EFFICACY OF RISK-BASED CORRECTIVE ACTION (RBCA) FOR CLEANING UP FUEL RELEASES FROM LEAKING FEDERALLY-REGULATED UNDERGROUND STORAGE TANK SYSTEMS

by

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DEDICATION

This work is dedicated to my mentor, the late Dr. William T. Back of the U.S. Geological Survey, for it was his counsel that provided the impetus for me to begin the long and rewarding academic journey.

DISCLAIMER

This dissertation was conceived and written by Harold O. White, Jr. in his private capacity. Although Mr. White is an employee of the Environmental Protection Agency (EPA), no official support or endorsement by the EPA or any other agency of the federal government is intended or should be inferred. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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LIST OF ABBREVIATIONS

AS – American Samoa
CC – Cleanup Completed
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (of 1980)
CFR – Code of Federal Regulations
CI – Cleanup Initiated
CNMI – Commonwealth of Northern Marianas Islands
CQ – alternate abbreviation for CNMI
CR – Confirmed Release
EPA – Environmental Protection Agency
FR – Federal Register
GU – Guam
GAO – Government Accountability Office (formerly Government Accounting Office)
IC – Institutional Control
IID – Independent Identically Distributed
LTF – LUST Trust Fund
LUST – Leaking Underground Storage Tank
MNA – Monitored Natural Attenuation
MTBE – methyl tertiary-butyl ether
NFA – No Further Action
NRC – National Research Council
OIG – Office of Inspector General
OLS – Ordinary Least Squares
OMB – Office of Management and Budget
OSWER – Office of Solid Waste and Emergency Response (EPA)
OUST – Office of Underground Storage Tanks
PR – Puerto Rico
RBCA – Risk-Based Corrective Action
RBDM – Risk-Based Decision Making
RCRA – Resource Conservation and Recovery Act (of 1976)
SAB – Science Advisory Board
SPA – State Program Approval
UST – Underground Storage Tank
VI – Virgin Islands

ABSTRACT

EFFICACY OF RISK-BASED CORRECTIVE ACTION (RBCA) FOR CLEANING UP FUEL RELEASES FROM LEAKING FEDERALLY-REGULATED UNDERGROUND STORAGE TANK SYSTEMS

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The primary purpose of the underground storage tank (UST) regulations is protection and clean up of groundwater resources used by millions of Americans as the source of their drinking water. Annual expenditures to clean up fuel releases from leaking UST systems are in excess of $1.5 billion, a significant portion of which is derived from public funds. Government programs have a responsibility to ensure that such funds are used effectively and efficiently for their intended purpose. One of the UST program's policy initiatives designed to promote more effective and efficient cleanups is risk-based corrective action (RBCA). RBCA differs from conventional cleanup decision making in that cleanup levels are established on a site-by-site basis according to the relative risk associated with contaminants at the site, the physical characteristics of the site, and the threat posed to potential receptors. Cleanup decisions based on actual risks posed, rather than uniform standards that are characteristic of conventional decision-making, were anticipated to result in an increase in the number of completed cleanups and a decrease in the average cost per cleanup. Though RBCA was first launched in 1995, the impact of RBCA has not been systematically evaluated. This dissertation evaluates whether RBCA has been effective in meeting expectations, and whether these expectations have been met in a cost-efficient manner. With regard to the question of effectiveness, evidence suggests that some states have experienced an increase in the number of cleanups completed due to RBCA, while other states have not. With regard to the question of efficiency, there is some evidence that the cost-savings anticipated due to RBCA implementation have not been realized in all states. Weaknesses in the data available for this investigation point to the need for collection and reporting of more accurate and useful information to support better quantitative evaluations of the impact of RBCA specifically and environmental programs and policies more generally. Prior to implementation of new policies, meaningful and measurable indicators of performance should be identified and appropriate steps taken to ensure that relevant data are collected so that efficacy of a new program or policy can be accurately evaluated. The findings of this investigation are a substantial improvement over previous reviews of UST program reported in the literature and merit consideration by policymakers.

1. INTRODUCTION

The fact is that environmental policies nearly always emerge after the problems they [are] designed to address are well established.
(Fiorino, 1995)

1.1 Overview

Data from the U.S. Geological Survey (2009) indicate that approximately 128 million Americans (approximately 42 percent of the U.S. population) rely on groundwater as their source of drinking water.[1] Underground storage tanks (USTs) are often located in close proximity to drinking water sources (Shih, et al., 2004). USTs are recognized by states[2] as a leading source of groundwater contamination (EPA, 2002), and are responsible for the majority of contaminated sites in the U.S. (NRC, 1994). The gasoline constituents methyl tertiary-butyl ether (MTBE) and toluene, which commonly result from UST releases, are among the top 5 most frequently occurring groundwater contaminants (Carter, Lapham, and Zogorski, 2008).

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[1] This statistic is calculated from data presented in Tables 5 and 6 of the U.S.G.S. Circular 1344, Estimated Use of Water in the United States in 2005. The U.S. population in 2005 was approximately 301 million, of which 42 million persons derived their drinking water from private wells and 86 million were supplied with public drinking water derived from groundwater resources. (128 million/301 million = 42%)

[2] The term "states" in the relevant statute and the literature on USTs refers collectively to UST programs implemented by the 50 U.S. states, and also includes the District of Columbia and 5 overseas U.S. territories. Thus, there are a total of 56 "states" with UST programs. See the definition of "State" in the Solid Waste Disposal Act (SWDA) of 1976 (42 U.S.CA. 6903 at *http://uscode.house.gov/search/criteria.shtml*).

Cleaning up releases from a leaking UST system[3] is expensive, and approximately 500,000 releases from leaking USTs have occurred at sites all across the U.S. (EPA, 2010). States collect and spend more than $1.5 billion annually to clean up leaking USTs.[4] In comparison, EPA distributes an average of $60 to $70 million (which is less than 5 percent of the states' contributions) to state and tribal UST programs from the federal Leaking Underground Storage Tank (LUST) Trust Fund each year. Cleanups have been completed at more than 400,000 of these sites, but there is a backlog of more than 90,000 sites yet to be cleaned up (EPA, 2010). The Government Accountability Office (GAO, 2007) estimates it will cost about $12 billion in public funds to fully clean up half the backlog of contaminated sites, with the other half to be paid for by tank owners and operators.

Government regulatory agencies have an obligation to ensure that public funds are used effectively and efficiently for their intended purpose. One of the UST policy initiatives intended to ensure that leaking UST cleanups are effective and efficient is risk-based corrective action (RBCA, which is pronounced "Rebecca").[5] Risk-based corrective

[3] Federal regulations at 40 CFR 280.12 define an UST system as consisting of: "an underground storage tank, connected underground piping, underground ancillary equipment, and containment system, if any." Thus, an UST system can be comprised of one or more USTs and associated piping. The UST system at an typical gasoline filling station is comprised of 2.78 USTs on average.

[4] Most states have created financial assurance funds which help cover the costs of cleanups. State fund programs are authorized through state legislation and also must be approved by EPA. These funds rely on revenue-generating mechanisms such as annual tank registration fees, taxes on each gallon of gasoline sold, and (typically) a deductible that the owner or operator is responsible for paying in the event that a cleanup is necessary. Some states also restrict eligibility to participate in the fund. Tank owners/operators who are either barred from participation or opt not to participate must fund clean ups themselves. However, since the costs associated with each of these various mechanisms are ultimately passed along to consumers, the public bears at least a majority of the costs whether directly or indirectly.

[5] RBCA is a derived from the broader concept of risk-based decision-making. Although RBCA as initially developed pertained exclusively to fuel releases from leaking UST systems, the concept of considering the risk that a site poses in decisions about cleanup has subsequently been adapted by other EPA programs (in particular Superfund and RCRA) to address a variety of different contaminants from various sources.

action is described as “the integration of site assessment, remedial action selection, and monitoring with USEPA-recommended and exposure assessment practices.” (ASTM, 1995). It prescribes a tiered approach in which each successive tier requires increasing quantity and quality of site-specific data to ensure that corrective action decisions are based on site-specific conditions and relative risks posed to human health and the environment. The RBCA process is envisioned as being more streamlined and more focused than conventional cleanup decision making, which typically defaults to regulatory standards applied uniformly to all sites without regard to actual risks. Conventional, uniform cleanup standards are presumed to be unnecessarily stringent for a significant number of leaking UST sites. Implicit in this assumption is the notion that achieving a conventional, uniform cleanup standard will take longer and hence cost more than a risk-based cleanup. Consequently, risk-based cleanups are expected to lead to more effective risk reduction and more expeditious site closures.

Because measurement of environmental outcomes, such as risk-reduction, is difficult, surrogate measures are used instead. Numerous proponents of RBCA cite its primary benefits (which are both outputs) as being an increase in the number of cleanups completed and a decrease in the cost of cleanups (Benson, Conklin, and Fricke, 1994; Clarke and Salhotra, 1994; Davis, Reed, and Kiernan, 1997; GSI, Inc., 1996; and Malaier et al., 1999). EPA requires that state programs collect and report to EPA only a few performance-related measures, and these represent the primary data available for evaluation of program impact. Among these required measures is the number of cleanups completed; cost information is not required to be collected or reported to EPA, and as such cost data are neither as easily accessible nor comparable among states.

In 1995, EPA determined that the use of RBCA was “conceptually and operationally compatible” with cleanups carried out under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as “Superfund”) and the Resource Conservation and Recovery Act of 1976 (RCRA), as well as Comprehensive State Ground Water Protection Plans (CSGWPPs), environmental justice initiatives, and Brownfields (EPA, 1995). These expectations have sparked considerable interest (and political pressure) in applying RBCA to a wide variety of environmental issues beyond cleanup of leaking UST sites. Application of RBCA has since been extended to (or proposed for) a number of other areas including:

- recovery of fuel released into the environment (“free product”) (Lundy, 1997; and Tomasko, Williams, and Butler, 2001),
- remediation of Superfund sites (Hersh and Wernstedt, 1999),
- land use planning (Hauptmanns, 2005),
- hazardous waste disposal (Tungun, Loehr, Xuijin, 2003),
- cleanup of chemical release sites (Smalley, Minsker, and Goldberg, 2000),
- cleanup of sites contaminated with chlorinated solvents (Sheahan, Ball, and Hahn, 1998),
- regulation of dam safety, and the utility and nuclear power industries (Khadam and Kaluarachchi, 2003),

- regulation of nuclear reactors, space systems, waste repositories and incinerators (Apostolakis, 2004), and
- prioritization of terrorist threat mitigation measures for bridges (Ray, 2007).

Yet, since RBCA was launched in 1995, whether this risk-management policy has had the desired impacts has not been convincingly demonstrated. No systematic evaluation has been attempted, and what little information does appear in the literature comes from RBCA proponents and not independent policy evaluators. This dissertation is an evaluation of the efficacy[6] of RBCA as public policy for cleaning up fuel releases from federally-regulated leaking UST systems. I define "underground storage tank" and explain the significance of the terms "federally-regulated" and "fuel releases" in the following section.

1.1.1. Background. The Office of Underground Storage Tanks (OUST) was created in 1985 to implement the provisions of Subtitle I of the Resource Conservation and Recovery Act (RCRA) (EPA, 2007). The purpose of the UST program is to protect groundwater resources from contamination caused by releases of regulated substances (*e.g.*, petroleum-based motor fuels and their additives as well as hazardous substances, but not wastes) from leaking USTs. The key House sponsor of the Subtitle I legislation, Representative Joe Florio, stated:

> ...implementation of these safeguards during the next decade and removal of leaking tanks will, in my view, go a long way toward preserving

[6] Efficacy is the power or capacity to produce a desired effect. In the context of my evaluation of RBCA, efficacy is comprised of two measures: (1) effectiveness and (2) efficiency. The desired characteristic of effectiveness is an increase in the number of cleanups completed. The desired characteristic of efficiency is that cleanups are completed at least cost.

America's most valuable natural resource, its freshwater aquifers. (EPA, 2004, p.8)

The EPA was charged with developing a program to meet three goals: (1) prevent leaks, (2) detect leaks, and (3) cleanup leaks (EPA, 2004). To meet these goals, in 1988, EPA promulgated regulations (at 40 CFR Part 280) designed to achieve two objectives: (1) prevention of releases from UST systems, and (2) early detection of releases and expeditious clean up of contamination from releases that do occur (Federal Register, 1988a).

At the time that these regulations were being developed, it was estimated that there were approximately 4 million underground storage tanks in the U.S. Of these, nearly 2 million were used for storage of gasoline and other petroleum fuels and federally regulated substances.[7] The other 2 million were heating oil tanks, primarily for home use (EPA, 1986; EPA, 2000a; EPA, 2004a). EPA recognized that a universe of regulated entities this large would be unmanageable; thus, several classes of tanks were excluded or deferred from being regulated or not included in the definition of a UST (Table 1). Also, federal regulations apply only to USTs that contain more than a *de minimis*[8] concentration of regulated substances. By definition (at 40 CFR 280.12) a federally-regulated UST is then

[7] The term "regulated substance" in the context of the UST regulations includes certain hazardous substances defined in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (with the exception of any hazardous wastes regulated under Subtitle C of RCRA) and petroleum and its various fractions.
[8] The preamble to 40 CFR 280 explains that *de minimis* refers to very small concentrations, such as chlorine in drinking water and swimming pools (generally, a few parts per million) (53 Fed. Reg. 37108 (1988).

Table 1. Classes of Tanks that Are not Considered to be USTs

Excluded Tanks	Deferred Tanks	Tanks Not Included In The Definition of UST
• Any UST system holding hazardous wastes • Any wastewater treatment tank system • Equipment or machinery that contains regulated substances for operational purposes • Any UST system whose capacity is 110 gallons or less • Any UST system that contains a *de minimis* concentration of regulated substances • Any emergency spill or overflow containment UST system that is expeditiously emptied after use	• Wastewater treatment tank systems • Any UST systems containing radioactive materials • Any UST system that is part of an emergency generator system at nuclear power generation facilities • Airport hydrant fuel distribution systems • UST systems with field-constructed tanks • Any UST system that stores fuel soley for use by emergency power generators	• Farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for non-commercial purposes • Tanks used for storing heating oil for consumptive purposes on the premises where stored • Septic tanks • Pipeline facilities • Surface impoundment, pit, pond, or lagoon • Stormwater or wastewater connection system • Flow through process tank • Liquid trap or associated gathering lines • Storage tanks situated in an underground area if the storage tank is situated above the surface of the floor

> ...any one or combination of tanks (including underground pipes connected thereto) that is used to contain an accumulation of regulated substances and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground. (Federal Register,1988a, p.37197)

Even after the target UST universe was pared down, federal regulations still covered nearly 2 million storage tanks and nearly 750,000 individual owners and operators (Brand, 1987; Cohen and Brand, 1990). Ron Brand, OUST's founding Director, was faced with two significant challenges (Cohen and Brand, 1990). First, Brand recognized that changing the behavior of this large a number of people and regulating such a large number of USTs would require mass regulation, the implementation of which was challenged by the Reagan administration's anti-regulatory agenda. Second, Brand realized that a federal program would never have sufficient resources (both funding and personnel) to accomplish the task and, thus, states would have to bear the bulk of the burden.[9] In this at least, the Reagan Administration's desire to shift the balance of power from the federal government to the states (an initiative known as "New Federalism") provided necessary political support. Subtitle I's chief Senate sponsor, Senator David Durenberger, expressed that: "It is my expectation that this program will be run by the state governments with very little Federal involvement." (EPA, 2004a, p.10)

[9] One of the decisions made early on to minimize the reporting on the states was to abstain from developing a national database. While this was rationalized as reducing burden on the states, it has in some respects complicated the federal role as manager of the national program. The OUST often lacks data to be able to answer even basic questions about the nature of the individual state programs and their universe of regulated USTs. Data unavailability and poor quality of data are two consequences of this decision that have significant implications for program evaluation in general and this dissertation more specifically.

Consistent with the ideals of New Federalism, EPA's official policy toward devolution of authority to state and local governments, as articulated by then EPA Administrator William Ruckelshaus, was that "EPA would reduce its involvement in the states' day-to-day decision making activities." (Tobin, 1992, p.97). Lee Thomas, EPA's Administrator when the UST regulations were promulgated, continued to promote regulatory power-sharing partnerships with the states (Tobin, 1992).[10]

Brand was successful in accommodating the Administration's promotion of New Federalism by implementing a franchise approach for the UST program: EPA would serve as the franchisor and the states as the franchisees in implementing their own programs in lieu of the federal program. This approach was institutionalized in regulations also promulgated in 1988 (Federal Register, 1988b). These regulations, *Approval of State Underground Storage Tank Programs* (40 CFR Part 281), prescribe the procedures for approving state programs to operate in lieu of federal regulations.[11] The franchise approach has been largely successful; currently 36 states, the District of Columbia and Puerto Rico have approved programs, and the remaining states and territories implement their own programs through grants and cooperative agreements with EPA. Except for a small core of headquarters personnel (approximately 30 in

[10] The National Environmental Performance Partnership System (NEPPS) is the latest initiative to attempt to change the nature of the EPA-state relationship from predominant Federal oversight to collaborative federalism, though its expectations far exceed its accomplishments (Scheberle, 2005; Rabe, 2007).

[11] This process is known as "State Program Approval", or SPA (see *http://www.epa.gov/oust/fsstates.htm*). The procedures for approving such state programs are found at 40 CFR Part 281: "Approval of State Underground Storage Tank Programs". While most states have EPA-approved programs, the approval process entails a certain amount of administrative burden, especially in cases where state statutes to be amended or rewritten. Because this can be a lengthy and cumbersome legislative process, it presents a disincentive for undertaking the approval process. As of the end of 2010, 36 states plus the District of Columbia and Puerto Rico had received approval for their programs. Even in states without EPA-approved programs the state implements the program under a cooperative agreement with EPA.

Washington, DC), federal UST program personnel are geographically dispersed to EPA's ten Regional offices.[12] Frederickson and Frederickson (2006) point out that such a geographic distribution is efficient because Regional personnel both implement the program at the local level and also provide technical, logistical, and administrative support to each state UST program in their respective region.[13]

The UST regulations explicitly provide the states with considerable discretion and flexibility to design and implement their own programs. States may choose either to regulate certain categories of tanks that the federal program explicitly does not, or to regulate a subset of the federally-regulated UST systems.[14] For example, states may regulate home heating oil tanks.[15] For tanks that are not federally-regulated, there are no requirements for states to report them to EPA. The State of Tennessee opted not to regulate hazardous substance USTs; thus, regulatory authority for these tanks is retained by EPA. Such discretion and flexibility has been hailed (for other programs) as increasing the efficiency of state programs to achieve federal goals (Dwyer, 1997; and Posner and Wrightson, 1996). The federal UST program is, thus, a textbook example of a hollowed-out program, implemented by third parties, in this case state environmental agencies (Frederickson and Frederickson, 2006). Indeed, for a federal program to be successful, it must have such support from a horizontal and vertical network of advocates and service

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[12] Nationwide, including regional and headquarters staff, there are approximately 150 EPA staff compared to approximately 3,000 state personnel.

[13] Scheberle (1997) notes that "federal regional officials often identify more closely with their state counterparts than they do with federal officials" (which is consistent with my own experience at EPA).

[14] For a state program to receive EPA approval its regulations must be "no less stringent" than federal regulations. Some state regulations stipulate that they can be "no more stringent" than federal regulations, so in order to meet the "no less stringent" criterion these regulations must be identical to federal regulations.

[15] See http://www.epa.gov/oust/faqs/heatoil.htm

providers (Posner, 2002). This arrangement, however, also results in state-to-state variation in certain program attributes, a prime example of which is cleanup standards.

Such variation has unintended drawbacks such as confusion for interstate fuel marketers who have to deal with differing compliance standards, variation in the level of contamination to which exposure is designated as "safe", and complication of efforts to evaluate program effectiveness due to the patchwork nature of performance indicators and lack of centralized control. This is a common problem for federal programs whose primary function is to provide funds to states; it is challenging to provide accountability for outcomes over which the federal government has relatively limited influence.[16]

The federal UST regulations required that within 10 years of promulgation (so until December 28, 1998, which is known as the "1998 Deadline") all UST systems be equipped with spill, overfill, and corrosion prevention devices; UST systems that were not so equipped were to be upgraded or closed.[17] There was a wide range of responses to the deadline. Many automotive fueling station owners/operators opted to close their existing tanks and install new ones, and though many owners/operators waited until the last minute (and others beyond it), some began preparations years in advance while others

[16] The tension established between the competing objectives of flexibility and accountability is extensively discussed, see for instance Frederickson and Frederickson (2006), Posner (2007), Posner and Wrightson (1996), Radin (2000, 2006), and Percival et al. (2000). Posner (2007), writing about coercive Federalism, documents that in some programs with a relatively minor Federal fiscal role, federal officials are able to "achieve new influence" in their relationship with state and local partners through stipulation of national performance metrics. Federal influence is increasingly more difficult for states to ignore as the size of the federal grant increases (Posner, 2001). For example, some state UST programs have expressed a preference to forego federal funding—typically a small amount relative to the states' own funding—to be relieved of the obligations it entails. In particular, Florida's program (which would receive one of the 5 largest allocations) had not accepted Federal money for several years until presented with funding from the American Recovery and Reinvestment Act (ARRA) of 2009. The size of the associated grants has induced some ideologically opposed states to accept federal funds while at the same time bemoaning federal intrusion.

waited or simply abandoned their tanks.[18] This several year period was a tumultuous time for the UST program, and trends in confirmed releases, cleanups initiated, and cleanups completed were influenced by factors that were not necessarily the same before the 1998 deadline as they were afterwards.

On an annual basis through 1995, the number of new releases from leaking UST systems exceeded the number of cleanups completed, and consequently the backlog of sites to be cleaned up continued to increase. After falling in 1996 and 1997 the backlog increased over the following 2 years reaching a maximum of 171,795 sites. Since 1999, the backlog of sites to be cleaned up has been decreasing though the pace is slowing and there are still more than 93,000 sites yet to be cleaned up (Figure 1).

Partly in recognition of the considerable cost of cleaning up releases from leaking UST systems, the American Society for Testing and Materials (ASTM)[19] developed a consensus standard (E 1739-95) for incorporating risk into cleanup decision-making for leaking UST sites: *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. In 1995, EPA's official endorsement of risk-based decision-making (RBDM) by state leaking UST cleanup programs was issued as regulatory Policy Directive 9610.17, *Use of Risk-Based Decision-Making in UST Corrective Action Programs*. The EPA defines RBDM as

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[17] Replacement of a substandard UST system was at the discretion of the owner/operator; it was not a federal requirement.

[18] As of the end of FY1999 EPA estimated that 85 percent of the regulated UST universe (approximately 646,000 tanks) were in compliance with the 1998 deadline (leaving 114,000 tanks out of compliance). (EPA, 2000)

[19] ASTM has since changed its name to ASTM International.

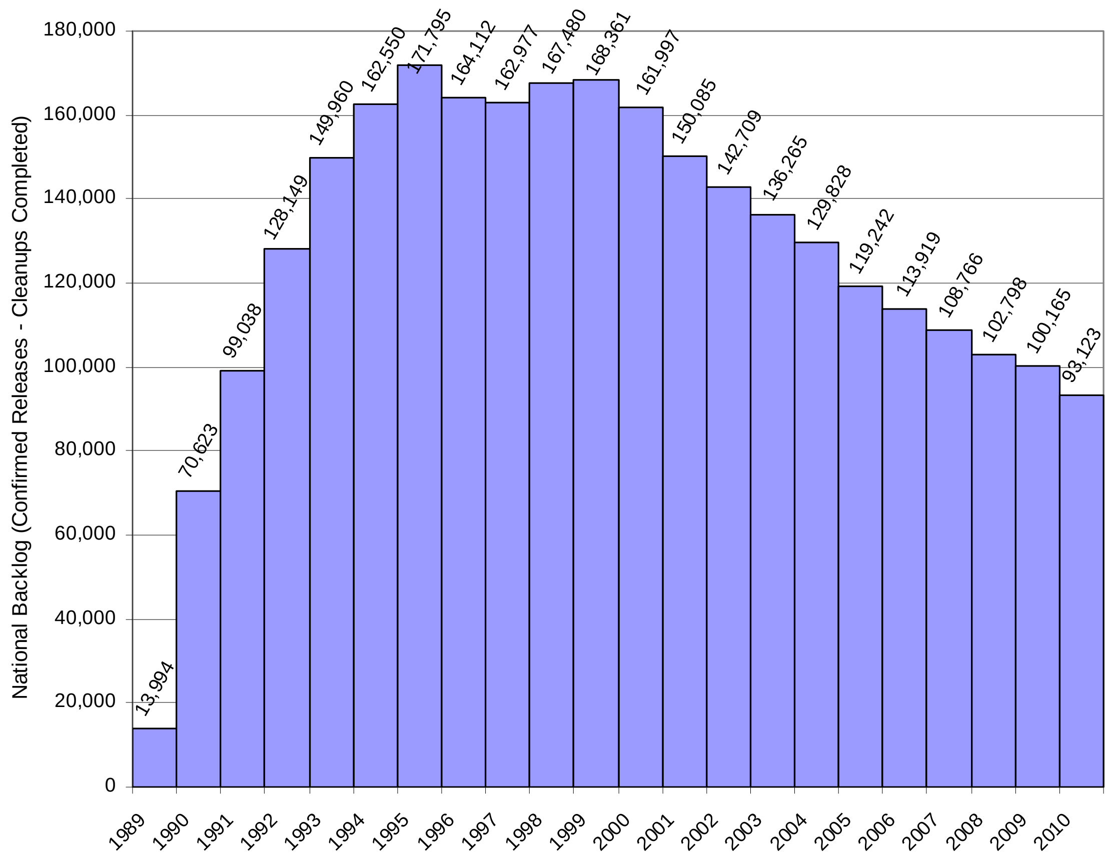

Figure 1. UST National Backlog FY 1989 Through End of Year FY 2010. (source: Semi-Annual Report Of UST Performance Measures End Of Fiscal Year 2009 – As Of September 30, 2010, US EPA Office of Underground Storage Tanks, December 2010. *http://www.epa.gov/oust/cat/ca_10_34.pdf*)

> . . . a process that utilizes risk and exposure assessment methodology to help UST implementing agencies make determinations about the extent and urgency of corrective action and about the scope and intensity of their oversight of corrective action by UST owners and operators." (EPA, 1995, p.1)

When RBDM is adopted into a state's UST corrective action process the result is generally recognized as "RBCA". However, ASTM's RBCA guidance is only one example of how RBDM can be incorporated into state UST corrective action programs in a manner consistent with EPA policies and regulations. Indeed, most states have a RBCA-like process that has been tailored to meet their own state-specific preferences and requirements. The OUST (1995) cautions that "risk-based decision-making is not intended to be primarily a money-saving tool, even though its use may save money in many cases." Policy Directive 9610.17 discusses several misconceptions about RBDM to prevent its misapplication. The Directive clarifies that RBDM should not be considered to be:

- a means of identifying sites requiring no further action,
- a means of identifying sites at which corrective action can be deferred,
- a substitute for the initial steps specifically required by EPA regulations, nor
- a requirement for more elaborate or extensive data collection and analysis than necessary for site assessment, exposure assessment, and establishing cleanup goals.

Today, while most state leaking UST programs claim to implement "RBCA", there is considerable variation in the specifics from one state to the next. Even in states that disclaim having a formal "RBCA" program, risk is accommodated into cleanup decisions in some manner. These inconsistencies reflect different attitudes in risk management decisions and acceptance of modeling results given data uncertainty and concerns about the model assumptions (Brewer and Small, 1997; and Chang, et al., 2004).

1.1.2. Statement of the Problem. Given the significant amount of money spent by state and federal governments to cleanup leaking UST sites, it is perhaps encouraging that the UST program has sought out ways to manage these cleanups more effectively and efficiently. RBCA is one of the policy initiatives intended to ensure that leaking UST cleanups are effective and efficient; yet since RBCA was launched in 1995, only one study on its impact has been conducted. Connor and McHugh (2002) describe their study as being "national" in scope despite it being limited to only 5 states (more detailed discussion of this study is presented in the literature review and discussion sections). Thus, the question of whether or not RBCA has been effective and efficient in cleaning up releases from leaking UST sites has neither been adequately investigated nor convincingly demonstrated.

1.1.3. Research Questions and Hypotheses. The purpose of public policy is to improve social welfare. With regard to cleaning up releases from leaking USTs, the efficacy of RBCA as public policy may be measured in terms of the resulting number of completed cleanups (effectiveness) and the cost of those cleanups (efficiency). My dissertation seeks to answer two questions, the first regarding RBCA effectiveness and the second RBCA efficiency:

1. When compared to states that do not implement RBCA, do states that implement RBCA complete a higher, lower, or similar proportion of cleanups?
2. When compared to states that do not implement RBCA, in states that implement RBCA is the average cost per cleanup higher, lower, or similar?

Hypotheses corresponding to these two research questions, respectively, are:

1. The rate of cleanups completed will increase following a State's implementation of risk-based corrective action to guide cleanup decisions at leaking underground storage tank sites (thus, more cleanups will be completed in RBCA states compared to non-RBCA states).
2. The average cost of completed cleanups will decrease following a State's implementation of risk-based corrective action to guide cleanup decisions at leaking underground storage tank sites (thus, the average cost of a completed cleanup will be lower in RBCA states compared to non-RBCA states).

1.2 Literature Review

1.2.1. Introduction. I grouped pertinent literature relating to my research into three categories: 1) background information on the UST program, 2) information on program evaluation and performance measurement, and 3) information on risk-based corrective action (RBCA), particularly as it pertains to leaking UST sites.

I searched several electronic databases using a variety of search terms while conducting this literature review. Databases searched include Web of Science, JSTOR, and Dissertation Abstracts Online. I also searched several individual journals and collections of a specific publishers' journals. These include the *Journal of Policy Analysis and Management*, *Review of Policy Research*, *New Directions for Evaluation*, *Evaluation and Program Planning*, *Environmental Issues and Policy*, *Environmental Sciences and Pollution Management*, *Publius*, and the collections of Wiley Interscience and Blackwell-Synergy. I used multiple search terms for each search and in various combinations, including among others: risk-based decision-making, risk-based corrective action, risk, underground storage tank, contamination, environmental policy, program evaluation, and performance measurement. I also perused the "references cited" section of key references to identify additional relevant literature.

1.2.2. The Underground Storage Tank Program. Prior to formation of EPA's OUST in 1985, few states regulated UST systems, and UST-related literature is relatively sparse. One of the earliest reports on underground storage tanks was prepared in 1986 by Westat, Inc., *et al.* for EPA's Office of Pesticides and Toxic Substances. This report, "Underground Motor Fuel Storage Tanks: A National Survey", was instrumental in defining the regulated universe of USTs for developing the UST regulations (EPA, 1986, Westat, 1986). Although the scope and volume of the UST-related literature expanded significantly following promulgation of federal regulations in 1988, the focus was principally on UST system components (EPA, 1986; 1987; 1988a; 1988b; 1988c, 1989; 2008a; 2008b; 2008c) behavior of fuel constituents in the subsurface environment (EPA, 1990), and cleanup technologies (EPA, 1990; 1994; 1996a). The OUST web site[20] contains links to laws, regulations, guidance, and other policies plus links to each state regulatory program's web site. Many sections contain links to non-EPA sources of information such as technical reports, guidance documents, and journal articles.

1.2.3. Program Evaluation and Performance Measurement. Program evaluations are defined by the Government Accountability Office (2005a) as "individual systematic studies conducted periodically or on an *ad hoc* basis to assess how well a program is working." Performance measurement and monitoring in contrast focuses on whether a program is meeting its pre-established goals. Program evaluation uses performance measures in assessing program performance to identify program strengths and weaknesses and guide decisions for improving performance. The crucial difference is that program evaluation is concerned not only with whether program processes are working, but also with *why* they are or are not working.

Although program evaluation and performance measurement are not new concepts, it was not until the 1970s that they became an integral part of assessing the performance of government programs in general and then not until the 1990s that they

[20] See *http://www.epa.gov/oust/*

become important in the context of environmental policy (Rich, 1998). One reason for this is many environmental statutes and regulations passed in the 1970s and 1980s were just becoming sufficiently “ripe” for review (Rich, 1998). Another reason is that the 1990s saw the rise of the “government reinvention” movement and passage of the Government Performance Results Act (GPRA), the purpose of which was to increase the public’s confidence in government through improvements in program effectiveness, efficiency, and accountability. Introduction of the Program Assessment Rating Tool (PART) process in 2001 by the Office of Management and Budget (OMB) further stimulated interest in assessing the performance of government programs, especially in regard to whether public funds were being spent effectively and efficiently.[21]

While these management initiatives generated an increase in attention given to evaluation of government programs, evaluations of environmental programs (federal and state) are still relatively rare, lagging behind development in other disciplines (Bartlett, 1994; Knaap and Kim,1998; Berrens et al., 1999; Mickwitz, 2003b; Bennear and Coglianese, 2005; Coglianese and Nash, 2006).[22] Due at least in part to the difficulty associated with evaluating accountability associated with third-party governance, these issues are infrequently addressed in the literature (Posner, 2002). GPRA was not designed for programs (such as the UST program) that are not directly implemented by the Federal

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[21] The PART was not itself a program evaluation *per se*. It was a management tool that comprised a summary of available program evaluation-related information and assigned a numerical score so that performance of federal programs could be compared. As PART was a Bush Administration initiative, it was discontinued in 2009 with change in administration.

[22] Several EPA programs have been the subject of program evaluation research, including Superfund (Hird, 1994; Hamilton and Viscusi, 1999), the Clean Air Act (Greenstone, 2002, 2003, 2004), the Toxics Release Inventory (TRI) (Hamilton, 1995), and the Inspection/Maintenance program for automobile exhaust (Harrington, McConnell, and Ando, 2000).

government (Frederickson and Frederickson, 2006). Many Federal programs require state participation for data collection and reporting on a variety of topics, each of which requires attention and imposes a burden on states. Much of the reporting burden is focused on processes and other aspects of program implementation that are not directly related to environmental outcomes (EPA, 1999, 2000a,b, 2002; Metzenbaum, 1998). State capacity is limited, and competing priorities can lead to delays in acquiring necessary data of adequate quality (Mihm, 2001; EPA, 1996b). The impact of environmental policies and programs is difficult to measure (Gysen, 1996; Bartlett, 1994; and Hahn, 1994), at least in part because benefits are not priced in the market (Bueckman, 1992). When outcomes are difficult to measure, the typical response is to revert to reporting outputs instead (Stahl, 2004; Heckman, Hannah, and Smith, 1997). Indeed, much of the resulting program evaluation effort was superficial, based on measures that were readily available rather than those that were more reliable or salient (Frederickson and Frederickson, 2006; GAO, 2005b; Funnell, 2000). Meeting targets became more important than accomplishing the goals a program was designed to achieve (Cohen and Brand, 1990). The Inspector General (OIG, 1997) determined that such goal displacement is so prevalent that the EPA (and states) lacked data necessary to evaluate effectiveness of the UST program. Cashore and Nash (2003) question whether EPA more broadly is evaluating programs or merely performing performance measurement.

As PART was largely concerned with accountability, independent evaluations were explicitly preferred over participatory or collaborative evaluations. Evaluations that are truly independent are ones in which the evaluator, either autonomously or under commission by a sponsoring entity that is not the subject of the evaluation, develops the plan, conducts the evaluation, and disseminates the results (Rossi, Lipsey, and Freeman, 2004). Primarily because program evaluations are expensive and sources of funding are limited, truly independent evaluations and evaluations that consider programs in their entirety are rare. Evaluations conducted by the Government Accountability Office (GAO), Office of the Inspector General (OIG), and the Science Advisory Board (SAB) may be considered to be independent. However, evaluations by these entities are conducted infrequently and are too narrowly focused, addressing only a limited aspect of a program's activities. Report titles are often misleading in that they give the impression of being more comprehensive than in fact they are.

Over a span of nearly two decades, the GAO conducted four evaluations of the UST program, not one of which is comprehensive, nor do any address RBCA. The topics of these evaluations are: USTs on Department of Defense Installations (GAO, 1992); status of UST upgrades and operation and maintenance, inspection frequency, and leaks from upgraded USTs (GAO, 2001); abandoned USTs, inspection frequency, and use of LUST Trust Fund monies for inspections (GAO, 2005c); and public costs to cleanups leaking UST releases, and sources of funds to cleanup releases (GAO, 2007).

The OIG has conducted four evaluations of the UST program since 1996, not one of which is comprehensive, nor do any address RBCA. The topics of these evaluations are: state's oversight and enforcement of high risk sites, cost recovery, and timeliness of reporting (OIG, 1996); accuracy and timeliness of reporting, cost recovery, eligibility of costs charged to the LUST Trust Fund, and effective use of funds for oversight at high risk sites (OIG, 1997); appropriate use of contract funds and cleanups in Indian Country (OIG, 2004b); and appropriateness of charges against the LUST Trust Fund, expiration of funds, and improper obligation of funds (OIG, 1997).

The SAB has conducted three evaluations of the UST program, the most recent of which is now nearly 10 years old, and none of these “evaluations” is comprehensive, nor do any address RBCA. The topics addressed are: adequacy of EPA’s UST release model (SAB, 1988), inventory of ORD research applicable to the UST program (SAB, 1993), and critique of EPA’s planning for conducting an economic assessment of the UST program as part of a broader evaluation that includes the RCRA Subtitle C program (SAB, 1996).

The OUST has been involved in a number of participatory/collaborative activities with industry and state partners that are described as “evaluations” (and hence appear in lists of results for on-line searches), but are really studies or tests conducted on UST system components (e.g., materials compatibility, leak detection) or related data. Not one of these investigations is a program evaluation.

1.2.4. Risk-Based Corrective Action (RBCA). The consideration of risk in environmental regulation is not a recent development; risk assessment is explicitly incorporated in such long-standing statutes such as the 1970 Clean Air Act and the 1972 Clean Water Act, among others. Yosi (1987) presents one of the earliest discussions of the use of risk assessment in EPA’s regulatory process. The year 1993 saw passage of the GPRA and the signing of Executive Order 12866. Both of these policy directives mandated the use of risk assessment and risk management as a primary criterion for development of environmental regulations and decision-making for cleanup of contaminated sites. Not surprisingly, EPA's Superfund program has been the subject of many such studies, including Viscusi, Hamilton, and Dawkins (1997); Gupta, VanHoutven, and Cropper (1996); Hamilton and Viscusi (1995, 1997), Revesz and Stewart (1995); and Hird (1994), to cite just a few representative examples.

In 1995 the American Society of Testing and Materials (ASTM) published *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (*E 1739-95), and the EPA's OUST issued regulatory Policy Directive 9610.17, *Use of Risk-Based Decision-Making in UST Corrective Action Programs*. Both of these documents promoted the use of RBCA and were the primary impetus behind many states' UST programs embrace of it as their cleanup policy. Though Khan and Husain (2001) credit ASTM's RBCA as being the first formalization of the concept that site management strategies should be risk based, at least two articles on the subject predate ASTM RBCA: (1) Hinchee et al. (1986) propose a risk assessment approach to cleanup leaking UST sites, and (2) Heath and Day (1992) suggest that the basic concepts of risk assessment could be scaled down to contribute to closure decisions at leaking UST sites.[23] Bratberg and Hopkins (1995) conducted a national survey of 25 states to record their RBCA status. ASTM RBCA (or some variant thereof) proved to be especially popular: by 1998, the number of states/territories described as having "adopted RBCA" had increased to 49

[23] Smith (2006) documents efforts by the National Research Council to improve transparency of the risk-based decision-making process by dividing the regulatory process into two discrete functions: (1) risk assessment and (2) risk management. Risk assessment is science-driven while risk management incorporates values such as politics and socio-economic factors. This dichotomy is also discussed by Younger, Coulton, and Froggat (2005); Tesfamarian and Sudiq (2006); Coglianese and Marchant (2005), among others.

(Rifai and Suarez, 2000).[24] Partly due to the collaborative nature of state UST programs toward each other, states were anxious to share their implementation experiences with others and gain recognition for their own programs' accomplishments. National Ground Water Association (NGWA) and American Petroleum Institute (API) conferences hosted special sessions devoted to RBCA. States providing testimony to their RBCA experiences include: Alabama (Malaier, Arakere, and Salhotra, 1999); California (Odermatt, 1988; Mills, et al., 1996; and Chang et al., 2004); Delaware (Fischer and Ellis, 2001; Fischer, 2003); Florida (Conrardy, 1998); Indiana (Troy, et al., 1997); Michigan (Potts and Anderson, 1997); Pennsylvania (Parsonage, Scott, and Shaw, 2002); and Texas (Chen, et al., 2002; Clarke, 1995; Clarke and Salhotra, 1994). Many states customized ASTM RBCA to address their specific needs and preferences. For example, Illinois developed "TACO" for Tiered Approach to Corrective Action Objectives; Delaware developed "DERBCAP" for Delaware Risk Based Corrective Action Program. Other variations were also promoted; Uddameri (2001) discusses a systems-based framework in which risk assessment and remedial evaluation are conceptualized as being integrated with one another instead of being addressed separately as they often are at leaking UST sites.

A study initiated in 1997 to evaluate the performance of RBCA in state leaking UST programs in 2002 in *Human and Ecological Risk Assessment*. This article, by Connor and McHugh, describes the results of a cursory examination of data from 5 states, which the authors characterize as a "nationwide study". The investigation period was

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[24] As part of my investigation, I contacted all the state UST programs to determine the current number of states that were implementing RBCA. I found that 45 were implementing RBCA, and the specific states differs from that presented by Rifai and Suarez (2000). I provide my findings in Section 2.3.6 below.

from 1990 to 1999 so that the post-RBCA implementation period was only 1 or 2 years in 3 out of the 5 states, which is not sufficiently long to either allow for the initial impact of RBCA to be measureable or assess whether the impact (if any) would be sustained. A significant confounding factor is that during the study period (i.e., 1990 through 1999) the “1998 deadline” took effect. This federal regulatory deadline mandated that all substandard UST systems had to be either upgraded or closed by December 28, 1998. As a result, for a year or so leading up to the deadline and a year or more afterwards, cleanup activities were at an unusually heightened pace that bore no relationship to historical trends, which was what Connor and McHugh’s study used for comparison. No attempt was made to account or control for this, or any other, potential confounding factor. In sum, this isolated study, which represents the only assessment to date of the efficacy of RBCA in cleaning up releases at leaking UST sites, does not present a convincing demonstration that RBCA has been effective.[25]

Despite the widespread initial enthusiasm for ASTM RBCA, not all of the experiences were positive and some cautions were aired. Fischer and Ellis (2001) acknowledge that there is the potential that at any given site the “one size fits all” default parameters may not be conservative enough to ensure protection of human health and the environment. Touted cost savings may not be achieved at all sites as site characterization for a cleanup under a RBCA program requires more data at higher cost (Fischer, 2003; Malaier, Arakere, and Salhotra, 1999), and cost-savings that are realized come at the

[25] Connor and McHugh’s work has been the source of material for at least two publications on the impact of RBCA, neither of which include new information or additional analyses. These are: Connor (2000), and Rifai and Suarez (2000).

price of a relaxed margin of safety (Fischer, 2003). Application of RBCA generally requires reliance on modeling results, which can be unreliable (Cushman and Ball, 1993), and receptor surveys that are typically incomplete (Murdy, et al., 1998). Because risk-based standards require reliable, appropriate data that are difficult (if not impossible in some situations) to obtain, Coglianese, Nash, and Olmstead (2003) caution that performance-based regulation is not necessarily the best regulatory strategy. While performance-based regulation provides flexibility in achieving goals, and optimally encourages innovation, difficulty in verifying achievement of goals may mask failure to meet regulatory goals.

In his position as editor of the journal *Ground Water Monitoring and Remediation*, Paul Johnson (one of the original developers of ASTM RBCA) published a series of editorials that sought to spur discussion/debate on whether or not RBCA had a beneficial impact on leaking UST site decision-making. He concludes that, based on responses from readers, most leaking UST site closure decisions were based on administratively-imposed quotas rather than risk reduction or risk management (Johnson, 2003a, 2003b, 2003c). Andrews (2006) observes that technology- or incentive-based approaches have been demonstrably more effective than have risk-based regulations in reducing environmental risks.

1.2.5. Summary. The literature pertaining to performance of federal or state UST programs in general is essentially non-existent. There is a need for research into both the evaluation of environmental policies, and in particular the efficacy of RBCA as public policy for cleaning up fuel releases at leaking UST sites. As no systematic evaluation has been conducted of the impact of RBCA before now, my research is an original and timely contribution to the body of knowledge on evaluation of environmental policy in general, and of the efficacy of RBCA specifically.

2. METHODS

[A non-partisan] evaluation is and is regarded by partisans of all persuasions as balanced, fair, and faithful, so that if methodological quality is high, debates focus on the implications of the findings for practice or policy, not on the credibility of the findings themselves. (Datta, 2000)

2.1 Research Design

My research is designed to determine whether RBCA implementation by state UST programs has had a positive impact as measured by an increase in the number of cleanups completed at leaking UST sites and a decrease in the cost of those cleanups. To determine the causal effect of RBCA (the treatment), two groups of states are compared: those that implement a RBCA program (the treatment group) versus those that do not (the control group). Program impact is the difference in performance between these two groups. The strongest method to determine the program impact of RBCA (or any intervention) is a randomized field experiment (Bennear and Coglianese, 2005; Cook and Campbell, 1979; Rossi, Lipsey, and Freeman, 2004). In such an experiment, states would be assigned randomly to treatment (RBCA) or control (non-RBCA) groups. Random assignment allows the assumption that all other factors are statistically equivalent between treatment and control groups, and thus, differences in the groups' performance is the result of the intervention.

As a practical matter, randomized experimental designs are rare (or non-existent) for environmental policies (Coglianese and Bennear, 2005). Reasons for this include the fact that environmental policies are generally not conceived and implemented as experiments and the implementing agencies may not implement a policy at the same time or in exactly the same manner. Alternative evaluation designs are recognized as being necessary and able to provide credible results (GAO, 2009). From the outset I recognized that my research design could not be experimental since it was not possible to randomly assign states to treatment or control groups because they had already self-selected their group (that is they had already chosen whether or not to implement RBCA). Instead, my research design is a nonequivalent comparison design. As the name implies, equivalence of the groups cannot be assured, because of endogenous differences between the units of analysis (Bennear, 2007), but it is often assumed that unmeasured factors affect members of both groups in similar ways (Buckley and Shang, 2003). The primary concern is selection bias (or in this case self-selection bias), which potentially presents a threat to validity of measurement of the program effect (the "attribution problem") if confounding factors are present and cannot be controlled for (Gilmour, 2006). To produce a credible estimate of an intervention (such as RBCA) all other potential confounding factors must be controlled for statistically to minimize as much as possible the nonequivalence of the groups, and hence minimize the effect of self-selection bias (Blank, 2002).

I designed my research to progress in three stages to develop multiple lines of evidence upon which to evaluate the efficacy of RBCA. Stage 1 is analysis of graphical trends and simple, descriptive statistics. States provide data to EPA on a semi-annual basis for four primary reporting measures: the number of active USTs, number of cumulative confirmed releases, number of cumulative cleanups initiated, and number of cumulative cleanups completed. Each of these four measures are plotted for each individual state, the national aggregate of all states, aggregate of RBCA states, and aggregate of non-RBCA states. Similarities and differences between the RBCA group and the non-RBCA group are assessed. Trends between groups are compared with the non-RBCA group behavior serving as a baseline from which a RBCA counterfactual is constructed; differences between this counterfactual and observed trend in RBCA group behavior provide a measure of the impact of RBCA.[26] Given that there are 45 RBCA states versus 11 non-RBCA states, aggregate numbers for the RBCA group are much larger than aggregate numbers for the non-RBCA group. Aggregate data for each group are converted to percentages to enable comparison between the two groups. The first year in the interval is used as the baseline and percentage changes are determined relative to the baseline.[27]

Additional stratification of states into smaller groups is also considered to aide in determination of whether members of these smaller groups are more similar to themselves than to members either of other stratified groups or to the larger group as a whole. Two criteria were selected for stratification: (1) size of state population, and (2) number of active USTs in a state (more detailed discussion is presented in section 2.4.1).

[26] A counterfactual is a conditional statement of what could have happened as opposed to what in fact happened. Construction of a counterfactual is necessary to compare behavior prior to some potential causal event with behavior after the event in order to measure the impact of the event. For a more detailed discussion, see Frondel and Schmidt (2005).

Trends for these different strata are then compared against each other and to the larger group; significant differences could indicate that the observed trends are potentially due to factors that may or may not be related to RBCA.

In Stage 2, multiple regression techniques are used to determine if there are statistically significant relationships among certain independent (predictor) variables and the dependent (response) variable. Variables that show promise as predictors (by exhibiting strong correlation) will be the focus of further investigation.[28] Multiple linear regression produces an equation of the form $y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_n x_{ni} + \varepsilon_i$, where: y is the dependent variable; x_1, x_2, and x_n are the independent variables; β_0 is the y-intercept; β_1, β_2, and β_n are the coefficients, and ε is unexplained variation due to factors not included in the model.

To assess both the effectiveness and efficiency of RBCA, two different regression models must be constructed, each drawing from its own dataset. The first model is the effectiveness model and the dependent variable is the cumulative number of cleanups completed; the second model is the efficiency model and the dependent variable is the cost per cleanup completed. The independent variables of interest are the three remaining primary reporting variables (cumulative number of confirmed releases, cumulative number of cleanups initiated, and number of active USTs), plus state population. These were chosen because they represent the measures of program performance that state UST

[27] The percentage of the first (baseline) year is set equal to 1. Subsequent values are greater than 1 when the next data point exceeds the value of the baseline, and less than 1 when the next data point is less than that of the baseline.

[28] Correlation, however, even if perfect does not necessarily indicate causation. There are likely several additional factors (confounding variables) not accounted for by any given regression model, and in fact there may be many that are unknown and/or unknowable.

programs currently collect (so they are available for analysis) and assessment of their utility should be of interest to program managers. During this second stage, additional independent variables are also tested including percentage of population using groundwater for drinking water, and commitment to environmental protection as measured by the League of Conservation Voters (described in detail in Section 2.3.4 below). Because cost data are not available for every year during the period of interest nor for all states[29], the efficiency model data set is a subset of the effectiveness model data set.

For both of the two models all of the independent variables are used in every possible combination; this is referred to as an "all possible subsets" regression study. [30] To illustrate the relationships between the number of combinations and number of independent variables, design matrices for models with 5 potential independent variables (thus 32 possible combinations) and 6 independent variables (thus 64 possible combinations) are presented in Appendix A. Initially all available potential independent variables will be tested in each regression model, only those variables that are statistically significant will be retained for statistical modeling.

The "goodness of fit" of the regression model to the data is measured by the coefficient of determination (R^2), which indicates the fraction of the variation in the dependent variable that is explained by the fitted equation; the remainder is random error.

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[29] The period for which continuous cost data are available is from 1999 to 2009, but only 19 of the 52 states have continuous cost data for this period. States without a continuous record of cost data cannot be used.
[30] Though the number of possible combinations is actually 2^p, this includes the trivial case where there are no independent variables in the equation. In this case the equation is $y = \beta_0$, which is merely a constant, meaning that the regression line is horizontal (i.e., slope equals zero) and thus x values do not provide any information about y. There are, therefore, 2^p-1 useful runs.

The value of R^2 ranges from 0 (no correlation) to 1 (perfect correlation), though it is usually expressed as a percentage. Because the value of R^2 increases with increasing number of independent variables, the fit can be improved simply by adding more variables to the equation even if they do not contribute useful information to the model (that is they are insignificant in predicting the value of y). While it is not my intent to artificially inflate the value of R^2, it is important to include (and thus control for) all the available independent variables that are significant in explaining the dependent variable. The value R^2-adjusted is used to account for the number of variables included in the regression model (so that models with different numbers of independent variables may be compared) and as it is usually lower than R^2, it is a more rigorous measure of goodness of fit. The value of either R^2 or R^2-adjusted that is considered to represent a good fit is not prescribed, but the higher the value the less the unexplained variation in the model. The value of R^2 (or R^2-adjusted) is not the only assessment of fit; the F statistic is also used to assess whether one or more independent variables contributed useful information to the model.[31]

It is possible that the relationship between the dependent variable and one or more independent variables is more closely approximated by a non-linear rather than linear equation. A non-linear equation is produced by either adding curvature to the model or transforming curved data so that it is linear. The least squares regression approach can be used to evaluate the fit of such a model as it allows for model variables to be functions of

[31] A table of the F-distribution can be found in virtually any statistics textbook or on numerous web sites. For example, StatTrek's web site provides an F distribution calculator (see *http://stattrek.com/Tables/F.aspx*).

other variables as long as they do not include unknown parameters. Two common models of non-linear equations are polynomial and interaction models. Polynomial models include independent variables and powers of these variables. A familiar example is the quadratic equation, which includes squares of variables (and is thus a second order equation). A cubic equation (third order) includes both squares and cubes of one or more variables; however, the instances where these models are applicable are rare. Interaction models include products of various combinations of independent variables as well as the individual variables themselves. To provide for the possibility that interaction effects are important, plausible interaction terms are included in the analysis. The most familiar data transformation is logarithmic (either natural or common). Log transformed data often plot as a straight line, which simplifies the equation and statistical analysis, but makes interpretation and explanation of the results more complicated.

Finally, in Stage 3, using the set of independent variables identified as being the most significant during Stage 2, the state-specific impact of RBCA (both for effectiveness and efficacy) in each individual state (this is now the unit of analysis) is determined using statistical modeling. Statistical modeling also uses multiple regression models, but because the relationships among variables are more complex, significantly more variables are required and the resulting model is more complex. In addition to the independent variables determined to be significant in Stage 2, matrices of dummy (categorical) variables are used to control for individual differences between states, and RBCA implementation during specific years in each state, so that differences due to RBCA can be identified. The regression model has the form $y_i = \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots +$

$\beta_n x_{ni} + \beta_A A_i + \beta_B B_i + \beta_C C_i + \varepsilon_i$, which is similar to the regression model developed during Stage 2. As before, y is the dependent variable; x_1, x_2, and x_n are the primary independent variables; β_1, β_2, and β_n are the coefficients of the primary independent variables, and ε is unexplained variation due to factors not included in the model. The terms A, B, and C represent matrices of dummy (categorical) variables, and β_A, β_B, and β_C are the coefficients for the respective matrix. This model differs from the simpler regression model in four significant ways: (1) there is no overall intercept term (β_0), (2) each state has its own intercept term ($\beta_A A$), (3) there is a baseline (pre-RBCA) term for each state ($\beta_B B$), and (4) there is a post-RBCA term for each RBCA state ($\beta_C C$). For RBCA states, this model produces two line segments: the first part represents modeled cumulative number of cleanups completed during the pre-RBCA period, and the second part represents modeled cumulative number of cleanups completed during the post-RBCA period. If RBCA has a positive impact in a given state, then the line segment following RBCA implementation will have a steeper positive slope (or potentially a less negative slope) than the pre-RBCA segment. If RBCA has no impact there would be no difference in slope between the pre- and post-RBCA implementation periods. If RBCA has a negative impact, the post-RBCA line segment will have a less-steep positive slope (or perhaps even a negative slope). For non-RBCA states the C-matrix is all zeros (i.e., there is no post-RBCA term) and there is only one line segment, which represents the baseline trend in cumulative cleanups completed.

Because there is no overall intercept, no value of R^2 (or R^2-adjusted) is calculated. Instead, the parameter S is calculated, which is the standard error of the estimate. Since S is in the same units as the dependent variable, the lower the value of S, the less error there is in the fitted values and the better the fit of the model.

2.2 Data Sources

For reasons of accountability, transparency, and reproducibility, my intention is to use only data that are publically available. These data are obtained from the following sources:

1. tank-specific data (number of active USTs, cumulative number of confirmed releases, cumulative number of cleanups initiated, and cumulative number of cleanups completed) from EPA's Office of Underground Storage Tanks (OUST) web site at h*ttp://www.epa.gov/oust/cat/camarchv.htm*,
2. cost of cleanup information (state fund balance, state fund obligations, costs per site, cost per cleanup completed) from the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) State Funds Task Force web site at*ttp://www.astswmo.org/publications_ tanks.htm*,
3. state population data from the U.S. Bureau of the Census web site at *http://www.census.gov/popest/ estimates.html*,
4. the strength of a state's commitment to environmental protection is derived from annual "Environmental Scorecards" produced by the League

of Conservation Voters, which are available at *http://lcv-ftp.org/scorecard09/ scorecard_archives.htm*, and

5. groundwater use for drinking water supplies from EPA's Office of Water web site "How to Access Local Drinking Water Information", more specifically under "Annual Public Water System Statistics" (see *http://water.epa.gov/scitech/datait/databases/drink/howtoaccessdata.cfm*).

Data obtained from the sources listed above provided quantitative input for analysis. In May through June, 2009, I attempted to contact all 56 state UST programs to determine which states were implementing RBCA and which states were not. I ultimately received responses from 53 state programs (I received no response from the territories of American Samoa-AS, Commonwealth of Northern Marianas Islands-CNMI, or Guam-GU). Eight state programs (KY, MS, NY, Puerto Rico-PR, Virgin Islands-VI, VT, WI, WY) indicated that they did not implement RBCA in their UST program; the remaining 45 states indicated that they did implement RBCA. These results were used to form the two comparison groups.[32] The distribution of states into their respective comparison groups is presented in Table 2.

As my investigation progressed, I felt that I needed additional information to better understand some of the nuances of how the states view RBCA and how their decisions to implement or not implement RBCA influence program effectiveness and efficiency. In January 2011, I interviewed UST program representatives from 6 states without RBCA programs (KY, MS, NY, VT, WI, and WY) to find out why they opted to

Table 2. Distribution of States into Their Respective Comparison Groups: RBCA versus Non-RBCA.

EPA Region	RBCA	Non-RBCA
1	CT, MA, ME, NH, RI	VT
2	NJ	NY, PR
3	DC, DE, MD, PA, VA, WV	
4	AL, FL, GA, NC, SC, TN	KY, MS
5	IL, IN, MI, MN, OH	WI
6	AR, LA, NM, OK, TX	
7	IA, KS, MO, NE	
8	CO, MT, ND, SD, UT	WY
9	AZ, CA, HI, NV	
10	AK, ID, OR, WA	
States organized by EPA Region.		

[32] The Non-RBCA comparison group was ultimately comprised of 7 of these states (KY, MS, NY, PR, VT, WI, WY), as data for VI was found to be inadequate for analysis.

not implement RBCA and if they were considering adopting RBCA in the future. I also interviewed UST program representatives from 6 states with RBCA programs (MO, NE, WA, IL, OH, and SC) to obtain information relating to the reasons why the state opted to either adopt RBCA or not adopt RBCA; whether the program could document whether RBCA produced any cost savings; and whether RBCA resulted in more cleanups being completed. I also sought information on the percentage of sites that were closed based on some criteria other than risk or a cleanup standard, whether RBCA resulted in more sites using monitored natural attenuation (MNA) or institutional controls, and whether the state was considering any changes to their program (e.g., adopting RBCA if they had not already done so; making changes/improvements to existing RBCA programs).

2.3 Data Limitations

Ordinary least squares (OLS) regression modeling is often premised on the assumption that the error terms are independent identically distributed (IID) normal random variables. However, when OLS is used for descriptive modeling purposes, this assumption is often violated, and even when some statistical inferences are desired, the inference techniques commonly associated with OLS are generally robust to violations of the IID normal error terms assumption. The data available for my analysis, in addition to specific issues discussed in greater detail in the following paragraphs, have two general limitations: (1) they are not selected randomly and (2) they may not be from a normal distribution. For my research purposes it is more likely that poor data quality (i.e., uncertainties and inconsistencies) will overwhelm potential issues arising from nonrandomness or non-normality (this is discussed in greater detail in the Results section).

2.3.1. UST Program-Specific Data. States report measures of program progress to their respective EPA regional office, which then provides the OUST with the numbers after they have been checked for accuracy. These measures are referred to as "Performance Measures".[33] Of the measures reported, four are of particular interest to this investigation and I refer to them as primary reporting measures. Formal definitions of these four measures are:

- <u>number of active USTs</u>: *The number of active Subtitle I regulated petroleum UST systems registered with the State added to the cumulative number of closed petroleum UST systems. This measure does not include exempt or deferred UST systems.*[34]
- <u>number of confirmed releases</u>: *The cumulative number of incidents (not UST systems) where the owner/operator has identified a release from a Subtitle I regulated petroleum UST system, reported the release to the state/local or other designated implementing agency and the state/local implementing agency has verified the release according to state procedures such as a site visit (including state contractors), phone call, follow-up letter, or other reasonable mechanism that confirmed the release.*

[33] Definitions of all program-related performance measures and serial reports are accessible on OUST's web site at http://www.epa.gov/oust/cat/camarchv.htm
[34] See Table 1.

- number of cleanups initiated: *The cumulative number of confirmed releases at which the state or responsible party (under supervision as designated by the state) has evaluated the site and initiated 1) management of petroleum-contaminated soil, 2) removal of free product (from the surface or subsurface environment), 3) management or treatment of dissolved petroleum contamination, 4) monitoring of the groundwater or soil being remediated by natural attenuation or 5) the state has determined that no further actions are currently necessary to protect human health and the environment.*
- number of cleanups completed: *The cumulative number of confirmed releases where cleanup has been initiated and where the state has determined that no further actions are currently necessary to protect human health and the environment. This number includes sites where post-closure monitoring [has been discontinued] as long as site-specific (e.g., risk-based) cleanup goals have been met. Site characterization, monitoring plans, and site-specific cleanup goals must be established and cleanup goals must be attained for sites being remediated by natural attenuation to be counted in this category.*

These are currently reported on a semi-annual basis, though from 1988 through 1995 they were provided quarterly. All data provided by the states are reported as cumulative beginning from 1988 (the first year data were required to be reported to EPA). I originally planned to use semi-annual data so as to provide additional data points and, hence, greater statistical power; however, mid-year data frequently were found to be inconsistent with year-end data. One of the reasons for this is that many states provide "estimates" at mid-year and focus on reporting actual numbers at year-end. Annual numbers for various performance measures (i.e., confirmed releases, cleanups initiated, and cleanups completed) are calculated by subtracting a prior year's cumulative number from a given year's cumulative number.[35] I found that even year-end data contain errors, though the errors are not always obvious until annual numbers are calculated. In theory, the annual number should be the difference in the current cumulative number and the previous cumulative number. However, this calculation frequently results in a negative annual number, which means that the state corrected for erroneous data reported during a prior reporting period (or possibly more than one prior reporting period).[36] My initial attempts to adjust obviously anomalous data only added additional uncertainty as it was not possible to determine either exactly when the original error—or errors—occurred or the magnitude of individual errors if they occurred in different years.[37] Data for 4 territories—AS, CNMI, GU, and VI—are unusable due to inconsistency and incompleteness; therefore, these data are deleted from further analysis. Excluding these territories will not have a significant impact since combined they account for only a small

[35] Though it is not impossible to compute annual numbers for active USTs, it is not necessarily meaningful as the computed numbers would all be negative because the trend from the beginning of program is downward as each year more old USTs are closed than new ones installed.
[36] Cumulative numbers are monotonically increasing (either strictly so, meaning that they always increase or are at least non-decreasing, meaning that there may be some instances where adjacent numbers are the same); they can never decrease (e.g., it is not possible to have a negative number of cleanups completed from one year to the next).
[37] My data correction scheme was to interpolate between the previous and following year's value and then subtract the sum of the interpolated value and the absolute value of the original negative value from all of the preceding annual entries in the same relative proportion as was initially reported. This kept the distribution of the annual values the same and kept the cumulative totals the same for the years following the "correction".

percentage of the universe of regulated USTs (less than one-tenth of 1 percent). The data set (including state population) that I used for my analysis is presented in Appendix B.

During initial data analysis, I also recognized that three characteristics of the entire data set would complicate analysis and interpretation of the results. First, during the initial few years of data reporting (1988 through 1990) most states were just beginning to implement their UST programs and many states did not submit any data.

Second, during the several years following program implementation, states were still grappling with the challenges of identifying all regulated tanks within their jurisdiction. During this period (1990 through 1993 to 1998, depending on the state) reported numbers fluctuate, sometimes wildly, as states' inventories of tanks rapidly increase as owners and operators notified state agencies of the presence of their USTs, and as states were sorting through their inventories to report only federally-regulated USTs (states can elect to regulate more—or fewer—tanks than does EPA). It was also during this period that two confounding factors came into play that influenced how state programs were implemented—especially in the numbers of releases confirmed, cleanups initiated, and cleanups completed—and the number of tanks in their inventories: (1) although only seven states had adopted RBCA as of 1993, the pace of adoption averaged nearly 4 states per year from 1995 through 2004 (Table 3), and (2) the 1998 deadline for UST upgrading or removal of substandard USTs resulted in closure of a significant number of USTs beginning a few years prior to the deadline and continuing through 1999 (or later).

Table 3. RBCA Implementation by Year (1985 through 2009).

Year	State(s) Implementing	Annual Number of States Implementing	Cumulative Number of States Implementing
1985	MD	1	1
1986		0	1
1987		0	1
1988		0	1
1989	VA	1	2
1990		0	2
1991	WA	1	3
1992	TN	1	4
1993	MA, ME, NJ, TX*	4	8
1994		0	8
1995	AR, CA, HI, MI, MN, SC, SD, UT	8	16
1996	CT, GA, NH, NV, OK, OR	6	22
1997	FL, IA, IL, PA, RI, WV	6	28
1998	AL, MT, NC	3	31
1999	AK, CO, NE, OH	4	35
2000	DE, LA, NM	3	38
2001	DC, IN	2	40
2002	AZ, KS, ND	3	43
2003		0	43
2004	ID, MO	2	45
2005		0	45
2006		0	45
2007		0	45
2008		0	45
2009		0	45

* - TX initially implemented RBCA in 1993 and expanded the program in 1997 (Connor and McHugh, 2002).

KY, MS, NY, PR, VT, WI, and WY have never implemented RBCA.

Third, beginning about 1999, the number of active USTs began to slowly and steadily decrease in contrast to steep decreases during the period from 1991 through 1999. The rates of increase in cumulative confirmed releases, cleanups initiated, and cleanups completed all exhibit a relatively steady, gentle decline for the period from 1999 through 2009 as compared to the earlier time period. Figures 2 and 3 illustrate the three characteristics just described. Figure 2 shows the national cumulative number of active USTs for the period 1988 through 2009. The years in the circle identified by the letter "A" correspond to the first characteristic described above (i.e., initial startup period of state UST programs). The line identified by the letter "B" corresponds to the second characteristic described above (i.e., period of program adjustment and pre-1998 deadline volatility). (Note that this period is highly variable from state to state, plots of which are provided in Appendixes B, C, D, and E for number of active USTs, cumulative number of confirmed releases, cumulative number of cleanups initiated, and cumulative number of cleanups completed, respectively.) The line identified by the letter "C" corresponds to the third characteristic described above (i.e., program stability and maturity). Figure 3, which is annotated in the same manner as Figure 2, shows the numbers of cleanups completed. Graphs of cumulative numbers of confirmed releases and cleanups initiated are similar to Figure 3. From these two representative plots, it is apparent that two very different mechanisms are at work during these two time periods and the data in their entirety cannot accurately be represented by a straight line or even a smooth curve. The inflection point is within a year or two of the 1998 deadline (which in itself is a likely confounding factor). Perhaps not unrelated is the fact that through 1998 more than 66%

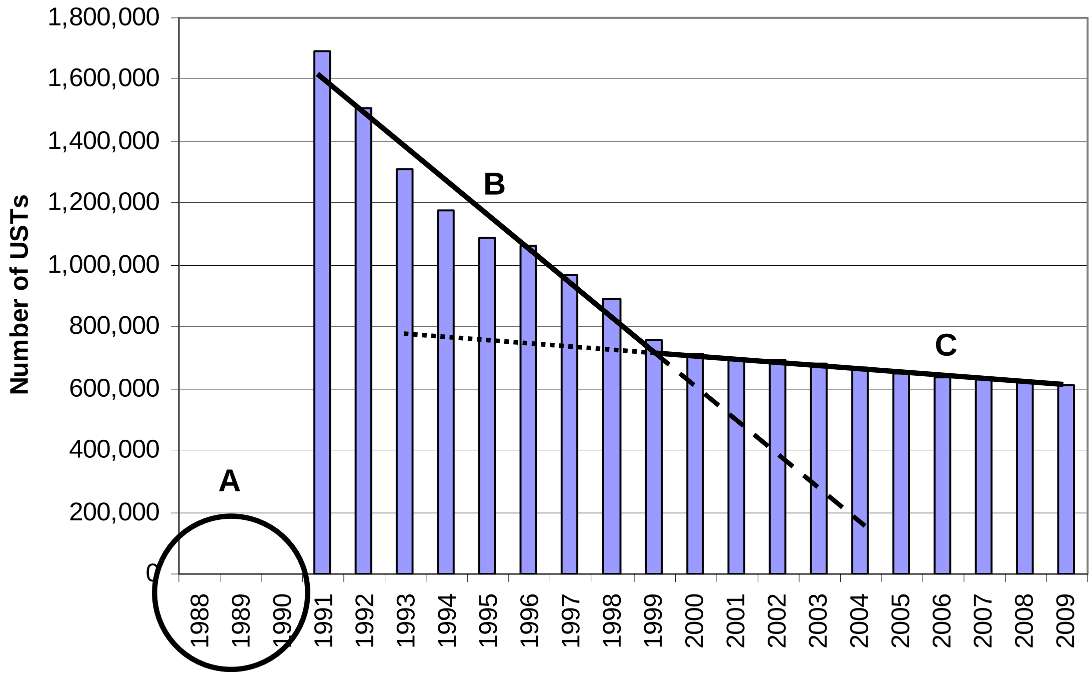

Figure 2. Identification of Distinctive Periods in Trends of National Number of Active USTs from 1988 through 2009.

