitoring schedule would result in increased risk. Real-time continuous sampling would mitigate the most risk possible based on sampling schedule; however, it would cost prohibitively more than the periodic sampling practiced under the 1989 TCR and included in the RTCR and the Alternative option. EPA's objective in proposing the sampling schedules included in the RTCR and Alternative option was to find an appropriate balance between the factors of risk mitigation and cost management.

1989 TCR

The 1989 TCR requires a large portion (approximately 40 percent) of water systems to perform monthly monitoring for TC. The remaining systems are eligible for reduced monitoring, as follows.

[38] TCRDSAC deliberations are described in Chapter 3 of this EA.

- GW noncommunity water systems (GW NCWSs) serving ≤1,000 people are required to monitor quarterly. States may allow annual monitoring if a sanitary survey conducted in the past 5 years shows the system is supplied solely by protected GW sources and is free of sanitary defects.

- GW community water systems (GW CWSs) serving ≤1,000 people may monitor quarterly if they have no history of TC contamination in their current configurations, and if a sanitary survey conducted in the past 5 years shows that the system is supplied solely by a protected GW source and has no sanitary defects.

RTCR

The eligibility requirements for GW systems to qualify for reduced monitoring under the RTCR are more stringent than under the 1989 TCR, leading to fewer PWSs qualifying for reduced monitoring and therefore a higher total number of routine samples being taken over the 25-year period of analysis. The primacy agency has the discretion to reduce monitoring frequency for well-operated GW NCWSs and GW CWSs serving ≤1,000 people. Under the RTCR, eligibility for reduced monitoring for NCWSs and CWSs, respectively, is provided only for the following types of PWSs, as discussed as follows.

NCWSs

To be eligible to qualify for and remain on annual monitoring after the compliance effective date, GW NCWSs serving ≤1,000 people must meet each of the following criteria:

- The most recent sanitary survey shows the system is free of sanitary defects and has a protected water source and meets approved construction standards;

- The system must have a clean (1989 TCR or RTCR) compliance history (no MCL violations, Level 1 triggers, Level 2 triggers, treatment technique violations or monitoring violations) for a minimum of 12 months;

- An annual site visit (recurring) by the primacy agency within the last 12 months and correction of all identified sanitary defects. A voluntary Level 2 assessment by a party approved by the primacy agency may be substituted for the primacy agency annual site visit; and

- The primacy agency should encourage additional enhancements to the barriers protecting the distribution system from contamination. These measures could include but are not limited to the following:

  – Cross connection control, as approved by the primacy agency;

  – An operator certified by an appropriate primacy agency certification program; regular visits by a circuit rider may substitute for this requirement for some PWS types as permitted by the state;

- Continuous disinfection entering the distribution system and a residual in the distribution system in accordance with criteria specified by the primacy agency; and
- Maintenance of at least a 4-log inactivation of viruses each day of the month based on daily monitoring as specified in the Ground Water Rule (GWR) (with allowance for a 4-hour exception).
- Other equivalent enhancements to water system barriers as approved by the primacy agency.

CWSs

To be eligible to change from monthly to quarterly reduced monitoring after the compliance date, GW CWSs serving ≤1,000 people must be in compliance with any state-certified operator provisions and meet each of the following criteria:

- The most recent sanitary survey shows the system is free of sanitary defects (or has an approved plan and schedule to correct them), has a protected water source, and meets approved construction standards;
- The system must have a clean (1989 TCR or RTCR) compliance history (no MCL violations, Level 1 or Level 2 triggers, treatment technique violations or monitoring violations) for a minimum of 12 months; and
- Meet at least one of the following criteria:
  - An annual site visit by the primacy agency or a voluntary Level 2 assessment by a party approved by the primacy agency and correction of all identified sanitary defects (or an approved plan and schedule to correct them); or
  - A cross connection control program, as approved by the primacy agency; or
  - Continuous disinfection entering the distribution system and a residual in the distribution system in accordance with criteria specified by the primacy agency; or
  - At least 4-log inactivation of viruses each day of the month based on daily monitoring as specified in the GWR (with allowance for a 4-hour exception); or
  - Other equivalent enhancements to water systems as approved by the primacy agency.

Based on the additional protection provided by the more stringent criteria to qualify for reduced monitoring, the RTCR is expected to reduce risk for GW systems that qualify for

reduced monitoring compared to the eligibility requirements under the 1989 TCR. In addition, those systems that no longer qualify for reduced monitoring are expected to have a reduced risk as a function of the increased numbers of samples taken.

Seasonal systems (NCWSs that are not operated as a PWS on a year-round basis and start up and shut down the system at the beginning and end of each operating season) that sample on a reduced schedule under the 1989 TCR may retain their current schedules unless a state determines that more frequent sampling is appropriate. For seasonal systems required to move to an increased monitoring schedule, risk would decrease as a function of the increase in monitoring. In addition, more explicit procedural requirements related to monitoring under the RTCR (i.e., samples must be taken during the period of highest vulnerability or peak usage) would also be expected to reduce risk for seasonal systems.

Alternative option

Under the Alternative option, all systems must initially collect TC samples monthly regardless of size or type (i.e., water source), which is more frequent for those systems on reduced monitoring schedules under the 1989 TCR or RTCR. Over time, in the second year of rule implementation and beyond, the Alternative option would allow some GW systems to reduce to quarterly monitoring if the systems meet the same qualifications required for quarterly monitoring under the RTCR. Reduced monitoring on an annual schedule is not allowed under the Alternative option, creating a further increase in samples taken over the 1989 TCR and RTCR. Overall, the more frequent monitoring requirements (i.e., all PWSs monitor monthly in the first few years after promulgation and no annual reduced monitoring is allowed) would reduce risk as compared to the 1989 TCR to a greater extent than under the RTCR.

6.2.3 Repeat Monitoring

Under the 1989 TCR, PWSs serving ≤1,000 people take four repeat samples at and within five service connections upstream and downstream of the initial TC+ occurrence event over the course of 24 hours following the event. Three repeat samples are required for PWSs serving >1,000 people, including one sample at the site of the initial TC+ and two additional samples within five service connections up or downstream of that site.

Under the RTCR and Alternative option, PWSs serving ≤1,000 people are only required to take three repeat samples. The reduction in the number of repeat samples required could increase risk for any individual sampling event. However, the effect of the reduced sampling is expected to be minor. Analysis of the data (see Appendix H for the complete analysis) shows that for all PWSs serving 1,000 people or fewer, two or more of the repeat samples are positive in 75 percent of those instances in which there are any positive repeat samples. For those 75 percent of instances, reducing the number of repeat samples from four to three would have no effect on the number of systems that would be triggered to conduct an assessment of the system under the RTCR. In these cases, at least one of the remaining repeat samples would still be TC+, and only one positive repeat sample is required to trigger an assessment at these PWSs.

For 25 percent of the cases in which repeat samples are TC+ under the 1989 TCR, only one sample will be positive. EPA estimates that if the number of repeat samples were reduced

from four to three, any positive samples occurring at three of the four original locations (75 percent) would still be detected. Thus, if the number of required repeat samples were reduced from four to three, the number of situations triggering an assessment for the system would be 94 percent (0.75 + (0.75*0.25) = 0.94) of the number of assessments triggered by taking four repeat samples.

Although dropping the required number of repeat samples from four to three means that some fraction of triggered assessments may be missed, representing an increase in risk, EPA believes that the other provisions of the RTCR as described in this chapter compensate for that change and that, taken as a whole, the provisions of the RTCR provide for greater protection of public health.

6.2.4 Additional Routine Monitoring

Under the 1989 TCR, PWSs serving ≤4,100 people must conduct additional routine monitoring in the month following a TC+ sample. All systems must collect and test a minimum of five samples in the month following the TC+ sample, unless the primacy agency finds that additional sampling is unnecessary or the primacy agency determines the cause of the TC+ sample and establishes that the system has corrected or would correct the problem.

Under the RTCR, EPA will retain the requirement of taking additional routine samples the month following a TC+ sample for systems on quarterly or annual monitoring. Under the RTCR, a system that has a Level 1 trigger must conduct an assessment, and if a problem is found, the system must take corrective action. Under such circumstances, the advisory committee believed that additional samples collected the following month are appropriate to help recognize the problem if it still persists. Without the provision of additional monitoring, systems on annual or quarterly monitoring would not take any samples the following month. Systems having a Level 2 assessment are triggered into a monthly monitoring and therefore have less need for additional routine monitoring to indicate if a problem persists.

For systems required to take the additional routine samples the following month (i.e., systems on quarterly or annual monitoring), the RTCR changes the requirement from taking a total of five routine samples to a requirement of just three routine samples. The advisory committee recognized that it is appropriate to drop from five to three samples the following month to reduce monitoring costs while still maintaining a substantial likelihood of identifying a problem if a problem persists. EPA recognizes that a reduction in the number of samples taken could also mean a reduction in the number of positive samples found. However, the reduction in the number of additional routine samples in conjunction with the new assessment and corrective action provisions of the RTCR (discussed in sections III.E.2 and III.E.3 of the RTCR preamble (USEPA 2010c)) leads to a rule that is ultimately more protective of public health (i.e., more *E. coli* MCL violations being prevented) and improvement in water quality (i.e., decrease in the TC+ and EC+ hit rates observed as shown by EA occurrence modeling results).

For systems taking at least one sample monthly, the advisory committee recommended no additional routine samples for the following reason. Taking no additional routine samples the following month substantially reduces monitoring costs. The assessment and corrective action provisions will give systems the ability to identify and prevent the occurrence of problems. EA

modeling results show that although there is a decrease in the number of *E. coli* MCL violations found with the decrease in the number of additional routine samples taken (i.e., going from five samples to one during the month following a TC+ sample), the assessment and corrective action provisions leads to more *E. coli* MCL violations being prevented compared to the 1989 TCR (see Exhibit 6.7 for more details).

In addition, whenever a TC+ sample occurs during routine sampling, there is also a requirement to conduct repeat sampling to clarify if potential pathways to contamination persist. For systems serving 1,000 people or fewer, if a repeat sample is TC+, at least a Level 1 assessment will be triggered. If a sanitary defect is found, the system is required to correct the sanitary defect. The absence of any repeat positive sample provides some indication that the problem is not persisting. For systems on monthly monitoring, these two conditions mitigate the need for additional routine sampling for the following month.

Although the changes to the additional routine monitoring provisions mean that some fraction of triggers may be missed representing an increase in risk, EPA believes that the other provisions of the RTCR as described in this chapter compensate for that change and that, taken as a whole, the provisions of the RTCR provide for greater protection of public health.

6.2.5 Annual Site Inspections

The 1989 TCR does not include any requirements for annual site inspections. However, based on discussions with stakeholders, some states do perform annual site visits for any systems on an annual sampling schedule.

Under the RTCR, GW NCWSs serving ≤1,000 people must, within one year of the compliance effective date, have an initial (and annually thereafter) visit by the state or an annual voluntary Level 2 assessment by a party approved by the state to remain on an annual monitoring schedule. Because of the cost differential between conducting annual site inspections and the alternative (quarterly monitoring), EPA has estimated that only those states that already voluntarily conduct annual site inspections under the 1989 TCR would do so under the RTCR. Therefore, no risk reduction is expected for these systems (and thus overall) from this rule component under the RTCR.

The Alternative option does not allow systems to reduce to a frequency of annual monitoring and therefore does not include an annual site inspection requirement. However, based on discussions with stakeholders, those states that currently conduct annual site assessments under the 1989 TCR may no longer have the resources to continue the inspections and conduct quarterly monitoring under the Alternative option. For NCWSs on annual monitoring, the TCRDSAC believed that requiring a system to have an annual site visit or a Level 2 assessment provides at least an equivalent level of diagnosis of problems and vulnerabilities that might exist as compared to quarterly monitoring without an annual site visit. This tradeoff between annual monitoring with site inspections and three additional routine samples (i.e., quarterly monitoring with no site inspections) would potentially result in an increased risk for the Alternative option compared to the RTCR.

6.2.6 Assessments

Under the 1989 TCR there is no explicit "assessment" required when TC+ results are observed. However, systems are required to notify the public and state under different scenarios. Specifically, a PWS must:

- Report any acute MCL violation to the state no later than the end of the business after the system learns of a violation;
- Notify the public within 24 hours of an acute MCL violation.
- Notify the public within 30 days of a monthly/non-acute MCL violation;

Under the RTCR and Alternative option,[39] PWSs are required to perform and submit a Level 1 assessment if:

- Systems taking 40 or more samples per month have more than 5.0 percent TC+ samples;
- Systems taking less than 40 samples per month have two or more TC+ samples in one month; or
- A system fails to take all required repeat samples after a single TC+ sample

A more detailed examination of the system, including its monitoring and operational practices (a Level 2 assessment), is required if a system has:

- An *E. coli* MCL violation;
- A second Level 1 treatment technique trigger within a rolling 12-month period, unless the first Level 1 treatment technique trigger was based on exceeding the allowable number of TC+ samples, the State has determined a likely reason for the TC+ samples that caused the initial Level 1 treatment technique trigger, and the State establishes that the system has fully corrected the problem; or
- For PWSs with approved reduced annual monitoring, the system has a Level 1 treatment technique trigger in two consecutive years.

Mandatory assessments are a new requirement under the RTCR and Alternative option, and also represent an increased focus on problem solving from the less defined investigations (if any) conducted under the 1989 TCR. Because of the more explicit requirements of the assessments, it is expected that more problems would be identified and resolved. As a result, the risk relative to the 1989 TCR is assumed to decrease.

[39] Requirements for the 1989 TCR, RTCR, and Alternative option are described in detail in Chapter 3 of this EA.

6.2.7 Corrective Actions

Corrective actions are not explicitly required under the 1989 TCR. However, responsible, well-operated systems do perform corrective actions based on investigations they perform (see Section 6.2.6) in response to positive samples.

Under the RTCR and Alternative option, PWSs must correct any sanitary defects found during either a Level 1 or Level 2 assessment. For corrections not completed by the time of submission of the assessment form, systems must complete the corrective action(s) on a schedule determined by the state in consultation with the system. Systems are required to notify the state when they have completed each corrective action. Failure to implement a corrective action is considered a treatment technique violation, subject to public notification (PN).

EPA does not have data on the existing rates at which corrective actions are completed under the 1989 TCR, so an assumption of the net change in the percentage of assessments resulting in corrective action (10 percent)[40] is made for the RTCR and Alternative option as part of this EA and subsequent evaluation of changes in risk. Overall, increased protection provided by this net increase in corrective action as a result of requiring systems to implement a correction action through an enforceable mechanism would reduce risk under both the RTCR and Alternative option.

6.2.8 Public Notification

Monthly/Non-acute MCL Violations

The 1989 TCR requires PN within 30 days of a monthly/non-acute MCL violation or 24 hours of an acute MCL violation.

Both the RTCR and Alternative option would require:

- Tier 1 PN within 24 hours of an *E. coli* MCL violation;
- Tier 2 PN within 30 days of a treatment technique violation; and;
- Tier 3 PN within a year following either a routine monitoring violation or a reporting violation.

However, under both the RTCR and Alternative option, the PN requirements for monthly/non-acute MCL violations would no longer be required (the RTCR and Alternative options do not include monthly/non-acute MCL violations). Since monthly/non-acute violations account for a large number of violations under the 1989 TCR, there is expected to be a large decrease in the number of notices presented to the public. If it is assumed that such notices provide information that aid in risk avoidance by water customers, risk may increase as a result of reducing this PN requirement to the extent that a risk exists. Because PWSs are no longer

[40] The 10 percent assumption is based on EPA discussions with stakeholders regarding experiences with implementing the 1989 TCR and the expected impact of RTCR. A sensitivity analysis evaluating alternative assumptions was conducted. Results of these analyses are discussed in Chapter 5 (section 5.3.3.1).

required to send out notices for monthly/non-acute MCL violations or the monitoring results[41] that triggered them under the 1989 TCR, there is also the potential that some PWSs may become less responsive in addressing TC hits or preventing them from occurring in the first place.

The TCRDSAC evaluation of the 1989 TCR PN also concluded that the numbers of monthly/non-acute MCL violation notices that go out to the public are confusing. Unlike acute MCL violations associated with positive *E. coli* samples, monthly/non-acute MCL violations may have no connection to a direct health risk because TC+ samples do not indicate a direct threat to public health. To the extent that a high number of notices issued for monthly/non-acute MCL violations result in false alarms, consumers may not give appropriate attention to a notice of an acute MCL violation that indicates a greater potential risk to public health. Therefore, the EPA concluded, using best professional judgment informed by the TCRDSAC's evaluation that risk may decrease through the elimination of the PN requirement for monthly/non-acute MCL violations under the RTCR and Alternative option. Additionally, resources used to issue high numbers of monthly/non-acute MCL violations and the time spent responding to customer inquiries about the violations may be better employed on other PWS issues which could result in further reduced risk.

As discussed above, the influences on risk of eliminating the PN requirements for monthly/non-acute MCL violations may move risk in both directions. A decrease in the overall information received by consumers may result in reduced use of averting behaviors when they become necessary to avoid potentially contaminated drinking water, thus increasing potential risk. Conversely, too frequent notice of information that may not be directly related to a health risk may reduce confidence in the PWS, resulting in averting behavior that is not necessary, or may cause confusion or indifference that may result in consumers not taking averting actions when appropriate (i.e., ignoring an acute violation notice). Thus focusing on fewer, yet more "serious" notices may result in a decrease in potential risk. Risk may also decrease as a result of PWSs being able to better employ resources currently used on notice issuance and follow-up.

EPA also considered the effect of Tier 2 PN requirements for treatment technique violations, which allow for up to a 30-day time delay between incurrence of the violation and notification to the public. This time delay could equate to some increased risk for the public relative to a scenario where an immediate notification was required. However, the change in risk relative to the 1989 TCR, which does not require assessments or corrective actions, is a decrease in risk. In allowing PWSs the flexibility to take up to a month to correct a sanitary defect before being required to issue PN, EPA is attempting to balance the potential public health benefits associated with having prompt notification for all treatment technique violations with the potential inefficiency and extra costs related to cases where the same level of expedience may not be necessary. Tier 1 PN is still required within 24 hours to address situations where an imminent health threat occurs.

In summary, EPA assumes that there would not be an overall increase in risk by changing PN requirements for monthly/non-acute MCL violations under the RTCR, but given the

[41] Under the 1989 TCR, for systems taking fewer than 40 samples per month, a non-acute violation occurs if 2 or more samples are TC+; for systems taking 40 or more samples per month, a non-acute violation is triggered by >5 percent of TC+ samples.

contradictions in potential risk reductions the potential change in risk is best characterized as "unknown."

Monitoring and Reporting Violations

The TCRDSAC also evaluated the effects of revised PN requirements for monitoring and reporting violations under the RTCR and Alternative option and concluded that significant reductions in monitoring and reporting violations and associated costs may be realized through the regulatory framework of the RTCR. For the 1989 TCR, monitoring and reporting violations result in Tier 3 PN. Under the RTCR and Alternative option, monitoring violations are separate from the reporting violations, and the PN requirements for failing to take some types of samples are more stringent as compared to the monitoring and reporting violations under the 1989 TCR. For repeat sampling, a PWS that fails to take every required repeat sample following a routine EC+ sample must:

- Initiate Tier 1 PN within 24 hours;
- Initiate consultation with the state no later than 24 hours after learning of the violation, to determine additional PN requirements, if any;
- Perform a level 2 assessment/corrective action: and
- Increase to a minimum of monthly monitoring.

For a PWS that fails to take every required repeat sample after any single TC+ sample, the PWS must perform a level 1 assessment/corrective action. Failure to perform a required assessment and/or corrective action results in a treatment technique violation (Tier 2) and a minimum of monthly monitoring.

For routine and additional routine monitoring, a PWS that does not take every required routine sample, or every required additional routine sample, in a compliance period is still subject to Tier 3 PN; noncompliance with sampling requirements does not necessarily increase the likelihood that a PWS will be contaminated with fecal contamination and/or a waterborne pathogen and so does not present a direct or immediate public health risk. However, if the PWS has monitoring violations in 2 of 4 quarters (for systems on quarterly monitoring) or misses its required annual sample (for systems on annual monitoring), the PWS must revert to monitoring no less than monthly.

Overall, the added PN stringency for monitoring violations is expected to decrease potential risk under the RTCR and Alternative option as PWSs opt to perform required sampling to avoid transition to increased monitoring requirements or other additional actions.

Summary Exhibit

The component discussions in Sections 6.2.1 through 6.2.8 above address the individual effects under each rule component on the various system types and sizes. The terms "increase," "decrease," and "no change" in Exhibit 6.1 indicate the direction of change in risk under the RTCR and Alternative option relative to the 1989 TCR. Risk may change for some system sizes

or types and not for others under a given rule component. In such cases, Exhibit 6.1 reflects the overall change in risk direction and does not necessarily apply to all types and sizes of systems.

Exhibit 6.1 Potential Changes in Risk under the RTCR and Alternative Option Relative to the 1989 TCR

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	Alternative option	RTCR	Alternative option	RTCR	Alternative option
Implementation Activities	None	None	None	None	No change	No change
Routine Monitoring (Including Reduced Monitoring)	None	None	Increased stringency in requirements to qualify for reduced monitoring along with requirement to return to baseline monitoring upon loss of these criteria is expected to result in decreased risk (i.e., fewer PWSs will qualify and therefore more will monitor more frequently).	PWSs all monitor monthly in the first few years of implementation of the RTCR, which is an increase in sampling frequency for systems that monitor quarterly or annually under the 1989 TCR. After the first few years, systems may reduce to quarterly, but none may reduce to annual monitoring, creating a decrease in risk for systems on annual monitoring under the 1989 TCR.	Decrease	Decrease
Repeat Monitoring	Required repeat samples reduced from 4 to 3 for systems serving <1,000 people	Required repeat samples reduced from 4 to 3 for systems serving <1,000 people	None	None	Increase	Increase

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	**Alternative option**	**RTCR**	**Alternative option**	**RTCR**	**Alternative option**
Additional Routine Monitoring	Additional routine samples are no longer required for PWSs monitoring monthly. GW PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.	Additional routine samples are no longer required for PWSs monitoring monthly. GW PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.	None	None	Increase	Increase
Annual Site Visits	None (only states currently performing annual site visits are expected to continue)	Annual monitoring is not permitted under the Alternative option, so the protective benefit of the annual site visit is lost.	None (only states currently performing annual site visits are expected to continue)	None	No change	Increase
Assessments	None	None	Mandatory assessments are a new requirement.	Mandatory assessments are a new requirement.	Decrease	Decrease
Corrective Actions	None	None	Mandatory corrective actions are a new requirement.	Mandatory corrective actions are a new requirement.	Decrease	Decrease

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	**Alternative option**	**RTCR**	**Alternative option**	**RTCR**	**Alternative option**
Public Notification—Monthly/Non-Acute MCL Violations	Reduction in available public information Possible PWS complacency	Reduction in available public information Possible PWS complacency	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Unknown	Unknown
Public Notification—Monitoring and Reporting Violations	None	None	Increased stringency of PNs motivates PWSs to conduct required sampling.	Increased stringency of PNs motivates PWSs to conduct required sampling.	Decrease	Decrease
Overall					Decrease	Decrease

Note:

1) Detailed discussion of the rationale for determinations of potential risk for each rule component is presented in Ch. 6 (Sections 6.2.1–6.2.8 above) of this EA. Implementation activities consist of administrative activities by PWSs and states to implement the rule.
2) Assessment of potential changes in risk for monitoring components is an *overall* assessment. Potential changes (or static state) of risk for particular system sizes and types differ according to individual rule requirements and are discussed in Sections 6.2.1–6.2.8 above. Chapter 3 provides a detailed description of the rule components for all three regulatory options, and the Preamble to the RTCR provides additional discussion of the TCRDSAC process and the rationale underlying the structure of the regulatory options considered.

6.2.9 Summary of Qualitative Benefits Analyses

The discussions above describe relative risks in terms of individual components of the regulatory options. Based on the discussions presented above, EPA has used best professional judgment informed by the TCRDSAC to qualitatively estimate the potential changes in public health for each regulatory option, as compared with the 1989 TCR. These assessments were made with contributions from a wide range of drinking water experts, including public health scientists, engineers, administrators, and regulatory experts. The overall change in risk relative to the 1989 TCR is a result of the complex interactions of all rule components. As the discussion above shows, under repeat and additional routine monitoring provisions for the RTCR and Alternative option, there is a potential for increased risk for PWS customers because TC monitoring frequency may be reduced for some PWSs. However, this increase is expected to be more than offset by potential decreases in risk from increased routine monitoring for some PWSs due to more stringent criteria to qualify and stay on reduced monitoring and the addition of the assessments and corrective action provisions that will find and fix problems identified by monitoring.

The consensus opinion resulting from the TCRDSAC deliberations was that the RTCR would achieve a net risk reduction compared to the 1989 TCR. The committee applied best professional judgment in determining that the increased protection provided by the new requirements for implementing focused assessments and implementing appropriate corrective actions would more than offset any potential increase in risk introduced by the reduction in samples and other changes resulting from the RTCR. To present the potential for further reduction in risk due to the increased numbers of samples taken, especially in the first several years of implementation, the committee considered monthly monitoring for all systems, similar to that required under the Alternative option. However, the additional burden[42] of requiring all PWSs to initially monitor on a monthly basis (regardless of PWS size or type) and limiting reduced monitoring to quarterly (disallowing annual monitoring) would fall disproportionately on small systems based on their proportionately large increase in activity under the RTCR.

6.3 Assessment of Predictive Analysis Results

Based on discussions in and information developed for the TCRDSAC meetings (described in Chapter 3 of this EA), EPA anticipated prior to beginning this EA that the RTCR would not be a significant rule in terms of costs (i.e., less than $100 million annually). However, EPA considered the feasibility of performing a traditional risk assessment that would produce quantified estimates of costs, benefits, and net costs and benefits, as outlined in section 1412 (b)(3)(C) of the Safe Drinking Water Act (SDWA). For this type of analysis, the minimum information requirements comprise data on contaminant occurrence; exposure rates in the population defined for the various pathways (i.e., water consumption, inhalation, and dermal contact); potential health effects associated with exposure to contaminated water; and a dose-response relationship. A quantified benefits analysis would use this information to estimate the number of avoided cases of morbidity or mortality associated with the rule, which would then be valued in terms of saved lives and preserved quality of life and work capacity.

[42] Additional costs under the Alternative option are discussed Chapter 7 of this EA.

For the RTCR EA, the available information includes data on the incidence of TC+ samples collected under the 1989 TCR over the 6-year period from 1998–2005, from which EPA selected one complete year (2005) to use for analyses in this EA, as explained in Section 4.2.2 of this EA. For the year 2005, EPA also has data on TC+ samples that subsequently test positive for *E. coli* (using EPA-approved standard methods available at that time). No other national occurrence data are available.

As discussed in Chapter 2 of this EA, the presence of *E. coli* is an indication that the water contains fecal contamination. Some *E. coli* strains (or serotypes) such as *E. coli* O157:H7, for example, are pathogens. However, EPA recognizes that the EPA-approved standard methods available for *E. coli* do not typically identify the presence of the pathogenic *E. coli* strains, such as *E. coli* O157:H7. Thus, *E. coli* occurrence, as used in this EA, serves as an indication of fecal contamination but not necessarily pathogenic contamination. *E. coli* occurrence does not confer any significant quantitative information about the likelihood of health effects (e.g., acute gastrointestinal illness or chronic illnesses as described in Chapter 2 of this EA) from consuming drinking water contaminated with fecal indicator organisms.

There are few data reporting the co-occurrence in a single sample of fecal indicator *E. coli* (assayed using EPA-approved standard methods) and pathogenic *E. coli* strains. One notable exception are the data reported by Cooley et al. (2007), which showed high concentrations of pathogenic *E. coli* strains in samples containing high concentrations of fecal indictor *E. coli*. These data are from streams and other poor quality surface waters surrounding California spinach fields associated with an *E. coli* O157:H7 foodborne outbreak. Data equivalent to these are not available from drinking water samples collected under the 1989 TCR**.**

Absent any definitive data on co-occurrence of fecal indicator (*E. coli*) and pathogenic *E. coli*, EPA did not estimate the cases of morbidity or mortality avoided. Instead, EPA estimated changes in occurrence and the resulting changes in assessments and corrective actions performed for systems serving ≤4,100 people. For systems serving >4,100 people, EPA applied the 2007 violations data to estimate the increase in effective corrective actions implemented. Discussion of reductions in risk, then, considers the change in occurrence and corrective actions implemented for systems serving ≤4,100 and the changes in corrective actions implemented for systems serving >4,100.[43]

For all systems, EPA also estimated the behavioral response of the regulated community based on projected occurrence rates or violations under the RTCR and Alternative option, including the frequency of Level 1 or Level 2 assessments and the type and number of corrective actions implemented by PWSs to address the problems identified. EPA expects that the effects of these changes on risk will be varied, as described in Section 6.3.1 below.

[43] The rationale for using different metrics as proxies for risk reduction in systems serving ≤4,100 people and those serving >4,100 is explained in Chapters 4 and 5 of this EA.

6.3.1 Assessment of Predictive Analysis Results for Systems Serving ≤4,100 People and Systems Serving >4,100 People

Because the PWSs serving 4,100 people or fewer have a higher initial *E. coli* occurrence and will be triggered into more assessments and corrective actions than PWSs serving >4,100 people, the increase in benefits for systems serving ≤4,100 people will be more evident as compared to the systems serving >4,100 people. In particular, model results suggest that customers of GW TNCWSs serving 100 or fewer people, which constitute approximately 40 percent of PWSs, experience the most improvement in water quality under the RTCR. That is, the occurrence of *E. coli* is predicted to decrease more for these systems that for other systems types.

6.3.1.1 Systems Serving ≤4,100 People

For systems serving ≤4,100 people, EPA developed a model to simulate regulatory responses for a 30-year period of analysis, including years 1–5 in which GWR[44] is in effect, years 3–5 in which the RTCR is being implemented, and years 6–30 during which RTCR requirements are also in effect. The 30-year modeled time period includes a total of 28 years of RTCR impacts post-promulgation. Although this EA considers benefits and costs for only 25 years post-promulgation, the 30-year period was presented in Chapter 5 for broader consideration of the appropriateness of the model in terms of its results. The 25 years post-promulgation that are considered in this EA encompass years 3–27 of the 30-year modeled period. A complete description of the model is provided in Chapter 5 of this EA, and data sources used are described in Chapter 4.

Output from the system simulation model for systems serving ≤4,100 people includes the following estimates for each year of analysis:

- Samples taken (routine, additional routine, and repeat);
- Number of positive results (TC+ and/or EC+)
- Level 1 and Level 2 assessments conducted based on non-acute violations;
- Level 2 assessments conducted based on acute violations; and
- Corrective actions based on Level 1 assessments and Level 2 assessments.

The results of analyses in terms of expected changes in hit rates (positive samples/totals samples taken) over time are presented in chapter 5 (Section 5.3.3) and Appendix B. Predicted TC+ hit rate results reflect the overall increase in water quality expected over time under the RTCR and Alternative option. Exhibits 6.2–6.4 present a summary of the additional endpoints listed above for the 25-year period of analysis following rule promulgation.

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[44] Reductions in EC+ occurrence or violations are only attributable to the RTCR if they result from requirements of the RTCR regulatory options; reductions resulting from the GWR are not attributable to the RTCR and are not considered further in this chapter. As described in sections 4.2, 4.3, and 5.3 of this EA, GWR effects are incorporated to adjust source data to the appropriate baseline for this EA.

As discussed earlier in this section, because a dose-response relationship between EC+ occurrence (i.e., acute violations) and illness is not available, EPA is focusing on changes in EC+ occurrence. EPA assumes that reduced occurrence in PWSs should generally correlate with a reduction in risk of contamination to PWS drinking water. Therefore, the acute violation rates predicted under the RTCR and Alternative option (Exhibits 6.3–6.4) represent a level of risk of contamination that is reduced from that predicted under the 1989 TCR (Exhibit 6.2). The numbers of predicted acute violations have two major drivers. First, improvements in water quality are predicted to result in fewer acute violations. Second, the monitoring frequency impacts the number of acute violations found, regardless of water quality. Both decreases in acute violations attributable to water quality improvements and increases due to additional diagnostic ability of more samples taken result in reduced risk. The combination of these two influences in the predictive model means that the risk is expected to be lower even though the number of predicted acute violations may actually be higher or lower than under the 1989 TCR as reflected in exhibits 6.2–6.4. This concept is discussed in the uncertainty analysis in Section 6.4 of this chapter.

The changes in the *steady state* estimates of annual acute violations from the 1989 TCR to the RTCR and Alternative option are shown in Exhibit 6.5 and 6.6 in absolute numbers and as a percentage change from the 1989 TCR, respectively. The *steady state* in the model refers to the period beginning in years 7 (CWSs) and 9 (NCWSs) following promulgation, after the proportions of systems sampling on monthly, quarterly, or annual regimens are adjusted following a period of assessment.[45] systems that qualify for reduced monitoring will begin their new regimens in years 7 and 9 after promulgation, respectively, for CWSs and NCWSs. The estimates shown in Exhibit 6.5 for systems serving ≤4,100 people are from the predictive model and reflect the average annual estimates for the 25-year period of analysis, which includes 3 years of initial implementation followed by 22 years in which new rule requirements are also in effect. To accurately reflect the average annual results under this schedule, the model output for the 22 years of additional activity following the 3 years of initial implementation is divided by 22, rather than the entire 25 years, since that would distort the results downward. The steady state reductions in the number of annual acute violations found under the RTCR and Alternative option primarily reflect the benefits of corrective actions under these two options in preventing many of the acute violations that would otherwise occur over this period.

These results show that under the RTCR, no subgroups are predicted to experience an increase in annual acute violations. While most categories of systems/sizes would experience a decrease in predicted numbers of violations under the Alternative option, four categories would

[45] The effective date of the RTCR occurs after 3 years of initial implementation, that is, at the start of year 4 post-promulgation. For CWSs, years 4–6 post-promulgation are the period of assessment for potential to move to reduced monitoring; for NCWSs, years 4–8 post-promulgation are the period of assessment for reduced monitoring. Under the Alternative option, this period of assessment occurs in years 4–8 post-promulgation for all PWSs. In the aggregate, the steady state regarding reduced monitoring schedules under the Alternative option begins in year 9 post-promulgation. Chapter 5 provides a description of the criteria used to estimate the steady percent of systems qualifying for reduced monitoring under the RTCR and Alternative option. In this chapter, these transitions are presented on the 30-year scale of the modeling period, in which years 1–3 are the baseline occurrence for the 1989 TCR with the GWR effects and are pre-promulgation. Exhibits 5.16–5.21 show that the steady state begins in model year 9 (CWSs) and model year 11 (NCWSs). This modeling is not performed for systems operating under the 1989 TCR; they are assumed to remain on the initial schedule presented in Chapter 4 (baseline).

actually experience an increase (a positive percent value in Exhibit 6.6): GW NTNCWSs serving 501–1,000 people and GW TNCWSs serving ≤100, 101–500, and 501–1,000 people. It is important to note that in two of those cases, the absolute increases in annual acute violations predicted under either option is very small (≤1 annual acute violation as shown in Exhibit 6.5), but translate into observable percentage changes in Exhibit 6.6. The two categories with an increase of greater than one annual acute violation are the GW TNCWSs systems serving ≤100 people and those serving 101–500 people, for which increases of approximately 52 and 16 annual acute violations, respectively, are predicted. For these TNCWSs under the Alternative option, increased monitoring is expected to lead to an overall increase in annual acute violations (and is also the driver of the greater total number of annual acute violations predicted).

As discussed earlier, a decrease in acute violations may be caused by an improvement in water quality, which in this model would result from an increased number of effective corrective actions being implemented (i.e., occurrence events are "prevented"). An increase in acute violations can be attributable to a decrease in water quality or a PWS improving its ability to detect more issues (e.g., through more sampling). Alternatively, a decrease in acute violations could be caused by a decreased ability in PWSs to detect the occurrence of TC/EC because of a reduced sampling schedule, resulting in undetected or "missed" occurrence events. Section 6.4 of this chapter presents a stepwise analysis to discern the relative significance of the effects of reduced additional routine samples and increased corrective action efficacy as shown by predictions of "prevented", "found", and "missed" acute violations under the RTCR.

6.3.1.2 Systems Serving >4,100 People

The number of acute and non-acute MCL violations for a given group (based on system type and water source) of PWSs serving >4,100 people was estimated using 2005 Safe Drinking Water Information System/Federal Version (SDWIS/FED) data (USEPA, 2005). These estimates were used to determine the number of Level 1 and Level 2 assessments and associated corrective actions triggered for systems serving >4,100 in the period of analysis. EPA made a simplifying assumption that for PWSs serving >4,100 people the number of annual assessment triggers would remain constant throughout the 22 years following the 3 years of initial implementation of the RTCR. As assumed in the occurrence model for systems serving ≤4,100 people, this analysis also assumes that systems responding to a Level 2 assessment trigger (i.e., an acute MCL violation under the 1989 TCR) would identify and specifically address the cause of the contamination at a rate increased by 10 percent under the RTCR and Alternative option compared to the 1989 TCR.[46]

Exhibits 6.2–6.4, described in Section 6.3.1.1 for systems serving ≤4,100 people, also include the number of activities (assessments and corrective actions) EPA expects PWSs to implement under each of the regulatory options considered for systems serving >4,100. Any reduction in risk is estimated to derive from the additional corrective actions predicted per the explanation above. Exhibit 6.5 also reflects that EPA is not quantifying any potential change in

[46]The 10 percent assumption is based on EPA discussions with stakeholders regarding experiences with implementing the 1989 TCR and the expected impact of RTCR. A sensitivity analysis evaluating alternative assumptions was conducted. Results of these analyses are discussed in Chapter 5 (section 5.3.3.1).

the number of annual acute violations for PWSs serving >4,100 people during the period. This assumption simplifies the analysis and is consistent with EPA's understanding based on TCRDSAC deliberations and best professional judgment that systems serving >4,100 are at a relatively steady state with regard to operations. These systems have been in a position relative to systems serving ≤4,100 people to diagnose more and address the cause of acute violations more, and they have likely had more resources to apply in maintaining and updating their systems on a regular basis. Therefore, EPA does not believe that systems serving >4,100 will make many changes based on RTCR implementation, or that they will experience large changes in their occurrence rates for TC and *E. coli* after RTCR promulgation.

Exhibit 6.2 Predicted Outcomes (25-Year Period of Analysis) under the 1989 TCR

PWS Size (Population Served)	PWSs Subject to 1989 TCR	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	Number of Non-Acute Violation Assessments (Single Violations)	Number of Corrective Actions (based on Single Non-Acute Violation Assessment)	Number of Acute Violation Assessments	Number of Non-Acute Violation Assessments (Multiple Violations)	Number of Corrective Actions (based on Acute and Multiple Non-Acute Violation Assessments)	Tier 2 PNs
	A	B	C	D	E	F	G	H	I	J=E+G+H
Community Water Systems (CWSs) - SW										
≤100	1,170	304,247	23,167	18,698	525	-	157	184	-	865
101 - 500	2,150	562,198	27,009	21,684	649	-	167	111	-	927
501-1,000	1,173	306,605	15,334	12,299	361	-	102	63	-	526
1,001-4,100	2,938	1,921,237	55,132	33,729	954	-	162	149	-	1,265
4,101-33,000	3,164	10,636,296	-	186,729	2,152	-	197	-	-	2,349
33,001-96,000	720	11,058,960	-	194,149	534	-	56	-	-	590
96,001-500,000	308	10,190,400	-	178,901	233	-	24	-	-	257
500,001-1 Million	31	2,019,600	-	35,456	22	-	-	-	-	22
> 1 Million	17	1,686,960	-	29,616	-	-	-	-	-	-
Totals	**11,671**	**38,686,502**	**120,642**	**711,259**	**5,429**	**-**	**865**	**507**	**-**	**6,801**
Community Water Systems (CWSs) - GW										
≤100	11,938	2,815,951	286,073	194,462	9,772	-	1,141	5,383	-	16,295
101 - 500	13,892	3,344,578	243,895	171,252	8,169	-	1,025	4,214	-	13,408
501-1,000	4,467	1,072,202	70,803	51,673	2,250	-	284	1,050	-	3,584
1,001-4,100	6,443	3,997,293	160,710	100,618	3,545	-	477	2,808	-	6,831
4,101-33,000	3,156	9,145,224	-	230,201	4,545	-	263	-	-	4,807
33,001-96,000	335	4,884,000	-	122,938	656	-	53	-	-	709
96,001-500,000	63	1,945,680	-	48,976	129	-	10	-	-	139
500,001-1 Million	4	253,440	-	6,380	-	-	-	-	-	-
> 1 Million	3	269,280	-	6,778	-	-	-	-	-	-
Totals	**40,301**	**27,727,648**	**761,481**	**933,279**	**29,066**	**-**	**3,253**	**13,455**	**-**	**45,773**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW										
≤100	250	65,018	4,910	3,991	98	-	35	77	-	210
101 - 500	253	66,045	3,735	3,011	88	-	29	40	-	157
501-1,000	88	22,976	1,278	1,029	30	-	9	13	-	52
1,001-4,100	72	41,759	2,142	1,348	42	-	19	37	-	98
4,101-33,000	22	50,424	-	1,628	5	-	-	-	-	5
33,001-96,000	2	34,320	-	1,108	-	-	-	-	-	-
96,001-500,000	1	31,680	-	1,023	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**688**	**312,223**	**12,065**	**13,138**	**262**	**-**	**93**	**167**	**-**	**522**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW										
≤100	8,826	971,538	128,775	84,992	5,581	-	856	3,829	-	10,267
101 - 500	6,613	725,785	66,525	43,597	3,130	-	447	1,273	-	4,849
501-1,000	1,718	190,649	16,037	10,680	744	-	95	298	-	1,136
1,001-4,100	812	460,470	28,214	17,790	818	-	169	974	-	1,961
4,101-33,000	70	153,648	-	5,936	123	-	9	-	-	132
33,001-96,000	2	23,760	-	918	4	-	-	-	-	4
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**18,041**	**2,525,850**	**239,551**	**163,913**	**10,400**	**-**	**1,577**	**6,373**	**-**	**18,350**
Transient Noncommunity Water Systems (TNCWSs) - SW										
≤100	1,339	345,401	40,475	33,065	1,093	-	430	780	-	2,302
101 - 500	497	128,156	15,261	12,454	410	-	170	320	-	900
501-1,000	88	22,691	2,704	2,207	67	-	28	47	-	142
1,001-4,100	67	40,151	4,155	2,707	92	-	50	128	-	270
4,101-33,000	18	40,656	-	-	8	-	-	-	-	8
33,001-96,000	-	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	1	102,960	-	-	-	-	-	-	-	-
Totals	**2,010**	**680,015**	**62,596**	**50,434**	**1,670**	**-**	**677**	**1,275**	**-**	**3,622**
Transient Noncommunity Water Systems (TNCWSs) - GW										
≤100	60,200	4,493,808	905,554	600,315	44,730	-	6,649	25,425	-	76,805
101 - 500	19,275	1,614,924	316,238	210,714	14,530	-	2,089	8,864	-	25,483
501-1,000	1,963	177,264	32,730	22,064	1,477	-	221	896	-	2,595
1,001-4,100	617	335,283	29,957	19,113	927	-	186	1,138	-	2,251
4,101-33,000	67	156,288	-	8,909	116	-	4	-	-	120
33,001-96,000	2	34,320	-	1,956	-	-	-	-	-	-
96,001-500,000	1	26,400	-	1,505	-	-	-	-	-	-
500,001-1 Million	1	63,360	-	3,612	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**82,126**	**6,901,647**	**1,284,478**	**868,188**	**61,780**	**-**	**9,149**	**36,324**	**-**	**107,253**
Grand Total	**154,837**	**76,833,885**	**2,480,814**	**2,740,210**	**108,608**	**-**	**15,613**	**58,102**	**-**	**182,322**

Source:

1) Appendix A, Exhibit A.1.z.

2) Predicted outcomes for systems serving ≤4,100 are output from the occurrence model detailed in Ch. 5 of this EA; predicted outcomes for systems serving >4,100 people are from the larger systems model based on 2007 SDWIS violations data.

Notes:

1) For modeling purposes, EPA estimated only the net change in the number of corrective actions performed under the RTCR and Alternative option compared to the 1989 TCR. Because only the net change in the number of corrective actions is estimated, no additional corrective actions are modeled for the 1989 TCR (it is assumed that PWSs are already performing some corrective actions under the 1989 TCR).

2) Results differ slightly from those presented in Ex. 5.10 – 5.15 because they are capturing slightly different time periods of the 30 modeled years. For completeness in discussing the simulation model, Chapter 5 exhibits show 30 years of results, beginning with 5 years of GWR in effect, the last 3 of which also include initial implementation of the RTCR, followed by 25 years of RTCR in effect. Alternatively, Ex. 6.2 – 6.4 include the modeled period that encompasses years 3 - 27 of the 30-year modeling period, including the 3 years of RTCR initial implementation and the 22 years that follow of RTCR in effect. During the 3 years of RTCR initial implementation, under either the RTCR or Alternative option, systems are still working under the requirements of the 1989 TCR and GWR while incurring costs for the initial implementation activities of the new rule requirements.

Exhibit 6.3 Predicted Outcomes (25-Year Period of Analysis) for the RTCR

PWS Size (Population Served)	PWSs Subject to RTCR	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	Number of Level 1 Assessments	Number of Corrective Actions (based on Level 1 Assessments)	Number of Level 2 Assessments (based on Acute Violations)	Number of Level 2 Assessments (based on non-acute triggers)	Number of Corrective Actions (based on Level 2 Assessments)	Level 1 and Level 2 (based on non-acute triggers) Assessments
	A	B	C	D	E	F	G	H	I	J=E+H
Community Water Systems (CWSs) - SW										
≤100	1,170	308,880	-	13,764	400	36	100	102	21	501
101 - 500	2,150	567,600	-	15,660	539	56	119	75	20	615
501-1,000	1,173	309,672	-	8,708	277	27	75	40	12	317
1,001-4,100	2,938	1,951,224	-	33,326	920	95	146	132	29	1,052
4,101-33,000	3,164	10,636,296	-	181,661	2,152	215	197	-	20	2,152
33,001-96,000	720	11,058,960	-	188,880	534	53	56	-	6	534
96,001-500,000	308	10,190,400	-	174,046	233	23	24	-	2	233
500,001-1 Million	31	2,019,600	-	34,493	22	2	-	-	-	22
> 1 Million	17	1,686,960	-	28,812	-	-	-	-	-	-
Totals	**11,671**	**38,729,592**	**-**	**679,350**	**5,076**	**507**	**717**	**349**	**110**	**5,425**
Community Water Systems (CWSs) - GW										
≤100	11,938	2,870,075	8,760	156,897	8,004	791	853	3,523	398	11,527
101 - 500	13,892	3,391,200	6,127	136,906	6,502	669	696	2,399	335	8,901
501-1,000	4,467	1,085,730	1,844	39,659	1,780	168	188	626	85	2,406
1,001-4,100	6,443	4,079,328	-	96,939	3,208	318	342	1,705	206	4,913
4,101-33,000	3,156	9,145,224	-	217,321	4,545	454	263	-	26	4,545
33,001-96,000	335	4,884,000	-	116,060	656	66	53	-	5	656
96,001-500,000	63	1,945,680	-	46,236	129	13	10	-	1	129
500,001-1 Million	4	253,440	-	6,023	-	-	-	-	-	-
> 1 Million	3	269,280	-	6,399	-	-	-	-	-	-
Totals	**40,301**	**27,923,956**	**16,731**	**822,439**	**24,824**	**2,480**	**2,405**	**8,253**	**1,056**	**33,077**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW										
≤100	250	66,000	-	3,040	75	8	28	41	7	116
101 - 500	253	66,792	-	2,169	69	7	19	24	4	93
501-1,000	88	23,232	-	756	24	2	6	9	2	33
1,001-4,100	72	42,768	-	1,228	37	4	13	23	4	59
4,101-33,000	22	50,424	-	1,448	5	0	-	-	-	5
33,001-96,000	2	34,320	-	985	-	-	-	-	-	-
96,001-500,000	1	31,680	-	910	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**688**	**315,216**	**-**	**10,536**	**209**	**22**	**67**	**98**	**17**	**306**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW										
≤100	8,826	932,025	48,142	68,123	4,797	493	559	2,010	254	6,807
101 - 500	6,613	678,688	25,630	35,860	2,794	271	315	757	107	3,552
501-1,000	1,718	180,145	6,166	8,601	675	66	79	168	24	843
1,001-4,100	812	473,352	-	15,887	690	68	114	530	65	1,221
4,101-33,000	70	153,648	-	5,157	123	12	9	-	1	123
33,001-96,000	2	23,760	-	797	4	0	-	-	-	4
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**18,041**	**2,441,617**	**79,938**	**134,426**	**9,084**	**912**	**1,077**	**3,466**	**450**	**12,550**
Transient Noncommunity Water Systems (TNCWSs) - SW										
≤100	1,339	353,496	-	23,122	796	76	250	425	66	1,221
101 - 500	497	131,208	-	8,192	278	27	90	154	25	432
501-1,000	88	23,232	-	1,533	50	5	17	25	4	75
1,001-4,100	67	42,240	-	2,312	73	7	29	69	10	142
4,101-33,000	18	40,656	-	2,225	8	1	-	-	-	8
33,001-96,000	-	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	1	102,960	-	5,636	-	-	-	-	-	-
Totals	**2,010**	**693,792**	**-**	**43,020**	**1,204**	**116**	**386**	**674**	**105**	**1,878**
Transient Noncommunity Water Systems (TNCWSs) - GW										
≤100	60,200	6,076,163	446,166	631,105	47,190	4,755	5,477	20,628	2,593	67,818
101 - 500	19,275	1,940,946	135,822	194,697	13,780	1,363	1,608	5,694	799	19,474
501-1,000	1,963	206,130	14,078	20,078	1,396	143	177	585	76	1,982
1,001-4,100	617	348,480	-	16,027	773	77	117	638	76	1,412
4,101-33,000	67	156,288	-	7,188	116	12	4	-	0	116
33,001-96,000	2	34,320	-	1,578	-	-	-	-	-	-
96,001-500,000	1	26,400	-	1,214	-	-	-	-	-	-
500,001-1 Million	1	63,360	-	2,914	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**82,126**	**8,852,088**	**596,065**	**874,801**	**63,256**	**6,349**	**7,383**	**27,546**	**3,544**	**90,801**
Grand Total	**154,837**	**78,956,260**	**692,734**	**2,564,572**	**103,653**	**10,386**	**12,035**	**40,385**	**5,282**	**144,038**

Source:

1) Appendix A, Exhibit A.2.z.