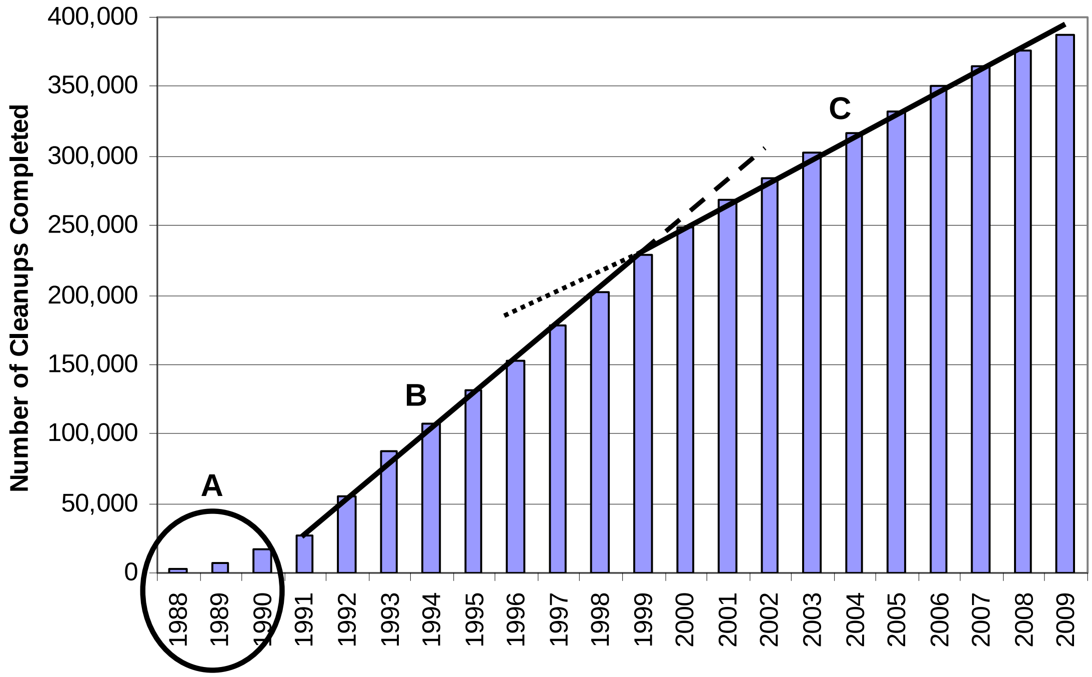

Figure 3. Identification of Distinctive Periods in Trends of National Cumulative Number of Cleanups Completed from 1988 through 2009.

of the states that would eventually adopt RBCA had done so, and through 1999 the number exceeds 75% (see Table 3). In order to simplify the graphical trend analysis conducted during Stage 1 it is, therefore, reasonable to exclude years prior to 1999 from the analysis, which results in simpler, linear trends.

For regression analysis conducted in Stages 2 and 3, multiple regression modeling is necessary to determine relationships among multiple variables, and it is capable of handling non-linearity in the data set. Depending upon the nature of the non-linearity, curvature may need to be added to the model through data transforms or other means.

2.3.2. Cost of Cleanup Information. Cost data are more disparate than other program data. Data on cost of cleanups in individual states is only available beginning with 1997, and these data are less complete and more uncertain than tank-specific data. Cost data are only available for the 50 states, not DC or the 5 territories. There are no state-specific data for 1998. Two or more years of cost data are missing for 25 states. Only 19 states have data for each year between 1999 and 2009: of these, 15 are RBCA states and 4 are non-RBCA states (Table 4). Given the large variation between states, and sometimes from year-to-year within the same state, there is some uncertainty as to whether in fact states are adhering to the same set of definitions and accounting standards when calculating the total cost to cleanup leaking UST sites. Further uncertainty in the comparability of cost data is introduced by state-imposed caps on expenditures at cleanup sites; thus these data do not represent a continuous function. Costs vary considerably from state to state and even within the same state due to factors such as complexity of the hydrogeology, volume of contamination released from the UST, type of contaminants

Table 4. States in the RBCA Comparison Group and the Non-RBCA Comparison Group with Continuous Cost Data Over the Period 1999 through 2009 Required for the Efficiency Assessment.

EPA Region	RBCA	Non-RBCA
1		VT
2		
3	DE	
4	AL, GA, SC, TN	KY, MS
5	MI, OH	WI
6	AR, LA, OK, TX	
7	MO	
8	SD, UT	
9		
10	WA	

States organized by EPA Region.

released, cleanup standards, and local differences in costs for labor and materials. Cost data also only account for public expenditures; additional amounts spent by UST owners are not represented in these data. Finally, these data are submitted on a voluntary basis by the states and not all states practice the same degree of rigor in their calculations.

The available cost reports provide a reported aggregate annual average cost per site at closure (these figures are generally accepted and used in other studies). However, exactly how these cost figures are determined is not known, as they apparently are not calculated from the annual data for each state published by ASTSWMO. The annual average costs calculated from the annual data are not exactly the same as reported aggregate annual average costs. Fortunately, the difference between these cost figures is relatively small (the average annual difference is less than 2%, the maximum annual difference is approximately 6%), and their general pattern during the period from 1999 to 2009 is similar to the national aggregate (in only one year—2005—is the reported aggregate average greater than the calculated average; see Figure 4). This indicates that the abridged set of cost data can be considered to be a reasonable representation of reported costs, and can be used in the current analysis (with the understanding that these data are not perfect, but they are the only data available). Also, it is convenient that the period (1999-2009) for which complete cost data are available (even if for only 19 states) corresponds to the period for which tank-specific data are available.

2.3.3. Population Data. State population counts based on actual census data are available, strictly speaking, only for census years (i.e., every 10 years on the decadal year). Population counts for the intervening years are considered by the Census Bureau to

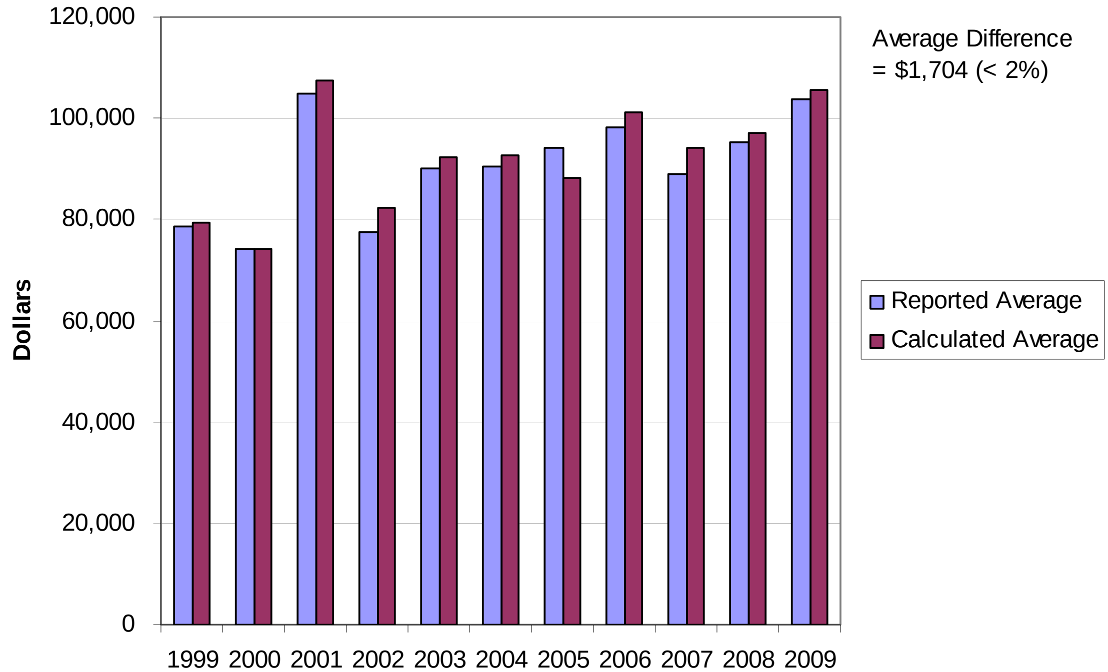

Figure 4. Comparison of Reported Average Cost per Site at Closure versus Calculated Average Cost.

be estimates. These estimates are reported as being for July 1st of each year. Census data and annual estimates are available only for the 50 states, the District of Columbia, and for Puerto Rico (they are not available for the 4 territories: AS, CQ, GU, VI). Population data for the period 1999 through 2009 were used in the final analysis.

2.3.4. State Commitment to Environmental Protection. Data relating to a state's commitment to environmental protection were derived from "Environmental Scorecards" produced by the League of Conservation Voters. These data are comprised of a numerical score (expressed as a percentage) based on each state's congressional delegation's (both House and Senate) support for, or opposition to, congressional bills supported by (or opposed to) by the League. Perfect correspondence between the League's position of support (or opposition) and a member of the state's delegation's (either House or Senate) position on all of the bills brought to a vote during the year would earn that state's delegate a rating of 100%. A state's score was calculated as the average of all the delegation's members' (both House and Senate) scores. Preliminary graphical and statistical analyses revealed no meaningful correlation between these scores and the other variables considered, thus these data were not used in the final analysis.

2.3.5. Groundwater Use for Drinking Water. Data relating to groundwater use for drinking water supplies were obtained from EPA's Office of Water web site. These data reports, "FACTOIDS: Drinking Water and Ground Water Statistics", provide a breakdown by state of the number of people provided with drinking water from both surface water and groundwater sources. The most recent year for which these data are available is 2008. Because groundwater use for drinking water logically could be an important factor influencing decisions whether or not to cleanup leaking UST sites, special data sets for the period from 1999 through 2008 (instead of through 2009) were created and analyzed. Though these data exhibit some degree of correlation with other variables when compared pair-wise, they were not statistically significant in multiple linear regression analysis and were dropped from further analysis.

2.3.6. Interviews with Representatives from Selected State UST Programs. The principal finding from my interviews with program representatives from 6 *non*-RBCA states is that the answer to the question "Does your state have a RBCA program?" depends on how the respondent views his/her program compared to ASTM's RBCA. Most states today include consideration of risk as one criterion (of typically several criteria) when making decisions about cleaning up contamination at a leaking UST site. States differ on whether they consider their own "risk-based" program to be "RBCA". Some states adhere to a strict distinction between "RBCA" (often reserved for programs that are "ASTM RBCA") as opposed to being risk-based. Other states have hybrid programs, wherein some cleanup decisions are risk-based (e.g., soil clean up levels) while others are based on uniform standards (e.g., groundwater cleanup standards in states with statutory mandates for non-degradation of groundwater resources[38]). Still other states may have elements of ASTM RBCA (e.g., the three-tiered approach), yet they may not be exactly the same; in fact, many states have modified the original ASTM approach, customizing it to their own unique needs. Another example is that in some states application of a risk-based approach to a specific cleanup may be voluntary on the part of the party responsible for cleaning up the site. Highlights of these interviews are summarized in Table 5 for the 6 non-RBCA state programs.

The blurry line between RBCA and non-RBCA, but risk-informed or risk-based, programs presents a dilemma for partitioning states into RBCA or non-RBCA groups. I attempted to resolve this dilemma by referring to the paper by Rifai and Suarez (2000) in which 49 states were identified as having RBCA programs and seven were described to have "abstained" (AS, CZ, GU, MD, ND, NV, and VT). Besides the three territories (for which data are inadequate for analysis, and I omitted from further consideration), VT is the only state in common between my distribution and that of Rifai and Suarez. Since my findings are more current, and the result of person-to-person interviews with program officials, I used my own results for all subsequent analyses.

Interviews with representatives from UST programs in RBCA states are summarized in Table 6. These results reveal a high degree of variability from state-to-state. States were able to provide qualitative responses but no quantitative statistics. State databases typically contain a lot of information on a site-specific basis, but in many/most cases, the data relating to cleanup process and status are not sufficiently detailed.[39]

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[38] State programs with groundwater standards generally do not consider themselves to be RBCA states, even though the standards are based on some sort of risk-based criteria.

[39] The OUST is in the process of completing a study of the cleanup backlog in 14 states, each of which provided their leaking UST databases for analysis. None of the 14 databases were sufficiently detailed (in terms of accuracy and completeness) to enable determination of the presence of specific contaminants of concern or type of remediation technology deployed (or even whether passive or active in most cases). One state could provide information on the presence of free product. Four states could provide information on whether sties were closed with institutional or engineering controls. Eight states could provide information on site cleanup priority.

Table 5. Characteristics of State Cleanup Programs Based on Interviews with Representatives from Six Non-RBCA State UST Programs (KY, MS, NY, VT, WI, WY).

State	Reasons for not Implementing RBCA	Features of Cleanup Decision-Making	Future Plans for RBCA Implementation
KY	- numerical goals easier to understand/explain - MCLs used for ground-water contamination	- elevated contaminant levels allowed on-site if no off-site migration	Moving toward more inclusive risk-based program, but probably not full ASTM RBCA
MS	- complex legal issues with regard to ground-water contamination (property boundaries, property use restrictions)	- Tier 1 risk tables for soil and groundwater are available on voluntary basis	Trying to integrate RBCA across all waste cleanup programs
NY	- politically untenable - RBCA is information intensive and costly	- sites remediated without regard to risk - among the most stringent cleanup standards in the U.S.	Risk-based decision-making not used in petroleum UST program
VT	- small state, able to adequately address cleanup workload without formal RBCA process	- contaminated groundwater sites must be cleaned up to MCLs	None
WI	- statutory requirements relating to groundwater conflict with RBCA	- state groundwater standards apply to every leaking UST site - soil contamination may use risk tables	None (existing rule-based program is adequate)
WY	- statutory requirements relating to groundwater protection and cleanup	- soil and groundwater must be cleaned up to MCLs - all cleanups are state-led	None
MCL – Maximum Contaminant Level			

Table 6. Impact of RBCA Based on Interviews with Representatives from Six RBCA State UST Programs (IL, MO, NE, OH, SC, WA).

State	Reasons for Implementing RBCA	Documented Cost Savings	Documented Faster Cleanups	Increased Use of ICs or MNA
IL	- cost savings - improve cleanup process	Yes (since the 1996 changes to the RBCA process)	No (but making good progress)	No data
MO	- address growing backlog of sites with contaminated groundwater	No (data kept by separate agency)	No (under RBCA average cleanup time 3 years—believed to be longer prior to RBCA)	- MNA not allowed - ICs used when remedial goals not achieved
NE	- cost savings - faster cleanups	No (but common sense says "yes")	Yes (but initial rate was faster than at present)	- use of MNA discouraged - ICs used rarely
OH	- EPA and industry pushed RBCA	No (but decreased stringency of cleanup should reduce cost)	Yes (shorter time to closure due to reduced stringency of cleanup goals)	ICs used in a "fair number" of cases
SC	- cost savings	Yes (savings of $100,00 to $150,000 per site)	No (but decreased stringency of cleanup goals reduces time to closure)	None (existing rule-based program is adequate)
WA	- improve cleanup process	No (but neither have costs increased)	No (number of sites receiving NFA is decreasing)	Use of MNA requires intensive monitoring

MNA – Monitored Natural Attenuation
IC – Institutional Control
NFA – No Further Action

2.4 Data Analyses

I created data files in MS Excel to facilitate formatting, sorting, and conducting various manipulations and computations for graphical and statistical analyses. I used MINITAB Version 15 by Minitab, Inc., State College, PA, for correlation analysis and multiple linear regression modeling.

2.4.1. Stage 1: Graphical Trend Analysis and Descriptive Statistics. I generated graphs for all 56 states and territories for each of the 4 primary reporting measures defined previously: number of active USTs (see Appendix C), number of confirmed releases (see Appendix D), number of cleanups initiated (see Appendix E), and cumulative number of cleanups completed (see Appendix F). I divided states into two comparison groups: those with a RBCA program and those without. For the effectiveness analysis, the RBCA group is comprised of 45 states and the non-RBCA group is comprised of 7 states (see Table 2).

I assessed RBCA effectiveness in two steps. In the first step, cumulative values for each year of the period of interest (1999 through 2009) for the 4 primary reporting measures were aggregated for all states within their respective group and then the annual percentage relative to 1999 (the base year) was calculated for each subsequent year. These annual percentages were then plotted to determine if there were discernable differences between the RBCA and non-RBCA groups. Figures 5 through 8 present comparisons of annual percentages between RBCA and non-RBCA groups for number of active USTs (Figure 5), number of confirmed releases (Figure 6), number of cleanups initiated (Figure 7), and number of cleanups completed (Figure 8).

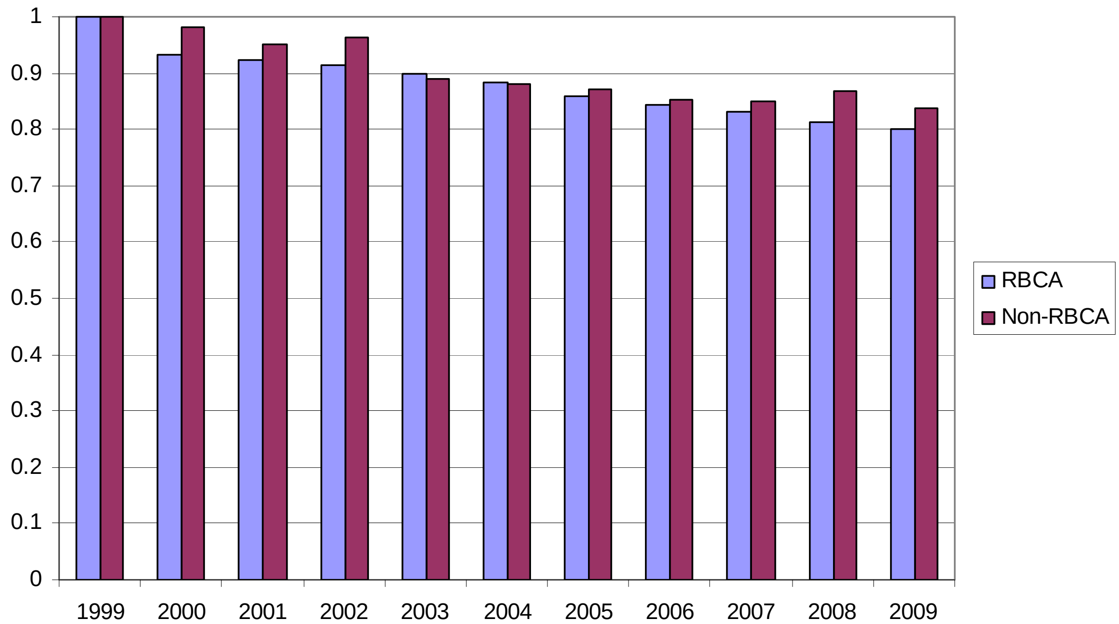


Figure 5. Comparison of Annual Percentages of Number of Active USTs for RBCA States versus Non-RBCA States for the Period 1999 through 2009.

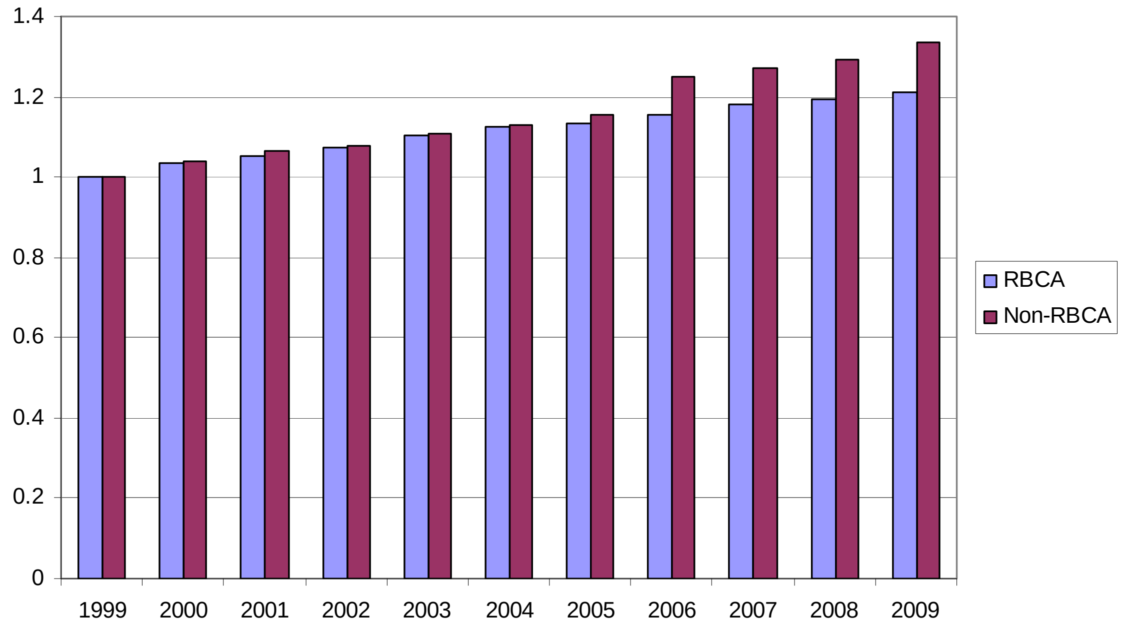


Figure 6. Comparison of Annual Percentages of Cumulative Number of Confirmed Releases for RBCA States versus Non-RBCA States for the Period 1999 through 2009.

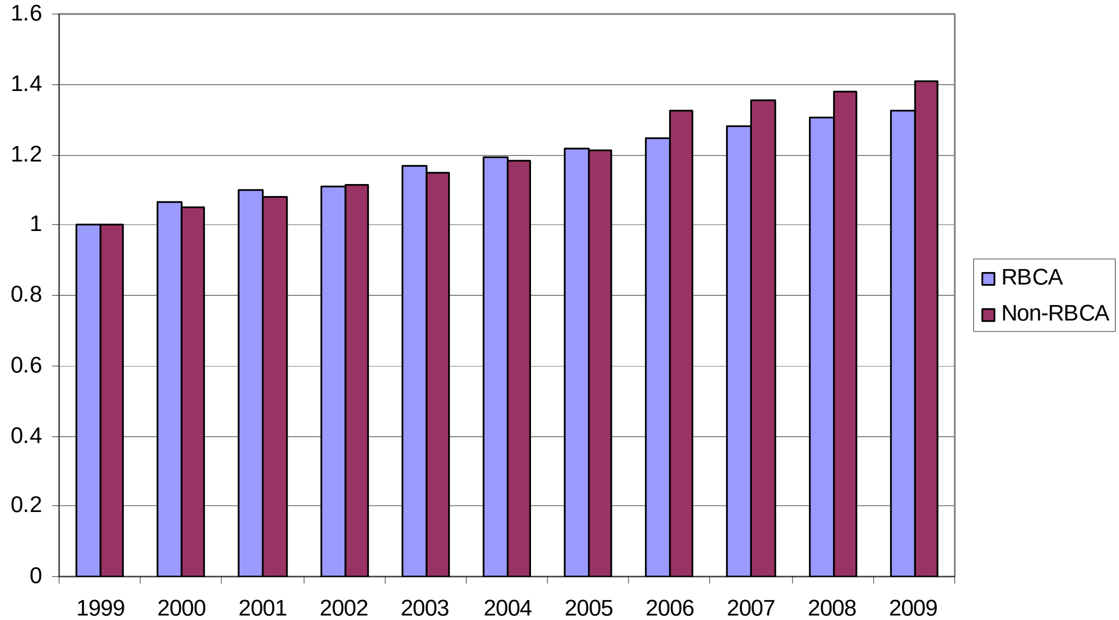


Figure 7. Comparison of Annual Percentages of Cumulative Number of Cleanups Initiated for RBCA States versus Non-RBCA States for the Period 1999 through 2009.

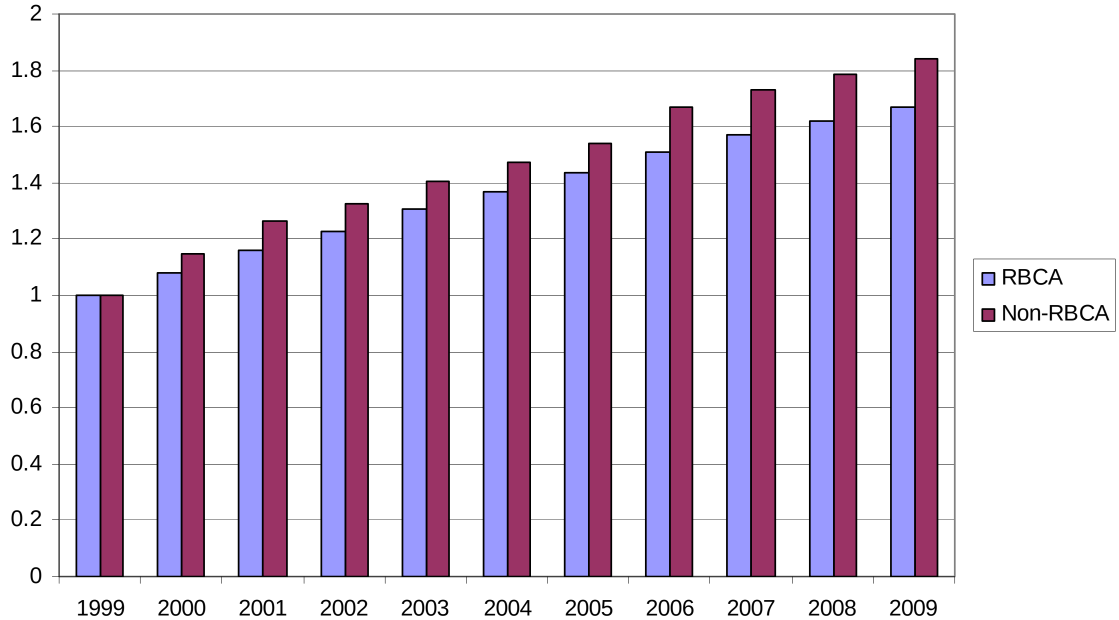


Figure 8. Comparison of Annual Percentages of Cumulative Number of Cleanups Completed for RBCA States versus Non-RBCA States for the Period 1999 through 2009.

In the second step, the annual percentages calculated for the group of non-RBCA states were used to produce a hypothetical distribution (the "counterfactual") of number of cleanups completed for the group of RBCA states, with any difference being attributable to RBCA. In other words, this hypothetical distribution represents the number of cleanups that the RBCA states would have completed had they not implemented RBCA. If the actual number of cleanups completed is greater than the counterfactual number of cleanups completed, then RBCA is deemed effective.

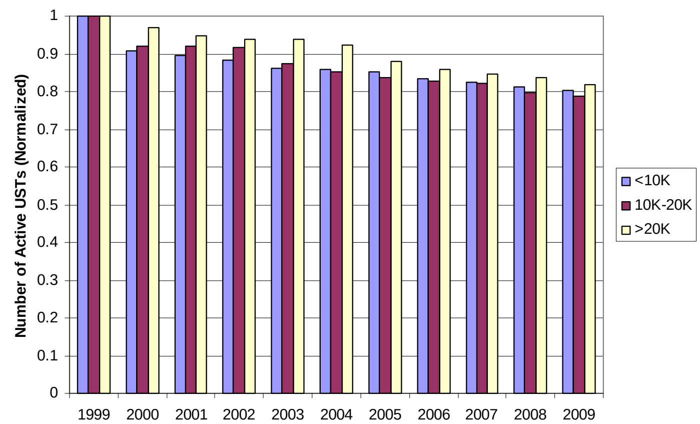
To investigate whether "size" of a state possibly exerts an influence on a state's performance characteristics, states were stratified into smaller groups based on; (1) state population, and (2) number of active USTs. For each of these two groups, three strata were selected (Table 7). States were ordered from largest to smallest and then divided into three groups based on observed clustering rather than establishing arbitrary intervals and then partitioning states into these intervals. This is based on the assumption that states in clusters would be more likely to exhibit characteristics more similar to other members of the cluster than to other states that are dissimilar in size. The problem with this method is that the groups do not contain equal numbers of states. Another problem with further dividing the states into smaller and smaller groups is that the number of states in each group is small, and extreme values (outliers) can have a disproportionately large influence on the characteristics of the group as a whole.

I generated a family of graphs for both stratification groups; state population (Figures 9 through 13), and number of active USTs (Figures 14 through 18). Each family of graphs compares the annual percentages for each year over the interval from 1999

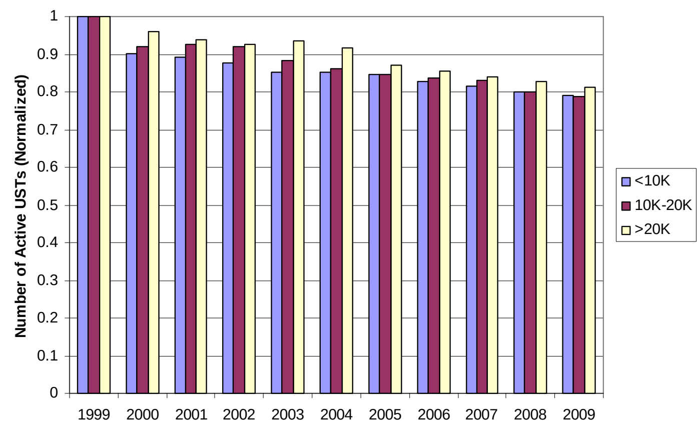
Table 7. Stratification Criteria and Number and States in Each Stratum.

	Stratification Criteria	
	USTs <10,000	**Population <2,000,000**
All States	(30) AK, AR, AZ, CO, CT, DC, DE, HI, IA, ID, KS, MD, ME, MO, MS, MT, ND, NE, NH, NM, NV, OR, PR, RI, SD, UT, VT, WA, WV, WY	(15) AK, DC, DE, HI, ID, ME, MT, ND, NE, NH, RI, SD, VT, WV, WY
RBCA States	(26) AK, AR, AZ, CO, CT, DC, DE, HI, IA, ID, KS, MD, ME, MO, MT, ND, NE, NH, NM, NV, OR, RI, SD, UT, WA, WV	(13) AK, DC, DE, HI, ID, ME, MT, ND, NE, NH, RI, SD, WV
Non-RBCA States	(4) MS, PR, VT, WY	(2) VT, WY
	USTs 10,000 to 20,000	**Population 2,000,000 to 5,000,000**
All States	(13) AL, IN, KY, LA, MA, MI, MN, NJ, OK, SC, TN, VA, WI	(15) AL, AR, CT, IA, KS, KY, LA, MS, NM, NV, OK, OR, PR, SC, UT
RBCA States	(11) AL, IN, LA, MA, MI, MN, NJ, OK, SC, TN, VA	(12) AL, AR, CT, IA, KS, LA, NM, NV, OK, OR, SC, UT
Non-RBCA States	(2) KY, WI	(3) KY, MS, PR
	USTs >20,000	**Population >5,000,000**
All States	(9) CA, FL, GA, IL, NC, NY, OH, PA, TX	(22) AZ, CA, CO, FL, GA, IL, IN, MA, MD, MI, MO, MN, NC, NJ, NY, OH, PA, TN, TX, VA, WA, WI
RBCA States	(8) CA, FL, GA, IL, NC, OH, PA, TX	(20) AZ, CA, CO, FL, GA, IL, IN, MA, MD, MI, MO, MN, NC, NJ, OH, PA, TN, TX, VA, WA
Non-RBCA States	(1) NY	(2) NY, WI

(a)



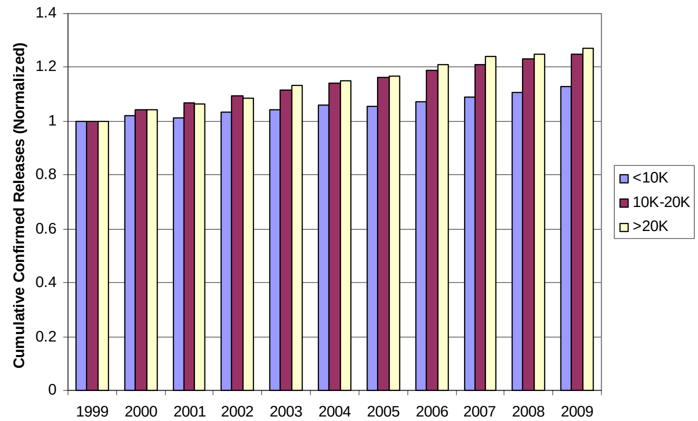
(b)



(c)

Figure 9. Comparison of Annual Percentages of Number of Active USTs for States Stratified by Number of Active USTs: (a) All States, (b) RBCA States, (c) Non-RBCA States.

(a)



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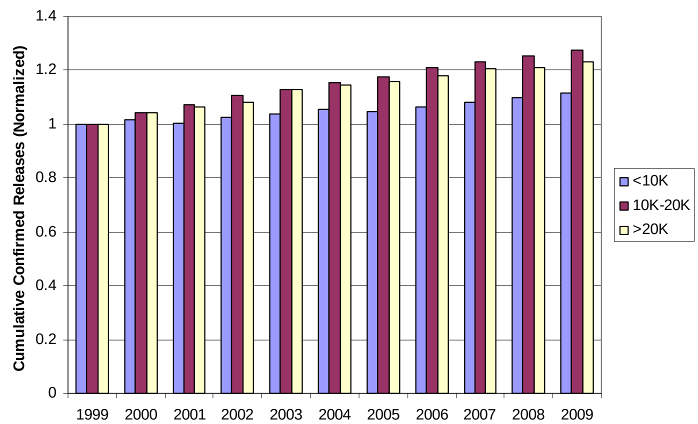


(c)

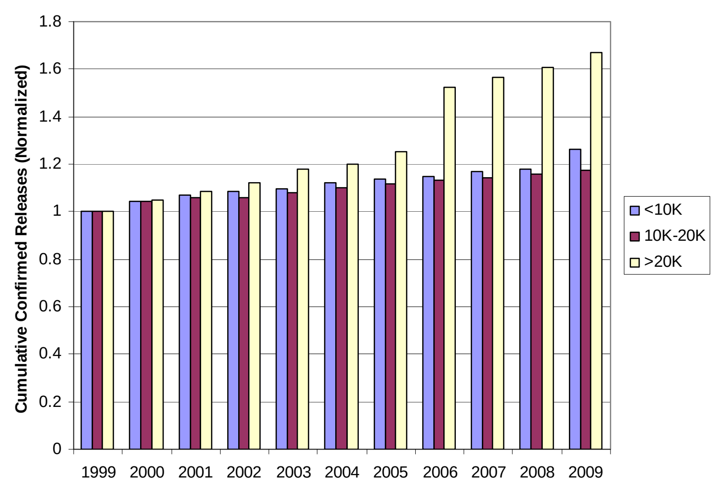
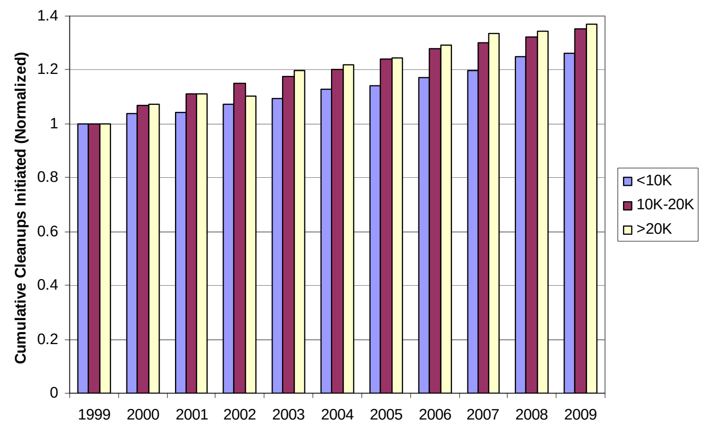
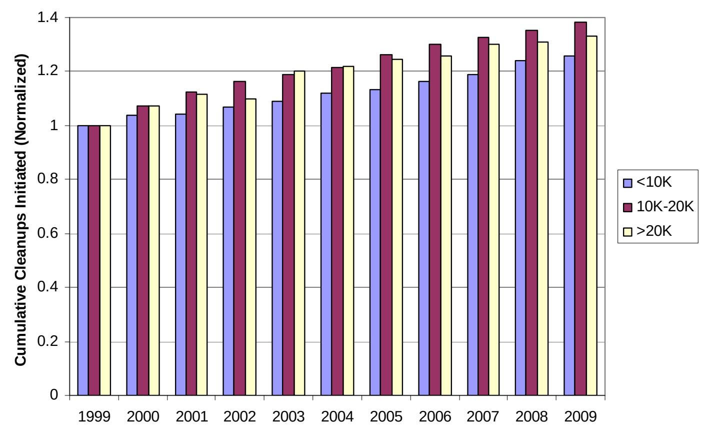


Figure 10. Comparison of Annual Percentages of Cumulative Confirmed Releases for States Stratified by Number of Active USTs: (a) All States, (b) RBCA States, (c) Non-RBCA States.

(a)



(b)



(c)

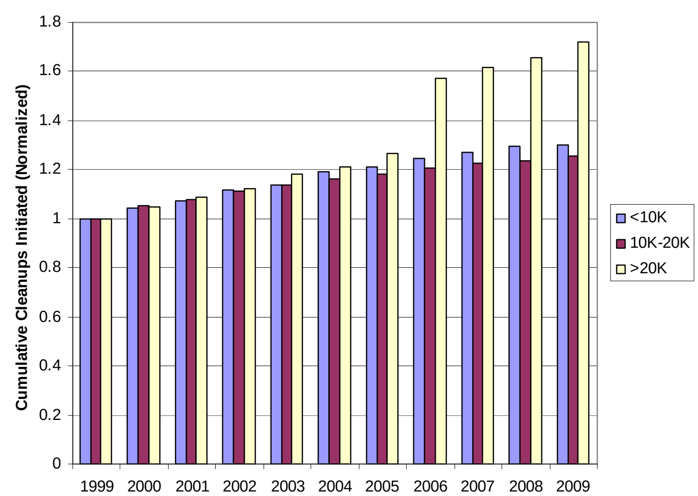
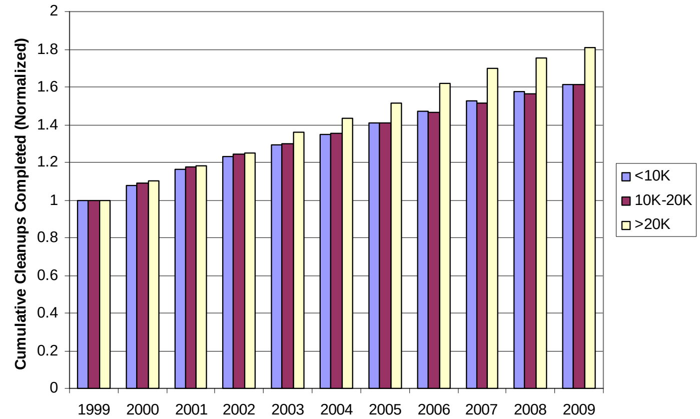
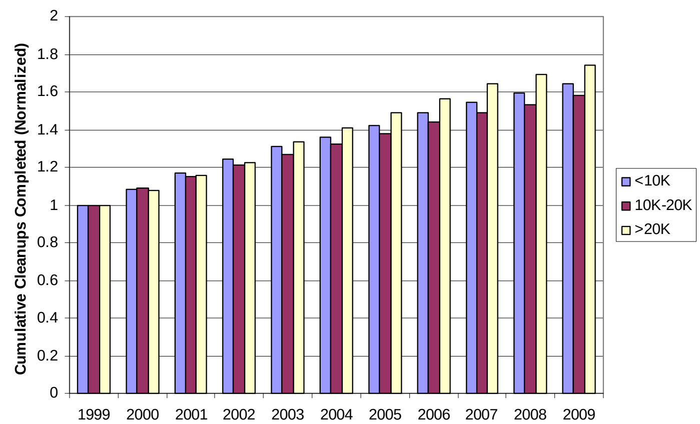


Figure 11. Comparison of Annual Percentages of Cumulative Cleanups Initiated for States Stratified by Number of Active USTs: (a) All States, (b) RBCA States, (c) Non-RBCA States.

(a)



(b)



(c)

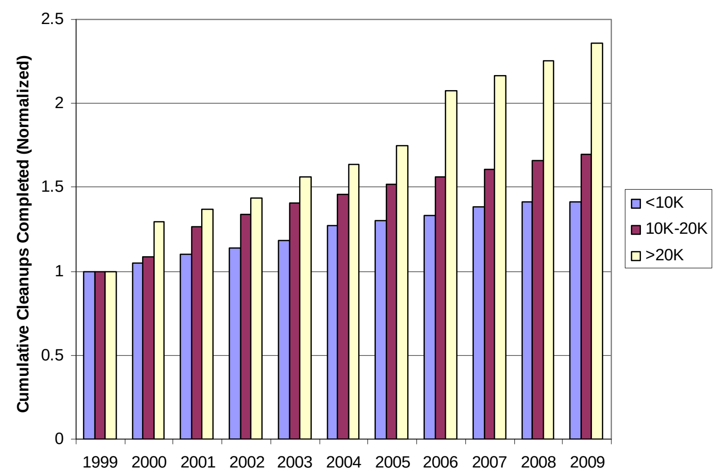


Figure 12. Comparison of Annual Percentages of Cumulative Cleanups Completed for States Stratified by Number of Active USTs: (a) All States, (b) RBCA States, (c) Non-RBCA States.

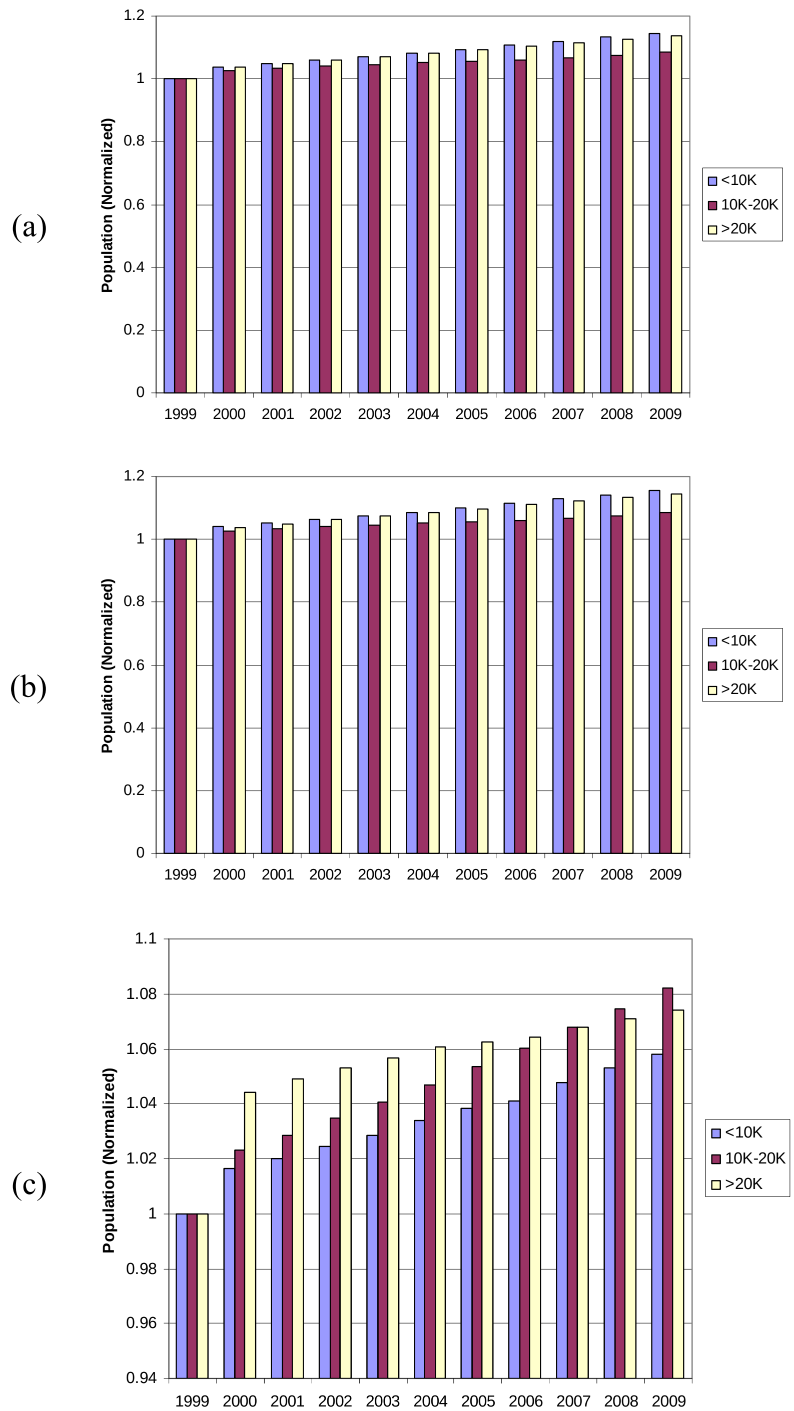
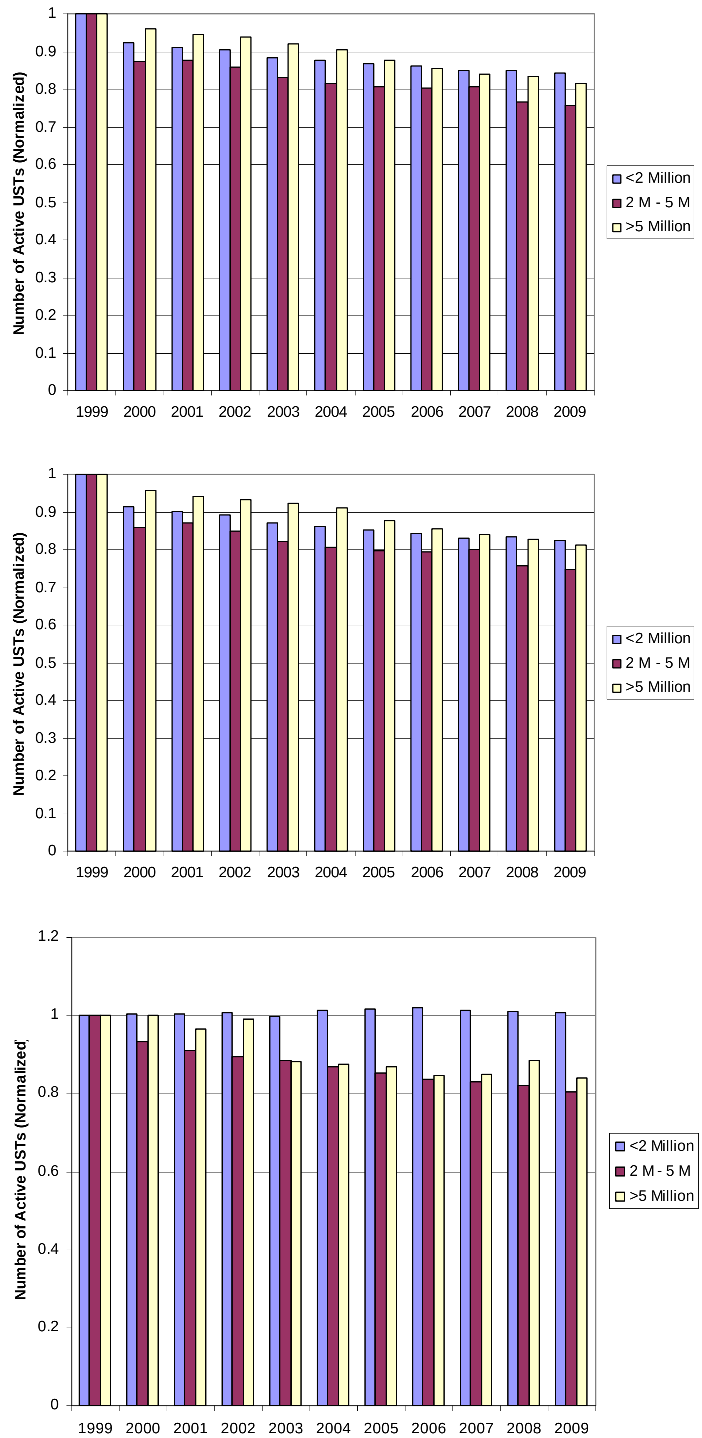


Figure 13. Comparison of Annual Percentages of State Population Stratified by Number of Active USTs: (a) All States, (b) RBCA States, (c) Non-RBCA States.



(a)

(b)

(c)

Figure 14. Comparison of Annual Percentages of Number of Active USTs for States Stratified by Population: (a) All States, (b) RBCA States, (c) Non-RBCA States.

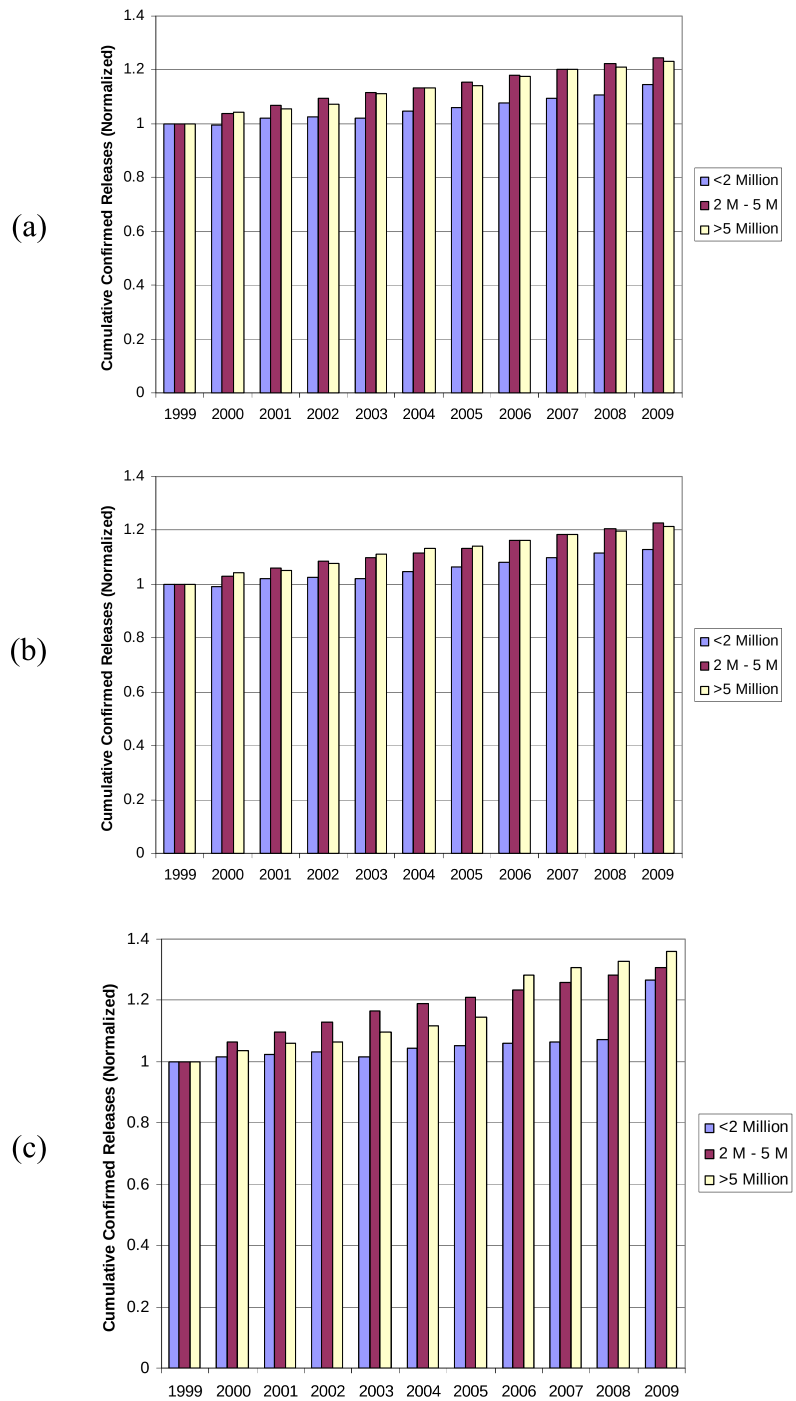
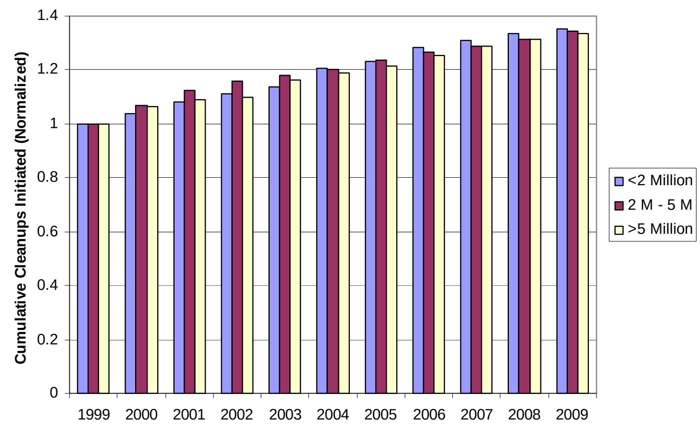
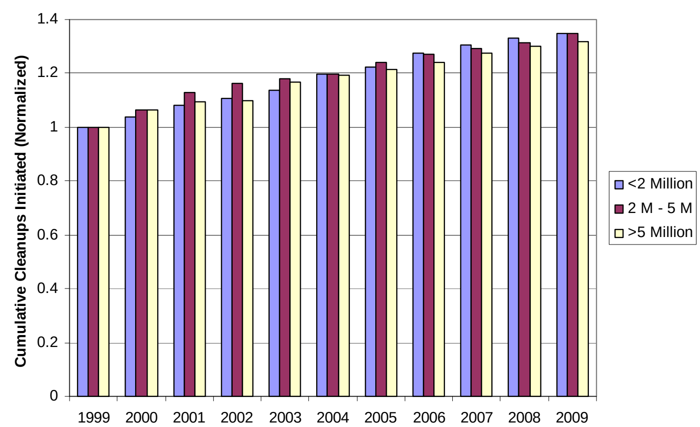


Figure 15. Comparison of Annual Percentages of Cumulative Confirmed Releases for States Stratified by Population: (a) All States, (b) RBCA States, (c) Non-RBCA States.

(a)



(b)



(c)

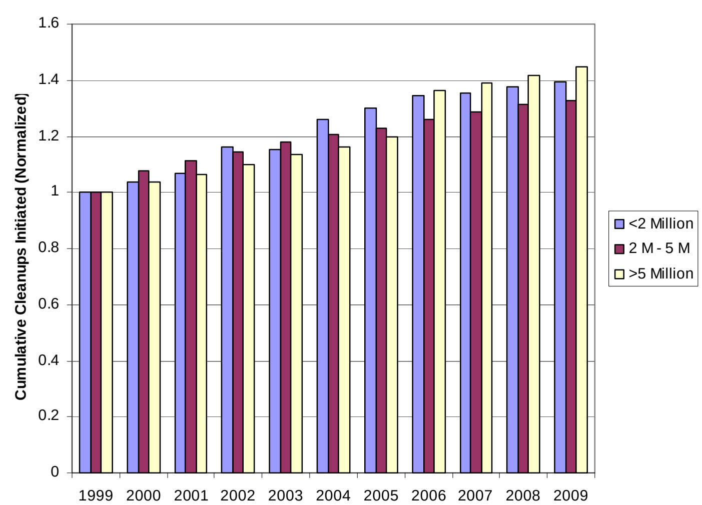


Figure 16. Comparison of Annual Percentages of Cumulative Cleanups Initiated for States Stratified by Population: (a) All States, (b) RBCA States, (c) Non-RBCA States.

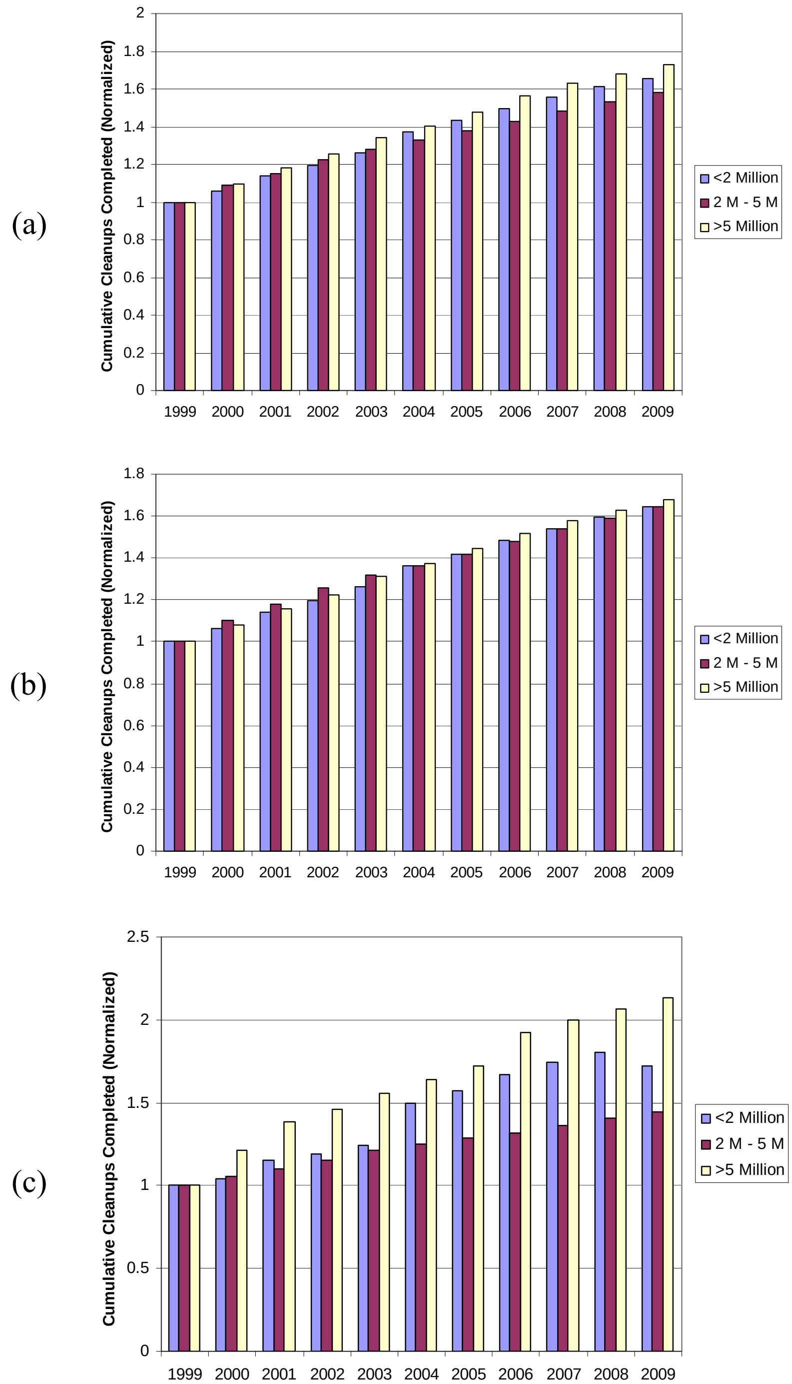


Figure 17. Comparison of Annual Percentages of Cumulative Cleanups Completed for States Stratified by Population: (a) All States, (b) RBCA States, (c) Non-RBCA States.

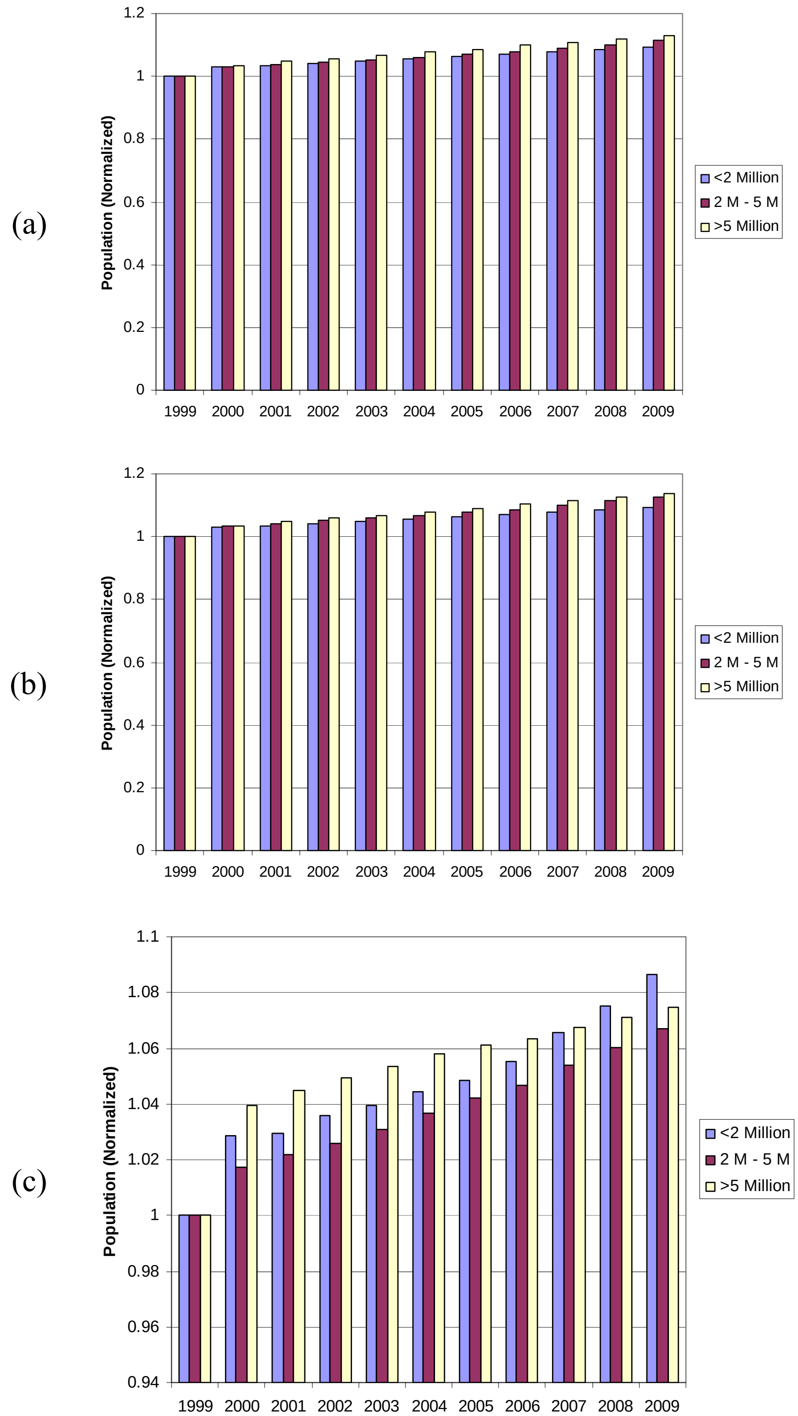


Figure 18. Comparison of Annual Percentages of State Population Stratified by Population: (a) All States, (b) RBCA States, (c) Non-RBCA States.

through 2009 for each of the 3 strata for each of the 4 primary reporting variables, and state population. The purpose of these plots is to aid in determining if there are differences both within and between comparison groups that may be due to the “size” of a state. In all cases, the group comprised of RBCA states (designated “b” in Figures 9 through 18) more closely resembles the aggregate group comprised of all states (designated “a” in Figures 9 through 18) than does the group comprised of non-RBCA states (designated “c” in Figures 9 through 18). This is not unexpected since the RBCA group is comprised of 45 of the 52 states in the combined group. While trends for the non-RBCA group (seven states) are much different than the RBCA group and the combined group, this may be more a function of fewer members in the group and the influence of data outliers than to any functional differences between the groups. From these observations it is not clear that stratification by either number of active USTs or by state population provides useful information.

Determination of efficiency is simpler than determining effectiveness because reported costs are presented on a per cleanup basis so differences between the RBCA and non-RBCA groups can be calculated directly without having to construct a counterfactual. As discussed in “Data Limitations”, in the RBCA group there are only 15 states for which cost data are available for the entire period from 1999 through 2009, and only 4 states in the non-RBCA group (see Table 7).

2.4.2. Stage 2: Relationships Among Variables. Data for the period 1999 through 2009 was used for this stage of the investigation to be consistent with the first stage. For the effectiveness assessment, 3 of the 4 primary reporting measures were initially selected to be independent variables for initial model construction and testing: number of active USTs, cumulative confirmed releases, cumulative cleanups initiated. State population was added as a fourth independent variable. Table 8 presents the dependent and independent variables used to develop both the effectiveness model and the efficiency model. I tested several additional independent variables including:

- EPA Region (weakly correlated and usually not significant),
- year (weakly correlated and usually not significant),
- states' commitment to environmental protection derived from "Environmental Scorecards" produced by the League of Conservation Voters for the House, Senate, and an average index (weakly correlated—except among themselves—and usually not significant), and
- groundwater usage for drinking water (moderately correlated, but data are incomplete: not available for all states, only available through 2008).

The variable correlation feature of MINITAB was used to calculate Pearson Correlation Coefficients (*r*) and corresponding p-values for each pair of variables. These results are presented in Table 9. The first column (lightly shaded) shows correlations between the dependent variable and candidate independent variables. There are strong and statistically significant correlations between variables that represent the program's 4 primary reporting variables, plus characteristics that are logically linked to these measures (e.g., state population, groundwater usage[40]).

[40] Groundwater usage data are only available through 2008, therefore, the data sets including groundwater usage only contained data for the other parameters through 2008 as well. Ultimately groundwater usage

Table 8. Dependent and Independent Variables for Each Statistical Model.

	Effectiveness Model	Efficiency Model
Dependent Variable (y)	○ Cumulative Number of Cleanups Completed	○ Cost per Site at Closure
Independent Variables (x_1, x_2, …, x_n)	● Number of USTs ● Cumulative Number of Confirmed Releases ● Cumulative Number of Cleanups Initiated ● State Population ● State Commitment to Environmental Protection ● Groundwater Usage as Source of Drinking Water	● Number of USTs ● Cumulative Number of Confirmed Releases ● Cumulative Number of Cleanups Initiated ● Cumulative Number of Cleanups Completed ● State Population ● State Commitment to Environmental Protection ● Groundwater Usage as Source of Drinking Water

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was found not to be significant in linear regressions and was subsequently dropped from further consideration.

Table 9. Correlation Matrix for Variables Tested in Effectiveness Regressions: Pearson Correlation Coefficient (p-Value).

	Cumulative Cleanups Completed	**Cumulative Confirmed Releases**	**Cumulative Cleanups Initiated**	**No. of Active USTs**	**State Population**
Cumulative Confirmed Releases	0.939** (0.000)				
Cumulative Cleanups Initiated	0.996** (0.000)	0.982** (0.000)			
No. of Active USTs	0.778** (0.000)	0.820** (0.000)	0.788** (0.000)		
State Population	0.837** (0.000)	0.904** (0.000)	0.887** (0.000)	0.861** (0.000)	
Groundwater Usage	0.563** (0.000)	0.704** (0.000)	0.640** (0.000)	0.689** (0.000)	0.803** (0.000)
LCV Score (Senate)	0.035 (0.433)	0.096* (0.031)	0.103* (0.022)	-0.065 (0.148)	0.136** (0.002)
LCV Score (House)	0.048 (0.287)	0.033 (0.465)	0.059 (0.188)	-0.050 (0.261)	0.078 (0.083)
LCV Score (average)	0.044 (0.330)	0.073 (0.103)	0.089* (0.046)	-0.063 (0.162)	0.118** (0.008)
Region	-0.085 (0.058)	-0.069 (0.123)	-0.068 (0.132)	-0.178** (0.000)	-0.039 (0.383)
Year	0.159 (0.287)	0.061 (0.172)	0.084 (0.059)	-0.066 (0.142)	0.028 (0.536)

* = correlation significant at 0.05
** = correlation significant at 0.01

Table 9. Continued.