2) Predicted outcomes for systems serving ≤4,100 are output from the occurrence model detailed in Ch. 5 of this EA; predicted outcomes for systems serving >4,100 people are from the larger systems model based on 2007 SDWIS violations data.

Notes:

1) Estimates of the number of assessments and corrective actions are net increases in activity predicted to occur under the RTCR relative to the 1989 TCR; estimates of "zero" reflect that no additional such activity occurs as compared to baseline (the 1989 TCR).

2) Results differ slightly from those presented in Ex. 5.10 – 5.15 because they are capturing slightly different time periods of the 30 modeled years. For completeness in discussing the simulation model, Chapter 5 exhibits show 30 years of results, beginning with 5 years of GWR in effect, the last 3 of which also include initial implementation of the RTCR, followed by 25 years of RTCR in effect. Alternatively, Ex. 6.2 – 6.4 include the modeled period that encompasses years 3 - 27 of the 30-year modeling period, including the 3 years of RTCR initial implementation and the 22 years that follow of RTCR in effect. During the 3 years of RTCR initial implementation, under either the RTCR or Alternative option, systems are still working under the requirements of the 1989 TCR and GWR while incurring costs for the initial implementation activities of the new rule requirements.

Exhibit 6.4 Predicted Outcomes (25-Year Analysis Period) for the Alternative Option

PWS Size (Population Served)	PWSs Subject to Alternative Option	Number of Routine Monitoring Samples	Number of Additional Routine Monitoring Samples	Number of Repeat Monitoring Samples	Number of Level 1 Assessments	Number of Corrective Actions (based on Level 1 Assessments)	Number of Level 2 Assessments (based on Acute Violations)	Number of Level 2 Assessments (based on non-acute triggers)	Number of Corrective Actions (based on Level 2 Assessments)	Level 1 and Level 2 (based on non-acute triggers) Assessments
	A	B	C	D	E	F	G	H	I	J=E+H
Community Water Systems (CWSs) - SW										
≤100	1,170	308,880	-	13,764	400	36	100	102	21	501
101 - 500	2,150	567,600	-	15,660	539	56	119	75	20	615
501-1,000	1,173	309,672	-	8,708	277	27	75	40	12	317
1,001-4,100	2,938	1,951,224	-	33,326	920	95	146	132	29	1,052
4,101-33,000	3,164	10,636,296	-	181,661	2,152	215	197	-	20	2,152
33,001-96,000	720	11,058,960	-	188,880	534	53	56	-	6	534
96,001-500,000	308	10,190,400	-	174,046	233	23	24	-	2	233
500,001-1 Million	31	2,019,600	-	34,493	22	2	-	-	-	22
> 1 Million	17	1,686,960	-	28,812	-	-	-	-	-	-
Totals	**11,671**	**38,729,592**	**-**	**679,350**	**5,076**	**507**	**717**	**349**	**110**	**5,425**
Community Water Systems (CWSs) - GW										
≤100	11,938	2,908,469	7,545	158,439	7,871	812	926	3,272	432	11,143
101 - 500	13,892	3,428,876	5,264	137,959	6,495	667	747	2,543	322	9,038
501-1,000	4,467	1,098,488	1,616	39,580	1,772	174	203	607	83	2,379
1,001-4,100	6,443	4,079,328	-	96,939	3,208	318	342	1,705	206	4,913
4,101-33,000	3,156	9,145,224	-	217,321	4,545	454	263	-	26	4,545
33,001-96,000	335	4,884,000	-	116,060	656	66	53	-	5	656
96,001-500,000	63	1,945,680	-	46,236	129	13	10	-	1	129
500,001-1 Million	4	253,440	-	6,023	-	-	-	-	-	-
> 1 Million	3	269,280	-	6,399	-	-	-	-	-	-
Totals	**40,301**	**28,012,784**	**14,425**	**824,956**	**24,675**	**2,504**	**2,544**	**8,127**	**1,077**	**32,802**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW										
≤100	250	66,000	-	3,040	75	8	28	41	7	116
101 - 500	253	66,792	-	2,169	69	7	19	24	4	93
501-1,000	88	23,232	-	756	24	2	6	9	2	33
1,001-4,100	72	42,768	-	1,228	37	4	13	23	4	59
4,101-33,000	22	50,424	-	1,448	5	0	-	-	-	5
33,001-96,000	2	34,320	-	985	-	-	-	-	-	-
96,001-500,000	1	31,680	-	910	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**688**	**315,216**	**-**	**10,536**	**209**	**22**	**67**	**98**	**17**	**306**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW										
≤100	8,826	1,314,175	36,965	91,416	5,673	562	723	3,390	399	9,063
101 - 500	6,613	976,627	19,382	48,269	3,551	356	446	1,333	183	4,884
501-1,000	1,718	249,760	4,802	11,817	814	81	99	298	41	1,112
1,001-4,100	812	473,352	-	15,887	690	68	114	530	65	1,221
4,101-33,000	70	153,648	-	5,157	123	12	9	-	1	123
33,001-96,000	2	23,760	-	797	4	0	-	-	-	4
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**18,041**	**3,191,322**	**61,149**	**173,343**	**10,855**	**1,080**	**1,393**	**5,551**	**689**	**16,406**
Transient Noncommunity Water Systems (TNCWSs) - SW										
≤100	1,339	353,496	-	23,122	796	76	250	425	66	1,221
101 - 500	497	131,208	-	8,192	278	27	90	154	25	432
501-1,000	88	23,232	-	1,533	50	5	17	25	4	75
1,001-4,100	67	42,240	-	2,312	73	7	29	69	10	142
4,101-33,000	18	40,656	-	2,225	8	1	-	-	-	8
33,001-96,000	-	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-	-
> 1 Million	1	102,960	-	5,636	-	-	-	-	-	-
Totals	**2,010**	**693,792**	**-**	**43,020**	**1,204**	**116**	**386**	**674**	**105**	**1,878**
Transient Noncommunity Water Systems (TNCWSs) - GW										
≤100	60,200	9,524,123	333,524	912,589	57,597	5,737	7,796	37,532	4,450	95,129
101 - 500	19,275	3,021,771	104,732	282,740	17,358	1,616	2,441	10,924	1,337	28,282
501-1,000	1,963	304,534	10,412	27,932	1,661	163	230	1,015	123	2,676
1,001-4,100	617	348,480	-	16,027	773	77	117	638	76	1,412
4,101-33,000	67	156,288	-	7,188	116	12	4	-	0	116
33,001-96,000	2	34,320	-	1,578	-	-	-	-	-	-
96,001-500,000	1	26,400	-	1,214	-	-	-	-	-	-
500,001-1 Million	1	63,360	-	2,914	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-	-
Totals	**82,126**	**13,479,275**	**448,667**	**1,252,181**	**77,506**	**7,605**	**10,589**	**50,109**	**5,986**	**127,615**
Grand Total	**154,837**	**84,421,981**	**524,241**	**2,983,387**	**119,526**	**11,834**	**15,695**	**64,908**	**7,983**	**184,433**

Source:
1) Appendix A, Exhibit A.3.z.
2) Predicted outcomes for systems serving ≤4,100 are output from the occurrence model detailed in Ch. 5 of this EA; predicted outcomes for systems serving >4,100 people are from the larger systems model based on 2007 SDWIS violations data.

Notes:
1) Estimates of the number of assessments and corrective actions are net increases in activity predicted to occur under the Alternative option relative to the 1989 TCR; estimates of "zero" reflect that no additional such activity occurs as compared to baseline (the 1989 TCR).
2) Results differ slightly from those presented in Ex. 5.10 – 5.15 because they are capturing slightly different time periods of the 30 modeled years. For completeness in discussing the simulation model, Chapter 5 exhibits show 30 years of results, beginning with 5 years of GWR in effect, the last 3 of which also include initial implementation of the RTCR, followed by 25 years of RTCR in effect. Alternatively, Ex. 6.2 – 6.4 include the modeled period that encompasses years 3 - 27 of the 30-year modeling period, including the 3 years of RTCR initial implementation and the 22 years that follow of RTCR in effect. During the 3 years of RTCR initial implementation, under either the RTCR or Alternative option, systems are still working under the requirements of the 1989 TCR and GWR while incurring costs for the initial implementation activities of the new rule requirements.

Exhibit 6.5 Predicted Average Annual Acute Violations by Regulatory Option and System Type[1]

PWS Size (Population Served)	Number of Systems	1989 TCR	RTCR	Alternative Option
Community Water Systems (CWSs) - SW				
≤100	1,170	7	5	5
101-500	2,150	8	5	5
501-1,000	1,173	5	3	3
1,001-4,100	2,938.0	7.4	6.6	6.6
4,101-33,000	3,164	9	9	9
33,001-96,000	720	3	3	3
96,001-500,000	308	1	1	1
500,001-1 Million	31	0	0	0
> 1 Million	17	0	0	0
Totals	**11,671**	**39**	**33**	**33**
Community Water Systems (CWSs) - GW				
≤100	11,938	52	39	42
101-500	13,892	47	32	34
501-1,000	4,467	13	9	9
1,001-4,100	6,443	22	16	16
4,101-33,000	3,156	12	12	12
33,001-96,000	335	2	2	2
96,001-500,000	63	0	0	0
500,001-1 Million	4	0	0	0
> 1 Million	3	0	0	0
Totals	**40,301**	**148**	**109**	**116**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW				
≤100	250	2	1	1
101-500	253	1.3	0.9	0.9
501-1,000	88	0.4	0.3	0.3
1,001-4,100	72	0.9	0.6	0.6
4,101-33,000	22	0	0	0
33,001-96,000	2	0	0	0
96,001-500,000	1	0	0	0
500,001-1 Million	0	0	0	0
> 1 Million	0	0	0	0
Totals	**688**	**4**	**3**	**3**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW				
≤100	8,826	39	25	33
101-500	6,613	20.31	14.31	20.29
501-1,000	1,718	4.31	3.61	4.51
1,001-4,100	812	8	5	5
4,101-33,000	70	0	0	0
33,001-96,000	2	0	0	0
96,001-500,000	0	0	0	0
500,001-1 Million	0	0	0	0
> 1 Million	0	0	0	0
Totals	**18,041**	**72**	**49**	**63**
Transient Noncommunity Water Systems (TNCWSs) - SW				
≤100	1,339	20	11	11
101-500	497	8	4	4
501-1,000	88.00	1.25	0.79	0.79
1,001-4,100	67.0	2.3	1.3	1.3
4,101-33,000	18	0	0	0
33,001-96,000	0	0	0	0
96,001-500,000	0	0	0	0
500,001-1 Million	0	0	0	0
> 1 Million	1	0	0	0
Totals	**2,010**	**31**	**18**	**18**
Transient Noncommunity Water Systems (TNCWSs) - GW				
≤100	60,200	302	249	354
101-500	19,275	94.93	73.11	110.96
501-1,000	1,963	10.07	8.04	10.47
1,001-4,100	617	8	5	5
4,101-33,000	67	0	0	0
33,001-96,000	2	0	0	0
96,001-500,000	1	0	0	0
500,001-1 Million	1	0	0	0
> 1 Million	0	0	0	0
Totals	**82,126**	**416**	**336**	**481**
Grand Total	**154,837**	**710**	**547**	**713**

Source:
Output from RTCR models as described in Sections 5.3 and 5.4 of this EA for systems serving <4,100 people and systems serving >4,100 people.
Note:
Monitoring activates under RTCR begin in year 4 after rule promulgation. Therefore to represent the average annual acute violations occurring over the 25-year modeled time period, the total number of violations is divided by 22 years where monitoring activities are conducted.

Exhibit 6.6 Predicted Change in Average Annual Acute Violations by Regulatory Option and System Type

PWS Size (Population Served)	RTCR	Alternative Option
Community Water Systems (CWSs) - SW		
≤100	-36%	-36%
101-500	-29%	-29%
501-1,000	-27%	-27%
1,001-4,100	-10%	-10%
Totals	**-17%**	**-17%**
Community Water Systems (CWSs) - GW		
≤100	-25%	-19%
101-500	-32%	-27%
501-1,000	-34%	-29%
1,001-4,100	-28%	-28%
Totals	**-26%**	**-22%**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW		
≤100	-20%	-20%
101-500	-35%	-35%
501-1,000	-32%	-32%
1,001-4,100	-30%	-30%
Totals	**-28%**	**-28%**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW		
≤100	-35%	-15%
101-500	-30%	0%
501-1,000	-16%	5%
1,001-4,100	-32%	-32%
Totals	**-32%**	**-12%**
Transient Noncommunity Water Systems (TNCWSs) - SW		
≤100	-42%	-42%
101-500	-47%	-47%
501-1,000	-37%	-37%
1,001-4,100	-43%	-43%
Totals	**-43%**	**-43%**
Transient Noncommunity Water Systems (TNCWSs) - GW		
≤100	-18%	17%
101-500	-23%	17%
501-1,000	-20%	4%
1,001-4,100	-37%	-37%
Totals	**-19%**	**16%**
Grand Total	**-23%**	**1%**

Source:
Exhibit 6.5. Percentages may not match results calculated directly from exhibit 6.5 due to rounding in exhibit 6.5.
Notes:
1) Monitoring activates under RTCR begin in year 4 after rule promulgation. Therefore to represent the average annual acute violations occurring over the 25-year modeled time period, the total number of violations is divided by 22 years where monitoring activities are conducted.
2) Negative changes indicate reductions in the number of acute violations under either option in comparison to the 1989 TCR; positive changes indicate increases in acute violations. As described further in Section 6.4, a net increase in acute violations is caused by increased diagnostic power from increased sampling.
Systems serving >4,100 were omitted from this table because there were no changes predicted in the number of violations to be incurred.

6.3.1.3 Overall Assessment of Predictive Analysis Results

For PWSs serving ≤4,100 people, EPA expects risk to decrease under the RTCR and Alternative option as compared to the 1989 TCR. As shown by the year by year detail of the output provided in Appendix A of this EA and summarized in Exhibits 5.16–5.21, risk is further reduced for PWSs under the Alternative option relative to baseline (the 1989 TCR) for the first 5 years after the effective date as compared to the RTCR relative to baseline. This additional reduction in risk under the Alternative option is driven by the increase in additional sampling that would occur while all systems were still on monthly sampling. Over time, some of these systems could qualify to move from monthly to quarterly under either the RTCR or the Alternative option, or from quarterly to annual sampling under the RTCR. Unlike the RTCR, no systems under the Alternative option would be able to sample annually. However, additional costs are incurred under the Alternative option for this increased monitoring, especially for the systems most impacted by the RTCR (TNCWSs serving ≤500 people). Chapter 7 presents the full discussion of costs associated with implementation of the regulatory options considered.

When considering the period beginning in Year 9 after RTCR promulgation through the end of the period of analysis (model year 11 in Exhibits 5.16–5.21), the RTCR and Alternative option generally have similar estimates of occurrence. Year 9 after RTCR promulgation represents the first year of the steady state for monitoring regimens, when all PWSs that qualified for reduced monitoring are following their new regimens. However, for some categories and sizes of PWSs the RTCR actually has a lower rate of occurrence than the Alternative option. This may occur because states under the RTCR may have more resources available to perform the annual site visits at more PWSs based on states needing fewer resources for activities related to monitoring (tracking, compliance) than under the Alternative option. Appendix B includes graphs of predicted occurrence for each of the size and PWS categories considered in this analysis.

EPA does not expect changes in risk for the PWSs serving >4,100 people under the RTCR to be as significant as they are for the systems serving ≤4,100 people. Systems serving >4,100 people are starting from a smaller baseline level of occurrence than systems serving ≤4,100 people, and have a correspondingly lower level of triggered assessment and correction action activity. This suggests that such small percentage increases in these activities will result in relatively less change in risk, although the expected change is still a reduction in risk. Additionally, monitoring requirements for PWSs serving >4,100 people would remain essentially unchanged under either the RTCR or the Alternative option as compared to the 1989 TCR. Thus the observed overall net increase in benefits (and costs) for PWSs serving >4,100 people is driven by the requirements to conduct assessments and to correct any sanitary defects that are found. The increase of 10% from baseline in effective corrective actions implemented applies to systems serving >4,100 people just as it does to systems serving ≤4,100 people; however, as shown in Chapter 4 (Exhibit 4.10), the systems serving >4,100 people have a much smaller level of violations than systems serving ≤4,100 people, based on reasons discussed in Chapter 5 (Section 5.4). Therefore, increases in corrective actions will be less evident in absolute (not percentage) terms.

6.4 Uncertainty and Sensitivity Analyses

Key sources of uncertainty in the estimates provided in this EA include the data used to develop baseline estimates and the assumptions made regarding model input variables, as described in Chapters 4 and 5 of this EA, respectively. The quality and representativeness of the data used in this EA are discussed in Section 4.2, while uncertainty in model input variables is discussed in Section 5.3.3.1. A summary of assumptions made in developing the baseline and input parameters to the predictive model that contribute uncertainty to the analysis are included in Chapters 4 and 5 (Exhibits 4.13 and 5.22a–b). By definition, those uncertainty factors that are incorporated into the baseline will have a similar effect on the 1989 TCR, the RTCR and Alternative option; therefore, EPA believes that they will not significantly affect the net results of the EA. These assumptions are shown in Ex. 5.22a, and include the estimates representing GWR effects. Although EPA believes its GWR efficacy estimates are conservative, the estimates are applied in similar fashion to the baseline (1989 TCR) and RTCR and Alternative option; therefore, any bias that could be introduced is essentially canceled out in the net analysis. By contrast, the assumptions listed in Ex. 5.22b include those assumptions that will affect only the RTCR and Alternative option, such as the assumed increase in the number of effective corrective actions implemented as compared to the 1989 TCR. These types of assumptions are not canceled out in the net analysis, and are expected to have some effect on net results. Therefore, EPA has identified the key drivers of the analysis among this type of assumption and performed a sensitivity analysis on their values (Chapter 5, Section 5.3.3.1).

This discussion focuses on the provisions of the RTCR and Alternative option for conducting corrective actions based on the results of Level 1 and Level 2 assessments performed, and the reductions in repeat samples following TC+ samples and in the additional routine samples required in the month following a TC+. The analyses performed and presented here are intended to provide insight into the overall impact of these two changes in rule provisions under the RTCR, each of which moves risk (as defined in this EA) in opposite directions. Unlike the uncertainty analysis presented in Chapter 5 (Occurrence and Predictive Model), this analysis does not consider variations on the assumptions related to corrective actions, but instead tests the relative impact of changes in the sampling regimen given the assumptions for corrective actions applied in the primary analysis of this EA (and summarized in Section 5.3).

The primary benefit of the RTCR is a potential reduction in exposure to microbial contaminants from drinking water provided by PWSs. Two features of the RTCR are expected to influence the exposure reduction.

The first feature is the requirement to perform corrective actions based on the results of the Level 1 and Level 2 assessments performed in response to their individual triggers. Implementation of additional corrective actions beyond the level currently implemented under the 1989 TCR will reduce exposure to microbial contamination both by addressing the immediate problem identified by the Level 1 or Level 2 assessment and by preventing some additional future exposures to fecal contamination.

The second feature, which primarily affects the smaller systems, is the reduction in the numbers of additional routine and repeat samples that systems are required to take whenever routine samples are found to be TC+. This reduction in sampling may contribute to increased

exposure and risk because fewer samples provide fewer opportunities to identify and address TC and *E. coli* exposures.

The analyses that were performed used the predictive model with the occurrence input parameters for the nondisinfecting GW TNCWS serving <101 people. This set of systems was chosen because: 1) it contains the largest number of systems of the 27 occurrence sets (46,642 systems in this set); 2) it is subject to all of the changes in sampling requirements; and 3) it has the highest routine TC hit rate so that effects on this set of systems are likely to be more pronounced (and therefore more clearly observable) than other sets. The analysis was carried out by running simulations of 10,000 systems each for monthly, quarterly, or annual monitoring schedules.

There were five sampling and corrective action "regimens" considered in the model. As shown in Exhibit 6.7, Regimens 1 through 3 assume a routine sampling regimen equivalent to the 1989 TCR (i.e., 1 regular routine sample and a minimum of five routine samples in the month following a TC+). Regimen 1 is the only one of the five regimens that assumes there are no corrective actions (in addition to those already conducted under the 1989 TCR); Regimens 2 through 5 all assume corrective actions are conducted in accordance with requirements under the RTCR. Regimens 3 through 5 decrease the repeat samples from four to three. Regimen 4 also decreases the minimum number of routine samples in the month following a TC+ from five to three; Regimen 5 uses the sampling requirements of the RTCR where systems doing monthly sampling need only take their one regular routine sample in a month following a TC+, while for those that monitor quarterly and annually, the requirement remains for a minimum of three additional routine samples in the month following a TC+.

In this analysis, Regimen 1 describes the 1989 TCR and Regimen 5 describes the RTCR. Going from Regimen 1 to Regimen 2, where corrective actions are brought in without any change in sampling, provides key insights to the benefits (reduction in exposure) derived from the corrective action aspect of the RTCR. Going from Regimen 2 through Regimen 5 provides some insight into how much of those corrective action benefits might be foregone because of the small reductions in the number of TC samples required.

The metric used for comparing the relative impacts of these five regimens was the number of acute violations based on EC+ assays (referred to as "acutes" throughout this section) because this was considered to be the most relevant measure of the potential microbial health risk-based benefits of the RTCR. The numbers presented are the average annual numbers of acute violations.

It is important to note that in order to isolate the effects of the RTCR corrective actions and sampling changes, this analysis excluded any effect of the GWR. To further understand the effects of sampling regimen, this analysis also presents the results separately for monthly, quarterly, and annual sampling since one of the changes in the RTCR applies only to those on monthly sampling. Exhibit 6.7 provides a summary of the results of this analysis.

Exhibit 6.7 Relative Impacts Analysis for TNCWS Serving <101 People for the Range of Corrective Action and Sampling Regimens Predicted

Regimen	Minimum Samples in Month Following a TC+			Repeat Samples	L1 & L2 CAs?	Average Total TC Samples per Year			Average Acutes Per Year Found			Average Acutes Per Year Prevented			Average Acutes Per Year Missed		
	M	Q	A			M	Q	A	M	Q	A	M	Q	A	M	Q	A
1	5	5	5	4	No	168,252	60,980	15,317	279	106	25						
2	5	5	5	4	Yes	160,394	59,693	15,103	198	92	26	80	14	-1	0	0	0
3	5	5	5	3	Yes	156,779	57,851	14,894	172	79	25	70	12	-1	37	14	2
4	3	3	3	3	Yes	151,500	55,411	14,031	189	82	21	77	13	-1	13	11	5
5	1	3	3	3	Yes	146,129			175			71			32		
											Ratios of Prevented to Found:	**0.41**	**0.15**	**-0.05**			

Key: (CA) = correction action; L1 and L2 = Level 1 and Level 2; M = monthly; Q = quarterly; and A = annual.
Definitions: Acutes "found" are acute violations the model predicts will be identified; acutes "prevented" are those avoided by implementation of CAs; acutes "missed" are those found under the sampling regimen of the 1989 TCR option (Regimen 1) that were not found under the reduced sampling of Regimens 3, 4, and 5 (calculated by subtracting acutes found under Regimens 3, 4, and 5 from those found under Regimen 1).
Notes:
Results shown are averages based on simulations of 10,000 systems each for monthly, quarterly, and annual monitoring using occurrence inputs for nondisinfecting GW TNCWS serving <101 people.
Assumptions for L1 and L2 CA efficacy and resulting duration of reduced occurrence are those used in the primary analysis.
For the purpose of isolating the relative impacts of changes in monitoring regimens and implementation of L1 and L2 CAs, no GWR effects (including GWR corrective actions) are modeled in these runs.
Ratios of acutes "prevented" to those "found" are based on Regimen 2 results, which reflect the 1989 TCR option sampling regimen but includes implementation of L1 and L2 CAs.

Regimen 1, representing the 1989 TCR, provides a baseline against which the other regimens can be compared. Although arguably more acute violations could be found if more routine and repeat samples were taken, the numbers of acute violations shown here as "found" (monthly = 279, quarterly = 106, and annual = 25) represent the maximum number that can be found given the amount of sampling done. This finding is based on analysis using 10,000 simulated systems each for monthly, quarterly, and annual; the sampling scheme under the 1989 TCR; and no additional corrective actions being performed.

Regimen 2 uses the exact same sampling scheme as Regimen 1, but includes the performance of Level 1 and Level 2 corrective actions consistent with the RTCR. Here there is a reduction observed in the number of acutes found for monthly and quarterly sampling although not for annual sampling. Since there is no change in the sampling requirements, differences (and similarities) between Regimen 1 and Regimen 2 numbers are due to: a) the implementation of corrective actions under Regimen 2; and b) and random variation that is endemic to the Monte Carlo simulation.

For monthly sampling, which requires a large number of TC samples per year, Monte Carlo variation is relatively small with respect to the effect of the parameter adjustments. Approximately 80 acute violations occur under monthly sampling for Regimen 1 (279 acutes) that do not occur under Regimen 2 (198 acutes) as the result of corrective actions. Quarterly and annual sampling regimens require far fewer TC samples per year, and therefore the Monte Carlo variation may obscure the salient data trends in those model results. For instance, the increase in the number of acutes under annual sampling under Regimen 1 from 25 to 26 under Regimen 2, which is not consistent with the trend seen in the larger sample size in the simulation of monthly systems, is likely to be reflective of stochastic noise from the Monte Carlo simulation performed rather than of the impact of corrective actions. For this reason most of the discussion that follows on the trends across these regimens focuses on the monthly sampling results.

Regimen 3 reflects the reduction in repeat sampling requirements of four to three following a TC+. As would be expected, this also results in a small reduction in the number of acutes found. For example, in the monthly sampling group this falls from 198 to 172. Using an

assumption that the ratio of acutes prevented to acutes found in Regimen 2 apply to the other regimens as well, then results for the monthly sampling group (where 80/198 = 0.41 for Regimen 2) indicate that 70 acutes are still prevented under Regimen 3. The sum of those found under Regimen 3 (172) and those prevented under Regimen 3 (70) for the group of systems on monthly sampling is 242. This implies, then, that as a result of the reduction in repeat sampling from four to three, a total of 37 acutes are missed under Regimen 3. 279 acutes are found under the 1989 TCR sampling regimen (Regimen 1); therefore, the number of acutes missed is calculated as 279 – (172+70) = 37. That is, these 37 acute violations are neither found nor prevented under Regimen 3, but are assumed to occur unobserved.

Regimen 4 reduces the number of routines in a month following a TC+ from five to three, but retains the three repeats and the corrective action requirements. The number of acutes now "missed" changes to 13, 11, and 5 respectively for those on monthly, quarterly, and annual sampling.

Regimen 5, which represents the RTCR, excludes any additional routine samples in the month following a TC+ for those on monthly sampling. Here the number of "missed" acutes for those on monthly increases from 13 to 32. There are no changes for those on quarterly or annual sampling relative to Regimen 4 since systems sampling quarterly and annually are treated identically in both scenarios.

In addition to displaying the changes in the number of annual average acutes for these five regimens, Exhibit 6.7 also shows the average annual number of TC samples (regular routine, additional routines and repeat samples) taken. The number of samples declines considerably across the regimens due both to the reduction in actual sampling requirements and to reduced number of additional routines and repeats that need to be taken because of the prevention of TC occurrence by the corrective actions taken.

This analysis points first and foremost to the highly positive public health benefits of including the corrective actions as part of the RTCR (based on the modest assumptions regarding their effectiveness used in the occurrence analysis detail in Chapter 5 of this EA). This is seen not only in the number of acutes that are found for which corrective actions may be performed, but also—and perhaps more importantly—in the large number of additional acutes that are prevented from occurring again in those systems as a result of the corrective actions.

While some of these potential benefits are "missed" as a result of the reductions in additional routine and repeat sampling requirements, these numbers (shown in Exhibit 6.7) seem small when compared to the numbers found and prevented. This is particularly important when considering the potential cost savings from reducing the number of TC samples that are taken, as discussed in Chapter 9 (Net Benefits) of this EA.

The group of 61,539 TNCWSs serving ≤100 currently has, and will continue to have, a vast majority of systems on either quarterly or annual sampling in the steady state of the analysis period, beginning in approximately Year 9 after RTCR promulgation. Since quarterly and annual estimates of acutes are less stable, predictions for this specific subset of systems are less reliable. Nonetheless, since approximately 40% of systems affected by the RTCR are on monthly sampling, the trends in the monthly numbers cited above should be indicative of trends for other

types and sizes of systems included in this model (those serving ≤4,100 people). That is, relative to the 1989 TCR, the inclusion of the Level 1 and Level 2 corrective actions will always result in more benefits accruing from corrective actions being performed and acute violations being avoided than the relatively small reductions in sample numbers will result in "missing" acute violations.

Because all of the other system types have lower overall TC and *E. coli* hit rates than the nondisinfecting GW TNCWS serving <101 people, on a per system basis their missed acute violations would be fewer than those estimated for the set of systems addressed in this analysis. Furthermore, for the systems serving 1,001 to 4,100 people where the RTCR change in the minimum number of samples to be taken in the month following a TC+ is smaller, the number of missed acute violations would be less than that seen in this analysis for the systems serving <101 people. For example, for systems serving 3,301 to 4,100 (which are all on monthly sampling), the minimum number of next month samples is reduced from five to four compared with a reduction from five to one for the systems serving fewer than 1,001 people that perform monthly sampling. Thus this analysis presents an estimate that is near the higher end of the range for various system types in expected missed acute violations due to reduced sampling requirements under the RTCR. In spite of this conservative estimate, the effect of the RTCR requirements for corrective actions more than balances this effect with a larger change in risk in the opposite (reducing) direction, as shown by the relatively large number of prevented to missed acute violations.

6.5 Other Potential Benefits

A number of other benefits may accrue to PWSs and their populations served that are not included in the qualitative relative risk comparison or reductions in occurrence discussed in Sections 6.1–6.4 (above), they are described in the following sections.

6.5.1 Increased System Knowledge

By requiring additional assessments focused on isolating and identifying system problems in response to TC+ or EC+ samples, the RTCR will increase the likelihood that PWS operators, in particular those of systems triggered to conduct assessments, will develop further general understanding of system operations and potential issues. This heightened familiarity with the system may increase preventive maintenance, or may increase the efficiency with which future problems are identified, decreasing risk to the PWS population served in both cases. Delaying system component replacement costs or avoiding an increase in treatment costs may also result from this increased knowledge and result in cost savings for some communities.

6.5.2 Accelerated Infrastructure Repair/Replacement

As described in 6.5.1 (above), the increased familiarity of operators with their systems may encourage an increase in preventive maintenance, preempting some potential contamination issues and decreasing risk for the PWS population served. Some systems may see additional non-quantified benefits associated with the acceleration of their capital replacement fund investments in response to early identification of impending problems with large capital components. Although such capital investment would have occurred anyway, earlier investment may ensure

that problems are addressed in a preventive manner and may preclude some decrease in protection that may have occurred otherwise. At the very least, the increased operator awareness should reduce the occurrence of unplanned capital expenditures in any given year.

6.5.3 Reduction in Averting Behavior

As the risk of contamination is reduced in PWSs over time following RTCR promulgation, EPA expects that the public will eventually become aware of increased quality, and consistency of quality, of their water. This may lead to PWS customers becoming increasingly comfortable with drinking tap water and cause them to exercise less averting behavior (e.g., drinking bottled water or using point of use filtration devices). Such averting behaviors are costly relative to consuming tap water.

6.5.4 Reduction of Co-Occurring and Other Contaminants

In addition to the specific *E. coli* endpoint targeted by the RTCR, there are many potentially co-occurring and emerging pathogens (such as viruses, parasitic protozoa and/or other bacteria) that may be avoided as part of any avoided contamination event. To the extent that *E. coli* co-occurs with pathogens sufficiently in abundance to result in health effects, the RTCR offers the potential for additional morbidity and mortality prevention.

Potential benefits from the RTCR include avoidance of a full range of health effects, including acute and chronic illness, endemic and epidemic disease, associated outbreaks and death that may occur from the consumption of fecally contaminated drinking water. Also, since fecal contamination may contain waterborne pathogens including bacteria, viruses, and parasitic protozoa, in general, a reduction in fecal contamination should also reduce the risk from these other contaminants.

Systems may choose corrective actions that also address other drinking water contaminants. For example, correcting for a pathway of potential contamination into the distribution system can mitigate a variety of potential contaminants. Due to a lack of contamination co-occurrence data that quantify the effect that treatment corrective action may have on contamination entering through distribution system pathways, EPA has not quantified such potential benefits.

6.5.5 Reduction in Outbreak Risk and Response Costs

Besides reducing the endemic risk of illnesses from waterborne pathogens, the RTCR would reduce the likelihood of major outbreaks from occurring. These avoided illnesses and other costs are not estimated or included in the RTCR analyses and would be difficult to quantify. The economic value of reducing the risk of outbreaks could be quite high when the magnitude of potential costs is considered. The Agency was unable to quantify or monetize the cost associated with acute and chronic illnesses or death acquired from consuming water contaminated with waterborne pathogens because cases avoided could not be calculated, as described in Section 6.2. Examples of potential illnesses associated with ingestion of waterborne pathogens and their potential costs are described in Chapter 2 of this EA.

Other types of costs associated with outbreaks include spending by local, state, and national public health agencies; emergency corrective actions by utilities; and possible legal costs if liability is a factor. Affected water systems and local governments may incur costs through provisions of alternative water supplies and issuing customer water use warnings and health alerts. Commercial establishments (e.g., restaurants) and their customers may incur costs due to interrupted and lost service. Local businesses, institutions, and households may incur costs associated with undertaking averting and defensive actions. Thus, to the extent that the RTCR reduces the likelihood of waterborne disease outbreaks, avoided response costs are potentially numerous and significant. For example, an analysis of the economic impacts of a waterborne disease outbreak in Walkerton, Ontario (population 5,000) estimated the economic impact (excluding estimates of the value of a statistical life for seven deaths and intangible costs for illness-related suffering) to be over $45.9 million[47] in 2007 Canadian dollars (approximately 42.8 million 2007 U.S. dollars)[48] (Livernois, 2002). Note that some of these costs were incurred by individuals and businesses in neighboring communities. The author believed that this was a conservative estimate.

[47] Households and businesses in the town of Walkerton were unable to use municipal water for eight months following the contamination event. The response involved a massive effort at all levels of government in terms of public health response and investigation of the cause. The paper asserts that the impact of the crisis extended beyond Walkerton to nearby towns and the countryside, resulting in economic costs that the author expects were at a minimum equal to the costs presented in the paper (of which only the non-medical costs are included here).

[48] Updated from $43 million in Canadian dollars, $32 million U.S. dollars in 2000. Costs updated from 2000 dollars to 2007 dollars using the Canadian core CPI (= 95.71667 ÷ 109.8167 = 1.14731) and the 2007 exchange rate (1.0734 Canadian dollars /1.0 U.S. dollars).

7 Cost Analysis

7.1 Introduction

This chapter presents estimates of the total national and household costs of the Revised Total Coliform Rule (RTCR). To estimate the national costs of the RTCR, the United States Environmental Protection Agency (EPA or Agency) calculated the net change in costs (i.e., incremental costs over the 1989 Total Coliform Rule (1989 TCR)) of rule components associated with state[49] practices and system activities required under the revised rule. The remainder of this chapter provides detailed discussion of the methodology used and results from the cost analyses and is organized as follows:

- **Section 7.2** describes the cost model and general costing and compliance assumptions used to estimate national costs of the RTCR.
- **Section 7.3** describes the methodology of projecting costs over a 25-year period (discounted at 3 and 7 percent, respectively) according to the RTCR compliance schedule, estimating the present value of each cost, and annualizing each over a 25-year period.
- **Section 7.4** describes the methodology for developing costs for all rule activities.
- **Section 7.5** presents household cost estimates.
- **Section 7.6** presents a discussion of non-quantified costs.
- **Section 7.7** presents a discussion of uncertainties in cost estimates.
- **Section 7.8** presents a comparison of cost estimates for all regulatory options.

7.2 General Cost Assumptions and Methodology

The RTCR cost model builds on the baseline data, occurrence analysis, and benefits model results described in Chapters 4–6. Based on these analyses, the annual and cumulative numbers of public water systems (PWSs) that would be required to comply with each rule component of the RTCR over the 25-year compliance period are provided in Appendix A (Exhibits 6.2–6.4 provide a summary of this information). In general, the numbers of PWSs presented in Appendix A are multiplied by the unit cost assumptions described in this chapter to calculate total annual costs.

There are also several general costing assumptions that are unique to the costing process and are used as inputs to the cost model. The derivation of these inputs is discussed in detail below.

[49] The term "state" in the context of this chapter refers to any state or other primacy agency that has oversight authority for drinking water programs.

7.2.1 Labor Rates

For costing purposes, EPA estimates the labor needs and hourly labor rates of PWSs and states. EPA recognizes that there may be significant variation in labor rates across all PWSs. However, for purposes of this economic analysis (EA), and to implement national policy, EPA uses national-level estimates from *Labor Costs for National Drinking Water Rules* (USEPA, 2003a) (as used in the *Ground Water Rule Economic Analysis* (USEPA, 2006a)). For the RTCR cost analyses, these labor rates were inflated to 2007$ using the Employee Cost Index (ECI), and weighted based on the PWS size categories used in the RTCR EA. To account for the general composition of staff at PWSs of smaller sizes (e.g., PWSs serving 3,300 or fewer), EPA uses only the technical rate. For PWSs serving more than 3,300 people, EPA uses a ratio of 80 percent technical labor to 20 percent managerial labor to arrive at a labor cost, or weighted labor rate. The actual ratio between technical and managerial rates employed may vary by PWS and among the different compliance activities under the RTCR. However, for simplicity, the 80/20 ratio is used as a general assumption for costing purposes in this EA. A full description of the derivation of the labor rates used is provided in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d). The weighted labor rates ($2007) are shown in Exhibit 7.1.

Exhibit 7.1 Labor Rates by PWS Size (2007$)

PWS Size (population served)	Weighted Labor Rate ($/hour)
≤ 100	$ 25.10
101 - 500	$ 27.03
501 - 1,000	$ 28.96
1,001 - 4,100	$ 29.73
4,101 - 33,000	$ 36.00
33,001 - 96,000	$ 36.39
96,001 - 500,000	$ 41.01
500,001-1 Million	$ 41.01
> 1 Million	$ 41.01

Note: Labor rates for each size category are assumed to be the same regardless of system type (CWS, NTNCWS, and TNCWS).

Source: Final RTCR T&C Document

For states, the administrative and field engineer labor rates from the *2001 State Drinking Water Needs Analysis* (ASDWA, 2001) are used in the RTCR EA (as used in the Ground Water Rule (GWR) EA (USEPA, 2006a)). These rates include a 60 percent overhead rate and were inflated to 2007$ using the ECI. EPA recognizes that there may be significant variation in labor rates across all states. The state labor rates in 2007$ are $39.22 for an administrative state employee and $43.58 for a state field engineer. EPA assumes that the state field engineer would conduct annual site visits,[50] and the administrative state employee would work with PWSs on all remaining aspects of the RTCR. Because this separation between field engineer and

[50] Because of the high cost for an annual site visit by a state, for this analysis, EPA assumes that no states would choose to conduct annual site visits unless they already do so under the 1989 TCR. See section 7.4.4 for additional information.

administrative employee is used, the 80/20 weighting ratio between technical and managerial rates is not used to develop state costs.

7.2.2 TCR Monitoring Costs per Sample

A cost per sample is associated with distribution system monitoring. For the purpose of this cost analysis, PWSs would perform total coliform (TC) monitoring, supplemented by *E. coli* analyses as required. EPA estimated the sample analysis cost for both in-house and commercial laboratory analysis. The weighted unit costs for monitoring provided in Exhibit 7.2 are based on the percentage of PWSs conducting in-house and commercial laboratory analysis based on conversations of the Total Coliform Rule Distribution System Advisory Committee (TCRDSAC) Technical Workgroup (TWG). For in-house sample analysis, the estimated burden includes sample collection and analysis and also accounts for operations and maintenance (O&M) costs such as equipment and maintenance. For commercial laboratory analysis, the estimated burden includes sample collection, shipping and delivery, and the laboratory analysis fee. These estimates reflect a national average; however, individual PWSs may realize collection burden that is either less than or greater than this average depending on the locations of sampling points in a particular PWS.

Rates may vary due to regional variations in laboratory fees, the number of samples processed (quantity discounts), and laboratory capacity. As shown in Exhibit 7.2, the cost per sample decreases as more samples are taken, and as PWSs take advantage of savings from bulk shipping. A full description of the derivation of the monitoring costs per sample is provided in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

Exhibit 7.2 Monitoring Costs per Sample (2007$)

PWS Size (population served)	Numbers of Samples Taken and Delivered at the Same Time				
	1	2	3	4	≥ 5
≤ 100	$ 50.54	$ 42.64	$ 40.01	$ 38.69	$ 37.90
101 - 500	$ 51.55	$ 43.63	$ 40.99	$ 39.67	$ 38.87
501 - 1,000	$ 59.81	$ 51.86	$ 49.21	$ 47.88	$ 47.09
1,001 - 4,100	$ 60.40	$ 52.45	$ 49.79	$ 48.47	$ 47.67
4,101 - 33,000	$ 65.26	$ 57.23	$ 54.55	$ 53.21	$ 52.40
33,001 - 96,000	$ 60.57	$ 56.55	$ 55.21	$ 54.54	$ 54.14
96,001 - 500,000	$ 72.38	$ 71.57	$ 71.30	$ 71.17	$ 71.09
500,001-1 Million	$ 72.38	$ 71.57	$ 71.30	$ 71.17	$ 71.09
> 1 Million	$ 72.38	$ 71.57	$ 71.30	$ 71.17	$ 71.09

Note: Per sample monitoring costs for each size category are assumed to be the same regardless of PWS type (CWS, NTNCWS, and TNCWS).
Source: Final RTCR T&C Document

7.2.3 Technology Unit Costs and Compliance Forecasts

EPA has assumed that PWSs may use a variety of existing best management practices (BMPs) and technologies to address distribution system deficiencies discovered during Level 1

and Level 2 assessments. These BMPs and technologies include a combination of flushing programs, training of personnel to collect samples, replacing valves/pipes/hydrants/meters, installing new water mains, modifying operation of storage facilities, booster disinfection, physical security devices, etc. For a full list of technologies and BMPs that are anticipated to be used to meet rule requirements, see Appendix D. EPA estimated unit costs for these various components using equipment price lists and quotes, costs associated with BMPs from PWSs, engineering cost data sources (e.g., Means, 1998), consultations with the TWG supporting the TCRDSAC Federal Advisory Committee (FAC), and other relevant assumptions used in economic analyses performed for existing drinking water rules (e.g., GWR). Detailed explanations of the unit cost derivations for these BMPs and technologies are presented in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

Compliance forecasts (or technology selection forecasts) are estimates of which technologies PWSs undergoing corrective action would use. Section 7.4.6 provides details on compliance forecasts for PWSs performing corrective actions based on Level 1 and Level 2 assessments.

7.2.4 Cost Model

National costs are estimated using a cost model specifically developed for the RTCR. The model builds on the occurrence model described in Chapter 5. Within the modeling structure, costs for PWSs serving >4,100 retail customers are analyzed differently from smaller PWSs to capture differing baseline structures and to account for differences in available occurrence data as described in Chapter 4.

PWS costs are estimated for different PWS types and size categories (nine size categories are used based on population served, consistent with the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d)). PWS cost analyses include estimates to implement the rule; to revise sample siting plans; to conduct routine monitoring, additional routine monitoring, and repeat monitoring; to perform Level 1 and Level 2 assessments and implement corrective actions; and to provide public notification (PN). State cost analyses include estimates of the labor burdens that states would face, including staff training on RTCR requirements and conducting annual administration, reviewing monitoring reports, reviewing assessments, reviewing and approving corrective action plans, and recordkeeping. Section 7.4 provides detailed discussion on the underlying cost-buildup for each rule component analyzed within the cost model.

7.2.5 Modeled Variability and Uncertainty in National Costs

As noted throughout this EA, there is variability among many of the input parameters to the RTCR cost model and several rule compliance assumptions based on PWS size and type (e.g., population served, labor rates, TC hit rates, and occurrence distributions are different for different sizes and types of PWSs). However, there is insufficient information to fully characterize the distribution of variability (i.e., calculating confidence bounds) within each of these PWS size and type classifications on a national scale; therefore, EPA uses mean values for these input parameters.

EPA also recognizes that there is uncertainty in the national cost estimates, much of which has the same impact on the modeled results of both the 1989 TCR and RTCR (e.g., baseline assumptions and effects of GWR implementation). Because the EA analyses focus on net changes between the 1989 TCR and the RTCR, these common sources of uncertainty cancel each other out in the net change analyses. For assumptions that are major drivers of the analysis and differ between the 1989 TCR and RTCR (e.g., corrective action compliance forecast), EPA has evaluated uncertainty and performed sensitivity analyses to qualitatively and quantitatively characterize the potential impacts of alternative input parameters. Chapter 5 discusses uncertainty and presents sensitivity analyses pertaining to the predictive occurrence model results, which also impact the cost calculations. Section 7.7 discusses uncertainty and provides sensitivity analysis results as they specifically pertain to the cost analyses.

7.3 Projecting and Discounting National Costs

Costs must be expressed in common units so they can be added together to calculate total annual costs and compared to benefits. For the RTCR, the performance of activities varies over time in response to regulatory requirements and monitoring results. To compare the values of performing these activities, the year or years in which all costs are expended must be determined and the costs must be calculated as a net present value. For the purposes of this EA, one-time and yearly costs were projected over a 25-year time period to allow comparison with other drinking water regulations using the same analysis period. The net present values of costs are calculated using discount rates of 3 and 7 percent based on EPA policy and guidance from the Office of Information and Regulatory Affairs of the Office of Management and Budget (OMB).[51] A summary of the steps used in making adjustments to the national-level costs presented in this EA is as follows:

- Estimate all costs (noncorrective action, corrective action, and state) over a 25-year time horizon based on the rule implementation schedule.
- Calculate total net present value costs using 3 and 7 percent discount rates.
- Annualize the costs over 25 years using the same discount rates.

Appendix C presents step-by-step results for the projection and discounting of costs to show how yearly costs for each rule component are accounted for by the cost model for community water systems (CWSs), nontransient noncommunity water systems (NTNCWSs), transient noncommunity water systems (TNCWSs), and states. Exhibits C.1 through C.9 show the nominal costs projected over the rule schedule and the present value of each cost calculated to the expected year of rule implementation for the 1989 TCR. Exhibits C.10 through C.45 show the results for the RTCR and the Alternative option.

[51] The choice of an appropriate discount rate is a complex and controversial issue among economists and policy makers. Therefore, the Agency compares streams of future national level costs and benefits using two alternative discount rates, 3 and 7 percent. The underlying logic for each discount rate can be found in *Guidelines for Preparing Economic Analyses* (USEPA, 2000).

7.4 Derivation of Costs for PWSs and States

This section presents the methodology and unit costs used to derive national costs for PWSs and states to perform 1989 TCR- and RTCR-related activities. Chapter 3 contains detailed summaries of the activities under the 1989 TCR, RTCR, and Alternative option. The following subsections provide a brief summary of each activity and the assumptions used to estimate the burden and costs attributable to both PWSs and states for:

7.4.1 Rule Implementation and Annual Administration
7.4.2 Revise Sample Siting Plan
7.4.3 Monitoring
7.4.4 Annual Site Visits
7.4.5 Assessments
7.4.6 Corrective Actions
7.4.7 Public Notification

This chapter uses information from the baseline analysis in Chapter 4 as a starting point for analysis of PWSs subject to each rule requirement. Additional baseline information and detailed intermediate model outputs are provided in Appendix A. There are also 57 states and primacy agencies that would incur costs as a result of the rule.

7.4.1 Rule Implementation and Annual Administration

PWSs

Under the RTCR and Alternative option, all PWSs subject to the rule would incur one-time costs that include time for staff to read the rule and become familiar with its provisions and to train employees on rule requirements. No additional implementation burden or costs are incurred by PWSs to implement the 1989 TCR, as these PWSs have already performed implementation and are continuing to perform annual administration activities under the 1989 TCR. Under the RTCR and Alternative option, all PWSs subject to the RTCR would perform additional or transitional implementation activities. The labor rates presented in Section 7.2.1 are used along with estimates of labor hours to generate estimated implementation costs for all PWSs. Based on previous experience with rule implementation and consistent with estimates used in the GWR EA, EPA estimates that PWSs would require a total of 4 hours to read and understand the rule, and a total of 8 hours to plan and mobilize (i.e., assign appropriate personnel and resources to carry out rule activities).

Exhibit 7.3 Net Change in PWS Unit Burden and Cost Estimates for Rule Implementation (2007$)

PWS Size (Population Served)	Labor Cost (per hour)	Read and Understand Rule (hours/system)	Planning and Mobilization (hours/system)	Unit Cost
	A	B	C	D=A*(B+C)
Community Water Systems (CWSs)				
≤100	$ 25.10	4.0	8.0	$ 301.20
101-500	$ 27.03	4.0	8.0	$ 324.36
501-1,000	$ 28.96	4.0	8.0	$ 347.52
1,001-4,100	$ 29.73	4.0	8.0	$ 356.76
4,101-33,000	$ 36.00	4.0	8.0	$ 432.00
33,001-96,000	$ 36.39	4.0	8.0	$ 436.68
96,001-500,000	$ 41.01	4.0	8.0	$ 492.12
500,001-1 Million	$ 41.01	4.0	8.0	$ 492.12
> 1 Million	$ 41.01	4.0	8.0	$ 492.12
Nontransient Noncommunity Water Systems (NTNCWSs)				
≤100	$ 25.10	4.0	8.0	$ 301.20
101-500	$ 27.03	4.0	8.0	$ 324.36
501-1,000	$ 28.96	4.0	8.0	$ 347.52
1,001-4,100	$ 29.73	4.0	8.0	$ 356.76
4,101-33,000	$ 36.00	4.0	8.0	$ 432.00
33,001-96,000	$ 36.39	4.0	8.0	$ 436.68
96,001-500,000	$ 41.01	4.0	8.0	$ 492.12
500,001-1 Million	$ 41.01	4.0	8.0	$ 492.12
> 1 Million	$ 41.01	4.0	8.0	$ 492.12
Transient Noncommunity Water Systems (TNCWSs)				
≤100	$ 25.10	4.0	8.0	$ 301.20
101-500	$ 27.03	4.0	8.0	$ 324.36
501-1,000	$ 28.96	4.0	8.0	$ 347.52
1,001-4,100	$ 29.73	4.0	8.0	$ 356.76
4,101-33,000	$ 36.00	4.0	8.0	$ 432.00
33,001-96,000	$ 36.39	4.0	8.0	$ 436.68
96,001-500,000	$ 41.01	4.0	8.0	$ 492.12
500,001-1 Million	$ 41.01	4.0	8.0	$ 492.12
> 1 Million	$ 41.01	4.0	8.0	$ 492.12

Notes:

PWS burden and cost estimates for implementation activities are assumed to be identical under the RTCR and Alternative Option.

Sources:

(A) Labor rates for PWSs from Exhibit 7.1.

(B), (C) EPA estimates based on best professional judgment.

States

States would incur administrative costs to implement the RTCR. These implementation costs are not directly required by specific provisions of the RTCR but are necessary for states to ensure that the provisions of the RTCR are properly carried out. States would need to allocate time for their staff to establish and maintain the programs necessary to comply with the RTCR, including developing and adopting state regulations and modifying data management systems to track new required PWS reports to the states. As a one-time burden covered under the 520 hours allocated to modifying data management systems, each state would modify their data management system to be able to track the changes in monitoring regimes. Note, on average no on-going annual cost is assumed for modifying data management because the tracking system would already be in place and oversight would be accounted under state review of sampling results, assessments, etc. Time requirements for a variety of state agency activities and responses are estimated in this EA. Exhibit 7.4 lists the activities required to revise the program following promulgation of the RTCR along with their respective costs and burden. Because time requirements for implementation and annual administration activities vary among state agencies, EPA recognizes that the burden and cost estimates presented in Exhibit 7.4 may be an over- or underestimate for some states.

Exhibit 7.4 Net Change in State Unit Burden and Cost Estimates for Rule Implementation (2007$)

Compliance Activity	Labor Cost (per hour) A	Hours B	FTEs C=B/2,080	Cost D=A*B
Read and Understand Rule	$ 39.22	15	0.01	$ 588
Regulation Adoption and Program Development	$ 39.22	260	0.13	$ 10,197
Initial Laboratory Certification	$ 39.22	-	-	$ -
Modify Data Management Systems	$ 39.22	520	0.25	$ 20,393
PWS Training and Technical Assistance	$ 39.22	520	0.25	$ 20,393
Staff Training	$ 39.22	130	0.06	$ 5,098
Per State Total		1,445		$ 56,670
National Totals (57 States/Primacy Agencies)		82,365		$ 3,230,201

Notes:
Detail may not add due to independent rounding.
State burden and cost estimates for Implementation activities are assumed to be identical under the RTCR and Alternative Option.
Sources:
(A) Labor rate for state employee from Section 7.2.1.
(B) Labor hours for start-up activities are based on GWR estimates. Because the RTCR is a revision of the 1989 TCR, one fourth of the State unit start up burden from GWR is used in the RTCR.
(C) Full-time equivalent (FTE) assumes individual working 40 hours per week, 52 weeks per year.

In addition to these one-time costs, states would use resources to continue administrative activities. On an annual basis, states must coordinate with their particular EPA regional office to be certain that the state's program is consistent with federal requirements. States would also continue to train state and PWS staffs, maintain laboratories' certifications, and report PWS compliance information to the Safe Drinking Water Information System (SDWIS). However,

based on discussions with stakeholders, once the initial implementation activities are complete, the annual burden (on average) for general administrative tasks for the RTCR would not be any higher than the burden incurred under the 1989 TCR requirements. In some cases, the general administrative burden for the 1989 TCR may actually decrease as PWSs experience better performance, and thus require less state interaction, under the RTCR. Therefore, no continuing annual administrative costs are estimated for the EA.

States would also spend time responding to specific requirements under the RTCR (i.e., review assessment reports, consult with PWSs, etc.). In these cases, the state costs are estimated under the costing for that particular rule requirement.

Implementation Net Cost Summary

Because EPA does not anticipate early implementation of the RTCR, EPA expects that implementation activities would take place in years 1 through 3 of the 25-year compliance period before PWSs begin monitoring activities. Annualized cost estimates for PWSs and states to perform implementation activities are estimated by multiplying the number of PWSs or states required to comply with the RTCR (i.e., all PWSs) by the unit costs presented in Exhibits 7.3 and 7.4. Total and net change in annualized present value cost estimates for PWSs and states to perform implementation activities under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.5.

Exhibit 7.5 Annualized Cost Estimates for Rule Implementation ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
RTCR - Net Change	**$ 2.77**	**$ 0.18**	**$ 2.95**	**$ 4.00**	**$ 0.26**	**$ 4.26**
Alternative Option - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Alternative Option - Net Change	**$ 2.77**	**$ 0.18**	**$ 2.95**	**$ 4.00**	**$ 0.26**	**$ 4.26**

Notes:
1) Detail may not add due to independent rounding.
2) PWS and state burden and cost estimates for implementation activities are assumed to be identical under the RTCR and Alternative Option.
Source: Final RTCR Cost Model.

7.4.2 Revise Sample Siting Plan

PWSs

Under the RTCR and Alternative option, all PWSs subject to the RTCR would incur one-time costs to revise existing sample siting plans to identify sampling locations and collection schedules that are representative of water throughout the distribution system. System sample siting plans must include routine and repeat sample sites and any sampling points necessary to meet GWR requirements. Under the TCR, no additional burden or costs are expected to be incurred by PWSs to revise sample siting plans, as these PWSs are already collecting TC samples in accordance with a written sample siting plan. The labor rates presented in Section 7.2.1 are used along with estimates of labor hours to generate sample siting plan costs for all

PWSs. Based on previous experience, EPA estimates that PWSs would require 2–8 hours for revising their sample siting plan, depending on PWS size. Estimates of PWS unit costs to revise sample siting plans are presented in Exhibit 7.6.

States

Under the RTCR and Alternative option, states are expected to incur one-time costs to review sample siting plans and recommend any revisions to PWSs. Under the 1989 TCR, no additional burden or costs are incurred by states to review sample siting plans, as these PWSs' sample siting plans have already been reviewed and approved. State costs are based on the number of PWSs submitting revised sample siting plans to PWSs each year. The state labor rate presented in Section 7.2.1, the number of PWSs in each PWS size category required to revise sample siting plans, and estimates of labor hours are used to generate sample siting plan costs incurred by states. Based on previous experience, EPA estimates that states would require 1–4 hours to review revised sample siting plans and provide any necessary revisions to PWSs, depending on PWS size. Estimates of state unit costs to revise sample siting plans are presented in Exhibit 7.6.

Exhibit 7.6 Net Change in PWS and State Burden and Cost Estimates to Revise Sample Siting Plans (2007$)

PWS Size (Population Served)	PWSs			States		
	PWS Labor Cost (per hour)	Revise Sample Siting Plan (hours/system)	Unit Cost	State Labor Cost (per hour)	Review and Revise Sample Siting Plan (hours/system)	Unit Cost
	A	B	C=A*B	D	E	F=D*E
Community Water Systems (CWSs)						
≤100	$ 25.10	2.0	$ 50.20	$ 39.22	1.0	$ 39.22
101-500	$ 27.03	2.0	$ 54.06	$ 39.22	1.0	$ 39.22
501-1,000	$ 28.96	4.0	$ 115.84	$ 39.22	2.0	$ 78.44
1,001-4,100	$ 29.73	4.0	$ 118.92	$ 39.22	2.0	$ 78.44
4,101-33,000	$ 36.00	6.0	$ 216.00	$ 39.22	3.0	$ 117.65
33,001-96,000	$ 36.39	8.0	$ 291.12	$ 39.22	4.0	$ 156.87
96,001-500,000	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
500,001-1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
> 1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
Nontransient Noncommunity Water Systems (NTNCWSs)						
≤100	$ 25.10	2.0	$ 50.20	$ 39.22	1.0	$ 39.22
101-500	$ 27.03	2.0	$ 54.06	$ 39.22	1.0	$ 39.22
501-1,000	$ 28.96	4.0	$ 115.84	$ 39.22	2.0	$ 78.44
1,001-4,100	$ 29.73	4.0	$ 118.92	$ 39.22	2.0	$ 78.44
4,101-33,000	$ 36.00	6.0	$ 216.00	$ 39.22	3.0	$ 117.65
33,001-96,000	$ 36.39	8.0	$ 291.12	$ 39.22	4.0	$ 156.87
96,001-500,000	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
500,001-1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
> 1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
Transient Noncommunity Water Systems (TNCWSs)						
≤100	$ 25.10	2.0	$ 50.20	$ 39.22	1.0	$ 39.22
101-500	$ 27.03	2.0	$ 54.06	$ 39.22	1.0	$ 39.22
501-1,000	$ 28.96	4.0	$ 115.84	$ 39.22	2.0	$ 78.44
1,001-4,100	$ 29.73	4.0	$ 118.92	$ 39.22	2.0	$ 78.44
4,101-33,000	$ 36.00	6.0	$ 216.00	$ 39.22	3.0	$ 117.65
33,001-96,000	$ 36.39	8.0	$ 291.12	$ 39.22	4.0	$ 156.87
96,001-500,000	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
500,001-1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87
> 1 Million	$ 41.01	8.0	$ 328.08	$ 39.22	4.0	$ 156.87

Notes:
PWS and state burden and cost estimates to review and revise sample siting plans are assumed to be identical under the RTCR and Alternative Option.

Sources:

(A) Labor rates for systems from Exhibit 7.1.

(B) PWS labor hours to review and revise sample siting plans reflect EPA estimate.

(D) Labor rates for state employee from Section 7.2.1.

(E) State labor hours to review and revise sample siting plans reflect EPA estimate.

Sample Siting Plan Net Cost Summary

PWSs are expected to revise sample siting plans before monitoring begins. For modeling purposes costs are split between years 2 and 3 of the 25-year compliance period (monitoring is required starting in year 4). Total and net change in annualized present value cost estimates for PWSs to revise sample siting plans and states to review the revised sample siting plans (and consult with PWSs if necessary) under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.7.

Exhibit 7.7 Annualized Cost Estimates to Revise (PWSs) and Review (States) Sample Siting Plans ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
RTCR - Net Change	**$ 0.59**	**$ 0.42**	**$ 1.01**	**$ 0.84**	**$ 0.59**	**$ 1.42**
Alternative Option - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Alternative Option - Net Change	**$ 0.59**	**$ 0.42**	**$ 1.01**	**$ 0.84**	**$ 0.59**	**$ 1.42**

Note: Detail may not add due to independent rounding.
Source: Final RTCR Cost Model.

7.4.3 Monitoring

PWSs

Monitoring costs for PWSs are calculated by multiplying the total numbers of routine, additional routine, and repeat samples required under the 1989 TCR, RTCR, and Alternative option (Exhibit 7.9) by the monitoring costs per sample presented in Exhibit 7.2.

EPA assumed that the numbers of systems on monthly, quarterly, and annual monitoring remain unchanged at the rule effective date for a continuation of the 1989 TCR. For RTCR, EPA assumed that only systems that received an annual site visit under the 1989 TCR would continue on annual monitoring; systems that would no longer qualify for annual monitoring under the RTCR were assumed to revert to baseline quarterly monitoring. (See section 7.4.4 for more information regarding annual site visits.) Under the Alternative option, all PWSs, regardless of size or type, start at monthly monitoring at the rule effective date. These differences in monitoring requirements between the 1989 TCR and the RTCR and Alternative option, which are presented in more detail in Exhibit 7.8 below, drive the differences in monitoring costs between the options. Chapters 4 (Exhibit 4.4) and 5 (Exhibit 5.9a–5.9c) show the distribution of monitoring frequencies prior to and after rule implementation, that are used to further inform the analysis. The effects of the differences in monitoring regimes on net changes in costs are described in further detail following the exhibit.

Exhibit 7.8 Summary of Monitoring Requirements Under the 1989 TCR, RTCR, and Alternative Option

Monitoring Requirement	1989 TCR	RTCR	Alternative Option
Default Routine Monitoring Frequency	The default TC monitoring frequency for ground water Noncommunity Water Systems (NCWSs) serving ≤1,000 people is quarterly The default TC monitoring frequency for all other PWSs is monthly for TC	The default TC monitoring frequency for non-seasonal ground water NCWSs serving ≤1,000 people is quarterly The default TC monitoring frequency for all other PWSs is monthly PWSs would be permitted to transition to the RTCR at their current TC monitoring frequencies[52]	The default TC monitoring frequency for all PWSs is monthly All PWSs would start on monthly TC monitoring
Reduced/Increased Routine Monitoring Frequency	Ground water NCWSs serving ≤1,000 people can reduce to annual monitoring if no sanitary defects and served only by protected GW sources Ground water CWSs serving ≤1,000 can reduce to quarterly monitoring if no history of TC+ in current configuration, no sanitary defects, and served only by protected GW sources All other PWSs are ineligible for reduced monitoring PWSs not meeting criteria for reduced monitoring return to default monitoring (no increased monitoring provision under 1989 TCR)	Ground water NCWSs serving ≤1,000 people can reduce to annual monitoring if no sanitary defects, clean compliance history for minimum of 12 months, and annual site visit or Level 2 assessment, and correction of all identified sanitary defects Ground water CWSs serving ≤1,000 people can reduce to quarterly monitoring if no sanitary defects, clean compliance history for a minimum of 12 months, and at least one of the following: 1) Annual site visit or voluntary Level 2 assessment and correction of all identified sanitary defects; 2) An approved cross connection control program; 3) Continuous disinfection & a residual; 4) 4-log inactivation of viruses daily as per GWR (4-hr exception allowed); or 5) Other equivalent measures as approved by the primacy agency. All other PWSs are ineligible for reduced	Ground water NCWSs serving ≤1,000 people can reduce to quarterly monitoring if no sanitary defects, clean compliance history for minimum of 12 months, and annual site visit or Level 2 assessment, and correction of all identified sanitary defects. Ground water CWSs serving ≤1,000 people can reduce to quarterly monitoring if no sanitary defects, clean compliance history for a minimum of 12 months, and at least one of the following: 1) Annual site visit or voluntary Level 2 assessment and correction of all identified sanitary defects; 2) An approved cross connection control program; 3) Continuous disinfection & a residual; 4) 4-log inactivation of viruses daily as per GWR (4 hour exception allowed); or 5) Other equivalent measures as approved by the primacy agency. All other PWSs are ineligible for reduced

[52] In order for PWSs to be able to transition to the RTCR at their current TC monitoring frequencies, an annual site visit or voluntary Level 2 assessment would be needed in the first year for PWSs on annual monitoring, including those transitioning.

Monitoring Requirement	1989 TCR	RTCR	Alternative Option
		monitoring Ground water PWSs serving ≤1,000 people on quarterly or annual monitoring that experience any of the following events will be required to begin monthly monitoring: 1) System triggers a Level 2 assessment (or a 2nd Level 1 assessment in a rolling 12-month period); 2) System has an *E. coli* Maximum Contaminant Level (MCL) violation; 3) System has an RTCR treatment technique violation (either Level 1 or 2); or 4) System has two monitoring violations in a rolling 12-month period. 5) NCWSs serving ≤1,000 increase from quarterly to monthly monitoring if system has one monitoring violation and one Level 1 assessment within 12 months. 6) NCWSs serving ≤1,000 increase from annual to quarterly monitoring if system has one monitoring violation.	monitoring Ground water PWSs serving ≤1,000 people on quarterly monitoring that experience any of the following events will be required to begin monthly monitoring (i.e., return to default monitoring frequency): 1) System triggers a Level 2 assessment (or a 2nd Level 1 assessment in a rolling 12-month period); 2) System has an *E. coli* MCL violation; 3) System has an RTCR treatment technique violation (either Level 1 or 2); or 4) System has two monitoring violations in a rolling 12-month period. 5) NCWSs serving ≤1,000 increase from quarterly to monthly monitoring if system has one monitoring violation and one Level 1 assessment within 12 months. 6) NCWSs serving ≤1,000 increase from annual to quarterly monitoring if system has one monitoring violation.
Additional Routine Monitoring Frequency	All PWSs serving ≤4,100 people must take at least 5 samples in the month following a TC+ unless state performs site visit and deems additional sampling unnecessary OR determines the reason for the TC+ and PWS has or will correct problem. Not required for PWSs serving >4,100 people	Ground water NCWSs serving ≤1,000 people and monitoring quarterly or annually must take at least 3 samples in the month following TC+ Ground water CWSs serving ≤1,000 people and monitoring quarterly must take at least 3 samples in the month following TC+ Not required for PWSs monitoring monthly	Ground water PWSs (NCWS and CWS) serving ≤1,000 people and monitoring quarterly must take at least 3 samples in the month following TC+ Not required for PWSs monitoring monthly
Repeat Monitoring Frequency	All PWSs serving ≤1,000 people must take 4 repeat TC samples All PWSs serving >1,000 people must take 3 repeat TC samples	All PWSs must take 3 repeat TC samples	All PWSs must take 3 repeat TC samples

Routine Monitoring

Under the RTCR, the increased stringency to qualify for reduced monitoring results in more routine samples being taken over time (fewer PWSs are on reduced monitoring) for most PWS sizes and types. The only PWSs predicted to have a decrease in routine monitoring under the RTCR are ground water NTNCWSs serving ≤1,000 people due to more PWSs monitoring quarterly than under the 1989 TCR. For the Alternative option, this effect would be combined with the requirement that all PWSs start the implementation period on monthly monitoring, resulting in more routine samples being taken for all PWS sizes and types. The Alternative option also prohibits annual monitoring leading to an even greater increase in the number of routine samples. The resulting increases in total national costs due to increased monitoring on the national level are reflected in the routine monitoring costs shown in Exhibit 7.10.

Additional Routine Monitoring[53]

The overall reductions in additional routine samples required under the RTCR and Alternative option result in reduced costs (Exhibit 7.10). Under the RTCR and Alternative option, additional routine monitoring is no longer required for systems that monitor at least monthly, and when additional routine monitoring is required, the number of samples required is reduced from five to three. Cost reductions are greater under the Alternative option than under the RTCR because all PWSs start on monthly monitoring and are not required to take additional routine samples during that period.

Repeat Monitoring

Under the RTCR and Alternative option, all PWSs are only required to take three repeat samples. However, EPA assumes that ground water PWSs treating to less than 4-log would still take an additional source water sample to comply with the GWR (no change in cost). Additionally, the number of repeat samples taken is a function of the number of regular and additional routine samples taken, which in turn affects the number of TC+ samples found (i.e., the more samples taken, the greater chance of finding a TC+). Thus, the overall increase in routine sampling under the RTCR and Alternative option would result in more repeat samples while the decreases in additional routine samples under both of these options would lead to fewer repeat samples.

In most PWS size and type categories, the large reductions in additional routine monitoring samples is the major driver, leading to decreases in repeat samples. Under the RTCR, only ground water TNCWSs serving ≤100 people are predicted to see an increase repeat sampling due to the large increase in routine sampling within this category. Under the Alternative option, ground water NTNCWSs and TNCWSs serving ≤1,000 people are predicted to have increased repeat monitoring as a function of large increases in routine monitoring. The overall effect on the national level is a reduction in the number (and cost) of required repeat samples under the RTCR and an increase under the Alternative option compared to the 1989 TCR (Exhibit 7.10).

[53] For modeling purposes and discussion throughout the cost chapter, regular routine monitoring samples taken in the month following a TC+ are included in the additional routine monitoring sample counts.

Cumulative Monitoring Summary

Exhibit 7.9 summarizes the total number of samples taken by PWS size and category for routine, additional, and repeat monitoring under the 1989 TCR, RTCR, and Alternative option over the entire 25-year period of analysis. Appendix A presents additional information on samples taken for each individual year during the analysis period.

States

Under the 1989 TCR, states are estimated to incur a monthly 15-minute burden to review each PWS's sample results. This estimate reflects the methodology used to calculate reporting and recordkeeping burden under the 1989 TCR in the *Information Collection Request for the Microbial Rules* (USEPA, 2008b). Because the existing methodology is calculated on a per PWS basis and the total number of PWSs is the same for cost modeling under the 1989 TCR, RTCR, and Alternative option, the net change in costs for reviewing monitoring results is estimated to be zero for the RTCR and Alternative option. Specific actions by states related to positive samples are accounted for under the actions required in response to those samples. Maintenance of sample results in SDWIS is accounted for under general implementation and administrative activities, which are discussed in Section 7.4.1.

Monitoring Net Cost Summary

Total and net change in annualized present value cost estimates for PWSs and states to perform monitoring under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.10. All monitoring is modeled to begin in year 4 of the 25-year analysis period.

The overall estimated increase in monitoring costs seen under the RTCR is driven by increases in routine monitoring due to stricter requirements to qualify for reduced monitoring. However, this is mostly offset by reductions in additional routine and repeat monitoring required under the revised regulation. For the Alternative option, the requirement for all PWSs to sample on a monthly basis at the beginning of rule implementation results in a large cost differential that is only partially offset by reduced costs due to reductions in additional routine monitoring requirements. Although not shown in Exhibit 7.10, costs for individual PWS categories (size and type) are expected to move in the same direction relative to the numbers of samples taken as reflected in Exhibit 7.9. Exceptions to the general trends on the national level are discussed in the subsections describing routine, additional routine, and repeat sampling above.

Exhibit 7.9 Cumulative Number of Samples over 25-Year Period of Analysis

PWS Size (Population Served)	1989 TCR			RTCR			Alternative Option		
	Routine Monitoring Samples	Additional Routine Monitoring Samples	Repeat Monitoring Samples	Routine Monitoring Samples	Additional Routine Monitoring Samples	Repeat Monitoring Samples	Routine Monitoring Samples	Additional Routine Monitoring Samples	Repeat Monitoring Samples
	A	B	C	D	E	F	G	H	I
Community Water Systems (CWSs) - SW									
≤100	304,247	23,167	18,698	308,880	-	13,764	308,880	-	13,764
101-500	562,198	27,009	21,684	567,600	-	15,660	567,600	-	15,660
501-1,000	306,605	15,334	12,299	309,672	-	8,708	309,672	-	8,708
1,001-4,100	1,921,237	55,132	33,729	1,951,224	-	33,326	1,951,224	-	33,326
4,101-33,000	10,636,296	-	186,729	10,636,296	-	181,661	10,636,296	-	181,661
33,001-96,000	11,058,960	-	194,149	11,058,960	-	188,880	11,058,960	-	188,880
96,001-500,000	10,190,400	-	178,901	10,190,400	-	174,046	10,190,400	-	174,046
500,001-1 Million	2,019,600	-	35,456	2,019,600	-	34,493	2,019,600	-	34,493
> 1 Million	1,686,960	-	29,616	1,686,960	-	28,812	1,686,960	-	28,812
Total	**38,686,502**	**120,642**	**711,259**	**38,729,592**	**-**	**679,350**	**38,729,592**	**-**	**679,350**
Community Water Systems (CWSs) - GW									
≤100	2,815,951	286,073	194,462	2,870,075	8,760	156,897	2,908,469	7,545	158,439
101-500	3,344,578	243,895	171,252	3,391,200	6,127	136,906	3,428,876	5,264	137,959
501-1,000	1,072,202	70,803	51,673	1,085,730	1,844	39,659	1,098,488	1,616	39,580
1,001-4,100	3,997,293	160,710	100,618	4,079,328	-	96,939	4,079,328	-	96,939
4,101-33,000	9,145,224	-	230,201	9,145,224	-	217,321	9,145,224	-	217,321
33,001-96,000	4,884,000	-	122,938	4,884,000	-	116,060	4,884,000	-	116,060
96,001-500,000	1,945,680	-	48,976	1,945,680	-	46,236	1,945,680	-	46,236
500,001-1 Million	253,440	-	6,380	253,440	-	6,023	253,440	-	6,023
> 1 Million	269,280	-	6,778	269,280	-	6,399	269,280	-	6,399
Total	**27,727,648**	**761,481**	**933,279**	**27,923,956**	**16,731**	**822,439**	**28,012,784**	**14,425**	**824,956**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW									
≤100	65,018	4,910	3,991	66,000	-	3,040	66,000	-	3,040
101-500	66,045	3,735	3,011	66,792	-	2,169	66,792	-	2,169
501-1,000	22,976	1,278	1,029	23,232	-	756	23,232	-	756
1,001-4,100	41,759	2,142	1,348	42,768	-	1,228	42,768	-	1,228
4,101-33,000	50,424	-	1,628	50,424	-	1,448	50,424	-	1,448
33,001-96,000	34,320	-	1,108	34,320	-	985	34,320	-	985
96,001-500,000	31,680	-	1,023	31,680	-	910	31,680	-	910
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**312,223**	**12,065**	**13,138**	**315,216**	**-**	**10,536**	**315,216**	**-**	**10,536**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW									
≤100	971,538	128,775	84,992	932,025	48,142	68,123	1,314,175	36,965	91,416
101-500	725,785	66,525	43,597	678,688	25,630	35,860	976,627	19,382	48,269
501-1,000	190,649	16,037	10,680	180,145	6,166	8,601	249,760	4,802	11,817
1,001-4,100	460,470	28,214	17,790	473,352	-	15,887	473,352	-	15,887
4,101-33,000	153,648	-	5,936	153,648	-	5,157	153,648	-	5,157
33,001-96,000	23,760	-	918	23,760	-	797	23,760	-	797
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**2,525,850**	**239,551**	**163,913**	**2,441,617**	**79,938**	**134,426**	**3,191,322**	**61,149**	**173,343**
Transient Noncommunity Water Systems (TNCWSs) - SW									
≤100	345,401	40,475	33,065	353,496	-	23,122	353,496	-	23,122
101-500	128,156	15,261	12,454	131,208	-	8,192	131,208	-	8,192
501-1,000	22,691	2,704	2,207	23,232	-	1,533	23,232	-	1,533
1,001-4,100	40,151	4,155	2,707	42,240	-	2,312	42,240	-	2,312
4,101-33,000	40,656	-	-	40,656	-	2,225	40,656	-	2,225
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	102,960	-	-	102,960	-	5,636	102,960	-	5,636
Total	**680,015**	**62,596**	**50,434**	**693,792**	**-**	**43,020**	**693,792**	**-**	**43,020**
Transient Noncommunity Water Systems (TNCWSs) - GW									
≤100	4,493,808	905,554	600,315	6,076,163	446,166	631,105	9,524,123	333,524	912,589
101-500	1,614,924	316,238	210,714	1,940,946	135,822	194,697	3,021,771	104,732	282,740
501-1,000	177,264	32,730	22,064	206,130	14,078	20,078	304,534	10,412	27,932
1,001-4,100	335,283	29,957	19,113	348,480	-	16,027	348,480	-	16,027
4,101-33,000	156,288	-	8,909	156,288	-	7,188	156,288	-	7,188
33,001-96,000	34,320	-	1,956	34,320	-	1,578	34,320	-	1,578
96,001-500,000	26,400	-	1,505	26,400	-	1,214	26,400	-	1,214
500,001-1 Million	63,360	-	3,612	63,360	-	2,914	63,360	-	2,914
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**6,901,647**	**1,284,478**	**868,188**	**8,852,088**	**596,065**	**874,801**	**13,479,275**	**448,667**	**1,252,181**
Grand Total	**76,833,885**	**2,480,814**	**2,740,210**	**78,956,260**	**692,734**	**2,564,572**	**84,421,981**	**524,241**	**2,983,387**

Note: (B), (E), (H) For modeling purposes, additional routine sample counts include regular routine samples taken in the same month.

Source: Appendix A - Total PWS Counts (A.1z, A.2z, A.3z)

Exhibit 7.10 Annualized PWS and State Cost Estimates for Monitoring Costs ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
	Routine Monitoring					
1989 TCR - Total	$ 170.59	$ -	$ 170.59	$ 163.94	$ -	$ 163.94
RTCR - Total	$ 174.71	$ -	$ 174.71	$ 167.74	$ -	$ 167.74
RTCR - Net Change	**$ 4.12**	**$ -**	**$ 4.12**	**$ 3.80**	**$ -**	**$ 3.80**
RTCR - Percent Change	**2.42%**	**-**	**2.42%**	**2.32%**	**-**	**2.32%**
Alternative Option - Total	$ 187.50	$ -	$ 187.50	$ 182.48	$ -	$ 182.48
Alternative Option - Net Change	**$ 16.91**	**$ -**	**$ 16.91**	**$ 18.54**	**$ -**	**$ 18.54**
Alternative Option - Percent Change	**9.91%**	**-**	**9.91%**	**11.31%**	**-**	**11.31%**
	Additional Routine Monitoring					
1989 TCR - Total	$ 3.87	$ -	$ 3.87	$ 3.72	$ -	$ 3.72
RTCR - Total	$ 1.12	$ -	$ 1.12	$ 1.09	$ -	$ 1.09
RTCR - Net Change	**$ (2.75)**	**$ -**	**$ (2.75)**	**$ (2.63)**	**$ -**	**$ (2.63)**
RTCR - Percent Change	**-71.11%**	**-**	**-71.11%**	**-70.75%**	**-**	**-70.75%**
Alternative Option - Total	$ 0.78	$ -	$ 0.78	$ 0.66	$ -	$ 0.66
Alternative Option - Net Change	**$ (3.10)**	**$ -**	**$ (3.10)**	**$ (3.06)**	**$ -**	**$ (3.06)**
Alternative Option - Percent Change	**-79.98%**	**-**	**-79.98%**	**-82.29%**	**-**	**-82.29%**
	Repeat Monitoring					
1989 TCR - Total	$ 5.11	$ -	$ 5.11	$ 4.92	$ -	$ 4.92
RTCR - Total	$ 4.88	$ -	$ 4.88	$ 4.70	$ -	$ 4.70
RTCR - Net Change	**$ (0.23)**	**$ -**	**$ (0.23)**	**$ (0.22)**	**$ -**	**$ (0.22)**
RTCR - Percent Change	**-4.53%**	**-**	**-4.53%**	**-4.43%**	**-**	**-4.43%**
Alternative Option - Total	$ 5.66	$ -	$ 5.66	$ 5.59	$ -	$ 5.59
Alternative Option - Net Change	**$ 0.54**	**$ -**	**$ 0.54**	**$ 0.67**	**$ -**	**$ 0.67**
Alternative Option - Percent Change	**10.61%**	**-**	**10.61%**	**13.71%**	**-**	**13.71%**
	Total					
1989 TCR - Total	$ 179.57	$ -	$ 179.57	$ 172.57	$ -	$ 172.57
RTCR - Total	$ 180.71	$ -	$ 180.71	$ 173.52	$ -	$ 173.52
RTCR - Net Change	**$ 1.14**	**$ -**	**$ 1.14**	**$ 0.95**	**$ -**	**$ 0.95**
RTCR - Percent Change	**0.63%**	**-**	**0.63%**	**0.55%**	**-**	**0.55%**
Alternative Option - Total	$ 193.93	$ -	$ 193.93	$ 188.72	$ -	$ 188.72
Alternative Option - Net Change	**$ 14.36**	**$ -**	**$ 14.36**	**$ 16.15**	**$ -**	**$ 16.15**
Alternative Option - Percent Change	**7.99%**	**-**	**7.99%**	**9.36%**	**-**	**9.36%**

Notes:

1) Detail may not add due to independent rounding.

2) For modeling purposes, additional routine sample counts include regular routine samples taken in the same month.

3) State costs are premised on a per system basis. State costs for monitoring are expected to be identical under the 1989 TCR, RTCR, and Alternative Option, and are therefore not included in the total costs.

Source: Final RTCR Cost Model.

7.4.4 Annual Site Visits

Under the RTCR, any PWS on an annual monitoring schedule would be required to also have an annual site visit conducted by the state or state-designated third party. A voluntary Level 2 assessment can also satisfy the annual site visit requirement. In many cases a sanitary survey performed during the same year can also be used to satisfy this requirement.[54] Although similar annual site visits are not currently required under the 1989 TCR, discussions with states during the TCRDSAC proceedings revealed that some do, in fact, conduct such inspections for PWSs on annual monitoring schedules. Because of the high cost for an annual site visit by a state, for this analysis, EPA assumes that no states would choose to conduct annual site visits unless they already do so under the 1989 TCR. Similarly, because of the high cost of the voluntary Level 2 assessment relative to other options that PWSs have to comply with the rule (such as quarterly monitoring) it was assumed that any PWS that is currently on annual monitoring, but not receiving an annual site visit, would opt not to conduct a voluntary Level 2 assessment. Therefore, for overall costing purposes, no net change in state or PWS costs are assumed for annual monitoring site visits under the RTCR or Alternative option.

7.4.5 Assessments

PWSs

Level 1 Assessments

Under the RTCR and Alternative option, all PWSs experiencing a Level 1 trigger must complete a Level 1 assessment of the PWS. A Level 1 trigger under the RTCR and Alternative option is defined as:

- For PWSs taking ≥40 samples per month, TC+ exceeds 5.0% for a given month;
- For PWSs taking <40 samples per month, two or more TC+ in a month; or
- Failure to take all required repeat samples after a single TC+ sample.

The 1989 TCR does not require a specific assessment to be performed in response to events comparable to the Level 1 triggers described above (i.e., non-acute violations). However, PWSs do perform some level of activity similar to a Level 1 assessment in response to violations. This effort is taken into account in the cost model to accurately assess the net cost of changes attributable to the RTCR.

A Level 1 assessment is an evaluation to identify the possible presence of sanitary defects, defects in distribution system coliform monitoring practices, and (when possible) the likely reason that the system triggered the assessment. It is conducted by the system operator or

[54] In some instances, the performance of an assessment (especially a Level 2 assessment) may overlap with a scheduled sanitary survey. To the extent that the requirements for performing a sanitary survey may be satisfied as part of the assessment process, PWSs and states may realize a cost savings compared to performing a separate sanitary survey. This potential for indirect cost savings is not captured in the cost model, resulting in a potential overestimate of costs stemming from RTCR implementation.

owner. Minimum elements include review and identification of atypical events that could affect distributed water quality or indicate that distributed water quality was impaired; changes in distribution system maintenance and operation that could affect distributed water quality (including water storage); source and treatment considerations that bear on distributed water quality, where appropriate (e.g., whether a ground water system is disinfected); existing water quality monitoring data; and inadequacies in sample sites, sampling protocol, and sample processing. The state may tailor specific assessment elements to the size and type of the system. Systems may tailor their assessment activities based on the characteristics of the distribution system (consistent with any state directives). Additionally, as part of the Level 1 assessment, PWSs would be required to submit to the state a form identifying sanitary defects detected, corrective actions completed, and a timetable for any corrective actions not already completed. Additional detail on the requirements of a Level 1 assessment and the derivation of associated unit burden (labor hours) for performance of the assessment is provided in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

Level 2 Assessments

Under the RTCR and Alternative option, all PWSs experiencing a Level 2 trigger must complete a Level 2 assessment of the PWS. A Level 2 trigger under the RTCR and Alternative option is defined as:

- An *E. coli* MCL violation; or
- A second Level 1 treatment technique trigger, within a rolling 12-month period, unless the first Level 1 treatment technique trigger was based on exceeding the allowable number of TC+ samples, the state has determined a likely reason for the TC+ samples that caused the initial Level 1 treatment technique trigger, and the state establishes that the system has fully corrected the problem; or
- For PWSs with approved reduced annual monitoring, a Level 1 trigger in two consecutive years.

As with Level 1 assessments, the 1989 TCR does not require a specific assessment to be performed in response to events comparable to the Level 2 triggers described above (i.e., acute violations), but PWSs do currently perform some level of activity similar to a Level 2 assessment in response to acute violations. These actions are taken into account in the cost model to properly assess the net cost of changes attributable to the RTCR regulatory options.

A Level 2 assessment (or comparable assessment under the 1989 TCR) would be more involved than a Level 1 assessment. A Level 2 assessment would be an evaluation to identify the possible presence of sanitary defects, defects in distribution system coliform monitoring practices, and (when possible) the likely reason that the system triggered the assessment. A Level 2 assessment provides a more detailed examination of the system (including the system's monitoring and operational practices) than does a Level 1 assessment through the use of more comprehensive investigation and review of available information, additional internal and external resources, and other relevant practices. It is conducted by an individual approved by the state, which may include the system operator. Minimum elements include review and

identification of atypical events that could affect distributed water quality or indicate that distributed water quality was impaired; changes in distribution system maintenance and operation that could affect distributed water quality (including water storage); source and treatment considerations that bear on distributed water quality, where appropriate (e.g., whether a ground water system is disinfected); existing water quality monitoring data; and inadequacies in sample sites, sampling protocol, and sample processing. The state may tailor specific assessment elements to the size and type of the system. The state may also direct expedited actions or additional actions in the case of an *E. coli* MCL violation. Systems may tailor their assessment activities based on the characteristics of the distribution system (consistent with any state directives). Additionally, as part of the Level 2 assessment, PWSs must submit to the state a form identifying sanitary defects detected, corrective actions completed, and a timetable for completion of any corrective actions that not already completed. Additional detail on the derivation of associated unit burden (labor hours) for performance of the assessment is provided in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

The labor rates presented in Section 7.2.1 are used along with estimates of labor hours as presented in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d) to generate Level 1 and Level 2 assessment unit costs by PWS size and type. Labor hours provided are assumed to include time for reporting and recordkeeping activities. Estimates of PWS unit costs for Level 1 and Level 2 assessments are presented in Exhibits 7.11 and 7.12. Additionally, the numbers of Level 1 and level 2 assessments over the 25-year compliance period (used to calculate total costs) are presented in Exhibit 7.13.

Exhibit 7.11 PWS Unit Costs Estimates for Assessment Activities (1989 TCR) (2007$)

PWS Size (Population Served)	Labor Cost (per hour)	Activities Similar to Level 1 Assessments		Activities Similar to Level 2 Assessments			
		Non-Acute Violations (single violation) (hours)	Unit Cost	Acute Violations (hours)	Unit Cost	Non-Acute Violations (multiple violations) (hours)	Unit Cost
	A	B	C=A*B	D	E=A*D	F	G=A*F
Community Water Systems (CWSs) - SW							
≤100	$ 25.10	11.0	$ 276.10	14.0	$ 351.40	14.0	$ 351.40
101-500	$ 27.03	11.0	$ 297.33	14.0	$ 378.42	14.0	$ 378.42
501-1,000	$ 28.96	13.0	$ 376.48	15.0	$ 434.40	15.0	$ 434.40
1,001-4,100	$ 29.73	22.0	$ 654.06	29.0	$ 862.17	29.0	$ 862.17
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
Community Water Systems (CWSs) - GW							
≤100	$ 25.10	11.0	$ 276.10	14.0	$ 351.40	14.0	$ 351.40
101-500	$ 27.03	11.0	$ 297.33	14.0	$ 378.42	14.0	$ 378.42
501-1,000	$ 28.96	13.0	$ 376.48	15.0	$ 434.40	15.0	$ 434.40
1,001-4,100	$ 29.73	22.0	$ 654.06	29.0	$ 862.17	29.0	$ 862.17
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
Nontransient Noncommunity Water Systems (NTNCWSs) - SW							
≤100	$ 25.10	4.0	$ 100.40	6.0	$ 150.60	6.0	$ 150.60
101-500	$ 27.03	4.0	$ 108.12	6.0	$ 162.18	6.0	$ 162.18
501-1,000	$ 28.96	4.0	$ 115.84	6.0	$ 173.76	6.0	$ 173.76
1,001-4,100	$ 29.73	4.0	$ 118.92	6.0	$ 178.38	6.0	$ 178.38
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
Nontransient Noncommunity Water Systems (NTNCWSs) - GW							
≤100	$ 25.10	4.0	$ 100.40	6.0	$ 150.60	6.0	$ 150.60
101-500	$ 27.03	4.0	$ 108.12	6.0	$ 162.18	6.0	$ 162.18
501-1,000	$ 28.96	4.0	$ 115.84	6.0	$ 173.76	6.0	$ 173.76
1,001-4,100	$ 29.73	4.0	$ 118.92	6.0	$ 178.38	6.0	$ 178.38
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
Transient Noncommunity Water Systems (TNCWSs) - SW							
≤100	$ 25.10	4.0	$ 100.40	6.0	$ 150.60	6.0	$ 150.60
101-500	$ 27.03	4.0	$ 108.12	6.0	$ 162.18	6.0	$ 162.18
501-1,000	$ 28.96	4.0	$ 115.84	6.0	$ 173.76	6.0	$ 173.76
1,001-4,100	$ 29.73	4.0	$ 118.92	6.0	$ 178.38	6.0	$ 178.38
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
Transient Noncommunity Water Systems (TNCWSs) - GW							
≤100	$ 25.10	4.0	$ 100.40	6.0	$ 150.60	6.0	$ 150.60
101-500	$ 27.03	4.0	$ 108.12	6.0	$ 162.18	6.0	$ 162.18
501-1,000	$ 28.96	4.0	$ 115.84	6.0	$ 173.76	6.0	$ 173.76
1,001-4,100	$ 29.73	4.0	$ 118.92	6.0	$ 178.38	6.0	$ 178.38
4,101-33,000	$ 36.00	30.0	$ 1,080.00	36.0	$ 1,296.00	36.0	$ 1,296.00
33,001-96,000	$ 36.39	59.0	$ 2,147.01	75.0	$ 2,729.25	75.0	$ 2,729.25
96,001-500,000	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
500,001-1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17
> 1 Million	$ 41.01	108.0	$ 4,429.08	117.0	$ 4,798.17	117.0	$ 4,798.17

Note:

(F) EPA assumes that the burden incurred by operators to assess their PWSs following a second non-acute violation is equal to the burden incurred by an assessment following an acute violation.

Sources:

(A) Labor rates for PWSs from Exhibit 7.1.

(B), (D), (F) Final RTCR T&C Document.

Exhibit 7.12 PWS Unit Costs Estimates for Level 1 and Level 2 Assessments (RTCR and Alternative Option) (2007$)

PWS Size (Population Served)	Labor Cost (per hour)	Level 1 Assessments: Non-Acute Trigger (single trigger) (hours)	Level 1 Assessments: Unit Cost	Level 2 Assessments: Acute Violations (hours)	Level 2 Assessments: Unit Cost	Level 2 Assessments: Level 2 Triggers (triggered by multiple Level 1s) (hours)	Level 2 Assessments: Unit Cost
	A	B	C=A*B	D	E=A*D	F	G=A*F
Community Water Systems (CWSs) - SW							
≤100	$ 25.10	19.0	$ 476.90	23.0	$ 577.30	22.0	$ 552.20
101-500	$ 27.03	19.0	$ 513.57	23.0	$ 621.69	22.0	$ 594.66
501-1,000	$ 28.96	20.0	$ 579.20	24.0	$ 695.04	23.0	$ 666.08
1,001-4,100	$ 29.73	31.0	$ 921.63	48.0	$ 1,427.04	46.0	$ 1,367.58
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
Community Water Systems (CWSs) - GW							
≤100	$ 25.10	19.0	$ 476.90	23.0	$ 577.30	22.0	$ 552.20
101-500	$ 27.03	19.0	$ 513.57	23.0	$ 621.69	22.0	$ 594.66
501-1,000	$ 28.96	20.0	$ 579.20	24.0	$ 695.04	23.0	$ 666.08
1,001-4,100	$ 29.73	31.0	$ 921.63	48.0	$ 1,427.04	46.0	$ 1,367.58
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
Nontransient Noncommunity Water Systems (NTNCWSs) - SW							
≤100	$ 25.10	7.0	$ 175.70	21.0	$ 527.10	9.0	$ 225.90
101-500	$ 27.03	7.0	$ 189.21	21.0	$ 567.63	9.0	$ 243.27
501-1,000	$ 28.96	7.0	$ 202.72	21.0	$ 608.16	9.0	$ 260.64
1,001-4,100	$ 29.73	8.0	$ 237.84	29.0	$ 862.17	10.0	$ 297.30
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
Nontransient Noncommunity Water Systems (NTNCWSs) - GW							
≤100	$ 25.10	7.0	$ 175.70	21.0	$ 527.10	9.0	$ 225.90
101-500	$ 27.03	7.0	$ 189.21	21.0	$ 567.63	9.0	$ 243.27
501-1,000	$ 28.96	7.0	$ 202.72	21.0	$ 608.16	9.0	$ 260.64
1,001-4,100	$ 29.73	8.0	$ 237.84	29.0	$ 862.17	10.0	$ 297.30
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
Transient Noncommunity Water Systems (TNCWSs) - SW							
≤100	$ 25.10	7.0	$ 175.70	21.0	$ 527.10	9.0	$ 225.90
101-500	$ 27.03	7.0	$ 189.21	21.0	$ 567.63	9.0	$ 243.27
501-1,000	$ 28.96	7.0	$ 202.72	21.0	$ 608.16	9.0	$ 260.64
1,001-4,100	$ 29.73	8.0	$ 237.84	29.0	$ 862.17	10.0	$ 297.30
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
Transient Noncommunity Water Systems (TNCWSs) - GW							
≤100	$ 25.10	7.0	$ 175.70	21.0	$ 527.10	9.0	$ 225.90
101-500	$ 27.03	7.0	$ 189.21	21.0	$ 567.63	9.0	$ 243.27
501-1,000	$ 28.96	7.0	$ 202.72	21.0	$ 608.16	9.0	$ 260.64
1,001-4,100	$ 29.73	8.0	$ 237.84	29.0	$ 862.17	10.0	$ 297.30
4,101-33,000	$ 36.00	41.0	$ 1,476.00	71.0	$ 2,556.00	69.0	$ 2,484.00
33,001-96,000	$ 36.39	68.0	$ 2,474.52	121.0	$ 4,403.19	116.0	$ 4,221.24
96,001-500,000	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
500,001-1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38
> 1 Million	$ 41.01	159.0	$ 6,520.59	252.0	$ 10,334.52	238.0	$ 9,760.38

Sources:

(A) Labor rates for PWSs from Exhibit 7.1.