	Ground-water Usage	LCV Score (Senate)	LCV Score (House)	LCV Score (avg)	Region
Cumulative Confirmed Releases					
Cumulative Cleanups Initiated					
Number of Active USTs					
State Population					
Ground-water Usage					
LCV Score (Senate)	0.145** (0.001)				
LCV Score (House)	0.033 (0.465)	0.736** (0.000)			
LCV Score (average)	0.102* (0.023)	0.947**# (0.000)	0.915**# (0.000)		
Region	-0.023 (0.615)	-0.271** (0.000)	-0.465** (0.000)	-0.383** (0.000)	
Year	-0.001 (0.988)	0.110* (0.014)	0.126** (0.005)	0.125** (0.005)	0.000 (1.000)

* = correlation significant at 0.05
** = correlation significant at 0.01
# = Correlation not meaningful because variables are a function of one another

I also considered testing some additional program characteristics, but the data were either incomplete, variable over time, or not readily accessible. These include program affiliation (e.g., water or waste program in state organization), financial responsibility mechanism, and significant operational compliance.

Plots were generated for every pair of variables considered in the analysis to assess whether or not their relationships to one another were linear. Some of these plots display non-linear relationships. Data sets comprised of various data transformations (i.e., square root, logarithm, and negative reciprocal), polynomials (i.e., square and cube), and interaction terms (e.g., x_1x_2, x_1x_3, x_2x_3) were generated in an attempt to obtain a better fit of the regression model to the curved data. Initially the dependent variable was transformed, to try and tame heteroscedasticity (nonconstant variance), but the fit of the model was not greatly improved and neither were plots of residuals. Regression models constructed for all possible subsets of transformed independent variables, polynomials, and interaction terms generally fit no better, and were often worse, than simpler models. Ultimately, the independent variables selected for further statistical analyses of effectiveness were cumulative number of active USTs, cumulative number of confirmed releases, cumulative number of cleanups initiated, and state population.

For the efficiency assessment, the analysis process was similar to the effectiveness assessment. Correlation coefficients were calculated for each pair of variables (Table 10).The first column (lightly shaded) shows correlations between the dependent variable and candidate independent variables. None of these correlations are as strong as the correlations between variables for the effectiveness assessment. Regression

Table 10. Correlation Matrix for Variables Tested in Efficiency Regressions: Pearson Correlation Coefficient (p-value).

	Cost per Site at Closure (1999 Dollars)	**Cumulative Cleanups Completed**	**Cumulative Confirmed Releases**	**Cumulative Cleanups Initiated**	**No. of Active USTs**	**State Population**
Cumulative Cleanups Completed	-0.147* (0.043)					
Cumulative Confirmed Releases	-0.142 (0.051)	0.964** (0.000)				
Cumulative Cleanups Initiated	-0.145* (0.046)	0.962** (0.000)	0.991** (0.000)			
No. of Active USTs	0.007 (0.927)	0.701** (0.000)	0.737** (0.000)	0.682** (0.000)		
State Population	-0.037 (0.610)	0.776** (0.000)	0.810** (0.000)	0.767** (0.000)	0.942** (0.000)	
Groundwater Usage	0.107 (0.140)	0.648** (0.000)	0.680** (0.000)	0.634** (0.000)	0.781** (0.000)	0.866** (0.000)
LCV Score (Senate)	0.021 (0.771)	-0.191** (0.008)	-0.099 (0.174)	-0.091 (0.214)	-0.319** (0.000)	-0.214** (0.003)
LCV Score (House)	-0.099 (0.175)	-0.075 (0.301)	-0.039 (0.589)	-0.034 (0.638)	-0.239** (0.001)	-0.140 (0.054)
LCV Score (average)	-0.029 (0.694)	-0.156* (0.032)	-0.081 (0.267)	-0.073 (0.315)	-0.309** (0.000)	-0.199** (0.006)
Region	0.148* (0.041)	-0.105 (0.150)	-0.097 (0.183)	-0.108 (0.137)	-0.009 (0.904)	0.120 (0.100)
Year	0.015 (0.837)	0.164* (0.024)	0.074 (0.307)	0.104 (0.152)	-0.063 (0.389)	0.036 (0.620)
Cost per Site at Closure	.988**# (0.000)	-0.124 (0.088)	-0.131 (0.071)	-0.131 (0.072)	-0.001 (0.987)	-0.032 (0.657)

* = correlation significant at 0.05
** = correlation significant at 0.01
\# = correlation not meaningful because variables are scaled relative to each another

Table 10. Continued.

	Ground-water Usage	LCV Score (Senate)	LCV Score (House)	LCV Score (average)	Region	Year
Cumulative Cleanups Completed						
Cumulative Confirmed Releases						
Cumulative Cleanups Initiated						
No. of Active USTs						
State Population						
Groundwater Usage						
LCV Score (Senate)	-0.082 (0.262)					
LCV Score (House)	-0.035 (0.632)	0.714** (0.000)				
LCV Score (average)	-0.068 (0.352)	0.954**# (0.000)	0.892**# (0.000)			
Region	0.237** (0.001)	-0.054 (0.457)	-0.302** (0.000)	-0.165* (0.023)		
Year	0.003 (0.966)	0.106 (0.144)	0.179* (0.014)	0.146* (0.045)	-0.000 (1.000)	
Cost per Site at Closure	0.109 (0.133)	0.035 (0.631)	-0.079 (0.278)	-0.011 (0.876)	0.138 (0.058)	0.139 (0.055)

* = correlation significant at 0.05
** = correlation significant at 0.01
# = correlation not meaningful because variables are scaled relative to each another

models were nevertheless constructed for all possible subsets of variables, transformed untransformed. The fit of regression models to cost data (the efficiency model) was generally quite poor no matter which variables were used nor how many and most variables tested were dropped from further consideration. Ultimately, I selected 5 measures as independent variables: the 4 used in the effectiveness assessment plus the cumulative number of cleanups completed (which was the dependent variable for the effectiveness assessment). I selected cost per site at closure (in 1999 dollars) for the dependent variable as it is the most representative estimate of cleanup costs.

2.4.3. Stage 3: Statistical Modeling. Having determined that the most significant independent variables available for analysis of effectiveness are cumulative number of active USTs, cumulative number of confirmed releases, cumulative number of cleanups initiated, and state population, I used statistical modeling to determine the impact of RBCA (whether positive or negative) in each individual state. I constructed a more complex multiple regression model comprised of the 4 independent variables defined above plus three matrices of state-specific categorical variables: “State”, “State x Year”, and “State/RBCA x Year”. The “State” matrix consists of 52 columns, one for each state in the analysis. For each individual state, the entries are 1 in each of that state’s data rows and 0 in all other rows (this distinguishes each state’s data from that of every other state). The “State x Year” matrix also consists 52 columns, one for each state in the analysis. For each individual state, the entries are the product (interaction) of the “State” variable (which is 1 for each of a particular state’s data rows and 0 elsewhere) and the “Year” variable (which is simply each of the years of the interval of interest). The “RBCA x

Year" matrix also consists of 52 columns, one for each state in the analysis. For each individual state, the entries are the product of the "StateRBCA" variable (which is 1 in each of a particular state's data rows but only during years that RBCA was implemented and 0 elsewhere) and the "Year" variable (which is simply each of the years of the interval of interest).

I realized during the model development process that in order to have a pre-RBCA baseline trend with which to compare the post-RBCA trend in individual states, the period of interest had to be extended to earlier years (i.e., prior to 1999). This is because most states (35 out of 45) had implemented RBCA prior to 1999, while only 3 had implemented RBCA by 1991 (see Table 3). Suitable data are available for the primary variables of interest as early as 1991 (see Appendices B, C, D, E, and F); thus the data set used for statistical modeling extends from 1991 through 2009. Correlation coefficients were computed for this extended data set to ensure that they are consistent with previous results (Table 11). Comparing Tables 9 and 11, the strongest correlations are among the 4 primary reporting measures and state population for both data sets. However, correlations between number of active USTs and other variables, and state population and other variables are significantly weaker in the extended data set. Correlations between year and the 4 primary reporting measures are relatively weak but significant in the extended data set. I also compared regression model results using all 4 independent variables for both data sets (1999 through 2009, and 1991 through 2009) to assess whether there were any significant differences.

Table 11. Correlation Matrix for Variables Tested in Effectiveness Regressions Using Extended Data Set (1991-2009): Pearson Correlation Coefficient (p-value).

	Cumulative Cleanups Completed	**Cumulative Confirmed Releases**	**Cumulative Cleanups Initiated**	**No. of Active USTs**	**State Population**	**Region**
Cumulative Confirmed Releases	0.903** (0.000)					
Cumulative Cleanups Initiated	0.952** (0.000)	0.963** (0.000)				
No. of Active USTs	0.361** (0.000)	0.541** (0.000)	0. 614** (0.000)			
State Population	0.722** (0.000)	0.862** (0.000)	0.814** (0.000)	0.744** (0.000)		
Region	-0.050 (0.116)	-0.025 (0.439)	-0.034 (0.288)	-0.109** (0.001)	-0.025 (0.427)	
Year	0.400** (0.000)	0.244** (0.000)	0.297** (0.000)	-0.308** (0.000)	0.055 (0.082)	0.000 (1.000)

** = significant at 0.01

Using the output from the statistical model, the impact of RBCA in each individual state is determined using the following procedure:

1. over the period of interest, calculate the average value for each of the independent variables
2. multiply the average value for each independent variable—but not for the matrices—by its corresponding coefficient from the model output being careful to account for the sign of the coefficient (the product for each of the variables will be a constant). Add these numbers together.
3. to the result from #2 above, add the coefficient for the "State" term (this is also a constant since the state term is equal to 1; thus the product is merely the coefficient) again being careful to account for the sign. The sum of these is the constant (intercept) in the regression equation.
4. multiply each "State x Year" coefficient by its corresponding matrix value (which is simply the year for each year in the period of interest)
5. multiply each "StateRBCA x Year" coefficient by its corresponding matrix value (which is 0 for years prior to RBCA implementation and 1 for the year RBCA was implemented and all the years following through the end of the period of interest); the result will be zero for years prior to RBCA implementation. NOTE: for non-RBCA states this term will be 0 for each year in the period of interest.

6. for each year in the period of interest, add the constant from step #3 above to the value calculated for step #4 above plus the value calculated for step #5 above. This sum is the calculated value of the dependent variable for each year in the period of interest holding all other factors constant.
7. plot the values calculated in step #6 versus year on the x-axis. For RBCA states, the initial section of the corresponding line is the baseline trend; where the slope of the line changes, this is the first year that RBCA was implemented.

In theory, determining the efficiency of RBCA involves the same procedure as for effectiveness. However, due to the fact that so few states (19 out of the 52 used for the effectiveness modeling; see Table 4) have continuous cost data for the period from 1999 through 2009, and the very poor fit of regression models to cost data, statistical modeling of efficiency was abandoned.

3. RESULTS

It is difficult, both conceptually and empirically, to measure the success or failure of environmental policies. (Kraft and Vig, 2006)

At best, the efficacy of a program can only be estimated with confidence, but never measured with certainty. (Frondel and Schmidt, 2005)

3.1 Stage 1: Descriptive Statistics and Graphical Trend Analysis

3.1.1. Effectiveness Assessment. The national trend in number of active USTs is downward (Figure 19). The trends for both RBCA and non-RBCA states are also downward, though the rate of decline is greater for RBCA states (see Figure 5). This trend is not merely the result of there being a larger number of states (and USTs) in the RBCA states group. The average annual percentage as compared to the baseline year (1999) is 88.2% for RBCA states and 90.3% for non-RBCA states; thus a difference of 2.1 percentage points (Table 12). In all but two years (2003 and 2004) during the interval from 1999 through 2009 the rate of decrease was higher in RBCA states.

The national trend in cumulative number of confirmed releases is upward, though the rate of increase is slowing (Figure 20). The trends for both RBCA and non-RBCA states are also upward, though the rate of increase is greater for non-RBCA states and especially pronounced from 2006 though 2009 (see Figure 6). The average annual percentage as compared to the baseline year (1999) is 111.4% for RBCA states and 116.0% for non-RBCA states; thus a difference of 4.6 percentage points (see Table 12).

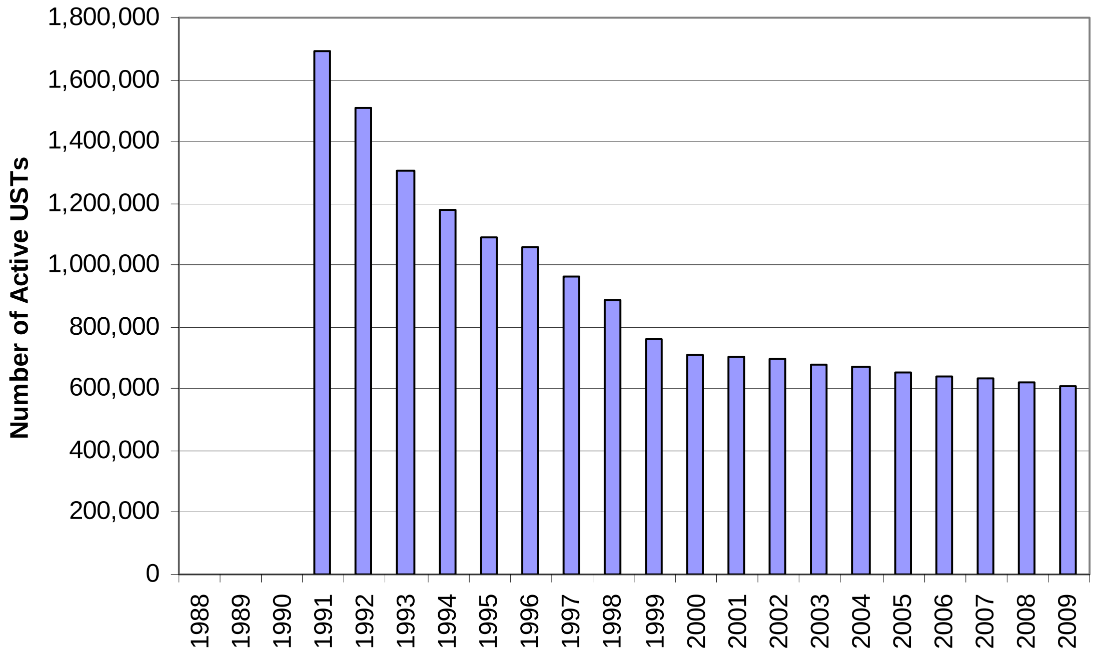


Figure 19. National Aggregate Number of Active USTs for the Period 1988 through 2009.

Table 12. Comparison of Annual Percentages of Number of Active USTs, Cumulative Confirmed Releases, Cumulative Cleanups Initiated, and Cumulative Cleanups Completed for RBCA versus Non-RBCA States.

	1999	**2000**	**2001**	**2002**	**2003**	**2004**
RBCA States						
USTs	1.000	0.933	0.924	0.913	0.899	0.885
CR	1.000	1.036	1.051	1.073	1.104	1.123
CI	1.000	1.064	1.098	1.108	1.168	1.193
CC	1.000	1.082	1.159	1.228	1.309	1.370
Non-RBCA States						
USTs	1.000	0.976	0.947	0.957	0.889	0.880
CR	1.000	1.044	1.068	1.083	1.113	1.134
CI	1.000	1.050	1.081	1.117	1.152	1.183
CC	1.000	1.145	1.264	1.329	1.409	1.479
	2005	**2006**	**2007**	**2008**	**2009**	**Average**
RBCA States						
USTs	0.858	0.843	0.831	0.813	0.799	0.882
CR	1.133	1.155	1.179	1.192	1.211	1.114
CI	1.220	1.246	1.280	1.303	1.325	1.182
CC	1.438	1.507	1.571	1.621	1.670	1.360
Non-RBCA States						
USTs	0.871	0.853	0.851	0.869	0.838	0.903
CR	1.161	1.252	1.275	1.297	1.337	1.160
CI	1.212	1.327	1.355	1.379	1.407	1.206
CC	1.544	1.677	1.737	1.794	1.845	1.475
Difference between RBCA and Non-RBCA States						
USTs	2.1 percentage points					
CR	4.6 percentage points					
CI	2.4 percentage points					
CC	11.5 percentage points					

USTs = number of active USTs
CR = confirmed releases
CI = cleanups initiated
CC = cleanups completed

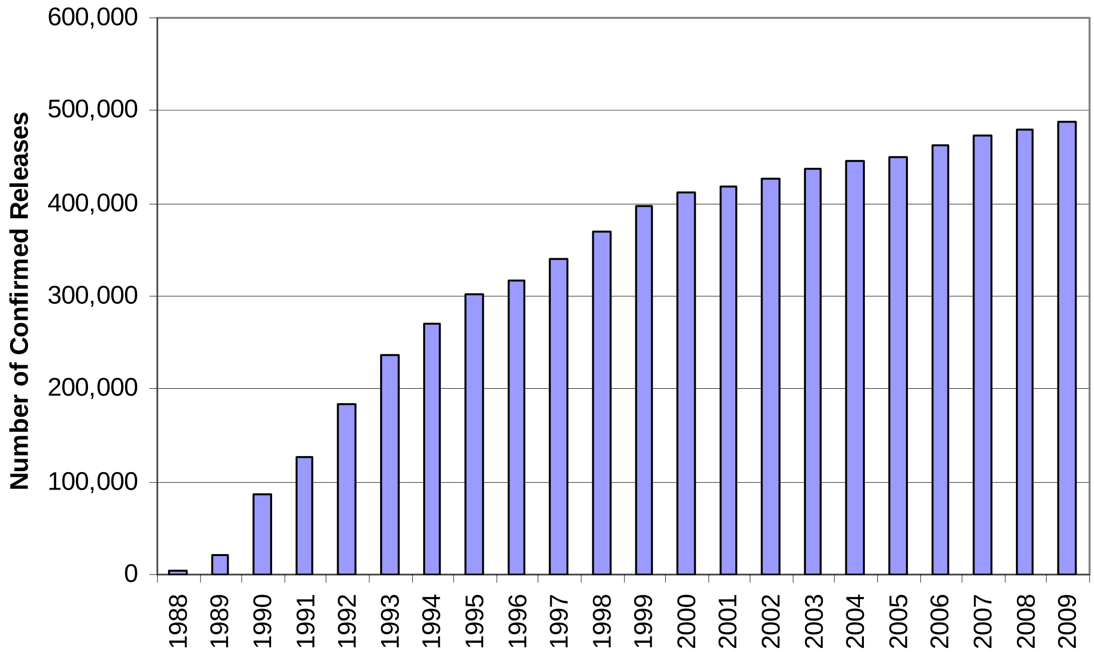


Figure 20. National Aggregate Cumulative Number of Confirmed Releases for the Period 1988 through 2009.

The national trend in cumulative number of cleanups initiated is upward, though the rate of increase is slowing (Figure 21). The trends for both RBCA and non-RBCA states are also upward, though the rate of increase is greater for non-RBCA states and especially pronounced from 2006 though 2009 (see Figure 7). The average annual percentage as compared to the baseline year (1999) is 118.2% for RBCA states and 120.6% for non-RBCA states; thus a difference of 2.4 percentage points (see Table 12).

The national trend in cumulative number of cleanups completed is upward, though the rate of increase is slowing (Figure 22). The trends for both RBCA and non-RBCA states are also upward, though the rate of increase is greater for non-RBCA states and especially pronounced from 2006 though 2009 (see Figure 8). The average annual percentage as compared to the baseline year (1999) is 136% for RBCA states and 147.5% for non-RBCA states; thus a difference of 11.5 percentage points (see Table 12).

I calculated a counterfactual number of cleanups completed for RBCA states by multiplying the actual number of annual cumulative cleanups completed for RBCA states by the annual percentage of cleanups completed for non-RBCA states (from Table 12) and taking the difference between these counterfactual numbers and the actual numbers for RBCA states. This represents the annual cumulative number of cleanups that RBCA states would have completed if they (like the non-RBCA states) had not implemented RBCA. If the number of cleanups completed in RBCA states followed the trend of non-RBCA states, 33,385 more cleanups would have been completed at the end of 2009 (Table 13 and Figure 23).

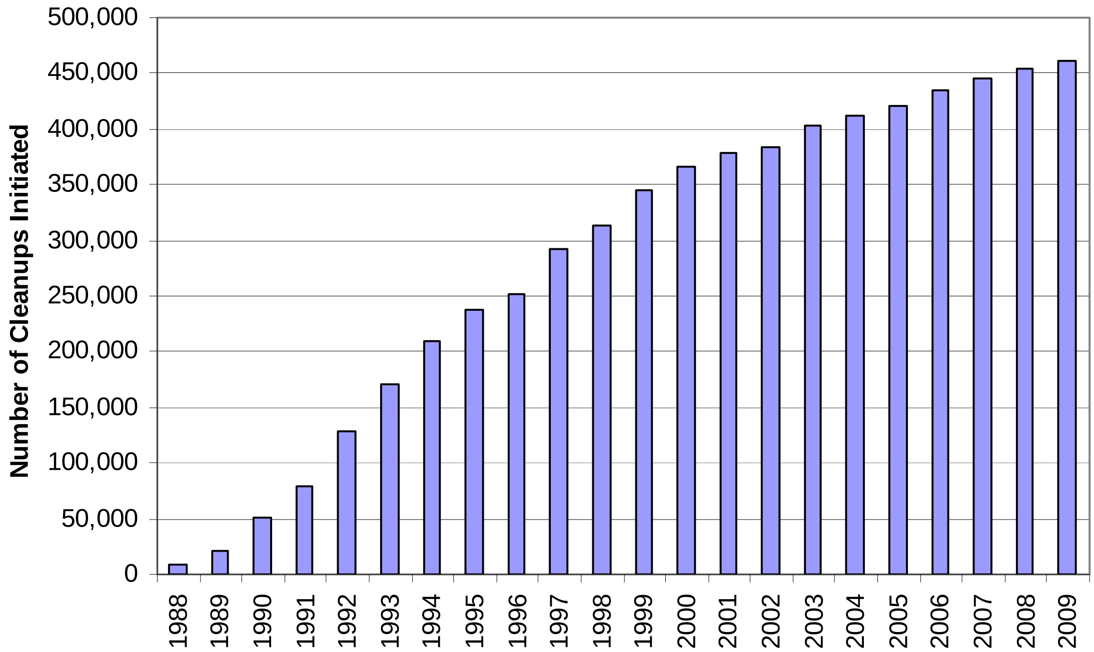


Figure 21. National Aggregate Cumulative Number of Cleanups Initiated for the Period 1988 through 2009.

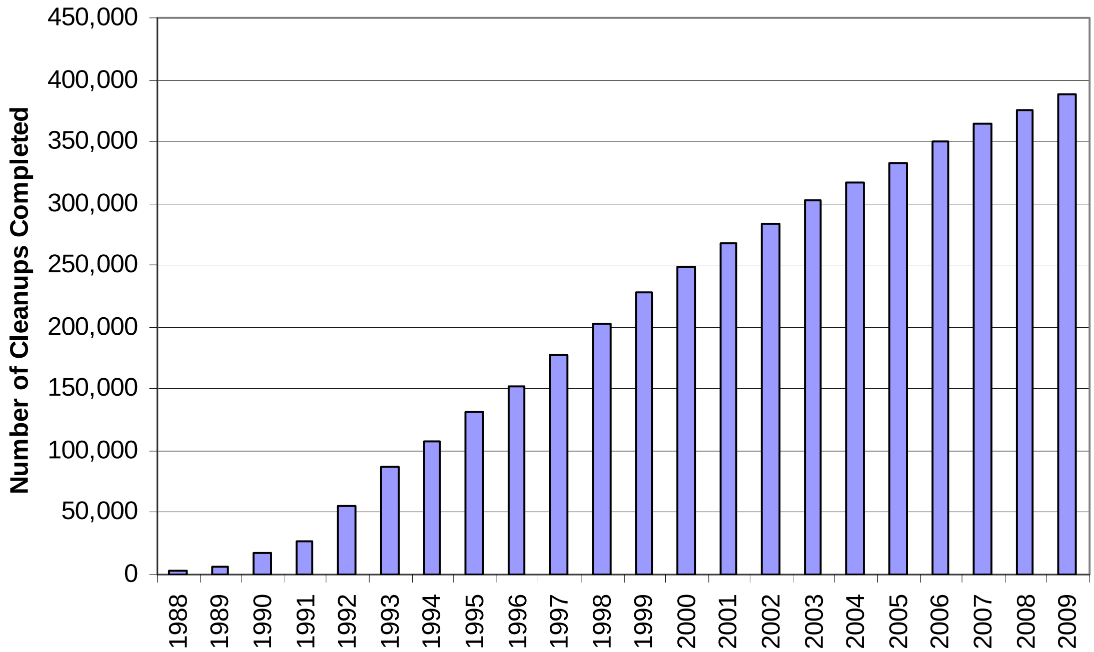


Figure 22. National Aggregate Cumulative Number of Cleanups Completed for the Period 1988 through 2009.

Table 13. Comparison of Actual and Counterfactual Numbers of Cumulative Cleanups Completed in RBCA States.

	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Actual	194,096	209,944	224,892	238,409	254,145	265,988
Counter-factual	194,096	222,240	245,337	257,954	273,481	287,068
Difference	0	12,296	20,455	19,545	19,336	21,080
	2005	**2006**	**2007**	**2008**	**2009**	
Actual	279,107	292,519	304,926	314,611	324,122	
Counter-factual	299,684	325,499	337,145	348,208	358,107	
Difference	20,577	32,980	32,219	33,597	**33,985**	

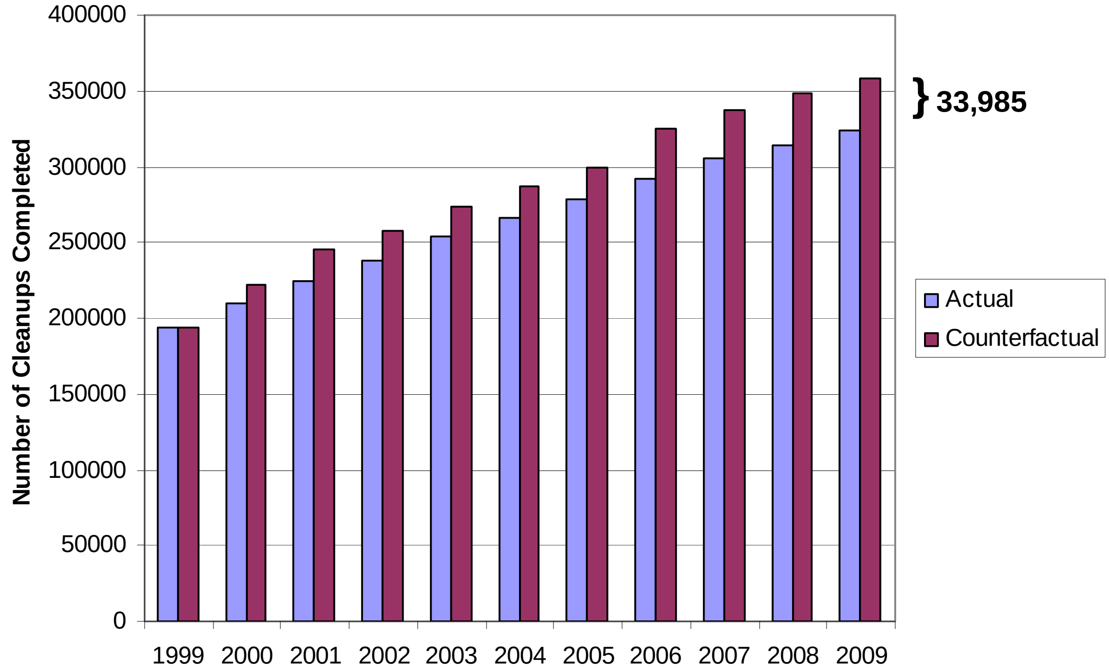


Figure 23. Comparison of Actual vs Counterfactual Cumulative Number of Cleanups Completed in RBCA States.

3.1.2. Efficiency Assessment. Comparison of the annual average cost per site at closure for the non-RBCA states versus the RBCA states (Figure 24) shows that in all but three years (2002, 2003, and 2005) of the period from 1999 through 2009 RBCA states had a higher average cost than non-RBCA states. Over this period, on average the cost per site at closure for RBCA states was $14,089 ($12,307 in 1999 dollars) more than for non-RBCA states.

3.2 Stage 2: Relationships Among Variables

3.2.1. Effectiveness Assessment. The regression model with the best fit (R^2-adjusted = 94.3%) over the period from 1999 through 2009 was comprised of 4 variables: 3 (of the 4) primary reporting measures; (1) number of active tanks, (2) cumulative number of confirmed releases, and (3) cumulative number of cleanups initiated; plus (4) state population. The same regression model using data for the period from 1991 through 2009 was very similar (R^2-adjusted = 91.6%). Parameter estimates and measures of significance for these two models are presented in Table 14.[41]

Plots of residuals for both of these models illustrate violations of several of the assumptions required for statistical inference (Figure 25). For example, the normal probability plot and histogram in Figures 25(a) and (b) indicate that the residuals are not normally distributed. The plots of residuals versus fits, which show increasing error with

[41] Note that the variable cumulative confirmed releases was not statistically significant in the regression model using the extended data set. This variable was retained for statistical modeling and was statistically significant.

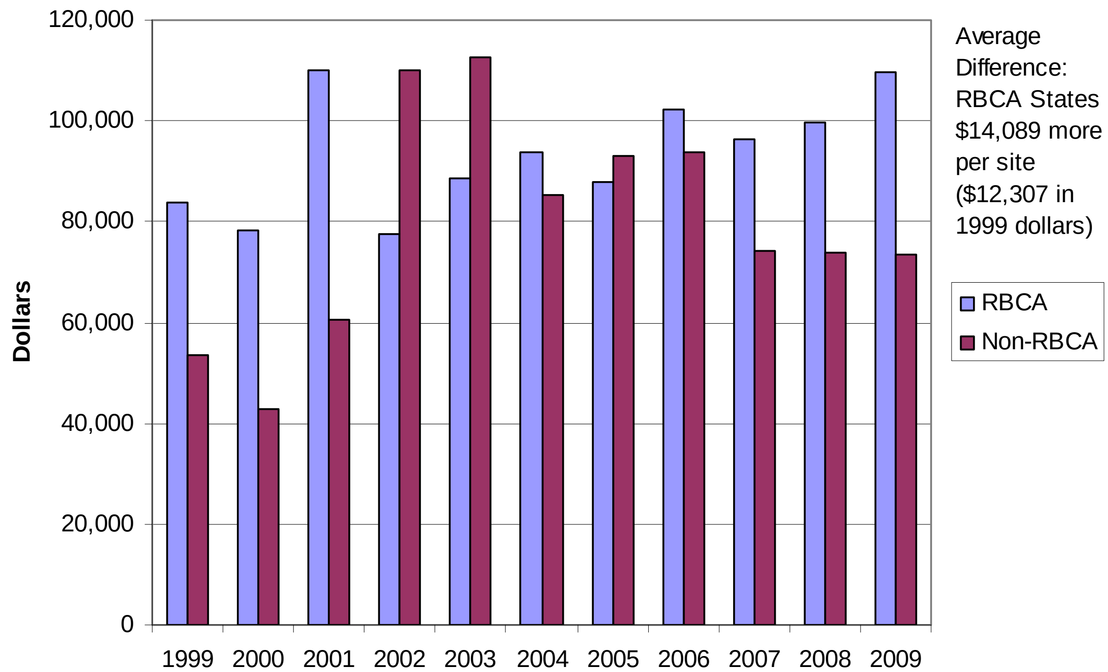
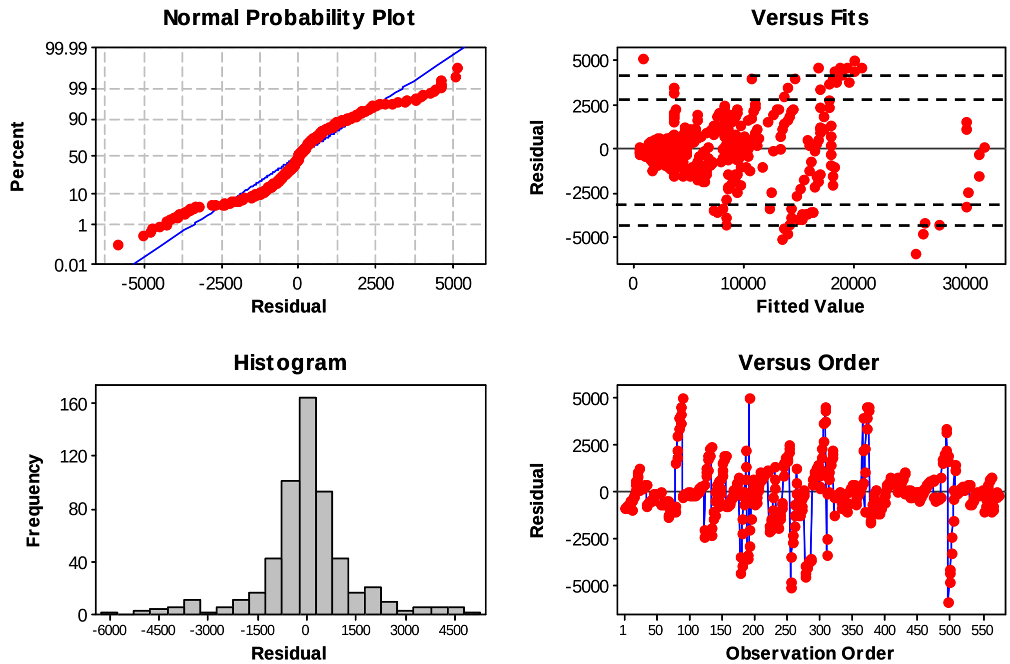


Figure 24. Comparison of Cost per Site at Closure for RBCA States versus Non-RBCA States.

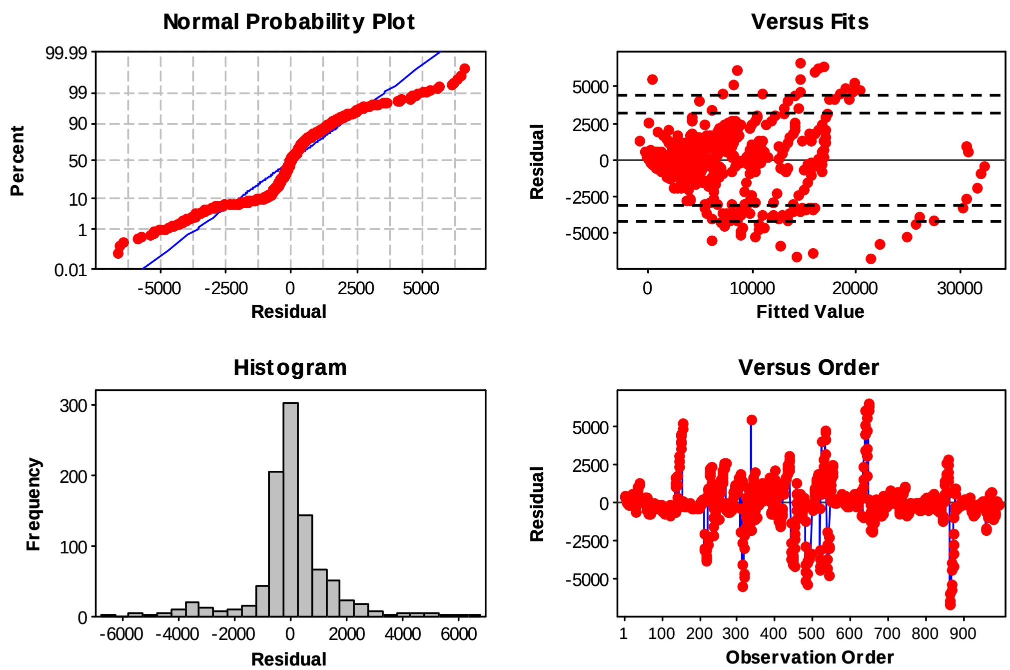
Table 14. Parameter Estimates and Measures of Significance for Effectiveness Regression Model.

Predictor	**Coefficient**	**Standard Error of Coefficient**	**T**	**P**
Data Set 1999 through 2009				
Constant	124.89	92.22	1.35	0.176
USTs	0.06998	0.01056	6.63	0.000**
CR	-0.18683	0.04289	-4.36	0.000**
CI	0.94970	0.04157	22.85	0.000**
Population	-0.00015090	0.00002526	-5.97	0.000**
S = 1442.33	R^2-adj = 94.3%	F_{reg} = 2368.97	P_{reg} = 0.000**	
Data Set 1991 through 2009				
Constant	249.68	72.79	3.43	0.001**
USTs	-0.01611	0.004408	-3.65	0.000**
CR	-0.01489	0.02723	-0.55	0.585
CI	0.80156	0.02646	30.29	0.000**
Population	-0.00007980	0.00002101	-3.80	0.000**
S = 1533.87	R^2-adj = 91.6%	F_{reg} = 2691.83	P_{reg} = 0.000**	

USTs = Number of Active USTs
CR = Cumulative Confirmed Releases
CI = Cumulative Cleanups Initiated
Population = State Population
S = standard error of estimate (standard error of y about the regression line)
R^2-adj = coefficient of determination (adjusted)
F_{reg} = F-value for regression equation
P_{reg} = P-value for regression equation
** = significant at 0.01



(a) 1999 through 2009 (R^2-adjusted = 94.3%)



(b) 1991 through 2009 (R^2-adjusted = 91.6%)

25. Plots of Residuals for Effectiveness Regressions for Both Data Sets.

larger fitted values, indicate non-constant variance (heteroscedasticity). However, heteroscedasticity does not bias OLS coefficient estimates (though it does bias estimates of variance), and regression analysis still provides an unbiased estimate of the relationship between independent and dependent variables. These violations are common with both cross-section and time-series measurements, and not of particular concern for my investigation since I am not using the results for statistical inference. Nor can the data be analyzed using traditional time-series analysis because there are too few data points.

As discussed previously, the extended data set is crucial for use in statistical modeling of the state-specific impact of RBCA in order to compare pre-RBCA and post-RBCA trends.

3.2.2. Efficiency Assessment. There are fewer states with usable data for assessment of efficiency than there were for the assessment of effectiveness. The same 4 independent variables used for the effectiveness assessment were selected for the efficiency assessment, but cumulative cleanups completed was added as a fifth independent variable. The dependent variable is cost per site at closure (expressed in 1999 dollars). This regression model has a value for R^2-adjusted of only 2.1%. Addition of several interaction variables resulted in only nominal improvement in fit. The model with the best fit (R^2-adjusted = 29.1%) was comprised of 10 independent variables, of which 4 are primary reporting measures:

- number of active tanks,
- cumulative numbers of confirmed releases,
- cumulative number of cleanups initiated, and

- cumulative number of cleanups initiated.

The other 6 are interaction variables:

- number of active USTs times cumulative confirmed releases,
- number of active USTs times cumulative cleanups initiated,
- number of active USTs times cumulative cleanups completed,
- cumulative confirmed releases times cumulative cleanups initiated,
- cumulative confirmed releases times cumulative cleanups completed, and
- cumulative cleanups initiated times cumulative cleanups completed.

Even with this large number of explanatory variables, this regression model leaves nearly 70% of the correlation unexplained, which is too much for it to be used to make any conclusions about the relationship between cost of site at closure and impact of RBCA. Clearly there are either confounding variables that are not accounted for by the regression and/or the available cost data are of insufficient quality and quantity (or both) to conduct statistical modeling.

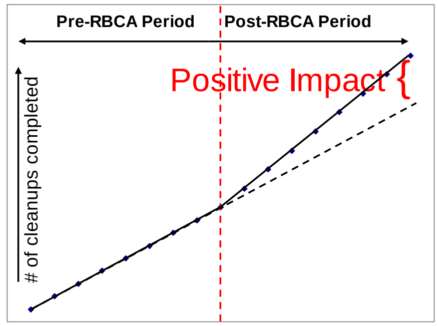
3.3 Stage 3: Statistical Modeling

3.3.1. Effectiveness Assessment. Using the best fit regression described above integrated with the three matrices of categorical variables (i.e., State, State x Year, and State/RBCA x Year), the effectiveness model results indicate that a positive impact of RBCA in 25 states and a negative impact in 17 states. It is not possible to determine the impact of RBCA in MD, VA, or WA because there is no pre-RBCA period over the period of interest (1991 through 2009) with which to compare the post-RBCA trend.

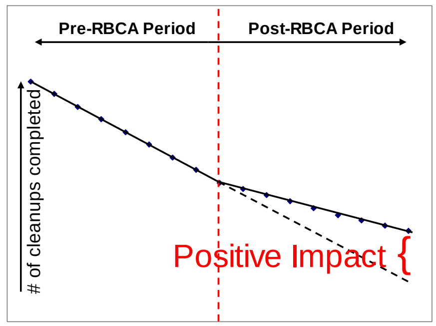
Figure 26 presents four different possibilities for RBCA impacts and the distribution of states among each of them. Figure 26(a) shows a positive impact. Initially there is an increasing trend in cumulative number of cleanups completed during the pre-RBCA period followed by a greater increase in the rate following implementation of RBCA. The 9 states in this category are IL, IN, KS, NC, NE, NM, PA, RI, and SD. Figure 26(b) also shows a positive impact. Initially there is a decreasing trend in cumulative number of cleanups completed, but the rate of decrease slows (or changes from a decrease to an increase) following implementation of RBCA. The 16 states in this category are AK, AR, CA, CT, FL, GA, HI, IA, LA, MA, MI, NH, OK, OR, SC, and WY. Figure 26(c) shows a negative impact. Initially there is an increasing trend in cumulative number of cleanups completed, but the trend decreases following implementation of RBCA. The 17 states in this category include AL, AZ, CO, DC, DC, ID, ME, MN, MO, MT, ND, NJ, NV, OH, TN, TX, and UT. Figure 26(d) shows a negative impact. Initially there is a decreasing trend in cumulative cleanups completed, but the trend is for a greater rate of decrease following implementation of RBCA. There are no states in this category.

States in each of the comparison groups (i.e., RBCA, non-RBCA) are, with the exception of Region 2, distributed across all 10 regions, though not uniformly (Figure 27). Region 2 is comprised of only 4 state programs: NJ, NY, PR, and VI. Neither PR nor NY has a RBCA program and VI was omitted from the analysis due to data inadequacy; thus, only NJ was left from Region 2. In the group of 25 states that exhibit a positive

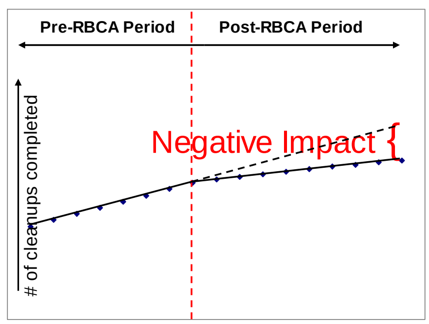
(a) Positive impact (9 states):
IL, IN, KS, NC, NE, NM, PA, RI, SD



(b) Positive impact (16 states):
AK, AR, CA, CT, FL, GA, HI, IA, LA,
MA, MI, NH, OK, OR, SC, WV



(c) Negative impact (17 states):
AL, AZ, CO, DC, DE, ID, ME, MN,
MO, MT, ND, NJ, NV, OH, TN, TX, UT



(d) Negative impact (0 states):

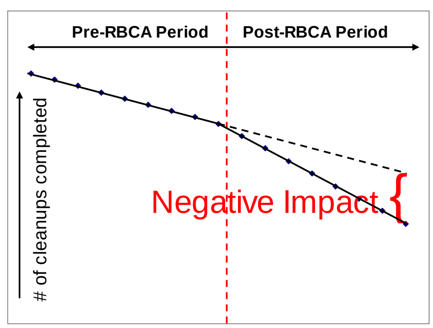


Figure 26. Graphical Representations of the Impact of RBCA on Number of Cleanups Completed and States in Each Category Based on the Effectiveness Model.

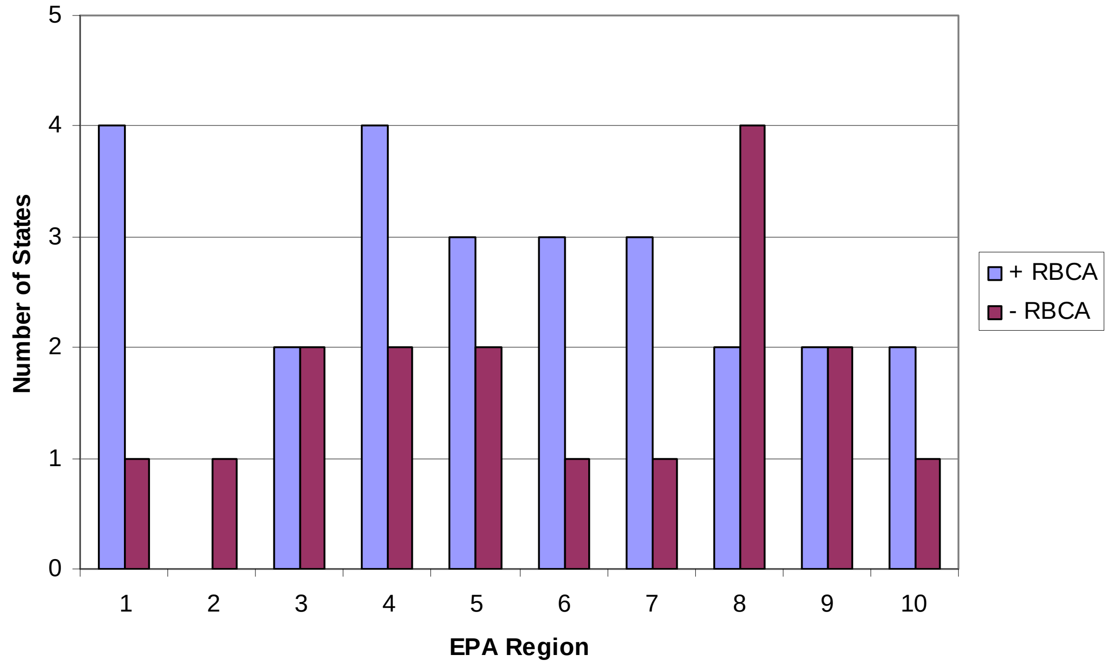


Figure 27. Distribution of States in Both Comparison Groups Across the 10 EPA Regions.

impact of RBCA, Regions 1 and 4 both contribute 4 states; each of the other regions (with the exception of Region 2) contributes either 2 or 3 states. In the group of 17 states that exhibit a negative impact of RBCA, Region 8 contributes 4 states; each of the other regions contributes either 1 or 2 states.

Table 15 presents coefficients and p-values for each of the three state-specific matrices used for statistical modeling. Many of the p-values exceed the target level of 0.01, but calculated p-values for heavy tailed (non-normal) distributions are typically artificially high. The purpose in presenting these data is to provide the coefficient values used to generate graphs of the impact of RBCA for each individual state (Appendix G).

3.3.2. Efficiency Assessment. Available cost data are inadequate for statistical modeling of efficiency. Too few states (19 out of the 52 used for the effectiveness modeling) have continuous cost data for the period from 1999 through 2009, and data are not comparable from state to state. Regression models fit the cost data very poorly; no combination of independent variables yielded a regression model suitable for reliable prediction of cost per site at closure. The best regression model of efficiency had an R^2-adjusted value of only 29% and this required seven independent variables.

Table 15. Coefficients and p-Values from Statistical Modeling of RBCA Effectiveness.

	State		State x Year		State-RBCA x Year	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
AK	42979	0.617	-21.96	0.611	102.54	0.134
AL	-844718	0	421.8	0	-356.08	0
AR	62186	0.745	-32.62	0.734	36	0.743
AZ	-144617	0.104	69.95	0.119	-21.63	0.768
CA	450673	0.106	-246.3	0.08	870.6	0
CO	-265576	0.005	131.01	0.006	-51.4	0.453
CT	31726	0.831	-17.69	0.813	13.97	0.877
DC	-22213	0.739	10.83	0.746	-2.02	0.976
DE	-126030	0.094	62.85	0.096	-22.9	0.733
FL	2373218	0	-1201.1	0	1545.32	0
GA	646530	0	-328.63	0	506.72	0
HI	41214	0.829	-21.44	0.823	87.3	0.425
IA	29579	0.808	-17.02	0.78	255.72	0.001
ID	-21003	0.679	9.92	0.696	-33.65	0.709
IL	-73121	0.588	28.71	0.673	517.08	0
IN	-57020	0.425	24.97	0.488	200.49	0.004
KS	-11202	0.853	4.07	0.893	85.94	0.233
KY	-547586	0	272.73	0	No RBCA	
LA	-760	0.992	-2.06	0.957	40.72	0.546
MA	750120	0.075	-380	0.072	505.7	0.022
MD	-780001	0	387.56	0	highly correlated	
ME	-200490	0.635	100.1	0.636	-62.1	0.779
MI	-1108	0.996	-6.1	0.955	288.6	0.013
MN	-789281	0	393.37	0	-174.4	0.115
MO	-113606	0.034	54.19	0.045	-13.49	0.881
MS	-261885	0	130.42	0	No RBCA	
MT	-134021	0.185	66.74	0.188	-65.6	0.364
NC	-80342	0.521	37.45	0.552	68.98	0.374
ND	-72774	0.224	36.15	0.228	-28.48	0.692
NE	-52881	0.545	25.41	0.562	139.98	0.043
NH	77162	0.602	-39.41	0.595	69.65	0.44
NJ	-910506	0.034	452.1	0.036	-410	0.067
NM	-5727	0.94	1.93	0.96	24.32	0.717
NV	-77231	0.607	38.08	0.613	-102.49	0.256
NY	-984302	0	483.85	0	No RBCA	
OH	-2130514	0	1061.98	0	-542.51	0
OK	-325	0.998	-1.69	0.982	121.07	0.181
OR	50384	0.737	-27.29	0.716	218.13	0.016

Table 15. Continued.

	State		State x Year		State-RBCA x Year	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
PA	-82809	0.539	34.14	0.613	361.84	0
PR	17061	0.615	-10.8	0.525	No RBCA	
RI	-9380	0.937	4.19	0.944	12.2	0.877
SC	269141	0.165	-137.58	0.157	271.9	0.014
SD	-126184	0.508	62.87	0.511	12.4	0.91
TN	-3592399	0	1801.3	0	-1597.6	0
TX	-2057092	0	1021.4	0	-773.9	0.002
UT	-433147	0.024	216.24	0.025	-178.3	0.105
VA	-448671	0	221.66	0	highly correlated	
VT	-28388	0.401	13.88	0.412	No RBCA	
WA	-56210	0.248	24.88	0.315	highly correlated	
WI	-1162478	0	579.22	0	No RBCA	
WV	2933	0.98	-2.63	0.965	74.05	0.347
WY	-15075	0.656	7.16	0.672	No RBCA	

Predictor	**Coefficient**	**p-value**
Number of Active USTs	-0.000957	0.807
Cumulative Confirmed Releases	0.33784	0**
Cumulative Cleanups Completed	0.17414	0**
State Population	0.0011528	0**

** = Significant at 0.01

4. DISCUSSION

What measures an agency chooses may be more a factor of data availability than data reliability and salience. (Frederickson and Frederickson, 2006)

4.1 Effectiveness of RBCA

Both graphical trend analysis and statistical modeling analysis of data provided to EPA by the states provide corroborating evidence that, at least in some states, RBCA has a negative effect on the number of cleanups completed. Graphical comparison (and spreadsheet calculations) of the behavior of RBCA states versus non-RBCA states indicates that over the period from 1999 through 2009, had their rate of completing cleanups been the same as the non-RBCA states, RBCA states would have cleaned up an additional 33,985 sites, which would be an increase of approximately 10% (see Table 12).

Statistical modeling of the state-specific impact of RBCA produces mixed results: RBCA has a positive impact in 25 states and a negative impact in 17 states. At first glance this comports (somewhat) both with the touted benefits of RBCA and my research hypothesis. On closer inspection, especially in regard to the backlog of cleanups to be completed, we are faced with a situation that is counterintuitive; if RBCA is effective in so many states, then why do these same states have such an exceptionally large backlog of cleanups yet to be completed? In the group of states with a positive RBCA impact are

9 (CA, FL, IL, MI, NC, NE, NH, PA, and SC) that are included in the group of 14 states selected for the OUST study of the cleanup backlog.[42] The backlog in these 9 states combined accounts for nearly 52,000 of the approximately 93,000 backlogged cleanups (56% of the total). Also in the group of states with positive RBCA impact are 6 states with more than 1,000 backlogged cleanups: IN, KS, GA, IA, LA, and OR. In the group of states with a negative RBCA impact, 3 (MT, NJ, and TX) are included in the OUST's backlog study; these account for 8% of the total backlog. Three more (AL, MO, and OH) have more than 1,000 backlogged cleanups. Though states in each group (i.e., positive RBCA impact and negative RBCA impact) are distributed across the 10 EPA Regions, they are not uniformly distributed. Positive impact states are clustered in Regions 1 and 4; negative impact states are clustered in Region 8.

These findings present a number of interesting points to consider. First, investigation results suggest that there is a greater likelihood of a state having a large backlog of sites to be cleaned up if it also has a RBCA program. This is contrary to expectations for RBCA programs, as one of the benefits touted is that implementation of RBCA results in an increase in the number of sites cleaned up. Yet, RBCA is premised on the appropriate reduction of risk at contaminated sites on a site-by-site basis. Sites in the RBCA process should not be closed until risk has been successfully reduced to below a threshold that is appropriate for the site considering its present and future uses and likelihood for exposure. So, perhaps what is happening is that sites truly in need of being

[42] The 14 states in the backlog study are CA, FL, IL, MI, MT, NC, NE, NH, NJ, NY, PA, SC, TX, and WA. Of these states, all but NY implement a RBCA program.

cleaned up are in fact being cleaned up to a more stringent level (or if not actively being cleaned up, they are not being prematurely closed) and as cleaning up sites is a lengthy process, fewer sites are actually closed. If RBCA results in more sites being cleaned up to levels that protect human health and the environment, it is not illogical to expect that there might actually be more sites, rather than fewer, in a state's cleanup backlog. If this situation is in fact the case, then the OUST's focus on reducing the backlog is an example of goal displacement and should be reassessed.

Second, the national trend in number of active USTs has been downward, for the period 1999 through 2009, but the average rate of decrease is greater in RBCA states. This may possibly be associated with greater regulatory stringency in terms of cleanup standards: Alberini (2001) cites data from Florida showing that in response to more strict UST regulations, many owners were closing their UST systems and switching to above ground storage tanks (ASTs). Prior to implementation of RBCA, most states had cleanup standards that were applied more-or-less uniformly to all sites. Often these standards were viewed (particularly by industry) as being too stringent, typically resulting in lengthy and costly cleanups. RBCA offered the logical advantage of cleanup standards being set to site-specific conditions, as after all not all sites would need to be cleaned up to the same level. As Small (1998) notes, the conversation regarding cleanup levels changed from asking how much contamination should be removed to asking how much contamination could safely be left behind. There is no bright-line demarking the threshold for how much contamination can be "safely" left in place and many owners of leaking UST sites may be uncomfortable with potential liability issues associated with a site that is perceived as being contaminated no matter how small the amount (Woodward and McMonagle, 1999). The unstated expectation of many RBCA proponents was that risk-based standards would be significantly less stringent than a uniform cleanup standard. Many state programs (and UST owners) have found out, however, that risk evaluation is a complicated, lengthy (and expensive) process. Many sites that were anticipated to move swiftly from screening assessment to closure may have instead moved up to a more advanced level of risk assessment (and complex modeling) and ultimately into a protracted cleanup phase (Connor and Newell, 1999; Alvarez, 1996). Concurrent with the proliferation of RBCA programs has been expansion of the list of contaminants of concern; the former list typically consisted of BTEX (benzene, toluene, ethylbenzene, and xylene isomers), but many states now are concerned with a broader array of petroleum constituents and fuel additives. Taking into consideration the toxicity of many of these compounds and their mobility and persistence in the environment, it can be argued that RBCA standards are not too stringent, but that they are in fact appropriate as the purpose of risk-based decision making is not to merely close more sites it is to reduce risks to human health and the environment.

Third, during the period from 1999 through 2009 the national trend in cumulative confirmed releases is upward, though the average rate of increase is slowing. The trends for both RBCA and non-RBCA states are also upward, though the average rate of increase is greater for non-RBCA states and especially pronounced from 2006 though 2009. One factor that may account for the greater number of confirmed releases in non-

RBCA states over RBCA states is the frequency of UST system inspections. For the group of RBCA states, in 2010 an average of 50% of the UST facilities were inspected on an annual basis; for the non-RBCA group the average was 57%. Though the relationship is indirect, in theory more frequent inspections should lead to a higher rate of compliance with release prevention regulations, which ultimately leads to smaller releases being detected sooner. In practice, however, UST system inspections rarely catch releases; the majority of releases are not detected (or at least they are not reported) until the UST system is removed from the ground and contamination is obvious, a site investigation is conducted for property transfer, the UST system is observed to behave in an unusual manner, or there are off-site impacts indicative of a release. The more frequent the regulatory presence at a site, the more likely it is that a release will be confirmed even if it is not definitively detected during the inspection.

Fourth, during the period from 1999 through 2009, the national trends in cumulative cleanups initiated for both RBCA and non-RBCA states are upward, though the rate of increase is greater for non-RBCA states and is especially pronounced from 2006 though 2009 than in RBCA states. By definition[43], a cleanup is not initiated until after site "evaluation" activities have been completed and one or more of the following activities have been initiated: 1) management of petroleum-contaminated soil, 2) removal of free product (from the surface or subsurface environment), 3) management or treatment of dissolved petroleum contamination, 4) monitoring of the groundwater or soil being remediated by natural attenuation or 5) the state has determined that no further actions are currently necessary to protect human health and the environment (EPA, 2008). Risk assessment, though not explicitly addressed in the definitions, would be considered to be an evaluation-related activity. Since the RBCA process begins with risk assessment, which could extend over a protracted time frame, this could explain the lower rate of cleanups initiated in RBCA states.

Fifth, the trends in cumulative cleanups completed for both RBCA and non-RBCA states are also upward, though the rate of increase is greater for non-RBCA states and is especially pronounced from 2006 though 2009. Both approaches used in this investigation to assess the impact of RBCA on number of cleanups completed provide evidence that at least in some states RBCA has a negative effect in this regard (that is RBCA results in fewer sites reaching closure). From this perspective RBCA as public policy must be viewed at best as only a qualified success. However, as discussed above, the RBCA process may have appropriately resulted in many sites being moved up to a more advanced level of risk assessment and presumably into a protracted cleanup phase instead of being summarily closed. While this serves to decrease the rate of completing cleanups, it potentially results in more appropriate protectiveness of human health and the environment. From this perspective, the fact that RBCA results in fewer cleanups being completed would indicate that RBCA is a success as public policy (albeit in a different manner than conceived and promoted). Whether this is in fact the case is a question to be addressed by a future investigation.

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[43] See "UST And LUST Performance Measures Definitions" (January 18, 2008) at *http://www.epa.gov/oust/cat/PMDefinitions.pdf*.

Sixth, differential regional clustering of states based on the impact of RBCA is curious (see Figure 27). One cluster in each group (positive impact versus negative impact) is comprised of three small states with one relatively larger; the positive impact group (from Region 1) is comprised of RI, CT, NH, and MA, while the negative impact group (from Region 8) is comprised of MT, ND, UT, and CO. In both of these groups the state with the largest inventory of sites in the cleanup backlog is one of the smaller states. The second positive impact group (from Region 4) is comprised of three relatively large states (NC, FL, and GA) and a medium-sized state (SC). All of these states have a significant backlog of cleanups to be completed. Thus, neither Region nor size of state appears to be predictive of RBCA impact.

4.2 Efficiency of RBCA

Graphical analysis of data on cost per site at closure indicates that each completed cleanup costs $14,089 more in RBCA states than in non-RBCA states.[44] Given that between 1999 and 2009 the group of RBCA states in aggregate completed 130,026 cleanups, these cleanups cost an additional $1.8 billion more than they would have cost if conducted by non-RBCA state programs.

Differences in cost of cleanups between the RBCA and non-RBCA groups have not been uniform over the period from 1999 through 2009 (see Figure 24). During the first three years of this period and the last three years, the cost of cleanups in non-RBCA states have been consistently and significantly lower than in RBCA states. During the last

[44] These are 2009 dollars.

three years the cost of cleanups in non-RBCA states exhibits a steady, gentle decrease; conversely, the cost of cleanups in RBCA states exhibits an aggressive increase each year such that the difference in costs between these two groups is significantly increasing.

As initially touted, RBCA was supposed to result in significant cost savings for sites using risk-based cleanup standards, yet simple graphical analysis found evidence to the contrary. From this perspective, RBCA appears to have failed. However, in evaluating whether the total cost was worthwhile, the benefit received from such an investment must also be considered. The crux of the issue is whether or not the additional expense was necessary to clean up sites to a certain standard in order to appropriately protect human health and the environment.

It is not possible, using the data available, to determine efficiency on a state by state basis using statistical modeling as no combination of independent variables yielded a regression model suitable for reliable prediction of cost per site at closure. The best regression model had an R^2-adjusted value of only 29% and this required seven independent variables.

At this point the best that can be said is that perhaps the added cost of risk-based cleanups has been worthwhile if all of the benefits have exceeded costs. To make a quantitative determination would require many data elements that are neither readily available nor easily calculated, such as benefits associated with avoided exposure to contaminants. Accurately accounting for all benefits is a common problem one encounters in evaluating public policies and environmental policies in particular. Such an evaluation of RBCA would have to be undertaken as a future investigation.

4.3 Comparison with Previous Investigation.

To date, only one investigation into the impact of RBCA has been published. This study, by Connor and McHugh (2002) examined the performance of RBCA in 5 states (IA, IL, NC, TX, and UT) over the period from 1990 through 1999. There are a number of issues associated with this interval in general and these states more specifically. First, as discussed previously in Section 2.3, Data Limitations, the late 1990s coincided with the regulatory deadline for all substandard UST systems to be upgraded or closed. This was a period of intense activity throughout the UST universe and trends in UST system closures and site cleanups to meet the deadline confuse separation of RBCA-related activity from overarching national trends. Second, data reported prior to 1991 are not reliable. Few states had fully-functioning programs and through the mid-1990s state statistics exhibit sometimes wild swings. Third, the earliest that RBCA was implemented in any of these 5 states was 1993 by TX; UT implemented RBCA in 1995, IA and IL implemented RBCA in 1997, and NC implemented RBCA in 1998. While TX has three years prior to RBCA implementation over which to establish a baseline for comparison against a 6 year post-implementation period, for the other 4 states the situation is reversed. The problem with this is that in all cases either the pre-implementation period is too short to establish a credible baseline, or the post-implementation is too short for assessing the longer-term impact of RBCA. Fourth, Connor and McHugh (2002) present graphs of cleanups completed for each of the 5 states; only in IA does it appear that the RBCA impact lasted longer than the first year. Following a spike in case closures in the year following RBCA implementation, closures declined to pre-RBCA levels by the second year in UT, TX, and NC. The trend in IL had been decreasing case closures for three years prior to RBCA implementation and it continued for the two years following RBCA. Figures 28 through 32 show the annual reported numbers of cleanups in these 5 states (IA, IL, NC, TX and UT, respectively) for the period 1988 through 2009. A trend line extends from the first year of RBCA implementation through 2009. This trend is only slightly increasing in NC and IL; in the other three states (TX, IA, and UT) the trend is decreasing and strongly so in TX and UT.

In comparison with the current graphical analysis, both studies are in agreement with regard to IL, TX, and UT. There is disagreement between the studies in regard to IA. The case with NC is less certain. The post-RBCA implementation periods in TX (the first from 1993 through 1996 and the second from 1997 through 1998; see Figure 31) and UT (1995 through 1998; see Figure 32) exhibit generally downward trends in number of cleanups completed over time, though there is considerable variation from year-to-year. In three of these states, the average number of cleanups completed in the first year of RBCA implementation is typically higher than the year before implementation, but the effect diminishes rapidly each year afterward. Comparison of pre-RBCA number of cleanups completed with post-RBCA numbers is not a fair comparison since data prior to 1992 are incomplete and programs are immature. The trend line established for graphical analysis of data for IL (see Figure 29) is nearly horizontal (no slope) and approximates the annual average number of cleanups completed over almost the entire period of record (1991 through 2009). Connor and McHugh (2002) show the number of case closures in IL remaining about the same in 1998 and 1999, the two years in their post-RBCA

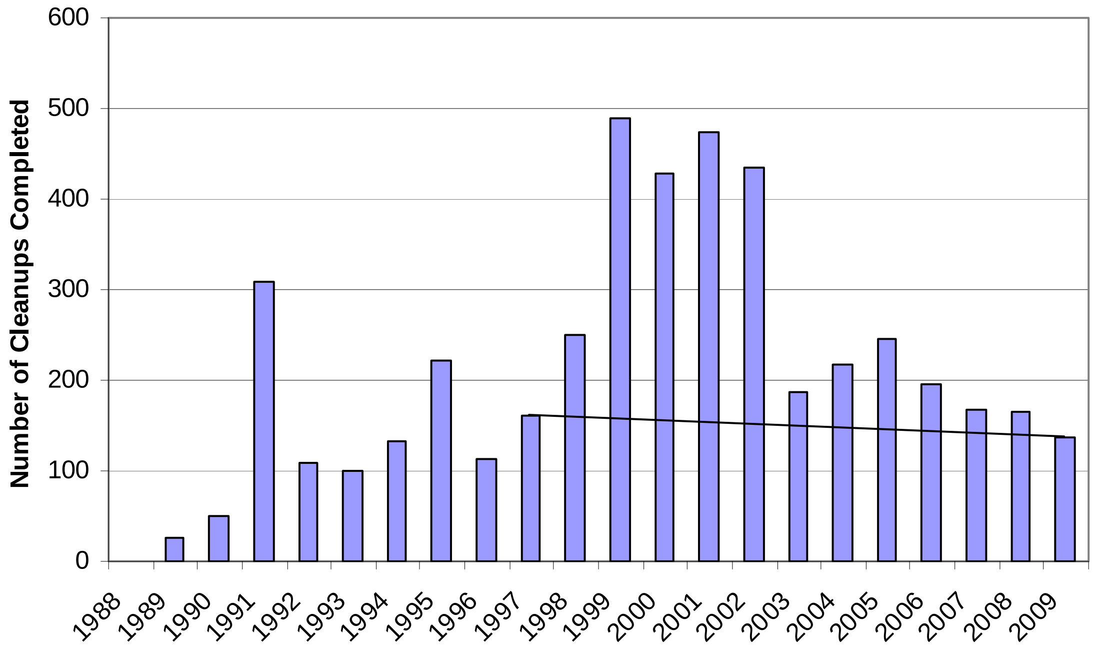


Figure 28. Annual Reported Number of Cleanups Completed in Iowa 1988 through 2009.

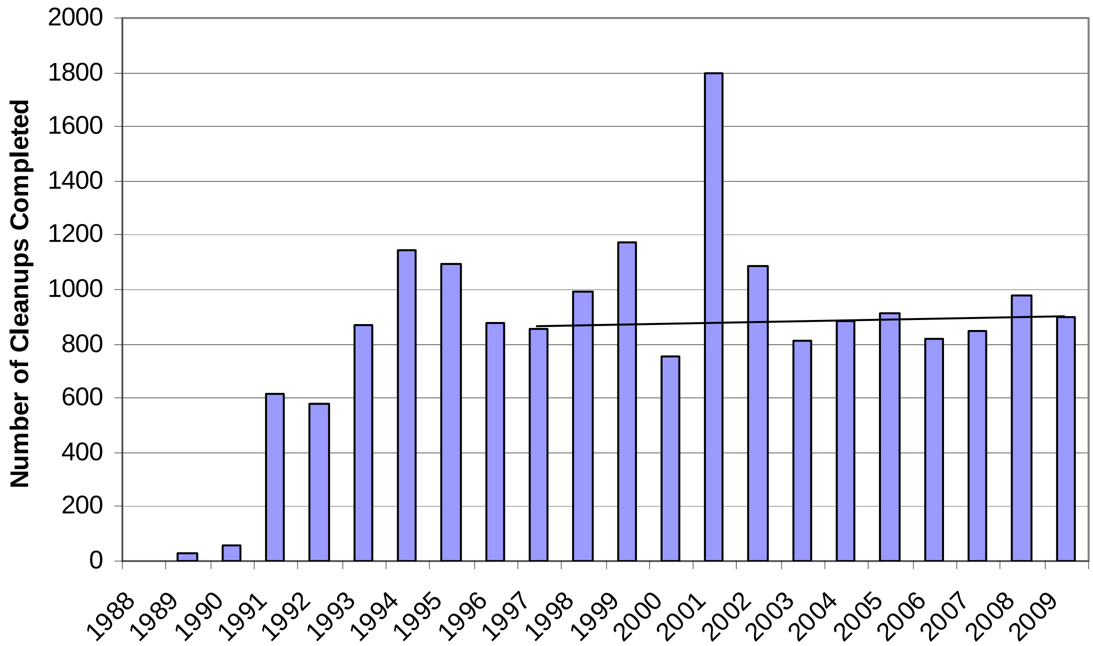


Figure 29. Annual Reported Number of Cleanups Completed in Illinois 1988 through 2009.

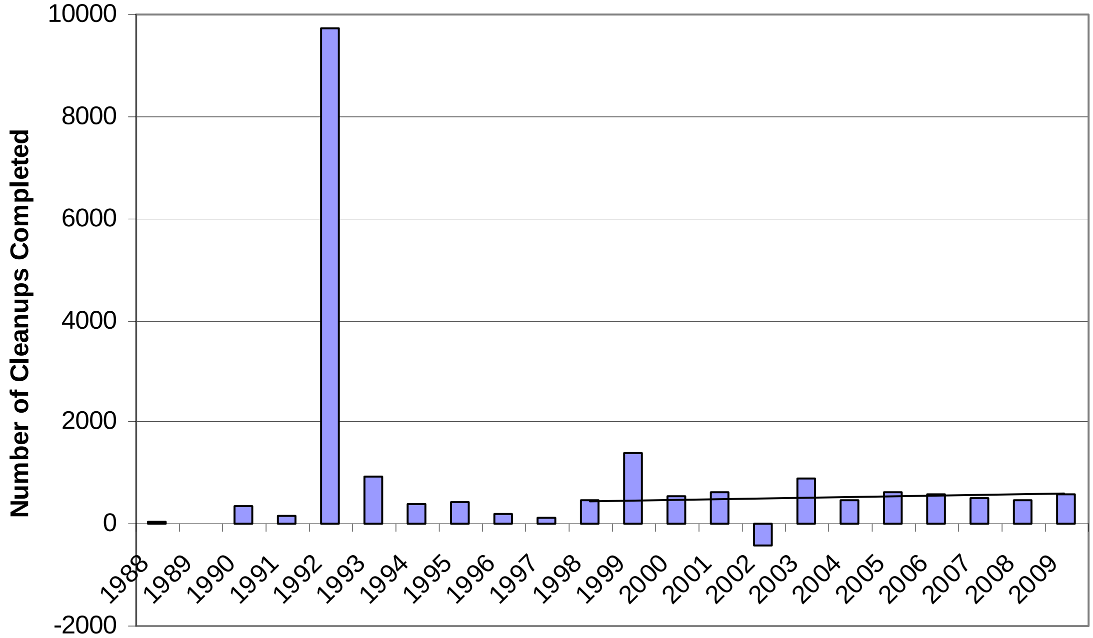


Figure 30. Annual Reported Number of Cleanups Completed in North Carolina 1988 through 2009.

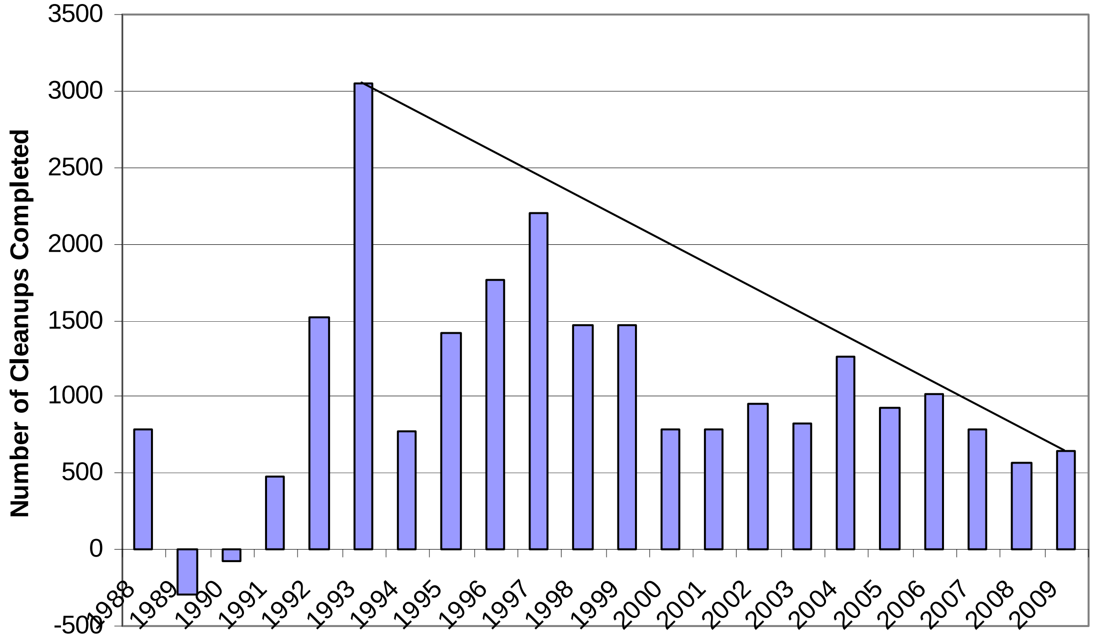


Figure 31. Annual Reported Number of Cleanups Completed in Texas 1988 through 2009.

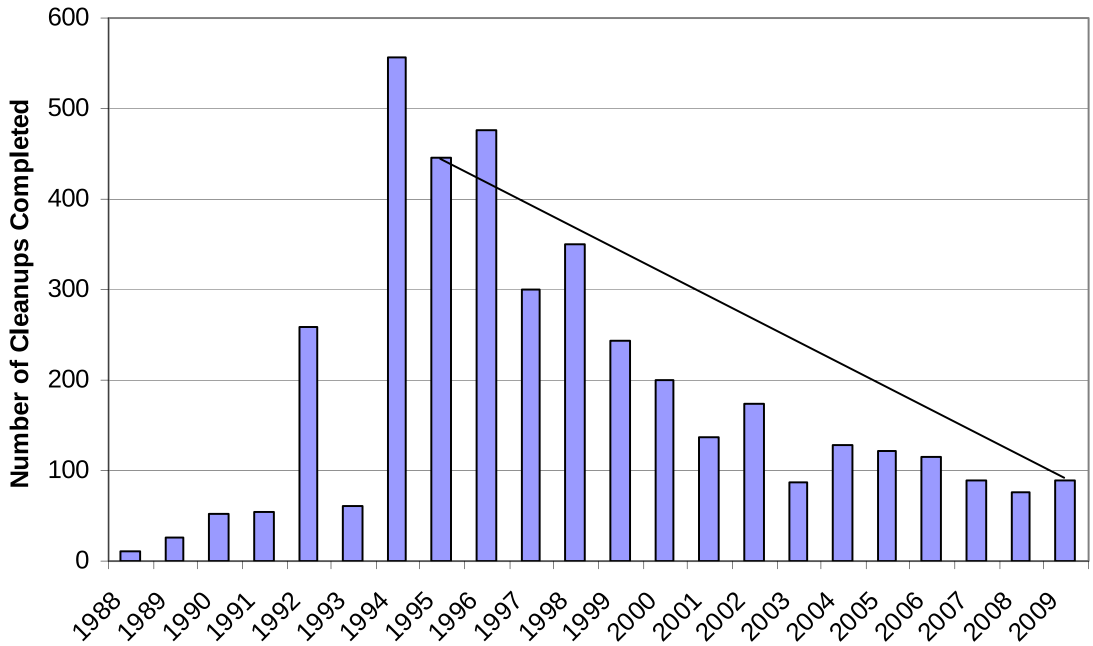


Figure 32. Annual Reported Number of Cleanups Completed in Utah 1988 through 2009.

implementation period. The trend in IA as presented by Connor and McHugh (2002) is strongly increasing as opposed to slightly decreasing as found in the current investigation (see Figure 28). Part of the discrepancy may be explained by the fact that Connor and McHugh apparently used a different set of cleanup data. Their graph shows stacked bars during the post-RBCA period with sites segregated into three groups: “RBCA Tier 1”, “RBCA Tier 2”, and “Other”. Data available for the current investigation are not differentiated in such a manner. It is apparent, however, from Figure 28 that the average number of cleanups completed in IA during the post-RBCA period is significantly greater than during the pre-RBCA period even when data prior to 1991 are ignored. The situation in NC (Figure 30) is unclear due to a peculiarity in the reported cleanups completed data: the anomalous spike in 1992. Though also evidenced by Connor and McHugh (2002), their spike is more than an order of magnitude lower (somewhat less than 800 compared to nearly 10,000). This anomaly in the data used in the current investigation is sufficient to boost the pre-RBCA period average to more than double the average of the post-RBCA period.

In looking at the result of statistical modeling, 3 (IA, IL, and NC) of these 5 states are identified as having a positive RBCA impact; the other 2 (TX and UT) have negative impacts in terms of cleanups completed. Granted that the time periods are not identical, the current investigation benefits from a longer post-implementation period to assess the impact of RBCA (1990 through 2009 versus 1990 through 1999), being able to control for a number of explanatory variables, and having nearly 10 times as many states for analysis.

4.4 Limitations of Current Investigation

My investigation is limited chiefly by data quality and confounding factors. Primary data elements reported by states to EPA (i.e., number of confirmed releases, number of cleanups initiated, and number of active tanks) have a large number of data anomalies, many of which have been “corrected” by later data submissions, but not all. Plots of residual errors also exhibit some data outliers, and because they can potentially influence (or distort) regression analysis it is preferable to correct or disregard them. This is not practicable in this case given the uncertainties inherent in the available data. Cost data are especially problematic. They are neither complete nor necessarily comparable with other states’ data. The data available also do not account for all potentially explanatory variables. Regression models do not fully satisfy the conditions necessary for statistical inference; however, neither heteroscedasticity nor non-normality disqualify the use of regression modeling for descriptive statistical analysis.

Most (if not all) states include risk considerations in their cleanup decision-making. Constructing a control group for comparing against the treatment group to determine the impact of RBCA was not as definitive as I would have liked it to be. However, since the evaluation is on the effectiveness of RBCA as public policy for cleaning up leaking UST sites, those states that could point to a definite date on which their RBCA programs were implemented clearly belonged in the treatment group. The formal implementation of RBCA is what differentiates the two groups. I argue that the fact that members of both groups consider risk in some manner indicates that the states are more alike than different except in their formal adoption of RBCA, and it is the impact of RBCA that my investigation seeks to determine.

In summary, this study does not achieve ideal methodological conditions. The data have weaknesses, and key assumptions underlying the statistical approaches are not fully met. However, such problems are not uncommon in policy analysis and program evaluation. Even given these unavoidable limitations, I suggest that the findings reported here are a substantial improvement over previous reviews of the UST program reported in the literature and merit consideration by policy makers.

5. CONCLUSIONS

Evaluation of environmental policies depends on significant improvements in monitoring and data collection at both state and Federal levels. (Kraft and Vig, 2006)

Cleaning up contamination from leaking UST sites to be protective of human health and the environment is an important, lengthy, and expensive task. Millions of Americans rely on groundwater resources for their drinking water. A typical site takes several years to a decade or more to clean up. Annual public expenditures for cleaning up UST system releases exceed $1.5 billion. Risk-based corrective action was developed to ensure that these sites are cleaned up to protective levels appropriate for the characteristics of the site, that they are cleaned up expeditiously, and they are cleaned up at the lowest cost. Whether these goals on a national level have been achieved has not, until now, been critically assessed. This dissertation is the first systematic, critical evaluation of whether RBCA results in more leaking UST sites being cleaned up at lower average cost than conventional cleanups. It also contributes to the body of knowledge on evaluation of environmental policies. My findings are contrary to expectations and desires; thus they are likely to be controversial. However, this dissertation is not, and does not claim to be, the final word on the efficacy of RBCA; instead this work should be considered to be a starting point for more extensive and detailed ongoing assessment.

Evidence developed during this investigation in regard to the effectiveness of RBCA suggests that the pace of cleanups in some states that have adopted RBCA is slower, rather than faster, than the pace in states that have not adopted RBCA. From this perspective, then, RBCA might be viewed as a policy failure. It is possible, however, that the slower pace is due to more sites being identified as posing a higher risk and in need of being cleaned up to levels that are in fact protective of human health and the environment. In other words, RBCA may be responsible for appropriate cleanup levels being established and achievement of these goals may require longer periods of time. The pace of remediation is constrained by physical laws that ultimately limit the effectiveness of engineered systems, no matter how many resources are thrown into optimizing system performance.

With regard to the efficiency of RBCA, available cost data are limited in both quality and quantity. Results of simple graphical trend analysis suggest that the average cost per site at closure in non-RBCA states is lower than in RBCA states. Unfortunately, given the inadequacy of the available data, it was not possible using statistical modeling to determine whether the cost of cleanups differed between states that implement RBCA and those that do not. Anecdotal evidence indicates that in some states (for example South Carolina; see Table 6) cost savings may be attributable to RBCA cleanups, but definitive results will require access to data that are not presently available, and thus will depend on future studies to be conducted.

So, what should be done in light of these findings? As Sheila Jasonoff (1990) observes, "The ultimate goal of policy analysis is to bridge from the empirical and analytical to the prescriptive." While the results of this investigation are only preliminary in regard to the efficacy of RBCA, and thus not sufficiently definitive to recommend radical changes in how RBCA is implemented, it is obvious that the present monitoring and data collection process must be improved if we are ever to estimate with confidence the efficacy of RBCA or any other environmental policy or program.

6. RECOMMENDATIONS

Many data are collected that never become information because nobody ever thought very seriously about how the data might be used to draw conclusions. (Funnell, 2000)

My recommendations fall into 2 categories: (1) further investigation, (2) improvements in program monitoring and data collection processes. Information gleaned from pursuit of these recommendations should then be used to inform decision-making to improve implementation of the UST program at both the federal and state level.

Further investigation should build upon and extend the investigation. As a first step in building on the current investigation, a manageable number of states should be selected to serve as a pilot study. The quality of the data and availability for analysis should be the primary selection criteria. Also, to better leverage the results, pilot states should have a significant cleanup backlog. For this group of pilot states conduct a statistical evaluation of RBCA efficacy, an audit of closed sites, and an investigation of the correlation of RBCA to the backlog. The statistical evaluation of RBCA efficacy should be similar to this dissertation using each pilot state's own database, which is likely to be more complete, more accurate, and more comprehensive than what is reported to EPA since these would contain site-specific information. These results should be compared with both other pilot states and to the results of my investigation. This is especially important for an efficiency analysis since the aggregate data that were available for my investigation were so poorly suited to the task. The audit of closed sites should include those closed under RBCA as well as other applicable criteria (e.g., drinking water standards) to determine if they should have been closed (that is if the contaminant levels necessary for closure were in fact achieved or if the site was closed using some other criteria) or whether they should have remained open. More in-depth study of pilot states' cleanup backlog should be conducted to determine whether or not RBCA is a contributing factor in delaying cleanups and contributing to the backlog. Closer examination of the backlog complements the audit of closed sites. It is important to understand if there are a significant number of sites in the backlog that are not yet ready for closure because appropriate cleanup levels have not yet been achieved, as this would indicate that RBCA is effective in protecting human health and the environment.

My investigation could be extended in several ways, for instance by:

- evaluating additional explanatory variables,
- examining the correlation between compliance and enforcement with release confirmation, and
- applying the methodology utilized in this investigation to other EPA programs.

The primary limitation of my investigation relates to data availability. Additional potentially explanatory variables should be identified and evaluated as to their salience in measuring program performance. Independent variables that show promise should be tested to determine if the regression model improves. Candidate variables could include;

groundwater usage (EPA should have information for the year 2009 posted on the Office of Water web site within a few months), compliance with UST regulations, characteristics of the parties responsible for a majority of the cleanups in a given state, and characteristics of state funding mechanisms for cleaning up UST sites. Correlation between subsets of all available variables, for instance between compliance and enforcement with frequency and severity of releases, may provide insight into strategies to improve program performance.

The general methodology utilized in this investigation could be extended to the analysis of other EPA programs. Given the nature of the programs themselves as well as the environmental impacts, it may be most practical to start with cleanup programs in EPA's Office of Solid Waste and Emergency Response (OSWER) such as Superfund or RCRA Corrective Action.

Improvements in monitoring and data collection processes should focus on critical assessment of data that are already being collected, with an eye toward identifying data that should in addition, or instead, be collected in order to better assess performance of the program in meeting its goals of protecting human health and the environment. This may lead to development of new measures of program performance (potentially including interim measures of cleanup progress), preferably ones that are outcome-based as opposed to output-based.

As I discussed in the Introduction, OUST's founding Office Director, Ron Brand, opted to not create a national database and to keep the reporting requirements to a minimum, thus lessening the burden on nascent state UST programs. Despite assurances by UST program managers that the data already being collected are “good enough” for managing the program, the fact is that the data collected are neither of very high quality nor are they especially useful. Current performance measures really do not measure the effect of the UST program on human health and environmental quality. In particular, they do not relate directly to groundwater quality, protection of which is the primary reason that the UST program was created. All of the reporting elements are outputs; for example number of confirmed releases, number of cleanups initiated, and number of cleanups completed. This made sense at the time; the program was just getting underway and it was too early to identify outcome measures that would be both representative of the program’s impact and measurable. These data have been collected since the beginning of the program and are now institutionalized; attention is focused on meeting targets rather than accomplishing the goals the program was designed to achieve. Though there have been discussions in the past about the need for more representative measures of the program’s impact, to date there has been no sustained follow-through.

The lack of comparable information on the cost of cleanups is especially problematic as without such data, definitive assessment of program efficiency will continue to be difficult if not impossible. Cost data are collected and maintained by state programs, though typically by a different branch or even a different agency. Perhaps the reason that cost information has not been given adequate attention is because EPA does not require it to be provided and it has never been used to evaluate program performance. Requiring states to submit any information does impose a burden on states, but EPA and states should work together to overcome the difficulties as cost information is too important to be ignored any longer.

It is ironic that without an objective assessment of the program's existing "performance measures" and a commitment to developing new, more indicative measures so that collected data become useful information, the program will, as Ron Brand warned early on in the program's history, remain entrenched in the "self-defeating bureaucratic patterns that accept the absence of failure as a substitute for true success" (Cohen and Brand, 1990).

APPENDICES

APPENDIX A

Design Matrices for All Possible Subsets Regression Models

Design Matrix for All Possible Subsets Model with Six Independent Variables (64 combinations).

Run	Independent Variables						Combination
	a (x_1)	**b** (x_2)	**c** (x_3)	**d** (x_4)	**e** (x_5)	**f** (x_6)	
1	+	-	-	-	-	-	**a**
2	-	+	-	-	-	-	**b**
3	+	+	-	-	-	-	**ab**
4	-	-	+	-	-	-	**c**
5	+	-	+	-	-	-	**ac**
6	-	+	+	-	-	-	**bc**
7	+	+	+	-	-	-	**abc**
8	-	-	-	+	-	-	**d**
9	+	-	-	+	-	-	**ad**
10	-	+	-	+	-	-	**bd**
11	+	+	-	+	-	-	**abd**
12	-	-	+	+	-	-	**cd**
13	+	-	+	+	-	-	**acd**
14	-	+	+	+	-	-	**bcd**
15	+	+	+	+	-	-	**abcd**
16	-	-	-	-	+	-	**e**
17	+	-	-	-	+	-	**ae**
18	-	+	-	-	+	-	**be**
19	+	+	-	-	+	-	**abe**
20	-	-	+	-	+	-	**ce**
21	+	-	+	-	+	-	**ace**
22	-	+	+	-	+	-	**bce**
23	+	+	+	-	+	-	**abce**
24	-	-	-	+	+	-	**de**
25	+	-	-	+	+	-	**ade**
26	-	+	-	+	+	-	**bde**
27	+	+	-	+	+	-	**abde**
28	-	-	+	+	+	-	**cde**
29	+	-	+	+	+	-	**acde**
30	-	+	+	+	+	-	**bcde**
31	+	+	+	+	+	-	**abcde**
32	-	-	-	-	-	+	**f**

Design Matrix for All Possible Subsets Model with Six Independent Variables (64 combinations)-Continued.

Run	Independent Variables						Combination
	a (x_1)	b (x_2)	c (x_3)	d (x_4)	e (x_5)	f (x_6)	
33	+	-	-	-	-	+	**af**
34	-	+	-	-	-	+	**bf**
35	+	+	-	-	-	+	**abf**
36	-	-	+	-	-	+	**cf**
37	+	-	+	-	-	+	**acf**
38	-	+	+	-	-	+	**bcf**
39	+	+	+	-	-	+	**abcf**
40	-	-	-	+	-	+	**df**
41	+	-	-	+	-	+	**adf**
42	-	+	-	+	-	+	**bdf**
43	+	+	-	+	-	+	**abdf**
44	-	-	+	+	-	+	**cdf**
45	+	-	+	+	-	+	**acdf**
46	-	+	+	+	-	+	**bcdf**
47	+	+	+	+	-	+	**abcdf**
48	-	-	-	-	+	+	**ef**
49	+	-	-	-	+	+	**aef**
50	-	+	-	-	+	+	**bef**
51	+	+	-	-	+	+	**abef**
52	-	-	+	-	+	+	**cef**
53	+	-	+	-	+	+	**acef**
54	-	+	+	-	+	+	**bcef**
55	+	+	+	-	+	+	**abcef**
56	-	-	-	+	+	+	**def**
57	+	-	-	+	+	+	**adef**
58	-	+	-	+	+	+	**bdef**
59	+	+	-	+	+	+	**abdef**
60	-	-	+	+	+	+	**cdef**
61	+	-	+	+	+	+	**acdef**
62	-	+	+	+	+	+	**bcdef**
63	+	+	+	+	+	+	**abcdef**
64	-	-	-	-	-	-	

Design Matrix for All Possible Subsets Model with Five Independent Variables (32 combinations).

Run	Independent Variables					Combination
	a (x_1)	b (x_2)	c (x_3)	d (x_4)	e (x_5)	
1	+	-	-	-	-	**a**
2	-	+	-	-	-	**b**
3	+	+	-	-	-	**ab**
4	-	-	+	-	-	**c**
5	+	-	+	-	-	**ac**
6	-	+	+	-	-	**bc**
7	+	+	+	-	-	**abc**
8	-	-	-	+	-	**d**
9	+	-	-	+	-	**ad**
10	-	+	-	+	-	**bd**
11	+	+	-	+	-	**abd**
12	-	-	+	+	-	**cd**
13	+	-	+	+	-	**acd**
14	-	+	+	+	-	**bcd**
15	+	+	+	+	-	**abcd**
16	-	-	-	-	+	**e**
17	+	-	-	-	+	**ae**
18	-	+	-	-	+	**be**
19	+	+	-	-	+	**abe**
20	-	-	+	-	+	**ce**
21	+	-	+	-	+	**ace**
22	-	+	+	-	+	**bce**
23	+	+	+	-	+	**abce**
24	-	-	-	+	+	**de**
25	+	-	-	+	+	**ade**
26	-	+	-	+	+	**bde**
27	+	+	-	+	+	**abde**
28	-	-	+	+	+	**cde**
29	+	-	+	+	+	**acde**
30	-	+	+	+	+	**bcde**
31	+	+	+	+	+	**abcde**
32	-	-	-	-	-	

APPENDIX B

Data Set for all 56 State Programs for the Period 1988 through 2009

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
AK	1988	0	46	43	0		
AK	1989	0	102	98	1		
AK	1990	0	235	181	13		
AK	1991	4957	358	221	57	569273	
AK	1992	5847	611	417	161	587073	
AK	1993	3405	744	496	245	596993	
AK	1994	3128	1081	885	399	600624	
AK	1995	2938	1202	1007	478	601345	
AK	1996	2665	1302	1154	544	604918	
AK	1997	2426	1446	1172	576	608846	194,200
AK	1998	1965	1644	1369	640	615205	194,200
AK	1999	1365	2031	1738	770	619500	
AK	2000	1220	2121	1975	952	627428	27,285
AK	2001	1168	2255	2062	1063	633160	27,285
AK	2002	1149	2265	2093	1145	642391	27,858
AK	2003	1120	2270	2121	1208	650426	80,000
AK	2004	1081	2280	2187	1395	660975	222,000
AK	2005	1065	2278	2206	1545	668625	222,000
AK	2006	1142	2292	2228	1636	676301	222,000
AK	2007	1151	2292	2266	1736	681111	222,000
AK	2008	1198	2305	2277	1788	686293	0
AK	2009	1191	2300	2245	1825	698473	0
AL	1988	0	80	19	25		
AL	1989	0	268	173	24		
AL	1990	0	715	573	55		
AL	1991	33262	1063	669	237	4091025	
AL	1992	31271	1547	963	493	4139269	
AL	1993	24882	5315	4365	3701	4193114	
AL	1994	23543	6622	5232	4390	4232965	
AL	1995	22665	7577	6263	5470	4262731	
AL	1996	21968	8292	6954	6051	4290403	
AL	1997	22255	8798	8492	7362	4320281	36,200
AL	1998	21520	9094	8784	7685	4351037	40,638
AL	1999	19918	9693	9357	7969	4369862	47,546
AL	2000	18560	10106	9775	8267	4451687	46,060
AL	2001	18570	10323	10230	8412	4462832	49,187
AL	2002	18385	10489	10401	8637	4469906	55,349
AL	2003	18267	10613	10526	8886	4486598	55,200
AL	2004	18153	10763	10647	9106	4506574	66,520
AL	2005	18021	10884	10755	9317	4537299	79,000
AL	2006	19063	11059	10830	9450	4587564	86,046
AL	2007	18885	11194	10914	9661	4626595	101,242

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
AL	2008	18728	11295	10980	9862	4661900	115,722
AL	2009	18602	11398	11303	10038	4708708	119,712
AR	1988	0	0	0	0		
AR	1989	0	49	28	6		
AR	1990	0	113	88	19		
AR	1991	16202	202	160	30	2370666	
AR	1992	16030	296	236	17	2394098	
AR	1993	19784	376	369	246	2423743	
AR	1994	20337	433	426	254	2450605	
AR	1995	20407	527	517	278	2480121	
AR	1996	20736	599	581	292	2504858	
AR	1997	20897	696	630	308	2524007	219,000
AR	1998	20023	763	676	324	2538202	127,036
AR	1999	18885	855	739	330	2551373	192,125
AR	2000	9952	1020	785	659	2678217	144,738
AR	2001	9858	1091	826	708	2689601	144,641
AR	2002	9840	1144	868	781	2701889	182,405
AR	2003	9979	1181	905	843	2717909	159,334
AR	2004	9873	1243	958	911	2740191	170,447
AR	2005	9749	1294	988	948	2768918	176,317
AR	2006	9597	1324	1023	1006	2804199	179,907
AR	2007	9455	1371	1066	1063	2830557	182,378
AR	2008	9347	1415	1107	1115	2855390	
AR	2009	9251	1448	1142	1152	2889450	
AS	1988	0	0	0	0		
AS	1989	0	0	0	0		
AS	1990	0	0	0	0		
AS	1991	56	0	0	0		
AS	1992	53	2	2	0		
AS	1993	50	1	1	0		
AS	1994	53	1	1	0		
AS	1995	46	1	1	0		
AS	1996	46	1	1	0		
AS	1997	44	1	1	0		
AS	1998	45	1	1	0		
AS	1999	45	1	1	0		
AS	2000	45	1	1	0		
AS	2001	45	3	3	0		
AS	2002	17	5	5	0		
AS	2003	12	7	7	0		
AS	2004	12	7	7	6		
AS	2005	16	7	7	6		
AS	2006	16	7	7	7		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
AS	2007	16	7	7	7		
AS	2008	16	7	7	7		
AS	2009	16	8	7	7		
AZ	1988	0	7	152	163		
AZ	1989	0	322	327	137		
AZ	1990	0	1346	430	259		
AZ	1991	19888	1846	586	306	3762394	
AZ	1992	18540	2270	1679	508	3867333	
AZ	1993	12648	2768	2135	608	3993390	
AZ	1994	10183	3364	2880	883	4147561	
AZ	1995	9893	3883	3035	1091	4306908	
AZ	1996	9489	6157	3331	2660	4432308	
AZ	1997	9205	6377	3650	2627	4552207	50,000
AZ	1998	8884	7061	4780	3648	4667277	34,658
AZ	1999	8694	7526	5200	4388	4778332	45,674
AZ	2000	8613	7773	5297	5054	5166810	46,998
AZ	2001	8681	7870	5407	5361	5303632	
AZ	2002	8750	7953	5463	5422	5449195	51,347
AZ	2003	8403	8008	5516	5638	5585512	51,347
AZ	2004	8119	8137	5571	5540	5750475	
AZ	2005	8194	8191	5682	5942	5961239	
AZ	2006	6875	8273	5764	6788	6178251	
AZ	2007	7003	8316	5783	7043	6353421	
AZ	2008	7061	8489	8050	7355	6500180	269,776
AZ	2009	7050	8523	7999	7557	6595778	269,776
CA	1988	0	0	334	318		
CA	1989	0	1683	479	882		
CA	1990	0	15002	4425	1828		
CA	1991	133552	18074	5621	2420	30414114	
CA	1992	124872	21127	7923	3818	30875920	
CA	1993	130000	24615	12949	6477	31147208	
CA	1994	97623	26347	20974	6728	31317179	
CA	1995	97623	28892	22983	7560	31493525	
CA	1996	97623	29824	25024	9346	31780829	
CA	1997	58676	31264	31264	14659	32217708	45,000
CA	1998	57516	32409	32409	16484	32682794	60,000
CA	1999	45672	35525	35525	19530	33145121	98,000
CA	2000	44688	36626	36626	21281	33998767	110,000
CA	2001	43007	37153	37153	22102	34507030	110,000
CA	2002	42707	38908	38908	23230	34916495	127,000
CA	2003	41649	42344	42344	26775	35307398	127,000
CA	2004	39849	42825	42825	27776	35629666	127,000
CA	2005	38753	44190	44190	29572	35885415	127,000

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
CA	2006	37750	44967	44510	30865	36121296	174,000
CA	2007	37498	45177	45177	31855	36377534	210,000
CA	2008	37379	42983	42983	31502	36756666	300,000
CA	2009	36899	43156	43156	31222	36961664	300,000
CO	1988	0	1	57	26		
CO	1989	0	15	219	66		
CO	1990	0	1439	494	109		
CO	1991	23277	2033	1074	282	3367567	
CO	1992	22246	2425	1562	502	3459995	
CO	1993	13646	2643	2099	760	3560884	
CO	1994	13091	2832	2641	1107	3653910	
CO	1995	12956	3078	3050	1563	3738061	
CO	1996	11933	3215	3163	1758	3812716	
CO	1997	13180	3810	3672	2424	3891293	78,895
CO	1998	9932	4617	4192	3099	3968967	84,400
CO	1999	8511	5082	4721	3707	4056133	
CO	2000	7990	5293	4932	4034	4327788	
CO	2001	8059	5494	5169	4176	4431918	
CO	2002	8145	5959	5502	4651	4503156	
CO	2003	8359	6210	5890	5142	4548339	
CO	2004	8214	6368	6218	5370	4600050	
CO	2005	8165	6541	6373	5602	4662734	
CO	2006	7981	6742	6720	5824	4751474	
CO	2007	7949	6895	6849	6053	4842770	
CO	2008	7934	7059	6994	6272	4939456	
CO	2009	7893	7221	7126	6455	5024748	
CQ	1988	0	0	0	0		
CQ	1989	0	0	0	0		
CQ	1990	0	1	0	0		
CQ	1991	70	1	0	0		
CQ	1992	89	2	2	2		
CQ	1993	95	2	1	0		
CQ	1994	91	8	1	0		
CQ	1995	78	6	4	0		
CQ	1996	78	6	4	0		
CQ	1997	76	6	4	0		
CQ	1998	76	6	4	0		
CQ	1999	74	6	4	0		
CQ	2000	76	6	4	0		
CQ	2001	73	6	4	0		
CQ	2002	73	7	7	0		
CQ	2003	69	11	11	0		
CQ	2004	79	9	8	2		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
CQ	2005	77	9	8	2		
CQ	2006	75	9	8	4		
CQ	2007	68	9	8	4		
CQ	2008	68	9	8	6		
CQ	2009	68	10	9	9		
CT	1988	0	8	499	300		
CT	1989	0	396	812	465		
CT	1990	0	1047	1033	754		
CT	1991	30574	1205	1177	836	3288640	
CT	1992	34792	1287	1258	883	3274997	
CT	1993	25149	1370	1344	927	3272325	
CT	1994	22059	1445	1416	961	3268346	
CT	1995	21820	1509	1480	988	3265293	
CT	1996	21539	1564	1511	998	3267030	
CT	1997	16923	1654	1610	1026	3268514	
CT	1998	16171	1786	1742	1060	3272563	151,132
CT	1999	13912	1955	1910	1169	3282031	148,621
CT	2000	13339	1920	2048	1282	3411714	146,516
CT	2001	12953	2193	2149	1377	3428208	114,722
CT	2002	12660	2289	2245	1459	3448261	123,357
CT	2003	12495	2364	2320	1524	3467932	108,958
CT	2004	12282	2408	2363	1551	3475351	127,356
CT	2005	11871	2465	2415	1596	3478714	130,492
CT	2006	11439	2497	2444	1671	3487896	167,766
CT	2007	10849	2534	2471	1710	3489868	170,169
CT	2008	9737	2588	2527	1760	3501252	171,632
CT	2009	8576	2672	2617	1817	3518288	171,632
DC	1988	0	1	2	5		
DC	1989	0	72	21	12		
DC	1990	0	172	117	61		
DC	1991	9776	250	191	118	593239	
DC	1992	5041	356	269	177	584183	
DC	1993	5270	458	351	236	576358	
DC	1994	5237	542	439	288	564982	
DC	1995	1351	632	521	339	551273	
DC	1996	1045	736	733	427	538273	
DC	1997	983	834	834	501	528752	
DC	1998	899	947	947	589	521426	
DC	1999	811	589	589	348	519000	
DC	2000	754	647	647	424	571723	
DC	2001	747	686	686	457	577678	
DC	2002	726	720	720	473	579112	
DC	2003	723	770	770	510	577371	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
DC	2004	720	788	788	545	579521	
DC	2005	732	815	815	572	582049	
DC	2006	720	841	841	597	585419	
DC	2007	696	864	849	628	587868	
DC	2008	690	879	864	662	591833	
DC	2009	667	881	866	691	599657	
DE	1988	0	70	37	22		
DE	1989	0	556	316	8		
DE	1990	0	637	405	48		
DE	1991	7419	891	589	215	680495	
DE	1992	6492	1229	939	495	690158	
DE	1993	4015	1475	1135	683	699475	
DE	1994	3021	1741	1394	960	708416	
DE	1995	2727	2028	1735	1227	718265	
DE	1996	2578	2271	1990	1483	727090	
DE	1997	2234	2310	1926	1441	735024	58,000
DE	1998	2081	2447	2050	1592	744066	70,445
DE	1999	1835	2616	2210	1746	753538	78,048
DE	2000	1744	2692	2296	1840	786404	91,232
DE	2001	1666	2736	2352	1906	794498	94,901
DE	2002	1655	2471	2113	1716	803774	100,226
DE	2003	1610	2137	2012	1835	814262	105,778
DE	2004	1566	2220	2166	1923	825682	118,682
DE	2005	1598	2284	2228	2010	838519	209,958
DE	2006	1606	2337	2222	2093	850366	239,893
DE	2007	1467	2399	2283	2178	861953	279,252
DE	2008	1450	2474	2367	2204	873092	332,270
DE	2009	1411	2529	2431	2293	885122	163,179
FL	1988	0	0	585	0		
FL	1989	0	0	1111	30		
FL	1990	0	6924	906	140		
FL	1991	0	9242	1982	316	13289497	
FL	1992	0	11020	4515	722	13504775	
FL	1993	48368	20956	3311	2643	13713593	
FL	1994	47345	23143	4037	2959	13961798	
FL	1995	44324	24878	4444	3020	14185403	
FL	1996	41984	25746	4793	3055	14426911	
FL	1997	46937	23785	9922	490	14683350	73,000
FL	1998	34450	28011	10108	3613	14908230	73,000
FL	1999	34611	24282	12058	3717	15111244	
FL	2000	33574	24521	13437	3955	16047246	
FL	2001	32777	24716	13689	4443	16340734	
FL	2002	32352	24895	13878	6206	16652679	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
FL	2003	33248	25114	13959	7066	16937337	
FL	2004	32236	25359	14140	7815	17313811	
FL	2005	31109	23990	14618	8761	17702476	
FL	2006	30051	24325	15216	9425	18019093	
FL	2007	28862	24633	15415	10099	18199526	
FL	2008	28042	24842	15683	10915	18328340	
FL	2009	25636	25955	15891	11624	18537969	
GA	1988	0	0	0	0		
GA	1989	0	0	92	11		
GA	1990	0	718	431	70		
GA	1991	38485	1359	899	164	6621279	
GA	1992	51233	2002	1421	330	6759474	
GA	1993	49576	3979	3183	1709	6894092	
GA	1994	48832	4772	3875	2050	7045900	
GA	1995	48929	5769	4597	2314	7188538	
GA	1996	49380	6520	5224	2776	7332225	
GA	1997	47040	6017	6017	2232	7486094	97,200
GA	1998	33053	6707	6707	2738	7636522	97,200
GA	1999	30695	8375	8375	3923	7788240	83,700
GA	2000	29959	9147	9147	4605	8230053	86,100
GA	2001	30598	9562	9562	5438	8418592	82,200
GA	2002	30496	9806	1744	5858	8583674	82,200
GA	2003	39152	10219	9689	6859	8732924	90,400
GA	2004	38437	10636	10166	7712	8910741	102,121
GA	2005	30320	11023	10654	8373	9093958	106,926
GA	2006	30081	11343	10988	8953	9318715	137,125
GA	2007	30049	11685	11320	9493	9523297	133,273
GA	2008	29928	12033	11738	9969	9685744	136,166
GA	2009	29821	12319	12044	10536	9829211	138,192
GU	1988	0	25	0	0		
GU	1989	0	25	0	0		
GU	1990	0	63	66	37		
GU	1991	446	67	66	40		
GU	1992	433	70	70	52		
GU	1993	541	78	78	77		
GU	1994	557	85	85	82		
GU	1995	577	93	93	93		
GU	1996	577	93	93	111		
GU	1997	577	93	93	93		
GU	1998	577	111	102	93		
GU	1999	577	111	102	93		
GU	2000	577	111	102	93		
GU	2001	577	111	102	93		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
GU	2002	280	132	132	108		
GU	2003	280	132	132	108		
GU	2004	280	136	136	108		
GU	2005	280	135	135	110		
GU	2006	259	135	135	111		
GU	2007	267	136	136	112		
GU	2008	259	137	138	112		
GU	2009	264	138	138	113		
HI	1988	0	0	24	22		
HI	1989	0	31	56	4		
HI	1990	0	177	86	0		
HI	1991	5195	293	168	0	1131412	
HI	1992	5618	464	205	4	1149926	
HI	1993	4468	588	316	26	1161508	
HI	1994	4080	754	373	110	1173903	
HI	1995	4085	868	494	200	1180490	
HI	1996	4053	916	563	253	1184434	
HI	1997	3005	1122	642	329	1189322	
HI	1998	2693	1408	873	532	1190472	
HI	1999	2300	1652	1115	786	1185497	
HI	2000	2056	1614	1365	1048	1211479	
HI	2001	1998	1660	1469	1158	1217955	
HI	2002	1925	1702	1605	1310	1227391	
HI	2003	1867	1732	1675	1385	1238333	
HI	2004	1814	1803	1690	1437	1251532	
HI	2005	1783	1840	1741	1504	1264468	
HI	2006	1755	1874	1780	1575	1275264	
HI	2007	1692	1909	1823	1631	1277356	
HI	2008	1671	1955	1879	1695	1288198	
HI	2009	1622	1989	1909	1755	1295178	
IA	1988	0	0	65	0		
IA	1989	0	139	359	26		
IA	1990	0	1583	161	76		
IA	1991	26125	3827	702	385	2791227	
IA	1992	15904	4325	815	494	2806923	
IA	1993	13128	4361	1224	594	2820525	
IA	1994	12131	4643	1908	726	2829422	
IA	1995	11199	4876	2906	947	2840860	
IA	1996	10715	5038	3770	1059	2848473	
IA	1997	10455	5183	4138	1220	2854396	32,500
IA	1998	9719	5294	4249	1471	2861025	26,000
IA	1999	9506	5407	4411	1961	2869413	28,364
IA	2000	8433	5489	4608	2390	2928046	30,574

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
IA	2001	8310	5569	5422	2865	2929294	30,923
IA	2002	8053	5630	5445	3299	2929395	29,441
IA	2003	7910	5683	5478	3485	2933407	31,814
IA	2004	7811	5741	5506	3702	2942739	34,607
IA	2005	7716	5791	5529	3948	2951775	38,431
IA	2006	7492	5839	5544	4143	2967270	35,806
IA	2007	7372	5869	5556	4310	2983360	38,045
IA	2008	7175	5947	5583	4476	3002555	38,045
IA	2009	7873	5977	5646	4613	3007856	38,045
ID	1988	0	28	9	5		
ID	1989	0	82	33	14		
ID	1990	0	281	205	106		
ID	1991	9124	394	311	173	1038915	
ID	1992	8493	561	460	272	1066490	
ID	1993	6392	682	594	302	1101204	
ID	1994	6262	843	749	474	1135459	
ID	1995	5729	963	868	594	1165000	
ID	1996	5295	1019	937	682	1187706	
ID	1997	5295	1078	989	780	1210638	11,000
ID	1998	4657	1107	1005	812	1230923	37,677
ID	1999	3844	1160	1100	869	1251700	
ID	2000	3479	1202	1154	922	1299474	
ID	2001	3500	1260	1222	992	1320732	
ID	2002	3498	1279	1246	1059	1341408	
ID	2003	3548	1301	1274	1115	1363010	
ID	2004	3528	1321	1295	1153	1390329	
ID	2005	3498	1345	1314	1184	1424127	
ID	2006	3395	1364	1335	1205	1461183	
ID	2007	3302	1378	1347	1228	1496145	
ID	2008	3496	1401	1370	1248	1523816	
ID	2009	3492	1424	1392	1276	1545801	
IL	1988	0	549	317	0		
IL	1989	0	1536	812	27		
IL	1990	0	3348	2576	86		
IL	1991	61792	5808	4647	705	11535973	
IL	1992	63922	8422	7110	1284	11635197	
IL	1993	58515	10524	8906	2151	11725984	
IL	1994	51288	11943	10819	3295	11804986	
IL	1995	49616	13184	12145	4392	11884935	
IL	1996	48407	14073	12956	5266	11953003	
IL	1997	49567	14316	14242	6124	12011509	53,000
IL	1998	45411	16262	15671	7120	12069774	53,000
IL	1999	29826	18066	17222	8292	12128370	83,000

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
IL	2000	26615	19421	18313	9046	12437888	83,000
IL	2001	24711	20387	19059	10841	12510596	82,000
IL	2002	23906	21113	19660	11929	12565228	84,000
IL	2003	23526	21723	20232	12743	12611047	89,000
IL	2004	23274	22218	20746	13627	12665718	75,000
IL	2005	23062	22410	21211	14540	12704063	102,000
IL	2006	22875	22871	21586	15358	12759673	107,000
IL	2007	22574	23396	22022	16209	12825809	112,000
IL	2008	22192	24028	22527	17188	12901563	200,000
IL	2009	21955	24358	22834	18089	12910409	102,178
IN	1988	0	0	245	0		
IN	1989	0	510	521	0		
IN	1990	0	1575	1263	120		
IN	1991	41058	1619	1362	78	5602062	
IN	1992	29227	2963	1364	256	5648649	
IN	1993	22965	3503	837	471	5701965	
IN	1994	22694	4126	2427	1097	5745626	
IN	1995	21513	4544	2898	1170	5791819	
IN	1996	20131	5151	3363	1991	5834908	
IN	1997	19014	5491	3568	2358	5872370	51,680
IN	1998	19010	5996	3670	2961	5907617	174,619
IN	1999	12610	6904	4321	2899	5942901	150,000
IN	2000	9842	7256	5678	3336	6091392	488,111
IN	2001	14726	7455	6308	3563	6123942	139,535
IN	2002	14588	7654	6576	3789	6146974	139,535
IN	2003	14399	7919	6843	4154	6178828	133,652
IN	2004	14194	8032	7157	4583	6210801	135,000
IN	2005	14049	8275	7457	4994	6248569	135,000
IN	2006	14111	8488	7745	5568	6294124	135,000
IN	2007	13840	8637	8109	6028	6335862	174,754
IN	2008	13685	8777	8366	6330	6376792	175,948
IN	2009	13614	8949	8633	6735	6423113	180,533
KS	1988	0	38	47	41		
KS	1989	0	242	208	94		
KS	1990	0	1477	1258	588		
KS	1991	22123	2149	1913	896	2495209	
KS	1992	15331	2806	2508	1239	2526042	
KS	1993	12766	3273	2807	1419	2547605	
KS	1994	11684	3710	3066	1579	2569118	
KS	1995	10841	4001	3206	1712	2586942	
KS	1996	10302	4232	3376	1829	2598266	
KS	1997	9771	3841	3311	1844	2616339	27,643
KS	1998	9177	3961	3605	1977	2638667	30,717

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
KS	1999	8089	4180	3844	2116	2654052	33,507
KS	2000	8971	4288	3964	2225	2692681	34,607
KS	2001	8853	4357	4056	2271	2701346	35,025
KS	2002	8822	4415	4195	2357	2712561	48,509
KS	2003	7628	4487	4236	2416	2722070	35,025
KS	2004	7473	4560	4280	2478	2731069	42,593
KS	2005	7236	4616	4379	2632	2742204	42,593
KS	2006	7102	4673	4449	2751	2756267	50,693
KS	2007	6967	4803	4606	3026	2777382	54,113
KS	2008	6989	4851	4713	3203	2802134	54,313
KS	2009	6898	4917	4790	3385	2818747	54,313
KY	1988	0	17	92	59		
KY	1989	0	365	373	111		
KY	1990	0	978	695	350		
KY	1991	31347	1554	1577	672	3714686	
KY	1992	34133	2642	2608	1030	3756358	
KY	1993	24866	3606	3543	1322	3792288	
KY	1994	23275	4469	4406	2024	3823215	
KY	1995	21718	5567	5504	2981	3855248	
KY	1996	20280	6354	6291	5370	3881051	
KY	1997	20067	7396	7333	6231	3907816	52,900
KY	1998	18335	8920	8857	7136	3934310	38,112
KY	1999	15841	10718	10402	8109	3960825	37,580
KY	2000	14797	11412	11383	8564	4048831	49,738
KY	2001	14209	11767	11767	8975	4066442	54,710
KY	2002	13954	12204	12196	9516	4086754	51,108
KY	2003	13648	12624	12617	10018	4110922	51,547
KY	2004	13380	12865	12853	10343	4135567	54,216
KY	2005	13098	13151	13100	10696	4165958	61,377
KY	2006	12749	13458	13448	11051	4199440	67,366
KY	2007	12415	13699	13692	11384	4236308	67,366
KY	2008	12152	13998	13971	11865	4269245	67,366
KY	2009	11786	14275	14241	12268	4314113	51,690
LA	1988	0	0	13	8		
LA	1989	0	155	107	23		
LA	1990	0	370	147	66		
LA	1991	26658	1143	576	429	4240950	
LA	1992	25265	1407	650	541	4270849	
LA	1993	25674	1717	849	807	4284749	
LA	1994	25168	1983	1101	911	4306500	
LA	1995	23891	2165	1352	1116	4327978	
LA	1996	23207	2301	1452	1199	4338763	
LA	1997	20747	2038	1493	1280	4351390	81,433

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
LA	1998	20550	2178	1380	1067	4362758	81,433
LA	1999	22540	2340	1563	1238	4372035	137,784
LA	2000	15948	2435	1650	1359	4468879	143,905
LA	2001	18452	2474	1756	1384	4460395	156,901
LA	2002	16898	2546	1805	1454	4465215	178,680
LA	2003	14544	2580	1858	1535	4473558	195,644
LA	2004	13697	2633	1923	1618	4487830	208,888
LA	2005	13953	2719	2719	1674	4495627	215,247
LA	2006	14047	3110	3110	1901	4243634	188,814
LA	2007	16601	3286	3286	2094	4373310	194,421
LA	2008	12294	3607	3607	2361	4410796	201,587
LA	2009	12243	3898	3898	2724	4492076	189,208
MA	1988	0	0	111	110		
MA	1989	0	838	197	111		
MA	1990	0	2209	1849	1467		
MA	1991	28986	2775	2348	1775	5998652	
MA	1992	24825	3406	2883	1944	5993474	
MA	1993	22615	3587	3066	2033	6010884	
MA	1994	25784	3896	3282	2083	6031352	
MA	1995	20824	4188	3467	2163	6062335	
MA	1996	20451	4517	3815	2362	6085393	
MA	1997	19858	4873	4163	2627	6115476	13,000
MA	1998	25484	5280	4551	2920	6144407	13,000
MA	1999	12619	5390	5139	3035	6175169	63,800
MA	2000	12122	5622	5438	3651	6362583	
MA	2001	11864	5693	5442	3799	6407269	79,768
MA	2002	11673	5817	5608	4070	6433043	97,000
MA	2003	11567	5906	5697	4385	6441440	121,000
MA	2004	11441	6009	5796	4715	6437414	97,000
MA	2005	11368	6103	5890	5026	6434343	127,000
MA	2006	11211	6186	5982	5230	6443424	142,000
MA	2007	11021	6263	6059	5422	6467915	174,970
MA	2008	10711	6316	6112	5584	6497967	156,000
MA	2009	10410	6202	6165	5792	6593587	188,907
MD	1988	0	77	31	36		
MD	1989	0	332	131	126		
MD	1990	0	4418	3784	878		
MD	1991	29472	6394	5625	1786	4856176	
MD	1992	21659	9798	7965	2813	4902545	
MD	1993	38630	10074	9222	3446	4942504	
MD	1994	21228	11034	10100	3871	4985411	
MD	1995	18920	11920	10900	4419	5023650	
MD	1996	17940	12831	11661	4904	5057142	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
MD	1997	17809	13287	11936	5532	5092914	56,518
MD	1998	17925	13728	12330	6148	5130072	63,550
MD	1999	8555	14266	12725	6942	5171634	69,000
MD	2000	8784	14679	12993	7517	5310451	69,700
MD	2001	8879	11448	9841	8002	5375659	56,843
MD	2002	9253	11659	10012	8404	5439327	55,495
MD	2003	9294	11937	10118	8604	5495009	46,154
MD	2004	9423	12216	10619	8936	5538989	70,287
MD	2005	9439	10201	9944	9282	5575552	62,462
MD	2006	9317	10421	10162	9641	5602258	62,462
MD	2007	9243	10903	10651	9971	5618899	62,462
MD	2008	8580	11109	10861	10432	5633597	
MD	2009	8337	11281	11036	10700	5699478	
ME	1988	0	0	160	284		
ME	1989	0	70	186	437		
ME	1990	0	676	663	580		
ME	1991	23217	803	793	680	1235439	
ME	1992	17134	924	896	751	1235748	
ME	1993	14999	1051	1004	900	1238256	
ME	1994	13816	1199	1195	1074	1237687	
ME	1995	12307	1332	1326	1257	1237438	
ME	1996	12226	1415	1400	1355	1241436	
ME	1997	12156	1559	1543	1471	1245215	44,950
ME	1998	5770	1744	1680	1597	1247554	41,517
ME	1999	3754	1797	1722	1633	1253040	31,883
ME	2000	3709	1845	1751	1659	1277179	42,000
ME	2001	3716	1882	1867	1784	1284663	42,000
ME	2002	3696	1968	1950	1891	1293667	42,000
ME	2003	3513	2039	2020	1938	1302729	63,067
ME	2004	3509	2129	2071	1995	1307904	64,125
ME	2005	3359	2215	2156	2075	1311044	64,563
ME	2006	3308	2261	2229	2173	1313355	
ME	2007	3199	2347	2305	2262	1315398	
ME	2008	3102	2443	2391	2403	1316456	
ME	2009	3049	2500	2477	2464	1318301	31,900
MI	1988	0	0	306	0		
MI	1989	0	0	754	140		
MI	1990	0	2747	1801	46		
MI	1991	72275	5401	4249	507	9395022	
MI	1992	69133	7296	6944	1048	9470323	
MI	1993	40317	9099	9160	1988	9529240	
MI	1994	38235	10423	10631	2759	9584481	
MI	1995	35804	13586	12635	3753	9659871	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
MI	1996	33880	14456	14285	4881	9739184	
MI	1997	29282	15486	15242	6428	9785450	
MI	1998	27648	16692	16149	7853	9820231	
MI	1999	24805	17997	17376	8975	9863775	87,169
MI	2000	23067	18914	18269	9768	9955146	87,169
MI	2001	20910	19322	18637	10235	10004341	87,169
MI	2002	23433	19676	19230	10796	10037303	87,246
MI	2003	21862	20058	19690	11135	10065881	87,169
MI	2004	21246	20511	19909	11472	10090280	87,169
MI	2005	20730	20822	20314	11740	10093266	87,169
MI	2006	20420	21129	20665	12060	10083878	87,169
MI	2007	20155	21371	20949	12294	10049790	50,000
MI	2008	19797	21635	21173	12452	10003422	64,000
MI	2009	19529	21818	21360	12655	9969727	64,000
MN	1988	0	612	452	0		
MN	1989	0	830	640	125		
MN	1990	0	3116	1331	353		
MN	1991	36032	4372	1947	857	4427429	
MN	1992	33033	3739	2978	1367	4471503	
MN	1993	21992	4337	3463	1840	4521709	
MN	1994	21624	4917	4111	2398	4566028	
MN	1995	21255	5442	4808	3137	4605445	
MN	1996	20712	5925	5286	3878	4647723	
MN	1997	15646	6396	5736	4632	4687726	41,000
MN	1998	16469	7013	6260	5292	4726411	41,000
MN	1999	13906	7755	6790	5794	4775508	
MN	2000	13574	8069	7178	6293	4933787	
MN	2001	13590	8202	7653	6732	4982339	
MN	2002	13778	9035	8335	7493	5016643	
MN	2003	13989	9243	8641	7873	5046708	
MN	2004	14129	9390	8920	8191	5078014	
MN	2005	14328	9555	9064	8490	5104890	
MN	2006	14414	9740	9697	8756	5143134	
MN	2007	14532	10020	9894	9090	5182360	
MN	2008	14608	10208	10111	9400	5220393	
MN	2009	14694	10416	10327	9684	5266214	
MO	1988	0	47	6	4		
MO	1989	0	62	30	20		
MO	1990	0	687	482	315		
MO	1991	24534	1396	1156	827	5157770	
MO	1992	20443	2121	1812	1283	5193686	
MO	1993	19619	2783	2404	1794	5237757	
MO	1994	17843	3542	3078	2265	5281206	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
MO	1995	16286	3971	3599	2681	5324610	
MO	1996	20271	4288	3977	2907	5367888	
MO	1997	20000	4500	4149	3141	5407113	25,840
MO	1998	13967	4867	4334	3327	5437562	30,687
MO	1999	11399	5196	5082	3788	5468338	35,888
MO	2000	11039	5568	5324	3538	5605868	90,048
MO	2001	10723	5628	5613	4289	5641994	54,425
MO	2002	10660	5775	5566	4413	5675641	59,155
MO	2003	10318	5933	5608	4525	5704639	63,309
MO	2004	10281	6075	5659	4619	5742650	65,430
MO	2005	10305	6184	5803	4798	5785130	67,385
MO	2006	10274	6252	5875	4928	5832977	69,596
MO	2007	10267	6297	6039	5051	5878399	
MO	2008	10109	6374	6112	5165	5911605	76,057
MO	2009	9717	6530	6256	5385	5987580	78,936
MS	1988	0	0	6	4		
MS	1989	0	83	25	32		
MS	1990	0	259	139	52		
MS	1991	20389	411	184	70	2591230	
MS	1992	17181	521	427	276	2610193	
MS	1993	13112	3383	3099	3068	2635574	
MS	1994	12167	3905	3510	3318	2663450	
MS	1995	11706	4259	4124	3870	2690788	
MS	1996	11420	4546	4435	4186	2709925	
MS	1997	11146	4867	4737	4478	2731826	60,882
MS	1998	10395	5291	5116	4842	2751335	66,666
MS	1999	9918	5700	5502	5237	2768619	82,161
MS	2000	9533	5926	5726	5487	2848293	75,900
MS	2001	9337	6048	5853	5642	2853061	98,046
MS	2002	9159	6177	5980	5786	2858013	94,010
MS	2003	9079	6298	6129	5966	2866711	113,222
MS	2004	8886	6456	6301	6155	2884596	113,534
MS	2005	8713	6540	6355	6224	2898209	120,465
MS	2006	8610	6626	6534	6302	2896713	134,000
MS	2007	8782	6815	6709	6510	2921030	72,833
MS	2008	8718	6934	6859	6645	2938618	130,831
MS	2009	8680	7031	6932	6721	2951996	142,437
MT	1988	0	54	25	14		
MT	1989	0	333	196	148		
MT	1990	0	374	336	144		
MT	1991	21154	721	594	248	807837	
MT	1992	12828	1118	904	431	822436	
MT	1993	7632	1405	1142	585	839876	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
MT	1994	6459	1775	1295	889	854923	
MT	1995	6028	2582	1543	1008	868522	
MT	1996	5715	2839	2839	1563	876656	
MT	1997	5211	3075	3075	1812	878706	29,200
MT	1998	4645	3360	2669	2028	879533	39,558
MT	1999	3988	3644	2853	2210	882779	
MT	2000	3610	2919	2237	1714	903283	
MT	2001	3615	2953	2244	1750	905854	
MT	2002	3605	2982	2259	1805	909859	
MT	2003	3415	2863	2146	1782	916754	
MT	2004	3342	2854	2106	1769	925969	
MT	2005	3311	2898	2123	1785	934888	
MT	2006	3308	2963	2601	1821	945428	
MT	2007	3290	2974	2614	1859	956624	
MT	2008	3260	2987	2614	1897	967440	
MT	2009	3247	2999	2620	1944	974989	
NC	1988	0	151	108	46		
NC	1989	0	310	417	42		
NC	1990	0	2125	1234	386		
NC	1991	84060	2991	2230	555	6748135	
NC	1992	60309	13272	12575	10284	6831850	
NC	1993	51537	15376	14328	11218	6947412	
NC	1994	46172	16901	15891	11608	7060959	
NC	1995	42513	18203	17289	12047	7185403	
NC	1996	42505	18696	17727	12232	7307658	
NC	1997	36726	18835	17816	12342	7428672	88,882
NC	1998	36092	19603	18176	12810	7545828	101,547
NC	1999	32823	21510	20081	14201	7650789	101,445
NC	2000	32012	22091	20628	14758	8078824	78,823
NC	2001	31594	22384	20920	15363	8199913	143,218
NC	2002	31322	21750	20456	14927	8311263	61,729
NC	2003	31057	22941	22232	15819	8409660	90,530
NC	2004	30693	23233	22338	16306	8523199	113,214
NC	2005	30271	23520	22438	16942	8661061	122,648
NC	2006	29424	23811	22527	17516	8845343	123,123
NC	2007	28705	24093	22673	18027	9041594	132,562
NC	2008	28375	24321	22745	18511	9222414	121,950
NC	2009	27806	24555	22808	19085	9380884	198,137
ND	1988	0	0	8	8		
ND	1989	0	18	26	8		
ND	1990	0	177	138	87		
ND	1991	8186	337	296	185	634199	
ND	1992	8030	474	426	229	635427	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
ND	1993	4336	564	512	297	637229	
ND	1994	3929	634	580	352	639762	
ND	1995	3715	679	629	391	641548	
ND	1996	3539	721	672	428	642858	
ND	1997	3140	767	718	465	640945	14,631
ND	1998	2992	610	311	311	637808	14,500
ND	1999	2506	743	648	672	633666	
ND	2000	2407	799	811	742	641183	
ND	2001	2296	810	824	765	636211	
ND	2002	2270	812	826	766	633521	
ND	2003	2198	789	780	745	632689	
ND	2004	2187	811	800	768	636196	
ND	2005	2185	812	803	779	635222	
ND	2006	2168	814	805	789	636453	
ND	2007	2163	825	814	802	637904	
ND	2008	2151	828	817	810	641481	
ND	2009	2136	834	821	820	646844	
NE	1988	0	79	17	16		
NE	1989	0	278	32	1		
NE	1990	0	818	46	4		
NE	1991	17658	1457	56	6	1590805	
NE	1992	10859	1837	260	117	1602406	
NE	1993	10745	2547	880	649	1612149	
NE	1994	10088	3020	1198	1009	1621551	
NE	1995	9618	3381	1353	1153	1635142	
NE	1996	9545	3868	1501	1280	1647657	
NE	1997	9009	4523	1925	1650	1656042	67,692
NE	1998	8839	4861	2209	1951	1660772	69,800
NE	1999	8586	5435	2468	2172	1666028	66,798
NE	2000	7135	5620	2617	2326	1713194	66,196
NE	2001	7044	5700	2782	2480	1717705	61,720
NE	2002	6997	5798	2963	2660	1724236	57,235
NE	2003	6955	5876	3237	2927	1732873	54,728
NE	2004	6959	5922	3973	3660	1741450	55,200
NE	2005	6999	5951	4089	3776	1751069	59,012
NE	2006	6915	6021	4332	4023	1759779	62,023
NE	2007	6903	6060	4476	4176	1769473	67,250
NE	2008	6886	6098	4591	4292	1783432	69,190
NE	2009	6825	6147	4705	4404	1796619	70,700
NH	1988	0	46	147	82		
NH	1989	0	292	269	106		
NH	1990	0	407	402	137		
NH	1991	11096	449	455	163	1107055	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
NH	1992	13366	575	575	266	1112766	
NH	1993	7162	1098	1098	414	1122191	
NH	1994	6747	1242	1242	534	1133054	
NH	1995	6327	1534	1534	632	1145604	
NH	1996	5913	1589	1589	696	1160768	
NH	1997	3923	1745	1745	773	1173239	56,418
NH	1998	3551	1819	1819	835	1185823	73,385
NH	1999	3245	1912	1912	904	1201134	
NH	2000	3061	1970	1970	1008	1240361	
NH	2001	3050	2018	2018	1118	1256625	69,000
NH	2002	3036	2062	2101	1222	1270701	
NH	2003	3023	2118	2118	1257	1281260	98,000
NH	2004	2996	2166	2166	1329	1292064	106,000
NH	2005	2935	2218	2218	1389	1300530	128,860
NH	2006	2891	2275	2275	1449	1308824	141,928
NH	2007	3063	2319	2319	1519	1312256	156,603
NH	2008	3102	2358	2358	1589	1315809	172,359
NH	2009	3143	2396	2396	1667	1324575	172,359
NJ	1988	0	0	147	57		
NJ	1989	0	753	822	26		
NJ	1990	0	2153	1636	53		
NJ	1991	47977	3073	2288	104	7784269	
NJ	1992	51558	4094	2981	732	7827770	
NJ	1993	30411	4481	3624	1303	7874891	
NJ	1994	27709	5123	4266	1857	7918796	
NJ	1995	15980	5734	4877	2413	7965523	
NJ	1996	29029	6136	5279	3053	8009624	
NJ	1997	28646	6559	5702	3497	8054178	
NJ	1998	27766	6978	6121	3854	8095542	
NJ	1999	24256	7533	6676	4208	8143412	
NJ	2000	23250	8070	7213	4543	8430913	
NJ	2001	22186	8565	7708	4956	8490942	
NJ	2002	21253	8948	8022	5207	8547410	
NJ	2003	19174	9146	8289	5416	8589562	
NJ	2004	18608	9383	8526	5558	8620770	
NJ	2005	17931	9669	8812	5734	8634657	
NJ	2006	17467	9889	9032	5889	8640218	
NJ	2007	16830	10064	9208	5991	8653126	
NJ	2008	16138	10266	9410	6120	8682661	
NJ	2009	15764	10431	9575	6270	8707739	
NM	1988	0	36	54	20		
NM	1989	0	102	154	42		
NM	1990	0	333	266	115		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
NM	1991	12290	616	457	206	1547115	
NM	1992	8411	1147	690	369	1580750	
NM	1993	6638	1425	912	587	1614937	
NM	1994	6431	1658	1080	742	1653329	
NM	1995	5903	1737	1286	904	1682417	
NM	1996	5433	1822	1313	943	1706151	
NM	1997	4387	1998	1442	1145	1722939	
NM	1998	4141	2063	1454	1145	1733535	10,000
NM	1999	4526	2190	1519	1203	1739844	
NM	2000	4293	2318	1554	1182	1820704	
NM	2001	4266	2350	1605	1224	1828330	350,000
NM	2002	4251	2377	1628	1392	1848986	49,012
NM	2003	4201	2408	1651	1478	1867909	49,012
NM	2004	4164	2433	1667	1520	1889266	
NM	2005	4098	2471	1786	1633	1912884	
NM	2006	4089	2490	1809	1706	1937916	
NM	2007	4027	2508	1843	1787	1964402	
NM	2008	3988	2524	1858	1852	1984356	
NM	2009	3958	2542	1879	1785	2009671	
NV	1988	0	87	30	54		
NV	1989	0	217	143	89		
NV	1990	0	622	351	223		
NV	1991	6576	892	671	495	1285046	
NV	1992	5986	1131	863	657	1330694	
NV	1993	6929	1511	1284	1011	1380197	
NV	1994	6249	1630	1437	1153	1456388	
NV	1995	6190	1754	1562	1292	1525777	
NV	1996	5836	1839	1648	1488	1596476	
NV	1997	4389	1992	1777	1642	1675581	89,446
NV	1998	4004	2070	1855	1739	1743772	89,446
NV	1999	3636	2211	2000	1879	1809253	
NV	2000	3490	2263	2052	1913	2018244	
NV	2001	3591	2357	2361	2030	2093973	
NV	2002	3649	2384	2384	2083	2164518	
NV	2003	3696	2407	2400	2130	2233830	
NV	2004	3677	2400	2390	2125	2323875	
NV	2005	3688	2416	2408	2166	2401671	
NV	2006	3721	2420	2419	2207	2484196	
NV	2007	3669	2425	2424	2233	2554344	
NV	2008	3770	2436	2435	2255	2600167	
NV	2009	3781	2457	2456	2288	2643085	
NY	1988	0	711	2033	50		
NY	1989	0	2209	3589	1755		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
NY	1990	0	6070	6039	3948		
NY	1991	85410	6666	6637	4309	18029532	
NY	1992	51006	7807	7737	5105	18082032	
NY	1993	78209	9475	9280	6222	18140894	
NY	1994	60883	10301	10106	6938	18156652	
NY	1995	58812	12162	11720	8818	18150928	
NY	1996	44730	13114	12641	8390	18143805	
NY	1997	40808	14042	13565	8651	18143184	
NY	1998	37232	14930	14705	9691	18159175	
NY	1999	31717	16327	15828	10567	18196601	
NY	2000	32928	17091	16569	13668	18998429	
NY	2001	32374	17729	17200	14439	19088220	
NY	2002	32749	18277	17729	15193	19161573	
NY	2003	30078	19275	18691	16477	19230877	
NY	2004	30161	19621	19200	17324	19301113	
NY	2005	29925	20442	20022	18442	19336376	
NY	2006	28749	24898	24881	21926	19367028	
NY	2007	28897	25591	25562	22904	19429316	
NY	2008	29419	26261	26244	23818	19490297	
NY	2009	27348	27225	27205	24896	19541453	
OH	1988	0	318	318	0		
OH	1989	0	1286	1146	0		
OH	1990	0	2116	1285	0		
OH	1991	74959	3730	3125	293	10933683	
OH	1992	74959	10406	9144	2286	11007609	
OH	1993	38181	13759	12360	4287	11070385	
OH	1994	36273	16398	14929	6178	11111451	
OH	1995	34270	17948	16591	8126	11155493	
OH	1996	31760	7488	7443	8785	11187032	
OH	1997	31712	15801	15517	11608	11212498	46,591
OH	1998	31244	17548	17142	13312	11237752	53,337
OH	1999	29500	20395	20085	15945	11256654	55,000
OH	2000	29037	21647	21195	16858	11363719	58,720
OH	2001	28289	22291	21728	17793	11391298	51,229
OH	2002	27605	22438	22014	18224	11410582	55,269
OH	2003	25049	22819	22440	19022	11430306	25,144
OH	2004	24475	23367	22946	19904	11445095	58,587
OH	2005	24025	23559	23028	20300	11450954	61,147
OH	2006	23594	24116	23309	21410	11458390	62,431
OH	2007	22998	26198	25640	23277	11477641	68,665
OH	2008	23382	27045	26173	24196	11485910	69,326
OH	2009	23067	27866	27064	25046	11542645	69,910
OK	1988	0	0	48	0		