(B), (D), (F) Final RTCR T&C Document.

Exhibit 7.13 Number of Level 1 and Level 2 Assessments over the 25-Year Compliance Period

PWS Size (Population Served)	1989 TCR			RTCR			Alternative Option		
	Activities Similar to Level 1 Assessments	Activities Similar to Level 2 Assessments		Level 1 Assessments	Level 2 Assessments		Level 1 Assessments	Level 2 Assessments	
	Non-Acute Violations (single violation)	Acute Violations	Non-Acute Violations (multiple violations)	Non-Acute Trigger (single trigger)	Acute Violations	Level 2 Triggers (triggered by multiple Level 1s)	Non-Acute Trigger (single trigger)	Acute Violations	Level 2 Triggers (triggered by multiple Level 1s)
	A	B	C	D	E	F	G	H	I
Community Water Systems (CWSs) - SW									
≤100	525	157	184	400	100	102	400	100	102
101-500	649	167	111	539	119	75	539	119	75
501-1,000	361	102	63	277	75	40	277	75	40
1,001-4,100	954	162	149	920	146	132	920	146	132
4,101-33,000	2,152	197	-	2,152	197	-	2,152	197	-
33,001-96,000	534	56	-	534	56	-	534	56	-
96,001-500,000	233	24	-	233	24	-	233	24	-
500,001-1 Million	22	-	-	22	-	-	22	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**5,429**	**865**	**507**	**5,076**	**717**	**349**	**5,076**	**717**	**349**
Community Water Systems (CWSs) - GW									
≤100	9,772	1,141	5,383	8,004	853	3,523	7,871	926	3,272
101-500	8,169	1,025	4,214	6,502	696	2,399	6,495	747	2,543
501-1,000	2,250	284	1,050	1,780	188	626	1,772	203	607
1,001-4,100	3,545	477	2,808	3,208	342	1,705	3,208	342	1,705
4,101-33,000	4,545	263	-	4,545	263	-	4,545	263	-
33,001-96,000	656	53	-	656	53	-	656	53	-
96,001-500,000	129	10	-	129	10	-	129	10	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**29,066**	**3,253**	**13,455**	**24,824**	**2,405**	**8,253**	**24,675**	**2,544**	**8,127**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW									
≤100	98	35	77	75	28	41	75	28	41
101-500	88	29	40	69	19	24	69	19	24
501-1,000	30	9	13	24	6	9	24	6	9
1,001-4,100	42	19	37	37	13	23	37	13	23
4,101-33,000	5	-	-	5	-	-	5	-	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**262**	**93**	**167**	**209**	**67**	**98**	**209**	**67**	**98**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW									
≤100	5,581	856	3,829	4,797	559	2,010	5,673	723	3,390
101-500	3,130	447	1,273	2,794	315	757	3,551	446	1,333
501-1,000	744	95	298	675	79	168	814	99	298
1,001-4,100	818	169	974	690	114	530	690	114	530
4,101-33,000	123	9	-	123	9	-	123	9	-
33,001-96,000	4	-	-	4	-	-	4	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**10,400**	**1,577**	**6,373**	**9,084**	**1,077**	**3,466**	**10,855**	**1,393**	**5,551**
Transient Noncommunity Water Systems (TNCWSs) - SW									
≤100	1,093	430	780	796	250	425	796	250	425
101-500	410	170	320	278	90	154	278	90	154
501-1,000	67	28	47	50	17	25	50	17	25
1,001-4,100	92	50	128	73	29	69	73	29	69
4,101-33,000	8	-	-	8	-	-	8	-	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**1,670**	**677**	**1,275**	**1,204**	**386**	**674**	**1,204**	**386**	**674**
Transient Noncommunity Water Systems (TNCWSs) - GW									
≤100	44,730	6,649	25,425	47,190	5,477	20,628	57,597	7,796	37,532
101-500	14,530	2,089	8,864	13,780	1,608	5,694	17,358	2,441	10,924
501-1,000	1,477	221	896	1,396	177	585	1,661	230	1,015
1,001-4,100	927	186	1,138	773	117	638	773	117	638
4,101-33,000	116	4	-	116	4	-	116	4	-
33,001-96,000	-	-	-	-	-	-	-	-	-
96,001-500,000	-	-	-	-	-	-	-	-	-
500,001-1 Million	-	-	-	-	-	-	-	-	-
> 1 Million	-	-	-	-	-	-	-	-	-
Total	**61,780**	**9,149**	**36,324**	**63,256**	**7,383**	**27,546**	**77,506**	**10,589**	**50,109**
Grand Total	**108,608**	**15,613**	**58,102**	**103,653**	**12,035**	**40,385**	**119,526**	**15,695**	**64,908**

Notes:

1) Detail may not add due to rounding.

2) Assessments conducted under the 1989 TCR are not labeled as Level 1 and Level 2 assessments; how ever they are similar to the assessments under the RTCR and Alternative option.

Sources:

(A), (B), (C) - A.1.z

(D), (E), (F) - A.2.z

(G), (H), (I) - A.3.z

States

Level 1 and Level 2 Assessments

Under the 1989 TCR, RTCR and Alternative option, states would incur burden to review the completed assessment forms required to be filed by PWSs (or similar reports required by states under the 1989 TCR). Although some states may choose to conduct assessments for their PWSs, EPA does not quantify these costs since this is not a regulatory requirement. State costs are based on the number of PWSs submitting assessment reports. The state labor rate presented in Section 7.2.1 and estimates of labor hours are used to generate state Level 1 and Level 2 assessment unit costs. EPA estimates that state burden to review PWS assessment forms would range from one to eight hours depending on PWS size and type, as well as the level of the assessment. This burden includes any time required to consult with the PWS about the assessment report. Estimates of state unit costs for Level 1 and Level 2 assessments are presented in Exhibit 7.14.

Assessment Net Cost Summary

Annualized cost estimates for Level 1 and Level 2 assessments under the 1989 TCR, RTCR, and Alternative option are calculated by multiplying the number of assessments estimated by the predictive modeling (summarized in Exhibit 7.13) by the unit costs presented in Exhibits 7.11, 7.12, and 7.14. Exhibit 7.13 presents the estimated totals of non-acute and acute MCL violations (1989 TCR) and Level 1 and Level 2 assessments (RTCR and Alternative option). The model predicts a total of approximately 109,000 single non-acute MCL violations, 58,000 cases of a second non-acute MCL violation, and 16,000 acute MCL violations for the 1989 TCR under which some PWSs do currently engage in some assessment activity which may or may not meet the RTCR criteria (see section 7.4.5). For the RTCR, the model predicts approximately 104,000 Level 1 assessments and 52,000 Level 2 assessments. For the Alternative option, the model predicts approximately 120,000 Level 1 assessments and 81,000 Level 2 assessments. (Appendix A provides a detailed breakout of the number of Level 1 and Level 2 assessments estimated by the occurrence model.) Total and net change in annualized present value cost estimates for PWSs and states to perform Level 1 and Level 2 assessments under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.15 below.

Under the RTCR, all PWSs are required to conduct assessments of their systems when they exceed Level 1 or Level 2 treatment technique triggers. While PWSs are not required to conduct assessments under the 1989 TCR, some PWSs do currently engage in some assessment activity (which may or may not meet the RTCR criteria) following non-acute and acute MCL violations. EPA estimates both the costs to PWSs to conduct assessments under the RTCR as well as the level of effort that PWSs already put towards assessment activities under the 1989 TCR; these estimates are based on the work of the stakeholders in the TWG during the proceedings of the TCRDSAC. These estimates allowed EPA to determine the average net costs to conduct assessments under the RTCR. EPA assumes that the numbers of non-acute and acute MCL violations would remain steady under a continuation of the 1989 TCR (based on review of SDWIS/FED violation data). Under the RTCR, EPA assumes that the numbers of assessment triggers decrease over time from the steady state level estimate based on the 1989 TCR to a new

steady state level, as a result of reduced fecal indicator occurrence associated with the beneficial effects of requiring assessments and corrective action.

The overall number of assessments increases under the Alternative option. This is a result of the initial monthly monitoring requirements for all PWSs under this analysis. The modeling results indicate that the much higher sampling early on after the rule's effective date would result in more positive samples and associated assessments despite the predicted long term reductions in occurrence. This increase in total assessments performed, combined with the higher unit cost of performing assessments compared to existing practices under the 1989 TCR, results in a higher net cost increase for PWSs under the Alternative option than under the RTCR. For states, the increase in the number of assessments is estimated to translate directly to a cost increase. The total net change in cost for the Alternative option is estimated to be positive, and greater than under the RTCR.

Exhibit 7.14 State Unit Cost Estimates for Review of Level 1 and Level 2 Assessments under the 1989 TCR, RTCR, and Alternative Option (2007$)

PWS Size (Population Served)	Labor Cost (per hour)	Level 1 Assessments		Level 2 Assessments			
		Non-Acute Trigger (single trigger) (hours)	Unit Cost	Acute Violations (hours)	Unit Cost	Level 2 Triggers (triggered by multiple Level 1s) (hours)	Unit Cost
	A	B	C=A*B	D	E=A*D	F	G=A*F
Community Water Systems (CWSs) - SW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
Community Water Systems (CWSs) - GW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
Nontransient Noncommunity Water Systems (NTNCWSs) - SW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
Nontransient Noncommunity Water Systems (NTNCWSs) - GW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
Transient Noncommunity Water Systems (TNCWSs) - SW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
Transient Noncommunity Water Systems (TNCWSs) - GW							
≤100	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
101-500	$ 39.22	1.0	$ 39.22	2.0	$ 78.44	2.0	$ 78.44
501-1,000	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
1,001-4,100	$ 39.22	2.0	$ 78.44	4.0	$ 156.87	4.0	$ 156.87
4,101-33,000	$ 39.22	3.0	$ 117.65	6.0	$ 235.31	6.0	$ 235.31
33,001-96,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
96,001-500,000	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
500,001-1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74
> 1 Million	$ 39.22	4.0	$ 156.87	8.0	$ 313.74	8.0	$ 313.74

Sources:

(A) Labor rates for state employee from Section 7.2.1.

(B), (D), (E) Labor hour assumptions based on best professional judgment.

Exhibit 7.15 Annualized PWS and State Cost Estimates for Level 1 and Level 2 Assessments ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
	Level 1 Assessment					
1989 TCR - Total	$ 1.13	$ 0.21	$ 1.34	$ 1.08	$ 0.20	$ 1.29
RTCR - Total	$ 1.63	$ 0.20	$ 1.84	$ 1.57	$ 0.20	$ 1.77
RTCR - Net Change	**$ 0.51**	**$ (0.01)**	**$ 0.50**	**$ 0.49**	**$ (0.01)**	**$ 0.48**
Alternative Option - Total	$ 1.76	$ 0.23	$ 1.99	$ 1.72	$ 0.23	$ 1.94
Alternative Option - Net Change	**$ 0.63**	**$ 0.02**	**$ 0.65**	**$ 0.63**	**$ 0.02**	**$ 0.65**
	Level 2 Assessment					
1989 TCR - Total	$ 0.70	$ 0.26	$ 0.96	$ 0.68	$ 0.25	$ 0.92
RTCR - Total	$ 0.90	$ 0.19	$ 1.08	$ 0.88	$ 0.18	$ 1.06
RTCR - Net Change	**$ 0.20**	**$ (0.07)**	**$ 0.12**	**$ 0.20**	**$ (0.07)**	**$ 0.13**
Alternative Option - Total	$ 1.26	$ 0.29	$ 1.55	$ 1.30	$ 0.31	$ 1.61
Alternative Option - Net Change	**$ 0.55**	**$ 0.03**	**$ 0.58**	**$ 0.62**	**$ 0.06**	**$ 0.68**

Note: Detail may not add due to independent rounding.
Source: Final RTCR Cost Model.

7.4.6 Corrective Actions

PWSs

Under the RTCR and Alternative option, all PWSs would be required to correct sanitary defects found through the performance of Level 1 or Level 2 assessments. For modeling purposes, EPA estimated only the net change in the number of corrective actions performed under the RTCR and Alternative option[55] compared to the 1989 TCR. Based on discussions with state representatives, EPA estimates that additional corrective actions (on top of those already being performed under the 1989 TCR) would be performed for only 10% of the assessments undertaken as a result of the RTCR. Because only the net change in costs is estimated, no additional costs for corrective actions are modeled for the 1989 TCR (it is assumed that PWSs are already performing some corrective actions under the 1989 TCR).

To estimate the costs incurred for the correction of sanitary defects, EPA estimated the percent distribution of PWSs that would perform different types of corrective actions as presented in the compliance forecast below (Exhibit 7.16a). The compliance forecast presented below focuses on the higher level categorization of corrective actions anticipated. The categories of anticipated corrective actions were informed by both EPA judgment and discussions of the TCRDSAC TWG and are essentially the same as those presented to the advisory committee. For each of the categories listed, a PWS is assumed to take a specific action that falls under that general category. Exhibit 7.16b lists the specific corrective actions that fall under the higher level categorization, along with the percent of PWSs estimated to perform that corrective action based on level 1 and level 2 assessments. Detailed compliance forecasts showing the specific corrective actions used in the cost analysis are provided in Appendix D, along with summary tables of the

[55] Any corrective actions based on a positive source water sample are assumed to be accounted for under the GWR and not under the RTCR.

unit costs used in the analysis. Each corrective action in the detailed compliance forecast is also assigned a representative unit cost. Detailed descriptions of the derivation of unit costs are provided in Exhibits 5-1 through 5-47 of the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

As shown in the compliance forecast in Exhibit 7.16a, EPA estimates that corrective actions found through Level 1 assessments would result in corrective actions that focus more on actions by PWS staff such as flushing or training (columns A and B) than on permanent fixes to the PWS. This reflects the assumption that Level 1 assessments would generally be less involved than Level 2 assessments and may not result in finding more complex problems. Corrective actions taken as a result of Level 2 assessments are expected to find a higher proportion of structural/technical issues (columns C-K) resulting in material fixes to the PWSs and distribution system. Consistent with the discussions of the TCRDSAC regarding major structural fixes or replacements, EPA did not include these major costs in the analysis. Distribution system appurtenances such as storage tanks generally have a useful life that is accounted for in water system capital planning and the assessments conducted in response to RTCR triggers could identify when that useful life has ended but are not solely responsible for the need to correct the defect.[56]

It is not anticipated that the overall effectiveness of corrective actions will differ significantly by the type of corrective action. Some activities, such as spot flushing, may have a shorter, transient impact on water quality. However, most PWSs are expected to institute ongoing flushing *programs* that will have a continuing impact on water quality. Other corrective actions in the compliance forecast are expected to have ongoing benefits, though the exact duration may be highly variable depending on the exact conditions at the PWS. The overall duration of reduced occurrence modeled as a result of corrective actions initiated in response to either a Level 1 or Level 2 assessment is intended to reflect an average effectiveness of corrective actions. Uncertainties and associated sensitivity analyses that inform the effect of the reduced occurrence predicted from corrective actions are discussed further in Section 7.7.

PWSs would also incur reporting and recordkeeping burden to notify the state upon completion of each corrective action. PWSs may also consult with the state or with outside parties to determine the appropriate corrective action to be implemented. PWS reporting and recordkeeping costs (including consultations) are derived by multiplying PWSs labor rates (Section 7.2.1) by an EPA-estimated labor burden. Exhibit 7.17 presents the estimated unit costs for this reporting and recordkeeping burden.

[56] Additionally, EPA ran two sensitivity analyses to assess the potential impacts of different distributions within the compliance forecast. Results of the sensitivity analyses are presented in Section 7.7, and indicate that the low bound estimates of annualized net change in costs at three percent discount rate are approximately $3M for the RTCR and $15M for the Alternative option, and the high bound estimates are approximately $25M for the RTCR and $40M for the Alternative option. Varying the assumptions about the percentage of corrective actions identified and the effectiveness of those actions had less than a linear effect on outcomes, and the RTCR continues to be less costly than the Alternative option under all scenarios modeled.

States

For each corrective action performed under the RTCR and Alternative option, states would incur recordkeeping and reporting burden to review and coordinate with PWSs. This includes burden incurred from any optional consultations states may conduct with PWSs or outside parties to determine the appropriate corrective action to be implemented. The state labor rate presented in Section 7.2.1 and estimates of labor hours are used to generate state unit corrective action costs. Exhibit 7.17 presents the estimated PWS and state reporting and recordkeeping unit costs (including consultations) by PWS size.

Exhibit 7.16a Compliance Forecast for Corrective Actions based on Level 1 and Level 2 Assessments

PWS Size (Population Served)	PWS Flushing	Sampler Training	Replace/Repair of Distribution System Components	Maintenance of Adequate Pressure	Maintenance of appropriate Hydraulic Residence	Storage Facility Maintenance	Booster Disinfection	Cross-connection Control and Backflow Prevention	Addition or Upgrade of On-line Monitoring and Control	Addition of Security Measures	Development and Implementation of an Operations Plan
	A	B	C	D	E	F	G	H	I	J	K
Level 1 Compliance Forecast											
≤100	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
101-500	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
501-1,000	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
1,001-4,100	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
4,101-33,000	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
33,001-96,000	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
96,001-500,000	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
500,001-1 Million	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
> 1 Million	39%	15%	12%	9%	8%	6%	4%	1%	3%	1%	2%
Level 2 Compliance Forecast											
≤100	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
101-500	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
501-1,000	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
1,001-4,100	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
4,101-33,000	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
33,001-96,000	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
96,001-500,000	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
500,001-1 Million	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%
> 1 Million	15%	4%	18%	15%	15%	11%	8%	2%	6%	2%	4%

Source: (A) - (K) Percent of PWSs performing corrective actions based on Level 1 and Level 2 assessments reflect EPA estimate.

Exhibit 7.16b Detailed PWS Compliance Forecast for Corrective Actions based on Level 1 and Level 2 Assessments

General Corrective Action Category	Specific Corrective Action	Level 1 Compliance Forecast	Level 2 Compliance Forecast
PWS Flushing	Routine Flushing	30%	10%
	Spot Flushing	9%	5%
Sampler Training	Operator Training/Certification	15%	4%
Replace/Repair of Distribution System Components	Replace Valve	2%	3%
	Installing a Dedicated Sampling Tap	2%	3%
	Replace Iron Pipe	2%	3%
	Replace Fittings	2%	3%
	Replace Hydrant	2%	3%
	Replace Meter	2%	3%
Maintenance of Adequate Pressure	New Booster Pump Station	2%	3%
	Modify/Replace Existing Pumps	2%	3%
	Install Variable Frequency Drives	2%	3%
Maintenance of Adequate Pressure	New Elevated Storage Tank	0%	0%
	Install Surge Relief valve	2%	3%
	Install Surge Control Tank	1%	3%
Maintenance of appropriate Hydraulic Residence Time	Install Auto Flushing Devices	2%	3%
	Modify Inlet/Outlet Piping	1%	2%
	Install Mixing Devices	1%	2%
	Loop Dead Ends	1%	2%
	Install Appropriate Main Sizes	1%	2%
	Modify Storage Operation	1%	2%
	Decommission Storage	1%	2%
Storage Facility Maintenance	Inspect & Clean Storage Tanks	2%	3%
	Line Storage Tanks	1%	2%
	Vent Repair/Replace Vent Screen	1%	2%
Storage Facility Maintenance	Repair/Replace Tank Hatch	1%	2%
	Repair Storage Tank	1%	2%
Booster Disinfection	Install Permanent Cl Booster Station	1%	2%
	Install Temp Cl Booster Station	1%	2%
	Install Permanent NH_2Cl Booster Station	1%	2%
	Install Temp NH_2Cl Booster Station	1%	2%
Cross-connection Control and Backflow Prevention Program	Backflow Prevention Assembly	1%	2%
Addition or Upgrade of On-line Monitoring and Control	Online Cl Monitoring & Programming	1%	2%
	Online NH_2Cl Monitoring & Programming	1%	2%
	Online Pressure Monitoring & Programming	1%	2%
Addition of Security Measures	Installation of Additional Security Measures	1%	2%
Development and Implementation of an Operations Plan	Develop/Implement/Maintain Operations Plan	1%	2%
	Operator Training/Certification	1%	2%

Exhibit 7.17 Net Change in PWS and State Unit Costs Estimates for Reporting and Recordkeeping for Corrective Actions (2007$)

PWS Size (Population Served)	Systems			States		
	Labor Cost (per hour)	Corrective Action Burden (hours/ corrective action)	Unit Cost	Labor Cost (per hour)	Corrective Action Burden (hours/ corrective action)	Unit Cost
	A	B	C=A*B	D	E	F=D*E
≤100	$ 25.10	0.5	$ 12.55	$ 39.22	0.5	$ 19.61
101-500	$ 27.03	0.5	$ 13.52	$ 39.22	0.5	$ 19.61
501-1,000	$ 28.96	0.5	$ 14.48	$ 39.22	0.5	$ 19.61
1,001-4,100	$ 29.73	0.5	$ 14.87	$ 39.22	0.5	$ 19.61
4,101-33,000	$ 36.00	0.5	$ 18.00	$ 39.22	0.5	$ 19.61
33,001-96,000	$ 36.39	0.5	$ 18.20	$ 39.22	0.5	$ 19.61
96,001-500,000	$ 41.01	0.5	$ 20.51	$ 39.22	0.5	$ 19.61
500,001-1 Million	$ 41.01	0.5	$ 20.51	$ 39.22	0.5	$ 19.61
> 1 Million	$ 41.01	0.5	$ 20.51	$ 39.22	0.5	$ 19.61

Notes:

PWS and state burden estimates identical for all PWS types under 1989 TCR, RTCR, and Alternative Option.

Sources:

(A) Labor rates for PWSs from Exhibit 7.1.

(B) PWS labor hours for corrective action recordkeeping/reporting reflect EPA estimate.

(D) Labor rates for state employee from Section 7.2.1.

(E) State labor hours for corrective action recordkeeping/reporting reflect EPA estimate.

Corrective Action Net Cost Summary

Annualized net cost estimates for PWSs and states to perform corrective actions are estimated by multiplying the number of Level 1 and Level 2 corrective actions estimated by the predictive model (i.e., 10 percent of Level 1 and Level 2 assessments representing the net increase in corrective actions found), by the percentages in the compliance forecast and unit costs of corrective actions and associated reporting and recordkeeping. Total and net change in annualized present value cost estimates for PWSs and states to perform corrective actions under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.18.

Because only the net change in corrective actions taken is modeled, no costs are estimated under the 1989 TCR. The differences in the net change in corrective action costs between the RTCR and Alternative option are a function different number of assessments estimated to be performed in the predictive model as discussed in Section 7.4.5 above.

Exhibit 7.18 Annualized PWS and State Cost Estimates for Corrective Actions based on Level 1 and Level 2 Assessments ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
	Corrective Actions based on Level 1 Assessments					
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 9.62	$ 0.01	$ 9.63	$ 8.14	$ 0.01	$ 8.15
Alternative Option - Total	$ 10.01	$ 0.01	$ 10.02	$ 8.52	$ 0.01	$ 8.53
RTCR - Net Change	**$ 9.62**	**$ 0.01**	**$ 9.63**	**$ 8.14**	**$ 0.01**	**$ 8.15**
Alternative Option - Net Change	**$ 10.01**	**$ 0.01**	**$ 10.02**	**$ 8.52**	**$ 0.01**	**$ 8.53**
	Corrective Actions based on Level 2 Assessments					
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.82	$ 0.00	$ 2.82	$ 2.49	$ 0.00	$ 2.49
Alternative Option - Total	$ 3.78	$ 0.01	$ 3.79	$ 3.57	$ 0.01	$ 3.58
RTCR - Net Change	**$ 2.82**	**$ 0.00**	**$ 2.82**	**$ 2.49**	**$ 0.00**	**$ 2.49**
Alternative Option - Net Change	**$ 3.78**	**$ 0.01**	**$ 3.79**	**$ 3.57**	**$ 0.01**	**$ 3.58**

Note: Detail may not add due to independent rounding.
Source: Final RTCR Cost Model.

7.4.7 Public Notification

PWSs

Tier 1 Public Notification

Acute violations (*E. coli* MCL violations) would require Tier 1 PN under all regulatory options (1989 TCR, RTCR, and Alternative option). PWSs with acute violations must report the violation to the state by the end of the business day after the PWS learns of the violation and must notify the public within 24 hours.

Tier 2 Public Notification

PWSs with non-acute violations under the 1989 TCR must report the violation to the state by the end of the business day after the PWS learns of the violation, and must provide Tier 2 PN within 30 days. PWSs with situations similar to 1989 TCR non-acute violations under the RTCR and Alternative option are not required to perform PN. These PWSs are required to perform Tier 2 notification for a treatment technique violation (failure to perform Level 1 or 2 assessment if triggered; failure to correct all sanitary defects found), but because the cost model assumes full compliance with RTCR requirements, no cost is estimated for these violations. Overall, costs decrease significantly for Tier 2 PN under the Final Rule for both the RTCR and Alternative option.

Tier 3 Public Notification

Under the 1989 TCR, RTCR, and Alternative option, Tier 3 PN for monitoring and reporting violations are assumed to be reported once per year as part of the consumer confidence report (CCR). Because of the use of the CCR to communicate Tier 3 PN on a yearly basis, no cost differential between the 1989 TCR and the RTCR and Alternative option is estimated in the cost model. However, although they are not quantitatively evaluated as part of the EA, the

TCRDSAC concluded that significant reductions in monitoring and reporting violations may be realized through the revised regulatory framework of the RTCR. See Section 7.6 for a discussion of non-quantified costs.

Estimates of PWS unit costs for PN are derived by multiplying PWS labor rates from Section 7.2.1 and burden hour estimates derived from the *Information Collection Request for the Public Water System Supervision Program* (USEPA, 2008c). PWS PN unit cost estimates are presented in Exhibit 7.19.

Exhibit 7.19 PWS Unit Cost Estimates for Public Notification (2007$)

			Tier 1 (acute)				Tier 2 (non-acute)			
PWS Size (Population Served)	Labor Cost (per hour)	Average Number of Service Connections per System	Preparation (labor) (hours/ violation)	Distribution (labor) (hours/ violation)	Distribution (O&M Cost/ notice) ($/service connection)	Unit Cost	Preparation (labor) (hours/ violation)	Distribution (labor) (hours/ violation)	Distribution (O&M Cost/notice) ($/service connection)	Unit Cost
	A	B	C	D	E	F=A*(C+D)+(B*E)	G	H	I	J=A*(G+H)+(B*I)
Community Water Systems (CWSs) - SW										
≤100	$ 25.10	440	8.5	12.0	$ 0.05	$ 536.55	3.5	9.0	$ 0.05	$ 335.75
101-500	$ 27.03	387	8.5	12.0	$ 0.05	$ 573.44	3.5	9.0	$ 0.05	$ 357.20
501-1,000	$ 28.96	303	8.5	12.0	$ -	$ 593.68	3.5	30.0	$ 0.26	$ 1,049.05
1,001-4,100	$ 29.73	850	8.5	12.0	$ -	$ 609.47	3.5	30.0	$ 0.26	$ 1,216.99
4,101-33,000	$ 36.00	4,288	9.2	12.0	$ -	$ 763.66	3.5	30.0	$ 0.25	$ 2,259.65
33,001-96,000	$ 36.39	17,273	10.0	12.0	$ -	$ 800.58	3.5	30.0	$ 0.23	$ 5,191.88
96,001-500,000	$ 41.01	56,465	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 14,360.67
500,001-1 Million	$ 41.01	205,609	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 48,663.97
> 1 Million	$ 41.01	448,564	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 104,543.57
Community Water Systems (CWSs) - GW										
≤100	$ 25.10	41	8.5	12.0	$ 0.05	$ 516.62	3.5	9.0	$ 0.05	$ 315.82
101-500	$ 27.03	99	8.5	12.0	$ 0.05	$ 559.05	3.5	9.0	$ 0.05	$ 342.81
501-1,000	$ 28.96	315	8.5	12.0	$ -	$ 593.68	3.5	30.0	$ 0.26	$ 1,052.07
1,001-4,100	$ 29.73	756	8.5	12.0	$ -	$ 609.47	3.5	30.0	$ 0.26	$ 1,192.61
4,101-33,000	$ 36.00	3,495	9.0	12.0	$ -	$ 757.48	3.5	30.0	$ 0.25	$ 2,076.93
33,001-96,000	$ 36.39	16,366	10.0	12.0	$ -	$ 800.58	3.5	30.0	$ 0.23	$ 4,983.17
96,001-500,000	$ 41.01	50,564	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 13,003.50
500,001-1 Million	$ 41.01	209,220	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 49,494.49
> 1 Million	$ 41.01	473,641	10.0	12.0	$ -	$ 902.22	3.5	30.0	$ 0.23	$ 110,311.34
Nontransient Noncommunity Water Systems (NTNCWSs) - SW										
≤100	$ 25.10	128	8.5	12.0	$ 0.05	$ 520.94	3.5	9.0	$ 0.05	$ 320.14
101-500	$ 27.03	21	8.5	12.0	$ 0.05	$ 555.16	3.5	9.0	$ 0.05	$ 338.92
501-1,000	$ 28.96	46	8.5	12.0	$ -	$ 593.68	3.5	9.0	$ 0.05	$ 364.29
1,001-4,100	$ 29.73	47	8.5	12.0	$ -	$ 609.47	3.5	9.0	$ 0.05	$ 373.97
4,101-33,000	$ 36.00	176	8.7	12.0	$ -	$ 745.36	3.5	9.0	$ 0.05	$ 458.08
33,001-96,000	$ 36.39	94	10.0	12.0	$ -	$ 800.58	3.5	9.0	$ 0.02	$ 456.75
96,001-500,000	$ 41.01	2,181	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 556.25
500,001-1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
> 1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
Nontransient Noncommunity Water Systems (NTNCWSs) - GW										
≤100	$ 25.10	4	8.5	12.0	$ 0.05	$ 514.76	3.5	9.0	$ 0.05	$ 313.96
101-500	$ 27.03	8	8.5	12.0	$ 0.05	$ 554.52	3.5	9.0	$ 0.05	$ 338.28
501-1,000	$ 28.96	11	8.5	12.0	$ -	$ 593.68	3.5	9.0	$ 0.05	$ 362.56
1,001-4,100	$ 29.73	42	8.5	12.0	$ -	$ 609.47	3.5	9.0	$ 0.05	$ 373.71
4,101-33,000	$ 36.00	130	8.7	12.0	$ -	$ 744.94	3.5	9.0	$ 0.05	$ 456.02
33,001-96,000	$ 36.39	75	10.0	12.0	$ -	$ 800.58	3.5	9.0	$ 0.02	$ 456.38
96,001-500,000	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
500,001-1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
> 1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
Transient Noncommunity Water Systems (TNCWSs) - SW										
≤100	$ 25.10	9	8.5	12.0	$ 0.05	$ 514.99	3.5	9.0	$ 0.05	$ 314.19
101-500	$ 27.03	30	8.5	12.0	$ 0.05	$ 555.62	3.5	9.0	$ 0.05	$ 339.38
501-1,000	$ 28.96	49	8.5	12.0	$ -	$ 593.68	3.5	9.0	$ 0.05	$ 364.45
1,001-4,100	$ 29.73	58	8.5	12.0	$ -	$ 609.47	3.5	9.0	$ 0.05	$ 374.50
4,101-33,000	$ 36.00	57	8.8	12.0	$ -	$ 747.00	3.5	9.0	$ 0.05	$ 452.55
33,001-96,000	$ 36.39	-	10.0	12.0	$ -	$ 800.58	3.5	9.0	$ 0.02	$ 454.88
96,001-500,000	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
500,001-1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63
> 1 Million	$ 41.01	2	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.67
Transient Noncommunity Water Systems (TNCWSs) - GW										
≤100	$ 25.10	5	8.5	12.0	$ 0.05	$ 514.82	3.5	9.0	$ 0.05	$ 314.02
101-500	$ 27.03	15	8.5	12.0	$ 0.05	$ 554.87	3.5	9.0	$ 0.05	$ 338.63
501-1,000	$ 28.96	30	8.5	12.0	$ -	$ 593.68	3.5	9.0	$ 0.05	$ 363.51
1,001-4,100	$ 29.73	43	8.5	12.0	$ -	$ 609.47	3.5	9.0	$ 0.05	$ 373.77
4,101-33,000	$ 36.00	39	8.7	12.0	$ -	$ 746.87	3.5	9.0	$ 0.05	$ 451.77
33,001-96,000	$ 36.39	14	10.0	12.0	$ -	$ 800.58	3.5	9.0	$ 0.02	$ 455.15
96,001-500,000	$ 41.01	9	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.81
500,001-1 Million	$ 41.01	1	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.65
> 1 Million	$ 41.01	-	10.0	12.0	$ -	$ 902.22	3.5	9.0	$ 0.02	$ 512.63

Notes:

(B) Service connections per system is consistent with SDWIS 2007 4th Quarter Freeze data. Data for certain size categories (e.g., ≤100, 101-500, 501-1,000) may seem counterintuitive. EPA is investigating the SDWIS database for any data discrepancies.

(F), (J) used to derived 1989 TCR PN costs; (F) used to derive RTCR and Alternative Option PN costs.

Sources:

(A) Labor rates for PWSs from Exhibit 7.1.

(B) SDWIS 2007 4th Quarter Freeze.

(C), (D), (G), (H) Labor hour assumptions based on best professional judgment as carried forward from the *Information Collection Request for the Public Water System Supervision Program* (USEPA, 2008c).

(E), (I) Distribution cost assumptions based on best professional judgment as carried forward from the original PN ICR.

States

Under the 1989 TCR, RTCR, and Alternative option, states would incur recordkeeping and reporting burden to provide consultation, review the PN certification, and file the report of the violation. State unit PN costs are based on the state labor rate presented in Section 7.2.1 and burden hour estimates derived from the *Information Collection Request for the Public Water System Supervision Program* (USEPA, 2008c). Estimates of state unit costs for PN are presented in Exhibit 7.20.

Exhibit 7.20 State Unit Costs Estimates for Public Notification (1989 TCR, RTCR, Alternative Option)

Labor Cost (per hour)	Tier 1 Consultation (labor) (hours/violation)	Tier 2 Consultation (labor) (hours/violation)	Receive/Review PN Certification (labor) (hours/violation)	File Reports (labor) (hours/violation)	Tier 1 Unit Cost	Tier 2 Unit Cost
A	B	C	D	E	F=A*(B+D+E)	G=A*(C+D+E)
$ 39.22	3.0	1.1	0.2	0.1	$ 129.42	$ 54.91

Sources:

(A) Labor rate for state employee from Section 7.2.1.

(B), (C), (D), (E) Labor hour assumptions based on best professional judgment as carried forward from the *Information Collection Request for the Public Water System Supervision Program* (USEPA, 2008c).

Public Notification Net Cost Summary

Total and net change in annualized present value costs for PN are estimated by multiplying the model estimates of PWSs with acute (Tier 1 PN) and non-acute (Tier 2 PN) violations by the PWS and state unit costs for performing PN activities. The RTCR Cost Model assumes that all violations are addressed following initial PN, and no burden would be incurred by PWSs or states for repeat notification. Exhibit 7.21 summarizes the total number of Tier 1 and Tier 2 PNs that would be prepared by PWS size and category for under the 1989 TCR, RTCR, and Alternative option over the entire 25-year period of analysis. Total and net change in annualized present value cost estimates for PWSs and states to perform PN under the 1989 TCR, RTCR, and Alternative option are presented in Exhibit 7.22.

A significant reduction in costs is estimated due to the elimination of Tier 2 PN for TC occurrence (non-acute violations under the 1989 TCR) under the RTCR and Alternative option. Because state costs are calculated on a per-violation basis, state costs decline. Under the Alternative option, some of this cost decrease is offset by additional Tier 1 PN.

Exhibit 7.21 Number of Tier 1 and Tier 2 Public Notifications over the 25-Year Compliance Period

PWS Size (Population Served)	1989 TCR		RTCR	Alternative Option
	Tier 1 PN	Tier 2 PN	Tier 1 PN	Tier 1 PN
	A	B	C	D
Community Water Systems (CWSs) - SW				
≤100	157	709	100	100
101-500	167	760	119	119
501-1,000	102	424	75	75
1,001-4,100	162	1,103	146	146
4,101-33,000	197	2,152	197	197
33,001-96,000	56	534	56	56
96,001-500,000	24	233	24	24
500,001-1 Million	-	22	-	-
> 1 Million	-	-	-	-
Total	**865**	**5,936**	**717**	**717**
Community Water Systems (CWSs) - GW				
≤100	1,141	15,155	853	926
101-500	1,025	12,383	696	747
501-1,000	284	3,300	188	203
1,001-4,100	477	6,354	342	342
4,101-33,000	263	4,545	263	263
33,001-96,000	53	656	53	53
96,001-500,000	10	129	10	10
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Total	**3,253**	**42,521**	**2,405**	**2,544**
Nontransient Noncommunity Water Systems (NTNCWSs) - SW				
≤100	35	175	28	28
101-500	29	128	19	19
501-1,000	9	42	6	6
1,001-4,100	19	79	13	13
4,101-33,000	-	5	-	-
33,001-96,000	-	-	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Total	**93**	**429**	**67**	**67**
Nontransient Noncommunity Water Systems (NTNCWSs) - GW				
≤100	856	9,411	559	723
101-500	447	4,402	315	446
501-1,000	95	1,042	79	99
1,001-4,100	169	1,792	114	114
4,101-33,000	9	123	9	9
33,001-96,000	-	4	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Total	**1,577**	**16,774**	**1,077**	**1,393**
Transient Noncommunity Water Systems (TNCWSs) - SW				
≤100	430	1,872	250	250
101-500	170	729	90	90
501-1,000	28	115	17	17
1,001-4,100	50	220	29	29
4,101-33,000	-	8	-	-
33,001-96,000	-	-	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Total	**677**	**2,945**	**386**	**386**
Transient Noncommunity Water Systems (TNCWSs) - GW				
≤100	6,649	70,156	5,477	7,796
101-500	2,089	23,394	1,608	2,441
501-1,000	221	2,373	177	230
1,001-4,100	186	2,065	117	117
4,101-33,000	4	116	4	4
33,001-96,000	-	-	-	-
96,001-500,000	-	-	-	-
500,001-1 Million	-	-	-	-
> 1 Million	-	-	-	-
Total	**9,149**	**98,104**	**7,383**	**10,589**
Grand Total	**15,613**	**166,709**	**12,035**	**15,695**

Note: Detail may not add due to rounding.

Sources:

(A), (B) - A.1.z

(C) - A.2.z

(D) - A.3.z

Exhibit 7.22 Annualized PWS and State Cost Estimates for Public Notification ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ 3.75	$ 0.44	$ 4.19	$ 3.60	$ 0.42	$ 4.02
RTCR - Total	$ 0.26	$ 0.06	$ 0.32	$ 0.25	$ 0.06	$ 0.31
RTCR - Net Change	**$ (3.49)**	**$ (0.38)**	**$ (3.86)**	**$ (3.35)**	**$ (0.36)**	**$ (3.71)**
RTCR - Percent Change	**-93%**	**-86%**	**-92%**	**-93%**	**-86%**	**-92%**
Alternative Option - Total	$ 0.35	$ 0.08	$ 0.43	$ 0.35	$ 0.08	$ 0.44
Alternative Option - Net Change	**$ (3.40)**	**$ (0.36)**	**$ (3.76)**	**$ (3.25)**	**$ (0.34)**	**$ (3.58)**
Alternative Option - Percent Change	**-91%**	**-81%**	**-90%**	**-90%**	**-80%**	**-89%**

Note: Detail may not add due to independent rounding.

Source: Final RTCR Cost Model.

7.4.8 Uncertainty in Unit Costs

As stated in Section 7.2.5, EPA recognizes that there are both variability and uncertainty in unit cost estimates used to develop national costs for the RTCR. Variability is expected in the actual costs that would be experienced by different PWSs of similar size conducting the same corrective action. Otherwise similar PWSs may experience different capital and/or O&M costs due to site-specific factors. Inputs to unit costs such as water quality conditions, labor rates, and land costs can be highly variable and increase the system-to-system variability in unit costs. In developing the unit cost estimates, there is insufficient information to fully characterize what the distribution of this variability would be on a national scale; therefore, EPA uses mean values for these input parameters.

The unit costs used in this EA are developed as average or representative estimates of what these unit costs would be nationally, and are not the unit costs of any particular PWS. Some components of monitoring costs, such as the purchase and wear-and-tear of vehicles, are not quantified because of either limited data or inability to attribute these costs directly to the RTCR. Additionally, the PWS and state labor hours for each rule component (specifically for Level 1 and Level 2 assessments) are meant to capture national averages for the purposes of developing national cost estimates and making comparisons between regulatory options. Thus, the unit costs presented in this document may over- or underestimate the unit costs of any particular PWS. Detailed information on the derivation of unit costs for each rule component is provided in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d).

7.5 Household Costs

The household cost analysis considers the impact that the costs incurred by CWSs have on the households they serve. This analysis considers the potential increase in a household's annual water bill if a CWS passed the entire cost increase resulting from the rule on to their customers. This analysis is a tool to gauge potential impacts and should not be construed as a precise estimate of potential changes to household water bills. State costs and costs to TNCWSs and NTNCWSs are not included in this analysis since their costs are not typically passed through directly to households.

To calculate household costs (which are in the units of $ per household per year), the CWS population subject to the RTCR by PWS size is divided by the average number of people per household, estimated as 2.56 for the year 2007 (United States Census Bureau, 2008), to calculate the number of households subject to the RTCR by PWS size. The cost of the rule, by size category, is then divided by that number of households to determine a per-household cost.

The first section of Exhibit 7.23 presents net costs per household under the RTCR and Alternative option for all rule components spread across all CWSs. In this scenario, comparison to the 1989 TCR shows a cost savings for households in the largest size category. For those households that are expected to see a cost increase, the average annual water bill would be expected to increase by less than ten cents on average. Although this average cost per household is very low, customers served by PWSs that incur greater costs to comply with the RTCR would be higher.

While the average increase in annual household water bills to implement the RTCR is less than a dollar, customers served by a small CWS that have to take corrective actions as a result of the rule would incur slightly larger increases in their water bills. The subsequent sections of the exhibit present net costs per household for different subsections of CWSs (e.g., CWSs that perform assessments but no corrective actions, CWSs that do perform corrective actions, and CWSs that do not perform assessments or corrective actions). As shown in the second section of Exhibit 7.23, approximately 67% of households belong to CWSs that would perform assessments but would not perform corrective actions (because no sanitary defects are found). These households would experience a slight cost savings on an annual basis, due to a slight reduction in monitoring and PN costs. The 9% of households belonging to CWSs that would perform corrective actions would experience an increase in annual net household costs of less than $1 to approximately $26 on an annual basis. The final section of the exhibit presents the 24% of households belonging to CWSs that would not perform assessments or corrective actions. Households of this category would experience an increase in cost savings when compared to those performing corrective actions, and a decrease in cost savings when compared to those performing assessments but no corrective actions. This decrease in costs savings is because no PN costs are associated with systems not performing assessments. Overall, the main driver of additional household costs under the RTCR is whether or not additional corrective actions are performed.

Exhibit 7.23 Summary of Net Annual Per-Household Costs for the RTCR (2007$)

PWS Size (Population Served)	Number of Households (RTCR)	Number of Households (Alternative Option)	3% Discount Rate				7% Discount Rate			
			RTCR Net	RTCR Net Cost per Household	Alternative Option Net	Alternative Option Net Cost per Household	RTCR Net	RTCR Net Cost per Household	Alternative Option Net	Alternative Option Net Cost per Household
	A	B	C	D=C/A	E	F=E/B	G	H=G/A	I	J=I/B
All Community Water Systems (CWSs)										
≤100	307,243	307,243	$ 111,694	$ 0.364	$ 225,693	$ 0.735	$ 207,140	$ 0.674	$ 348,782	$ 1.135
101-500	1,589,510	1,589,510	$ 371,004	$ 0.233	$ 464,207	$ 0.292	$ 471,664	$ 0.297	$ 598,244	$ 0.376
501-1,000	1,624,853	1,624,853	$ 46,687	$ 0.029	$ 87,294	$ 0.054	$ 96,473	$ 0.059	$ 148,274	$ 0.091
1,001-4,100	7,816,592	7,816,592	$ 371,294	$ 0.048	$ 371,294	$ 0.048	$ 418,935	$ 0.054	$ 418,935	$ 0.054
4,101-33,000	27,997,647	27,997,647	$ 2,385,056	$ 0.085	$ 2,385,056	$ 0.085	$ 2,083,266	$ 0.074	$ 2,083,266	$ 0.074
33,001-96,000	21,933,438	21,933,438	$ 1,532,410	$ 0.070	$ 1,532,410	$ 0.070	$ 1,273,202	$ 0.058	$ 1,273,202	$ 0.058
96,001-500,000	26,770,609	26,770,609	$ 1,479,280	$ 0.055	$ 1,479,280	$ 0.055	$ 1,214,316	$ 0.045	$ 1,214,316	$ 0.045
500,001-1 Million	9,764,979	9,764,979	$ 157,138	$ 0.016	$ 157,138	$ 0.016	$ 125,671	$ 0.013	$ 125,671	$ 0.013
> 1 Million	16,309,853	16,309,853	$ (2,223)	$ (0.000)	$ (2,223)	$ (0.000)	$ (1,479)	$ (0.000)	$ (1,479)	$ (0.000)
Total	**114,114,724**	**114,114,724**	**$ 6,452,342**	**$ 0.057**	**$ 6,700,151**	**$ 0.059**	**$ 5,889,190**	**$ 0.052**	**$ 6,209,211**	**$ 0.054**
Community Water Systems (CWSs) performing Level 1/Level 2 Assessments (and no Corrective Actions)										
≤100	125,340	124,920	$ (185,923)	$ (1.483)	$ (149,283)	$ (1.195)	$ (125,037)	$ (0.998)	$ (75,885)	$ (0.607)
101-500	460,577	464,568	$ (137,193)	$ (0.298)	$ (103,168)	$ (0.222)	$ (82,657)	$ (0.179)	$ (40,057)	$ (0.086)
501-1,000	394,643	401,009	$ (133,453)	$ (0.338)	$ (123,890)	$ (0.309)	$ (111,147)	$ (0.282)	$ (98,598)	$ (0.246)
1,001-4,100	2,341,578	2,341,578	$ (262,222)	$ (0.112)	$ (262,222)	$ (0.112)	$ (213,247)	$ (0.091)	$ (213,247)	$ (0.091)
4,101-33,000	24,827,588	24,827,588	$ (195,108)	$ (0.008)	$ (195,108)	$ (0.008)	$ (76,420)	$ (0.003)	$ (76,420)	$ (0.003)
33,001-96,000	19,232,570	19,232,570	$ (173,238)	$ (0.009)	$ (173,238)	$ (0.009)	$ (142,573)	$ (0.007)	$ (142,573)	$ (0.007)
96,001-500,000	23,912,325	23,912,325	$ (146,682)	$ (0.006)	$ (146,682)	$ (0.006)	$ (131,967)	$ (0.006)	$ (131,967)	$ (0.006)
500,001-1 Million	5,524,188	5,524,188	$ (40,160)	$ (0.007)	$ (40,160)	$ (0.007)	$ (36,993)	$ (0.007)	$ (36,993)	$ (0.007)
> 1 Million	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**76,818,809**	**76,828,746**	**$ (1,273,980)**	**$ (0.017)**	**$ (1,193,752)**	**$ (0.016)**	**$ (920,040)**	**$ (0.012)**	**$ (815,739)**	**$ (0.011)**
Community Water Systems (CWSs) performing Corrective Actions										
≤100	13,927	13,880	$ 365,576	$ 26.250	$ 388,703	$ 28.004	$ 330,235	$ 23.712	$ 353,002	$ 25.432
101-500	51,175	51,619	$ 516,102	$ 10.085	$ 508,146	$ 9.844	$ 452,342	$ 8.839	$ 450,070	$ 8.719
501-1,000	43,849	44,557	$ 178,205	$ 4.064	$ 181,189	$ 4.066	$ 155,596	$ 3.548	$ 158,538	$ 3.558
1,001-4,100	260,175	260,175	$ 590,719	$ 2.270	$ 590,719	$ 2.270	$ 512,568	$ 1.970	$ 512,568	$ 1.970
4,101-33,000	3,170,059	3,170,059	$ 2,605,551	$ 0.822	$ 2,605,551	$ 0.822	$ 2,198,499	$ 0.694	$ 2,198,499	$ 0.694
33,001-96,000	2,700,868	2,700,868	$ 1,709,801	$ 0.633	$ 1,709,801	$ 0.633	$ 1,424,758	$ 0.528	$ 1,424,758	$ 0.528
96,001-500,000	2,858,284	2,858,284	$ 1,625,742	$ 0.569	$ 1,625,742	$ 0.569	$ 1,346,704	$ 0.471	$ 1,346,704	$ 0.471
500,001-1 Million	613,799	613,799	$ 195,076	$ 0.318	$ 195,076	$ 0.318	$ 161,185	$ 0.263	$ 161,185	$ 0.263
> 1 Million	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**9,712,136**	**9,713,240**	**$ 7,786,773**	**$ 0.802**	**$ 7,804,928**	**$ 0.804**	**$ 6,581,888**	**$ 0.678**	**$ 6,605,324**	**$ 0.680**
Community Water Systems (CWSs) not performing Level 1/Level 2 Assessments, or Corrective Actions										
≤100	167,976	168,442	(67,959)	$ (0.405)	(13,728)	$ (0.081)	1,943	$ 0.012	71,665	$ 0.425
101-500	1,077,758	1,073,324	(7,905)	$ (0.007)	59,230	$ 0.055	101,979	$ 0.095	188,231	$ 0.175
501-1,000	1,186,361	1,179,288	1,936	$ 0.002	29,995	$ 0.025	52,024	$ 0.044	88,334	$ 0.075
1,001-4,100	5,214,839	5,214,839	42,797	$ 0.008	42,797	$ 0.008	119,614	$ 0.023	119,614	$ 0.023
4,101-33,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
33,001-96,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
96,001-500,000	-	-	-	$ -	-	$ -	-	$ -	-	$ -
500,001-1 Million	3,626,992	3,626,992	-	$ -	-	$ -	-	$ -	-	$ -
> 1 Million	16,309,853	16,309,853	-	$ -	-	$ -	-	$ -	-	$ -
Total	**27,583,779**	**27,572,738**	**$ (31,132)**	**$ (0.001)**	**$ 118,294**	**$ 0.004**	**$ 275,560**	**$ 0.010**	**$ 467,844**	**$ 0.017**

Source:
(C), (E), (G), (I) Exhibit 7.28.

7.6 Non-quantified Costs

EPA believes that all of the rule elements that are the major drivers of the net changes in costs of the 1989 TCR have been quantified to the greatest degree possible. However, cost reductions related to fewer possible monitoring and reporting violations are not specifically accounted for in the cost analysis, and their exclusion from consideration may result in an overestimate of net change in cost between the 1989 TCR and the RTCR or Alternative option.

In addition, under the 1989 TCR, RTCR, and Alternative option, Tier 3 PN for monitoring and reporting violations are assumed to be reported once per year as part of the CCR. Because of the use of the CCR to communicate Tier 3 PN on a yearly basis, no cost differential between the 1989 TCR and the RTCR and Alternative option is estimated in the cost model. However, the advisory committee concluded that significant reductions in monitoring and reporting violations may be realized through the revised regulatory framework of the RTCR. These possible reductions have not been quantified. System resources used to process monitoring violation notices for the CCR and respond to customer inquiries about the notices as well as state resources to remind systems to take samples, may be reduced if significant reductions are realized. Exclusion of this potential cost savings may lead to an underestimate of the PN cost savings under both the RTCR and Alternative option.

Additionally, as an underlying assumption to the costing methodology, EPA has assumed that all PWSs subject to the RTCR requirements are already complying with the 1989 TCR. There may be some PWSs that are not in full compliance with the 1989 TCR, and if so, additional costs would be incurred.

7.7 Uncertainty Analysis

There are two primary sources of uncertainty in the RTCR cost modeling. The first is related to the underlying estimates of events resulting from the rule revisions as generated from the occurrence and predictive modeling. The occurrence and predictive modeling (discussed in detail in Chapter 5) does not explicitly consider uncertainty, and therefore does not generate confidence intervals on the predicted outcomes. However, EPA evaluated the model inputs to determine which of the inputs were likely to have a significant effect on the results and subjected those to further review through sensitivity analyses. In particular, EPA evaluated the impacts of alternative estimates of the net change percentage of PWSs predicted to take corrective actions in response to an assessment (10 percent in the model) and the associated effectiveness of those corrective actions (Section 5.3.3.1 discusses these analyses in detail). The results of these analyses suggest that changes in the major assumptions about the net change percentage of corrective actions identified and the effectiveness of those actions have a less than linear effect on predicted outcomes. When applied to costs estimates they have even less impact.

In the case where PWSs increase the percentage of corrective actions taken in response to an assessment, costs are expected to increase corresponding to the greater number of corrective actions taken. Using the increases predicted for the small subset of PWSs analyzed, it is estimated that corrective actions (and related costs) would increase by 65% for Level 1 corrective actions and 7% for Level 2 corrective actions. This is in response to a doubling of the net change percentage of corrective actions taken in response to an assessment. However, the

increased effectiveness of more corrective actions has a dampening effect on other costs that would offset the increased corrective action costs. For instance, although the numbers of corrective actions increase due to the higher percentages found during assessments, the actual number of assessments decreases by 16% for Level 1 and by 43% for Level 2 because fewer positive samples (ranging from a 14% decrease in routine TC+ to a 28% decrease in repeat TC+) are predicted to be found. The overall effect of the cost increases and decreases in response to the major predictive occurrence model uncertainties is expected to be minimal.

The other major area of uncertainty that may affect the resulting cost calculations is the distribution of corrective actions taken by PWSs (the compliance forecast) in response to finding a problem during a Level 1 or Level 2 assessment. The compliance forecast presented in Exhibits 7.16a and 7.16b represents EPA's best estimate of a distribution of corrective actions that may be taken by PWSs to respond to problems identified under the RTCR. Because there is a wide variation in the unit costs of the actual corrective actions underlying the compliance forecast (see Appendix D for unit cost detail), EPA ran two sensitivity analyses to assess the potential impacts of different distributions within the compliance forecast. These two sensitivity runs attempt to bound the analysis of corrective action costs by generating a low and high cost bound to the estimates.

Low Bound Estimate

During discussions in the TCRDSAC meetings, several stakeholders suggested that almost all additional corrective actions taken in response to the RTCR would be in response to transient contamination events or poor sampling techniques. These are also the least expensive corrective actions. To examine the effects of greater emphasis on these types of corrective actions, EPA reran the cost model to reflect 90% selection of either spot flushing or sampler training as corrective actions. The remaining 10% of costs were distributed across the least costly corrective actions under each of the other compliance forecast categories. This results in an approximate 81 percent decrease in total net costs for the RTCR and an approximate 43 percent decrease in total net costs for the Alternative option, using a 3 percent discount rate. Exhibit 7.24 shows the change in the overall costs with this change.

High Bound Estimate

PWSs may also take actions that result in higher corrective action costs than those predicted by the current compliance forecast, although this would be a less likely scenario based on stakeholder discussions. Purely economic considerations also suggest that, given the option, PWSs would opt for the least costly option to address any issues identified. However, to test a potential high end of corrective action costs, EPA ran the cost model with the compliance forecast set to take the highest cost corrective action in each compliance forecast category. In this scenario, only 5% of corrective actions were predicted for flushing and sampler training, and 10% were estimated for each of the other compliance categories, and unit costs were assigned for the highest unit cost corrective action in each. This results in an increase in total net costs for the RTCR by approximately a factor of 1.8, and an increase in total net costs by approximately a factor of 1.5 for the Alternative option. Exhibit 7.24 shows the annualized total and net change cost estimates for PWSs and states to comply with RTCR under the 1989 TCR, RTCR, and Alternative options based on low bound and high bound estimates in the compliance forecast.

Exhibit 7.24 Sensitivity Analysis—Annualized Net Change in Costs based on Changes in Compliance Forecast ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
RTCR Net Change	$ 14.15	$ 0.15	$ 14.30	$ 13.75	$ 0.42	$ 14.17
RTCR Low Bound Net Change	$ 2.61	$ 0.15	$ 2.75	$ 3.91	$ 0.42	$ 4.33
RTCR High Bound Net Change	$ 25.10	$ 0.15	$ 25.25	$ 23.63	$ 0.42	$ 24.05
Alternative Option Net Change	$ 29.29	$ 0.31	$ 29.60	$ 31.09	$ 0.61	$ 31.69
Alternative Option Low Bound Net Change	$ 16.54	$ 0.31	$ 16.84	$ 19.93	$ 0.61	$ 20.54
Alternative Option High Bound Net Change	$ 42.68	$ 0.31	$ 42.99	$ 43.63	$ 0.61	$ 44.24

Note: Detail may not add due to independent rounding.

Source: Final RTCR Cost Model.

Overall, EPA recognizes that there is uncertainty in various parts of its estimates that could result in either an over- or underestimate of the costs as presented in this chapter. Exhibit 7.25 presents a summary of these issues, references the location in the EA where the information is introduced, and estimates the effects that each may have on national costs. All of the assumptions influencing the EA baseline (1989 TCR) do so in the same way for the RTCR and Alternative option. Therefore, EPA does not expect the net results of the analyses presented in this EA to be significantly influenced by the uncertainty in the assumptions applied in developing the RTCR cost analysis. EPA has been careful to use the best available data, to account for uncertainty quantitatively when possible, and to avoid any consistent biases in assumptions and the use of data.

Exhibit 7.25 Cost Uncertainty Summary

Uncertainty	Section with Full Discussion of Uncertainty	Most Likely Effect of Current Assumptions on Estimate of National Costs		
		Underestimate	Overestimate	Unknown Impact
Labor Rate	7.2.1			X
Labor Burden Estimates	7.4.1–7.4.8			X
Unit Costs	7.4.1–7.4.8			X [note 1]
Percentage of systems on monthly, quarterly, and annual monitoring frequencies	7.4.3			X
Number of acute violations	7.4.5			X
Number of systems performing level 1 and level 2 assessments	7.4.5			X
Compliance forecasts for corrective actions based on level 1 and level 2 assessments	7.4.6 and 7.7			X [note 2]
Corrective Actions based on level 1 and level 2 Assessments	7.4.6 and 7.7			X

Notes:

1) All unit costs (with the exception of those for corrective actions, which are not applied to the 1989 TCR) were used in the RTCR cost code in the same way for the 1989 TCR, RTCR, and Alternative option. Therefore, EPA expects that any under- or over-estimation would affect the baseline and other options similarly, resulting in no significant net effect on the results of the analysis.
2) The compliance forecast represents EPA's best estimate of a distribution of corrective actions that may be taken by PWSs to respond to problems identified under the RTCR. EPA ran two sensitivity analyses to assess the potential impacts of different distributions within the compliance forecast (see Section 7.7). These two sensitivity runs showed that under the low bound and high bound estimates, the net change costs for the RTCR were smaller than those for the Alternative option.

7.8 Comparison of Total and Net Annualized Costs for All Regulatory Options

Based on information presented previously in this chapter, EPA developed national cost estimates for the 1989 TCR, RTCR, and Alternative option. Exhibit 7.26 presents the total[57] and net change in annualized costs to PWSs and states at 3 and 7 percent discount rates. Exhibit 7.27 presents the total and net change in annualized costs for the 1989 TCR, RTCR, and Alternative option by rule component at 3 and 7 percent discount rates. Exhibit 7.28 presents the total and net change in annualized costs for the 1989 TCR, RTCR, and Alternative option by PWS size and type at 3 and 7 percent discount rates. Exhibit 7.29 presents the costs shown in Exhibit 7.28 on a per-PWS basis. Further discussion of the results follows these exhibits.

Exhibit 7.26 Comparison of Total and Net Change from 1989 TCR in Annualized Present Value Costs ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ 185	$ 0.9	$ 186	$ 178	$ 0.9	$ 179
RTCR - Total	$ 199	$ 1.1	$ 200	$ 192	$ 1.3	$ 193
RTCR - Net Change	**$ 14**	**$ 0.1**	**$ 14**	**$ 14**	**$ 0.4**	**$ 14**
RTCR - Percent Change	**8%**	**16%**	**8%**	**8%**	**48%**	**8%**
Alternative Option - Total	$ 214	$ 1.2	$ 216	$ 209	$ 1.5	$ 210
Alternative Option - Net Change	**$ 29**	**$ 0.3**	**$ 30**	**$ 31**	**$ 0.6**	**$ 32**
Alternative Option - Percent Change	**16%**	**34%**	**16%**	**17%**	**69%**	**18%**

Note: Detail may not add due to independent rounding. Because only the net change in costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

Source: Final RTCR cost model.

[57] Because only the net change in costs of some rule components are considered as part of the cost analysis, references to total costs in this section do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

Exhibit 7.27 Comparison of Total and Net Change in Annualized Present Value Costs by Rule Component ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
Rule Implementation and Annual Administration						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
RTCR - Net Change	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Alternative Option - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Alternative Option - Net Change	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Revising Sample Siting Plans						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
RTCR - Net Change	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Alternative Option - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Alternative Option - Net Change	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Routine Monitoring						
1989 TCR - Total	$ 170.59	$ -	$ 170.59	$ 163.94	$ -	$ 163.94
RTCR - Total	$ 174.71	$ -	$ 174.71	$ 167.74	$ -	$ 167.74
RTCR - Net Change	$ 4.12	$ -	$ 4.12	$ 3.80	$ -	$ 3.80
Alternative Option - Total	$ 187.50	$ -	$ 187.50	$ 182.48	$ -	$ 182.48
Alternative Option - Net Change	$ 16.91	$ -	$ 16.91	$ 18.54	$ -	$ 18.54
Additional Routine Monitoring						
1989 TCR - Total	$ 3.87	$ -	$ 3.87	$ 3.72	$ -	$ 3.72
RTCR - Total	$ 1.12	$ -	$ 1.12	$ 1.09	$ -	$ 1.09
RTCR - Net Change	$ (2.75)	$ -	$ (2.75)	$ (2.63)	$ -	$ (2.63)
Alternative Option - Total	$ 0.78	$ -	$ 0.78	$ 0.66	$ -	$ 0.66
Alternative Option - Net Change	$ (3.10)	$ -	$ (3.10)	$ (3.06)	$ -	$ (3.06)
Repeat Monitoring						
1989 TCR - Total	$ 5.11	$ -	$ 5.11	$ 4.92	$ -	$ 4.92
RTCR - Total	$ 4.88	$ -	$ 4.88	$ 4.70	$ -	$ 4.70
RTCR - Net Change	$ (0.23)	$ -	$ (0.23)	$ (0.22)	$ -	$ (0.22)
Alternative Option - Total	$ 5.66	$ -	$ 5.66	$ 5.59	$ -	$ 5.59
Alternative Option - Net Change	$ 0.54	$ -	$ 0.54	$ 0.67	$ -	$ 0.67
Annual Site Visits						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Net Change	$ -	$ -	$ -	$ -	$ -	$ -
Alternative Option - Total	$ -	$ -	$ -	$ -	$ -	$ -
Alternative Option - Net Change	$ -	$ -	$ -	$ -	$ -	$ -
Level 1 Assessment						
1989 TCR - Total	$ 1.13	$ 0.21	$ 1.34	$ 1.08	$ 0.20	$ 1.29
RTCR - Total	$ 1.63	$ 0.20	$ 1.84	$ 1.57	$ 0.20	$ 1.77
RTCR - Net Change	$ 0.51	$ (0.01)	$ 0.50	$ 0.49	$ (0.01)	$ 0.48
Alternative Option - Total	$ 1.76	$ 0.23	$ 1.99	$ 1.72	$ 0.23	$ 1.94
Alternative Option - Net Change	$ 0.63	$ 0.02	$ 0.65	$ 0.63	$ 0.02	$ 0.65
Level 2 Assessment						
1989 TCR - Total	$ 0.70	$ 0.26	$ 0.96	$ 0.68	$ 0.25	$ 0.92
RTCR - Total	$ 0.90	$ 0.19	$ 1.08	$ 0.88	$ 0.18	$ 1.06
RTCR - Net Change	$ 0.20	$ (0.07)	$ 0.12	$ 0.20	$ (0.07)	$ 0.13
Alternative Option - Total	$ 1.26	$ 0.29	$ 1.55	$ 1.30	$ 0.31	$ 1.61
Alternative Option - Net Change	$ 0.55	$ 0.03	$ 0.58	$ 0.62	$ 0.06	$ 0.68
Corrective Actions based on Level 1 Assessments						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 9.62	$ 0.01	$ 9.63	$ 8.14	$ 0.01	$ 8.15
RTCR - Net Change	$ 9.62	$ 0.01	$ 9.63	$ 8.14	$ 0.01	$ 8.15
Alternative Option - Total	$ 10.01	$ 0.01	$ 10.02	$ 8.52	$ 0.01	$ 8.53
Alternative Option - Net Change	$ 10.01	$ 0.01	$ 10.02	$ 8.52	$ 0.01	$ 8.53
Corrective Actions based on Level 2 Assessments						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.82	$ 0.00	$ 2.82	$ 2.49	$ 0.00	$ 2.49
RTCR - Net Change	$ 2.82	$ 0.00	$ 2.82	$ 2.49	$ 0.00	$ 2.49
Alternative Option - Total	$ 3.78	$ 0.01	$ 3.79	$ 3.57	$ 0.01	$ 3.58
Alternative Option - Net Change	$ 3.78	$ 0.01	$ 3.79	$ 3.57	$ 0.01	$ 3.58
Public Notification						
1989 TCR - Total	$ 3.75	$ 0.44	$ 4.19	$ 3.60	$ 0.42	$ 4.02
RTCR - Total	$ 0.26	$ 0.06	$ 0.32	$ 0.25	$ 0.06	$ 0.31
RTCR - Net Change	$ (3.49)	$ (0.38)	$ (3.86)	$ (3.35)	$ (0.36)	$ (3.71)
Alternative Option - Total	$ 0.35	$ 0.08	$ 0.43	$ 0.35	$ 0.08	$ 0.44
Alternative Option - Net Change	$ (3.40)	$ (0.36)	$ (3.76)	$ (3.25)	$ (0.34)	$ (3.58)

Notes:

1) Detail may not add due to independent rounding. Because only the incremental costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

2) For modeling purposes, additional routine sample counts include regular routine samples taken in the same month.

Source: Final RTCR cost model.

Exhibit 7.28 Total and Net Change in Annualized Costs to PWSs by PWS Size and Type ($Millions, 2007$)

PWS Size (Population Served)	3% Discount Rate					7% Discount Rate				
	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net
	A	B	C=B-A	D	E=D-A	F	G	H=G-F	I	J=I-F
Community Water Systems (CWSs)										
≤100	$7.4	$7.5	$0.1	$7.6	$0.2	$7.1	$7.3	$0.2	$7.5	$0.3
101-500	$9.0	$9.4	$0.4	$9.5	$0.5	$8.6	$9.1	$0.5	$9.2	$0.6
501-1,000	$3.7	$3.8	$0.0	$3.8	$0.1	$3.6	$3.7	$0.1	$3.7	$0.1
1,001-4,100	$13.2	$13.6	$0.4	$13.6	$0.4	$12.7	$13.1	$0.4	$13.1	$0.4
4,101-33,000	$42.4	$44.8	$2.4	$44.8	$2.4	$40.7	$42.8	$2.1	$42.8	$2.1
33,001-96,000	$34.9	$36.4	$1.5	$36.4	$1.5	$33.5	$34.8	$1.3	$34.8	$1.3
96,001-500,000	$34.7	$36.2	$1.5	$36.2	$1.5	$33.4	$34.6	$1.2	$34.6	$1.2
500,001-1 Million	$6.5	$6.7	$0.2	$6.7	$0.2	$6.2	$6.4	$0.1	$6.4	$0.1
> 1 Million	$5.6	$5.6	($0.0)	$5.6	($0.0)	$5.3	$5.3	($0.0)	$5.3	($0.0)
Total	**$157.4**	**$163.9**	**$6.5**	**$164.1**	**$6.7**	**$151.3**	**$157.2**	**$5.9**	**$157.5**	**$6.2**
Nontransient Noncommunity Water Systems (NTNCWSs)										
≤100	$2.6	$2.7	$0.1	$3.7	$1.1	$2.5	$2.7	$0.2	$3.8	$1.4
101-500	$1.9	$2.0	$0.1	$2.8	$0.9	$1.8	$2.0	$0.2	$2.9	$1.1
501-1,000	$0.6	$0.6	$0.1	$0.9	$0.3	$0.6	$0.6	$0.1	$0.9	$0.3
1,001-4,100	$1.2	$1.3	$0.1	$1.3	$0.1	$1.1	$1.2	$0.1	$1.2	$0.1
4,101-33,000	$0.4	$0.5	$0.1	$0.5	$0.1	$0.4	$0.5	$0.0	$0.5	$0.0
33,001-96,000	$0.1	$0.1	$0.0	$0.1	$0.0	$0.1	$0.1	$0.0	$0.1	$0.0
96,001-500,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
500,001-1 Million	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
> 1 Million	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**$6.9**	**$7.3**	**$0.4**	**$9.3**	**$2.5**	**$6.6**	**$7.2**	**$0.6**	**$9.6**	**$3.0**
Transient Noncommunity Water Systems (TNCWSs)										
≤100	$13.4	$18.7	$5.3	$28.1	$14.7	$12.8	$18.2	$5.3	$28.9	$16.1
101-500	$4.9	$6.5	$1.6	$9.5	$4.7	$4.7	$6.3	$1.6	$9.8	$5.1
501-1,000	$0.6	$0.8	$0.2	$1.2	$0.5	$0.6	$0.8	$0.2	$1.2	$0.6
1,001-4,100	$0.9	$1.0	$0.1	$1.0	$0.1	$0.9	$1.0	$0.1	$1.0	$0.1
4,101-33,000	$0.4	$0.5	$0.1	$0.5	$0.1	$0.4	$0.5	$0.0	$0.5	$0.0
33,001-96,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
96,001-500,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
500,001-1 Million	$0.2	$0.2	($0.0)	$0.2	($0.0)	$0.2	$0.2	($0.0)	$0.2	($0.0)
> 1 Million	$0.3	$0.3	$0.0	$0.3	$0.0	$0.3	$0.3	$0.0	$0.3	$0.0
Total	**$20.9**	**$28.1**	**$7.3**	**$41.0**	**$20.1**	**$20.1**	**$27.3**	**$7.3**	**$42.0**	**$21.9**
Grand Total	**$185.2**	**$199.3**	**$14.2**	**$214.4**	**$29.3**	**$177.9**	**$191.7**	**$13.8**	**$209.0**	**$31.1**

Note: Detail may not add due to independent rounding. Because only the incremental costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

Source: Final RTCR cost model.

Exhibit 7.29 Total and Net Change in Annualized Per PWS Costs by PWS Size and Type (2007$)

PWS Size (Population Served)	3% Discount Rate					7% Discount Rate				
	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net
	A	B	C=B-A	D	E=D-A	F	G	H=G-F	I	J=I-F
Community Water Systems (CWSs)										
≤100	$564	$573	$9	$581	$17	$542	$558	$16	$569	$27
101-500	$561	$584	$23	$590	$29	$539	$568	$29	$576	$37
501-1,000	$663	$671	$8	$679	$15	$637	$654	$17	$664	$26
1,001-4,100	$1,411	$1,451	$40	$1,451	$40	$1,356	$1,401	$45	$1,401	$45
4,101-33,000	$6,707	$7,084	$377	$7,084	$377	$6,445	$6,775	$330	$6,775	$330
33,001-96,000	$33,053	$34,506	$1,453	$34,506	$1,453	$31,764	$32,971	$1,207	$32,971	$1,207
96,001-500,000	$93,620	$97,607	$3,987	$97,607	$3,987	$89,969	$93,242	$3,273	$93,242	$3,273
500,001-1 Million	$185,678	$190,167	$4,490	$190,167	$4,490	$178,437	$182,027	$3,591	$182,027	$3,591
> 1 Million	$277,732	$277,621	($111)	$277,621	($111)	$266,902	$266,828	($74)	$266,828	($74)
Total	**$3,029**	**$3,153**	**$124**	**$3,158**	**$129**	**$2,911**	**$3,024**	**$113**	**$3,030**	**$119**
Nontransient Noncommunity Water Systems (NTNCWSs)										
≤100	$284	$295	$11	$406	$122	$273	$293	$20	$423	$150
101-500	$273	$291	$18	$409	$135	$263	$290	$28	$425	$163
501-1,000	$321	$349	$29	$472	$151	$308	$348	$40	$491	$183
1,001-4,100	$1,325	$1,441	$116	$1,441	$116	$1,274	$1,383	$110	$1,383	$110
4,101-33,000	$4,819	$5,382	$563	$5,382	$563	$4,631	$5,124	$493	$5,124	$493
33,001-96,000	$32,003	$33,305	$1,303	$33,305	$1,303	$30,755	$31,852	$1,096	$31,852	$1,096
96,001-500,000	$91,163	$90,898	($265)	$90,898	($265)	$87,609	$87,385	($224)	$87,385	($224)
500,001-1 Million	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
> 1 Million	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	**$366**	**$390**	**$23**	**$498**	**$132**	**$352**	**$384**	**$32**	**$510**	**$158**
Transient Noncommunity Water Systems (TNCWSs)										
≤100	$217	$304	$86	$457	$240	$209	$295	$87	$470	$261
101-500	$247	$327	$80	$483	$236	$237	$317	$80	$495	$257
501-1,000	$310	$408	$98	$567	$256	$298	$396	$97	$579	$281
1,001-4,100	$1,364	$1,528	$164	$1,528	$164	$1,311	$1,460	$150	$1,460	$150
4,101-33,000	$5,068	$5,679	$611	$5,679	$611	$4,871	$5,408	$537	$5,408	$537
33,001-96,000	$38,507	$38,155	($352)	$38,155	($352)	$37,008	$36,701	($307)	$36,701	($307)
96,001-500,000	$77,791	$77,043	($748)	$77,043	($748)	$74,762	$74,090	($672)	$74,090	($672)
500,001-1 Million	$186,699	$184,841	($1,858)	$184,841	($1,858)	$179,429	$177,725	($1,704)	$177,725	($1,704)
> 1 Million	$287,010	$302,862	$15,852	$302,862	$15,852	$275,817	$291,208	$15,391	$291,208	$15,391
Total	**$248**	**$334**	**$86**	**$487**	**$239**	**$238**	**$325**	**$86**	**$499**	**$260**
Grand Total	**$1,196**	**$1,287**	**$91**	**$1,385**	**$189**	**$1,149**	**$1,238**	**$42**	**$1,350**	**$154**

Note: Detail may not add due to independent rounding. Because only the incremental costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

Source: Final RTCR cost model.

Evaluation of Regulatory Options

Exhibit 7.26 summarizes the comparison of total and annualized present value of the net change difference in cost from the baseline for each of the three regulatory options (1989 TCR, RTCR, and Alternative option). A continuation of the 1989 TCR would result in no net change in costs. The net change in mean annualized present value national costs of the RTCR is estimated to be approximately $14 million using a 3% or 7% discount rate. The net change in mean annualized present value national costs for the Alternative option are estimated to be approximately $30 million using a 3% discount rate and $32 million using a 7% discount rate.

The total net change in national annualized present value costs for PWSs serving >4,100 people (approximately $5.6 million at a 3% discount rate) is the same under the RTCR and Alternative option. This is expected because the provisions for PWSs serving >4,100 are the same under both the RTCR and Alternative option. Monitoring requirements for PWSs serving >4,100 people would remain essentially unchanged under either the RTCR or Alternative option. The observed overall net increase in costs for PWSs serving >4,100 people is driven primarily by the requirements to conduct assessments and to correct any sanitary defects that are found.

Under the RTCR, PWSs are estimated to incur approximately 97% to 99% of the net annualized present value costs at 3 and 7 percent discount rates. States are expected to incur the remaining costs. EPA recognizes that state labor may be more expensive than PWS labor and that for some states, state costs may be passed onto PWSs. However, state costs are only a very small percentage of the total net change costs for the RTCR.

Exhibit 7.27 presents the comparison of total and net change in annualized present value costs by rule component. The exhibit shows that, for the RTCR, corrective action costs are the most significant contributor to the net increase in costs for PWSs. For the Alternative option, routine monitoring costs are the most significant contributor to the net increase in costs for PWSs. Under the RTCR and Alternative option, state costs to review revised sample siting plans contribute most to the cost increase. For both PWSs and states, a net decrease in costs associated with PN requirements helps to offset the total net cost increase.

The large difference in net cost increases between the RTCR and the Alternative option is primarily driven by the increased number of routine samples taken under the Alternative option in comparison to the RTCR. A larger number of samples are also estimated to result more in Level 1 and Level 2 triggers and to subsequently require corrective actions based on Level 1 and Level 2 assessments. Overall, the total net costs of the RTCR are estimated at 45% to 48% of the net costs of the Alternative option. This cost difference is an important consideration in the selection of the RTCR over the Alternative option as the preferred option.

Exhibit 7.28 presents the total and net change in annualized costs to PWSs by size and type for the three regulatory options. No net change in costs would result from a continuation of the 1989 TCR. Among PWSs serving ≤4,100 people, the largest increase in net costs would be incurred by the TNCWSs serving ≤100 people under either the RTCR ($5.3 million) or Alternative option ($14.7 million). As shown in Exhibit 7.29, on a per system basis, this translates to a net annualized present value (3% discounting) increase of approximately $86 per system under the RTCR and $240 per system under the Alternative option for the TNCWSs

serving ≤100 people. Significant impacts are also estimated for CWSs serving greater than 4,100 people, driven by the relatively high number of CWSs in this category, combined with relatively high unit costs for implementing corrective actions for PWSs of this size. However, PWSs of this size (and CWSs in general) are expected to be better able to absorb cost increases by passing costs through to a larger base of customers. Overall, the most important drivers of total net costs are the numbers of PWSs and the underlying baseline occurrence estimates in a given size category. Taken together, these influence the numbers of samples and ultimately the numbers of corrective actions taken, which drive the cost estimates.

Exhibit 7.29 shows the costs from Exhibit 7.28 on a per-PWS basis. On this basis, the annual impact of the RTCR generally increases with PWS size and the magnitude of the annual per-PWS net costs do not appear to be prohibitive, even for the most heavily impacted PWS categories. However, the range of per-PWS costs is expected to be fairly wide and some individual PWSs may be more heavily impacted.

8 Economic Impact Analysis

8.1 Introduction

As part of the rulemaking process, the United States Environmental Protection Agency (EPA) is required to address the direct and indirect burdens that the Revised Total Coliform Rule (RTCR) may place on certain types of governments, businesses, and populations. This chapter presents analyses performed by the EPA in accordance with the following 14 federal mandates and statutory reviews:

1. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review.

2. Paperwork Reduction Act (the Information Collection Request (ICR) document for the RTCR contains the complete analysis (USEPA, 2010a)).

3. The Regulatory Flexibility Act (RFA) of 1980, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996.

4. Unfunded Mandates Reform Act (UMRA) of 1995.

5. Executive Order 13132: Federalism.

6. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments.

7. Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks.

8. Executive Order 13211: Action Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use.

9. National Technology Transfer and Advancement Act (NTTAA).

10. Executive Order 12898: Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations.

11. Consultations with the Science Advisory Board (SAB), National Drinking Water Advisory Council (NDWAC), and the Secretary of Health and Human Services as Required by Section 1412 (d) and (e) of the Safe Drinking Water Act (SDWA).

12. Impacts on Sensitive Subpopulations as Required by Section 1412(b)(3)(c)(i)(V) of the 1996 Amendments to the Safe Drinking Water Act.

13. Effect of Compliance with the RTCR on the Technical, Financial, and Managerial Capacity of Public Water Systems as Required by Section 1420(d)(3) of SDWA.

Many of the requirements and executive orders listed above call for an explanation of why the rule is necessary, the statutory authority for the rule, and the primary objectives that the rule is intended to achieve (refer to Chapter 2 for more information regarding the objectives of the rule). Others are designed to assess the financial and health effects of the rule on sensitive, low-income, and tribal populations as well as on small public water systems (PWSs).

8.2 Executive Order 12866: Regulatory Planning and Review

Under Executive Order 12866 (58 Federal Register (FR) 51735, October 4, 1993), the Agency must determine whether the regulatory action is significant and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order. The Order defines "significant regulatory action" as one that is likely to result in a rule that may:

- Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlement, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Under Executive Order 12866, EPA has designated this action as a "significant regulatory action" because of the legal and policy issues raised. Accordingly, EPA submitted this action to the OMB for review under Executive Orders 12866 and 13563 (76 FR 3821, January 21, 2011) and any changes made in response to OMB recommendations have been documented in the docket for this action.

In addition, EPA prepared an analysis of the potential costs and benefits associated with this action. EPA estimates that the RTCR will have an overall annual impact on PWSs of $14 million and that the impact on small entities (PWSs serving 10,000 people or fewer) will be $10.0 million–$10.3 million annualized at 3 and 7 percent discount rates, respectively. These impacts are described in Section 8.4 as well as sections VI and VII.C of the RTCR preamble (USEPA, 2010c), respectively.

8.3 Paperwork Reduction Act

The information collection requirements for the RTCR have been submitted for approval to the OMB under the Paperwork Reduction Act (PRA), 44 U.S.C. 3501 *et seq*. The ICR document prepared by EPA has been assigned EPA ICR number 1895.06.

The PRA requires EPA to estimate the burden, as defined in 5 CFR 1320.3(b), on PWSs and state/primacy agencies of complying with the rule. The information collected as a result of

EPA's efforts toward proposing the RTCR should allow states/primacy agencies and EPA to determine appropriate requirements for specific systems and evaluate compliance with the RTCR. Burden is defined at 5 CFR 1320.3(b) and means the total time, effort, and financial resources required to generate, maintain, retain, disclose, or provide information to or for a federal agency. The burden includes the time needed to conduct the following state and PWS activities, as needed:

State activities:

- Read and understand the rule;
- Mobilize (including primacy application), plan, and implement;
- Train PWS and consultant staff;
- Track compliance;
- Analyze and review PWS data;
- Review sample siting plans and recommend any revisions to PWSs;
- Make determinations concerning PWS monitoring requirements;
- Respond to PWSs with positive samples;
- Recordkeeping;
- Review completed assessment forms and consult with the PWS about the assessment report;
- Review and coordinate with PWSs to determine optimal corrective actions to be implemented; and
- Provide consultation, review public notification certifications, and file reports of violations.

PWS activities:

- Read and understand the rule;
- Planning and mobilization activities;
- Revise existing sample siting plans to identify sampling locations and collection schedules that are representative of water throughout the distribution system;
- Conduct routine, additional routine, and repeat monitoring, and report the results as required;

- Complete a Level 1 Assessment if the PWS experiences a Level 1 trigger, and submit a form to the state to identify sanitary defects detected, corrective actions completed, and a timetable for any corrective actions not already completed;

- Complete a Level 2 Assessment if the PWS experiences a Level 2 trigger, and submit a form to the state to identify sanitary defects detected, corrective actions completed, and a timetable for any corrective actions not already completed;

- Correct sanitary defects found through the performance of Level 1 or Level 2 assessments and report on completion of corrective actions as required;

- Develop and distribute Tier 1 public notices when *E. coli* MCL violations occur;

- Develop and distribute Tier 2 public notices when the PWSs fail to take corrective action; and

- Develop and distribute Tier 3 public notices when the PWSs fail to comply with the monitoring requirements or with mandatory reporting of required information within the specified timeframe.

For the first three years after publication of the rule in the *Federal Register*, the major information requirements apply to 154,894 respondents. The net change in burden associated with moving from the information requirements of the 1989 TCR to those in the RTCR over the three years covered by the ICR is 2,518,577 hours, for an average of 839,526 hours per year. The total net change in costs (i.e., incremental costs over the 1989 TCR) over the three-year clearance period is $71.3 million, for an average of $23.8 million per year (simple average over three years). (The ICR estimate is higher than what is presented in the economic analysis (EA) for the RTCR because in the EA, the upfront costs that occur in the first three years, as well as future costs, are annualized over a 25-year time horizon.) The average burden per response (i.e., the amount of time needed for each activity that requires a collection of information) is 5.4 hours; the average cost per response is $153.4. The collection requirements are mandatory under SDWA (42 U.S.C. 300j-4 subsections (a)(1)(A) and (a)(1)(B)). Detail on the calculation of the RTCR information collection burden and costs can be found in the ICR for the RTCR and Chapter 7 of this EA. A summary of the burdens and costs of the collection is presented in Exhibit 8.1 below.

Exhibit 8.1 Average Annual Net Change Burden and Costs for the RTCR Information Collection Request

Respondent Type	Annual Burden Hours	Cost				Annual Responses
		Annual Labor Cost	Annual O&M Cost	Annual Capital Cost	Total Annual Cost	
PWSs	747,848	$ 20,171,639	$ -	$ -	$ 20,171,639	103,225
States and Territories	91,678	$ 3,595,421	$ -	$ -	$ 3,595,421	51,669
TOTAL	**839,526**	**$ 23,767,060**	**$ -**	**$ -**	**$ 23,767,060**	**154,894**

Notes:
1) Detail may not add exactly to total due to independent rounding.
2) "Annual Burden Hours" reflects an annual average for all system sizes over the 3-year ICR period.
Source: ICR for the Final RTCR (USEPA 2010b).

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

As part of the Federal Register notice on the proposed RTCR, EPA solicited comments on this information collection and the estimates in this ICR. EPA solicited comments on specific aspects of the proposed information collection, as described below:

1. Whether the collection of information is necessary for the proper performance of the functions of the Agency, including whether the information will have practical utility;

2. Whether the Agency's burden estimate is accurate including the validity of the methodology and assumptions used;

3. How to enhance the quality, utility, and clarity of the information to be collected; and

4. How to minimize the burden on respondents, including use of appropriate automated electronic, mechanical, or other technological collection techniques or other forms of information technology.

EPA did not receive comments that specifically referred to the ICR prepared for the proposed rule; however, it received several comments (such as the need to increase unit costs) on the associated EA, as well as the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d) (which contains many of the unit costs used to estimate costs for the Cost Analysis and the ICR). For the RTCR, EPA revised many of the unit costs associated with corrective actions to incorporate those comments; these changes have been incorporated into this ICR.

EPA's responses to comments received on the proposed rule are available at http://www.regulations.gov, docket number EPA-HQ-OW-2008-0878.

In compliance with the PRA (44 USC 3501 et seq.), EPA submitted the ICR for the RTCR Rule to OMB for review and approval prior to proposal. EPA did not receive any comments from OMB on the ICR at that time.

8.4 The Regulatory Flexibility Act

The RFA generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

The RFA provides default definitions for each type of small entity. Small entities are defined as: (1) a small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; and (3) a small organization that is any "not-for-profit enterprise which is independently owned and operated and is not dominant in its field." However, the RFA also authorizes an agency to use alternative definitions for each category of small entity, "which are appropriate to the activities of the agency" after proposing the alternative definition(s) in the Federal Register and taking comment. 5 USC 601(3)–(5). In addition, to establish an alternative small business definition, agencies must consult with SBA's Chief Counsel for Advocacy.

For purposes of assessing the impacts of the RTCR on small entities, EPA considered small entities to be PWSs serving 10,000 people or fewer. This is the cutoff level specified by Congress in the 1996 Amendments to the SDWA for small system flexibility provisions. As required by the RFA, EPA proposed using this alternative definition in the Federal Register (63 FR 7620, February 13, 1998), requested public comment, consulted with the SBA, and finalized the alternative definition in the Agency's Consumer Confidence Reports Rule (USEPA, 1998b, 63 FR 44524, August 19, 1998). As stated in that Final Rule, the alternative definition would be applied for all future drinking water regulations.

After considering the economic impacts of today's rule on small entities, EPA has certified that the RTCR will not have a significant economic impact on a substantial number of small entities. The small entities directly regulated by this rule are small PWSs serving 10,000 or fewer people. These include small community water systems (CWSs), non-transient noncommunity water systems (NTNCWSs), and transient noncommunity water systems (TNCWSs), entities such as municipal water systems (publicly and privately owned), and privately-owned PWSs and for profit businesses where provision of water may be ancillary, such as mobile home parks, day care centers, churches, schools and homeowner associations. In evaluating the impact on small PWSs, it has been determined that only 61 of 150,672 small systems (0.04 percent) will experience an impact of more than one percent of revenues, and that none of the small systems will experience an impact of three percent or greater of revenue. Exhibit 8.2 provides a summary of the numbers and percentages of small systems for which costs exceed one percent of revenues, by size category and system type using a three percent discount rate. Exhibit 8.3 provides a summary of the average costs and average revenues on a per system

basis. See Appendix I for the detailed methodology and supporting information for the RFA screening analysis.

Exhibit 8.2 RTCR - Average Annualized Revenue by System Size and Percent of Systems with Costs Exceeding One Percent and Three Percent of Revenue (Three Percent Discount Rate)

System Type	System Size	Total Systems	Average Revenue/ System	1% of Revenue	Systems Exceeding 1% of Revenue	Percent of Systems Exceeding 1% of Revenue	3% of Revenue	Systems Exceeding 3% of Revenue	Percent of Systems Exceeding 3% of Revenue
		A	B	C=B*0.01	D	E=D/A	F=B*0.03	G	H=G/A
CWS	≤500	29,150	$ 199,000	$ 2,000	60	0.21%	$ 6,000	0	0.00%
	501 - 4,100	15,021	$ 1,114,000	$ 11,000	0	0.00%	$ 33,000	0	0.00%
	4,101 - 10,000	3,672	$ 4,432,000	$ 44,000	1	0.03%	$ 133,000	0	0.00%
NTNCWS	≤500	15,942	$ 3,075,000	$ 31,000	0	0.00%	$ 92,000	0	0.00%
	501 - 4,100	2,690	$ 11,793,000	$ 118,000	0	0.00%	$ 354,000	0	0.00%
	4,101 - 10,000	80	$ 61,663,000	$ 617,000	0	0.00%	$ 1,850,000	0	0.00%
TNCWS	≤500	81,311	$ 1,811,000	$ 18,000	0	0.00%	$ 54,000	0	0.00%
	501 - 4,100	2,735	$ 3,192,000	$ 32,000	0	0.00%	$ 96,000	0	0.00%
	4,101 - 10,000	71	$ 11,280,000	$ 113,000	0	0.00%	$ 338,000	0	0.00%
All	≤10,000	150,672	N/A	N/A	61	0.04%	N/A	0	0.00%

Sources: (A) SDWIS 2007 (B) Average CWS revenues from 2006 CWSS survey. Average NTNCWS and TNCWS revenues calculated based on representative revenues for specific business categorizations (Appendix I provides additional detail.)
(D, G) Number of systems with costs exceeding one percent and three percent of revenue calculated based on distributions of costs for each rule component by system size compared to the average revenues. As a function of calculations in the cost model, fractional system counts may be generated. Analyses in the exhibit are based only on whole system counts. (Appendix I provides additional detail.)
Consistent with the rest of the EA, the population break is at 4,100 people rather than 3,300. This population break was based on TCRDSAC deliberations and consideration that concluded that breaking out the analysis at the 4,100 point would be most informative because of changes in the rule provisions at the 4,100 people point. (Chapter 4 provides further detail on data selection and size break outs.)

Exhibit 8.3 RTCR—Average Costs per System and as Percentage of Revenue (2007$)

System Size	Number of Systems	Average Annual Net Cost/ System	Average Revenue/ System[1]	Average Annual Net Costs as a Percentage of Revenue
	A	B	C	D=(B/C)*100
≤500	126,403	$ 60	$ 1,599,000	0.004%
501 - 4,100	20,446	$ 48	$ 2,797,000	0.002%
4,101 - 10,000	3,823	$ 276	$ 5,757,000	0.005%
All PWSs ≤10,000	150,672	$ 64	$ 1,867,000	0.003%

[1] Includes water revenues and non-water revenues (e.g., revenues related to the primary entities that operate a water system to support their business or municipal general revenue for publicly owned and operated systems).

Although this rule will not have a significant economic impact on a substantial number of small entities, EPA nonetheless has tried to reduce the impact of this rule on small PWSs. Provisions in the RTCR that result in reduced costs for many small entities include:

- Reduced routine monitoring for qualifying PWSs serving 1,000 or fewer people.
- Reduced number of repeat samples required for systems serving 1,000 or fewer people.
- Reduced additional routine monitoring for PWSs serving 4,100 or fewer people.
- Reduced public notification requirements for all systems, including small systems.

For some PWSs, cost savings may be offset in whole or in part by increased costs of more stringent assessment requirements, stricter rules for qualifying for reduced monitoring, or performing specific corrective actions. Additionally, seasonal PWSs are subject to increased monitoring.

A description of activities that small systems perform under the RTCR for each rule component is provided in Section 7.4 of this EA along with the associated change in cost. Exhibit 8.4 below provides the distribution of total costs to small entities by rule component. Underlying these estimates are EPA's assumptions regarding the types of corrective actions that will be implemented and the number of small PWSs predicted to implement each type. These assumptions are detailed in Appendix D of this EA.

Exhibit 8.4 RTCR—Annualized Net Rule Costs Predicted for Small Entities (PWSs serving ≤10,000) by Rule Component Using Three Percent and Seven Percent Discount Rates (2007$)

Rule Component	Net Costs at 3%	Net Costs at 7%
Rule Implementation	$ 2,673,000	$ 3,849,000
Revising Sample Siting Plans	$ 535,000	$ 755,000
Routine Monitoring	$ 4,120,000	$ 3,800,000
Additional Routine Monitoring	$ (2,753,000)	$ (2,633,000)
Repeat Monitoring	$ (178,000)	$ (171,000)
Annual Site Visits	$ -	$ -
Level 1 Assessment	$ 417,000	$ 404,000
Level 2 Assessment	$ 172,000	$ 179,000
Correction Actions based on Level 1 Assessments	$ 5,159,000	$ 4,425,000
Correction Actions based on Level 2 Assessments	$ 2,642,000	$ 2,340,000
Public Notification	$ (2,787,000)	$ (2,674,000)
Total	**$ 10,000,000**	**$ 10,273,000**

Source: Derived from cost model outputs (Appendix C).

EPA also conducted outreach to small entities and convened a Small Business Advocacy Review (SBAR) Panel to obtain advice and recommendations from representatives of the small entities that potentially would be subject to the rule's requirements. EPA consulted with small entity representatives before and during the review by the Panel. These small entity representatives included representatives from small water systems of various types and sizes, representatives from associations that assist and /or advocate for small systems, and federal agencies that operate small systems. Panel members included representatives from OMB, SBA, and the EPA Office of Ground Water and Drinking Water. The consultation led to the development of a report providing recommendations to EPA on how to revise the 1989 TCR to address small system concerns, which EPA considered in drafting the RTCR (SBAR Panel, 2008). EPA also made presentations to the advisory committee on the recommendations of the Panel so the advisory committee could consider their recommendations in developing the Agreement in Principle (AIP).

Consistent with the RFA/SBREFA requirements, the SBAR Panel evaluated the assembled materials and small-entity comments on issues and prepared a final report to the EPA Administrator. A copy of the SBAR Panel report is included in the docket for this rule. The rule is consistent with the SBAR Panel recommendations to use total coliform (TC) as a trigger for investigation and/or corrective action, to balance monitoring requirements and costs with risk, to further differentiate requirements based on differences in water systems, to coordinate requirements with other related rules, and to consider reporting and recordkeeping costs in estimating burden.

EPA further reviewed the potential impacts of the RTCR on small entities in terms of the assumption incorporated into SDWA major rulemakings that households or residential water users are most vulnerable to cost increases[58] (SBAR Panel, 2008). In an *Assessment of the Vulnerability of Noncommunity Water Systems to SDWA Cost Increases* (USEPA, 2008d), EPA considered the burden of SDWA rule costs in comparison to the average revenues of various categories of noncommunity water systems (NCWSs). All of the NCWS categories reviewed were found to be less vulnerable to SDWA-related increases than a typical household. The report notes that in some categories of businesses, costs are more easily passed on to the customer base than in others. However, in each NCWS category, expenditures on water were found to be a relatively small percentage of total revenues. Water expenditures (including expenditures for sewer service and miscellaneous other utilities) totaled less than one percent of total revenues in nearly all cases, and were not more than 1.3 percent of total revenues for any category. Several caveats were put forth in this report, including one that considered the potential for underestimating the impact to golf courses, which were grouped in with other recreational entities whose use of water was less significant to the core business than the golf courses. Despite the significant caveats listed, the report strongly suggests that TNCWS and NTNCWS should not be considered particularly vulnerable to operating cost increases resulting from SDWA rulemakings.