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
OK	1989	0	185	85	89		
OK	1990	0	603	207	157		
OK	1991	27924	918	325	365	3166471	
OK	1992	29384	1246	408	408	3204174	
OK	1993	20282	1923	1364	903	3228829	
OK	1994	18445	2395	1834	1079	3246119	
OK	1995	16898	2759	2329	1297	3265547	
OK	1996	16388	3021	2711	1619	3289634	
OK	1997	16070	3173	2711	1619	3314259	78,000
OK	1998	14725	3427	3015	1947	3339478	85,000
OK	1999	12143	3622	3172	2122	3358044	88,576
OK	2000	12067	3629	3629	2682	3453861	
OK	2001	12071	3731	3731	2957	3463387	
OK	2002	11937	3815	3815	3142	3482946	
OK	2003	11985	3871	3871	3312	3496157	
OK	2004	11796	3946	3946	3444	3511960	
OK	2005	11582	4036	4036	3537	3530087	
OK	2006	11378	4398	4398	3852	3568132	
OK	2007	11102	4504	4504	3991	3608123	
OK	2008	11003	4623	4623	4172	3642361	
OK	2009	10742	4720	4702	4320	3687050	
OR	1988	0	0	92	86		
OR	1989	0	606	501	314		
OR	1990	0	1726	1152	540		
OR	1991	17240	2657	1500	730	2918745	
OR	1992	16105	3535	2071	1074	2973934	
OR	1993	12864	4132	2532	1274	3034490	
OR	1994	12543	4637	4084	1396	3087142	
OR	1995	11794	4722	4430	1589	3141421	
OR	1996	10990	5100	3164	1721	3195087	
OR	1997	10554	5439	4128	2682	3243254	
OR	1998	9590	5844	4530	2844	3282055	
OR	1999	8370	6250	5506	3272	3316154	
OR	2000	7370	6277	5634	3584	3430828	
OR	2001	6961	6360	5870	4118	3470716	
OR	2002	6866	6616	6193	4675	3517982	
OR	2003	6755	6737	6369	5060	3551877	
OR	2004	6531	6794	6478	5268	3576262	
OR	2005	6375	6861	6613	5472	3621939	
OR	2006	6181	6935	6709	5646	3680968	
OR	2007	6112	7047	6755	5791	3735549	
OR	2008	6008	7122	6823	5907	3790060	
OR	2009	5896	7183	6933	6045	3825657	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
PA	1988	0	0	0	0		
PA	1989	0	0	0	0		
PA	1990	0	1103	887	248		
PA	1991	90321	1771	1438	343	11943160	
PA	1992	66289	2988	2231	487	11980819	
PA	1993	62679	3928	2931	624	12022128	
PA	1994	61500	5007	3740	851	12042545	
PA	1995	42290	5891	4512	1182	12044780	
PA	1996	41305	7286	5784	2196	12038008	
PA	1997	38829	8482	8187	3546	12015888	68,460
PA	1998	36767	9891	9497	4034	12002329	82,516
PA	1999	31239	10945	10504	6162	11994016	83,800
PA	2000	28842	12131	11613	7191	12285041	96,141
PA	2001	27878	12464	11920	7741	12284522	99,500
PA	2002	28095	12454	12267	8488	12298775	100,000
PA	2003	27079	13248	13140	9133	12317647	100,000
PA	2004	26992	13609	13495	9153	12335652	121,060
PA	2005	25545	13861	13440	9798	12351881	146,000
PA	2006	25116	14171	13641	10329	12388055	36,000
PA	2007	24677	14420	13837	10811	12419930	36,300
PA	2008	24235	14679	14599	11311	12448279	158,228
PA	2009	24125	14880	14782	11814	12604767	161,218
PR	1988	0	0	0	0		
PR	1989	0	10	10	4		
PR	1990	0	98	98	26		
PR	1991	6420	111	109	36	3800000	
PR	1992	6555	125	124	41	3800000	
PR	1993	7021	162	161	53	3800000	
PR	1994	6903	212	207	63	3800000	
PR	1995	7778	330	294	84	3800000	
PR	1996	7855	464	413	96	3800000	
PR	1997	6347	579	568	129	3800000	
PR	1998	5680	633	596	150	3800000	
PR	1999	5273	693	656	156	3889507	
PR	2000	4637	845	716	194	3814413	
PR	2001	4660	936	783	239	3837768	
PR	2002	4679	964	798	273	3858272	
PR	2003	4681	995	826	354	3876637	
PR	2004	4688	1002	853	405	3893931	
PR	2005	4602	1022	868	440	3910707	
PR	2006	4603	1026	882	458	3926698	
PR	2007	4560	1028	896	474	3941160	
PR	2008	4545	1030	900	487	3954037	

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
PR	2009	4501	1042	822	486	3967288	
RI	1988	0	58	53	57		
RI	1989	0	113	106	72		
RI	1990	0	160	168	86		
RI	1991	6271	251	259	131	1003990	
RI	1992	6264	345	345	328	1000571	
RI	1993	6438	449	449	383	997852	
RI	1994	6547	599	599	434	993412	
RI	1995	6604	743	743	567	989203	
RI	1996	6659	859	811	601	987858	
RI	1997	2551	920	815	608	986966	
RI	1998	2276	1168	842	623	987704	73,386
RI	1999	1824	1361	918	647	990819	87,604
RI	2000	1795	1114	1114	790	1050725	115,465
RI	2001	1757	1154	1154	859	1058065	
RI	2002	1746	1168	1167	875	1065937	139,001
RI	2003	1742	1189	1189	936	1071302	151,834
RI	2004	1708	1218	1218	958	1071095	190,027
RI	2005	1691	1238	1238	978	1064439	190,476
RI	2006	1648	1260	1260	1006	1058991	186,291
RI	2007	1627	1309	1309	1031	1053136	192,944
RI	2008	1619	1319	1319	1057	1050788	202,858
RI	2009	1612	1324	1324	1078	1053209	211,791
SC	1988	0	254	87	24		
SC	1989	0	406	281	90		
SC	1990	0	1461	340	33		
SC	1991	34090	1480	396	43	3559470	
SC	1992	26295	2870	414	46	3600576	
SC	1993	21644	2692	1656	280	3634507	
SC	1994	21262	3280	1941	372	3666456	
SC	1995	19387	4045	2052	575	3699943	
SC	1996	18897	4311	2531	647	3738974	
SC	1997	15986	6243	4298	2395	3790066	27,880
SC	1998	14531	6716	4864	2707	3839578	28,897
SC	1999	13043	7483	6224	3438	3885736	32,961
SC	2000	12727	7852	7158	3952	4023396	33,629
SC	2001	12654	8085	7601	4248	4061844	35,298
SC	2002	12508	8265	7873	4438	4102211	39,727
SC	2003	12398	8411	7949	4776	4143420	41,773
SC	2004	12255	8541	8127	5026	4196799	44,155
SC	2005	12137	8698	8239	5325	4249385	47,556
SC	2006	12027	8851	8344	5573	4324799	48,173
SC	2007	11981	9019	8480	5865	4404914	52,086

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
SC	2008	11925	9168	8503	6096	4479800	56,337
SC	2009	11861	9319	8956	6358	4561242	62,178
SD	1988	0	23	45	55		
SD	1989	0	40	102	59		
SD	1990	0	550	471	110		
SD	1991	7889	922	754	228	701445	
SD	1992	8325	1226	1015	459	708698	
SD	1993	4699	1366	1128	617	716258	
SD	1994	5325	1474	1272	722	723038	
SD	1995	4724	1590	1396	899	728251	
SD	1996	4355	1703	1504	1059	730699	
SD	1997	4510	1799	1597	1112	730855	47,400
SD	1998	3949	1937	1725	1194	730789	48,765
SD	1999	3730	2090	1938	1311	733133	49,355
SD	2000	3292	2176	2041	1511	755657	
SD	2001	3248	2250	2128	1658	758705	
SD	2002	3173	2263	2181	1840	761709	
SD	2003	3027	2210	2148	1959	766440	
SD	2004	3060	2323	2302	2076	773539	
SD	2005	2980	2347	2344	2147	779315	
SD	2006	3019	2357	2357	2197	787380	
SD	2007	3021	2368	2368	2271	795689	
SD	2008	3055	2382	2381	2310	804194	
SD	2009	3035	2411	2410	2424	812383	
TN	1988	0	238	43	136		
TN	1989	0	564	122	79		
TN	1990	0	940	409	178		
TN	1991	42512	1311	590	235	4946886	
TN	1992	44243	5050	4344	3910	5013999	
TN	1993	31453	6014	5031	4424	5085666	
TN	1994	30205	7252	6296	5462	5163016	
TN	1995	28839	7851	6965	6380	5241168	
TN	1996	27527	8567	7691	7077	5313576	
TN	1997	27071	9330	8841	7866	5378433	66,600
TN	1998	21259	10274	9775	8720	5432679	110,000
TN	1999	17758	11057	10484	9325	5483535	88,700
TN	2000	17219	11339	10719	9890	5703094	88,400
TN	2001	16847	11672	11032	10278	5753497	91,000
TN	2002	16831	11993	11337	10647	5799093	92,000
TN	2003	16487	12236	11576	10930	5849563	92,000
TN	2004	16279	12512	11846	11291	5906936	112,000
TN	2005	16147	12842	12914	11892	5983211	176,222
TN	2006	17575	13124	13224	12331	6068306	109,500

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
TN	2007	17105	13390	13510	12854	6149116	112,000
TN	2008	16978	13751	13740	13205	6214888	113,174
TN	2009	16636	13962	13851	13450	6296254	113,174
TX	1988	0	196	690	783		
TX	1989	0	2686	2572	487		
TX	1990	0	5392	4441	412		
TX	1991	132954	8647	6339	894	17339904	
TX	1992	104366	12473	7907	2418	17650479	
TX	1993	93180	15228	9123	5473	17996764	
TX	1994	87568	16543	9378	6249	18338319	
TX	1995	83987	17737	10094	7671	18679706	
TX	1996	81239	19556	11012	9434	19006240	
TX	1997	76788	20391	12410	11639	19355427	52,395
TX	1998	72433	21205	13485	13111	19712389	50,485
TX	1999	64058	22337	13917	14579	20044141	
TX	2000	61966	22633	16898	15362	20946049	
TX	2001	61433	22829	19670	16151	21333928	52,852
TX	2002	60171	23231	22553	17105	21713397	52,852
TX	2003	58564	23487	21364	17927	22062119	52,852
TX	2004	58124	23771	21582	19194	22424884	63,153
TX	2005	57219	24301	21689	20120	22811128	63,153
TX	2006	56265	24655	21743	21137	23367534	73,500
TX	2007	54946	25096	23416	21927	23843432	73,580
TX	2008	53838	25524	23893	22491	24326974	73,580
TX	2009	53094	25813	24530	23130	24782302	83,086
UT	1988	0	16	30	10		
UT	1989	0	201	149	36		
UT	1990	0	855	327	89		
UT	1991	12882	1239	464	143	1771941	
UT	1992	10299	1558	1089	402	1821498	
UT	1993	7713	1662	1137	462	1875993	
UT	1994	8135	2239	1743	1019	1930436	
UT	1995	5655	2459	2014	1465	1976774	
UT	1996	5186	2798	2380	1941	2022253	
UT	1997	4920	3055	2633	2240	2065397	57,000
UT	1998	4631	3336	3060	2591	2100562	66,300
UT	1999	4254	3571	3259	2834	2129836	74,400
UT	2000	4181	3709	3425	3034	2244210	81,600
UT	2001	4188	3767	3510	3170	2291066	108,000
UT	2002	4160	3952	3713	3344	2334462	122,000
UT	2003	4019	3951	3749	3431	2380462	132,000
UT	2004	3995	4058	3874	3560	2439852	175,000
UT	2005	4051	4120	4032	3681	2501262	175,000

State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
UT	2006	4065	4240	4200	3796	2585155	45,483
UT	2007	4024	4341	4278	3886	2668925	46,616
UT	2008	4005	4395	4368	3963	2736424	50,000
UT	2009	3972	4456	4415	4053	2784572	50,654
VA	1988	0	199	106	24		
VA	1989	0	717	433	48		
VA	1990	0	1739	1363	218		
VA	1991	60399	2890	2084	307	6283853	
VA	1992	52648	3467	1777	480	6383315	
VA	1993	48412	4809	4454	1461	6464795	
VA	1994	44488	5512	5262	3930	6536771	
VA	1995	39937	6651	6650	5555	6601392	
VA	1996	40309	7775	7723	6220	6665491	
VA	1997	37545	8105	8049	6780	6732878	27,206
VA	1998	36469	7949	7808	6824	6789225	27,206
VA	1999	33894	8593	8467	7148	6872912	
VA	2000	32267	8764	8671	7417	7104354	
VA	2001	30612	9370	9212	8086	7188251	68,866
VA	2002	29728	9552	9407	8518	7276785	29,871
VA	2003	28524	9821	9528	8894	7363300	34,906
VA	2004	26994	10181	9847	9271	7454688	38,497
VA	2005	25464	10474	10204	9662	7546725	38,497
VA	2006	22101	10805	10571	10107	7628347	37,037
VA	2007	20600	10971	10712	10293	7698775	35,151
VA	2008	19964	11217	10983	10595	7769089	34,944
VA	2009	19455	11437	11337	10908	7882590	34,823
VI	1988	0	0	3	3		
VI	1989	0	2	2	1		
VI	1990	0	8	8	0		
VI	1991	273	12	11	0		
VI	1992	280	13	12	12		
VI	1993	293	15	15	13		
VI	1994	296	19	15	13		
VI	1995	298	19	15	13		
VI	1996	305	21	15	13		
VI	1997	304	24	15	13		
VI	1998	305	25	15	13		
VI	1999	116	10	10	0		
VI	2000	114	10	10	0		
VI	2001	113	10	10	0		
VI	2002	124	14	14	0		
VI	2003	124	14	14	0		
VI	2004	124	22	14	0		

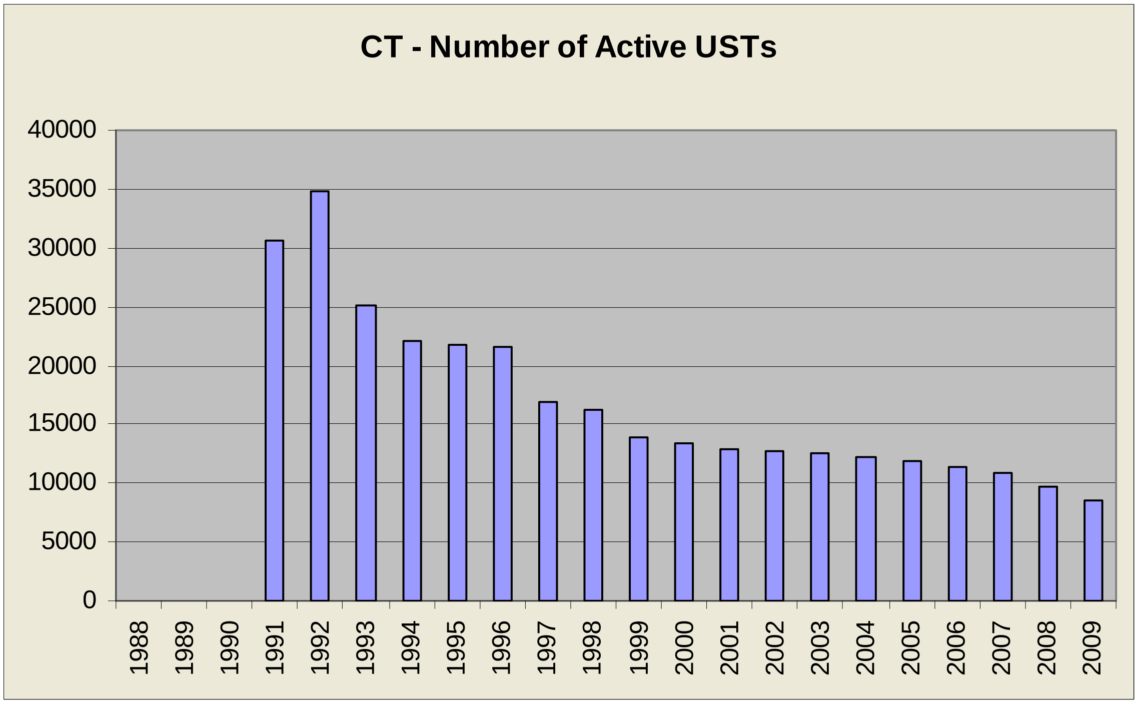
State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
VI	2005	134	22	14	2		
VI	2006	144	22	14	6		
VI	2007	144	22	15	6		
VI	2008	144	22	15	7		
VI	2009	144	24	23	13		
VT	1988	0	0	307	128		
VT	1989	0	246	409	167		
VT	1990	0	595	595	304		
VT	1991	6252	754	754	389	567141	
VT	1992	4236	907	907	421	570115	
VT	1993	3462	1024	1024	475	574004	
VT	1994	3309	1175	1175	548	578900	
VT	1995	3275	1310	1310	614	582827	
VT	1996	3058	1374	1374	682	586352	
VT	1997	2974	1494	1494	737	588665	62,395
VT	1998	2816	1628	1628	825	590579	63,811
VT	1999	2893	1783	1783	908	593740	58,216
VT	2000	2926	1837	1837	957	609876	62,180
VT	2001	2935	1852	1852	1017	612134	60,205
VT	2002	2951	1873	1873	1037	614994	66,517
VT	2003	2962	1892	1880	1062	616702	60,929
VT	2004	2982	1904	1892	1107	618432	65,651
VT	2005	3011	1930	1918	1136	619282	68,229
VT	2006	3039	1945	1933	1176	620196	66,231
VT	2007	3067	1967	1955	1211	620748	68,868
VT	2008	3088	1985	1973	1252	621270	70,053
VT	2009	3133	2008	1993	1302	621760	71,145
WA	1988	0	0	1	0		
WA	1989	0	319	323	97		
WA	1990	0	1071	1040	274		
WA	1991	25594	1874	1763	403	5013443	
WA	1992	23720	2594	2396	539	5139011	
WA	1993	19464	3340	3048	1179	5247704	
WA	1994	16016	4076	3717	1468	5334896	
WA	1995	15015	4507	4050	1662	5431024	
WA	1996	14750	4789	4079	1933	5509963	
WA	1997	14411	5113	4419	2215	5604105	71,428
WA	1998	13013	5520	4764	2601	5687832	238,215
WA	1999	11651	5988	5202	2863	5756361	81,630
WA	2000	11332	6009	5523	3225	5911104	131,669
WA	2001	11133	6155	5694	3535	5987181	109,369
WA	2002	9458	6217	5808	3844	6055613	57,058
WA	2003	8457	6286	5894	4105	6110202	60,284

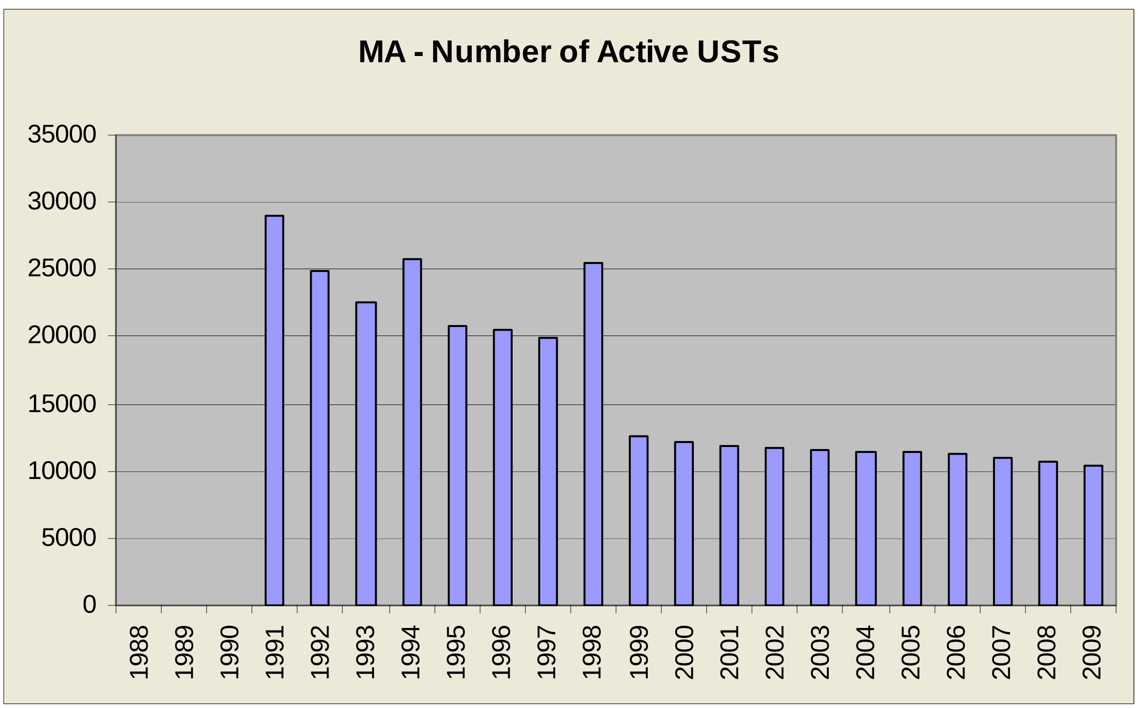
State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
WA	2004	9872	6026	5702	4024	6179645	67,842
WA	2005	10397	6142	5779	4115	6254579	74,477
WA	2006	10299	6240	5933	4265	6360529	76,230
WA	2007	10112	6321	5998	4375	6449511	76,230
WA	2008	10054	6399	6408	4464	6549224	85,635
WA	2009	9900	6442	6382	4464	6664195	90,000
WI	1988	0	0	140	0		
WI	1989	0	1	227	62		
WI	1990	0	2739	2484	250		
WI	1991	53190	4798	4341	557	4952675	
WI	1992	67281	6719	6074	791	5004636	
WI	1993	35233	8637	7800	1717	5055318	
WI	1994	29825	10644	9609	2695	5095504	
WI	1995	28483	12182	10915	4969	5137004	
WI	1996	24283	13742	13962	5706	5173828	
WI	1997	22485	14999	13526	7184	5200235	92,465
WI	1998	24965	17489	15782	8948	5222124	140,864
WI	1999	18526	17495	15650	8881	5250446	114,482
WI	2000	17262	17982	16082	9948	5374133	114,482
WI	2001	16073	18080	16335	12513	5408061	71,373
WI	2002	17011	17725	16835	13185	5444638	124,817
WI	2003	14212	17863	17064	13830	5474360	133,767
WI	2004	13744	18136	17423	14495	5508789	133,581
WI	2005	13721	18353	17650	15033	5538806	132,871
WI	2006	13757	18469	17977	15513	5568505	132,279
WI	2007	13725	18578	18241	15970	5598893	131,682
WI	2008	15044	18691	18283	16299	5627967	131,682
WI	2009	14920	18801	18437	16592	5654774	130,897
WV	1988	0	46	32	12		
WV	1989	0	175	134	5		
WV	1990	0	345	178	15		
WV	1991	14247	484	362	136	1798212	
WV	1992	17939	803	446	50	1805462	
WV	1993	10249	1292	955	320	1816179	
WV	1994	9360	1546	1252	476	1818490	
WV	1995	8856	1784	1429	543	1820560	
WV	1996	8530	1945	1537	607	1818983	
WV	1997	8171	2100	1720	992	1815588	37,241
WV	1998	7780	2237	1934	1003	1811688	
WV	1999	7024	2403	2007	1076	1806928	85,057
WV	2000	6664	2504	2077	1157	1806977	
WV	2001	6567	2587	2156	1254	1798540	82,631
WV	2002	6501	2673	2237	1365	1799392	140,381

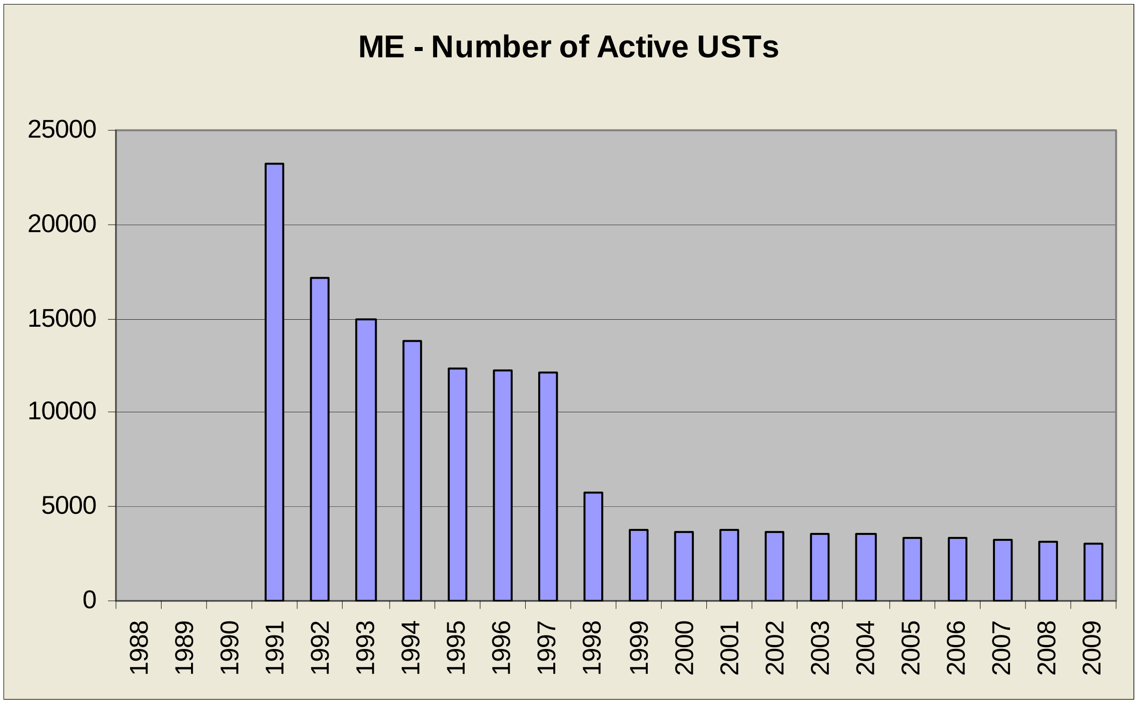
State	Year	No. of Active USTs	Cumulative Confirmed Releases	Cumulative Cleanups Initiated	Cumulative Cleanups Completed	Population	Avg Cost per Site @ Closure
WV	2003	6296	2760	2602	1527	1802287	140,218
WV	2004	6197	2828	2680	1614	1803312	140,381
WV	2005	6033	2909	2706	1751	1804020	140,381
WV	2006	5891	2988	2776	1873	1806760	140,881
WV	2007	5696	3059	2880	2025	1809836	140,381
WV	2008	5619	3128	2974	2177	1814468	
WV	2009	5589	3210	3022	2302	1819777	
WY	1988	0	162	91	74		
WY	1989	0	493	197	132		
WY	1990	0	698	346	259		
WY	1991	8054	835	415	301	457739	
WY	1992	8217	1038	478	340	463491	
WY	1993	3210	1360	543	361	469033	
WY	1994	2915	1472	607	366	474982	
WY	1995	2706	1602	652	375	478447	
WY	1996	2570	1739	664	385	480085	
WY	1997	2545	1795	704	389	480031	41,472
WY	1998	2277	1897	816	389	480045	429,989
WY	1999	2090	1939	840	400	479602	
WY	2000	2071	1948	888	402	493963	
WY	2001	2073	1958	950	491	492924	
WY	2002	2074	1968	1174	522	496969	305,100
WY	2003	2007	1893	1148	568	499056	305,100
WY	2004	2064	1979	1411	847	502816	340,986
WY	2005	2055	1989	1490	924	506007	269,200
WY	2006	2037	1995	1592	1011	512573	269,200
WY	2007	1980	1998	1592	1070	523252	110,470
WY	2008	1952	2000	1636	1105	532668	97,483
WY	2009	1889	2710	1659	954	544270	102,090

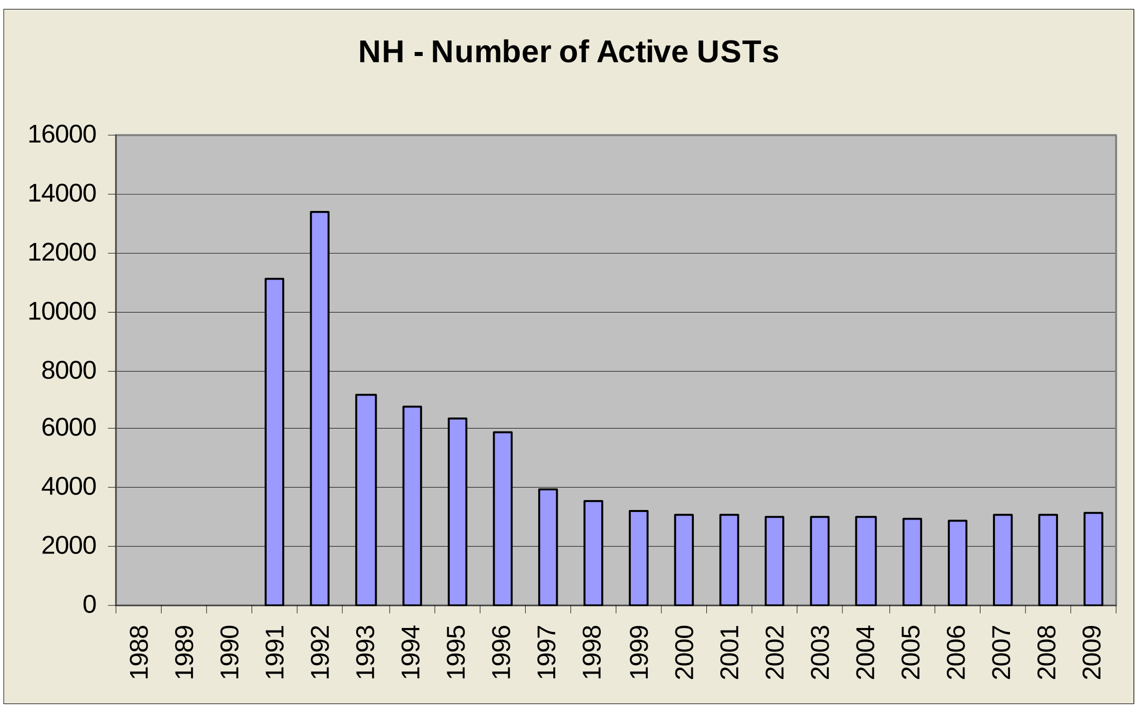
APPENDIX C

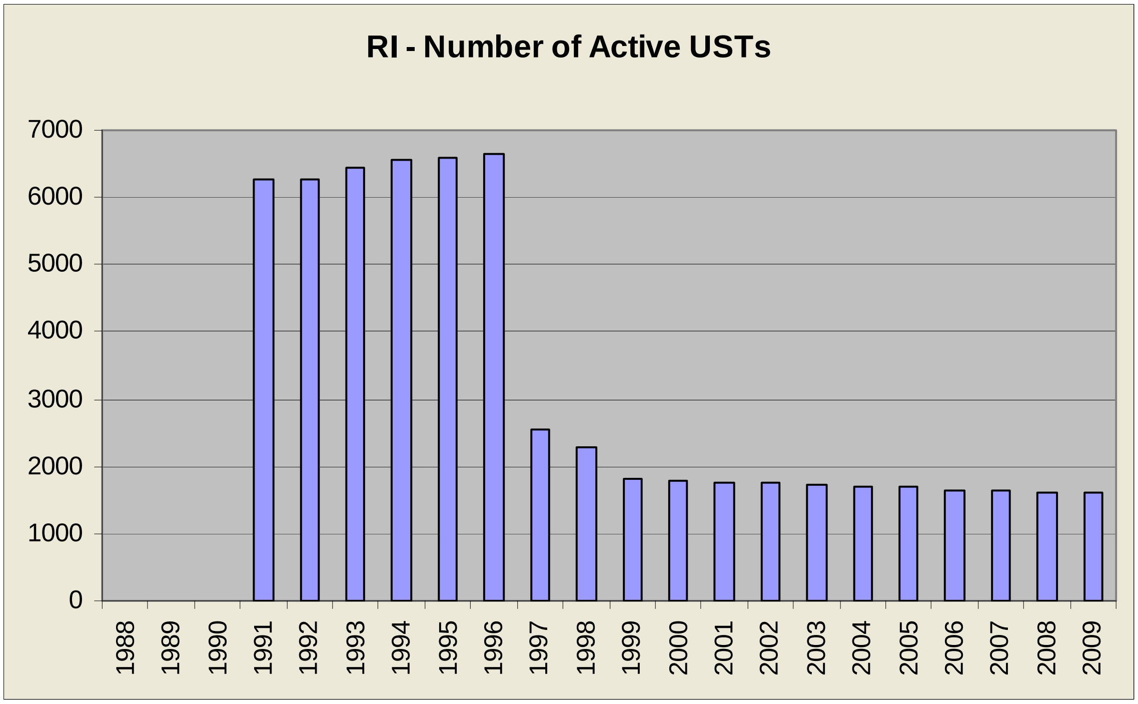
Graphs of Number of Active USTs for all 56 States for the Period 1988 through 2009

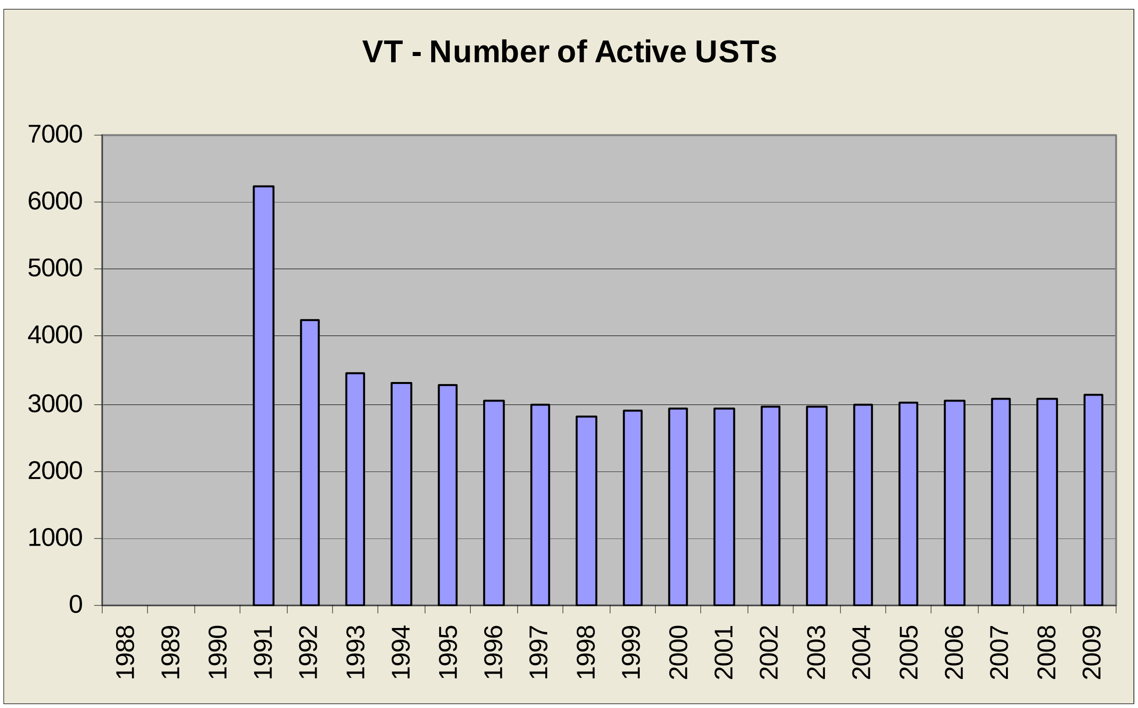

CT - Number of Active USTs
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

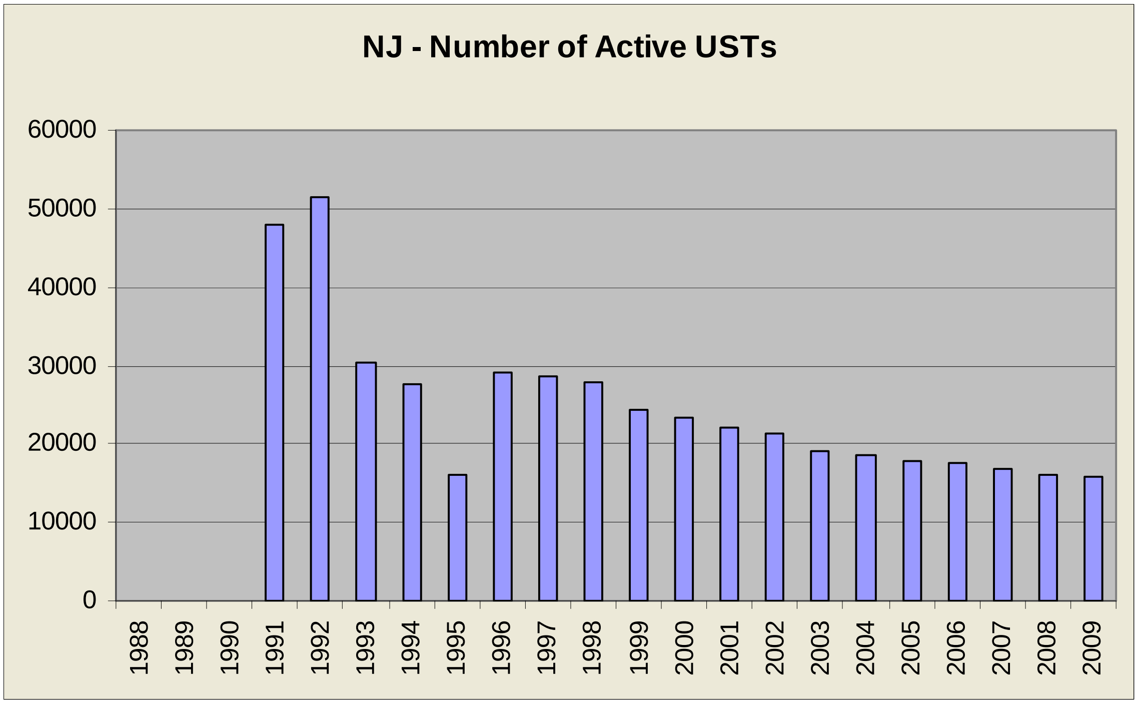

MA - Number of Active USTs
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

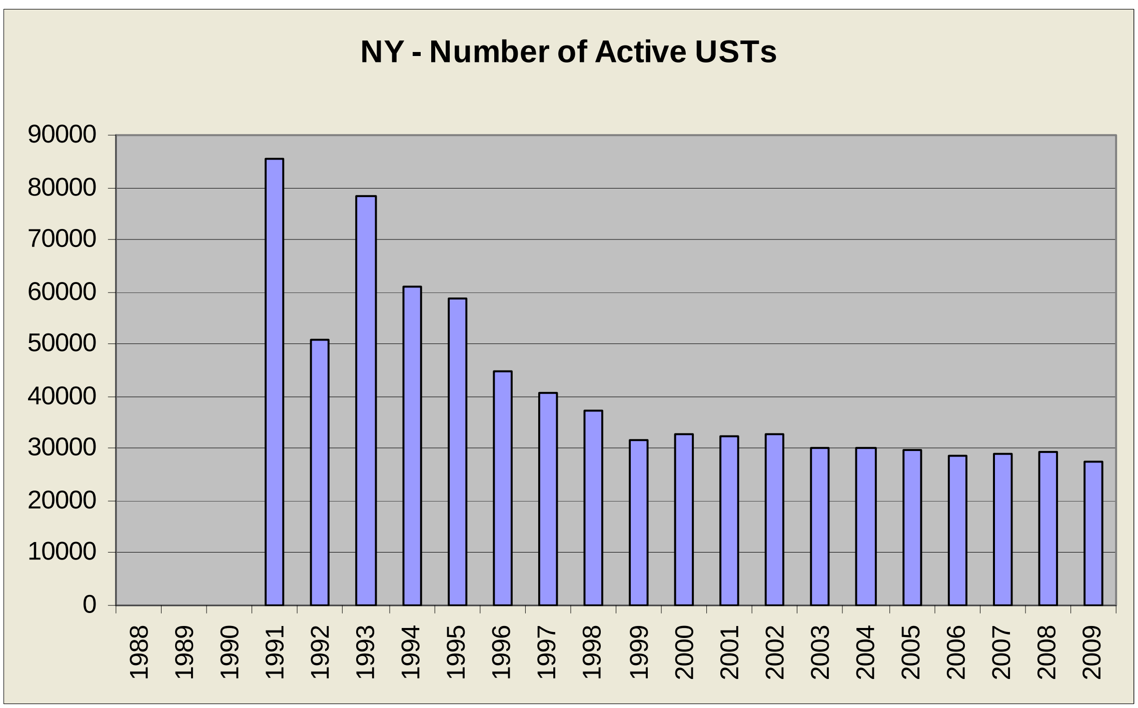

ME - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

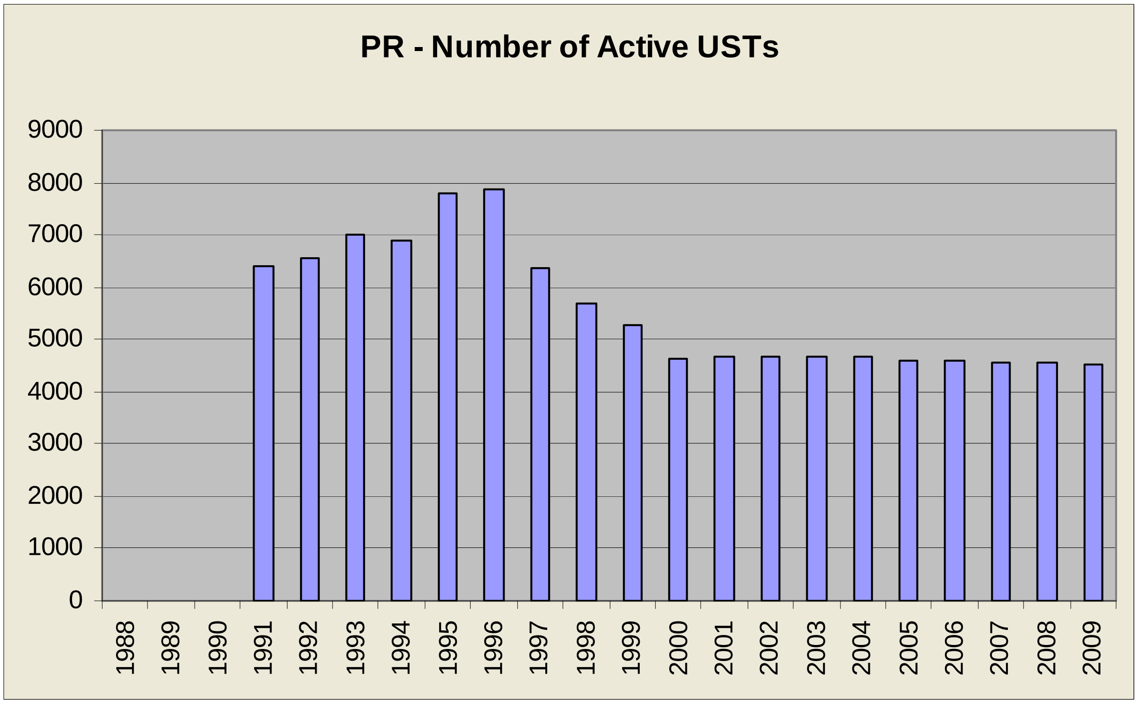

NH - Number of Active USTs
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

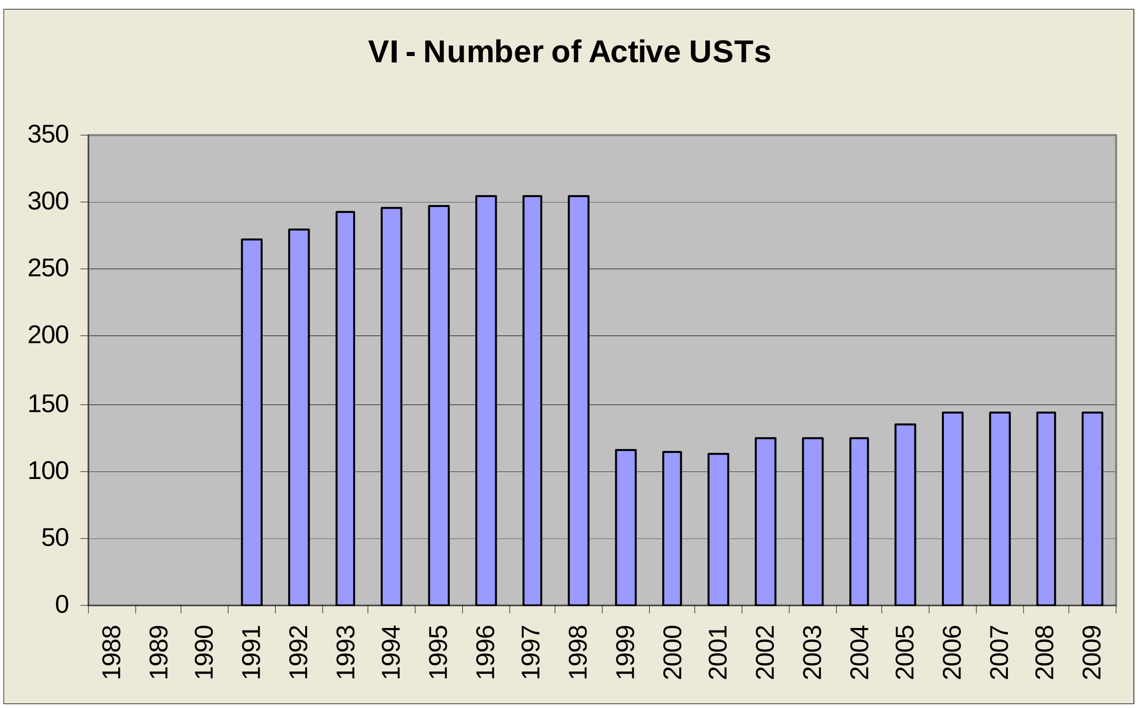

RI - Number of Active USTs
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

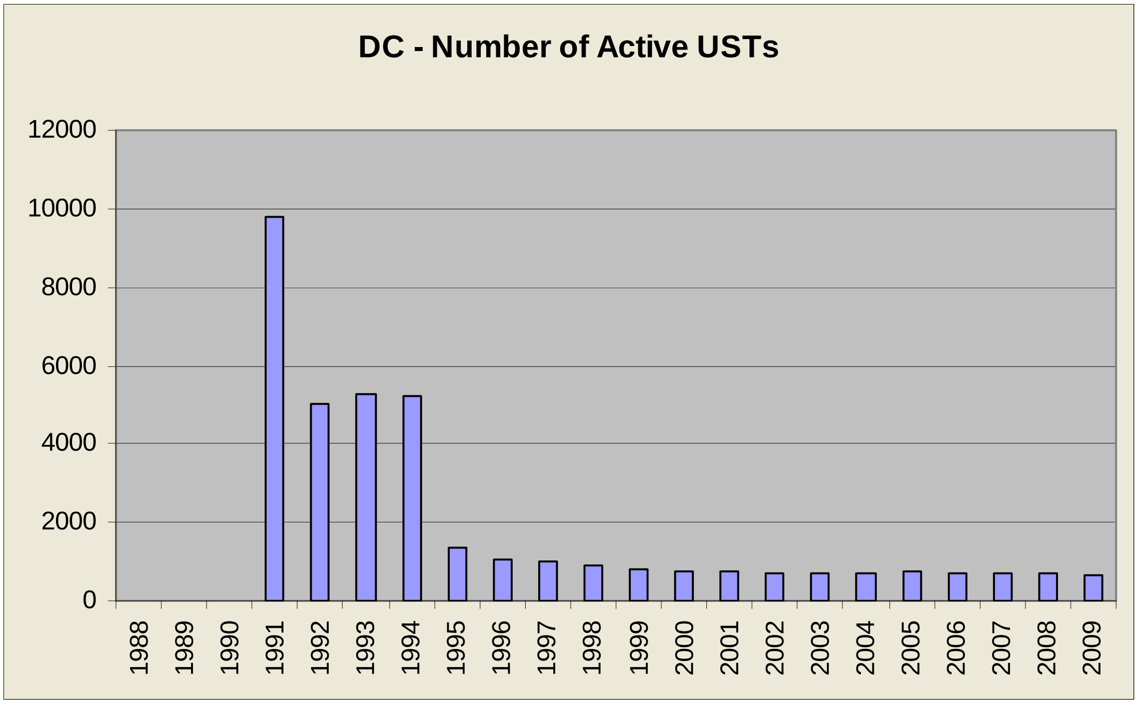

VT - Number of Active USTs
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

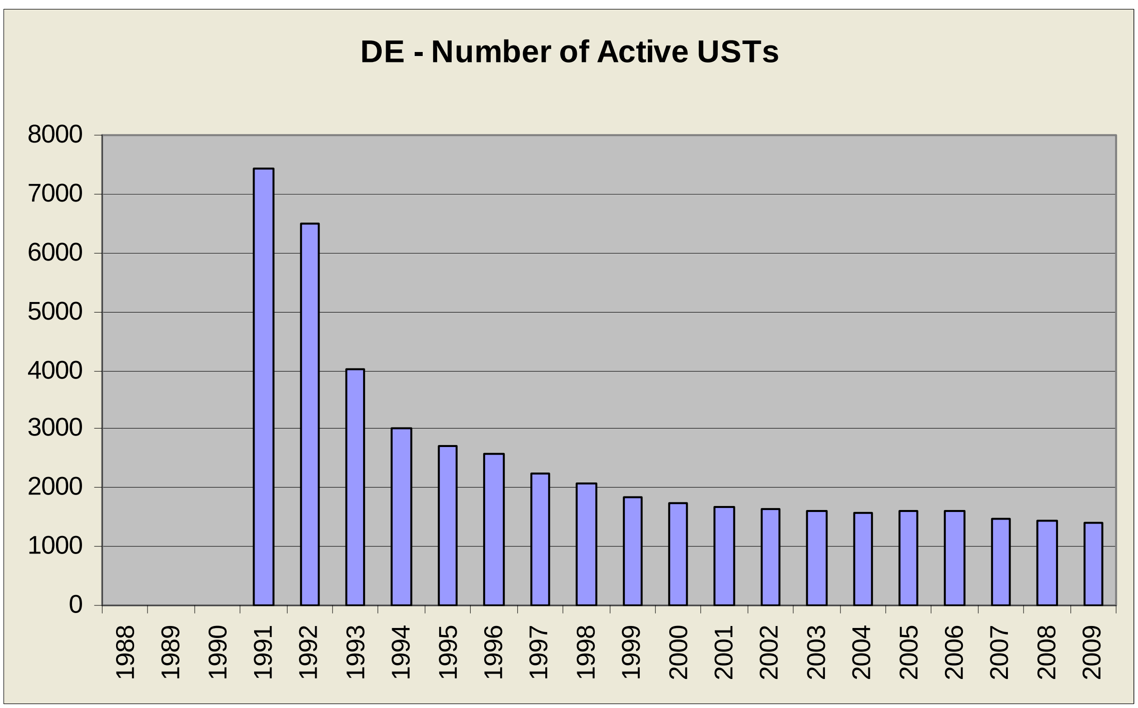

NJ - Number of Active USTs
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

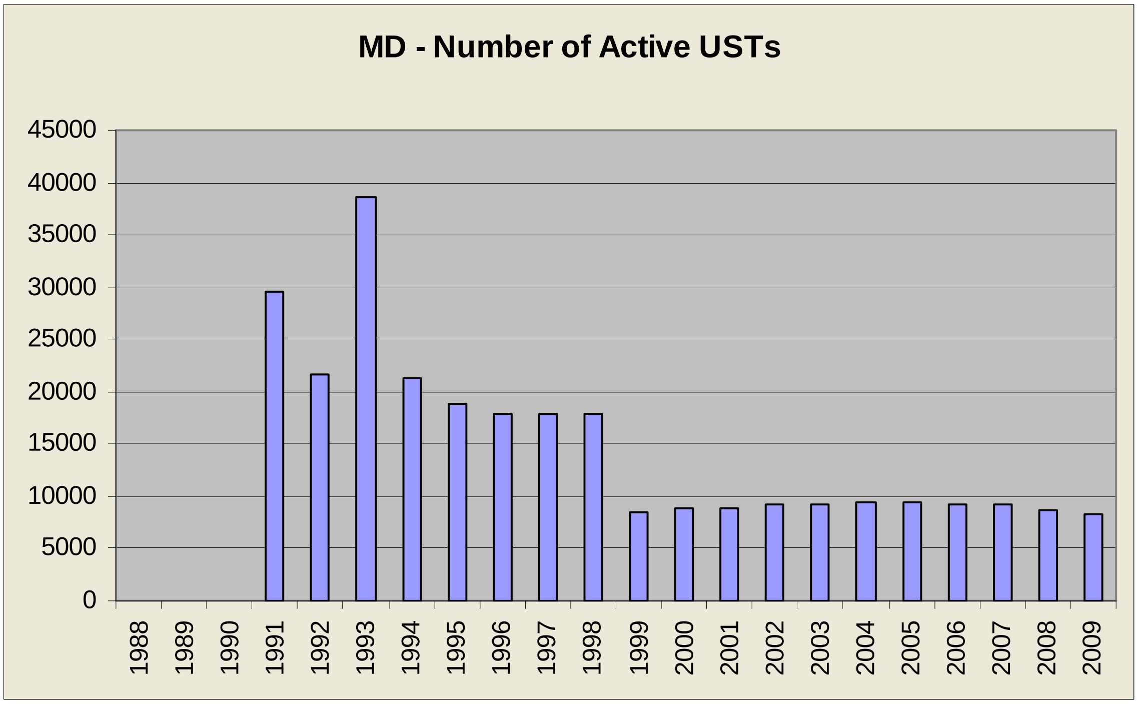

NY - Number of Active USTs
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

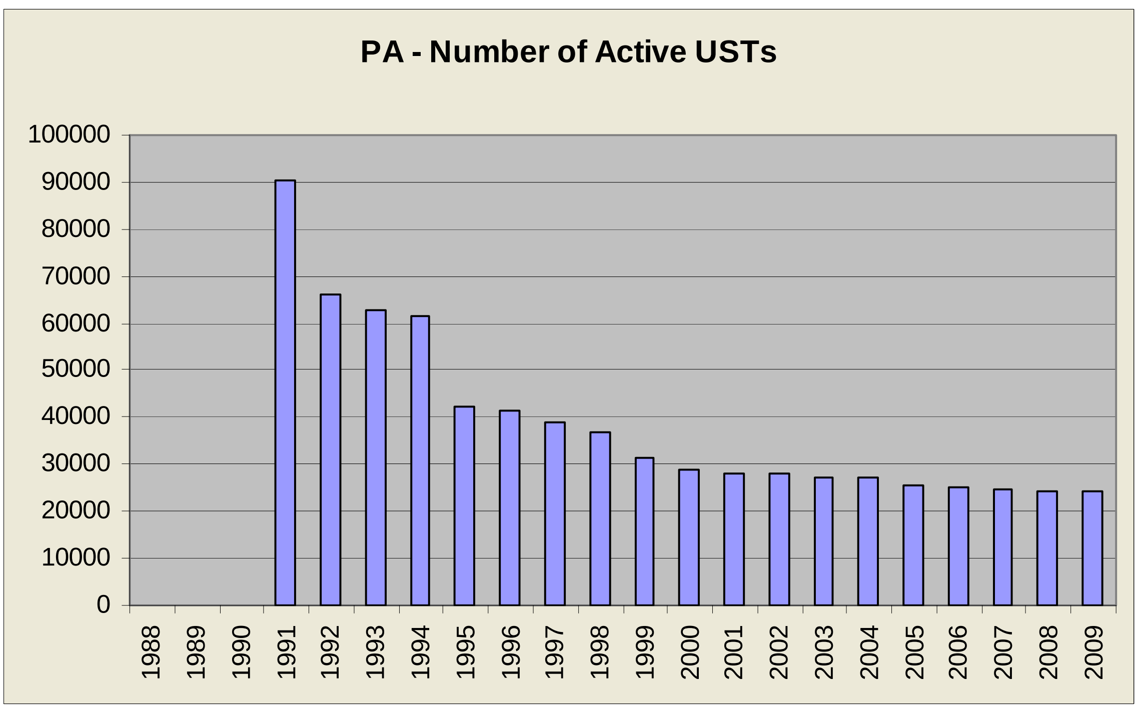

PR - Number of Active USTs
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

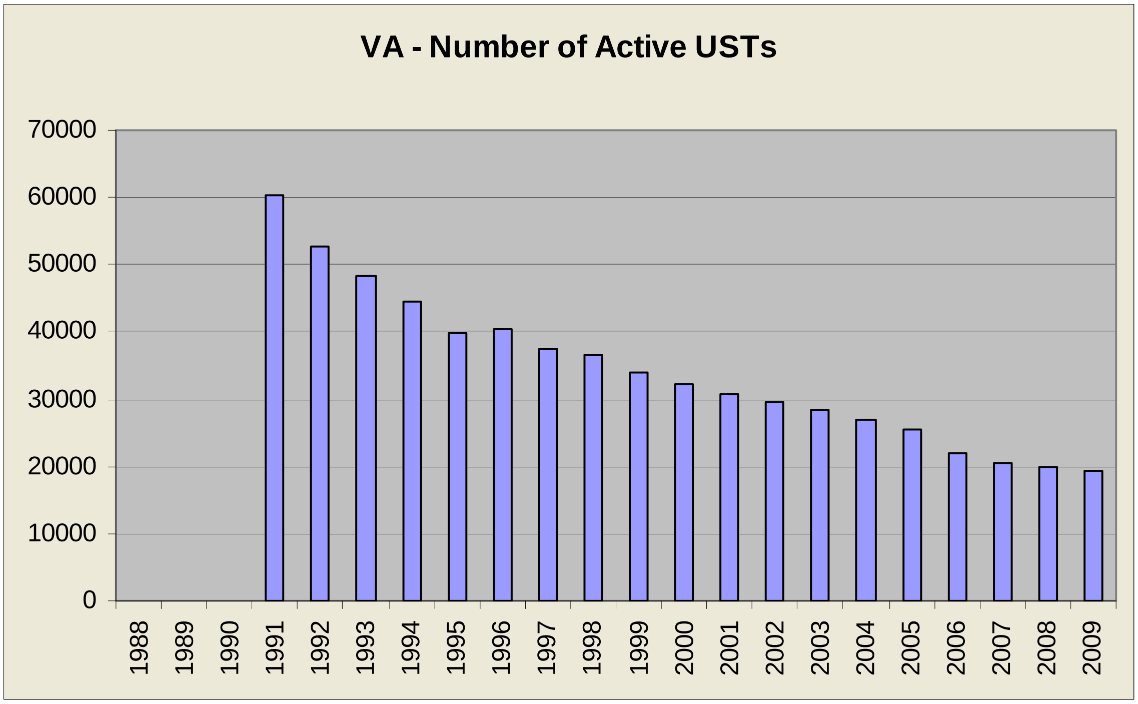

VI - Number of Active USTs
350
300
250
200
150
100
50
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

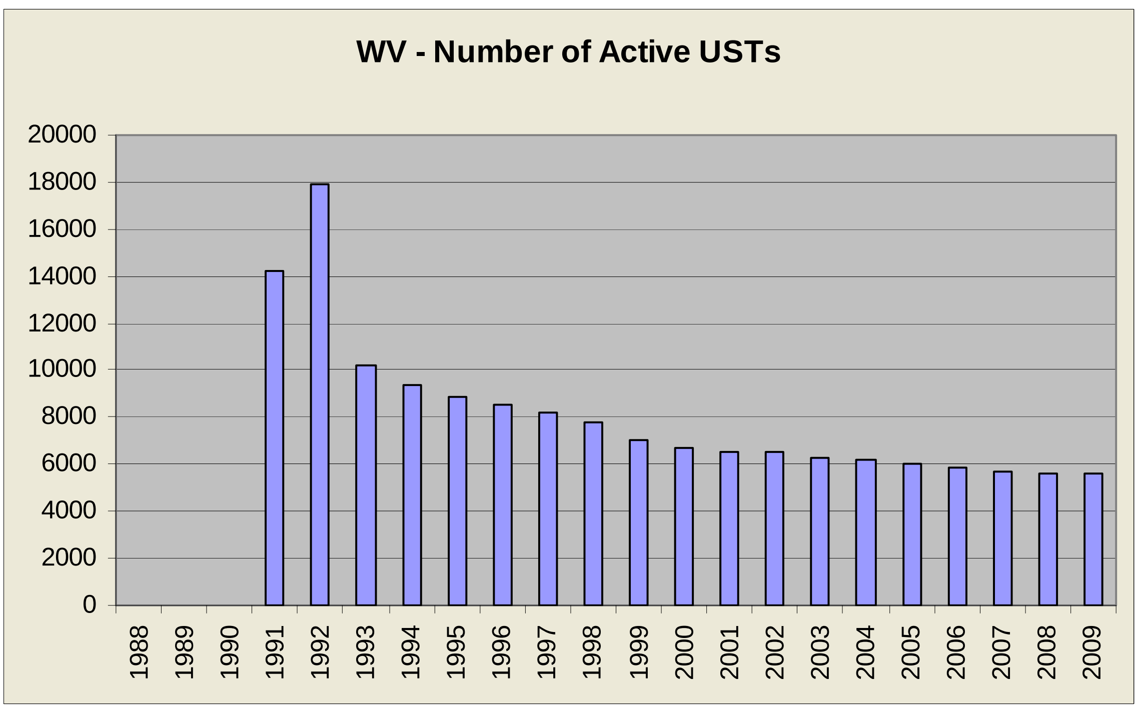

DC - Number of Active USTs
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

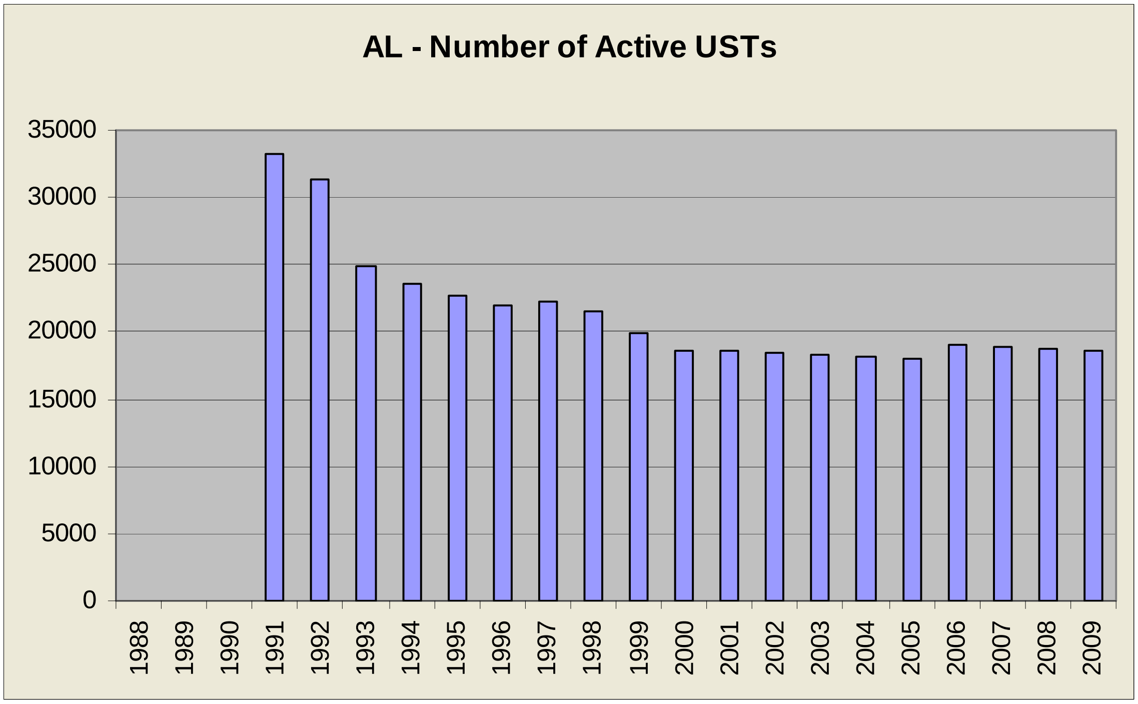

DE - Number of Active USTs
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

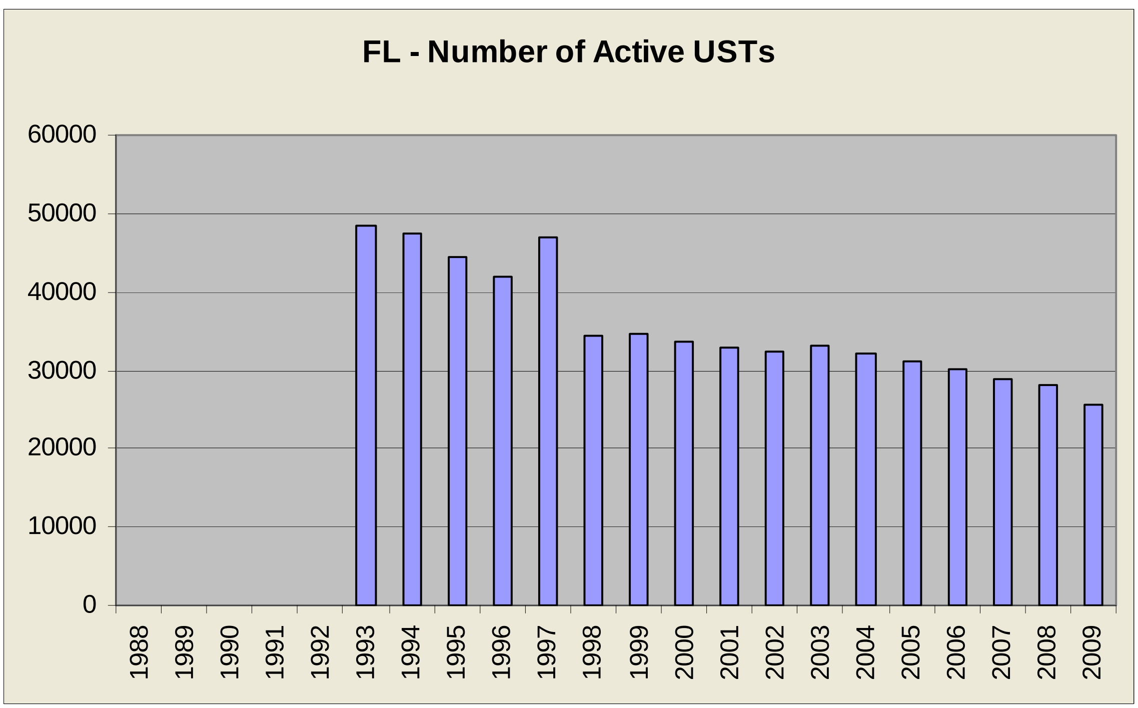

MD - Number of Active USTs
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

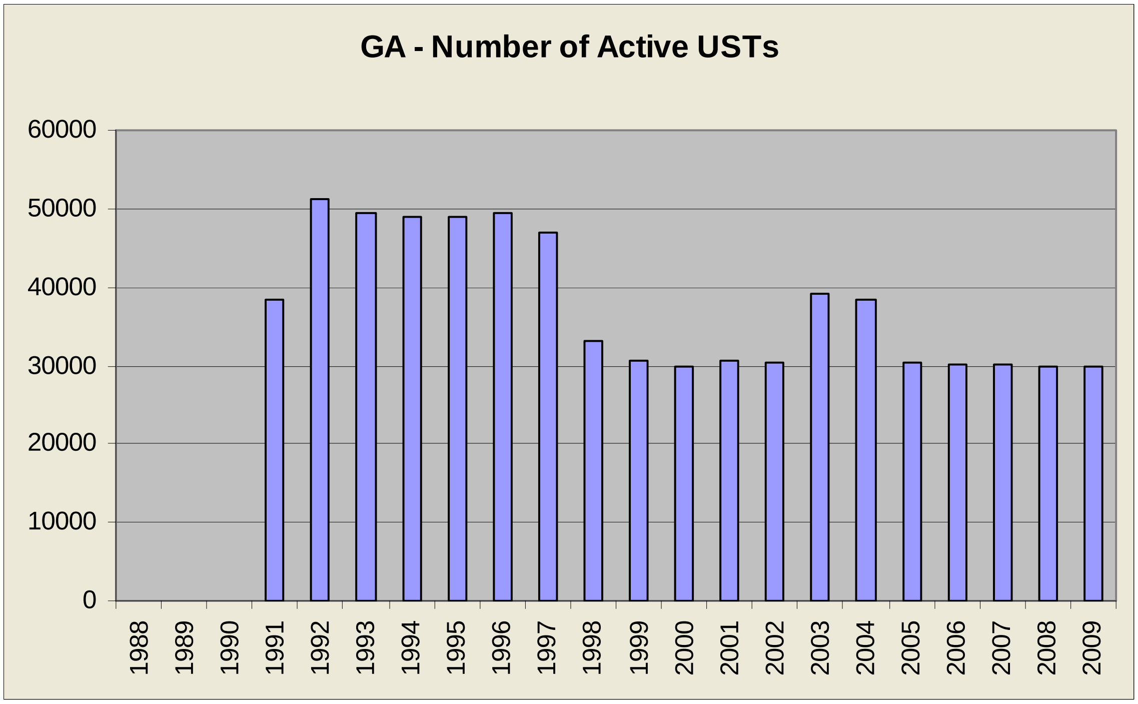

PA - Number of Active USTs
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

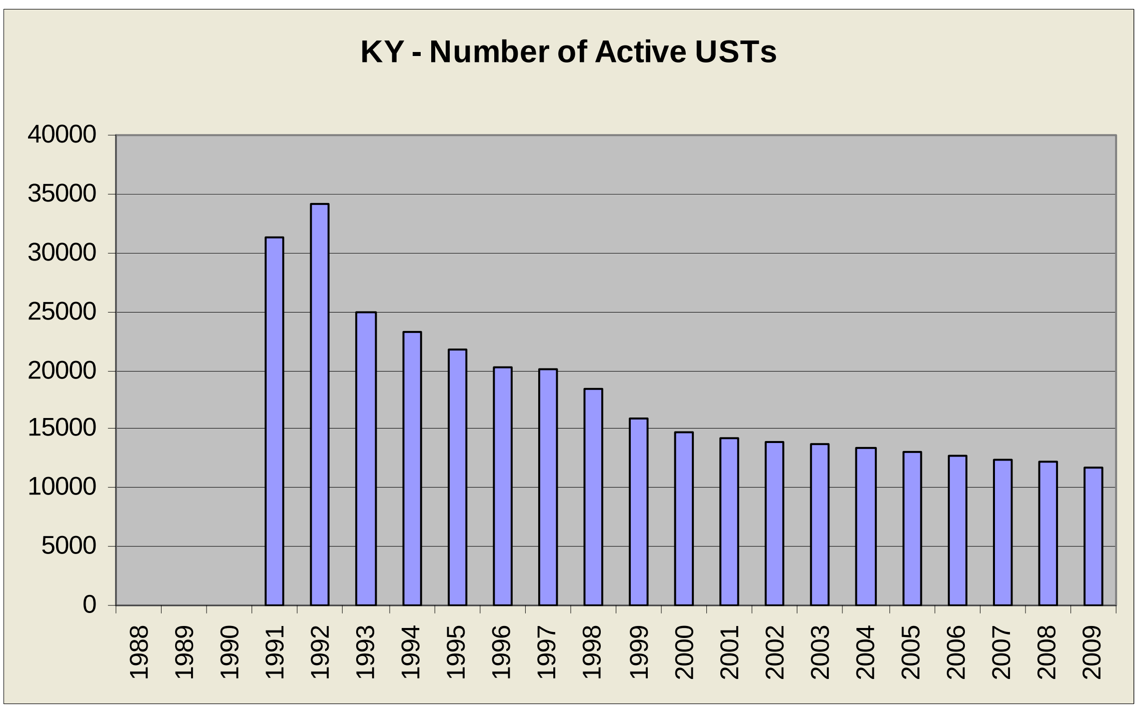

VA - Number of Active USTs
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

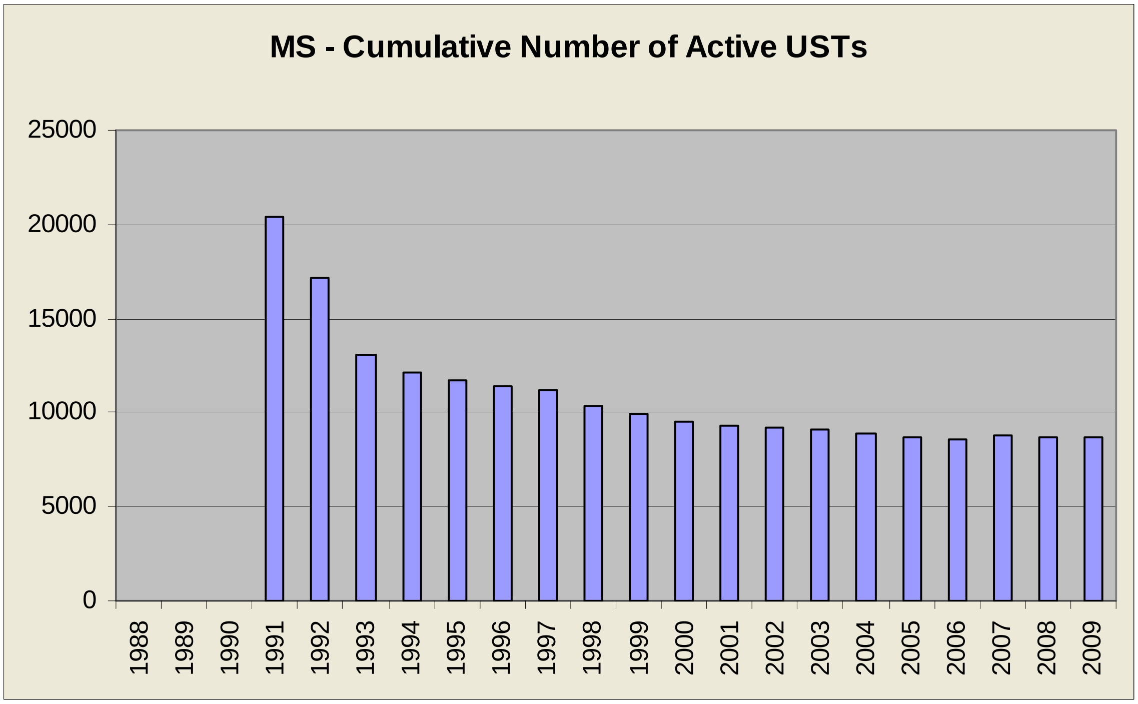

WV - Number of Active USTs
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

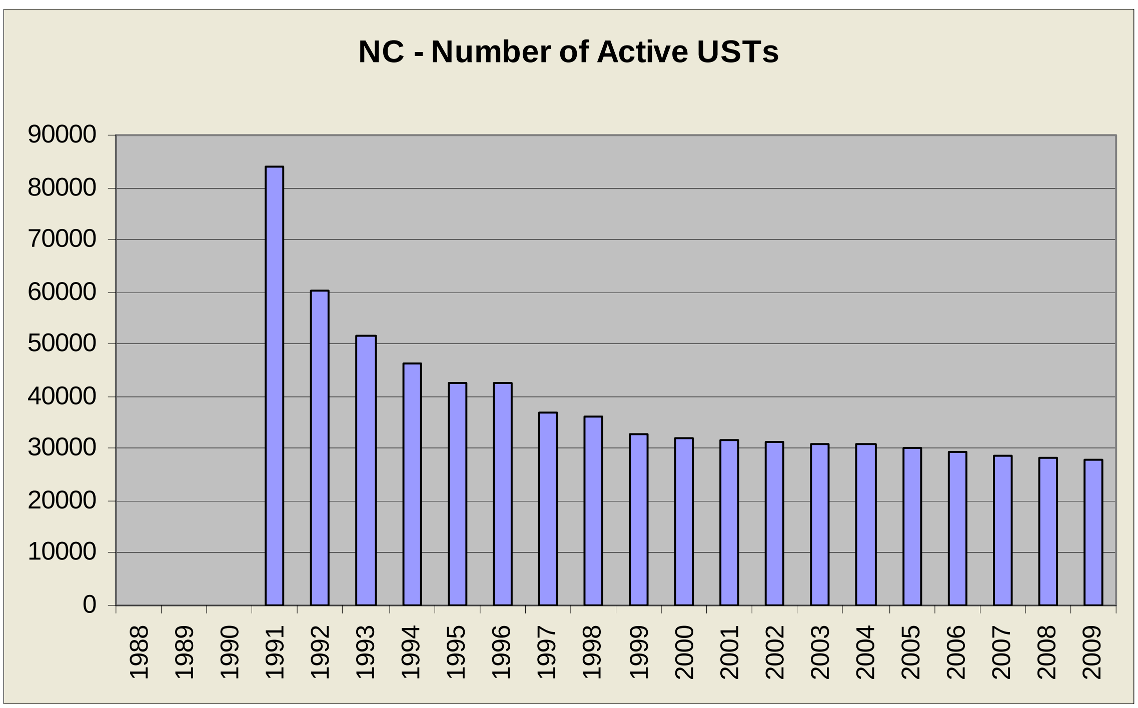

AL - Number of Active USTs
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

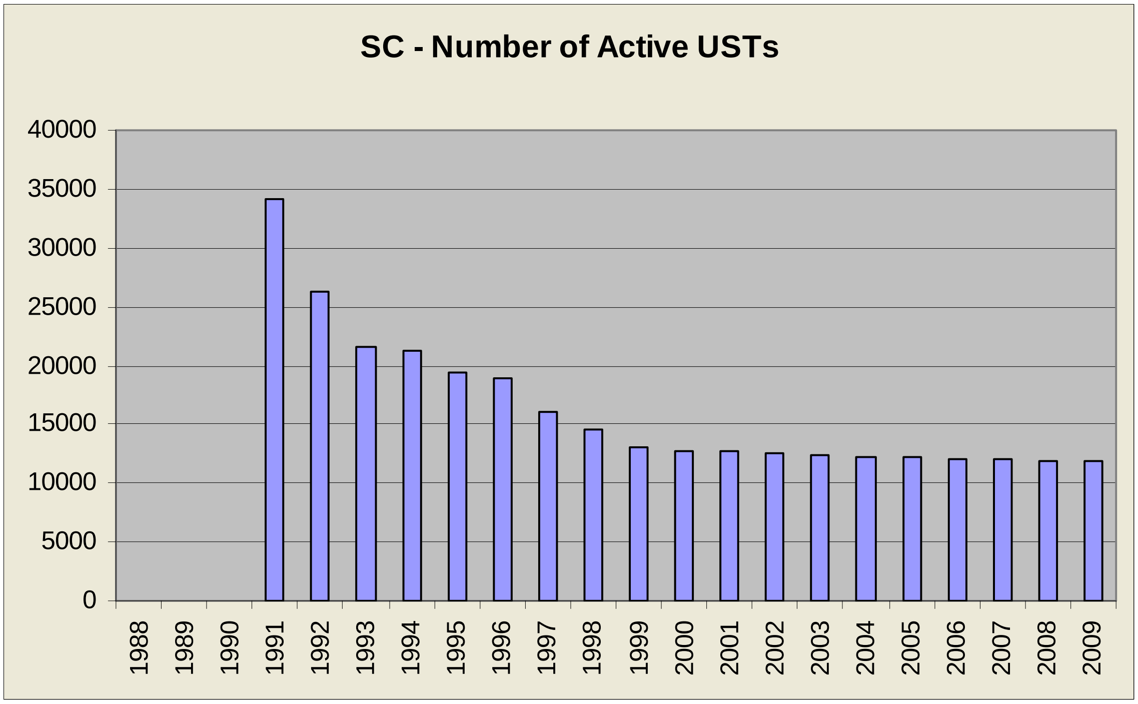

FL - Number of Active USTs
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

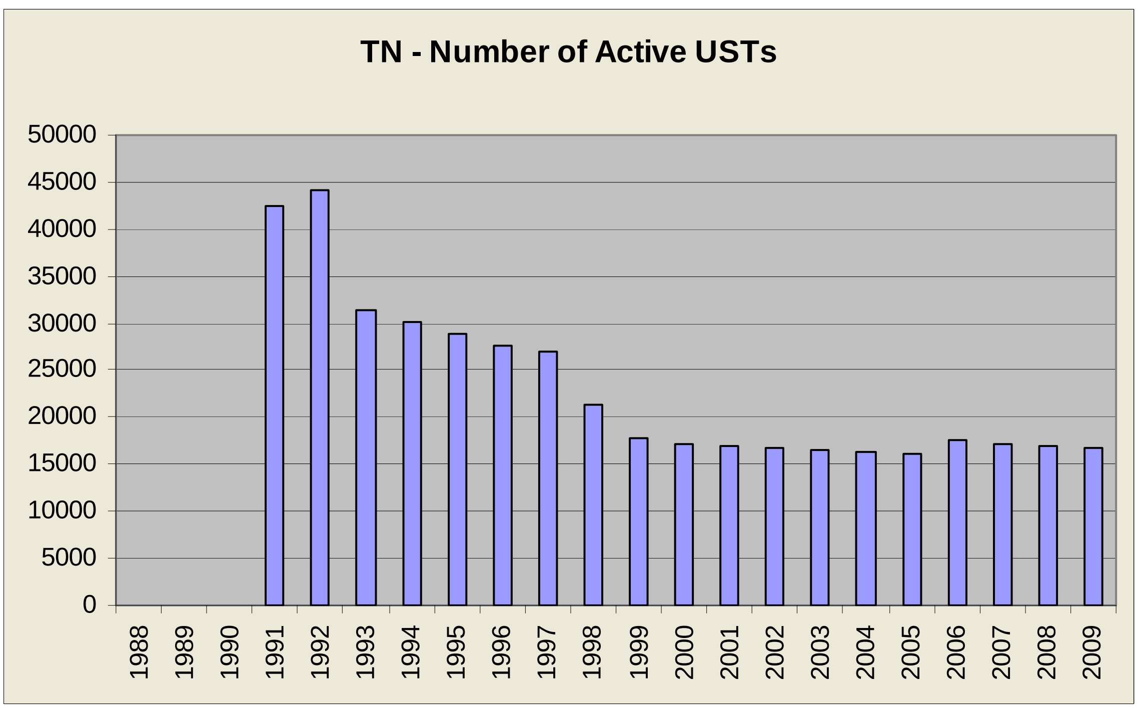

GA - Number of Active USTs
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

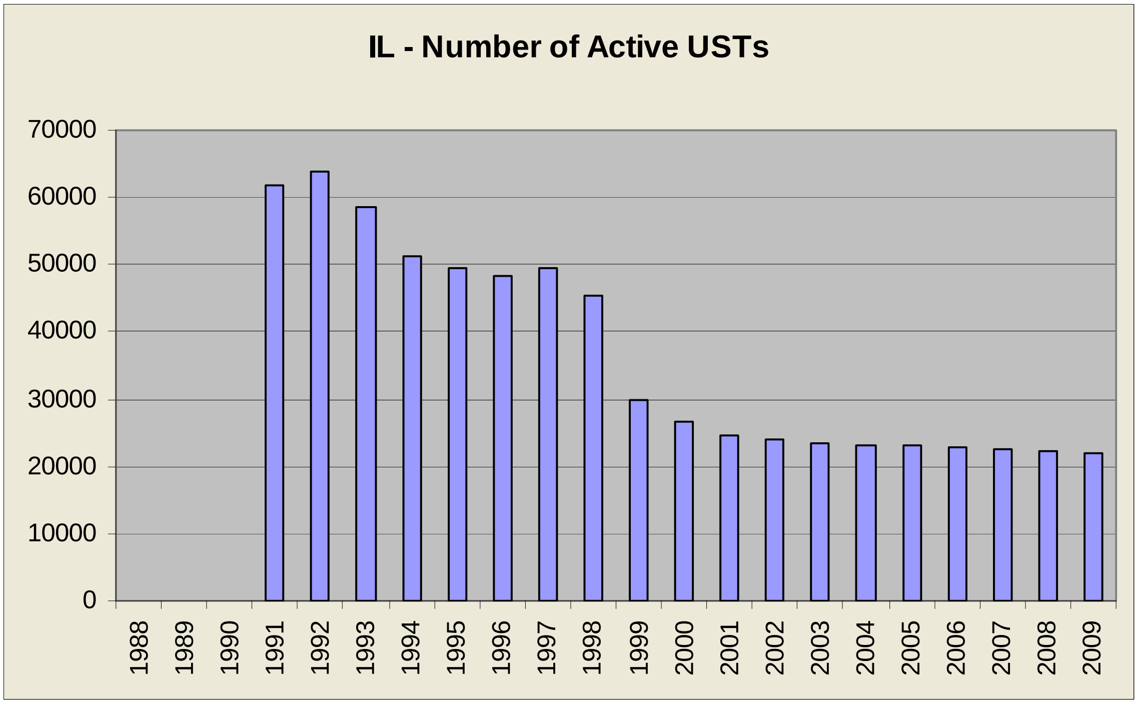

KY - Number of Active USTs
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


MS - Cumulative Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

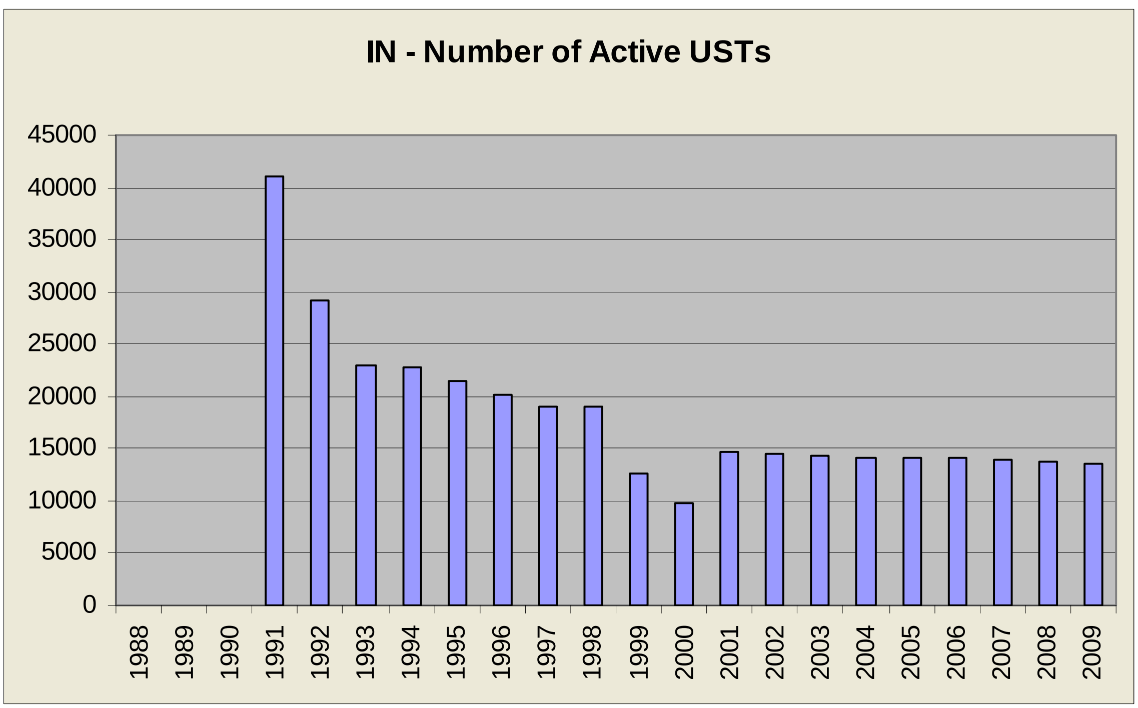

NC - Number of Active USTs
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


SC - Number of Active USTs
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

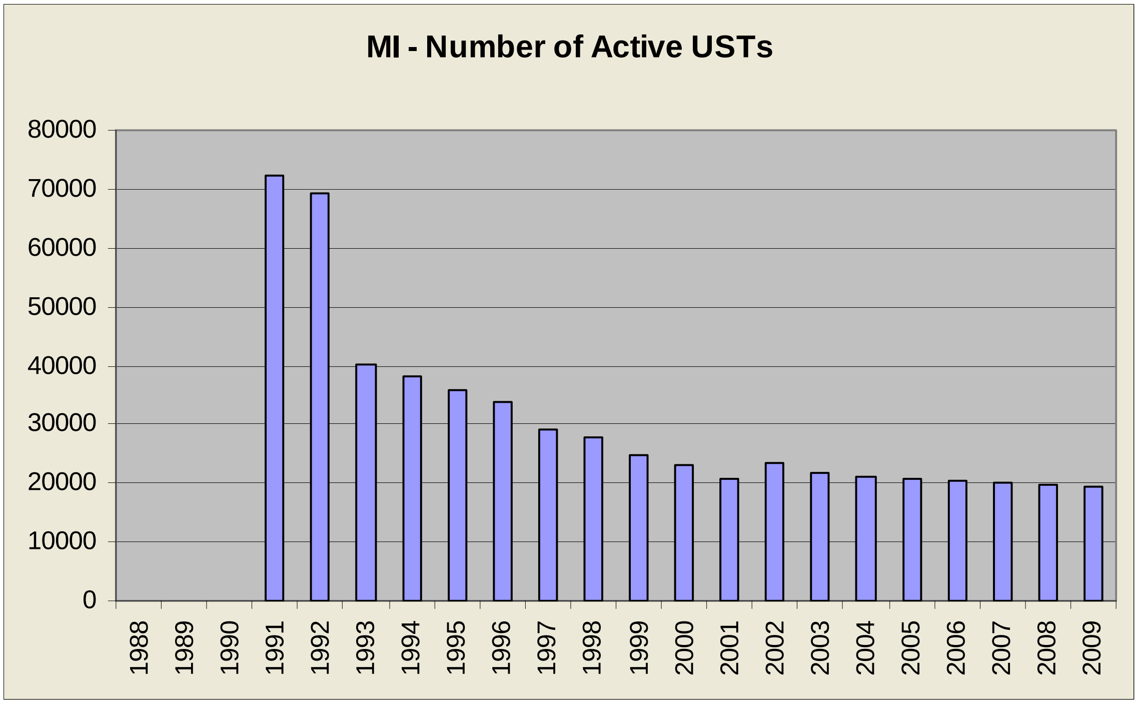

TN - Number of Active USTs
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

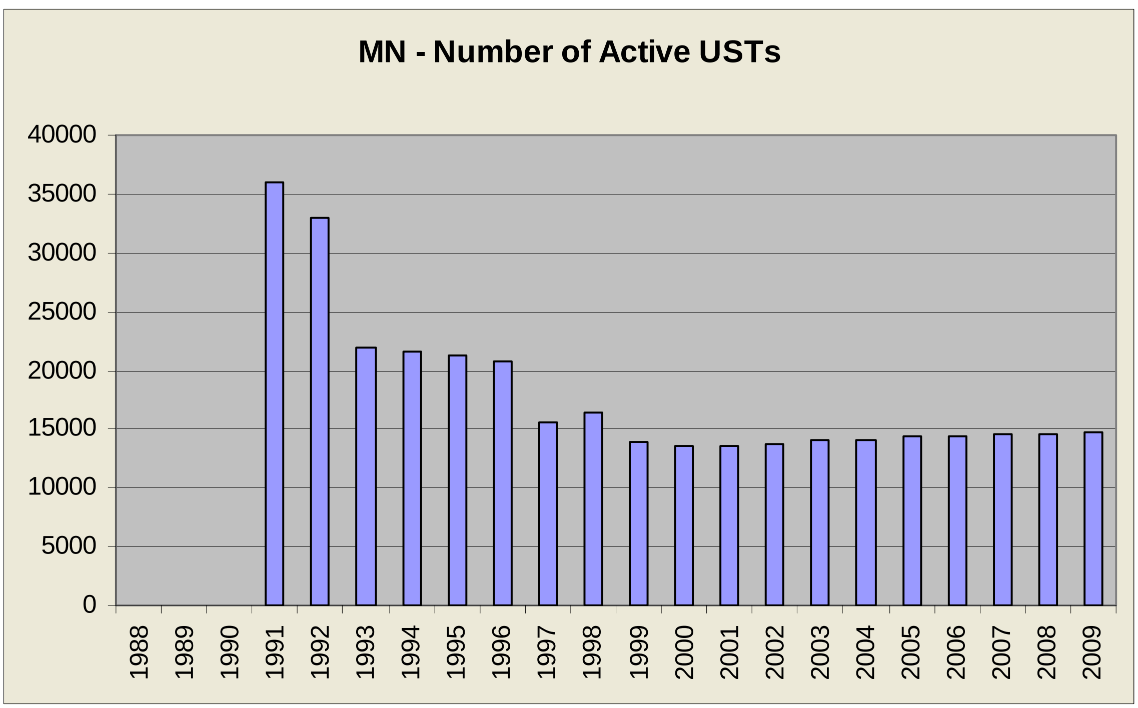


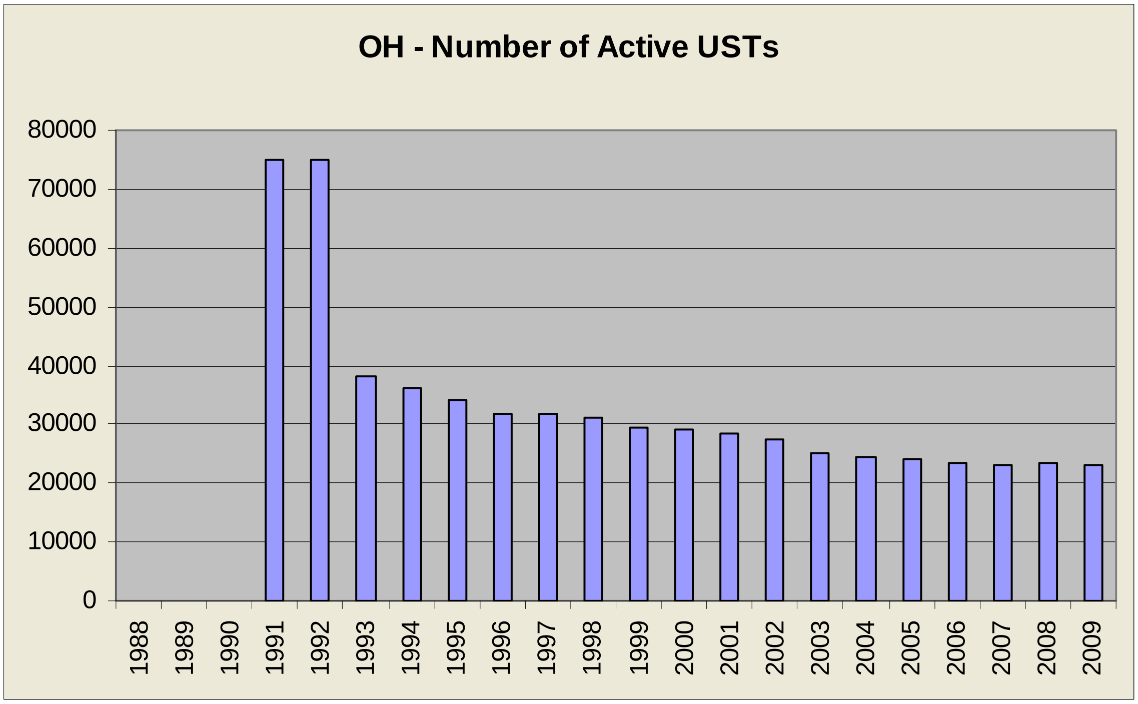
IL - Number of Active USTs
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

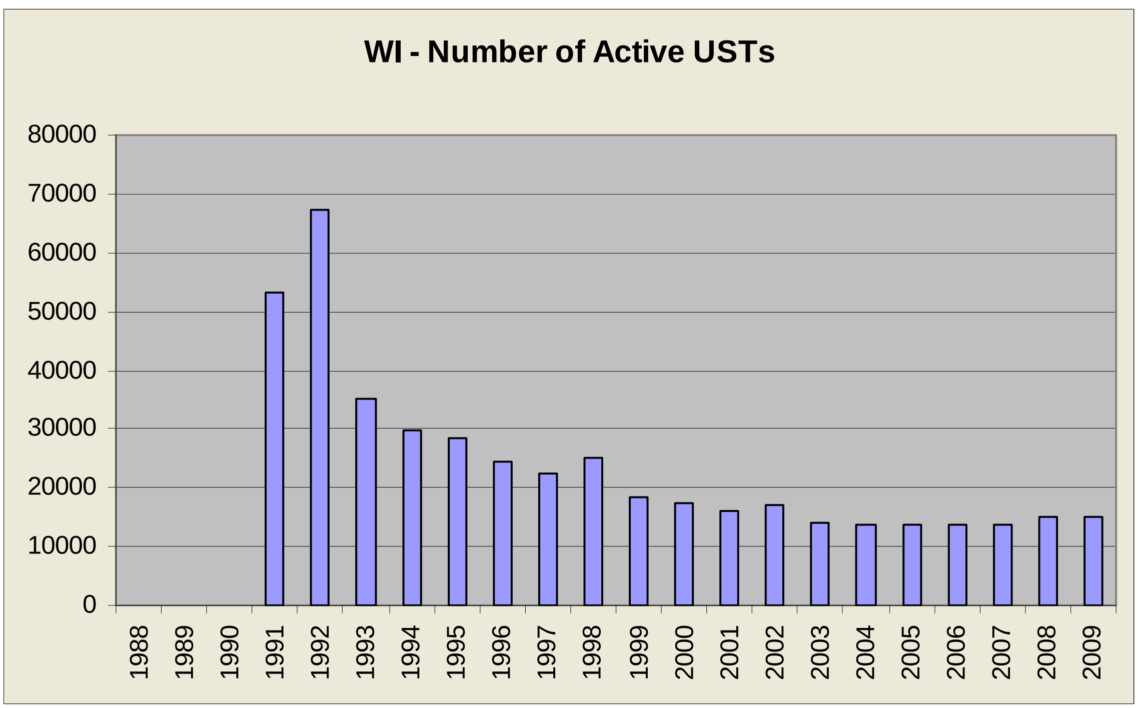


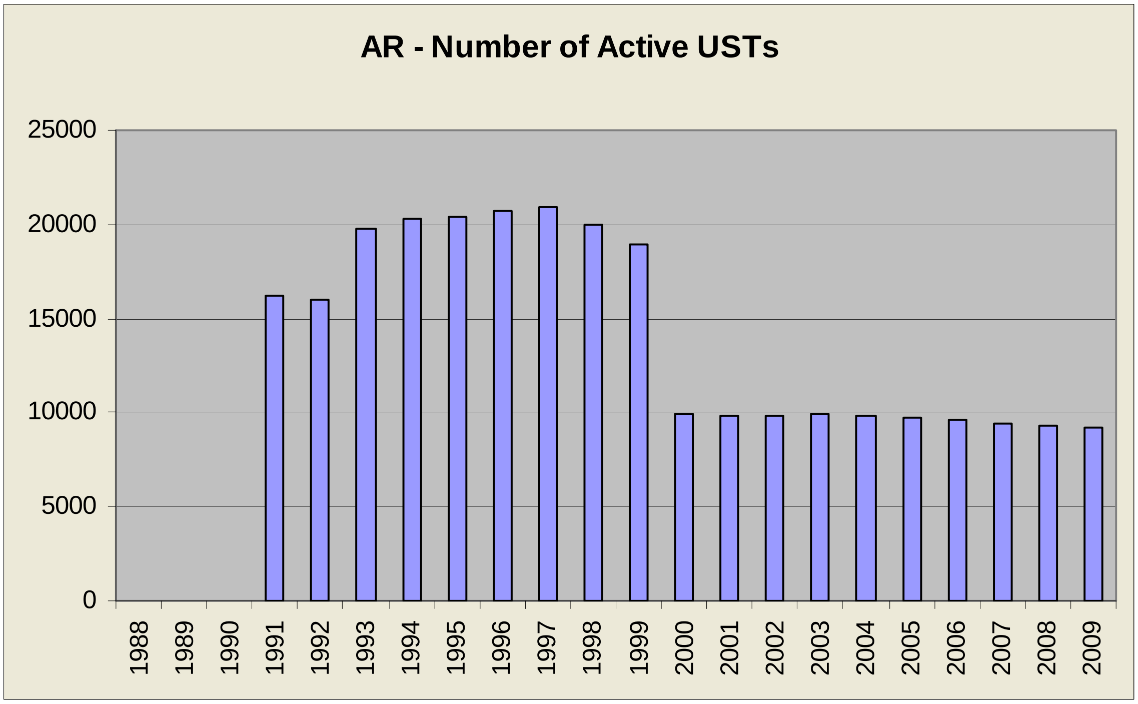
IN - Number of Active USTs
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

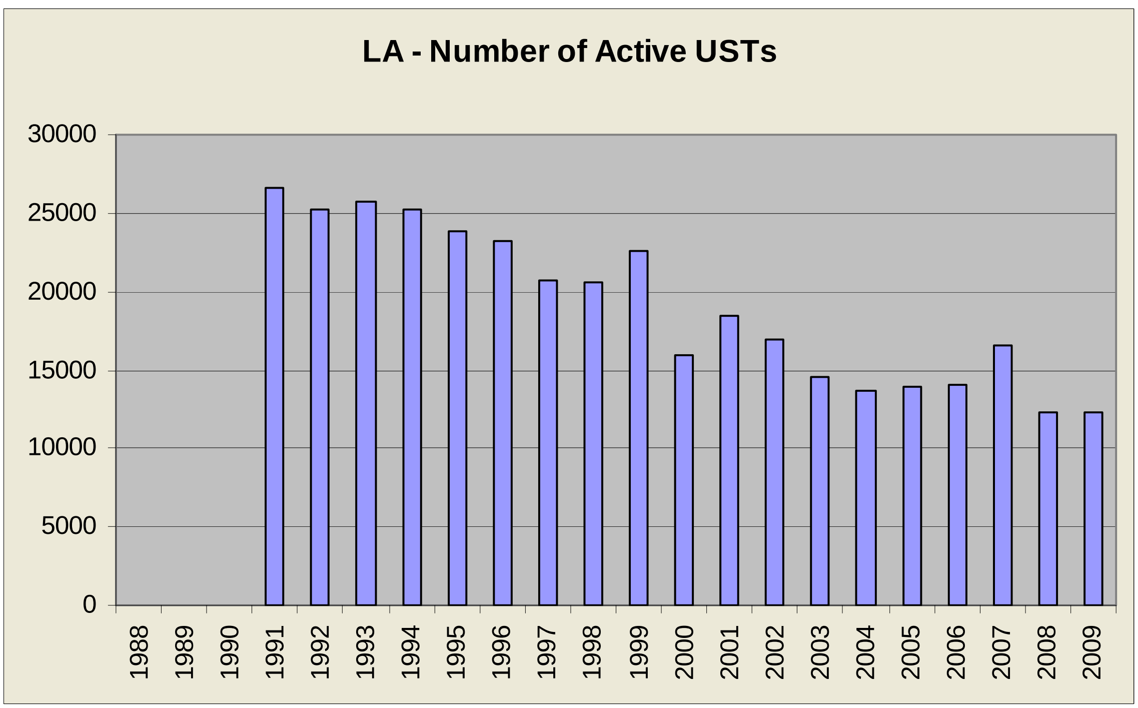

MI - Number of Active USTs
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

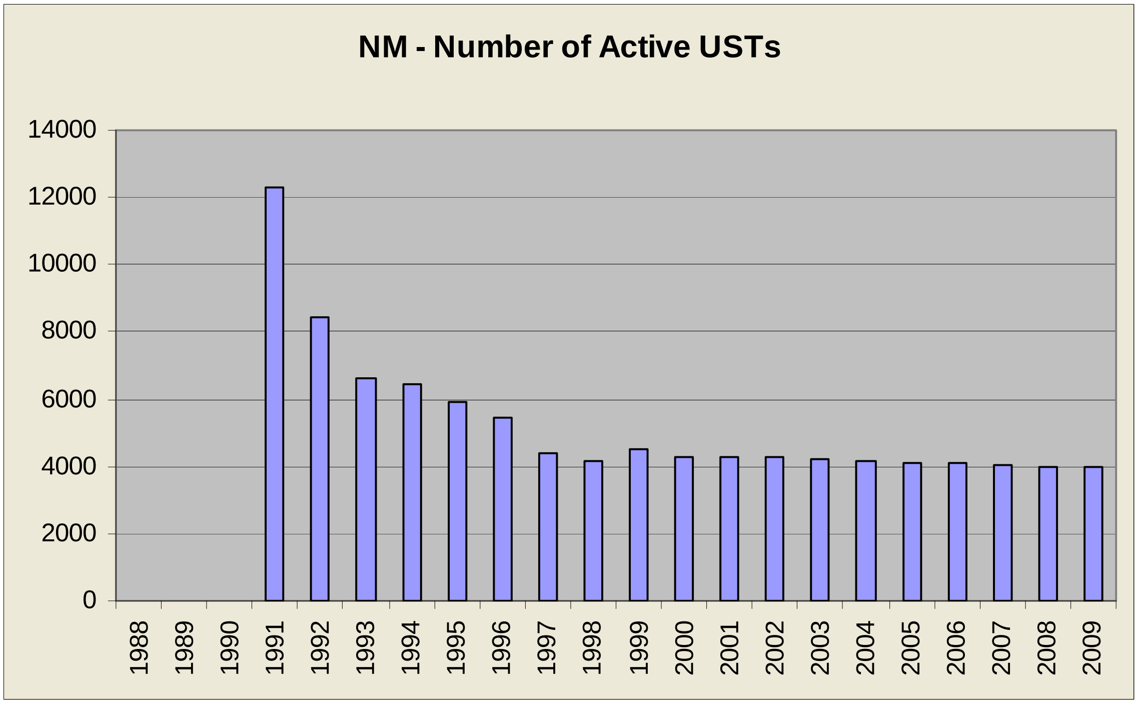

MN - Number of Active USTs
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

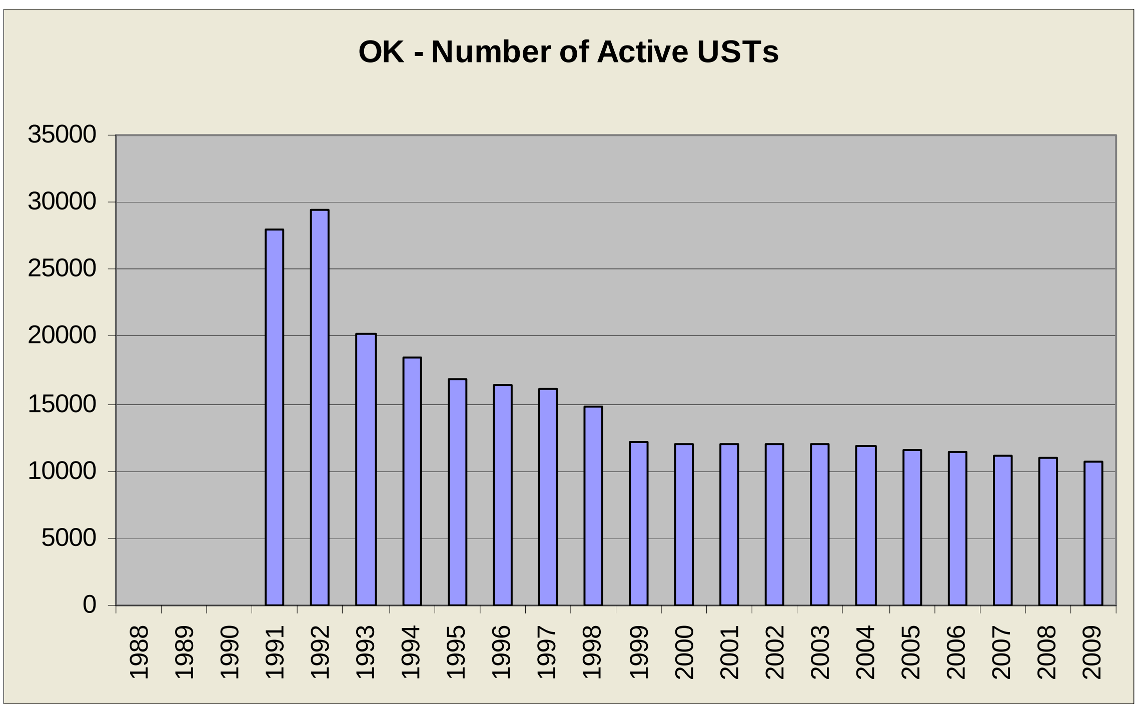

OH - Number of Active USTs
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

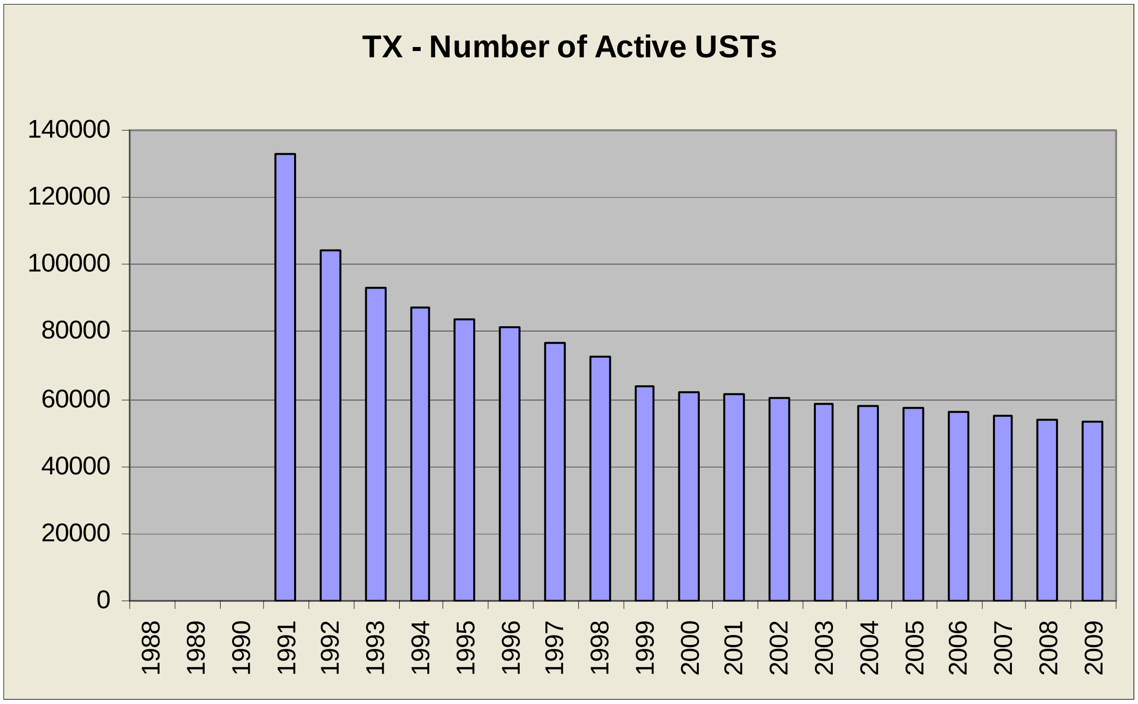

WI - Number of Active USTs
80000
70000
60000
50000
40000
30000
20000
10000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

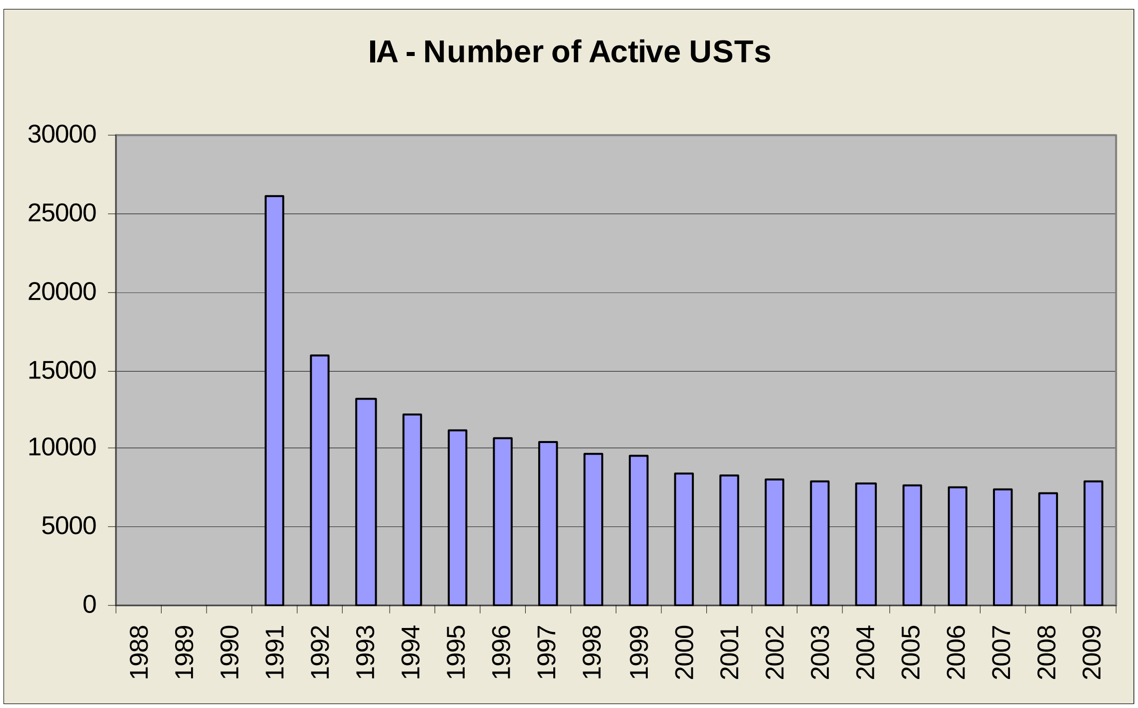

AR - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

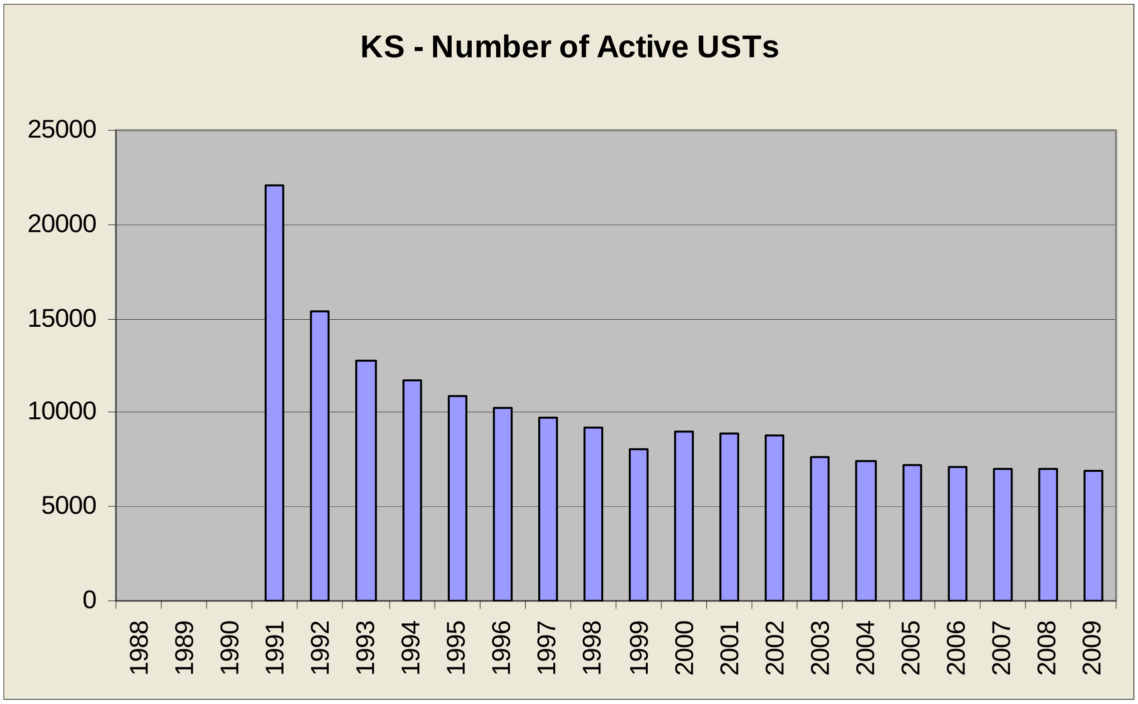

LA - Number of Active USTs
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

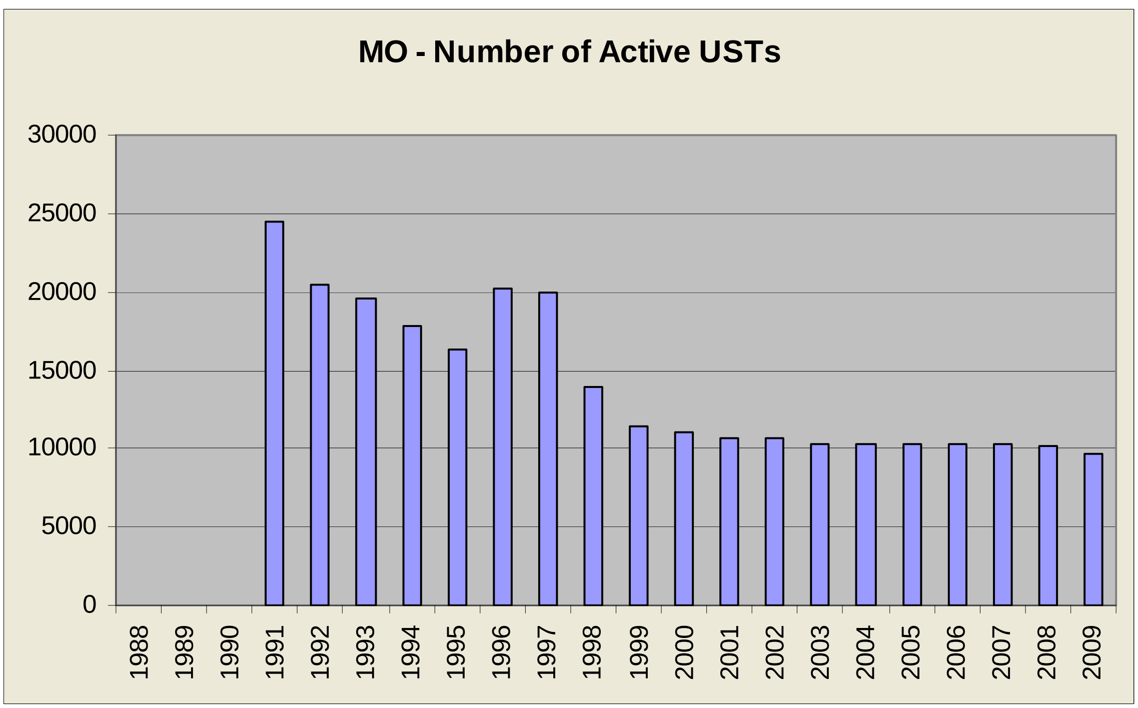

NM - Number of Active USTs
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

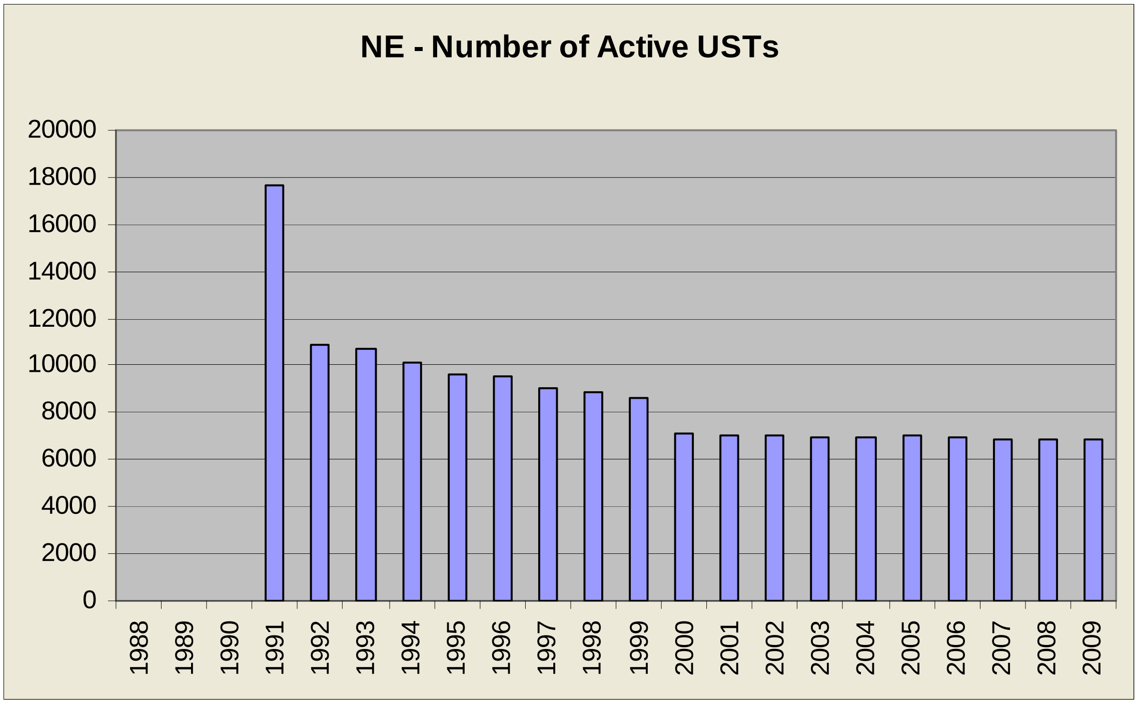

OK - Number of Active USTs
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

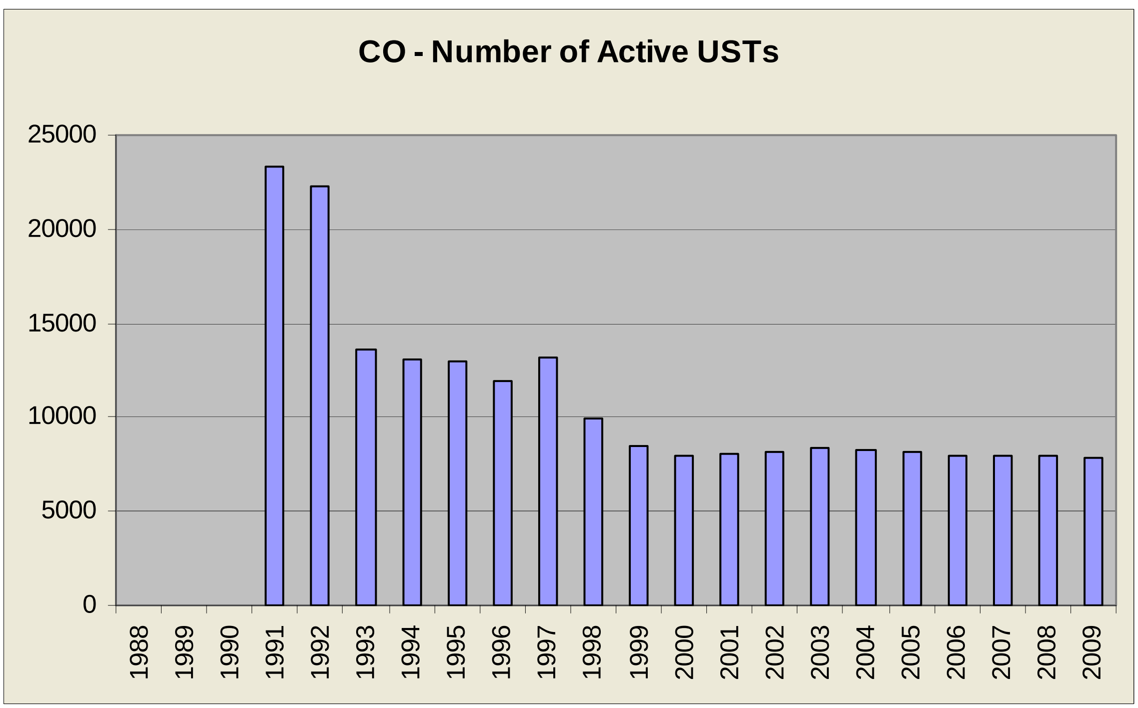

TX - Number of Active USTs
140000
120000
100000
80000
60000
40000
20000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