The consistency of many of the aspects of the RTCR with the recommendations of the SBAR Panel further support the conclusion of the RTCR EA that the RTCR requirements are conducive to minimizing net impacts on small entities. Overall, the economic analysis summarized in Exhibit 8.2 shows that net cost increases from the RTCR over time are low relative to revenue. Based on this result, EPA certifies that there will not be a significant impact on a substantial number of small entities under the RTCR.

8.5 Unfunded Mandates Reform Act

The UMRA seeks to protect state, local, and tribal governments from the imposition of unfunded federal mandates. In addition, the Act seeks to strengthen the partnership between the federal government and state, local, and tribal governments and ensure that the federal government covers the costs incurred during compliance with federal mandates.

Title II of the UMRA of 1995, Public Law 104-4, establishes requirements for federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments and the private sector. Under section 202 of UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with federal mandates that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year.

Section 205 of UMRA generally requires EPA to identify and consider a reasonable number of regulatory options and adopt the least costly, most cost-effective or least burdensome option that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an option

[58] Major SDWA rulemakings generally include a section in the EA that presents an analysis of costs of the rule per household.

other that the least costly, most cost-effective or least burdensome option if the Administrator publishes with the rule and explanation why that option was not adopted.

Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

This rule does not contain a federal mandate that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more in any one year. Expenditures associated with compliance, defined as the net change in costs beyond the 1989 TCR, will not surpass $100 million in the aggregate in any year. Thus, this rule is not subject to the requirements of sections 202 and 205 of UMRA.

This rule is also not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. Costs to small entities are generally not significant, as described previously in Section 8.4 and in section VII.C of the RTCR preamble. The regulatory requirements of the RTCR are not unique to small governments, as they apply to all PWSs regardless of size.

8.6 Executive Order 13132: Federalism

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure "meaningful and timely input by state and local officials in the development of regulatory policies that have federalism implications." "Policies that have federalism implications" is defined in the Executive Order to include regulations that have "substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government."

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government as specified in Executive Order 13132. The net change in cost for state, local, and tribal governments in the aggregate is estimated to be approximately $0.2 million and $0.4 million per year at three percent and seven percent discount rates, respectively. Thus, Executive Order 13132 does not apply to this rule.

Although section 6 of Executive Order 13132 does not apply to the RTCR, EPA conducted a federalism consultation, consistent with Executive Order 13132, in July 2008. The consultation included a stakeholder meeting where EPA requested comments on the impacts of the potential revisions to the 1989 TCR with respect to state, county and local governments. EPA did not receive any comments in response to this consultation. In addition, the TCRDSAC included representatives of state, local and tribal governments, and through this process EPA

consulted with state, local, and tribal government representatives to ensure that their views were considered when the revisions to the 1989 TCR were developed.

In the spirit of Executive Order 13132 and consistent with EPA policy to promote communications between EPA and state and local governments, during proposal of the RTCR, EPA specifically solicited comment on this action from state and local officials. EPA conducted two stakeholder meetings, in April of 2009 and May of 2010, to solicit stakeholder input as it developed a proposed rule consistent with the recommendations of the AIP. No specific concerns or considerations related to Federalism were received.

8.7 Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

Executive Order 13175, entitled "Consultation and Coordination with Indian Tribal Governments" (65 FR 67249, November 9, 2000), requires EPA to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." The Executive Order defines "policies that have tribal implications: to include regulations that have "substantial direct effects on one or more Indian tribes, on the relationship between the federal government and the Indian tribes, or on the distribution of power and responsibilities between the federal government and Indian tribes."

Under Executive Order 13175, EPA may not issue a regulation that has tribal implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the federal government provides the funds necessary to pay the direct compliance costs incurred by tribal governments, or EPA consults with tribal officials early in the process of developing the proposed regulation and develops a tribal summary impact statement.

This action does not have tribal implications, as specified in Executive Order 13175. Because the requirements of the RTCR are estimated to result in low net cost increases (or in many cases, net cost savings) compared to the 1989 TCR requirements, the RTCR is not anticipated to have a negative impact on tribal PWSs.

Although Executive Order 13175 does not apply to this action, EPA consulted with tribal officials in developing this action. EPA has consulted with tribal governments through the EPA American Indian Environmental Office, included a representative of the Native American Water Association on the advisory committee that developed recommendations regarding the proposed rule and signed the AIP, and has addressed tribal concerns throughout the regulatory development process, as appropriate. The consultation included participation in three tribal conference calls (EPA regional tribal call (February 2008), National Indian Workgroup call (March 2008), and National Tribal Water Conference (March 2008)). EPA requested comments on the 1989 TCR, requested suggestions for 1989 TCR revisions (March 2008), and presented possible revisions to the 1989 TCR to the National Tribal Council (April 2008). Furthermore, in the proposed RTCR, EPA specifically solicited additional comments on this action from tribal officials. None of these consultations or solicitations identified issues that were particular to tribal entities. As a result of the tribal consultations and other tribal outreach, EPA has

determined that the RTCR is not anticipated to have a negative impact on tribal systems. Thus, Executive Order 13175 does not apply to this action.

8.8 Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045 (62 FR 19885; April 23, 1997) applies to any rule initiated after April 21, 1998, that (1) is determined to be "economically significant" as defined under Executive Order 12866; and (2) concerns an environmental, health, or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, EPA must evaluate the environmental, health, or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible options considered by EPA.

The RTCR is not subject to Executive Order 13045 because it is not economically significant as defined in Executive Order 12866. This action's health and risk assessments in relation to Executive Order 13045 are contained in section VI.K.1 of the RTCR preamble and Chapter 6 of the EA. This EA uses a qualitative approach in assessing the changes in risk anticipated for each regulatory option relative the baseline (1989 TCR). EPA expects that the RTCR would provide additional protection, through the additional assessments and corrective action required, to both children and adults who consume drinking water supplied from PWSs. EPA also assumes that the benefits of the rule, including reduced health risk, will disproportionally accrue more to children because young children are more susceptible than adults to some waterborne illnesses and are more likely to experience more serious effects from infection. For example, the risk of mortality resulting from diarrhea is often greatest in the very young and elderly (Rose, 1997; Gerba et al., 1996), and viral and bacterial illnesses often disproportionately affect children. Any overall benefits of the rule would reduce this mortality risk for children.

During proposal of the RTCR, the public was invited to submit comments or identify peer-reviewed studies and data that assess effects of early life exposure to drinking water that contains fecal contaminants. No additional comments were made, nor were any additional studies or data identified.

8.9 Executive Order 13211: Action Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply Distribution, or Use" (66 FR 28355, May 22, 2001), provides that agencies shall prepare and submit to the Administrator of the Office of Information and Regulatory Affairs, OMB, a Statement of Energy Effects for certain actions identified as "significant energy actions." Section 4(b) of Executive Order 13211 defines "significant energy actions" as "any action by an agency (normally published in the *Federal Register*) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking: (1)(i) that is a significant regulatory action under Executive Order 12866 or any successor order, and (ii) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (2) that is designated by

the Administrator of the Office of Information and Regulatory Affairs as a significant energy action."

The RTCR is not a "significant energy action" as defined in Executive Order 13211, because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. This rule is not a significant regulatory action under Executive Order 12866, and has not been designated by the Administrator of the Office of Information and Regulatory Affairs as a significant energy action, for the reasons described as follows.

Energy Supply

The RTCR does not regulate power generation, either directly or indirectly, and public and private PWSs that the RTCR applies to do not, as a general rule, generate power. Further, the energy cost increases borne by customers of PWSs as a result of the RTCR are a low percentage of the total cost of water. Therefore, power generation utilities that purchase water as part of their operations are unlikely to face any significant effects as a result of the RTCR.

Energy Distribution

The RTCR does not regulate any aspect of energy distribution and PWSs that are regulated by the RTCR already have electrical service. The rule is not expected to increase peak electricity demand at PWSs. Therefore, EPA assumes that the existing connections are adequate and that the RTCR has no discernible adverse effect on energy distribution.

Energy Use

Because the RTCR modifies existing regulations, very few PWSs are expected to make modifications or changes that will alter energy use patterns as a result of this rule. Therefore, EPA does not expect any noticeable effect on the national levels of power generation in terms of average and peak loads.

8.10 National Technology Transfer and Advancement Act

Section 12(d) of the NTTAA of 1995, Public Law No. 104-113, 12(d) (15 U.S.C. 272 note), directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when EPA decides not to use available and applicable voluntary consensus standards.

The RTCR involves technical voluntary consensus standards. Under the RTCR, EPA will use several analytical methods to monitor for TC and/or *E. coli* as described in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998; Eaton et al., 2005). Methods included in Clesceri et al. (1998) and Eaton et al. (2005) are voluntary consensus standards. The RTCR includes 11 methods that can be used to test for TC, four of which are described in Clesceri et al. (1998) and Eaton et al. (2005).

During proposal of the RTCR, EPA welcomed comments on this aspect of the rulemaking and, specifically, invited the public to identify potentially applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

8.11 Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629, February 16, 1994) establishes federal executive policy on environmental justice. Its main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission. Agencies must do this by identifying and addressing, as appropriate, any disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

EPA has determined that the RTCR will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. The RTCR applies uniformly to all PWSs. Consequently, the RTCR provides health protection equally to all income and minority groups served by PWSs. The RTCR and other drinking water regulations are expected to have a positive effect on human health regardless of the social or economic status of a specific population. To the extent that contaminants in drinking water might be disproportionately high among minority or low-income populations (which is unknown), the RTCR contributes toward removing those differences by assuring that all PWSs meet drinking water standards and take appropriate corrective action whenever appropriate. Thus, the RTCR meets the intent of the federal policy requiring incorporation of environmental justice into federal agency missions.

8.12 Consultations with the Science Advisory Board, National Drinking Water Advisory Council, and the Secretary of Health and Human Services as Required by Section 1412 (d) and (e) of the SDWA

In accordance with section 1412(d) and (e) of the SDWA, EPA consulted with the Science Advisory Board (SAB), National Drinking Water Advisory Council (NDWAC), and the Secretary of the US Department of Health and Human Services (HHS) on the proposed RTCR. In addition, EPA consulted again with NDWAC and HHS before promulgation of the final RTCR.

EPA met with the SAB Drinking Water Committee (DWC) and considered their recommendations in developing data requirements to better understand the impacts of the RTCR. In response to the SAB DWC recommendations, EPA also conducted sensitivity analyses, to explore a wider range of assumptions regarding the percentage of assessments leading to corrective actions and to demonstrate that using an annual average for occurrence provided results comparable to varying the occurrence based on the season. In addition, EPA added an exhibit in the EA that summarizes all significant model parameters and assumptions, their influence on variability and uncertainty, and their most likely effect on benefits or costs. A copy of the SAB report (SAB 2010) is available in the docket for the RTCR.

EPA also consulted with NDWAC and requested comments in the proposed RTCR on areas of concern that NDWAC members raised during the consultation. EPA requested comment on the following: (1) whether the RTCR would be easier to implement than the 1989 TCR; and (2) the costs and benefits of reduced monitoring. EPA considered and addressed the comments it received in developing the final rule. EPA also considered NDWAC's recommendations in developing the public notification requirements for the rule.

EPA completed its consultation with HHS, as required by SDWA section 1412(d). In addition, EPA provided an informational briefing to the Food and Safety Group of the Food and Drug Administration.

Details about EPA's consultations (both for the proposed and Final Rule) with SAB, NDWAC, and HHS can be found at Section VII.K of the RTCR preamble.

8.13 Consideration of Impacts on Sensitive Subpopulations as Required by Section 1412(b)(3)(c)(i)(V) of the 1996 Amendments to the Safe Drinking Water Act (SDWA)

EPA is required to seek public comment regarding the effects of contamination associated with the RTCR on the general population and sensitive subpopulations. Sensitive subpopulations include "infants, children, pregnant women, the elderly, individuals with a history of serious illness, or other subpopulations that are identified as likely to be at greater risk of adverse health effects due to exposure to contaminants in drinking water than the general population" (SDWA section 1412(b)(3)(C)(i)(V), 42 U.S.C 300g-1(b)(3)(C)(i)(V)).

Pregnant and lactating women may be at an increased risk from pathogens as well as act as a source of infection for newborns. Infection during pregnancy may also result in the transmission of infection from the mother to the child in utero, during birth, or shortly thereafter. Since very young children do not have fully developed immune systems, they are at increased risk and are particularly difficult to treat.

Infectious diseases are also a major problem for the elderly because immune function declines with age. As a result, outbreaks of waterborne diseases can be devastating on the elderly community (e.g., nursing homes) and may increase the possibility of significantly higher mortality rates in the elderly than in the general population.

Immunocompromised individuals are a growing proportion of the population with the continued increase in HIV/AIDS, the aging population, and the escalation in organ and tissue transplantations. Immunocompromised individuals are more susceptible to severe and invasive infection. These infections are particularly difficult to treat and can result in a significantly higher mortality than in immunocompetent persons.

It is anticipated that the requirements of the RTCR will help reduce pathways of entry for fecal contamination and/or waterborne pathogens into the distribution system, thereby reducing exposure and risk from these contaminants in drinking water to the entire general population. The RTCR seeks to provide a similar level of drinking water protection to all groups including sensitive subpopulations, thus meeting the intent of this federal policy. See also section VI.K of the RTCR preamble.

8.14 Effect of Compliance with the RTCR on the Technical, Financial, and Managerial Capacity of Public Water Systems as Required by Section 1420(d)(3) of SDWA

Section 1420(d)(3) of the SDWA, as amended, requires that, in promulgating a National Primary Drinking Water Regulation, the Administrator shall include an analysis of the likely effect of compliance with the regulation on the technical, managerial, and financial (TMF) capacity of PWSs. The following analysis fulfills this statutory obligation by identifying the incremental impact that the RTCR will have on the TMF capacity of regulated PWSs. Analyses presented in this document reflect only the impact of new or revised requirements, as established by the RTCR; the impacts of previously established requirements on system capacity are not considered.

Overall water system capacity is defined in *Guidance on Implementing the Capacity Development Provisions of the Safe Drinking Water Act Amendments of 1996* (USEPA, 1998a) as the ability to plan for, achieve, and maintain compliance with applicable drinking water standards. Capacity encompasses three components: technical, managerial, and financial. Technical capacity is the operational ability of a water system to meet those SDWA requirements. Key issues of technical capacity include the following:

- Source Water Adequacy—Does the system have a reliable source of water with adequate quantity? Is the source generally of good quality and adequately protected?

- Infrastructure Adequacy—Can the system provide water that meets SDWA standards? What is the condition of its infrastructure, including wells or source water intakes, treatment facilities, storage facilities, and distribution system? What is the infrastructure's life expectancy? Does the system have a capital improvement plan?

- Technical Knowledge and Implementation—Are the system's operators certified? Do the operators have sufficient knowledge of applicable standards? Can the operators effectively implement this technical knowledge? Do the operators understand the system's technical and operational characteristics? Does the system have an effective operation and maintenance (O&M) program?

Managerial capacity is the ability of a water system's managers to make financial, operating, and staffing decisions that enable the system to achieve and maintain compliance with SDWA requirements. Key issues include:

- Ownership Accountability—Are the owners clearly identified? Can they be held accountable for the system?

- Staffing and Organization—Are the operators and managers clearly identified? Is the system properly organized and staffed? Do personnel understand the management aspects of regulatory requirements and system operations? Do they have adequate expertise to manage water system operations? Do personnel have the necessary licenses and certifications?

- Effective External Linkages—Does the system interact well with customers, regulators, and other entities? Is the system aware of available external resources, such as technical and financial assistance?

Financial capacity is a water system's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with SDWA requirements. Key issues include:

- Revenue Sufficiency—Do revenues cover costs?
- Creditworthiness—Is the system financially healthy? Does it have access to capital through public or private sources?
- Fiscal Management and Controls—Are adequate books and records maintained? Are appropriate budgeting, accounting, and financial planning methods used? Does the system manage its revenues effectively?

8.14.1 Requirements of the RTCR

This capacity analysis is presented only for the RTCR, although EPA took similar considerations into account in the selection of the RTCR over the other options. This process led to the incorporation of less expensive rule features for systems having fewer capabilities.

The RTCR establishes requirements that may result in the following activities that influence the TMF capacity of affected PWSs:

1. Familiarization with Rule Requirements
2. Revising Sample Siting Plans
3. Monitoring
4. Annual Site Visits
5. Assessments
6. Corrective Actions
7. Public Notification

8.14.2 Systems Subject to the RTCR

The RTCR will apply to all PWSs, including 51,972 CWSs, 18,729 NTNCWSs, and 84,136 TNCWSs—154,837 systems in all (Safe Drinking Water Information System/Federal Version (SDWIS/FED) 2007 4th quarter data). While most will not, some systems may require increased TMF capacity to comply with the new requirements, or will need to tailor their compliance approaches to match their capacities. Refer to section 8.14.4 for a detailed discussion of the changes in TMF capacity for small and large systems.

8.14.3 Impact of the RTCR on System Capacity

The estimates presented in Exhibits 8.5 and 8.6 reflect the anticipated impact of the RTCR on system capacity based on the expected measures that systems will be required to adopt. The extent of the expected impact of a particular requirement on system capacity is estimated using a scale of 0–5, where 0 represents a requirement that is not expected to have any impact, 1 represents a requirement that is expected to have a minimal impact, and 5 represents a requirement that is expected to have a very significant impact on system capacity. Criteria used to develop the scores and associated impacts are discussed further in section 8.14.4.

These impacts are assessed separately for small systems (those serving less than or equal to 10,000 persons, see Exhibit 8.5) and for large systems (those serving more than 10,000 persons, see Exhibit 8.6). This distinction is necessary because most large systems will face fewer challenges in implementing the rule than smaller systems. For both large and small systems, EPA evaluated the capacity impact of each requirement on those systems affected by that particular requirement. Because in many cases the requirements only affect a small percentage of systems, the exhibits also display the number of systems and percentage of systems (of the subset of small or large systems) estimated to be affected by each specific requirement.

Exhibit 8.5 Estimated Impact of the RTCR on Small Systems' Technical, Managerial, and Financial Capacity

(0 = no impact, 1 = minimal impact, and 5 = very significant impact)

Requirement/ Activity	Number & Percent of Small Systems	Technical Capacity			Managerial Capacity			Financial Capacity		
		Source Water Adequacy	Infrastructure Adequacy	Technical Knowledge and Information	Ownership Accountability	Staffing & Organization	Effective External Linkages	Revenue Sufficiency	Credit Worthiness	Fiscal Management & Controls
Familiarization with rule requirements	150,672 (100%)	0	0	1	1	1	1	1	1	1
Revise Sample Siting Plans	150,672 (100%)	1	1	1	1	1	1	1	1	1
Monitoring	150,672 (100%)	0	0	2	0	2	0	2	2	2
Annual Site Visits	0 (0%)	0	0	0	0	0	0	0	0	0
Assessments*	151,456	0	0	2	0	2	0	2	2	2
Corrective Actions*	15,206	3	3	3	3	3	3	3	3	3
Public Notification*	11,701	0	0	0	0	0	0	0	0	0

Source:
Number and percent of systems subject to each rule activity derived from Appendix A, Exhibit A.2.z. Impact on capacity is determined relative to previous regulations based on the cost and number of systems that require additional capacity to comply with each requirement, as described in section 8.14.4.
Notes:
Small systems are those serving less than or equal to 10,000 persons.
*For these three requirements the number of assessments, corrective actions, and public notifications over the 25-year period of analysis (not number of systems) is shown. A corresponding percentage, therefore, is not meaningful for these numbers. Additional information is available in Appendix A, Exhibit A.2.z.

1) To analyze the impact of these requirements on system capacity, the requirements believed to have the most and the least impact on affected systems were analyzed first. These initial analyses were then used as the bases against which the relative impact of the remaining requirements was assessed. The impact estimates developed for each requirement were also compared to those developed for the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) and the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR), and the Ground Water Rule (GWR) to ensure cross-rule consistency.
2) The scores presented above represent the worst case scenario; the requirements of this rule are expected to have less impact on the capacity of most systems affected by each requirement.

Exhibit 8.6 Estimated Impact of the RTCR on Large Systems' Technical, Managerial, and Financial Capacity

(0 = no impact, 1 = minimal impact, and 5 = very significant impact)

Requirement/ Activity	Number & Percent of Large Systems	Technical Capacity			Managerial Capacity			Financial Capacity		
		Source Water Adequacy	Infrastructure Adequacy	Technical Knowledge and Information	Ownership Accountability	Staffing & Organization	Effective External Linkages	Revenue Sufficiency	Credit Worthiness	Fiscal Management & Controls
Familiarization with rule requirements	4,165 (100%)	0	0	1	1	1	1	1	1	1
Revise Sample Siting Plans	4,165 (100%)	1	1	1	1	1	1	1	1	1
Monitoring	4,165 (100%)	0	0	1	0	1	0	1	1	1
Annual Site Visits	0 (0%)	0	0	0	0	0	0	0	0	0
Assessments*	4,617	0	0	1	0	1	0	1	1	1
Corrective Actions*	462	1	1	1	1	1	1	1	1	1
Public Notification*	334	0	0	0	0	0	0	0	0	0

Source:
Number and percent of systems subject to each rule activity derived from Appendix A, Exhibit A.2.z. Impact on capacity is determined relative to previous regulations based on the cost and number of systems that require additional capacity to comply with each requirement, as described in section 8.14.4.
Notes:
Large systems are those serving more than 10,000 persons.
* For these three requirements the number of assessments, corrective actions, and public notifications over the 25-year period of analysis (not number of systems) is shown. A corresponding percentage, therefore, is not meaningful for these numbers. Additional information is available in Appendix A, Exhibit A.2.z.

1) To analyze the impact of these requirements on system capacity, the requirements believed to have the most and the least impact on affected systems were analyzed first. These initial analyses were then used as the bases against which the relative impact of the remaining requirements was assessed. The impact estimates developed for each requirement were also compared to those developed for the LT2ESWTR, Stage 2 DBPR, and GWR to ensure cross-rule consistency.
2) The scores presented above represent the worst case scenario; the requirements of this rule are expected to have less impact on the capacity of most systems affected by each requirement.

8.14.4 Derivation of RTCR Scores

EPA developed a 5-point scoring system to analyze the impact compliance with all new regulations will have on the TMF capacity of PWSs. For each regulation, it is necessary to complete the following steps:

1. Determine the type and number of PWSs to which the regulation applies.

2. List all of the requirements of the regulation.

3. Determine the type and number of PWSs to which each requirement applies.

4. Evaluate the impact of each requirement on the capacity of affected PWSs.

The determination of the universe of affected systems and the evaluation of the capacity impact of individual requirements requires the use of the cost and technical information contained in the SDWIS, EAs developed for other rules, ICRs, and other supporting documentation for the rule. These data sources are also used to develop a qualitative description of the expected response of affected systems to each requirement.

The overall evaluation of the impact of a requirement on the affected systems, presented in Exhibits 8.5 and 8.6, is based on the impact each requirement and activity has on nine sub-categories of capacity—three sub-categories under each of the broader divisions of TMF capacity. Within these sub-categories, EPA evaluated the costs, number of systems affected, and complexity of each requirement. After estimating the technical, managerial, and financial impacts within each sub-category, EPA assigned the scores using best professional judgment. Costs were considered cumulatively for each requirement and activity for small and large systems. This score reflects the additional capacity that systems will need to develop to comply with each requirement. Due to a lack of available information on operating budgets, this analysis does not include a quantitative component.

To ensure cross-rule consistency, to standardize the assignment of numerical scores, and to minimize the subjectivity of the scoring system, the requirements for systems under the RTCR are compared to the requirements of those regulations for which capacity impact analyses have already been conducted (e.g., Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), LT2ESWTR, Stage 2 DBPR, GWR). Similar requirements are assigned similar impact scores.

8.14.5 Small Water Systems (Those Serving 10,000 or Fewer People)

Small systems will likely face only a small challenge to their technical and managerial capacity as a result of efforts to familiarize themselves with the monitoring requirements of the RTCR. Routine and repeat monitoring requirements under the RTCR are essentially the same as under the 1989 TCR, with more explicit criteria to qualify for reduced monitoring. Therefore, understanding the RTCR monitoring requirements is not expected to pose many new technical or managerial capacity issues for small systems.

Small system technical and managerial capacity may be affected by the assessment requirements of the RTCR. Performing assessments may require the system to evaluate staffing levels and/or the need to access outside assistance to conduct the assessments in addition to providing training to ensure that system staff understand how those assessments are to be performed. Reporting, record-keeping, and data administration requirements will also affect the managerial capacity of small systems.

Small systems that are required to take corrective action are expected to experience the most significant financial challenge since some corrective actions may consist of a large, one-time capital expenditure to resolve the problem.

8.14.6 Large Water Systems (Those Serving Greater Than 10,000 People)

Large systems will likely not face any significant challenge to their technical and managerial capacity as a result of efforts to familiarize themselves with the RTCR. Most large systems are familiar with the 1989 TCR and there are no changes in the basic monitoring requirements for large systems under the RTCR. They are therefore assumed to already have the TMF capacity in place for the RTCR.

Only large systems performing assessments and corrective actions would be expected to face a significant challenge meeting the TMF capacity requirements. However, this requirement is only necessary when monitoring reveals potential problems, and this is not expected to occur significantly in large systems above that experienced under the 1989 TCR. Many large systems already have the TMF capacity to conduct assessments and corrective actions if they are needed. These systems will be affected less significantly than smaller systems that have to implement corrective actions because it is recognized that they are typically already implementing similar assessments and corrective actions when a routine monitoring sample tests positive for fecal indicators under the 1989 TCR.

9 Comparison of Benefits and Costs

9.1 National Benefits and Costs of the RTCR Considered in Comparison to the 1989 Total Coliform Rule and Alternative Option

The RTCR is consistent with the majority of the Total Coliform Rule/Distribution System Advisory Committee (TCRDSAC) Agreement in Principle (AIP). The Final Rule was developed in consideration of the comments received on the proposed rule and therefore is not identical to the AIP. Chapter 3 of this EA provides more information about the specific requirements of the RTCR. The primary discussion of costs and benefits in this chapter focuses on the requirements of the RTCR in comparison to the 1989 Total Coliform Rule (TCR) and the Alternative option considered.

The primary benefit of the RTCR is to further reduce the risk of fecal contamination of public drinking water from the current baseline risk under the 1989 TCR. The indicator of this benefit that is most feasible to predict is the reduction in *E. coli* occurrence in public water systems (PWSs). As a fecal contamination indicator, *E. coli* can also co-occur with other pathogenic organisms shed in feces, such as viruses, bacteria, and pathogenic protozoa at a rate that is not quantified.[59] EPA believes that a reduction in *E. coli* occurrence, together with other RTCR actions, will result in reduced PWS fecal contamination and will likely facilitate a consequent reduction in endemic and epidemic waterborne disease in the United States.

The 1989 TCR mandates sampling for total coliforms (TC) and *E. coli* in PWSs in the U.S. However, under the 1989 TCR, PWSs that encounter samples testing positive for TC or *E. coli* have the option to implement an effective long-term corrective action, a short-term corrective action, or they can choose not to implement any corrective action. This wide variability in effectiveness of corrective actions increases the potential for exposure to fecally-contaminated drinking water when the response to *E. coli* occurrence is inadequate or ineffective.

EPA is augmenting the 1989 TCR with, among other components, the requirement for systems to implement mandatory assessments and corrective actions. PWSs would be required to conduct either a Level 1 or Level 2 assessment, depending on the severity of a trigger (based on TC vs. *E. coli* and the number of triggers). As described in Chapter 3, the Level 1 and 2 assessments require a PWS to more formally pursue the cause of triggers, (similar to non-acute or acute violations under the 1989 TCR), and to address the problem with an appropriate corrective action. It is the combination of these two requirements (assessments and corrective actions) from which most of the net benefits and costs of the RTCR would derive. Because of the benefits from assessment and corrective action and for the other reasons discussed in this chapter and in analyses and discussion presented throughout this economic analysis (EA), EPA concludes that the RTCR will improve public health protection compared to the 1989 TCR.

A significant amount of the costs of the additional activities required under the RTCR would be offset by the reduced costs from some decreases in monitoring (additional routine and

[59] Chapter 2 of this economic analysis provides examples of waterborne pathogens that can occur in PWSs. Also, Edberg, R. (2000) discusses the use of *E. coli* as an indicator of drinking water quality.

repeat) and decreases in public notification (PN). The decreases in monitoring may limit the ability of PWSs to identify *E. coli* positive samples at the levels found under the 1989 TCR when using the same monitoring techniques. However, predictive modeling results show that significantly more contamination events will be prevented by assessments that lead to additional corrective actions under the RTCR than would be missed by reduced additional routine and repeat monitoring for systems serving 4,100 or fewer people.[60] Systems serving 4,100 people or more have no changes in the number of required samples under the RTCR. Some of this reduction in both monitoring and costs would be offset by the increase in routine monitoring predicted for systems serving 1,000 or fewer people because fewer systems are likely to qualify for reduced monitoring based on the more stringent requirements under the RTCR.[61]

Further cost reductions may be achieved by the revisions to the requirement for a mandatory sample siting plan under the RTCR, which would increase monitoring efficiency by having the operator revise existing sample siting plans to identifying repeat sample locations in addition to including regular sampling sites that are representative of the water throughout the distribution system. The sample siting plan may also specify repeat sample locations that may, if approved by the state, satisfy source water sampling requirements as well; this benefit would likely apply to some of the PWSs with limited or no distribution systems.

The increases in routine monitoring for systems that no longer qualify for reduced monitoring, along with more efficient monitoring based on approved monitoring plans, are expected to increase the ability of PWSs to detect *E. coli* a larger percentage of the time when it is present. This increase in detection will be partially offset by reductions in additional routine and repeat monitoring.

The Alternative option considered in this EA would provide benefits equal to or greater than the RTCR in terms of decreased potential health risks from PWSs delivering contaminated water to the public. However, monitoring costs under the Alternative option would increase significantly, particularly for small systems, causing a significant challenge to the effective and efficient implementation of the Alternative option. The remainder of this chapter provides further detail on the costs and benefits and how they compare under the 1989 TCR, RTCR, and Alternative option:

- **Section 9.1.1** discusses national benefits.
- **Section 9.1.2** discusses national costs.
- **Section 9.2** discusses uncertainty and non-quantified benefits.
- **Section 9.3** presents a comparison of regulatory options in cost/benefit terms.

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[60] Chapter 6 of this EA explores the tradeoff in a stepwise analysis of the risk benefit resulting from implementation of assessments resulting in corrective actions vs. the potential increase in risk due to decreased sampling frequency. That analysis concludes that for each type of system and size category, the RTCR would avoid a larger number of acute events than it would fail to diagnose.

[61] Chapter 5 (Section 5.3) includes a description of the determination of PWS sampling frequencies that are applicable beginning in year 6 following RTCR promulgation.

9.1.1 National Benefits of the Regulatory Options Considered

The benefits analysis performed in this EA and summarized in this section consider the net changes in TC and *E. coli* occurrence under the RTCR as compared to the 1989 TCR.[62] In promulgating the RTCR, EPA expects to further reduce the overall risk of contamination of public drinking water from the current baseline risk under the 1989 TCR. The options considered during development of this rule and analyzed as part of this EA are designed to achieve this reduction while maintaining public health protection in a cost-effective manner.

This section examines the benefits in terms of trade-offs between compliance with the 1989 TCR, the RTCR, and Alternative option. Based on limitations in available data (described further in Chapter 6, Section 6.3), EPA determined that benefits could not be calculated in terms of avoided cases of (or costs related to) morbidity or mortality. EPA used several methods to qualitatively evaluate the benefits of the RTCR. The qualitative evaluation uses both the judgment of EPA as informed by the TCRDSAC deliberations as well as quantitative estimates of changes in *E. coli* occurrence and counts of systems implementing corrective actions. The evaluation characterizes, in relative terms, the reduction in risk for each regulatory option as compared to baseline conditions.

Since *E. coli* is an indicator of fecal contamination, EPA assumed that a decrease in *E. coli* occurrence in the distribution system would be associated with a decrease in fecal contamination in the distribution system. In general, this decrease in fecal contamination should reduce the potential risk to human health for PWS customers. Thus, any reduction in *E. coli* occurrence is considered a benefit of the RTCR and Alternative option. Also, since fecal contamination may contain waterborne pathogens including bacteria, viruses, and parasitic protozoa, in general, a reduction in fecal contamination should also reduce the risk from these other contaminants.

As presented in Exhibit 4.9, the percentages of samples that are positive for TC and *E. coli* are generally higher for PWSs serving 4,100 or fewer people than those serving more than 4,100 people. PWSs with higher TC and *E. coli* occurrence are more likely to be triggered into assessments and corrective action. As discussed previously, EPA believes that the assessments and corrective action under the RTCR and Alternative option will lead to a decrease in TC and *E. coli* occurrence. Because the PWSs serving 4,100 people or fewer have a higher initial *E. coli* occurrence and will be triggered into more assessments and corrective actions than larger PWSs, the increase in benefits for these small systems will be more evident as compared to the larger systems. In particular, model results suggest that customers of small ground water transient noncommunity water systems (TNCWSs) serving 100 people or fewer, which constitute approximately 40% of PWSs, would experience the most obvious benefit under the RTCR. That is, the occurrence of *E. coli* is predicted to decrease more for TNCWSs than for other systems types.

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[62] The 1989 TCR is the baseline used in the RTCR EA, and consists of the rule components and resulting activities of the 1989 TCR with effects of the Ground Water Rule (GWR) implementation in 2010 incorporated. Chapter 4 of this EA presents information used to develop this baseline, and Chapter 5 (Section 5.3.1) describes how the occurrence and predictive model incorporates the GWR effects.

As discussed previously, because there was insufficient data on the co-occurrence of *E. coli* and waterborne pathogens, it was not possible to quantify the health effects in the human population served by PWSs. Thus, EPA employed a qualitative approach as the primary method for analyzing the expected change in exposure to fecal contamination based on each individual rule component. The qualitative analysis considers the anticipated changes in sampling and corrective action regimens and estimates the corresponding anticipated reduction or increase in exposure to fecal contamination. Because the reduced exposure to fecal contamination conveys inadequate information about pathogen exposure, the analysis in this section is a hazard analysis rather than a risk analysis. Nevertheless, because the intent is to reduce risk by reducing hazard (potential exposure to fecal contamination and/or waterborne pathogens), risk is used as the discussion endpoint. Section 9.1.1.1, which follows, summarizes the results of the qualitative analysis, and Chapter 6 (Section 6.2) presents this information in more detail.

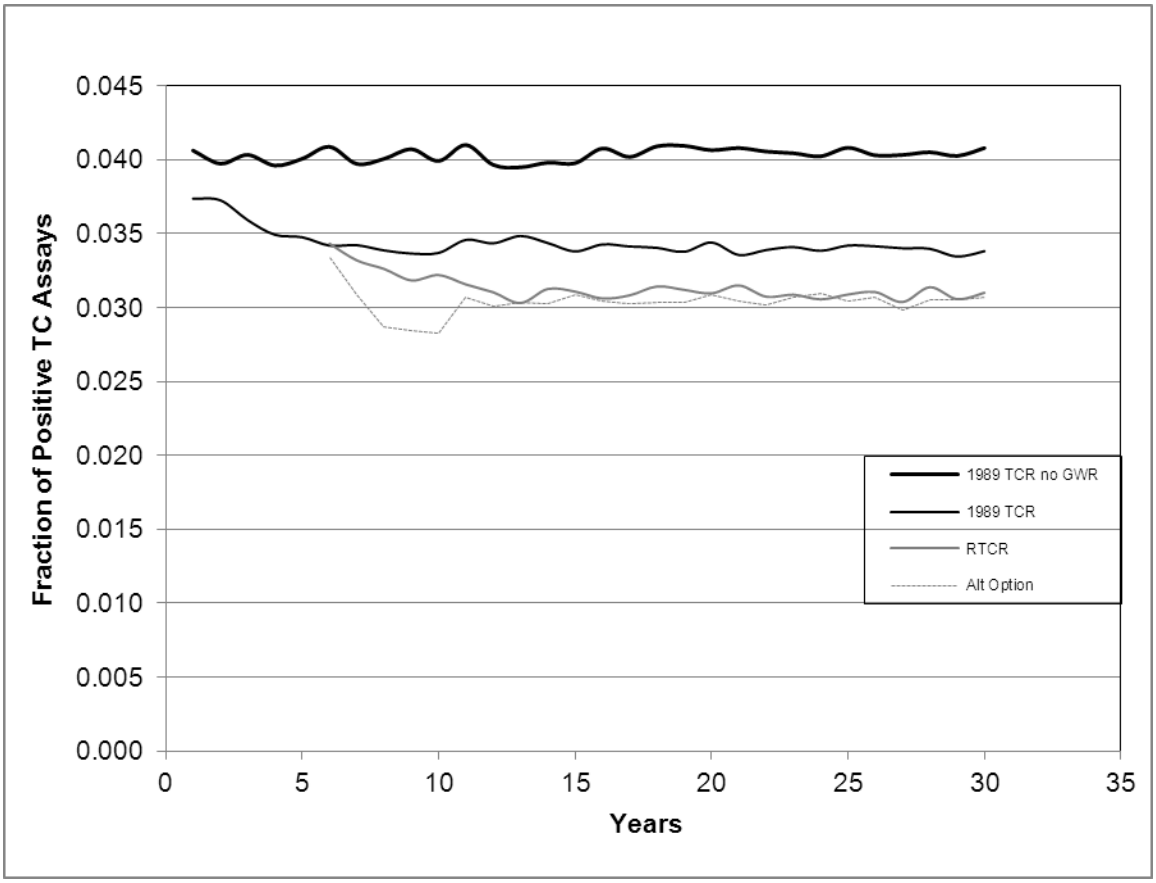
Although a qualitative analysis was the primary method employed for analyzing potential changes in risk, quantitative measures were used to support the qualitative conclusions, providing additional perspective on potential changes in risk. In particular, EPA considered modeled predictions of the reductions in the numbers of violations/assessment triggers and of the number of corrective actions to be performed as they may relate to risk. Section 9.1.1.2 discusses the predicted changes in these outcomes. More detailed discussions of the predictive model and analyses results are presented in Chapters 5 and 6.

9.1.1.1 Qualitative Comparison—Relative Risks of the RTCR and Alternative Option Compared to Baseline

When revising an existing drinking water regulation, one of the main concerns is to ensure that backsliding on water quality and public health protection does not occur. Risk reduction for the RTCR is characterized by the activities performed that are presumed to reduce risk of exposing the public to contaminated water. These activities are considered under each rule component presented in Exhibit 9.1b. Under repeat and additional routine monitoring provisions for both the RTCR and Alternative option, there is a potential to contribute to increased risk for some PWS customers because TC monitoring frequency may be reduced for some PWSs. However, this increase in risk is expected to be more than offset by potential decreases in risk from increased routine monitoring and the addition of the assessments and corrective action provisions that will find and fix problems identified by monitoring.

Exhibit 9.1a illustrates the predicted reduced frequency at which TC-positives occur subsequent to the implementation of the RTCR and Alternative option. TC occurrence is used as a surrogate for indicating the existence of potential pathways through which waterborne pathogens may enter a PWS. Exhibit 9.1a illustrates the combined effects on TC occurrence resulting from changes in monitoring and the effects of assessments and corrective actions for the different rule options illustrated. The relative trends evident in Exhibit 9.1a for TNCWSs also pertain to other PWS categories as illustrated in Chapter 5 and Appendix B of the RTCR EA. EPA chose to include the characterization for TNCWSs because they represent the system category of largest influence on the national impacts.

Exhibit 9.1a Ground Water (GW) Transient Noncommunity Water Systems (Serving ≤ 4,100) TC Occurrence



Notes:

1) Six Year 2005 TC-positive occurrence is representative of all GW TNCWS. The rate presented may underestimate the occurrence for systems serving 25-4,100 individuals.
2) Graph shows the 30-year modeled period discussed in Ch. 5. Model years 3–27 represent the 25-year period of analysis for this EA. Model year 11 begins the steady state, during which systems that qualified for reduced monitoring are now sampling on their reduced schedules. The criteria and timing of this monitoring adjustment is discussed in Section 5.3.2.2 of this EA.
3) The results represented by the curves for 1989 TCR, RTCR, and Alternative option all incorporate the effects of the GWR.

The effect that the changes to PN requirements for monthly/non-acute MCL violations have on risk is difficult to predict. Some factors, such as reduction in available public information and possible PWS complacency, lead to a potential increase in risk, whereas other factors, such as less confusion (PN more in line with potential health risks) and PWSs resources used more efficiently, lead to a potential decrease, as discussed in Exhibit 9.1b. This change to PN addresses a key concern expressed by various stakeholders in the advisory committee and during the Six-Year Review 1 comment solicitation process. By revising the PN requirements and adding assessment and corrective action requirements, the Agency expects less public confusion, more effective use of resources, and increased transparency. Other rule components are expected to have a negligible effect on risk. However, the overall effect of the RTCR is expected to be a further reduction in risk from the current baseline risk under the 1989 TCR.

Chapter 6 presents a detailed discussion of the potential influence on health risk for each rule component.

Exhibit 9.1b Potential Changes in Risk under the RTCR and Alternative Option Relative to the 1989 TCR

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
	RTCR	Alternative option	RTCR	Alternative option	RTCR	Alternative option
Implementation Activities	None	None	None	None	No change	No change
Routine Monitoring (Including Reduced Monitoring)	None	None	Increased stringency in requirements to qualify for reduced monitoring along with requirement to return to baseline monitoring upon loss of these criteria is expected to result in decreased risk (i.e., PWSs that qualify for reduced monitoring will be better operated, PWSs that no longer qualify will monitor more frequently).	PWSs all monitor monthly in the first few years of implementation of the RTCR, which is an increase in sampling frequency for systems that monitor quarterly or annually under the 1989 TCR. After the first few years, systems may reduce to quarterly, but none may reduce to annual monitoring, creating a decrease in risk for systems on annual monitoring under the 1989 TCR.	Decrease	Decrease
Repeat Monitoring	Required repeat samples reduced from 4 to 3 for systems serving ≤1,000 people	Required repeat samples reduced from 4 to 3 for systems serving ≤1,000 people	None	None	Increase	Increase

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
Additional Routine Monitoring	Additional routine samples are no longer required for PWSs monitoring monthly. Ground water PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.	Additional routine samples are no longer required for PWSs monitoring monthly. Ground water PWSs serving ≤1,000 people would reduce additional routine samples from 5 to 3.	None	None	Increase	Increase
Annual Site Visits	None (only states currently performing annual site visits are expected to continue)	Annual monitoring is not permitted so annual site visits will no longer be conducted.	None (only states currently performing annual site visits are expected to continue)	None	No change	Increase
Assessments	None	None	Mandatory assessments are a new requirement.	Mandatory assessments are a new requirement.	Decrease	Decrease
Corrective Actions	None	None	Mandatory corrective actions are a new requirement.	Mandatory corrective actions are a new requirement.	Decrease	Decrease
PN — Monthly/Non-Acute MCL Violations	Reduction in available public information Possible PWS complacency	Reduction in available public information Possible PWS complacency	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Less confusion (PN more in line with potential health risks) PWS resources used more efficiently	Unknown	Unknown

Rule Component	Factors Leading to a Potential Increase in Risk		Factors Leading to a Potential Decrease in Risk		Overall Predicted Change in Risk	
PN—Monitoring and Reporting Violations	None	None	Improved focus of required PN for rule aspects with potential adverse health consequences, notably *E. coli* MCL violations and failure to conduct assessments and corrective actions, will motivate PWSs to conduct sampling and other treatment technique requirements.	Improved focus of required PN for rule aspects with potential adverse health consequences, notably *E. coli* MCL violations and failure to conduct assessments and corrective actions, will motivate PWSs to conduct sampling and other treatment technique requirements.	Decrease	Decrease
Overall					Decrease	Decrease

Note:

1) Detailed discussion of the rationale for determinations of potential risk for each rule component is presented in Ch. 6 (Section 6.2) of this EA. Implementation activities consist of administrative activities by PWSs and states to implement the rule.
2) Assessment of potential changes in risk for monitoring components is an *overall* assessment. Potential changes (or static state) of risk for particular system sizes and types differ according to individual regulatory requirements and are discussed in Section 6.2. Chapter 3 provides a detailed description of the regulatory components for all three regulatory options, and the preamble to the RTCR provides additional discussion of the TCRDSAC process and the rationale underlying the structure of the regulatory options considered.

9.1.1.2 Comparison of Quantified Benefits between 1989 TCR and RTCR and Alternative Option

The quantified portion of the benefits analysis focuses on several measures that contribute to the changes in risk expected under the RTCR. Specifically, EPA modeled the predicted outcomes based on each regulatory option considered—baseline (1989 TCR), the RTCR, and the Alternative option—in the form of estimates of non-acute violations for the 1989 TCR and assessment triggers for the RTCR and Alternative option; *E. coli* violations; and the number of corrective actions implemented under each option.

This section presents a summary of the estimated impacts of the RTCR and Alternative option in comparison to the 1989 TCR. Evaluation of each of these endpoints informed EPA's understanding of potential changes to the underlying quality of drinking water. In particular, the number of corrective actions performed has a strong relationship to potential improvements in water quality and public health. For a given level of TC and *E. coli* occurrence, an increase in the number of corrective actions implemented would lead to improved water quality. However, a reduction in sampling leads to a reduction in TC and *E. coli* positives being found, which in turn leads to a reduction in assessments and corrective actions being implemented. The number of TC and *E. coli* positives that are prevented, missed, or found under each regulatory option is considered in comparison to those predicted under the 1989 TCR results in estimates of annual non-acute and acute violations (1989 TCR) and assessment triggers (RTCR and Alternative option). Section 6.4 of this EA presents a step-wise uncertainty analysis of the competing effects of additional protective activity (assessments and corrective actions) and decreased additional routine and repeat sampling of the regulatory options compared to the 1989 TCR. The results of this uncertainty analysis showed that for all categories of systems, more TC and *E. coli* positives would be prevented than missed.

For each of the graphs presented in Exhibit 9.2 through Exhibit 9.7 there are two main model drivers that impact the endpoints depicted: the total number of samples taken over time (including routine, additional routine, and repeat) and corrective actions taken. When looking at the comparisons between the 1989 TCR with the RTCR across all PWSs, the overall impact of the total numbers of samples taken is negligible because the total number of samples predicted to be taken throughout the period of analysis is almost the same (approximately 82 million samples under either the 1989 TCR or the RTCR) as shown in Exhibits 6.2–6.4 of this EA. For the Alternative option, the analysis predicts that approximately 88 million total samples will be taken over the period of analysis. Based on the relationships of total samples taken between the 1989 TCR, RTCR, and Alternative option, the best way to interpret the graphs presented in this section is in a step-wise manner.

The first comparison is between the 1989 TCR and the RTCR. Because a similar total number of samples is taken under the 1989 TCR and RTCR, the major effect seen in the graphs can be isolated to the effects that implementation of corrective actions will have on underlying occurrence and how that occurrence influences the endpoint in question. In each graph, this is depicted by a marked reduction in the endpoint under the RTCR compared to the TCR and is a reflection of overall better water quality. The second comparison can then be made of the Alternative option against the RTCR. In each graph, the endpoints for the Alternative option are above those for the RTCR and represent an additional benefit over the RTCR. This additional

benefit is primarily a function of the additional diagnostic abilities gained through increased monitoring under the Alternative option, and is especially prominent in the early years of the analysis when all systems are required to monitor at least monthly.

More detailed descriptions of each endpoint considered in terms of the evaluation process described previously are provided in this section as they apply to the individual graphs in Exhibits 9.2 through 9.7. The graphs shown in this section are presented first in nondiscounted terms and then based on a discount rate of 3% to reflect the reduced valuation of potential benefits over time, consistent with the presentation of costs in the section that follows. Graphs of benefits discounted using 7% discount rates are presented in Appendix B to this EA.

Exhibit 9.2 shows the effect (on average across all PWSs) of the RTCR and the Alternative option on the annual number of non-acute violations (Level 1 assessment triggers under the RTCR and Alternative option) over time. The estimated reduction of approximately 1,100 trigger events in moving from the 1989 TCR to the RTCR is a net result from the following effects described previously in this section: improved water quality (events prevented); retained diagnostic power (events found), which in turn leads to prevention of some future events; and reduced diagnostic power (missed events). The amount of this reduction would be some amount lower if the analysis could account for events where contamination was present but not diagnosed (missed events). This is why a similar, but smaller, reduction from the 1989 TCR is seen under the Alternative option. During the first 9 years of sampling under the RTCR and Alternative option sampling regimens, diagnostic power under the Alternative option is at a maximum based on the all-monthly sampling requirement. In year 9, following a 5-year period of assessment,[63] all systems that qualified for reduced monitoring begin sampling according to their new regimens. This is the start of the relatively steady state of the period of analysis, driven by the static nature of the percentages of systems following monthly, quarterly, or annual sampling regimens throughout the remainder of the analysis (years 9 through 25). Trigger events under the Alternative option remain at a higher steady state than under the RTCR based on the increased diagnostic ability provided by more frequent sampling under the Alternative option. The additional number of triggers identified by increased sampling under the Alternative option translates into greater potential benefits than those under the RTCR.

Exhibit 9.3 shows the effect (on average across all PWSs) of the RTCR and the Alternative option with respect to acute (*E. coli*) violations found over the 25-year period of analysis in comparison to the 1989 TCR. The overall reduction in annual acute violations under the RTCR of approximately 170 events is a measure that should correlate more closely with expected benefits (i.e., reductions in adverse health outcomes) than non-acute violations because acute violations are a direct result of measurement of *E. coli* in water. Again a similar, but smaller, reduction is seen under the Alternative option after steady state is achieved. This is the result of two off-setting effects. The true number of steady state violations under the Alternative option is lower, because there is a greater likelihood that violations will be found and fixed. However, the additional monitoring leads to a higher percentage of violations being detected. This second effect outweighs the first, so that the total number of detected violations in the steady state is higher than for the RTCR, even though the underlying true number of violations is

[63] The assessment period is 3 years for CWSs, and CWSs begin sampling on their reduced regimens in year 7 after promulgation.

lower. This lower number of true violations means that the Alternative option is more protective of public health, even though more violations are detected.

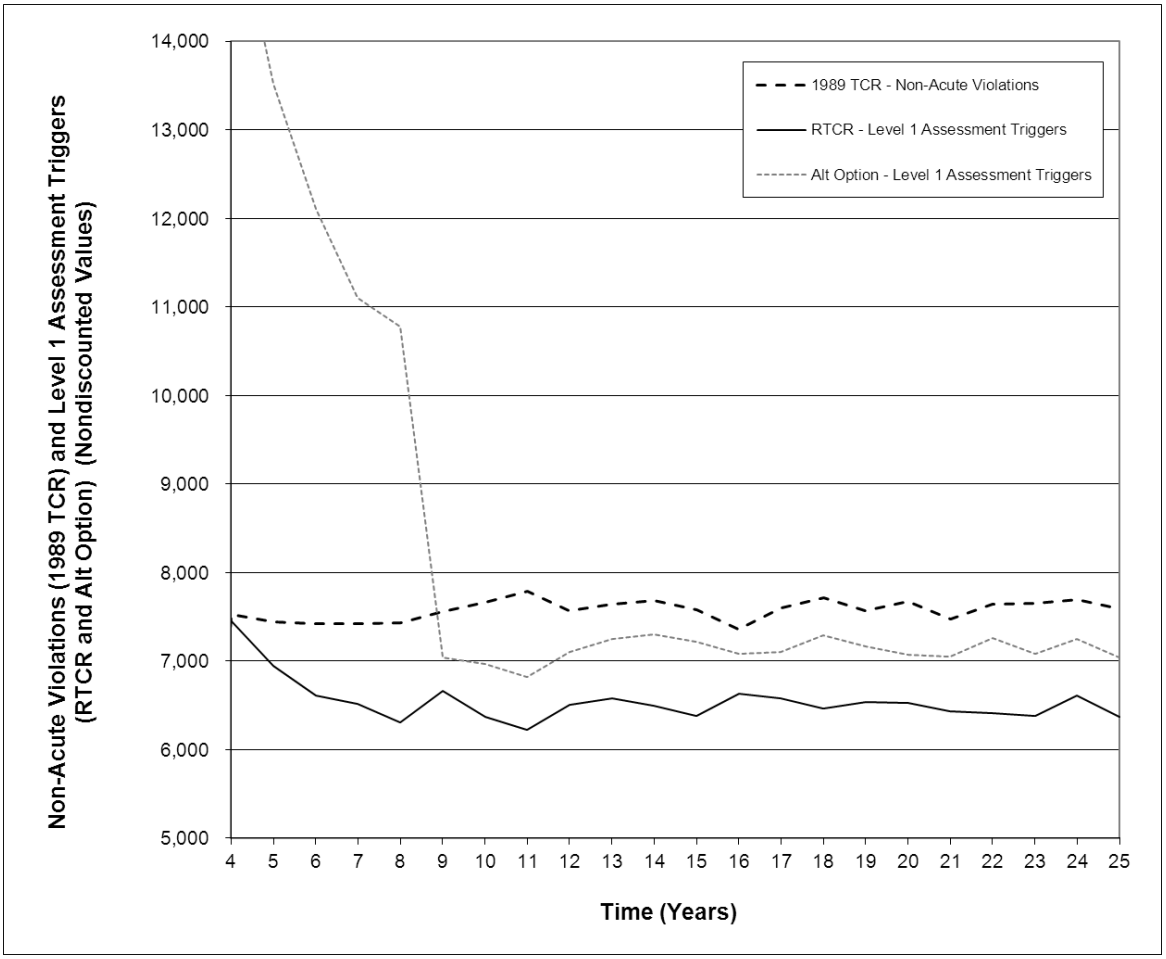
Exhibit 9.4 presents estimates over the 25-year period of analysis of the increase in corrective actions (on average across all PWSs) attributable to the regulatory options considered. The performance of these additional corrective actions is expected to result in the most direct benefits under the RTCR. Because only the numbers of net corrective actions estimated under the RTCR and Alternative option (i.e., corrective actions in addition to those estimated under the 1989 TCR) were modeled, the reference point for comparison to the 1989 TCR is the base (zero) line in the graph. The RTCR EA assumes that corrective actions are being performed under the 1989 TCR. These are taken into account by assuming only a modest net increase in effective corrective actions implemented, calculated as 10% of assessments performed under each regulatory option that are net of those performed under the 1989 TCR.

Exhibit 9.4 indicates that more corrective actions would be implemented under the Alternative option than under the RTCR. This is driven, again, by the increased diagnostic power of more sampling and reflects additional potential benefits beyond those gained under the RTCR. However, not quantified are the numbers of corrective actions that would be identified by the annual inspections required to qualify for annual monitoring under the RTCR but not under the Alternative option. Inclusion of the additional corrective actions taken under the RTCR due to the annual inspection requirement could narrow the difference between the potential benefits of the Alternative option and the RTCR.

Taken together, Exhibits 9.2–9.4 indicate that the modeled endpoints for the RTCR and Alternative option predict positive benefits in comparison to the 1989 TCR; in particular, the Alternative option would capture more benefits than the RTCR. These outcomes are consistent with the qualitative assessment of the benefits summarized in Section 9.1.1.1.

The assessment based on Exhibits 9.5–9.7 is also consistent with the qualitative analysis in Section 9.1.1.1. For each of the discounted endpoints presented over time in Exhibits 9.5–9.7, the graphs show that (on average across all PWSs) the Alternative option would provide more benefits than the RTCR, and both provide more benefits than the 1989 TCR. The major difference between the RTCR and Alternative option is the increased monitoring that would be required under the Alternative option. The increased diagnostic ability of the extra samples taken under the Alternative option is seen in the large difference in the endpoint counts through the first several years in the following graphs. Absent this effect, the Alternative option would mirror the RTCR in the graphs. Thus, even though the predicted endpoints are greater than the 1989 TCR at first, it is due to initially finding more problems through monitoring. This would reflect a frontloading of benefits under the Alternative option at the beginning of the implementation period. The benefits, however, would tend to even out over time between the RTCR and Alternative option as eligible systems qualify for less frequent (quarterly) monitoring under the Alternative option.

Exhibit 9.2 Estimates of Non-Acute Violations (TCR) and Level 1 Assessment Triggers (RTCR and Alternative Option)

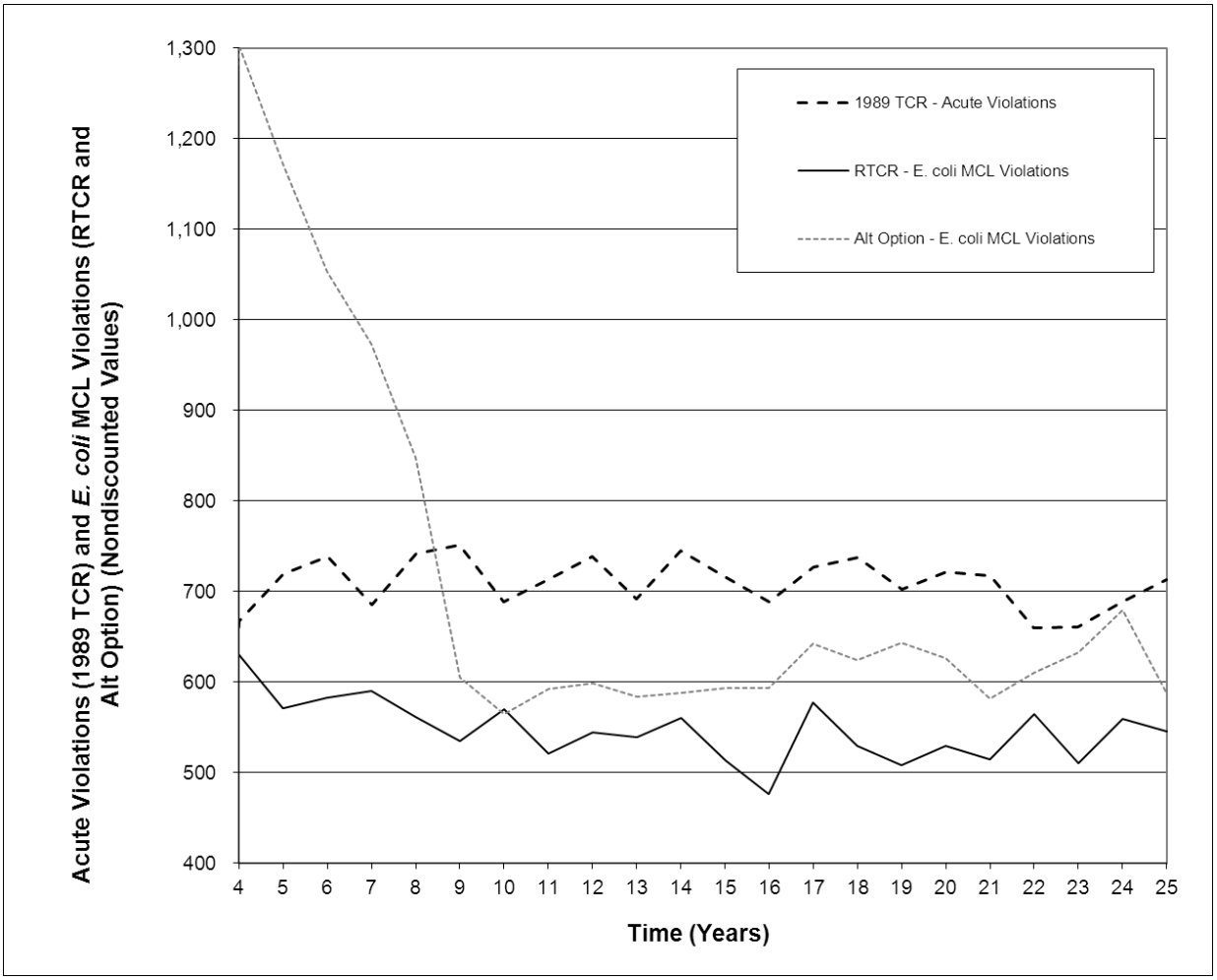


Source: RTCR occurrence model output.

Notes:

1) The X-axis begins at Year 4 after rule promulgation, which is the first year under full implementation of the RTCR or Alternative option.
2) The annual rates of non-acute violations (TCR) and Level 1 assessment triggers (RTCR and Alternative option) as predicted by the model reach a steady state beginning in approximately Year 9, by which time PWSs that would be expected to meet the criteria for reduced monitoring would have begun it.
3) Non-acute violations/Level 1 assessment triggers are predicted to be lower under the RTCR because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

Exhibit 9.3 Estimates of Acute Violations (TCR) and *E. coli* MCL Violations (RTCR and Alternative Option)

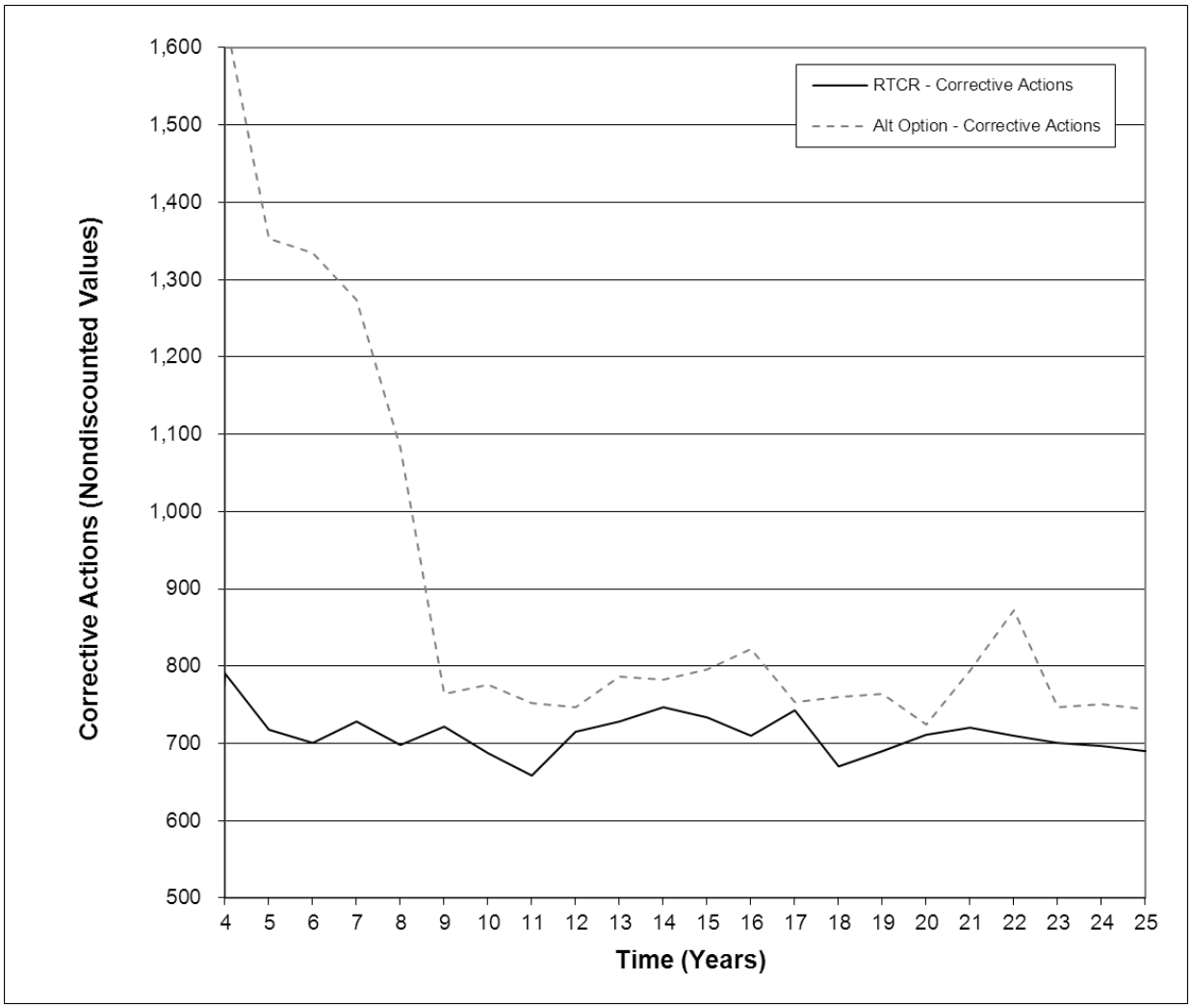


Source: RTCR occurrence model output.

Notes:

1) X-axis begins at Year 4 after rule promulgation, which is the first year under full implementation of the RTCR or Alternative option.
2) The annual rates of acute violations (TCR) and *E. coli* violations (RTCR and Alternative option) as predicted by the model reach steady state in approximately Year 9, by which time PWSs that would be expected to meet the criteria for a reduced monitoring schedule would have begun it. Estimates represent the annual number of acute violations found by each option and the TCR.
3) Acute violations are predicted to be lower under the RTCR because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

Exhibit 9.4 Estimates of Corrective Actions

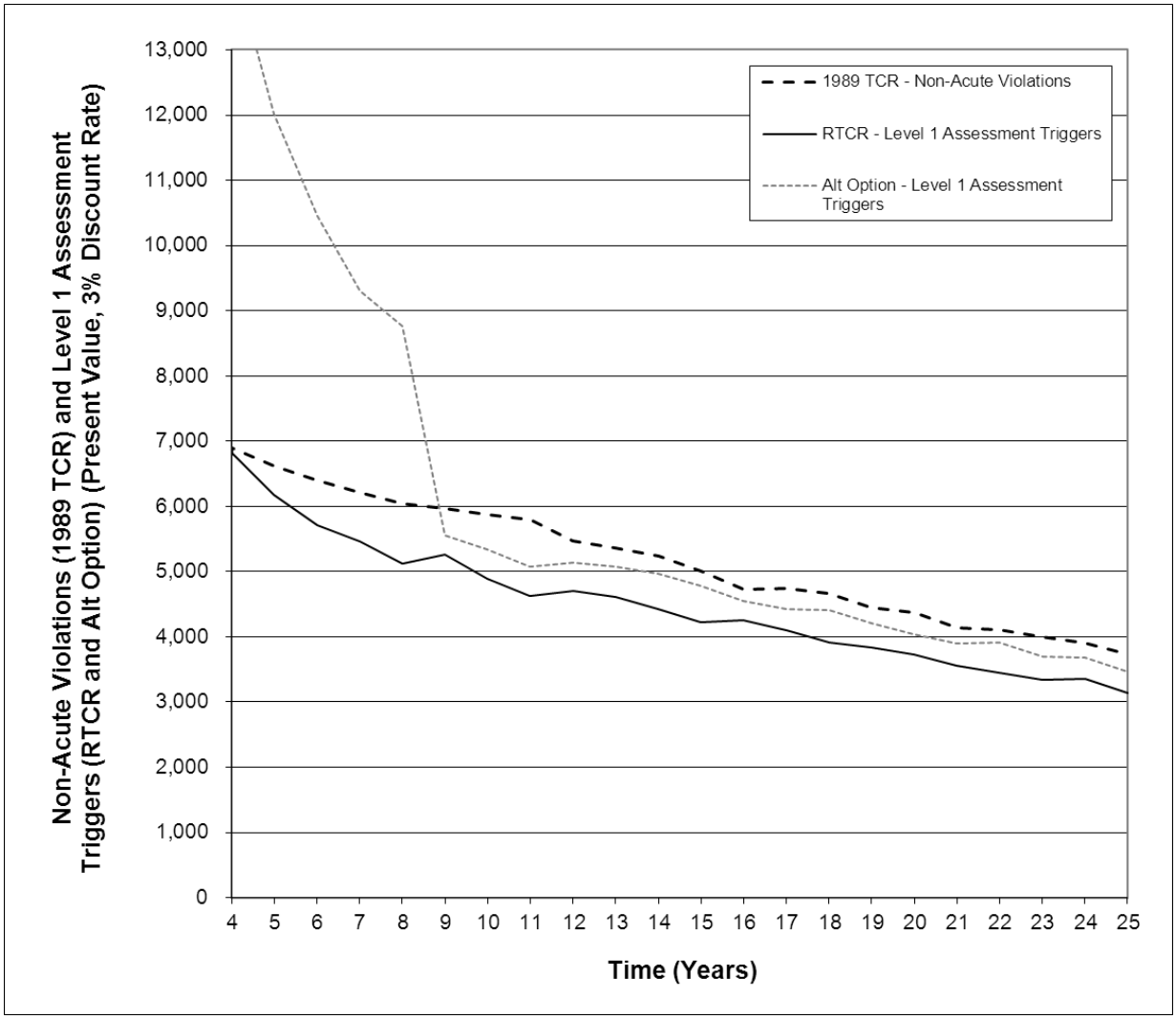


Source: RTCR occurrence model output.

Notes:

1) X-axis begins at Year 4 after rule promulgation, which is the first year under full implementation of the RTCR or Alternative option. The annual rates of corrective actions as predicted by the model reach a steady state beginning approximately in Year 9, by which time PWSs that would be expected to meet the criteria for reduced monitoring would have begun it.
2) Includes L1 and L2 corrective actions. All corrective actions performed are in addition to activity under the 1989 TCR, which does not require corrective actions. Therefore the 1989 TCR is not included in this graph.
3) Corrective actions are predicted to be higher under the Alternative option because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

Exhibit 9.5 Discounted Estimates of Non-Acute Violations (TCR) and Level 1 Assessment Triggers (RTCR and Alternative Option) (3% Discount Rate)

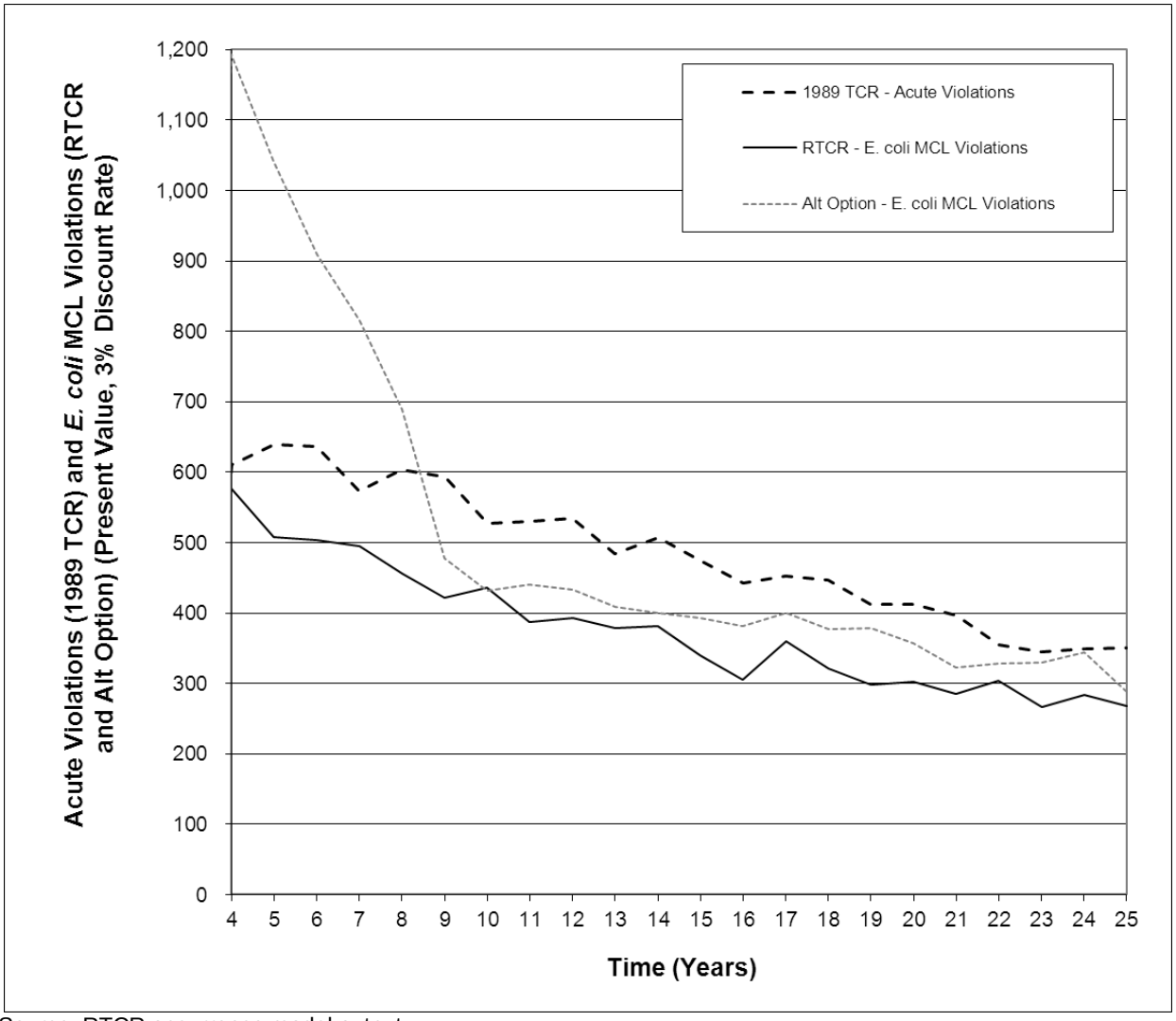


Source: RTCR occurrence model output.

Notes:

1) X-axis begins at Year 4 after rule promulgation, which is the first year under full implementation of the RTCR or Alternative option.
2) The annual rates of non-acute violations (TCR) and Level 1 assessment triggers (RTCR and Alternative option) as predicted by the model reach a steady state beginning in approximately Year 9, by which time PWSs that would be expected to meet the criteria for reduced monitoring would have begun it.
3) Non-acute violations/Level 1 assessment triggers are predicted to be lower under the RTCR because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

Exhibit 9.6 Discounted Estimates of Acute Violations (TCR) and *E. coli* MCL Violations (RTCR and Alternative Option) (3% Discount Rate)

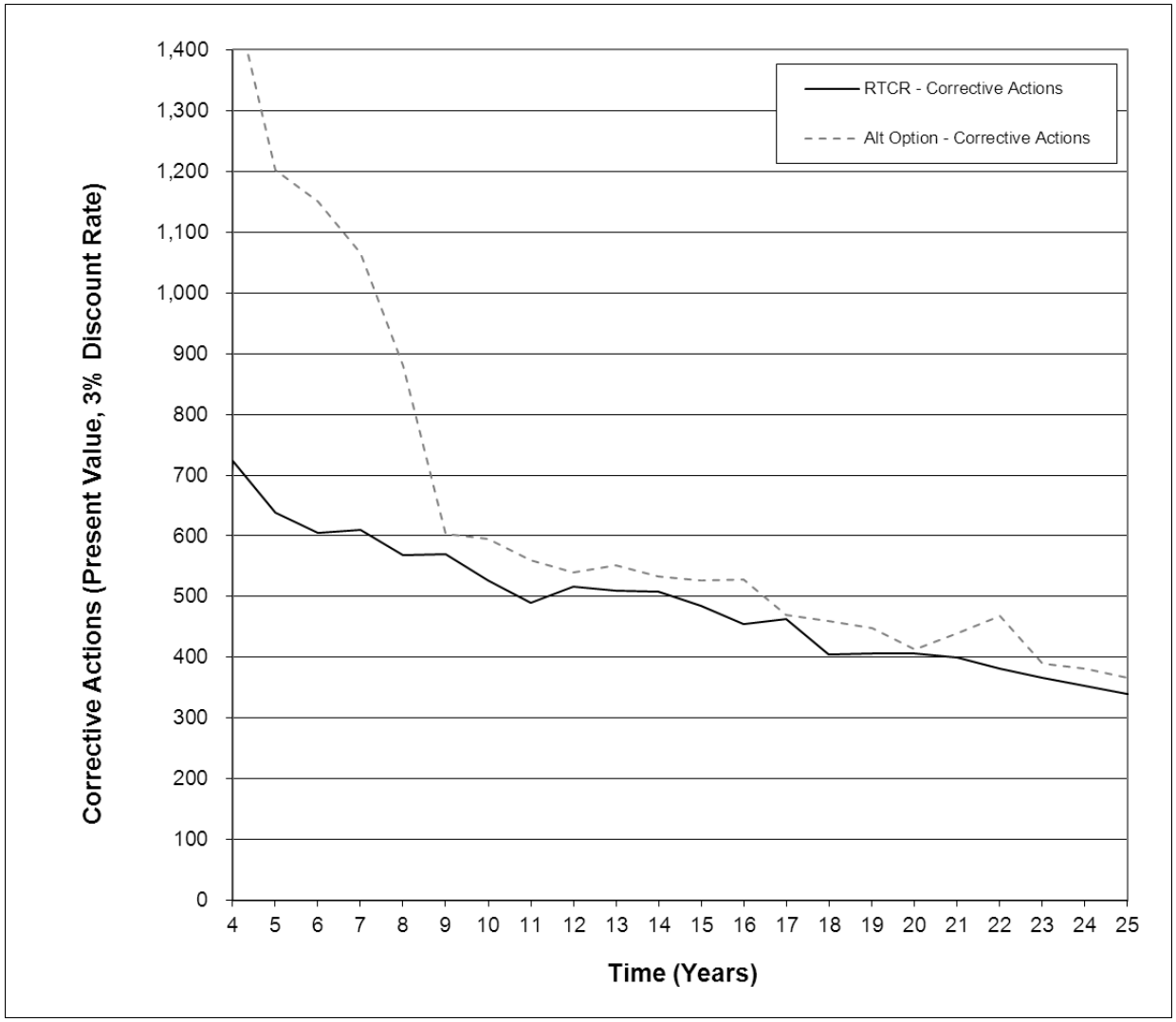


Source: RTCR occurrence model output.

Notes:

1) X-axis begins at Year 4 after rule promulgation, which is the first year under full implementation of the RTCR or Alternative option.
2) The annual rates of acute violations (TCR) and *E. coli* violations (RTCR and Alternative option) as predicted by the model reach steady state in approximately Year 9, by which time PWSs that would be expected to meet the criteria for reduced monitoring would have begun it.
3) Acute violations are predicted to be lower under the RTCR because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

Exhibit 9.7 Discounted Estimates of Corrective Actions (3% Discount Rate)



Source: RTCR occurrence model output.

Notes:

1) X-axis begins at Year 4, which is the first year under full implementation of the RTCR or Alternative option.
2) Includes L1 and L2 corrective actions. The annual rates of corrective actions as predicted by the model reach a steady state beginning in approximately Year 9, by which time PWSs that would be expected to meet the criteria for reduced monitoring would have begun it. All corrective actions performed are in addition to activity under the 1989 TCR, which does not require corrective actions. Therefore the 1989 TCR is not included in this graph.
3) Corrective actions are predicted to be higher under the Alternative option because, although both options are preventing contamination events as discussed in Section 6.3 of this EA, the Alternative option is finding more because of its increased sampling and correspondingly higher diagnostic power.

9.1.2 National Cost Summary

To understand the net impacts of the RTCR on PWSs and states, EPA first used available data, information, and best professional judgment to characterize how PWSs and states are currently implementing the 1989 TCR. Then, EPA considered the net change in costs (i.e., incremental costs over the 1989 TCR) that would result from implementing the RTCR or

Alternative option as compared to the costs of continuing with the 1989 TCR. The objective was to provide the net change in costs resulting from revisions to the 1989 TCR rather than absolute total costs of implementing the TCR as revised by the RTCR. The exhibits in this section present this net change in costs several different ways to help analyze the impacts of the RTCR.

Costs are estimated for different PWS types and size categories (nine size categories are used based on population served) using unit costs obtained from the advisory committee technical work group and vendors and presented in the *Technology and Cost Document for the Final Revised Total Coliform Rule* (USEPA, 2010d). Cost analyses for PWSs include estimates to implement the rule; to revise sample siting plans; to conduct routine monitoring, additional routine monitoring, and repeat monitoring; to perform Level 1 and Level 2 assessments and implement corrective actions; and to provide PN in the case of violations. State cost analyses include estimates of the labor burdens that states would incur, including staff training on RTCR requirements and conducting annual administration, reviewing monitoring reports, reviewing and approving corrective action plans, and for recordkeeping. Chapter 7 of this EA provides detailed discussion on the underlying cost-buildup for each rule component analyzed within the cost model.

Considering costs over time, Exhibits 9.8 through 9.10 show that most of the cost difference between the RTCR and Alternative option will be experienced in the first 8 years after promulgation. Nevertheless, the costs of the RTCR remain lower than those of the Alternative option throughout the period of analysis. The lower costs of the RTCR are driven by the monitoring requirements of the respective options (e.g., RTCR allows annual monitoring for qualifying PWSs while the Alternative option requires at least quarterly monitoring for all PWSs).

Exhibit 9.11 presents the total and net change in costs for PWSs and states for the 1989 TCR, the RTCR, and the Alternative option. The estimated net change in costs is relatively small for PWSs and states on a national level; for the RTCR, total costs would increase from the 1989 TCR by approximately 8%, or $14 million (using a 3 percent discount rate). The Alternative option, based on the increased sampling regimen, increases total costs from baseline by approximately 16%, or about $30 million (using a 3 percent discount rate). Given these relatively low net costs, both the RTCR and Alternative option are below the threshold of a "significant regulatory action" under Executive Order 12866. The approximate $16 million difference between the RTCR and the Alternative, and the net cost of each option over the 1989 TCR, are not particularly large in absolute terms compared to a threshold for economic significance of $100 million annually.

As shown in Exhibit 9.11, the largest portion of the net cost increase is borne by PWSs, which incur approximately 99% of the RTCR's net annualized present value costs (using a 3 percent discount rate). States are expected to incur the remaining costs. PWS costs represent only an 8% and 16% increase, respectively, for the RTCR and Alternative option, in costs over those estimated for the 1989 TCR. By comparison, state costs are expected to increase by 16% and 34% under the RTCR and Alternative option, respectively; however, state costs remain relatively low in absolute terms. The higher net change in PWS costs reflects the potential impact on the subsets of PWSs (primarily small TNCWSs) that would be most affected by either the RTCR or the Alternative option. Exhibit 9.13 shows that the greatest cost impact is on the smallest subset

of TNCWSs, for which the net change is more than double under the Alternative option as compared to the RTCR. The frontloading of costs (shown in Exhibits 9.8 through 9.10) would further amplify the impacts on small TNCWSs during the first few years of rule implementation.

Comparison of Costs of the Regulatory Options Considered

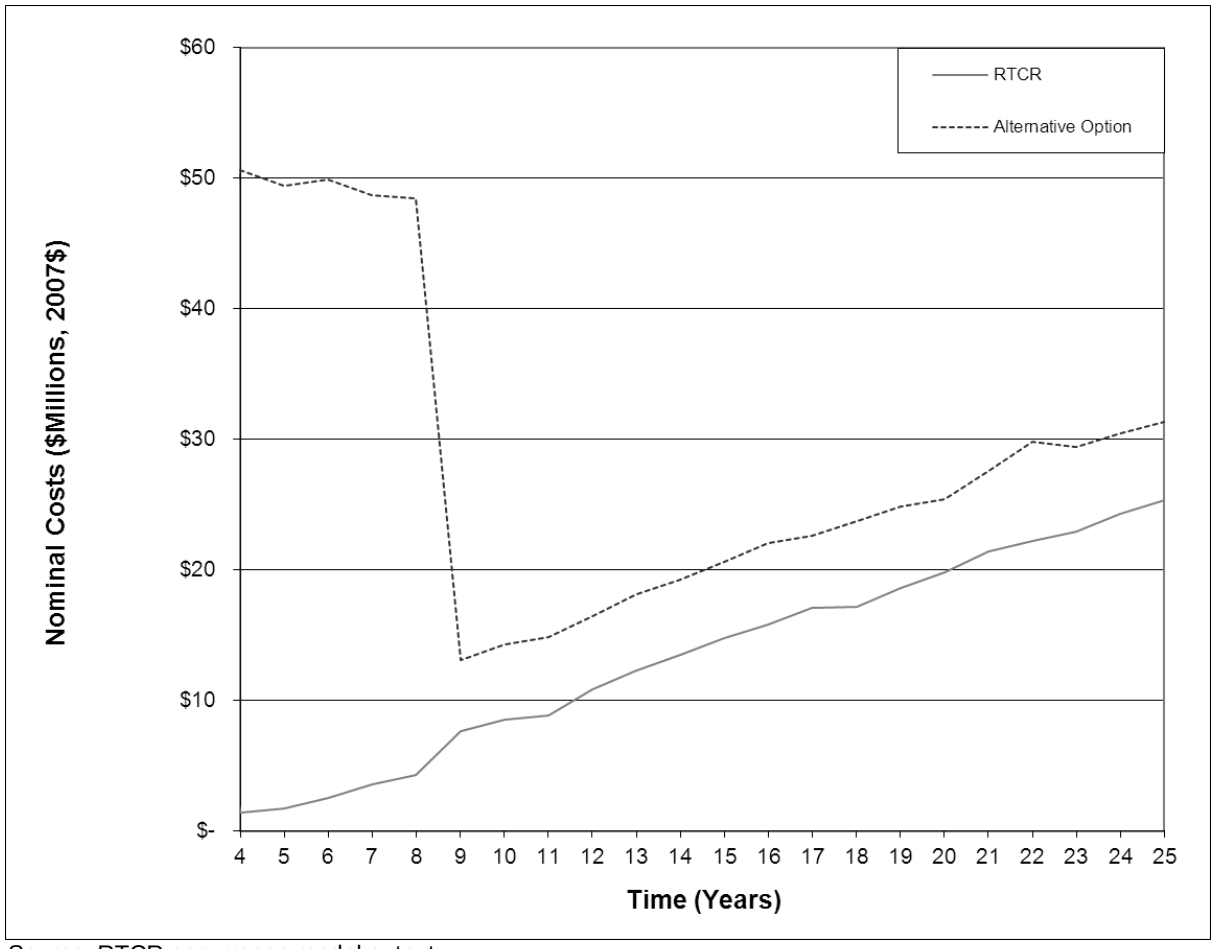
EPA estimated the net change in costs of the RTCR and Alternative option as compared to the baseline (1989 TCR).

Exhibit 9.12 presents the total and net change in costs to PWSs and states by rule component for each of the regulatory options considered. For PWSs, the main driver of additional costs under the RTCR and Alternative option would be additional corrective actions and increases in routine monitoring. Offsetting the cost increase are reductions in costs for additional routine monitoring and PN.

Under the RTCR and Alternative option, the main drivers of net cost increases for states are reviews of revised sample siting plans. States are expected to see a reduction in costs for PN, and additionally for assessment activities under the RTCR. States would, however, experience an overall estimated increase in net costs of $0.2 million and $0.3 million for the RTCR and Alternative option, respectively. The additional costs associated with the Alternative option would result from the increased sampling (and reporting) frequency, and the resulting increase in assessments and corrective actions.

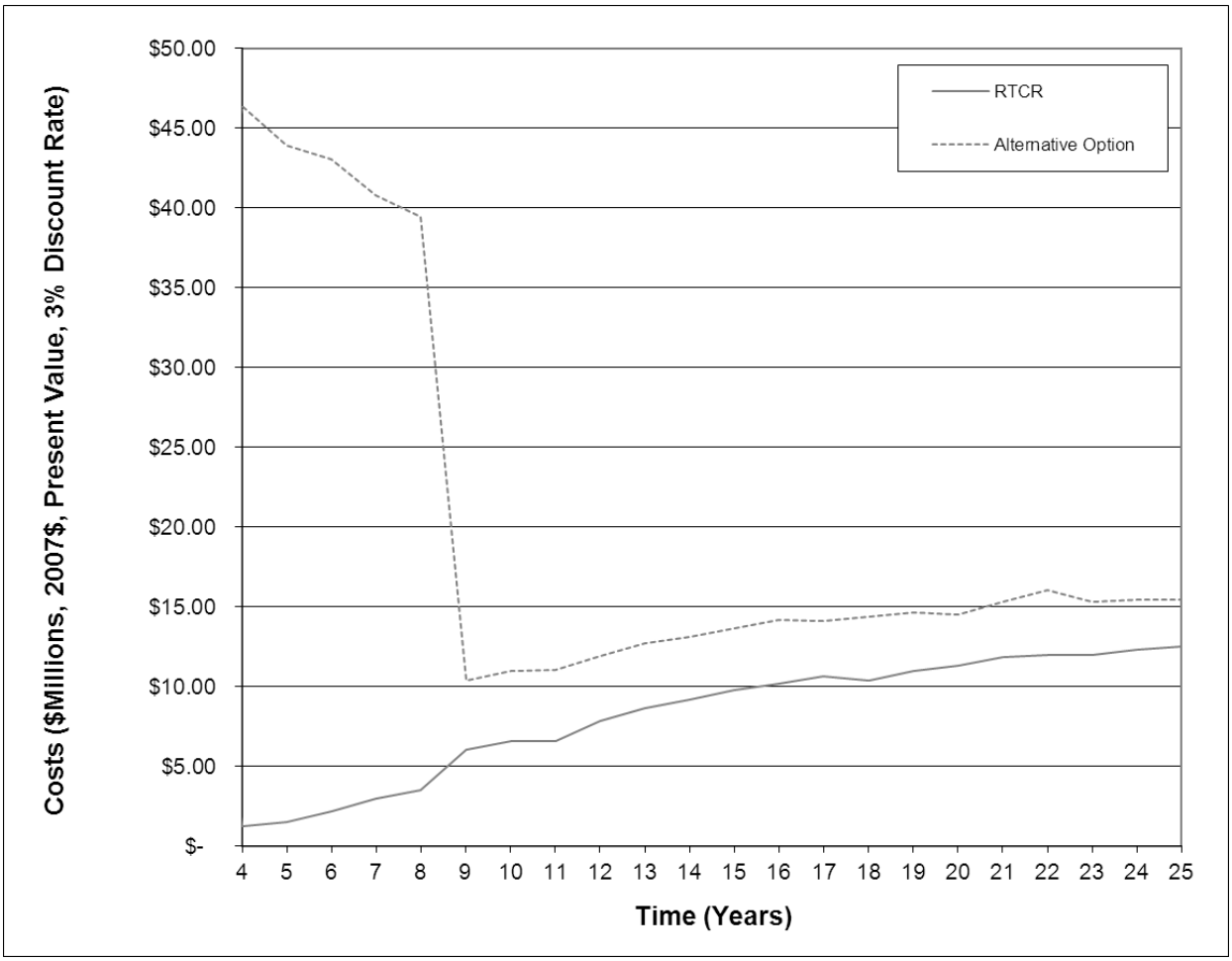
Exhibit 9.13 presents the total and net change in costs to PWSs by system size and type. For PWSs, the most significant total net cost impact is for the smallest category of TNCWSs (serving ≤100 people). Approximately 38% of the net cost increase under the RTCR is estimated to fall on these systems. This is an important factor in the evaluation of potential impacts when comparing regulatory options.

Exhibit 9.8 Net Costs to PWSs (2007$)



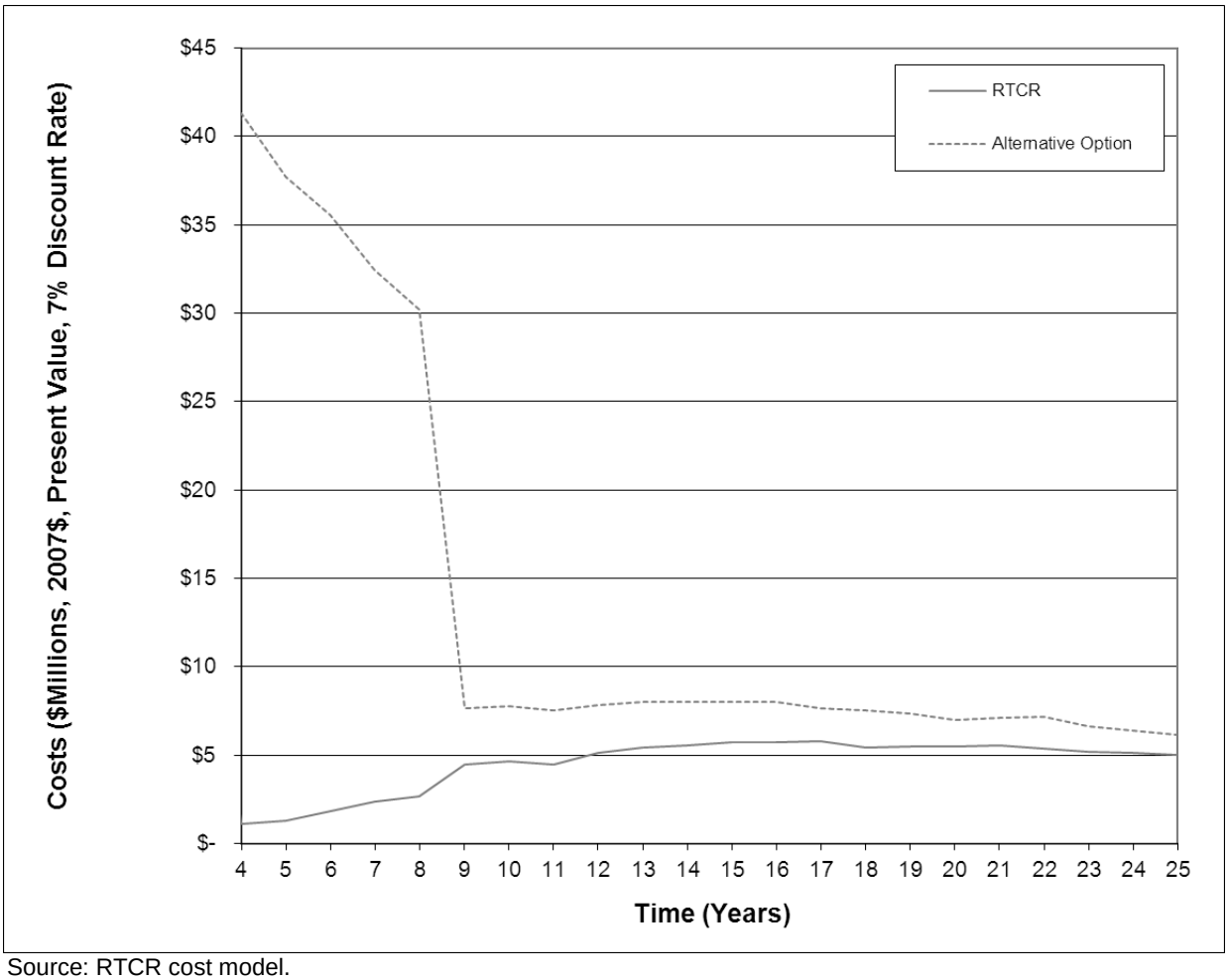
Source: RTCR occurrence model output.
Note: X-axis begins at Year 4, which is the first year of implementation of the RTCR or Alternative option. Steady state begins in approximately Year 9, by which time PWSs that would be expected to meet the criteria would have qualified for and would begin reduced monitoring.

Exhibit 9.9 Discounted Net Costs to PWSs Over Time (3% Discount Rate) (2007$)



Source: RTCR cost model.
Note: X-axis begins at Year 4, which is the first year of implementation of the RTCR or Alternative option. Steady state begins in approximately Year 9, by which time PWSs that would be expected to meet the criteria would have qualified for and would begin reduced monitoring.

Exhibit 9.10 Discounted Net Costs to PWSs (7% Discount Rate) (2007$)



Source: RTCR cost model.
Note: X-axis begins at Year 4, which is the first year of implementation of the RTCR or Alternative option. Steady state begins in approximately Year 9, by which time PWSs that would be expected to meet the criteria would have qualified for and would begin reduced monitoring.

Exhibit 9.11 Comparison of Total and Net Change in Annualized Present Value Costs ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
1989 TCR - Total	$ 185	$ 0.9	$ 186	$ 178	$ 0.9	$ 179
RTCR - Total	$ 199	$ 1.1	$ 200	$ 192	$ 1.3	$ 193
RTCR - Net Change	**$ 14**	**$ 0.1**	**$ 14**	**$ 14**	**$ 0.4**	**$ 14**
RTCR - Percent Change	**8%**	**16%**	**8%**	**8%**	**48%**	**8%**
Alternative Option - Total	$ 214	$ 1.2	$ 216	$ 209	$ 1.5	$ 210
Alternative Option - Net Change	**$ 29**	**$ 0.3**	**$ 30**	**$ 31**	**$ 0.6**	**$ 32**
Alternative Option - Percent Change	**16%**	**34%**	**16%**	**17%**	**69%**	**18%**

Note: Detail may not add due to independent rounding. Because only the net change in costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

Source: Final RTCR cost model.