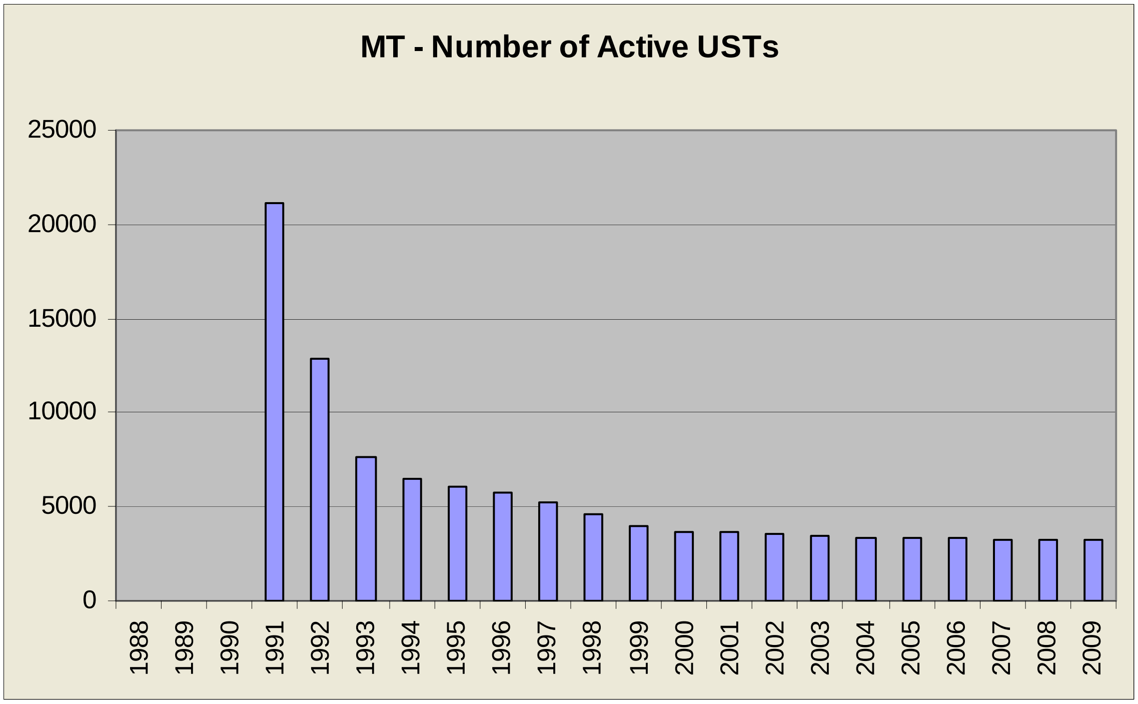

IA - Number of Active USTs
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

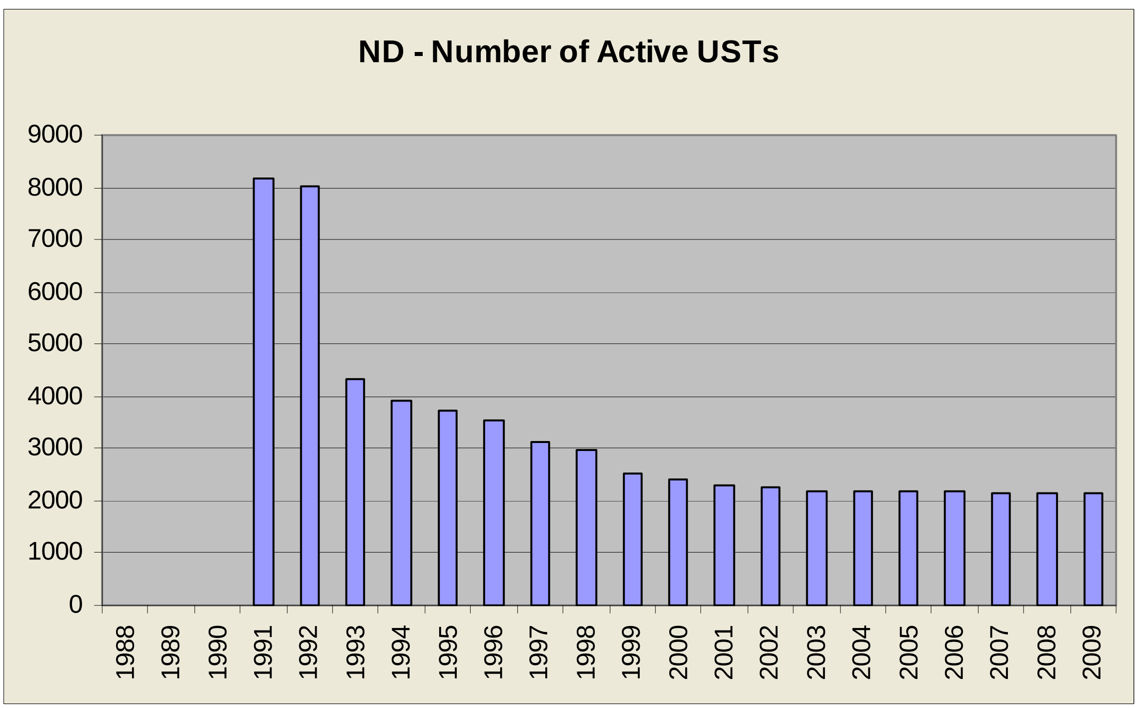

KS - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

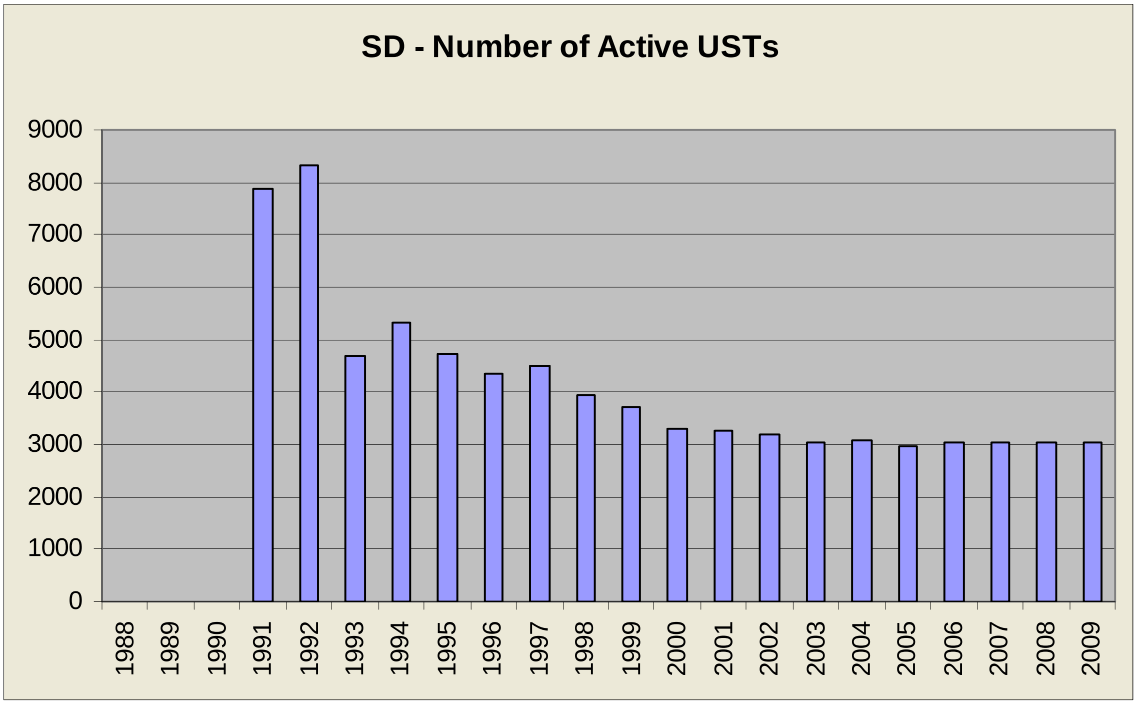

MO - Number of Active USTs
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

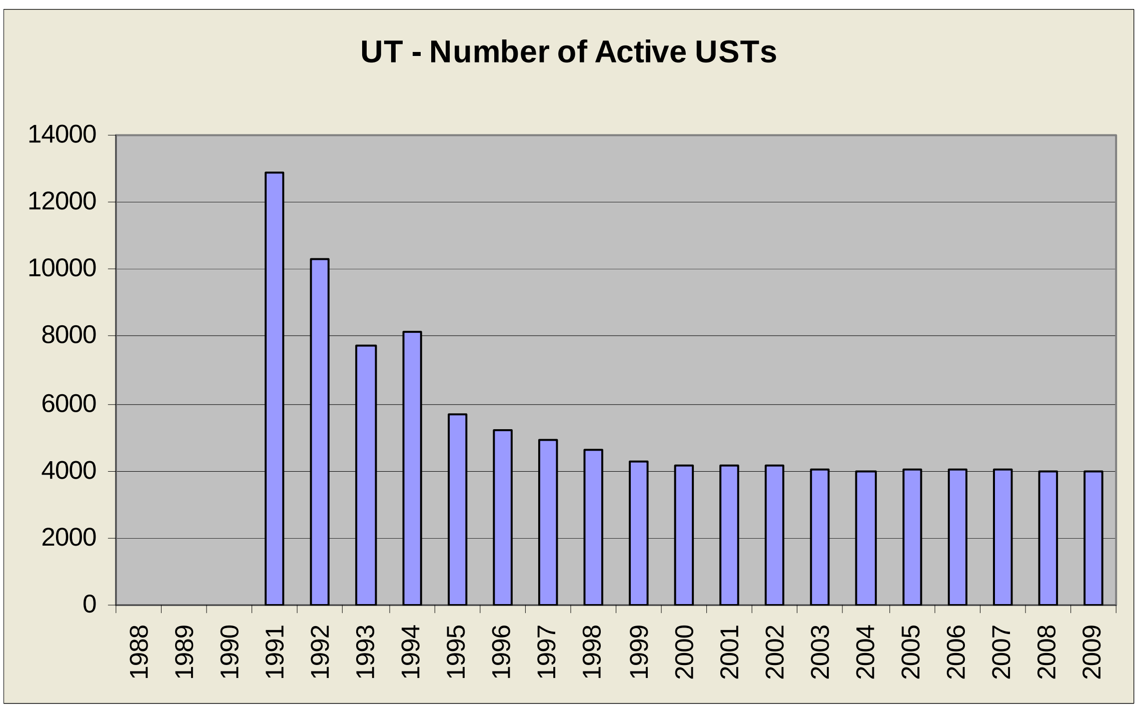

NE - Number of Active USTs
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

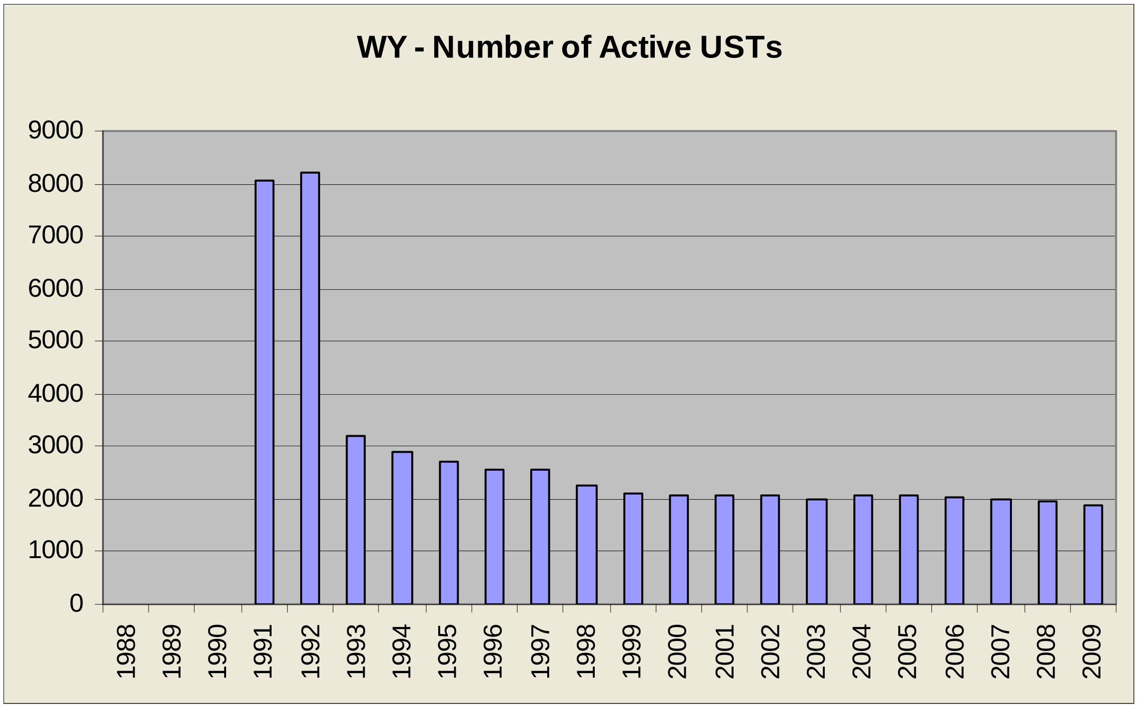

CO - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

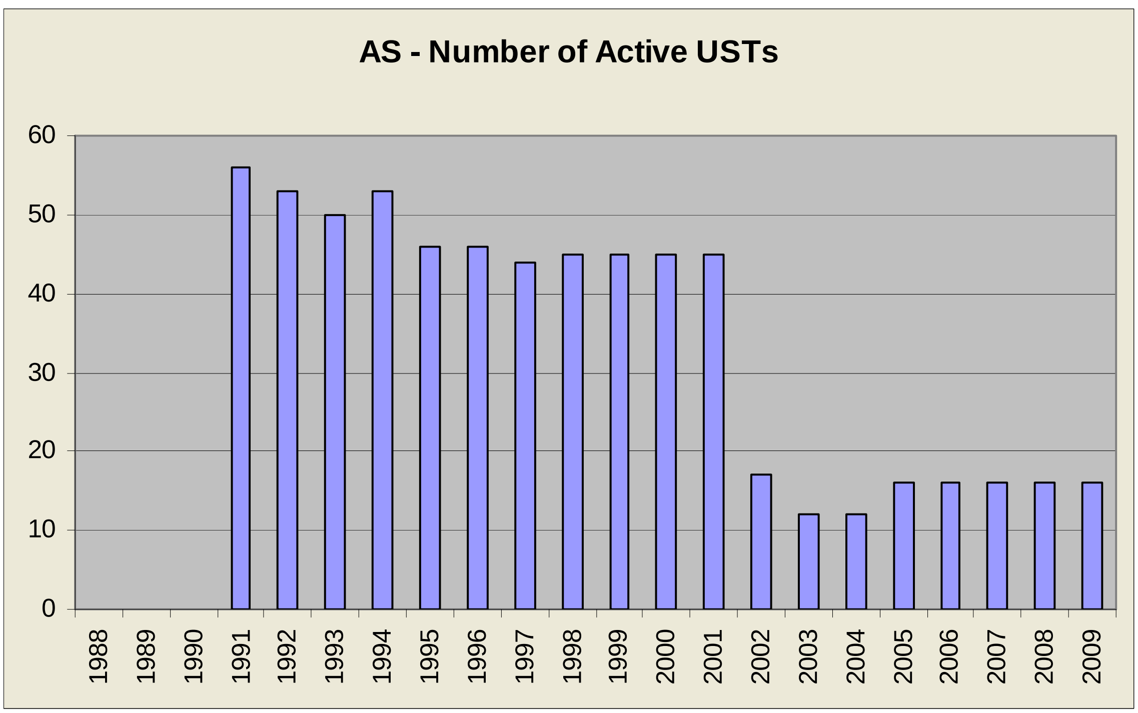

MT - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

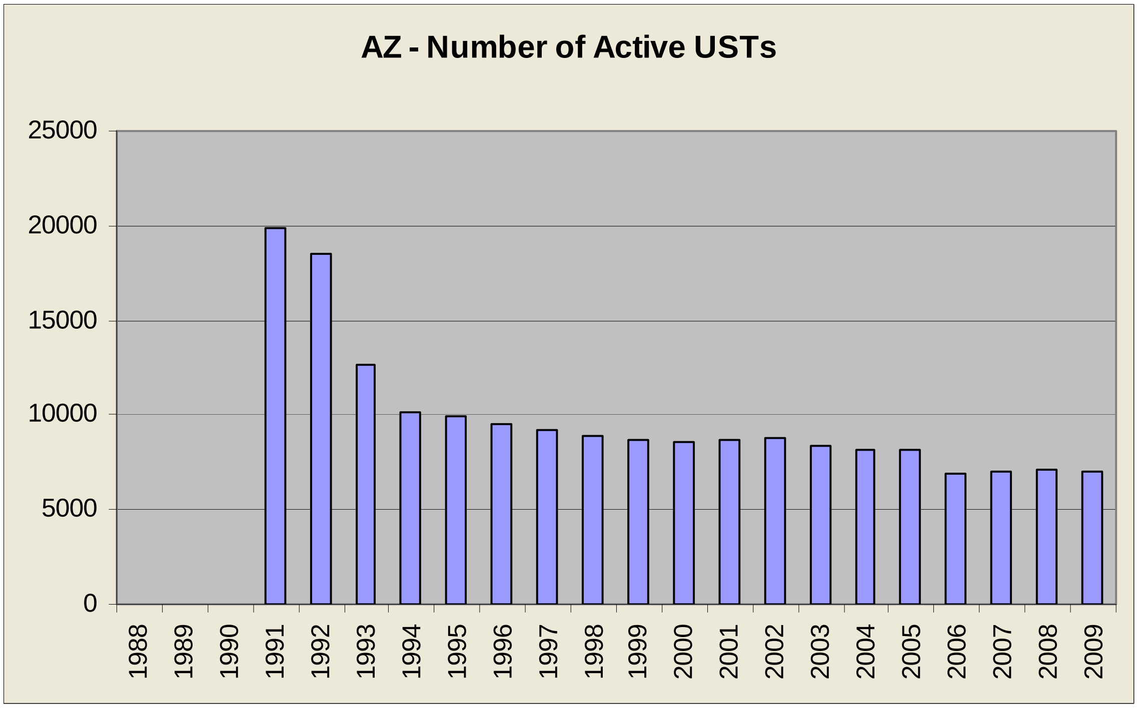

ND - Number of Active USTs
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

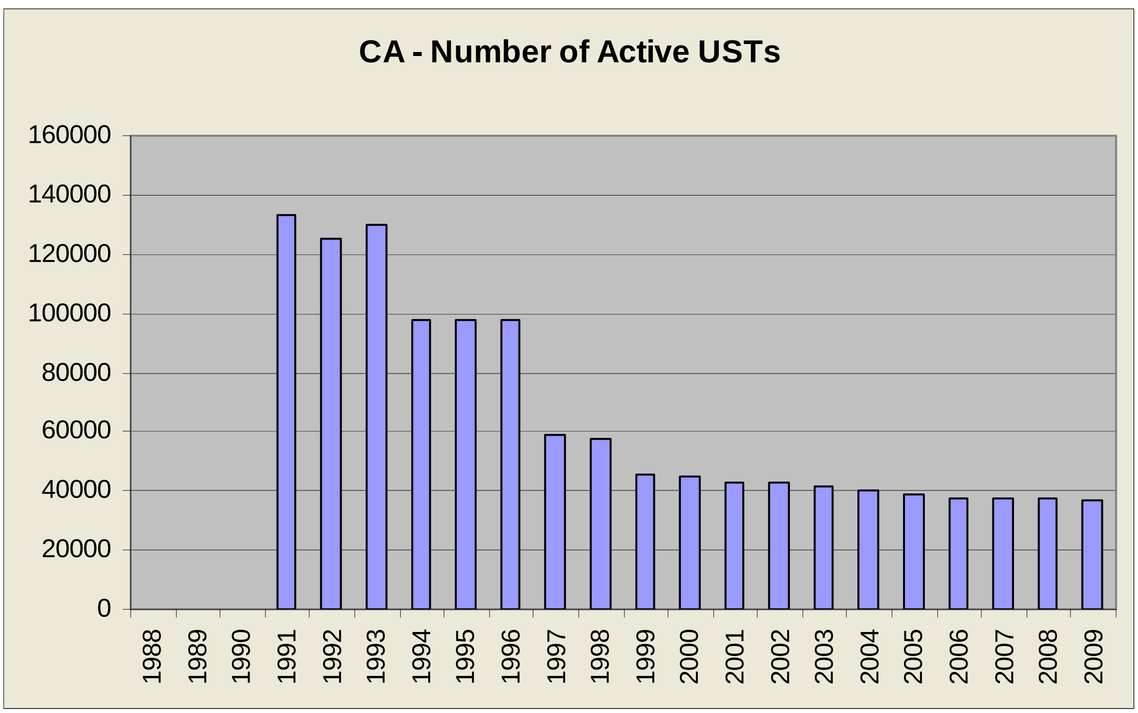

SD - Number of Active USTs
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

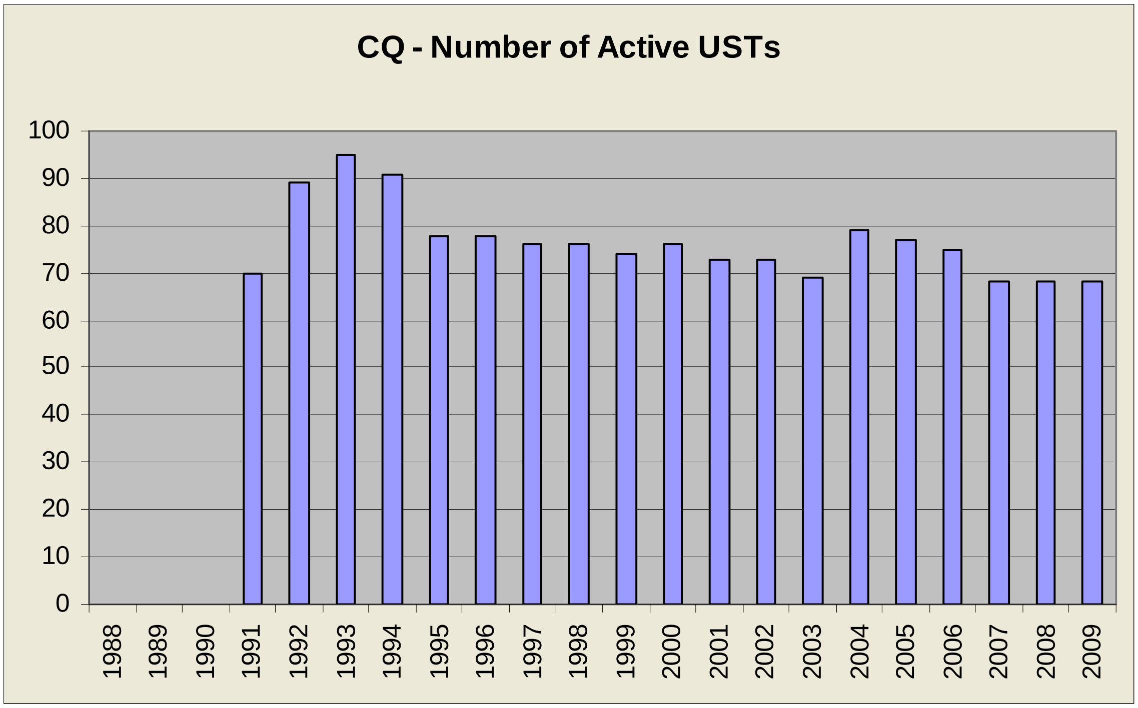

UT - Number of Active USTs
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

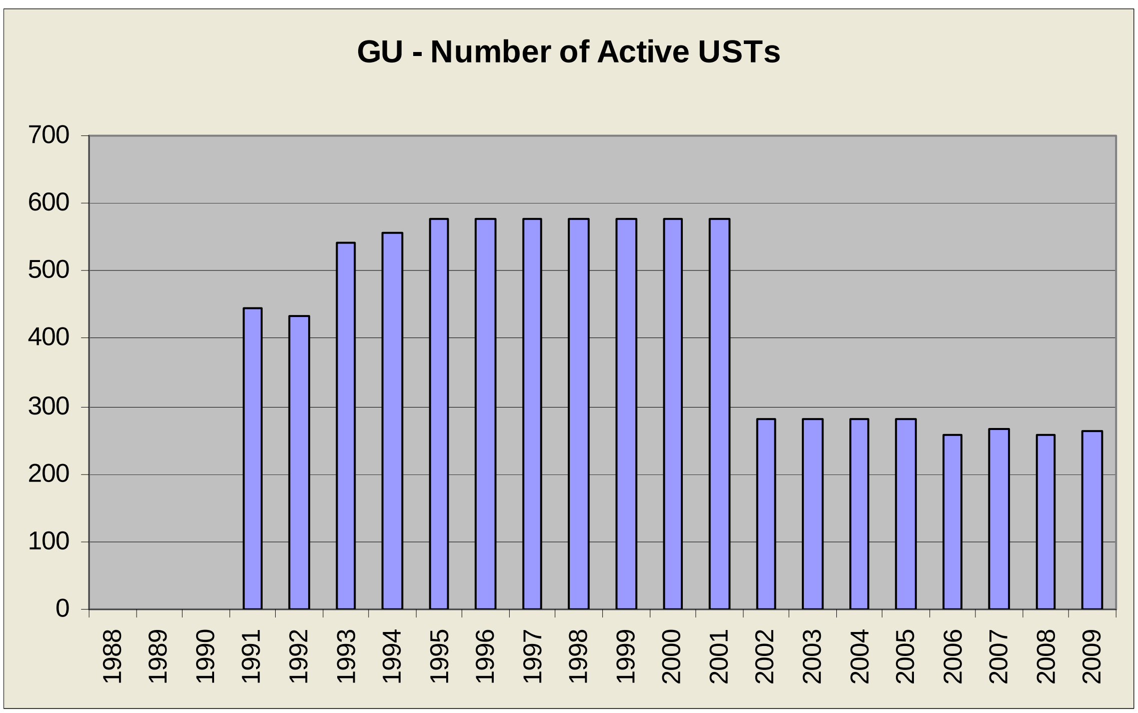

WY - Number of Active USTs
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

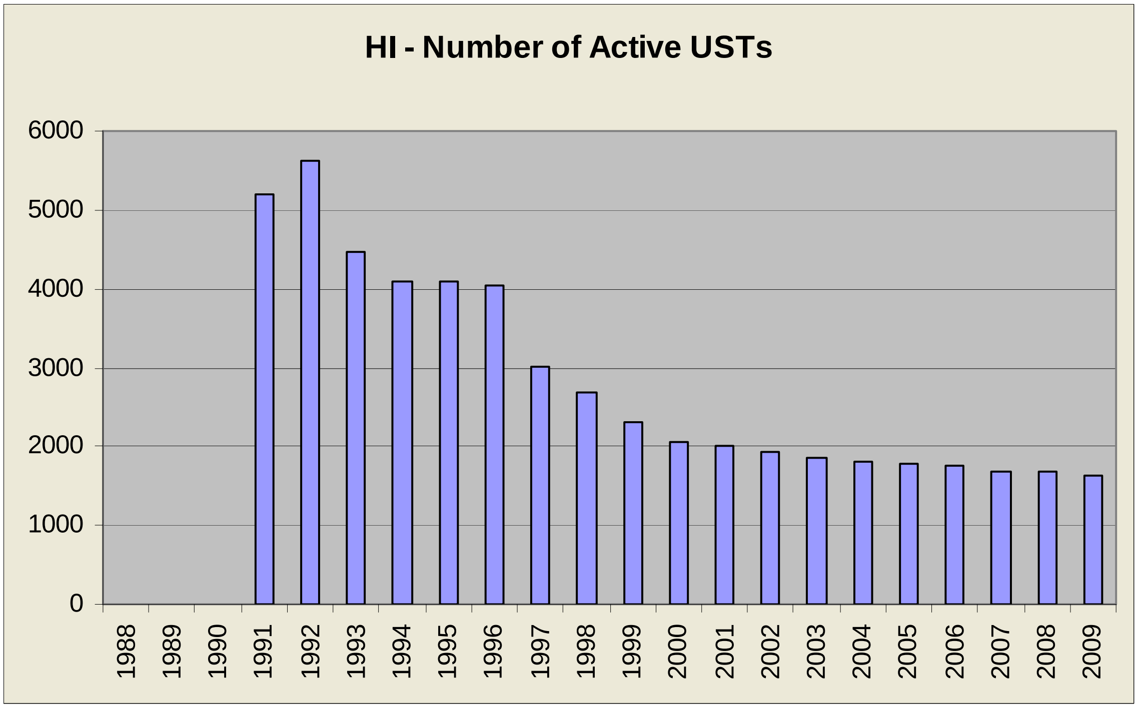

AS - Number of Active USTs
60
50
40
30
20
10
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

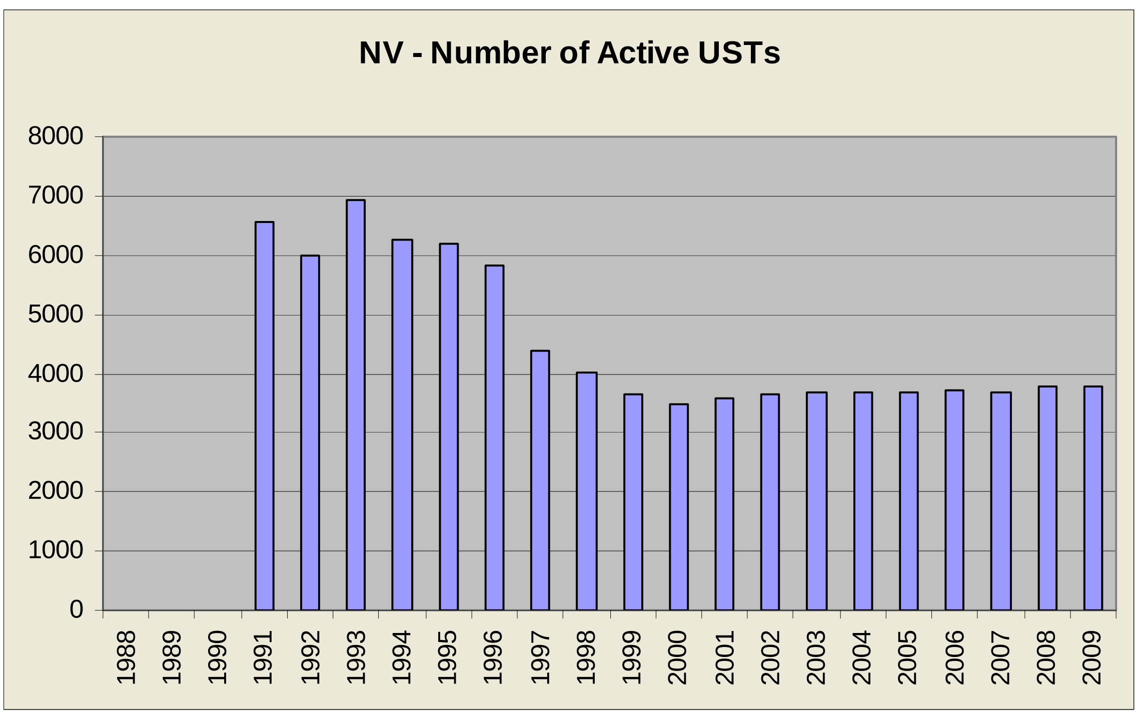

AZ - Number of Active USTs
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

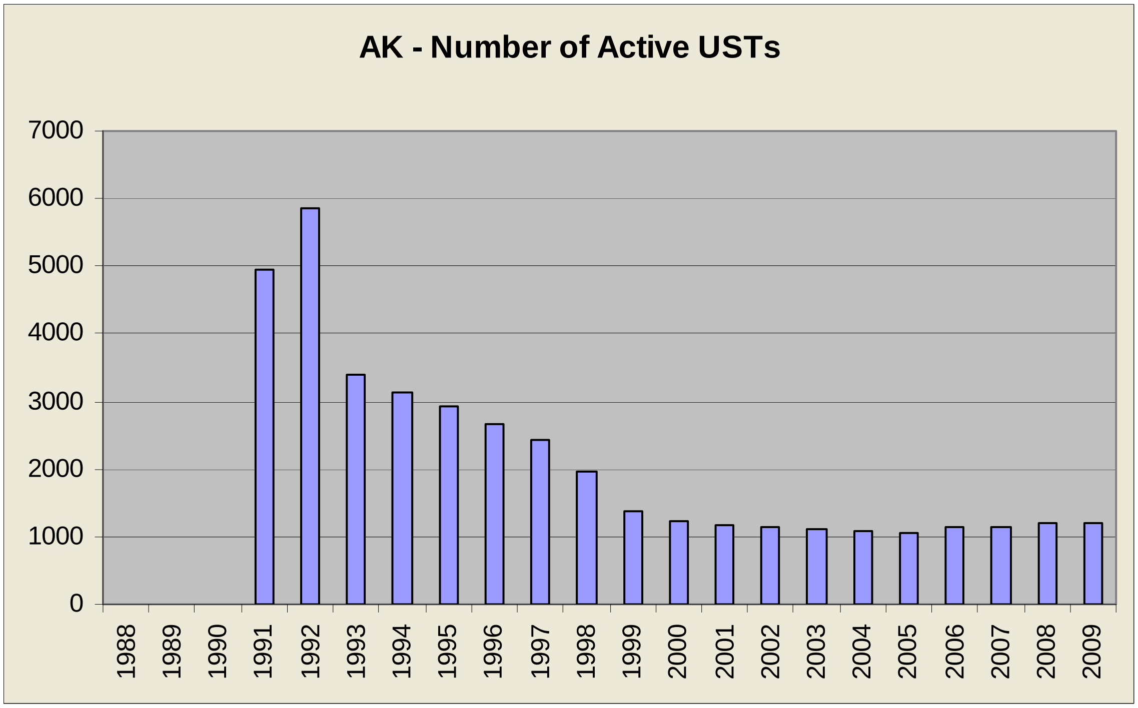

CA - Number of Active USTs
160000
140000
120000
100000
80000
60000
40000
20000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

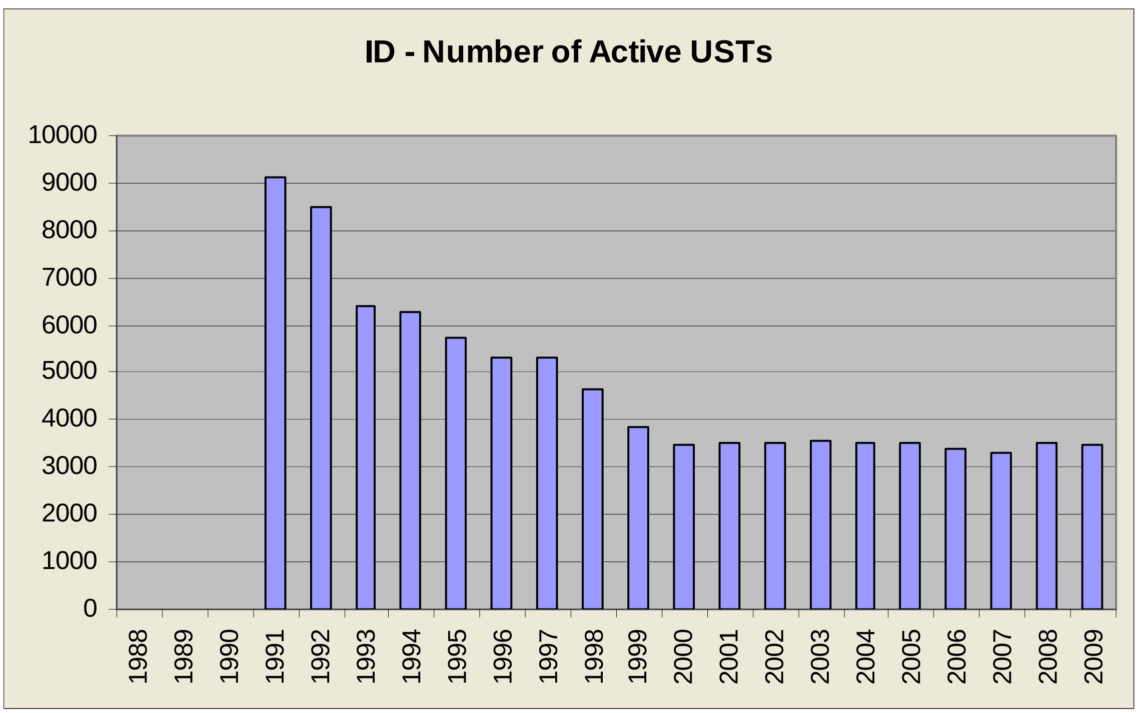

CQ - Number of Active USTs
100
90
80
70
60
50
40
30
20
10
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

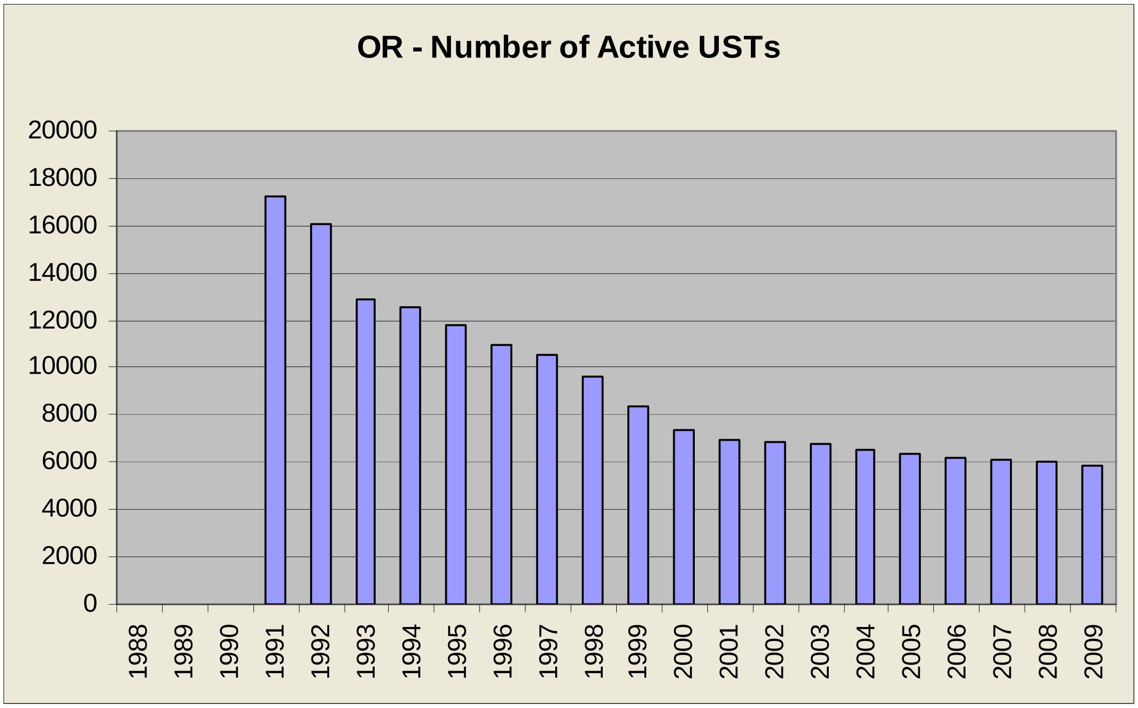

GU - Number of Active USTs
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

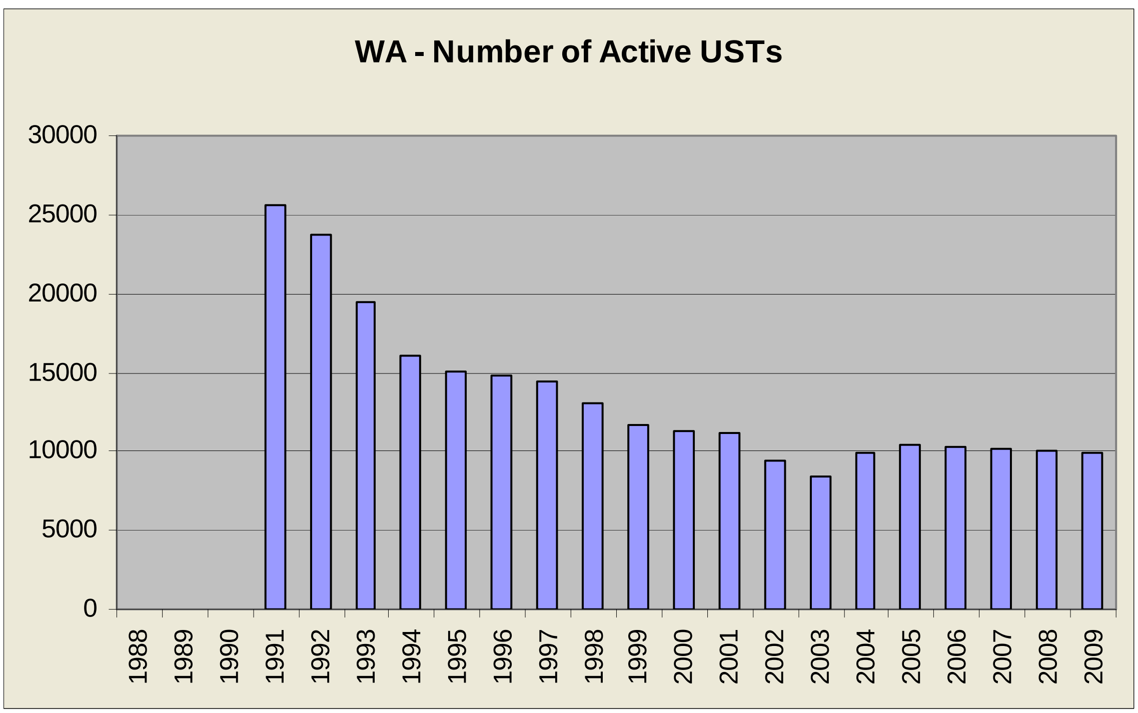

HI - Number of Active USTs
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

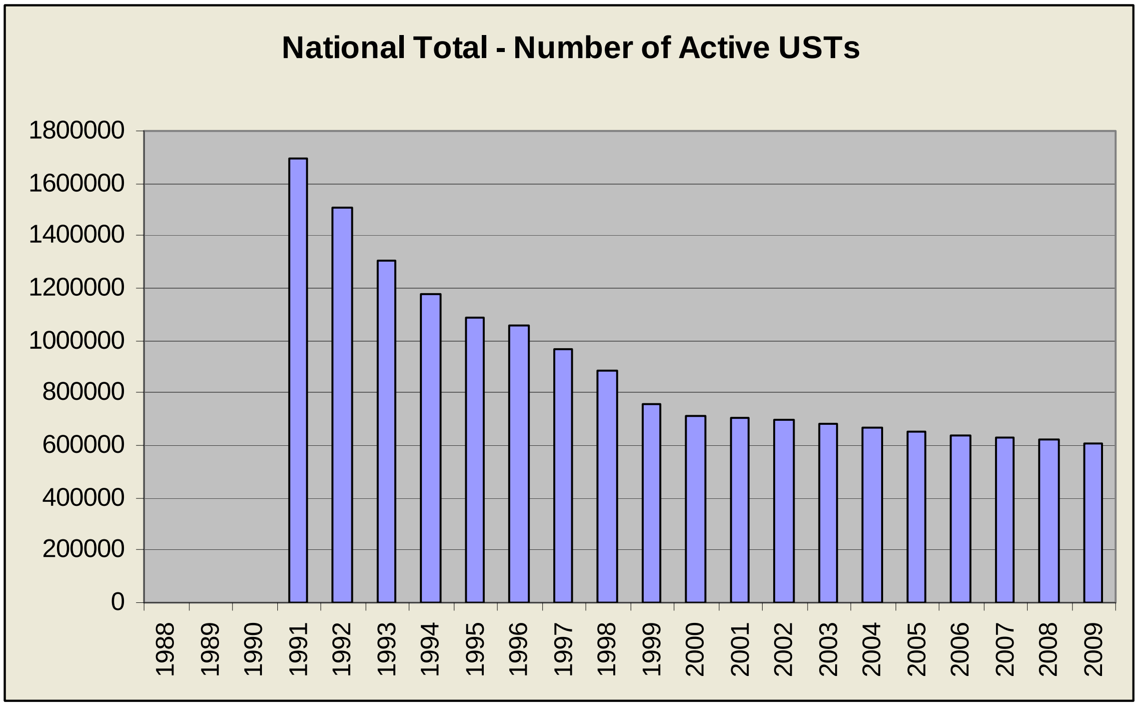

NV - Number of Active USTs
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


AK - Number of Active USTs
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


ID - Number of Active USTs
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

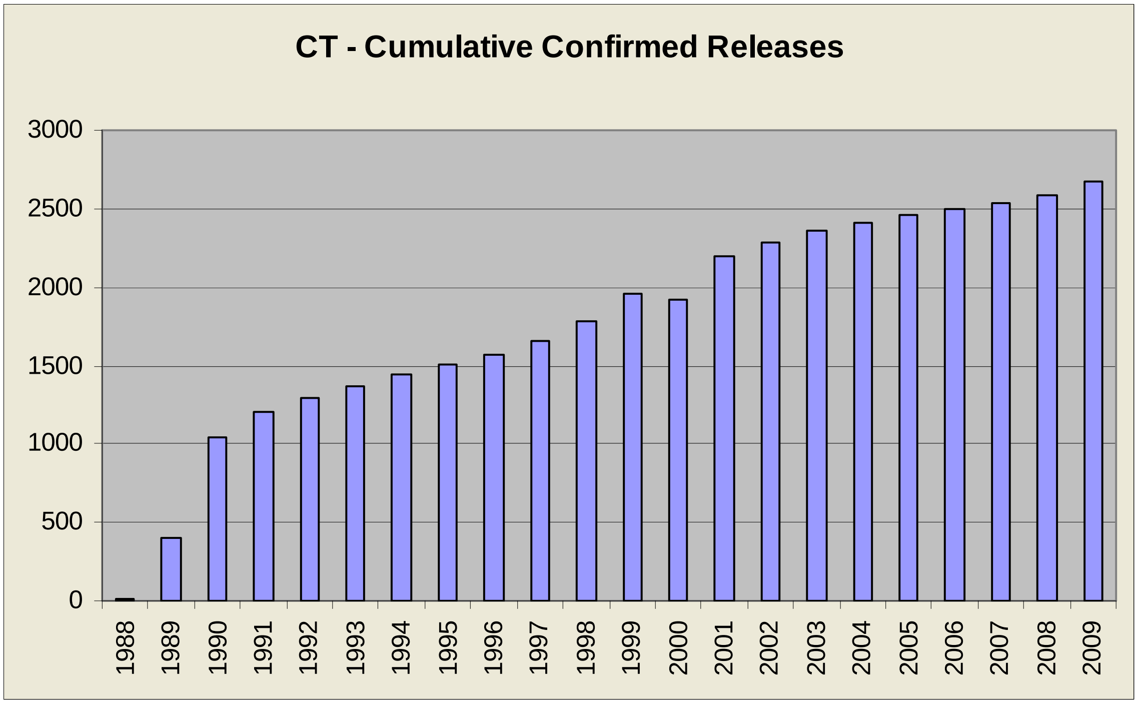

OR - Number of Active USTs
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

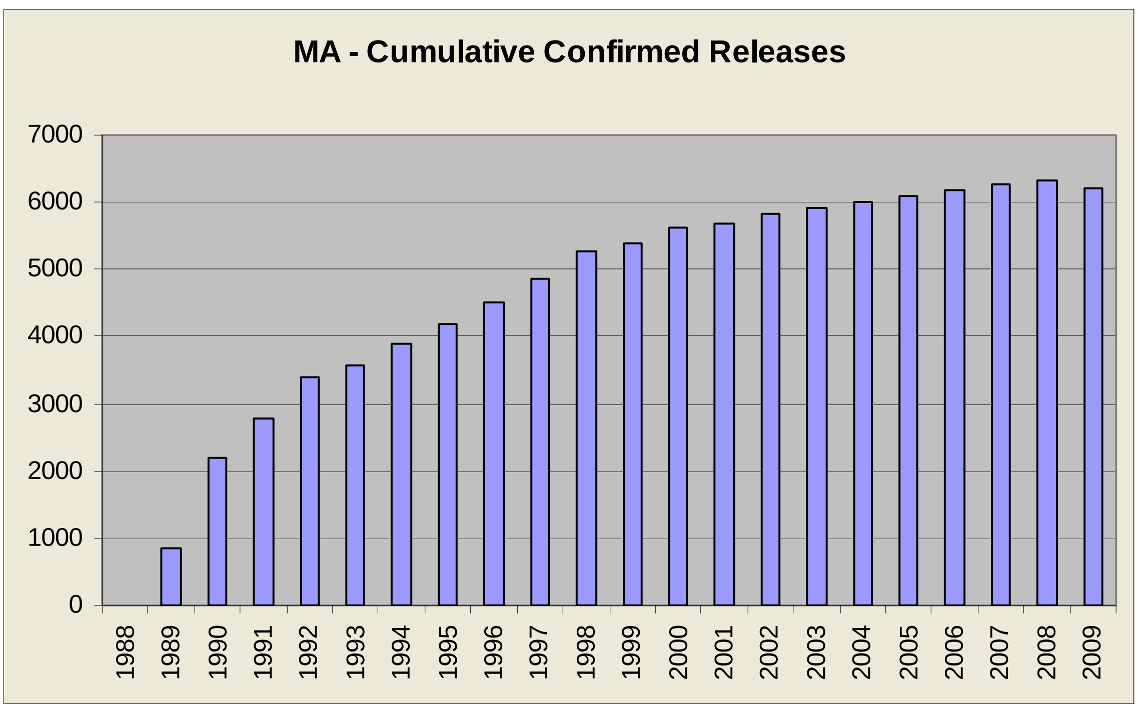

WA - Number of Active USTs
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

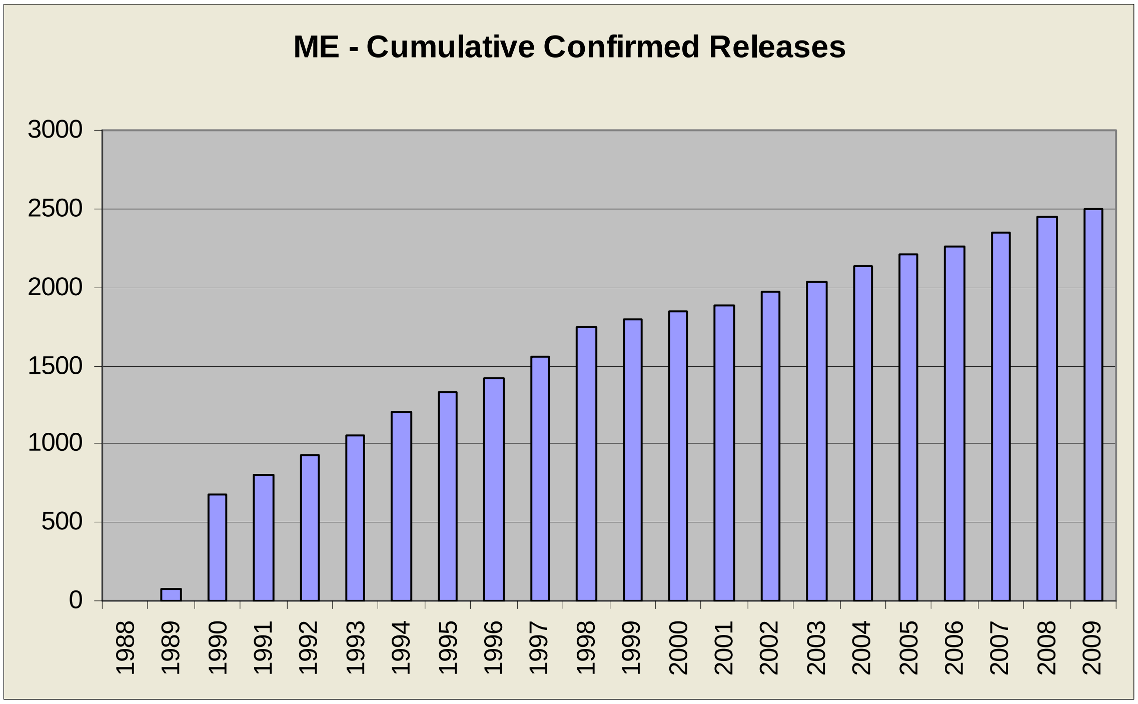

National Total - Number of Active USTs
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

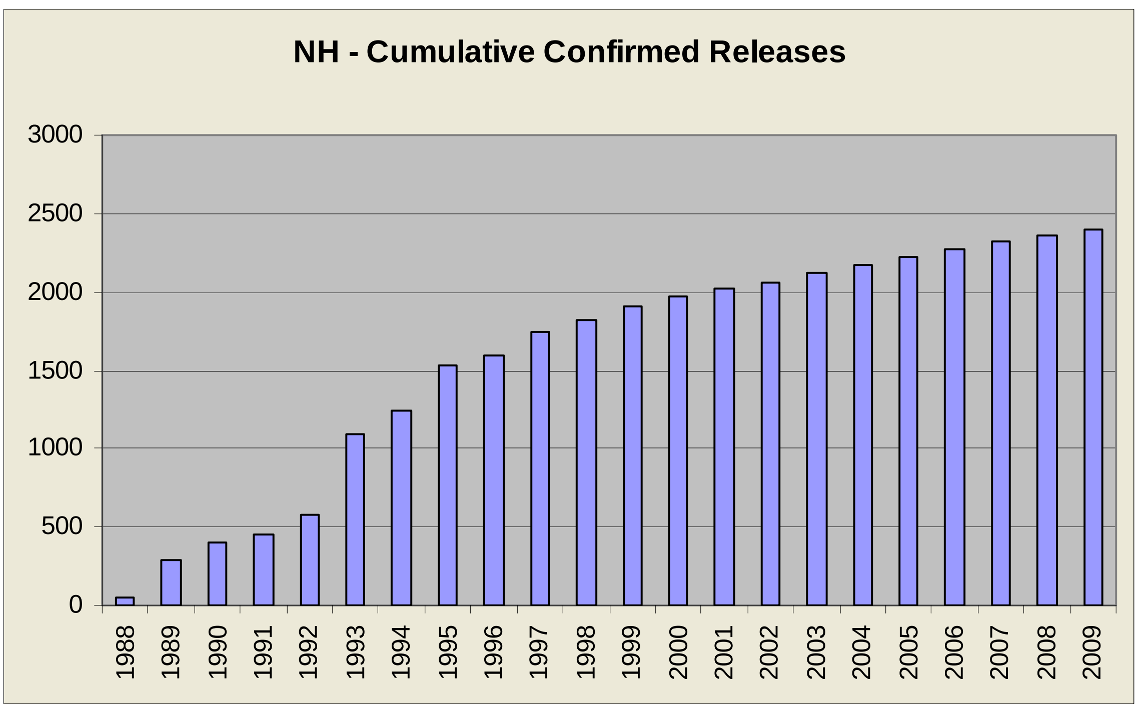
APPENDIX D

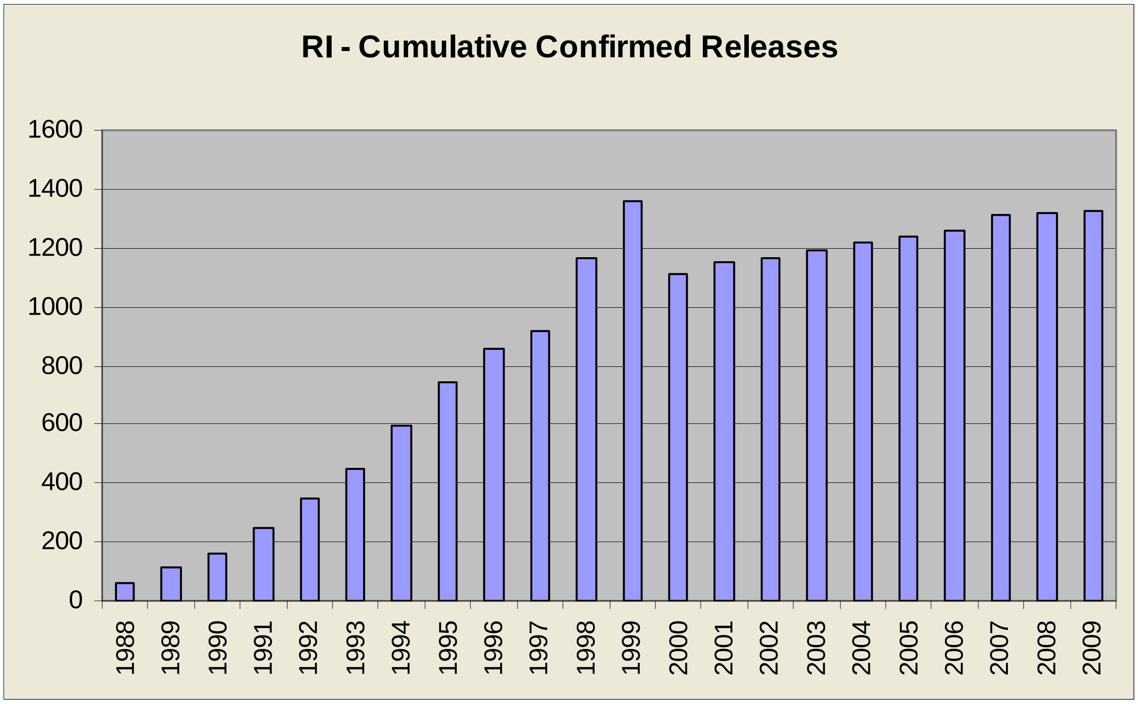
Graphs of Cumulative Confirmed Releases for all 56 States for the Period 1988 through 2009

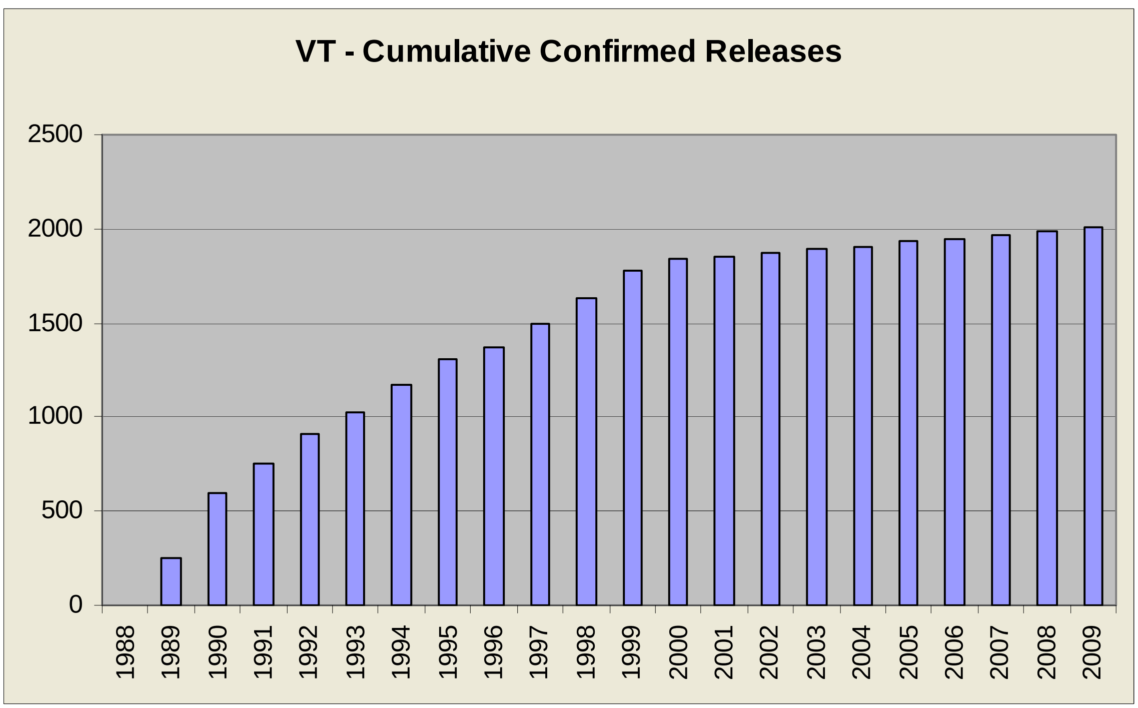

CT - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

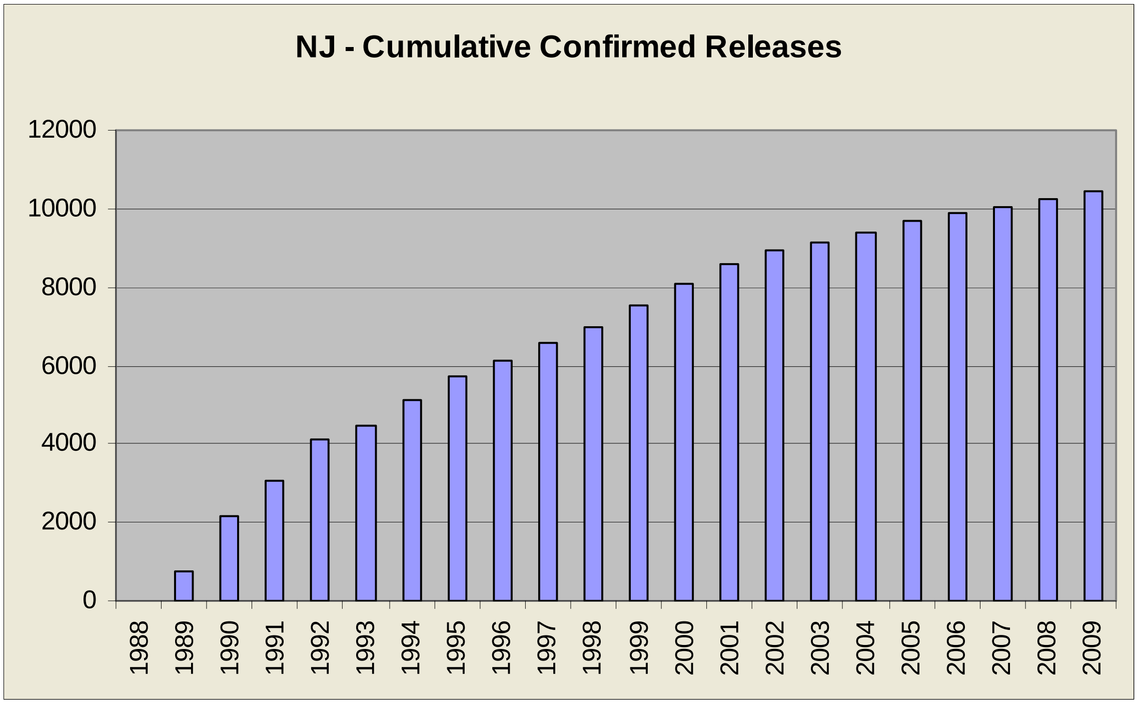

MA - Cumulative Confirmed Releases
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

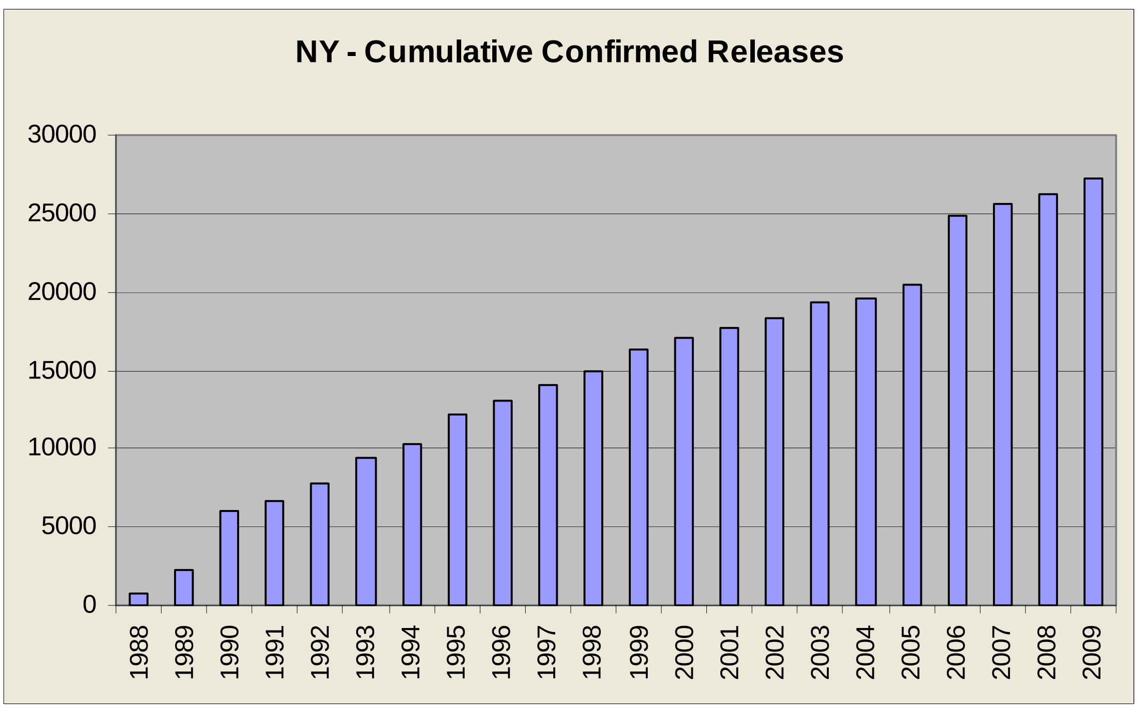

ME - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

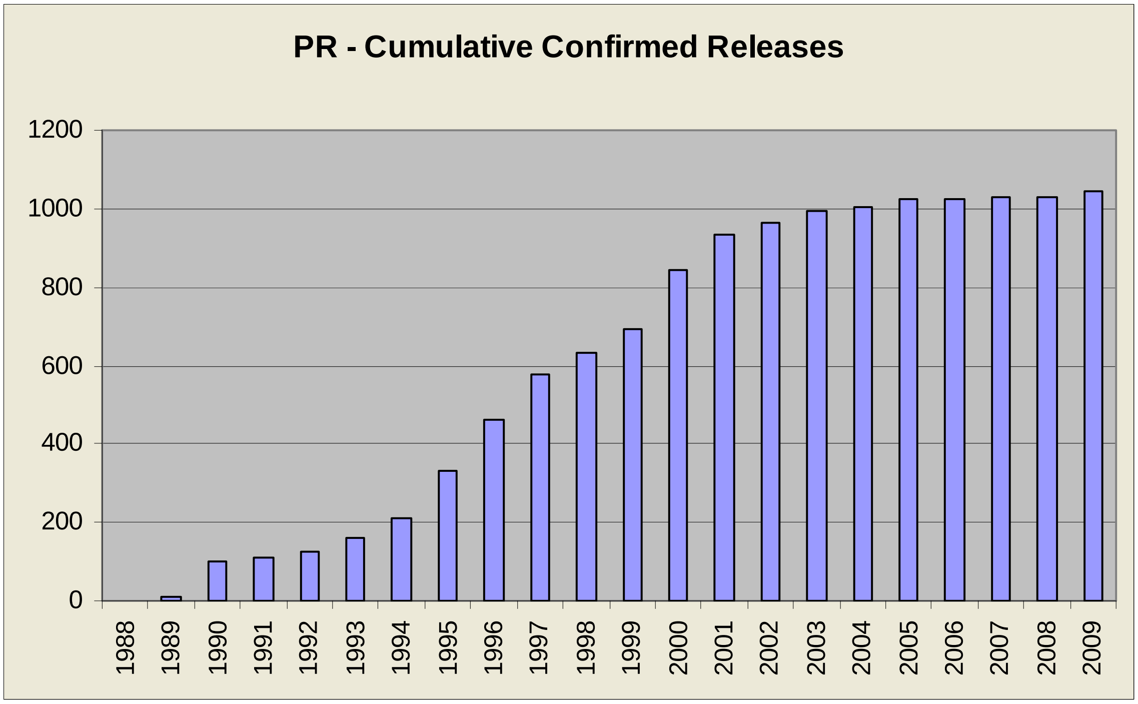

NH - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

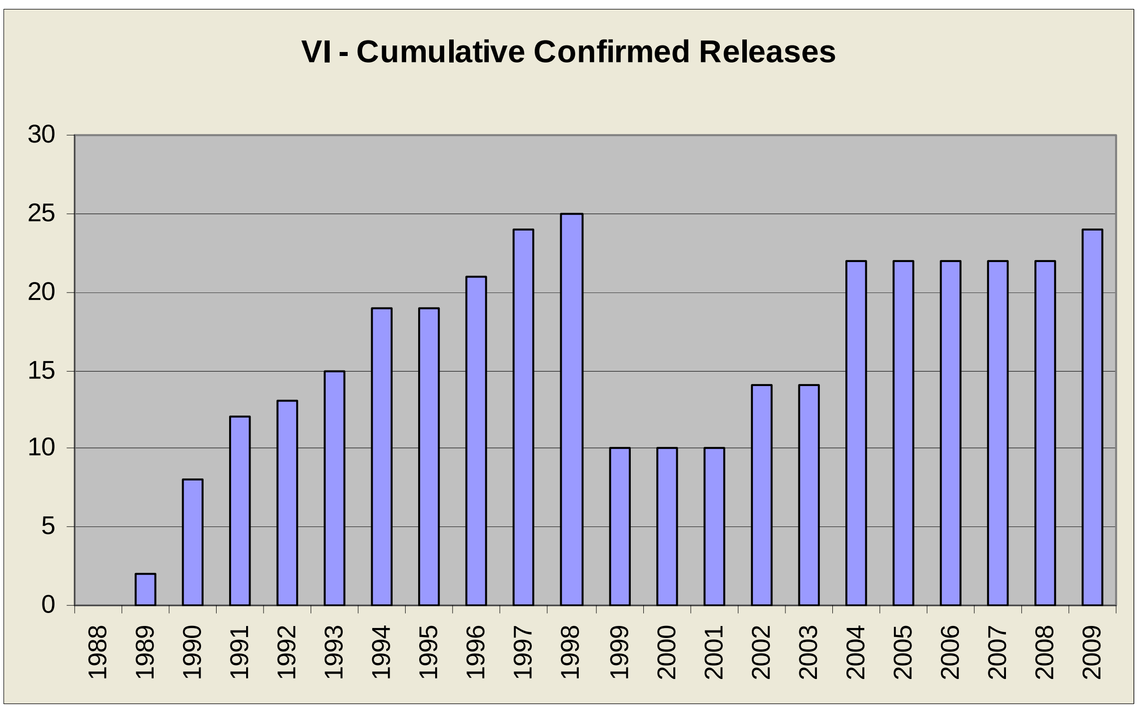

RI - Cumulative Confirmed Releases
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

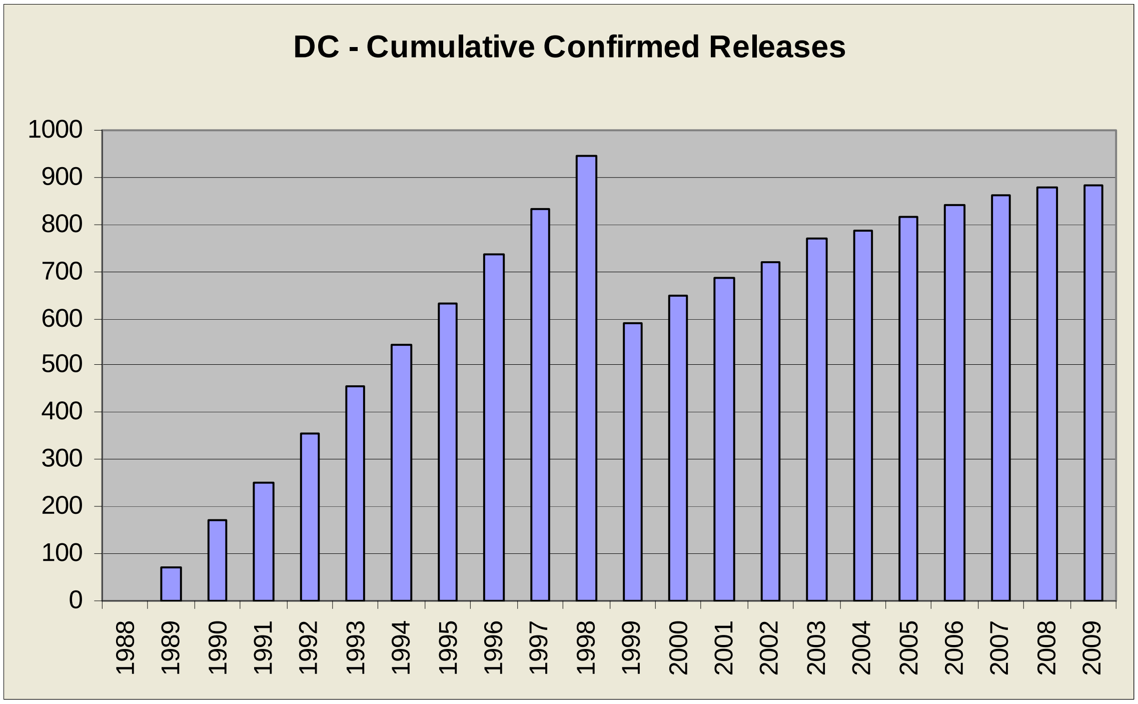

VT - Cumulative Confirmed Releases
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


NJ - Cumulative Confirmed Releases
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


NY - Cumulative Confirmed Releases
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


PR - Cumulative Confirmed Releases
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


VI - Cumulative Confirmed Releases
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