Exhibit 9.12 Comparison of Total and Net Change in Annualized Present Value Costs by Rule Component ($Millions, 2007$)

	PWSs	State	Total	PWSs	State	Total
	3% Discount Rate			7% Discount Rate		
Rule Implementation and Annual Administration						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
RTCR - Net Change	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Alternative Option - Total	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Alternative Option - Net Change	$ 2.77	$ 0.18	$ 2.95	$ 4.00	$ 0.26	$ 4.26
Revising Sample Siting Plans						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
RTCR - Net Change	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Alternative Option - Total	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Alternative Option - Net Change	$ 0.59	$ 0.42	$ 1.01	$ 0.84	$ 0.59	$ 1.42
Routine Monitoring						
1989 TCR - Total	$ 170.59	$ -	$ 170.59	$ 163.94	$ -	$ 163.94
RTCR - Total	$ 174.71	$ -	$ 174.71	$ 167.74	$ -	$ 167.74
RTCR - Net Change	$ 4.12	$ -	$ 4.12	$ 3.80	$ -	$ 3.80
Alternative Option - Total	$ 187.50	$ -	$ 187.50	$ 182.48	$ -	$ 182.48
Alternative Option - Net Change	$ 16.91	$ -	$ 16.91	$ 18.54	$ -	$ 18.54
Additional Routine Monitoring						
1989 TCR - Total	$ 3.87	$ -	$ 3.87	$ 3.72	$ -	$ 3.72
RTCR - Total	$ 1.12	$ -	$ 1.12	$ 1.09	$ -	$ 1.09
RTCR - Net Change	$ (2.75)	$ -	$ (2.75)	$ (2.63)	$ -	$ (2.63)
Alternative Option - Total	$ 0.78	$ -	$ 0.78	$ 0.66	$ -	$ 0.66
Alternative Option - Net Change	$ (3.10)	$ -	$ (3.10)	$ (3.06)	$ -	$ (3.06)
Repeat Monitoring						
1989 TCR - Total	$ 5.11	$ -	$ 5.11	$ 4.92	$ -	$ 4.92
RTCR - Total	$ 4.88	$ -	$ 4.88	$ 4.70	$ -	$ 4.70
RTCR - Net Change	$ (0.23)	$ -	$ (0.23)	$ (0.22)	$ -	$ (0.22)
Alternative Option - Total	$ 5.66	$ -	$ 5.66	$ 5.59	$ -	$ 5.59
Alternative Option - Net Change	$ 0.54	$ -	$ 0.54	$ 0.67	$ -	$ 0.67
Annual Site Visits						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Net Change	$ -	$ -	$ -	$ -	$ -	$ -
Alternative Option - Total	$ -	$ -	$ -	$ -	$ -	$ -
Alternative Option - Net Change	$ -	$ -	$ -	$ -	$ -	$ -
Level 1 Assessment						
1989 TCR - Total	$ 1.13	$ 0.21	$ 1.34	$ 1.08	$ 0.20	$ 1.29
RTCR - Total	$ 1.63	$ 0.20	$ 1.84	$ 1.57	$ 0.20	$ 1.77
RTCR - Net Change	$ 0.51	$ (0.01)	$ 0.50	$ 0.49	$ (0.01)	$ 0.48
Alternative Option - Total	$ 1.76	$ 0.23	$ 1.99	$ 1.72	$ 0.23	$ 1.94
Alternative Option - Net Change	$ 0.63	$ 0.02	$ 0.65	$ 0.63	$ 0.02	$ 0.65
Level 2 Assessment						
1989 TCR - Total	$ 0.70	$ 0.26	$ 0.96	$ 0.68	$ 0.25	$ 0.92
RTCR - Total	$ 0.90	$ 0.19	$ 1.08	$ 0.88	$ 0.18	$ 1.06
RTCR - Net Change	$ 0.20	$ (0.07)	$ 0.12	$ 0.20	$ (0.07)	$ 0.13
Alternative Option - Total	$ 1.26	$ 0.29	$ 1.55	$ 1.30	$ 0.31	$ 1.61
Alternative Option - Net Change	$ 0.55	$ 0.03	$ 0.58	$ 0.62	$ 0.06	$ 0.68
Corrective Actions based on Level 1 Assessments						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 9.62	$ 0.01	$ 9.63	$ 8.14	$ 0.01	$ 8.15
RTCR - Net Change	$ 9.62	$ 0.01	$ 9.63	$ 8.14	$ 0.01	$ 8.15
Alternative Option - Total	$ 10.01	$ 0.01	$ 10.02	$ 8.52	$ 0.01	$ 8.53
Alternative Option - Net Change	$ 10.01	$ 0.01	$ 10.02	$ 8.52	$ 0.01	$ 8.53
Corrective Actions based on Level 2 Assessments						
1989 TCR - Total	$ -	$ -	$ -	$ -	$ -	$ -
RTCR - Total	$ 2.82	$ 0.00	$ 2.82	$ 2.49	$ 0.00	$ 2.49
RTCR - Net Change	$ 2.82	$ 0.00	$ 2.82	$ 2.49	$ 0.00	$ 2.49
Alternative Option - Total	$ 3.78	$ 0.01	$ 3.79	$ 3.57	$ 0.01	$ 3.58
Alternative Option - Net Change	$ 3.78	$ 0.01	$ 3.79	$ 3.57	$ 0.01	$ 3.58
Public Notification						
1989 TCR - Total	$ 3.75	$ 0.44	$ 4.19	$ 3.60	$ 0.42	$ 4.02
RTCR - Total	$ 0.26	$ 0.06	$ 0.32	$ 0.25	$ 0.06	$ 0.31
RTCR - Net Change	$ (3.49)	$ (0.38)	$ (3.86)	$ (3.35)	$ (0.36)	$ (3.71)
Alternative Option - Total	$ 0.35	$ 0.08	$ 0.43	$ 0.35	$ 0.08	$ 0.44
Alternative Option - Net Change	$ (3.40)	$ (0.36)	$ (3.76)	$ (3.25)	$ (0.34)	$ (3.58)

Notes:

1) Detail may not add due to independent rounding. Because only the incremental costs of some rule components are considered as part of the cost analysis, references to "total" costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.

2) For modeling purposes, additional routine sample counts include regular routine samples taken in the same month.

Source: Final RTCR cost model.

Exhibit 9.13 Total and Net Change in Annualized Costs to PWSs by PWS Size and Type ($Millions, 2007$)

PWS Size (Population Served)	3% Discount Rate					7% Discount Rate				
	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net	1989 TCR - Total	RTCR - Total	RTCR - Net	Alternative Option - Total	Alternative Option - Net
	A	B	C=B-A	D	E=D-A	F	G	H=G-F	I	J=I-F
Community Water Systems (CWSs)										
≤100	$7.4	$7.5	$0.1	$7.6	$0.2	$7.1	$7.3	$0.2	$7.5	$0.3
101-500	$9.0	$9.4	$0.4	$9.5	$0.5	$8.6	$9.1	$0.5	$9.2	$0.6
501-1,000	$3.7	$3.8	$0.0	$3.8	$0.1	$3.6	$3.7	$0.1	$3.7	$0.1
1,001-4,100	$13.2	$13.6	$0.4	$13.6	$0.4	$12.7	$13.1	$0.4	$13.1	$0.4
4,101-33,000	$42.4	$44.8	$2.4	$44.8	$2.4	$40.7	$42.8	$2.1	$42.8	$2.1
33,001-96,000	$34.9	$36.4	$1.5	$36.4	$1.5	$33.5	$34.8	$1.3	$34.8	$1.3
96,001-500,000	$34.7	$36.2	$1.5	$36.2	$1.5	$33.4	$34.6	$1.2	$34.6	$1.2
500,001-1 Million	$6.5	$6.7	$0.2	$6.7	$0.2	$6.2	$6.4	$0.1	$6.4	$0.1
> 1 Million	$5.6	$5.6	($0.0)	$5.6	($0.0)	$5.3	$5.3	($0.0)	$5.3	($0.0)
Total	**$157.4**	**$163.9**	**$6.5**	**$164.1**	**$6.7**	**$151.3**	**$157.2**	**$5.9**	**$157.5**	**$6.2**
Nontransient Noncommunity Water Systems (NTNCWSs)										
≤100	$2.6	$2.7	$0.1	$3.7	$1.1	$2.5	$2.7	$0.2	$3.8	$1.4
101-500	$1.9	$2.0	$0.1	$2.8	$0.9	$1.8	$2.0	$0.2	$2.9	$1.1
501-1,000	$0.6	$0.6	$0.1	$0.9	$0.3	$0.6	$0.6	$0.1	$0.9	$0.3
1,001-4,100	$1.2	$1.3	$0.1	$1.3	$0.1	$1.1	$1.2	$0.1	$1.2	$0.1
4,101-33,000	$0.4	$0.5	$0.1	$0.5	$0.1	$0.4	$0.5	$0.0	$0.5	$0.0
33,001-96,000	$0.1	$0.1	$0.0	$0.1	$0.0	$0.1	$0.1	$0.0	$0.1	$0.0
96,001-500,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
500,001-1 Million	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
> 1 Million	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**$6.9**	**$7.3**	**$0.4**	**$9.3**	**$2.5**	**$6.6**	**$7.2**	**$0.6**	**$9.6**	**$3.0**
Transient Noncommunity Water Systems (TNCWSs)										
≤100	$13.4	$18.7	$5.3	$28.1	$14.7	$12.8	$18.2	$5.3	$28.9	$16.1
101-500	$4.9	$6.5	$1.6	$9.5	$4.7	$4.7	$6.3	$1.6	$9.8	$5.1
501-1,000	$0.6	$0.8	$0.2	$1.2	$0.5	$0.6	$0.8	$0.2	$1.2	$0.6
1,001-4,100	$0.9	$1.0	$0.1	$1.0	$0.1	$0.9	$1.0	$0.1	$1.0	$0.1
4,101-33,000	$0.4	$0.5	$0.1	$0.5	$0.1	$0.4	$0.5	$0.0	$0.5	$0.0
33,001-96,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
96,001-500,000	$0.1	$0.1	($0.0)	$0.1	($0.0)	$0.1	$0.1	($0.0)	$0.1	($0.0)
500,001-1 Million	$0.2	$0.2	($0.0)	$0.2	($0.0)	$0.2	$0.2	($0.0)	$0.2	($0.0)
> 1 Million	$0.3	$0.3	$0.0	$0.3	$0.0	$0.3	$0.3	$0.0	$0.3	$0.0
Total	**$20.9**	**$28.1**	**$7.3**	**$41.0**	**$20.1**	**$20.1**	**$27.3**	**$7.3**	**$42.0**	**$21.9**
Grand Total	**$185.2**	**$199.3**	**$14.2**	**$214.4**	**$29.3**	**$177.9**	**$191.7**	**$13.8**	**$209.0**	**$31.1**

Note: Detail may not add due to independent rounding. Because only the incremental costs of some rule components are considered as part of the cost analysis, references to total costs in this exhibit do not refer to the complete costs for regulatory implementation, but only to the specific costs considered to calculate net changes in costs.
Source: Final RTCR cost model.

9.1.3 Comparison of National Benefits and Costs of the Regulatory Options Considered

Because the potential benefits of the RTCR and Alternative option have not been monetized, direct questions of how benefits compare to costs cannot be quantitatively answered (i.e., whether monetary benefits exceed costs and by how much). However, EPA's collective evaluation of the results presented in this EA lead to the conclusion that the benefits of the RTCR will, in fact, exceed costs. Further evaluation of the cost effectiveness of the RTCR in comparison to the Alternative option considered is provided in Section 9.3. The break-even analysis described in Section 9.3.2 entails determining how many cases of morbidity and/or mortality would need to be avoided in order for the benefit of those avoided cases to equal the cost of the rule option. It does not predict cases of illness avoided as a result of the rule. Instead, it is included to help provide some context for considering the magnitude of cases of waterborne illness that would need to be avoided to break-even with rule costs.

9.2 Effect of Uncertainties and Non-quantified Benefit/Cost Estimates on the Estimation of National Benefits and Costs

Throughout the development of the analyses in this EA, EPA closely evaluated uncertainties in data used. EPA presents a discussion and comprehensive list of assumptions that introduce uncertainty into the analysis in Sections 4.5 and 5.3.3.1 (Exhibits 4.13 and 5.22a-b, respectively). Certain assumptions are incorporated into the predictive model for all three regulatory options in a similar fashion (1989 TCR as well as the RTCR and Alternative option). Because the analysis is based on net changes from the 1989 TCR to the RTCR and Alternative option, incorporating these uncertainties into the 1989 TCR and the options results in no significant net effect on the analysis results. As discussed in Chapters 4 and 5, although GWR assumptions are considered by EPA to be conservative estimates of the effectiveness of the GWR, they are incorporated into the model in similar fashion for all three regulatory options considered, and therefore are not expected to significantly affect net results of the EA. However, assumptions for certain variables identified as key drivers in producing the net results of this EA (the frequency and effectiveness of corrective actions) affect the RTCR and Alternative option but not the 1989 TCR. These assumptions are further evaluated in a sensitivity analysis in Ch. 5, which is summarized in Section 9.2.1.

EPA also assessed non-quantified costs and benefits to estimate how they would affect the overall conclusions of the analyses performed. Potential impacts of non-quantified costs and benefits are discussed in Chapter 7 and Chapter 6, respectively, of the EA. Section 9.2.2 summarizes the major non-quantified costs and benefits evaluated.

9.2.1 Summary of Major Uncertainties in EA Analyses

The primary sources of uncertainty in the RTCR are introduced into the analysis in the occurrence model and cost model. In the occurrence model, uncertainty is introduced in two types of information. First, data on TC/*E. coli* occurrence and acute and non-acute violations data are adapted from the Six-Year Review and Safe Drinking Water Information System/Federal Version. Second, EPA used best professional judgment and stakeholder input in choosing the values of model inputs to represent the net increase in effective corrective actions to be implemented under the RTCR, and the resulting period of reduced occurrence (both in length of time and percent reduction). The data limitations are discussed in Chapter 4 of this EA. The influence of selected inputs on the model output was tested in a sensitivity analysis, using substitute values that were factors of 0.5 and 2.0 of the original values. Model runs based on the 0.5 decrease in original inputs yielded results that decreased by a factor less than 0.5 (i.e., the results were between 0.5 and 1.0 of the original value). Similarly, model runs based on inputs that were two times the value of the original inputs yielded results that were less than a multiple of two times the original output. These results, showing that input variable selection has less than a one-to-one influence on model output, indicate that the model output is not highly sensitive to changes in these input variables.

Additionally, uncertainty in the analysis results stemmed from the complexity of interactions between the effects of the various rule components. The occurrence model produced outputs that showed a decrease in acute violations under the RTCR and an increase under the Alternative option. Given that the Alternative option incorporated the same risk reducing

features (assessments and corrective actions) as the RTCR, EPA considered that the additional sampling under the Alternative option was having a larger upwards effect (increase) on occurrence compared to the downward effect of the additional corrective actions. EPA developed a stepwise sensitivity analysis to test the relative importance of the following competing effects under the RTCR relative to the 1989 TCR:

- New assessments and corresponding corrective actions.
- Reduced repeat and additional routine monitoring.

The results (Section 6.4) revealed that acute violations under the RTCR as compared to the 1989 TCR differed as follows:

- Many acute violations were prevented from occurring by implementation of assessments and corresponding corrective actions.
- Some acute violations were missed by the reduction in repeat and additional routine sampling.

From these results (described in Section 6.4), EPA concluded that under the RTCR, more acute violations are prevented than are missed. Additionally, the increase in routine monitoring under the RTCR finds additional acute violations as compared to the 1989 TCR, which explains the net increase in the acute violations found as compared to the 1989 TCR. Exhibits 9.2–9.7 show the larger net difference (between the alternative and baseline) seen in levels of acute violations, non-acute violations, and corrective actions implemented under the RTCR as compared to the Alternative option.

The sources of uncertainty embedded within the results of the occurrence model are also incorporated into the cost model. As described in reference to the occurrence model, EPA used best professional judgment and stakeholder input in choosing 10% as the factor of net increase over corrective actions implemented under the 1989 TCR. A sensitivity analysis of the effect of an increase in this factor on costs revealed that as the number of corrective actions increases, a portion of the corresponding cost is offset by the reduced number of assessments required as water quality improves (Section 7.7 of this EA).

A potentially significant additional source of uncertainty in costs is introduced in the distribution of corrective actions selected (i.e., the number of each type implemented) for the 10% additional corrective actions. Because there is a wide variation in the unit costs of the actual corrective actions underlying the compliance forecast (see Appendix D for unit cost detail), EPA ran two sensitivity analyses to assess the potential impacts of a high and low cost distribution in the compliance forecast. The results provide a low bound and a high bound on the original analysis results: approximately $3 million/$25 million for the RTCR and $17 million/$43 million for the Alternative option (at 3 percent discounting). This indicates that although the estimates of the number of systems that would choose each type of corrective action has a significant impact on costs of the rule, the rule remains a relatively low cost rule under the most conservative (costly) assumptions.

9.2.2 Summary of Non-quantified Costs and Benefits

EPA believes that all of the rule elements that are the major drivers of the net change in costs from the 1989 TCR have been quantified to the greatest degree possible. However, cost reductions related to fewer monitoring and reporting violations are not specifically accounted for in the cost analysis, and their exclusion from consideration may result in an overestimate of net change in cost between the 1989 TCR and the RTCR or Alternative option. Using *E. coli* as the endpoint, benefits have been estimated and predictions made about the reduced hazard associated with reduced exposure to fecal contamination and the potential benefits from corrective actions that, if effective, will reduce exposure. No attempt was made to monetize these benefits by predicting infections, illnesses or deaths and to compare these values directly with the monetized costs because of lack of data.

Because the cost analyses in this EA focus on net changes in costs, consideration of non-quantified costs can result in either an under- or overestimate of the net costs for the RTCR, as described in Section 7.7 of this EA. Overall, the non-quantified costs identified would potentially lower the net cost of the RTCR, and include the following:

- Reduced costs due to overlap between sanitary surveys and required assessments; and
- Reductions in costs related to less frequent PN for reporting and monitoring violations.

Additionally, EPA identified a potential cost and benefit increase for the RTCR and Alternative option related to the baseline assumption that all PWSs are currently meeting requirements of the TCR. To the degree that PWSs are not currently meeting TCR requirements, the 1989 TCR costs and benefits are overstated in the RTCR EA, resulting in an underestimate of the net change in costs and benefits under the RTCR.

EPA identified five additional potential areas of non-quantified benefits:

- Reductions in primary and secondary endemic disease burden, both acute and chronic, associated with consuming PWS drinking water;
- Reductions in risk of outbreak and associated illness and costs;
- Benefits from increased operator knowledge about their systems (including more consistent water quality);
- Accelerated infrastructure repair/replacement; and
- Reductions in averting behavior (due to higher consumer confidence in water quality).

Taken together, these items represent a potential for significant additional health benefits. For the first four items listed, benefits may be realized directly through the elimination, reduction, and/or prevention of pathogen occurrence. Reductions in averting behavior may lead

to benefits related to a more efficient use of resources (i.e., using tap water instead of more expensive, yet not necessarily safer, alternatives).

9.3 Comparison of the Regulatory Options Considered

The following subsections present further analysis of the RTCR in comparison to the Alternative option. Comparisons based on the net change in costs and benefits and several effectiveness measures are presented to inform the selection of the RTCR over the Alternative option.

9.3.1 Net Change in Costs and Benefits

The net change in costs and benefits are those that are incurred or realized to reduce pathogen illnesses and deaths from one option to the next more stringent option. Estimates of the net change in costs and benefits are useful when considering the economic efficiency of different regulatory options considered by EPA. One goal of this analysis is to identify the regulatory option where net social benefits are maximized. Net benefits analysis is not possible when benefits are not monetized as in the case with the RTCR. However, this type of analysis can still provide information on relative cost-effectiveness of different regulatory options.

For the RTCR only costs were monetized. An indirect proxy for benefits was quantified. Performance of corrective actions is expected to have an impact that is most directly translatable into potential health benefits. Therefore, to compare the additional cost increases and associated net benefits of the RTCR and Alternative option, benefits are presented in terms of corrective actions performed. Specifically, only Level 2 corrective actions are considered because they are performed in response to a Level 2 treatment technique trigger, which includes either an *E. coli* MCL violation or a second Level 1 treatment technique trigger within a 12-month period. Corrective actions performed in response to Level 2 triggers are, therefore, considered more indicative of addressing a public health problem than actions addressing a Level 1 trigger.

To compare the additional cost increases and associated benefits (shown as numbers of Level 2 corrective actions performed) of the RTCR and Alternative option, analyses of both the net change in costs and benefits are presented in Exhibit 9.14. Note, the RTCR net change in costs presented in Exhibits 9.14 to 9.17 represents the additional costs between the 1989 TCR and RTCR, the Alternative option net change in costs represent the additional costs between the RTCR and Alternative option.

Exhibit 9.14 shows that the annualized net change in costs for the Alternative option compared to the RTCR are similar to the annualized net change in costs for the RTCR compared to the 1989 TCR ($15.3 million vs. $14.3 million, using a 3% discount rate). Consistent with the lower net change in costs, the net change in benefits in terms of Level 2 corrective actions performed are fewer under the Alternative option than under the RTCR. The new requirement under both the RTCR and Alternative option for PWSs to implement assessments and corrective actions will capture the bulk of improvements to be made in comparison to the 1989 TCR. Also, the additional sampling required under the Alternative option relative to the RTCR provides an approximately equal increase in costs but a lower net effectiveness relative to the portion of incurred costs. This suggests that beyond a certain level of corrective action implementation,

PWSs would experience diminishing net marginal returns for their investment in correction actions. The relationship between the net change in costs and benefits is examined further with respect to cost effectiveness in Section 9.3.2.

Exhibit 9.14 Net Change in Annualized Present Value Costs ($Millions, 2007$) and Benefits (Number of Level 2 Corrective Actions)

Regulatory Option	Costs		Benefits (L2 Corrective Actions)	
	3%	7%	3%	7%
1989 TCR	$ 186.1	$ 178.8	No change[3]	No change[3]
RTCR	$ 200.4	$ 193.0	208	202
RTCR - Net Change[1]	**$ 14.3**	**$ 14.2**	**208**	**202**
Alternative Option	$ 215.7	$ 210.5	336	355
Alternative Option - Net Change[2]	**$ 15.3**	**$ 17.5**	**128**	**153**

[1]Represents the net change of the RTCR over the 1989 TCR.

[2]Represents the net change of the Alternative option over the RTCR. Add net change for Alternative option to net change for RTCR to calculate the total net change of the Alternative option over the 1989 TCR. Note: The RTCR occurrence model yields the number of corrective actions that are expected to be implemented in addition to (net of) those already implemented under the 1989 TCR. The model does not incorporate an estimate of the number of corrective actions implemented per year under the 1989 TCR and does not yield a total for the RTCR and Alternative option that includes the 1989 TCR corrective actions. Benefits shown include corrective actions based on L2 assessments. Detailed benefits and cost information is provided in Appendices A and C, respectively, of the Final RTCR EA (USEPA 2009a).

[3]As explained in section VI.F.2.f of the preamble, for modeling purposes, EPA estimates the net change only in the number of corrective actions performed under the RTCR and Alternative options compared to the 1989 TCR and thus did not quantify the (non-zero) baseline number of corrective actions performed under the 1989 TCR.

9.3.2 Cost Effectiveness Measures

To further differentiate between the RTCR and Alternative option results, EPA performed analyses to assess the cost effectiveness of each regulatory option. In this section, EPA provides an estimate of the cost per corrective action performed under the regulatory options, which is a measure of the cost effectiveness of each rule option. As noted elsewhere in this chapter, corrective actions are considered a clear enhancement to the efforts to reduce *E. coli* (and co-occurring pathogen) occurrence in PWSs, and the most direct benefit in this EA. Corrective actions are also a main driver of the net increases in costs for both rule options considered. In addition, the modeling of corrective actions is done only on a net basis relative to the level performed under the 1989 TCR, thus providing a clear dividing line between impacts under the 1989 TCR and each rule option. As shown in Exhibit 9.15, the annual net cost of the rule per corrective action performed beyond the baseline is approximately $0.02 million and $0.04 million (3% discount rate) for the RTCR and Alternative option, respectively.

Exhibit 9.15 Total Net Annual Cost Per Corrective Action Implemented under RTCR and Alternative Option, Annualized Using 3% and 7% Discount Rates ($Millions, 2007$)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 14.3	$ 14.2
RTCR - Incremental Number of Corrective Actions (L1 & L2)	616	594
RTCR - Cost Effectiveness Analysis[1]	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change	$ 29.6	$ 31.7
Alternative Option - Incremental Number of Corrective Actions (L1 & L2)	808	819
Alternative Option - Cost Effectiveness Analysis[1]	**$ 0.04**	**$ 0.04**

Notes:

[1]CEA = (Net Change)/(Incremental Number of corrective actions).

[2]Detailed cost information is provided in Appendix C.

EPA also considered the net cost effectiveness of the RTCR for the entire population of PWSs taken as a whole as compared to the Alternative option to determine the additional benefit associated with that portion of Alternative option cost beyond the cost of the RTCR. Exhibit 9.16 shows that the RTCR has a far lower marginal cost per corrective action for PWSs than the Alternative option ($0.02 million for the RTCR vs. $0.08 million for the Alternative option). This indicates that the additional corrective actions performed under the Alternative option are much more costly on a unit basis than those performed under the RTCR.

EPA further considered the issue of additional costs under the Alternative option as compared to the RTCR in terms of the effect on small TNCWSs using GW (serving ≤100). The additional net change in costs under the Alternative option could cause substantial additional burden on small TNCWSs, which incur the largest portion of costs of the rule among all categories of systems. However, these same TNCWSs would also receive the most benefits from the RTCR (increased assessments and corrective actions following a trigger). EPA considered the group of 60,200 TNCWSs using GW (serving ≤100), which are the largest subset of systems by size/type, and which are expected to bear the highest burden of all system categories under the RTCR. Exhibit 9.17 shows that the net cost effectiveness of the RTCR is significantly greater than of the Alternative option (a cost per corrective action of $0.02 million vs. $0.07 million, respectively) and both options are more cost effective for this subset (TNCWSs using GW serving ≤100) than for the entire population of PWSs taken as a whole. The two net change cost analyses indicate that, using a 3 percent discount rate to compare incremental benefits and costs, the RTCR is significantly more cost effective (by a factor of approximately 3.9) than the Alternative option for the most burdened subset of systems, and is significantly more cost effective (by a factor of approximately 3.4) than the Alternative option when considering all PWSs together.

Exhibit 9.16 Annualized Net Change in Costs per Corrective Action Implemented for All PWSs under RTCR and Alternative Option ($Millions, 2007$)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 14.30	$ 14.17
RTCR - Incremental Number of Corrective Actions (L1 & L2)[1]	615.82	593.71
RTCR - Incremental Cost per Corrective Action ($)	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change (over RTCR)[2]	$ 15.29	$ 17.52
Alternative Option - Incremental Number of Corrective Actions (L1 & L2) (over RTCR)[2]	192.23	224.93
Alternative Option - Incremental Cost per Corrective Action ($)	**$ 0.08**	**$ 0.08**

Notes:

[1]Exhibit includes the number of corrective actions predicted by the RTCR occurrence model to be implemented in addition to those implemented under the 1989 TCR.

[2]Add net values for Alternative option to net values for RTCR to calculate total net values of Alternative option over 1989 TCR.

[3]Detailed cost information is provided in Appendix C.

Exhibit 9.17 Annualized Net Change in Costs per CA Implemented for TNCWSs (Serving <100 people) under RTCR and Alternative Option ($Millions, 2007$)

Regulatory Option	3% Discount Rate	7% Discount Rate
RTCR - Net Change	$ 5.3	$ 5.3
RTCR - Incremental Corrective Actions (L1 & L2)[1]	287	275
RTCR - Incremental Cost per Corrective Action ($)	**$ 0.02**	**$ 0.02**
Alternative Option - Net Change (over RTCR)[2]	$ 9.4	$ 10.8
Alternative Option - Incremental Corrective Actions (L1 & L2) (over RTCR)[2]	132	155
Alternative Option - Incremental Cost per Corrective Action ($)	**$ 0.07**	**$ 0.07**

Notes:

[1]Derived by dividing incremental rule costs applicable to TNCWS <100 by the incremental number of corrective actions to be implemented under the RTCR (relative to baseline) and the Alternative option (relative to the RTCR) by TNCWSs using GW.

[2]Add net values for Alternative option to net values for RTCR to calculate total net values of Alternative option over 1989 TCR.

[3]Detailed cost information is provided in Appendix C.

9.3.3 Break-Even Analysis

As described in Chapter 6 of this EA, this analysis does not include a fully quantified risk assessment because there are insufficient data on the co-occurrence in PWSs of fecal indicator *E. coli* and pathogenic strains of *E. coli* or other bacteria, viruses, and parasitic protozoa that can cause waterborne disease. Given the absence of *E. coli* and waterborne pathogen co-occurrence data to predict health effects in PWSs, EPA developed a break-even analysis to inform the discussion of whether the benefits justify the costs of the regulation. A break-even analysis typically compares the rule cost with the estimated value of the medical cases (and related costs such as time off from work) that would be avoided annually by the rule to determine if the rule benefits break even with avoided costs. In the case of the EA, where cases avoided cannot be estimated, the break-even analysis informs the benefit/cost discussion by providing estimates of the number of fatal and non-fatal cases that the rule would need to avoid in order to break even with rule costs.

The underlying question this analysis seeks to inform is whether corrective actions performed under the RTCR will sufficiently reduce potential exposure to fecal contamination and/or waterborne pathogens to compensate for the net costs of the rule. One result of the

implementation of the RTCR predicted by the model and presented in Exhibit 6.5 is that some number of acute events will be prevented.[64] As discussed in Chapter 6, sufficient data are not available to quantify the numbers of illnesses and deaths potentially avoided by preventing such acute events. However, the presence of *E. coli* in a water system is an indicator of the presence of fecal contamination;[65] it suggests that a pathway for the introduction of waterborne pathogens may exist. The total numbers of acute events and potentially affected people are small (most events are predicted in small NCWSs), but nonetheless there will be a positive impact on public health by avoiding these events. The magnitude of this impact will depend heavily on the specific elements underlying any acute event avoided: who and how many in the population are affected, and the etiologic agent to which exposure is avoided. An event can be endemic to a single person or small group of persons, or it may reach the level of an outbreak. The cause of an event may be one or more of a range of bacterial, viral, or parasitic organisms, as described in Chapter 2 of this EA. Although there may be a range of waterborne pathogens mitigated by implementation of the RTCR, two potential waterborne pathogens are considered in this analysis to provide input for developing the break-even analysis: shiga toxin-producing *E. coli* O157:H7 (STEC O157)[66] and *Salmonella*.[67]

The Centers for Disease Control and Prevention (CDC) estimates that STEC O157 pathogens from all sources are responsible for approximately 73,000 illnesses in the United States annually. The CDC has found that 15% of outbreak cases of STEC 0157 are waterborne (Rangel et al., 2005); if that rate applies as well to endemic cases, then approximately 11,000 cases of STEC 0157 infection would be due to waterborne exposure. For *Salmonella* infections, the Economic Research Service (ERS) uses an estimate of 1,397,187 cases annually based on 1999 estimates from the CDC that included an estimate of non-reported illnesses. The 1999 estimate stated that the share of cases due to consumption of contaminated food was 95 percent, indicating that approximately 70,000 cases were due to other sources. While the portion of these cases due to waterborne exposure is unknown, some public systems have documented cases of waterborne Salmonellosis. In March of 2008, *Salmonella* in the water system of Alamosa, Colorado caused an outbreak in which hundreds of the 10,000 residents were sickened and one person died. The deep mountain aquifer from which the water was drawn was confirmed not to be the source of the bacteria (Berg, 2008), but two storage tanks had several inches of sediment

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[64]Results presented in Exhibit 6.5 of this EA indicate that fewer *E. coli* positive events would occur under the RTCR than under the 1989 TCR. These results are consistent with the net improvement in PWS water quality (as indicated by a decrease in fecal indicator *E. coli*) suggested by the stepwise analysis presented in Section 6.4 of this EA. Chapter 6 of the EA presents this information in further detail.

[65] Standridge, J. (2008) discusses the use of *E. coli* as an indicator of drinking water quality.

[66] According to the website of the American Academy of Family Physicians (http://www.aafp.org/afp/20000401/tips/11.html), "Shiga toxin-producing *Escherichia coli* is a group of bacteria strains capable of causing significant human disease. The pathogen is transmitted primarily by food and has become an important pathogen in industrialized North America. The subgroup enterohemorrhagic *E. coli* includes the relatively important serotype O157:H7, and more than 100 other non-O157 strains."

[67] *Salmonella*, according to the CDC website, is actually a group of bacteria that can cause diarrheal illness in humans. They are microscopic living creatures that pass from the feces of people or animals to other people or other animals. *Salmonella* serotype Typhimurium, which caused the 2008 Alamosa, CO outbreak, and *Salmonella* serotype Enteritidis are the most common in the United States. Every year, approximately 40,000 cases of salmonellosis are reported in the United States; most of these are foodborne, but some, as in the case of Alamosa, are waterborne. (http://www.cdc.gov/nczved/dfbmd/disease_listing/salmonellosis_gi.html#2, downloaded 10-6-09)

and breaches, and one tank had breaches large enough for birds and animals to enter (CDPHE, 2009).

For the break-even analysis, medical cases are classified as non-fatal or fatal, and analyses are presented for these two classifications.[68] The valuations for medical cases used in the break-even analysis are developed using the ERS Foodborne Illness Calculator[69] (ERS Foodborne Illness Calculator), as described in Appendix E of the RTCR, for the two example pathogens considered: STEC O157 and *Salmonella*. For most ERS calculator inputs, default or suggested alternative values are used to estimate costs. However, for the valuation of fatal cases within the model, EPA used a value of a statistical life (VSL)[70] estimate of $8.8 million[71] to be consistent with EPA methodology for calculating the value of this measure.[72]

To represent a range of estimates, EPA used the ERS calculator to calculate break-even thresholds for a low- and high-end valuation of cases avoided corresponding to "traditional" and "enhanced" methodologies for estimating Cost of Illness (COI) values. For the traditional COI valuation, EPA used the ERS calculator default values for STEC O157, with the exception of the VSL applied to fatalities, which EPA updated as shown in Appendix E of the RTCR EA. To estimate an enhanced COI valuation, EPA applied the basic settings used for the traditional COI valuation (including the EPA-updated VSL value) but with alternative values for estimated productivity and disutility losses. The traditional COI, as developed in this analysis based on the default setting in the ERS calculator, places no value on lost nonmarket work time, while the enhanced COI method values nonmarket work time based on opportunity costs (equivalent to market work time lost). The alternative valuation used (a suggested option within the calculator) is to apply the productivity losses to all lost time for market and non-market work (e.g., for individuals who stay home to raise children or care for the elderly). The ERS calculator default

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[68] Evaluation of fatal cases in this analysis includes consideration of the underlying non-fatal component of the illness prior to death.

[69] A full detailed description of the ERS Foodborne Illness Calculator, including detailed discussion of the items discussed previously and derivation of the underlying values used in calculations can be found online at: http://www.ers.usda.gov/Data/FoodborneIllness/ecoli_Intro.asp.

[70] The VSL represents an estimate of the monetary value of reducing risks of premature death. The VSL, therefore, is not an estimate of the value of saving a particular individual's life. The value of a "statistical" life represents the sum of the values placed on small individual risk reductions across an exposed population. For example, if a regulation were to reduce the risk of premature death by 1/1,000,000 for one million exposed individuals, the regulation would "save" one statistical life (1,000,000 X 1/1,000,000). If each of the 1,000,000 people were willing to pay $5 to achieve the risk reduction anticipated from the regulation, the VSL would be $5 million ($5 X 1,000,000). Appendix E of this EA provides further detail of the derivation of the updated VSL estimate.

[71] An EPA study characterized the range of possible VSL values as a Weibull distribution with a mean of $4.8 million (1990 price level) based on 26 individual study estimates (USEPA, 1997). This represents the value recommended for use in benefits analyses in EPA's *Guidelines for Preparing Economic Analyses* (USEPA, 2000) and endorsed by the Science Advisory Board (SAB) Arsenic review panel (USEPA, 2001a). For use in the break-even analysis, adjustments to the base value from the EPA study were made to account for income and price level changes over time. The mean VSL, after all adjustments were made, was $8.8 million in year 2007 dollars. These adjustments are explained further in Appendix E of this EA.

[72] Use of different VSL estimates corresponding to different government agency policy and methodologies is specifically suggested by ERS, and EPA's methodology is given as a specific example of an alternate value that may be used.

value is zero for other forms of disutility caused by the illness,[73] including pain and suffering, inconvenience, and lost non-work time; this setting is used for the traditional approach in this analysis. The alternative valuation, used for the enhanced approach in this analysis (also a suggested option within the calculator), is based on values (greater than zero) used by the Food and Drug Administration.

Exhibits 9.18 and 9.19 show the values calculated for avoided cases using the ERS Foodborne Illness Calculator for STEC O157 and *Salmonella*, as summarized previously in this section and described in Appendix E of this EA. In addition to separate calculations based on traditional and enhanced COI valuation methodologies, estimates are presented separately for non-fatal and fatal cases.

Using the valuations per case as described, EPA estimated the numbers of cases needed to break even by dividing the total net cost of the RTCR by the values from Exhibits 9.18 and 9.19. The resulting estimates of break-even thresholds are presented in Exhibit 9.20 and 9.21 separately for non-fatal and fatal cases for STEC O157 and *Salmonella*, respectively. Estimates are presented using both three and seven percent discount rates.

Exhibit 9.18 Average Estimated Value per STEC O157 Case Avoided (2007$)

Case Description	Value Per Case	
	Traditional COI	Enhanced COI
Non-fatal cases only	$ 1,756	$ 5,269
Fatal cases only[1]	$ 8,820,401	$ 8,821,911

[1] Calculations for fatal cases include the COI component for the underlying illness prior to death.
Notes: COI estimates derived using USDA ERS Foodborne Illness Cost Calculator: STEC O157:H7. Traditional COI estimates are based on ERS default values for all inputs except for the VSL estimate, for which EPA substituted its own estimate of approximately $8.8 million. Enhanced COI estimates are based on the same values except for the following changes: productivity losses are applied to all cases rather than just those employed in the formal market, and FDA disutility values are applied rather than the ERS default value of 0.

[73] Disutility is a specific category defined in the ERS calculator, as mentioned previously, to include: pain and suffering, inconvenience, and lost non-work time.

Exhibit 9.19 Average Estimated Value per *Salmonella* Case Avoided (2007$)

Case Description	Value Per Case	
	Traditional COI	Enhanced COI
Non-fatal cases only	$ 210	$ 1,397
Fatal cases only[1]	$ 8,802,998	$ 8,803,551

[1] Calculations for fatal cases include the COI component for the underlying illness prior to death.

Notes: COI estimates derived using USDA ERS Foodborne Illness Cost Calculator: Salmonella. Traditional COI estimates are based on ERS default values for all inputs except for the VSL estimate, for which EPA substituted its own estimate of approximately $8.8 million. Enhanced COI estimates are based on the same values except for the following changes: productivity losses are applied to all cases rather than just those employed in the formal market, and FDA disutility values are applied rather than the ERS default value of 0.

Exhibit 9.20 Estimated Annual Break-Even Threshold for Avoided Cases of STEC O157

COI Methodology	Discount Rate	RTCR		Alternative Option	
		Non-fatal cases only	Fatal cases only[1]	Non-fatal cases only	Fatal cases only[1]
Traditional COI	3%	8,000	1.6	17,000	3.4
	7%	8,000	1.6	18,000	3.6
Enhanced COI	3%	3,000	1.6	6,000	3.4
	7%	3,000	1.6	6,000	3.6

[1] Calculations for fatal cases include the non-fatal COI component for the underlying illness prior to death.

Notes:

1) The number of cases needed to reach breakeven threshold calculated by dividing the net change in costs for the RTCR (Exhibit 9.11) by the average estimated value of avoided cases (Exhibit 9.18). E. coli O157:H7 illness is only an example of a pathogenic endpoint that could be used for this analysis. Use of additional pathogenic contaminants in addition to this single endpoint would result in lower threshold values.

2) Detail may not add due to independent rounding.

3) The breakeven threshold is higher using a 7% discount rate than a 3% discount rate under the Alternative option. This result is consistent with the costs of the Alternative option being higher using the 7% discount rate, which is caused by the frontloading of costs in the period of analysis, as explained further in Chapter 7 of the EA.

Exhibit 9.21 Estimated Annual Break-Even Threshold for Avoided Cases of *Salmonella*

COI Methodology	Discount Rate	RTCR		Alternative Option	
		Non-fatal cases only	Fatal cases only[1]	Non-fatal cases only	Fatal cases only[1]
Traditional COI	3%	68,000	1.6	141,000	3.4
	7%	68,000	1.6	151,000	3.6
Enhanced COI	3%	10,000	1.6	21,000	3.4
	7%	10,000	1.6	23,000	3.6

[1] Calculations for fatal cases include the non-fatal COI component for the underlying illness prior to death.

Notes:

1) The number of cases needed to reach breakeven threshold calculated by dividing the net change in costs for the RTCR (Exhibit 9.11) by the average estimated value of avoided cases (Exhibit 9.19). Salmonella is only is only an example of a pathogenic endpoint that could be used for this analysis. Use of additional pathogenic contaminants in addition to this single endpoint would result in lower threshold values.

2) Detail may not add due to independent rounding.

3) The breakeven threshold is higher using a 7% discount rate than a 3% discount rate under the Alternative option. This result is consistent with the costs of the Alternative option being higher using the 7% discount rate, which is caused by the frontloading of costs in the period of analysis, as explained further in Chapter 7 of the EA.

The estimates shown in Exhibits 9.20 and 9.21 for STEC O157 and *Salmonella*, respectively, represent the number of fatal cases that would need to be avoided annually by the rule for its benefits and costs to society to be equal, or break even, with rule costs. Based on either example pathogen, the results show that both the RTCR and Alternative option would need to avoid a relatively small number of fatal cases annually to break even with the rule costs.

Under the RTCR, approximately two deaths would need to be avoided annually using a 3% discount rate based on consideration of the bacterial pathogen STEC O157. Alternatively, approximately 3,000 or 8,000 non-fatal cases, using the enhanced or traditional benefits valuations approaches,[74] respectively, would need to be avoided to break even with the RTCR costs. As expected based on its costs, the Alternative option would require that a higher number of cases be avoided annually for that option to break even (between 100% and 113% more than the RTCR under the enhanced and traditional approaches, respectively).

[74] Both traditional and enhanced COI approaches count the value of the direct medical costs and of time lost that would been spent working for a wage, but differ in their assessment of the value of time lost that would be spent in nonmarket work (e.g. housework, yardwork, and raising children) and leisure (e.g. recreation, family time, and sleep). They also differ in their valuation of (other) disutility, which encompasses a range of factors of well being, including both inconvenience and any pain and suffering. A complete discussion of the traditional and enhanced COI approaches can be found in Appendix E.

As Exhibit 9.21 shows, approximately two deaths would need to be avoided annually from a *Salmonella* infection for the RTCR to break even. The estimated number of non-fatal *Salmonella* cases that would need to be avoided to break even under RTCR is approximately 10,000 or 68,000 cases under the enhanced and traditional benefits valuations approaches, respectively. As expected based on its costs, the Alternative option would require that a higher number of *Salmonella* cases be avoided annually for that option to break even (approximately 110% more than the RTCR under either the enhanced or traditional approaches).

As the discussion presented in Chapter 2 of this EA describes, disease and deaths are attributable to drinking water contamination across the country. The CDC has found that 15% of outbreak cases of STEC O157 are waterborne (Rangel et al., 2005); if that rate applies as well to endemic cases, then approximately 11,000 cases would be due to waterborne exposure to STEC O157. The revised rule (RTCR) could mitigate pathways of contamination into PWSs and prevent some of these endemic cases. For only this one contaminant, if just 3,000 non-fatal cases under the enhanced COI approach, 8,000 non-fatal cases under the traditional COI approach, or approximately two fatal cases of STEC O157 are avoided annually by the RTCR, the rule would break even. If more than one contaminant was reduced or prevented from occurring in PWSs, the rule would be that much more likely to break even. Avoided illness and death from secondary transmission of infection could also be significant, and would increase the likelihood that total avoided cases reach a break-even threshold. An additional consideration is that a larger number of avoided cases would be predicted if all the benefits of the rule as described in Chapter 6 could be quantified in the analysis. If increased assessments and corrective actions result in a level of system knowledge that enables earlier mitigation of potential pathways of contamination, then additional illnesses or deaths may be avoided beyond those suggested by the decrease in acute events that the model predicts. In the case of the outbreak of *Salmonella* infections in Alamosa, Colorado, as described previously in this section of the EA, some of the key factors that contributed to the outbreak include significant levels of sediment and the presence of breaches to the integrity of the storage tank. These are two types of sanitary defects that could be identified in an assessment and eliminated by corrective action.

9.3.4 Summary of Conclusions

The preferred regulatory option for this rulemaking is the RTCR. The analyses performed as part of this EA support the collective judgment and consensus of the advisory committee that their AIP recommendations, as defined by the RTCR, provide for effective and efficient revisions to 1989 TCR regulatory requirements. The following is a summary of points that must be considered when weighing the benefits and costs of the rule options:

- The estimated net cost of the RTCR is not only small relative to the 1989 TCR (approximately $14 million annually using either a 3% or 7% discount rate), but it is also small compared to the net cost increase of the Alternative option relative to the 1989 TCR (approximately $30–$32 million using a 3% and 7% discount rate, respectively) (exhibit 9.11). This cost differential is especially important considering the potential concentration of impacts on the smallest TNCWSs (exhibit 9.13) and the potential frontloading of costs under the Alternative option (exhibits 9.8–9.10).

- The benefits are expected to be positive under the RTCR and no backsliding in overall risk is predicted (Section 9.1.1.1) from the 1989 TCR. The total benefits under the Alternative option would be greater than under the RTCR (Section 9.1.1.2), but the RTCR is more cost effective both on an average basis and based on the net change in costs (Exhibits 9.15–9.17).

  - Of the various outputs of the occurrence and cost models developed in this EA, the estimate of corrective actions to be implemented has the clearest connection to potential benefits. Based on this metric, the RTCR is more cost effective on average (i.e., costs less per corrective action achieved) than the Alternative option (Exhibit 9.15) by a factor of approximately 1.6.

  - EPA conducted a net cost effectiveness analysis based on the increasing stringency of the options from the 1989 TCR to the RTCR to the Alternative option. In comparing the ratio of additional costs and benefits associated with the RTCR compared to the 1989 TCR and of the Alternative option compared to the RTCR, EPA found the following results:

    - Exhibit 9.16 shows that the net cost effectiveness of the RTCR far exceeds that of the Alternative option for the entire population of PWSs when taken as a whole, by a factor of approximately 3.4.

    - Exhibit 9.17 shows that for TNCWSs the cost effectiveness of the RTCR far exceeds that of the Alternative option, by a factor of approximately 3.9.

- Although data limitations precluded estimating the number of fatal or non-fatal illnesses that would be avoided by implementation of the regulatory options considered, the break-even analysis (Section 9.3.3) shows that approximately two deaths would need to be avoided annually for the final rule to break even based on estimated net costs (exhibit 9.20) using a three percent discount rate. Considering the average costs of non-fatal illnesses resulting from STEC O157 infection, the RTCR would break even if it avoided 3,000 or 8,000 such cases annually based on the enhanced or traditional cost of illness approach, respectively. These thresholds under the Alternative option are 100% to 113% more than under the RTCR using the enhanced and traditional approaches. Under the RTCR, the estimated break-even threshold for non-fatal *Salmonella* cases is 10,000 or 68,000 annually for the enhanced and traditional approaches, respectively, and approximately 110% more (using either the enhanced or traditional approach) for the Alternative option. These break-even thresholds would be reduced if more than one type of pathogen is avoided through implementation of the RTCR, or if cases of secondary transmission are avoided, both of which are logical extensions of the benefits. Given the large variety of pathogens that may occur in PWS source water and the relatively low net costs of the RTCR, EPA believes the RTCR is likely to at least break even.

- There are several items that are not quantified in the EA that represent a potential for significant additional benefits (Section 9.2.2). These additional benefits may be realized due to reductions in co-occurring contaminants, increased systems knowledge (including more consistent water quality), reductions in outbreak risks, accelerated infrastructure repair/replacement, and reductions in averting behavior (due to higher consumer confidence in water quality).

As a result of these considerations, EPA believes that the estimated benefits of the RTCR as defined by the RTCR will likely exceed the modest increases in annualized national costs and will be effective in reducing risk to consumers from exposure to fecal contamination in drinking water.

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