DC - Cumulative Confirmed Releases
1000
900
800
700
600
500
400
300
200
100
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1988
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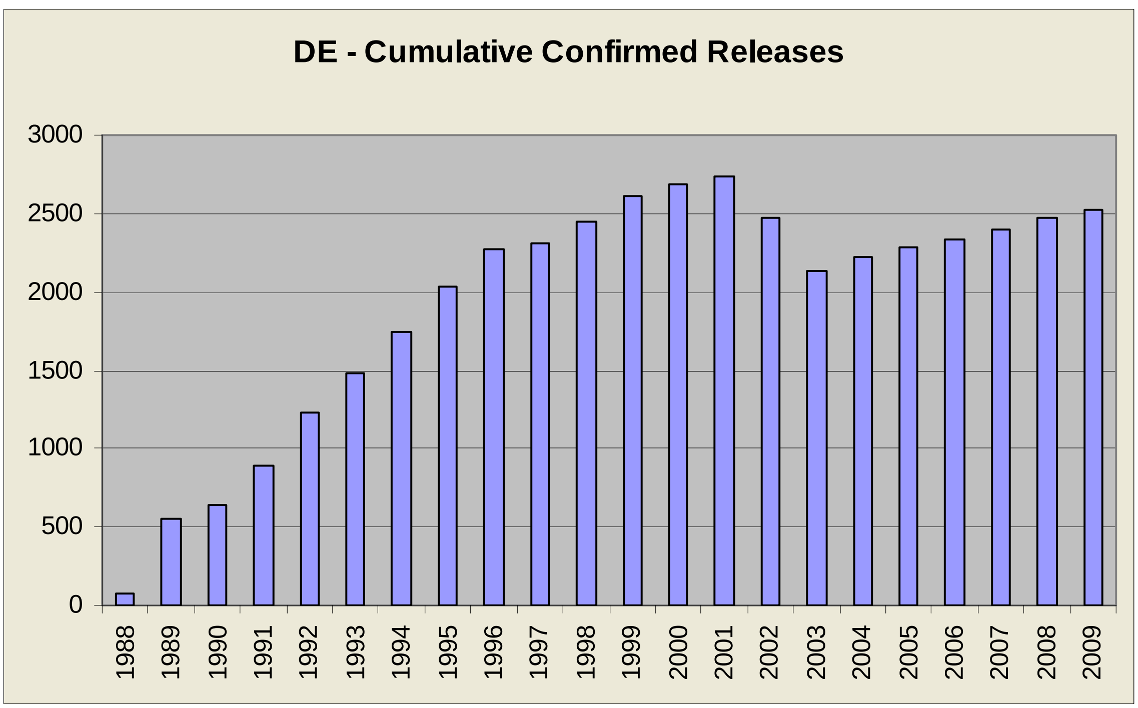
DE - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
1989
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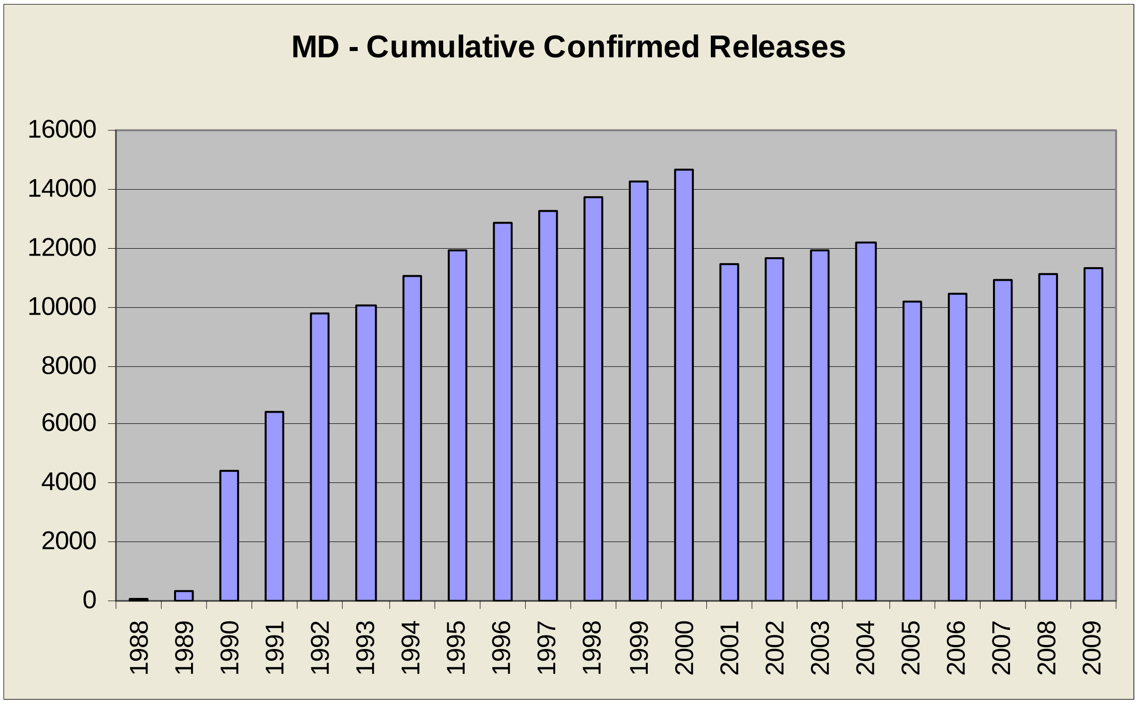
MD - Cumulative Confirmed Releases
16000
14000
12000
10000
8000
6000
4000
2000
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1988
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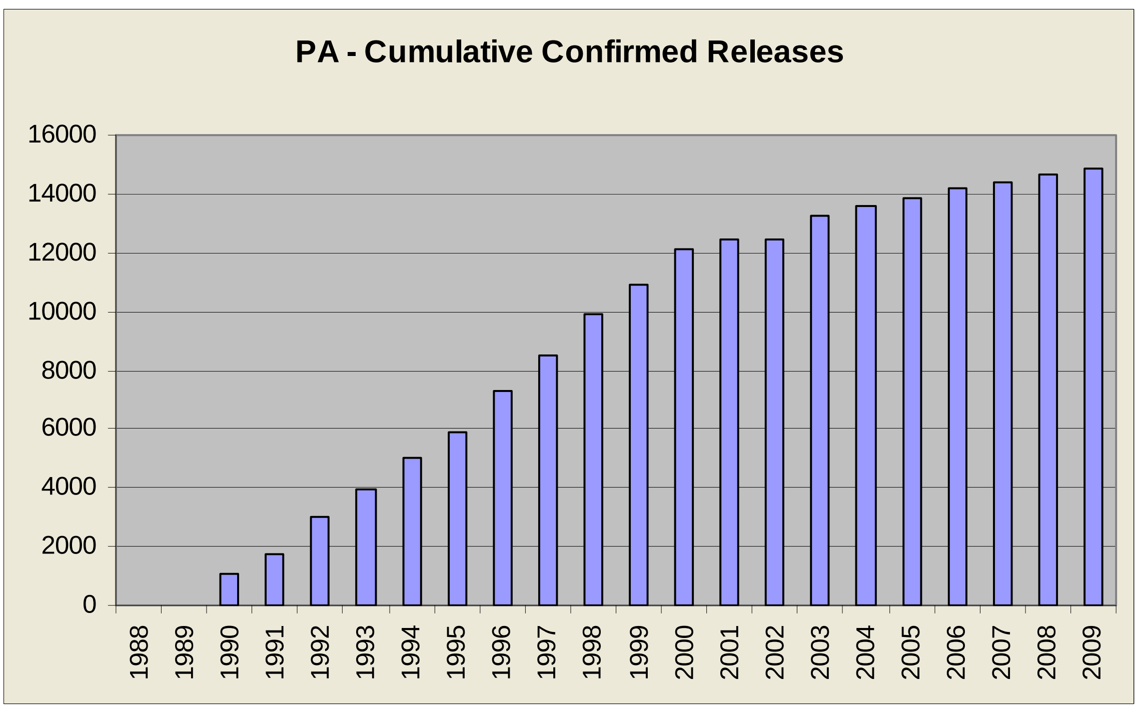
PA - Cumulative Confirmed Releases
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
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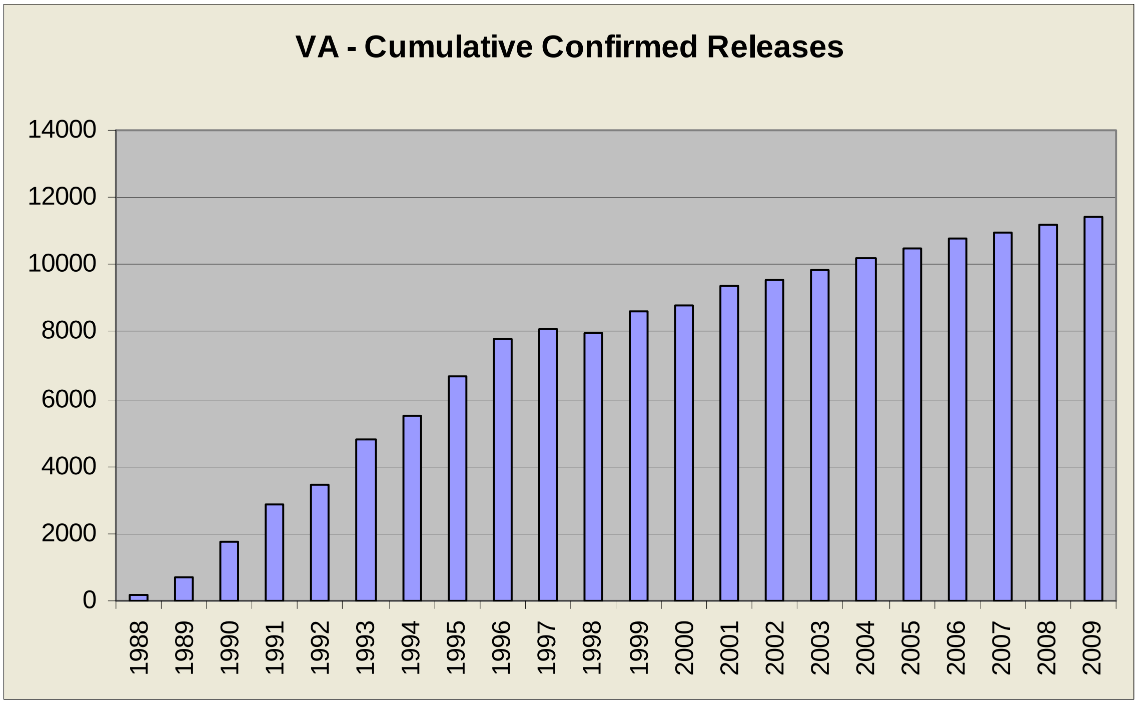
VA - Cumulative Confirmed Releases
14000
12000
10000
8000
6000
4000
2000
0
1988
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1995
1996
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1998
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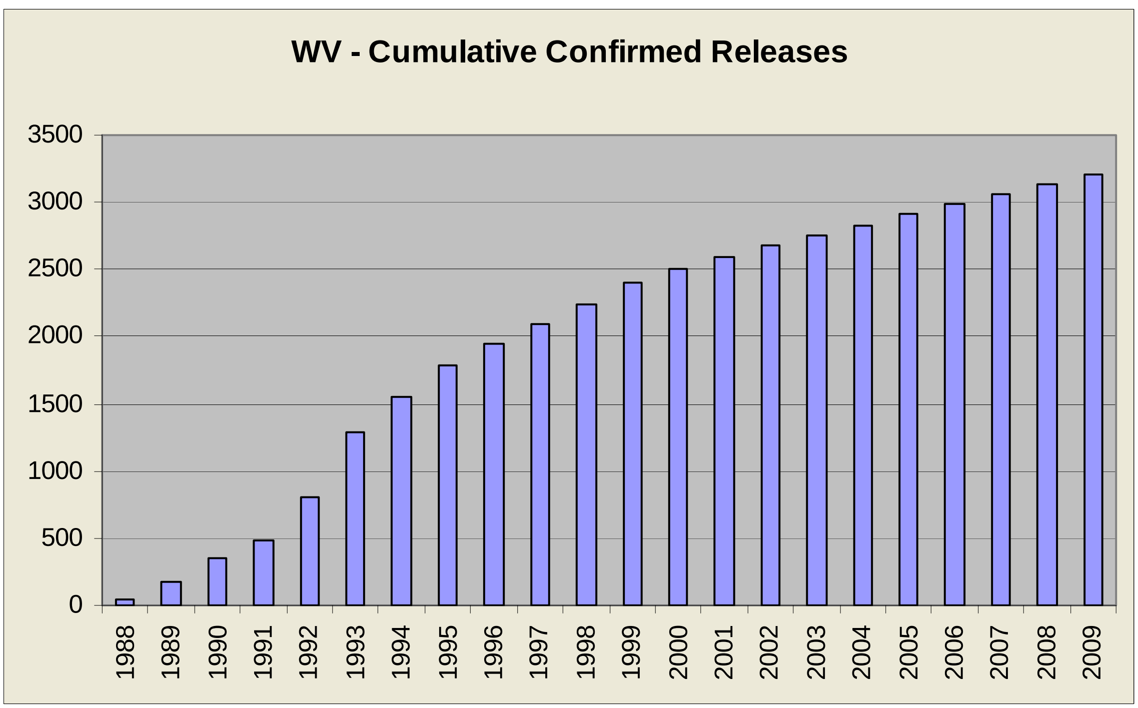
WV - Cumulative Confirmed Releases
3500
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1500
1000
500
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1988
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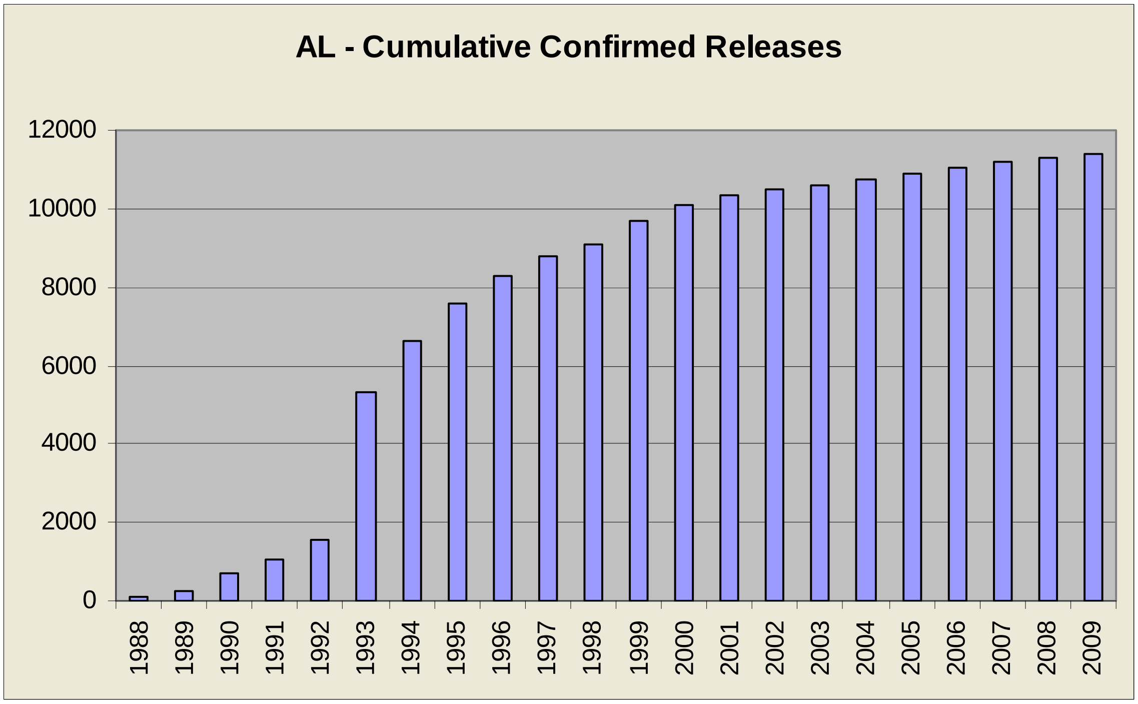
AL - Cumulative Confirmed Releases
12000
10000
8000
6000
4000
2000
0
1988
1989
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1995
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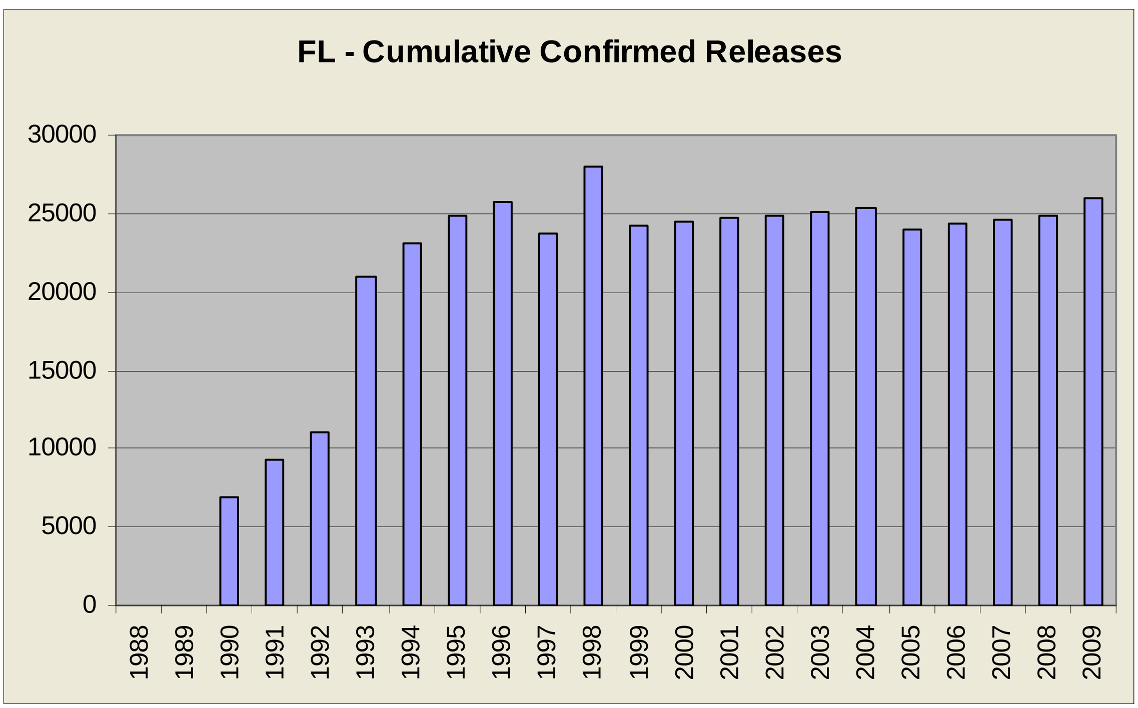
FL - Cumulative Confirmed Releases
30000
25000
20000
15000
10000
5000
0
1988
1989
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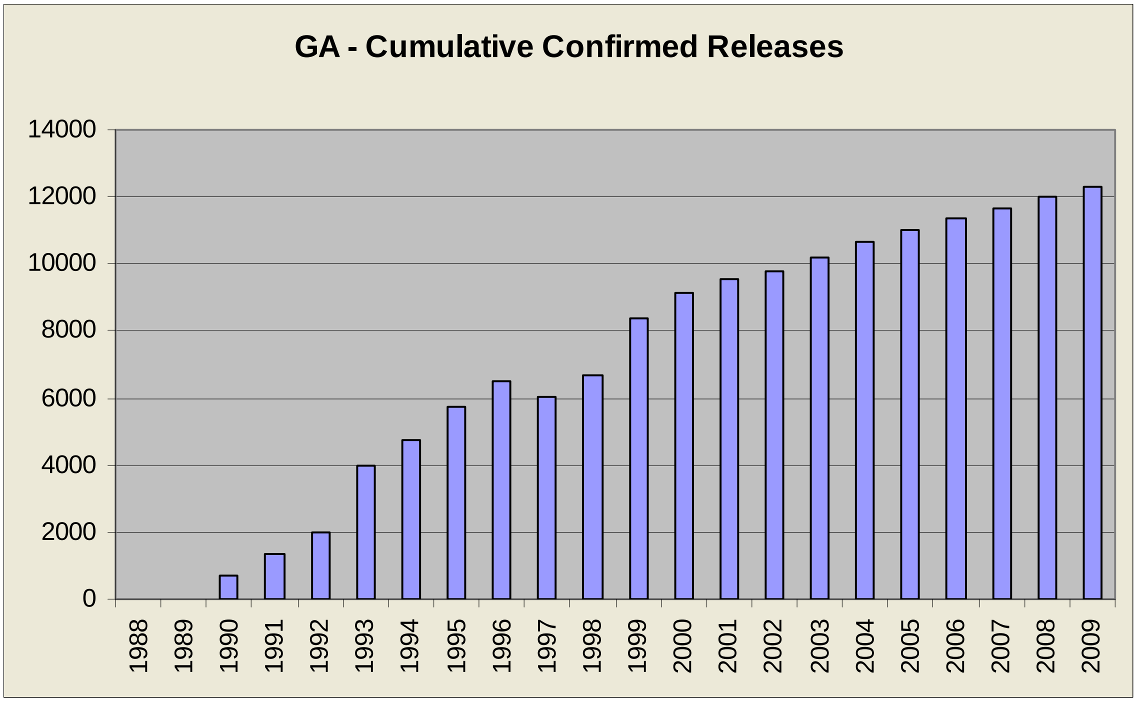
GA - Cumulative Confirmed Releases
14000
12000
10000
8000
6000
4000
2000
0
1988
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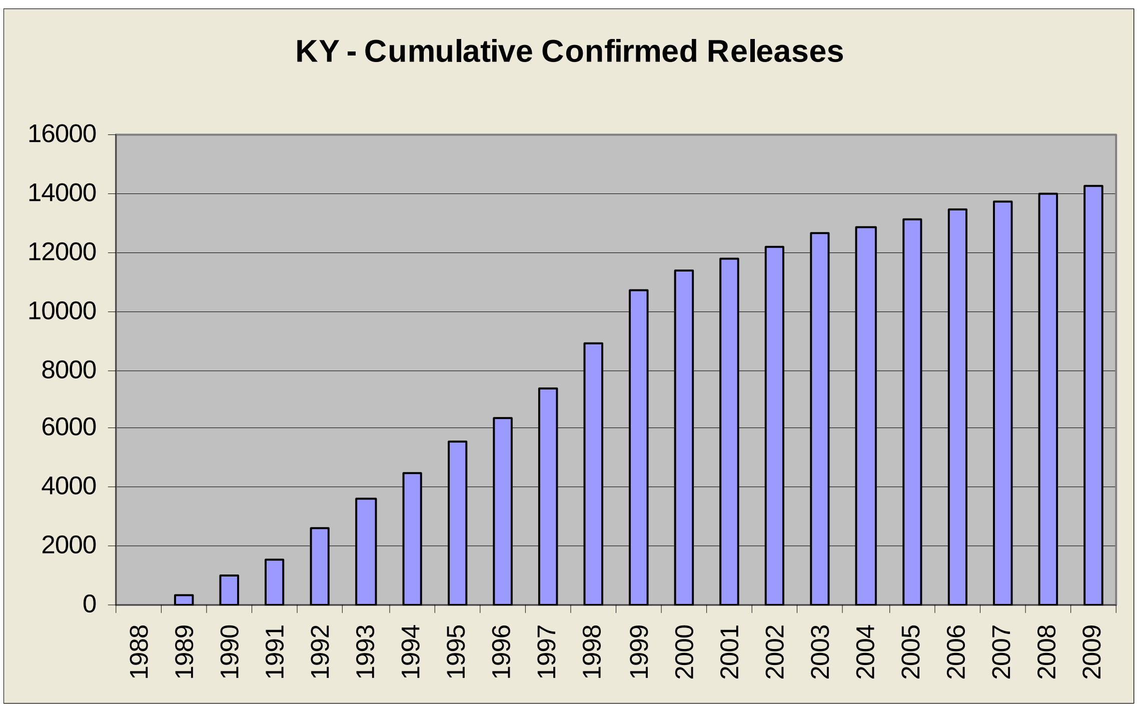
KY - Cumulative Confirmed Releases
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
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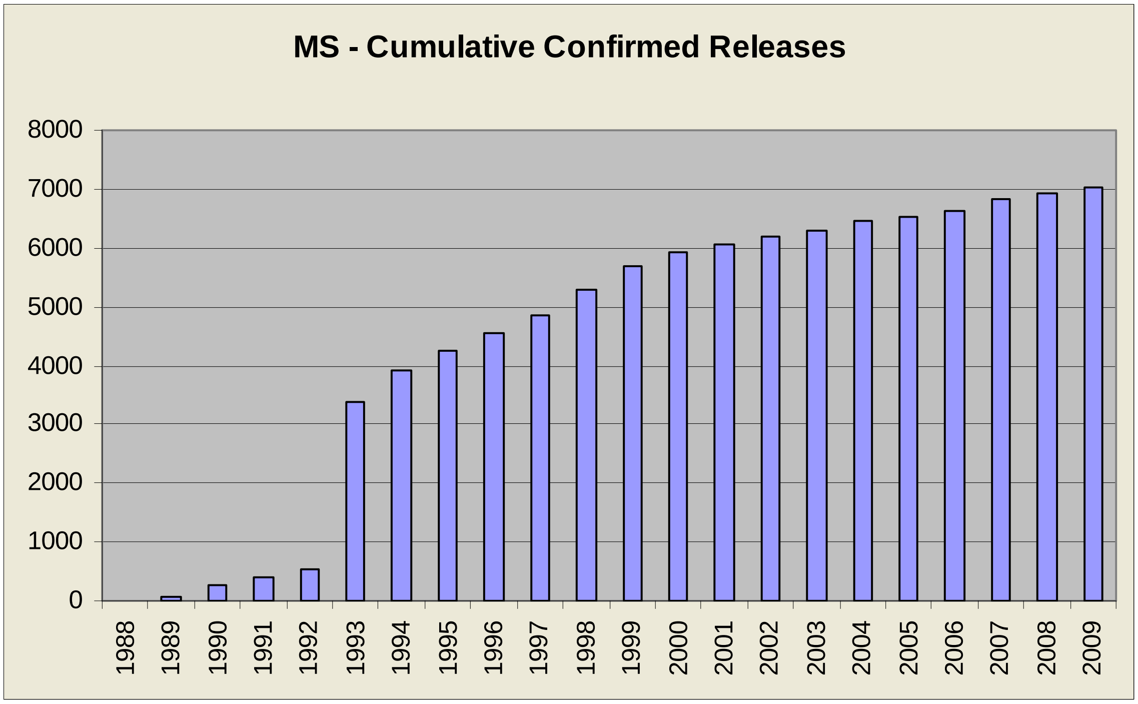
MS - Cumulative Confirmed Releases
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
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1995
1996
1997
1998
1999
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2006
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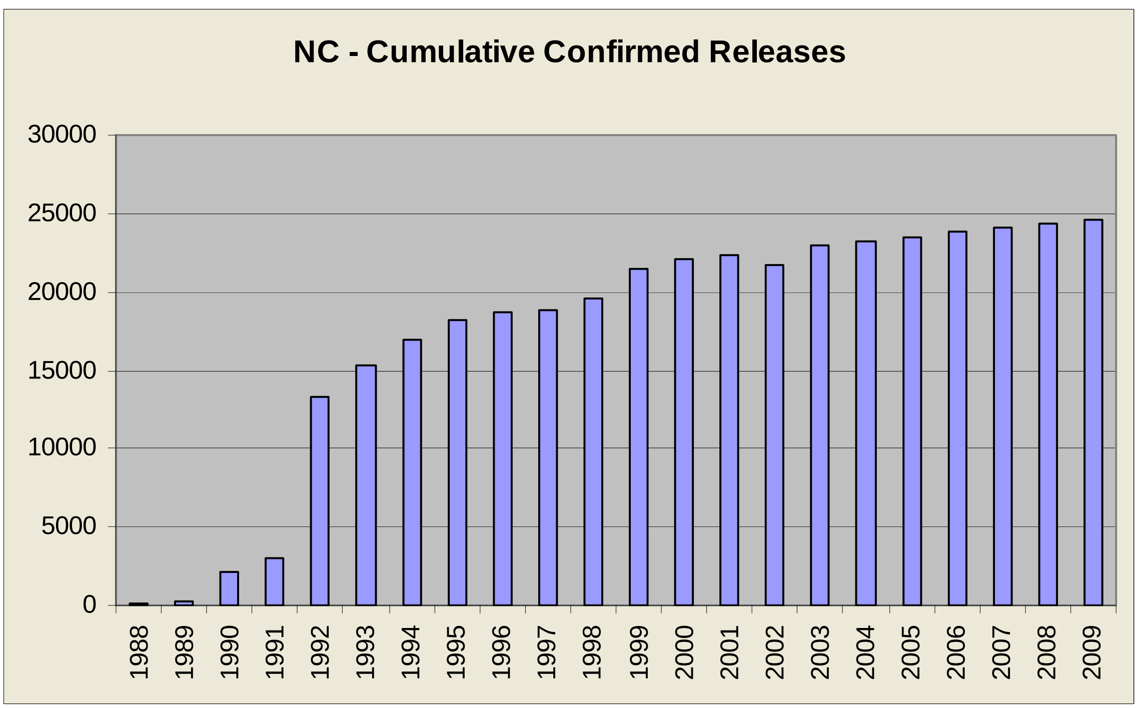
NC - Cumulative Confirmed Releases
30000
25000
20000
15000
10000
5000
0
1988
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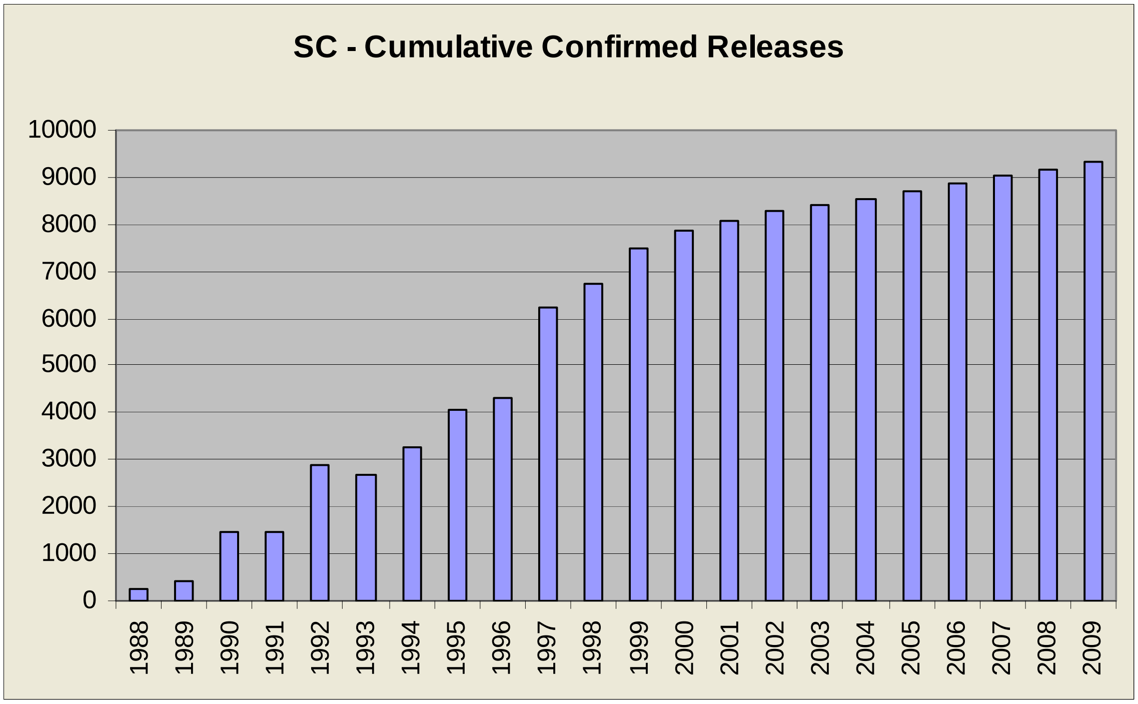
SC - Cumulative Confirmed Releases
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
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1994
1995
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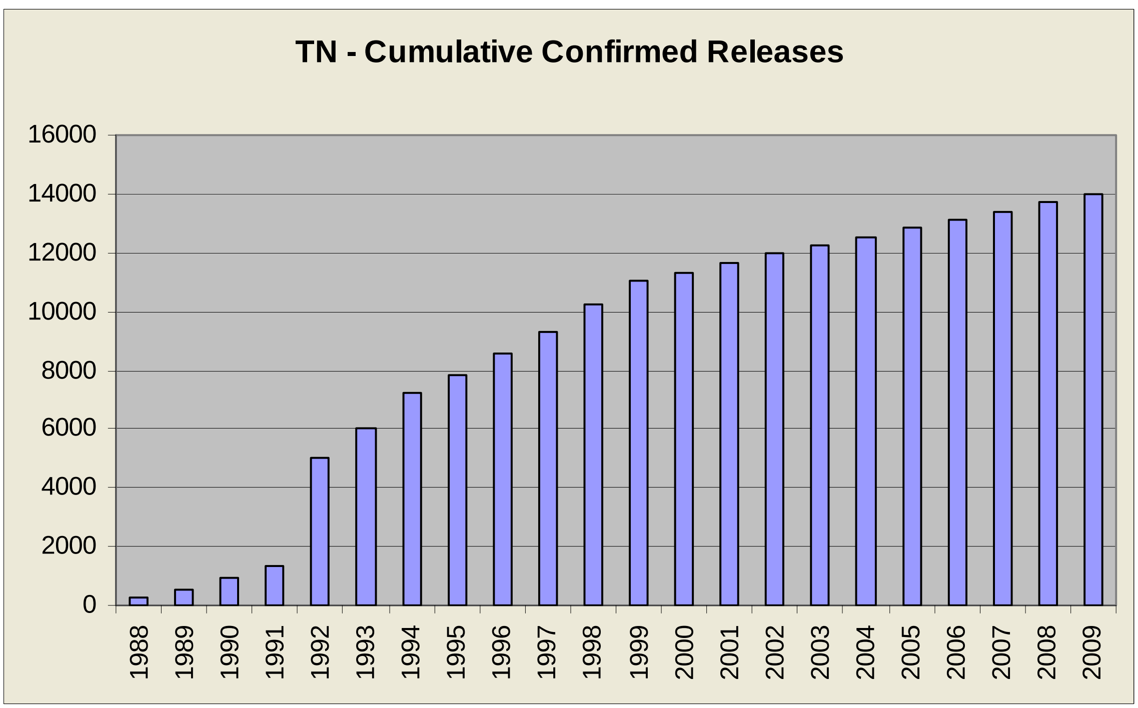
TN - Cumulative Confirmed Releases
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
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1995
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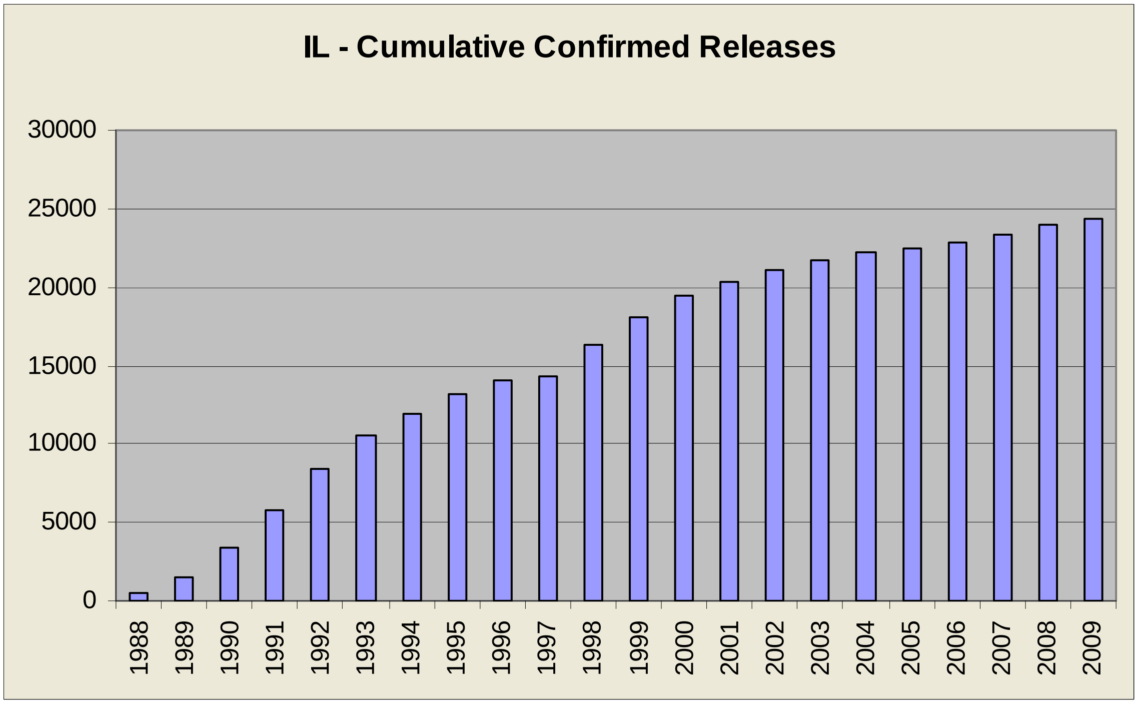
IL - Cumulative Confirmed Releases
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25000
20000
15000
10000
5000
0
1988
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2008
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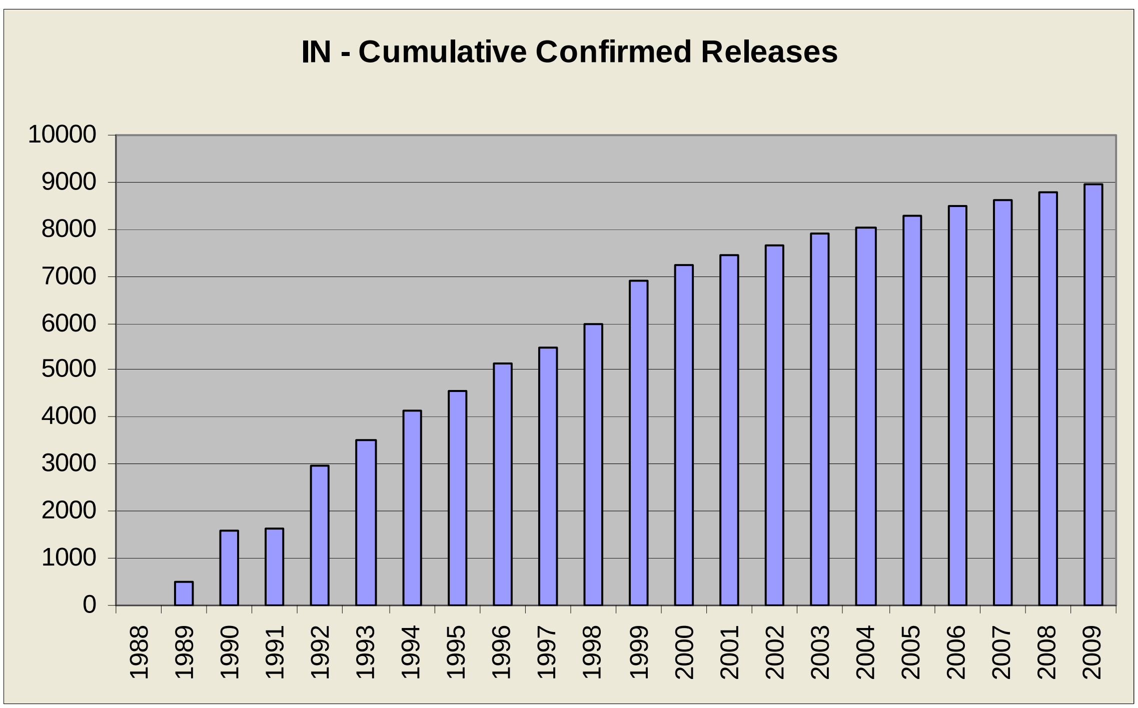
IN - Cumulative Confirmed Releases
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
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1995
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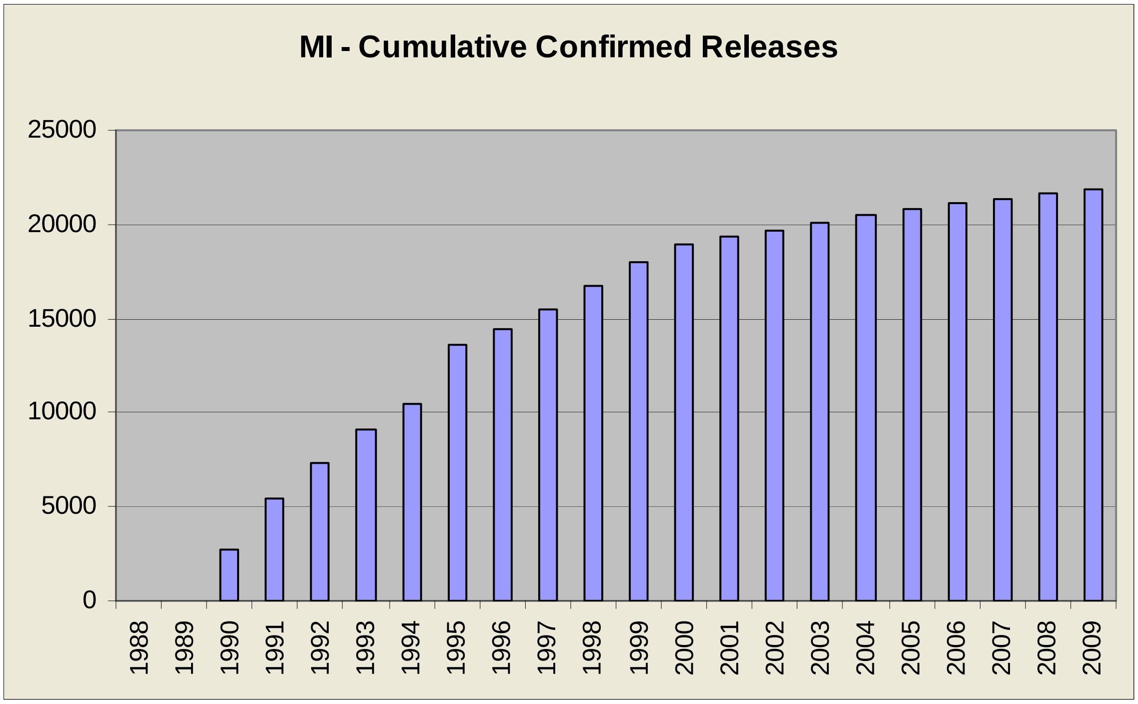
MI - Cumulative Confirmed Releases
25000
20000
15000
10000
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1988
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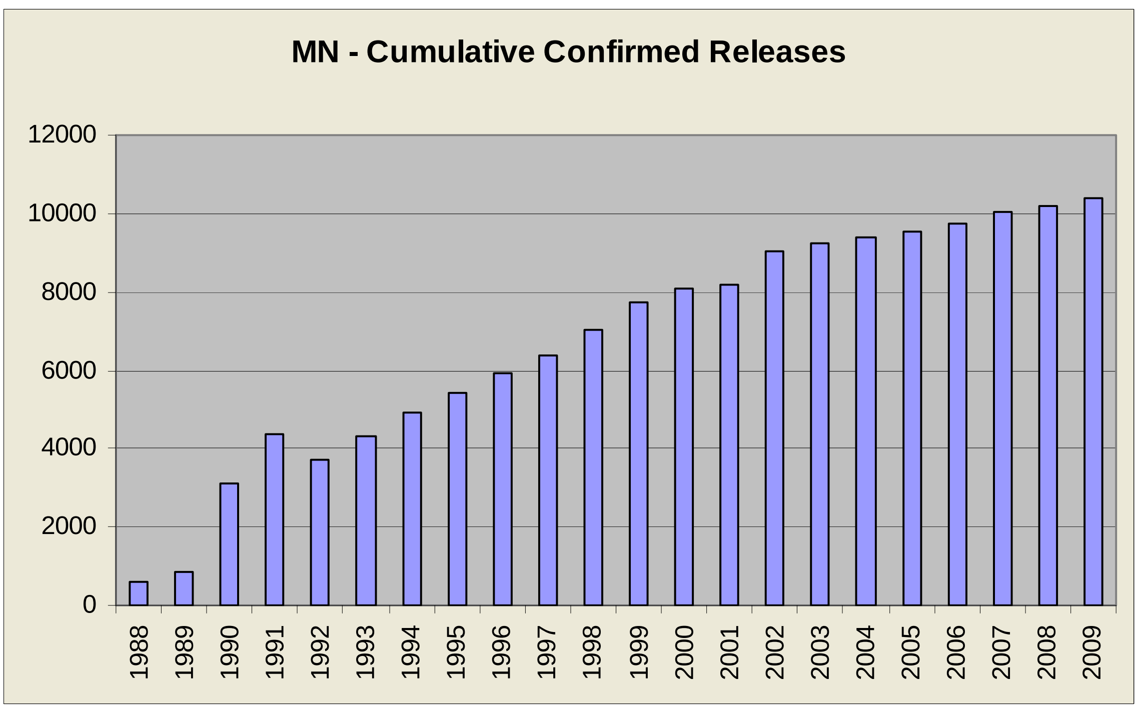
MN - Cumulative Confirmed Releases
12000
10000
8000
6000
4000
2000
0
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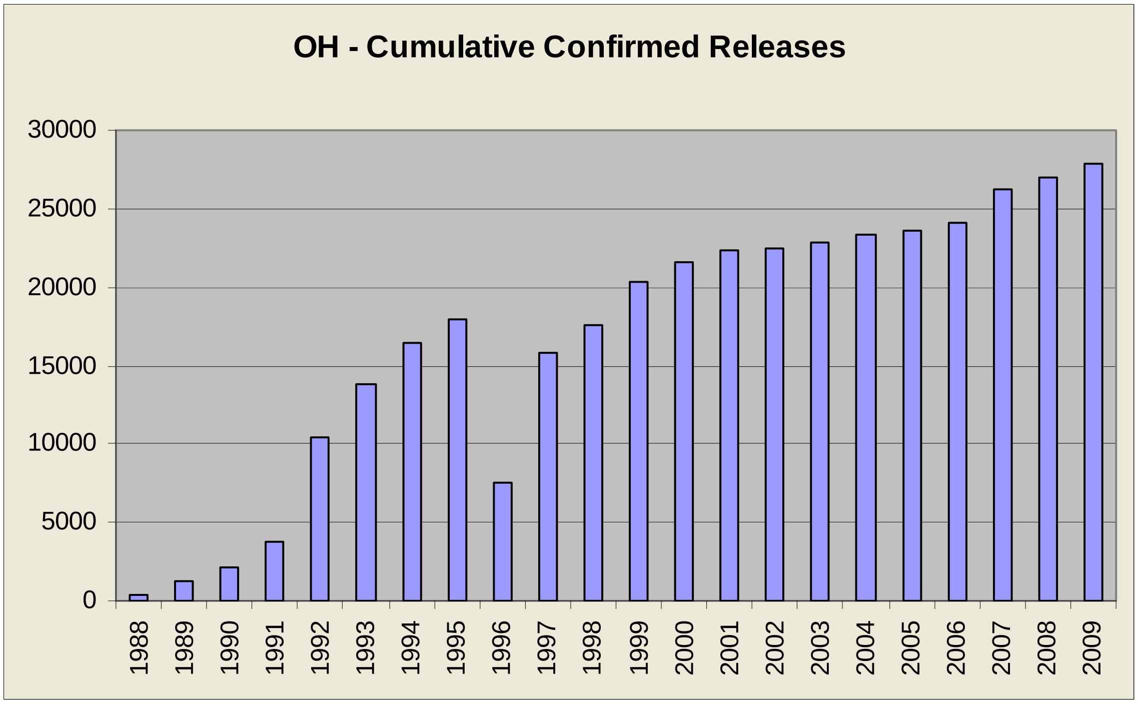
OH - Cumulative Confirmed Releases
30000
25000
20000
15000
10000
5000
0
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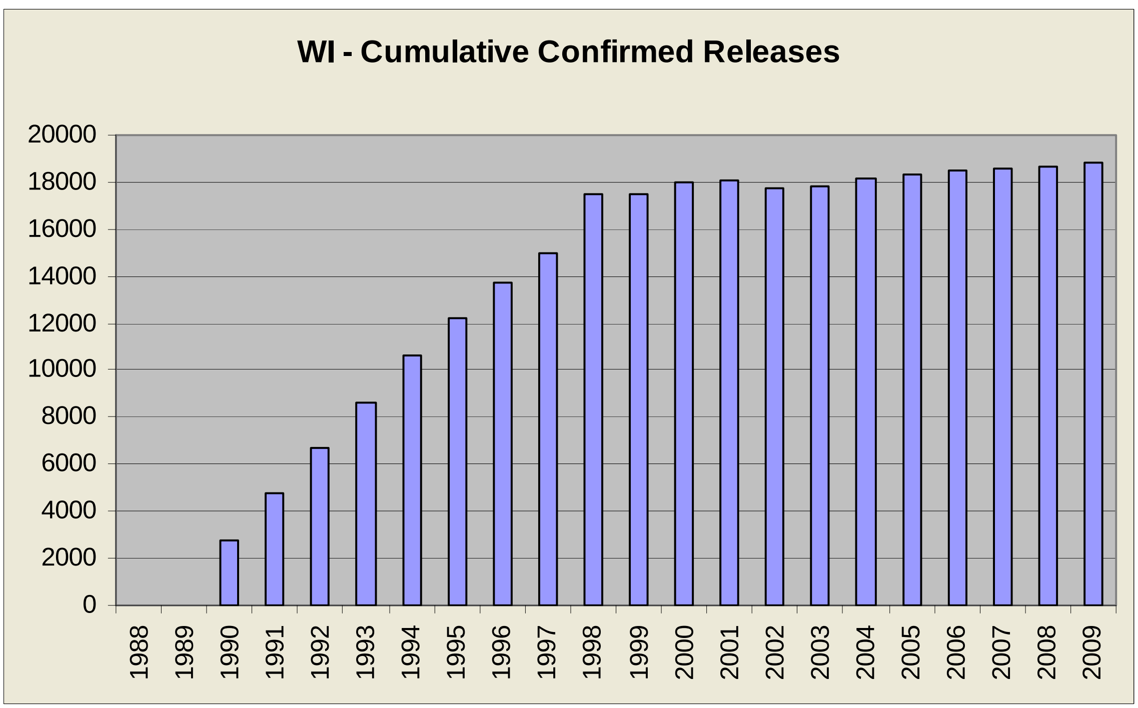
WI - Cumulative Confirmed Releases
20000
18000
16000
14000
12000
10000
8000
6000
4000
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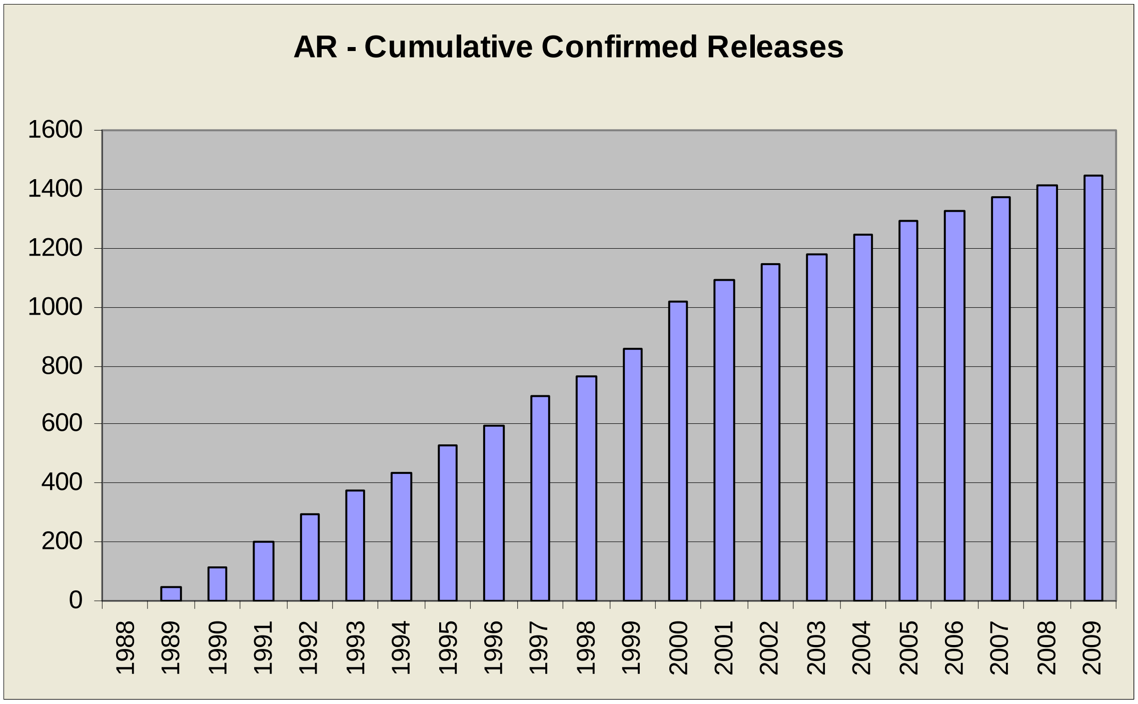
AR - Cumulative Confirmed Releases
1600
1400
1200
1000
800
600
400
200
0
1988
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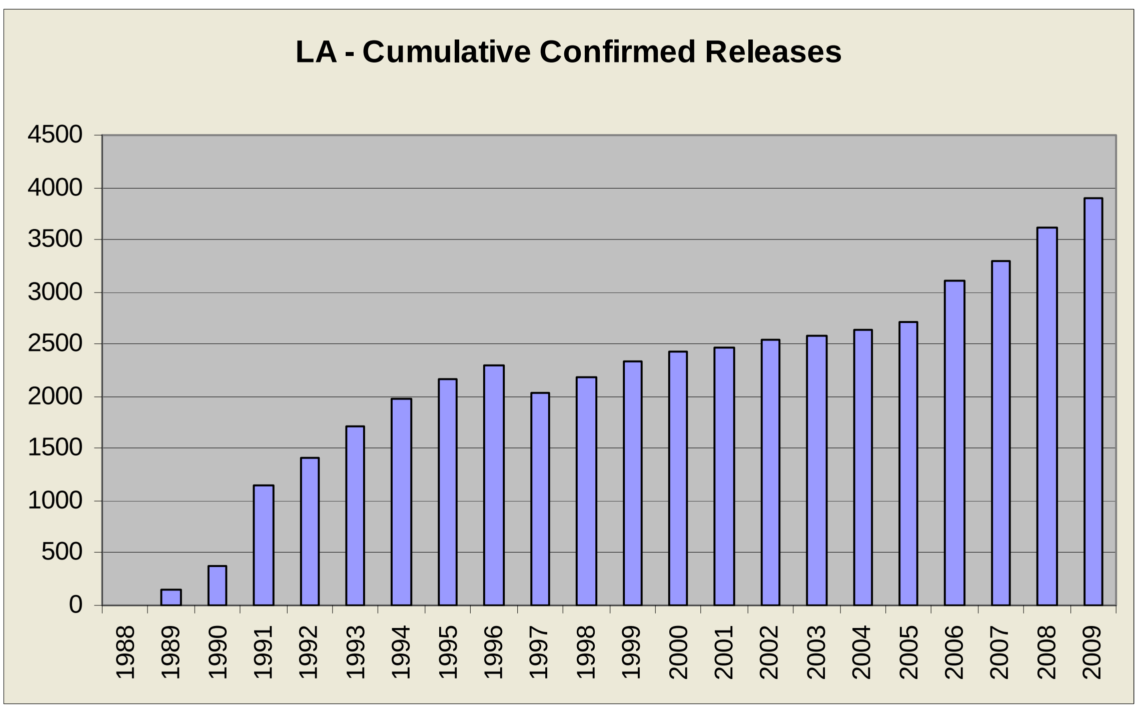
LA - Cumulative Confirmed Releases
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
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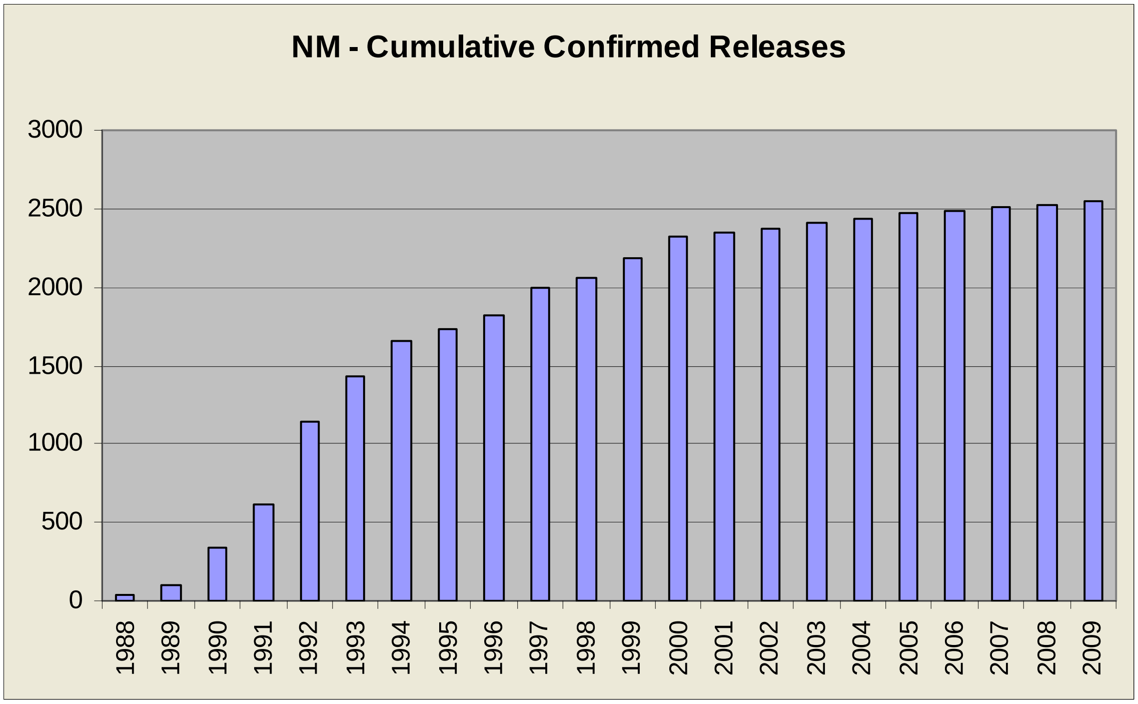
NM - Cumulative Confirmed Releases
3000
2500
2000
1500
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500
0
1988
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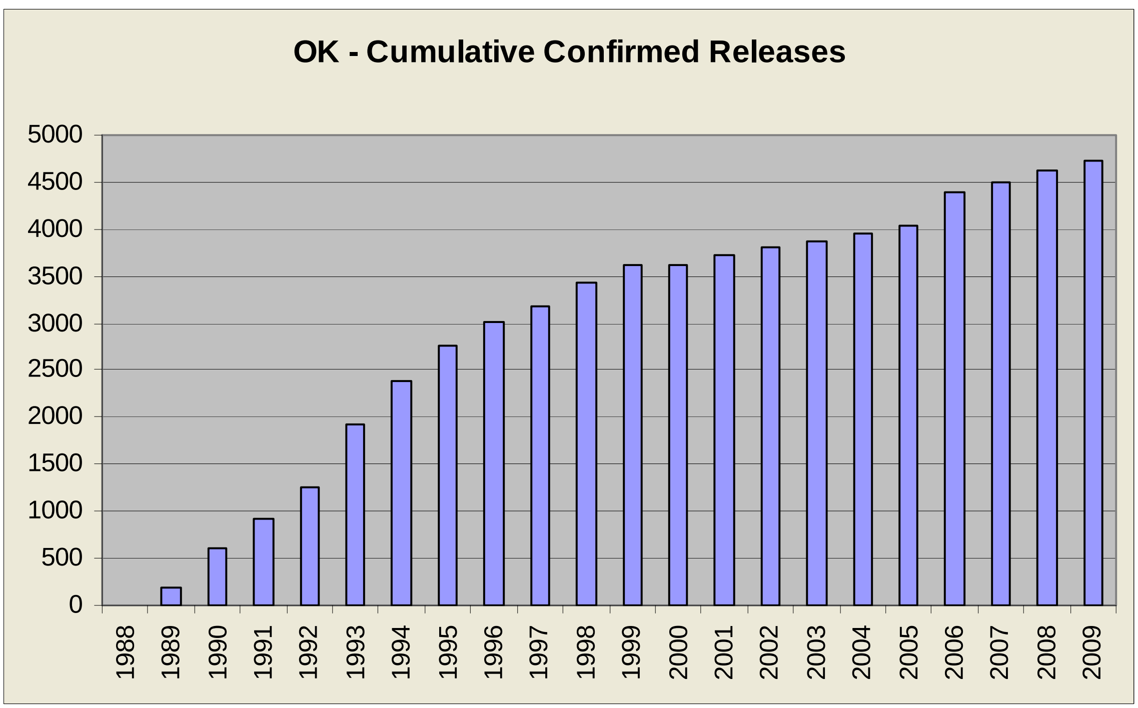
OK - Cumulative Confirmed Releases
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4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
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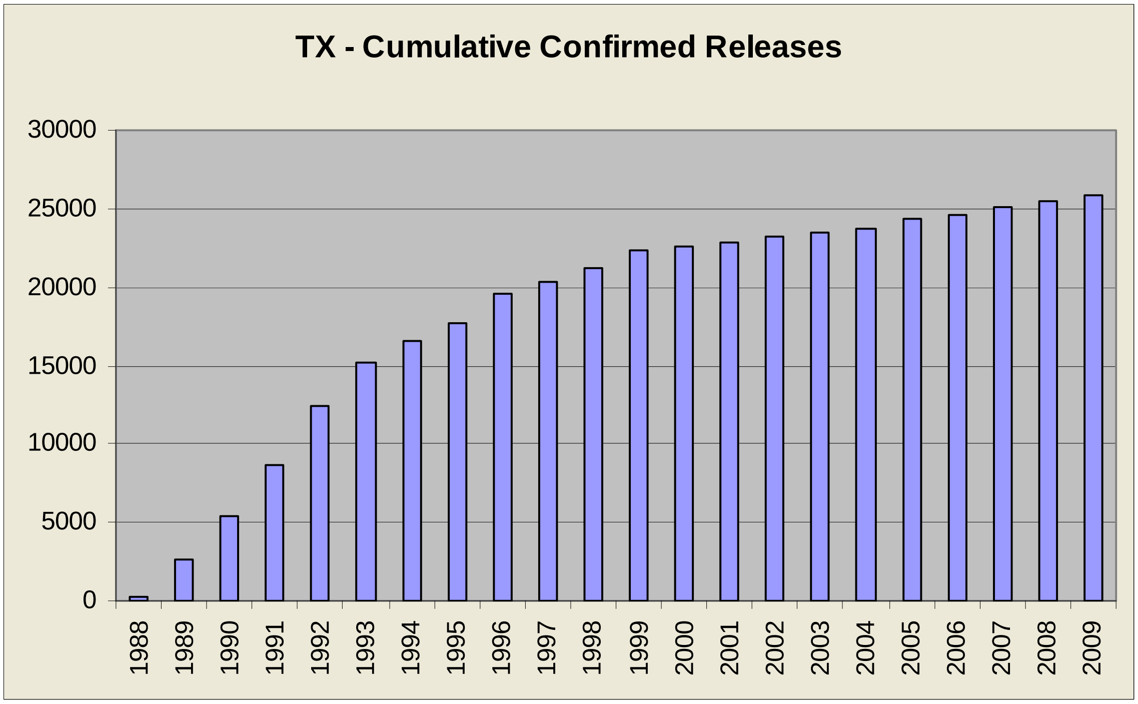
TX - Cumulative Confirmed Releases
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20000
15000
10000
5000
0
1988
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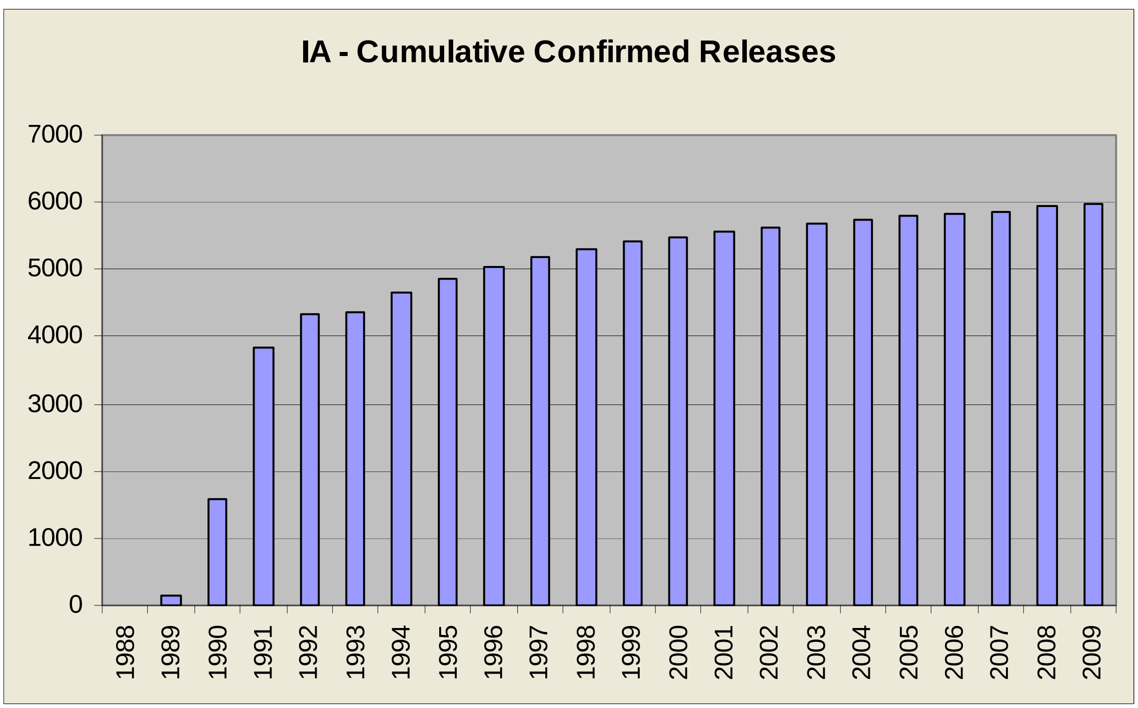
IA - Cumulative Confirmed Releases
7000
6000
5000
4000
3000
2000
1000
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1988
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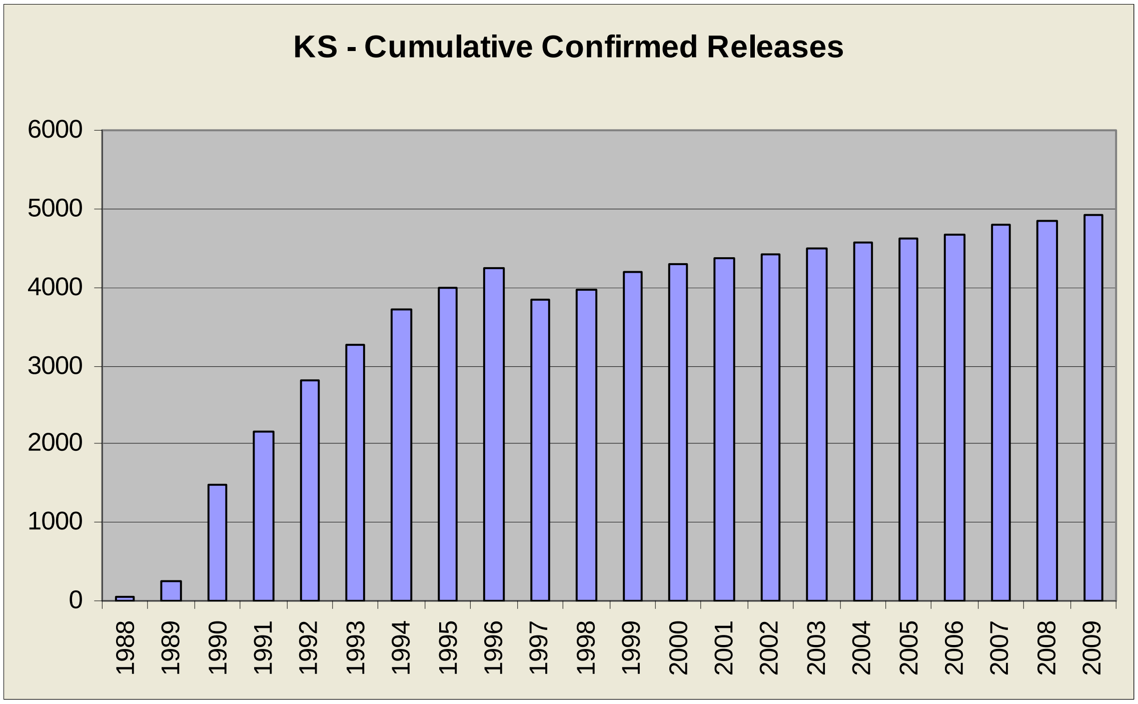
KS - Cumulative Confirmed Releases
6000
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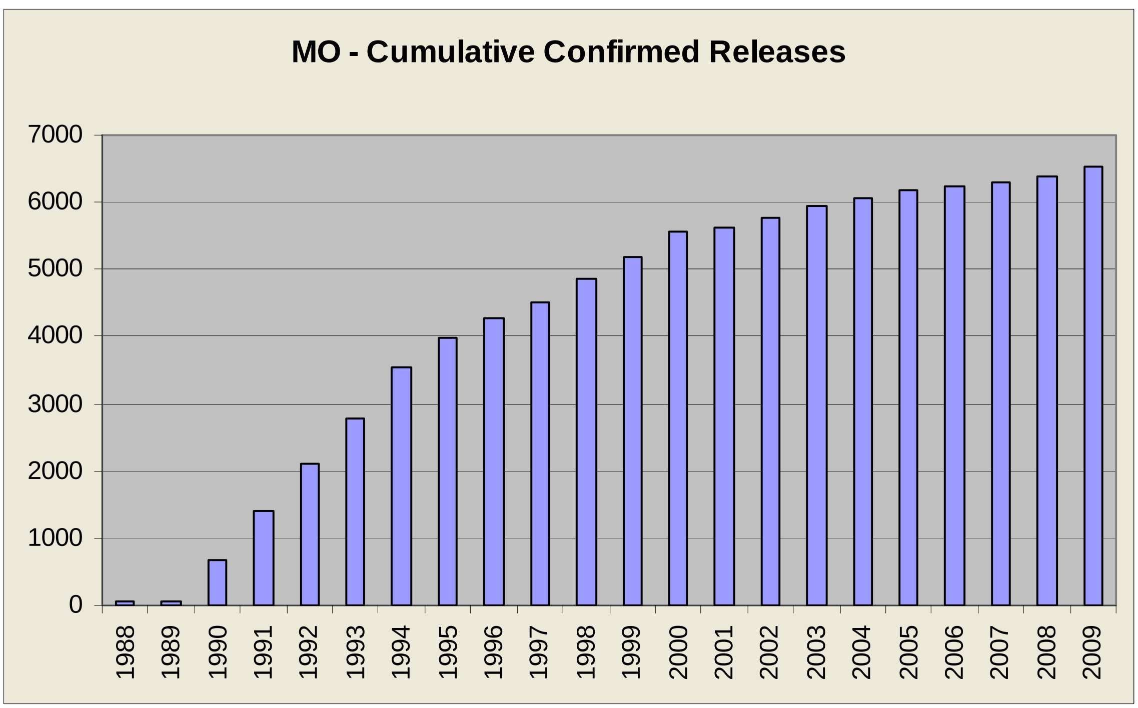
MO - Cumulative Confirmed Releases
7000
6000
5000
4000
3000
2000
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1988
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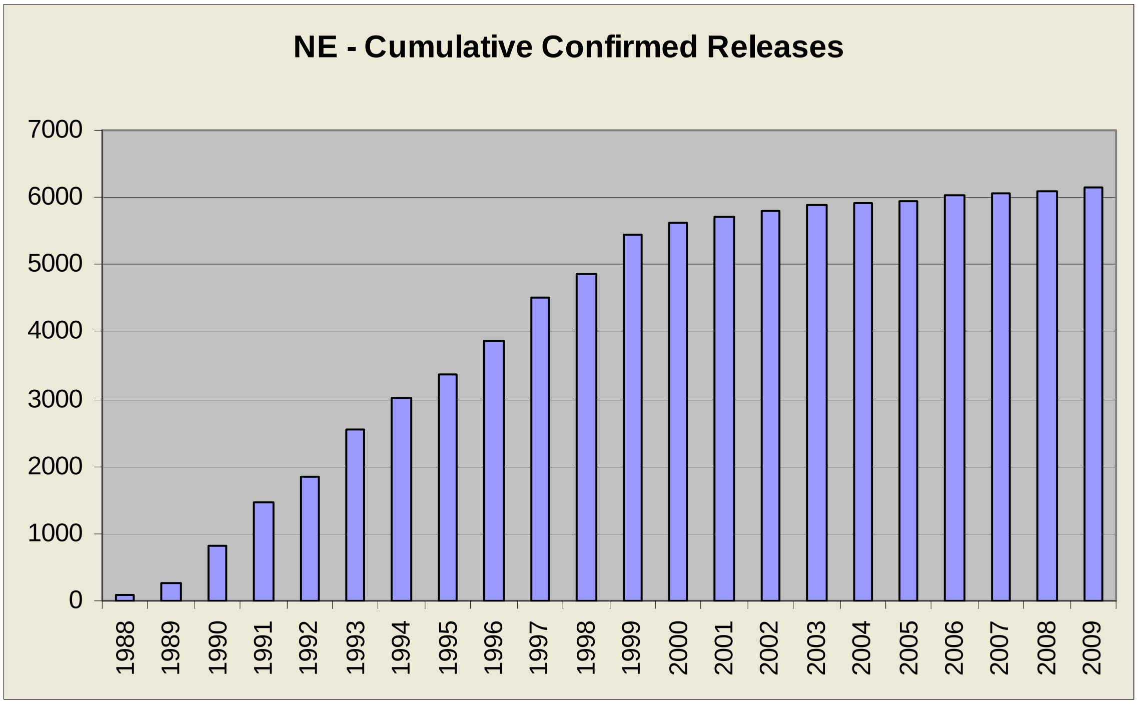
NE - Cumulative Confirmed Releases
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6000
5000
4000
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1000
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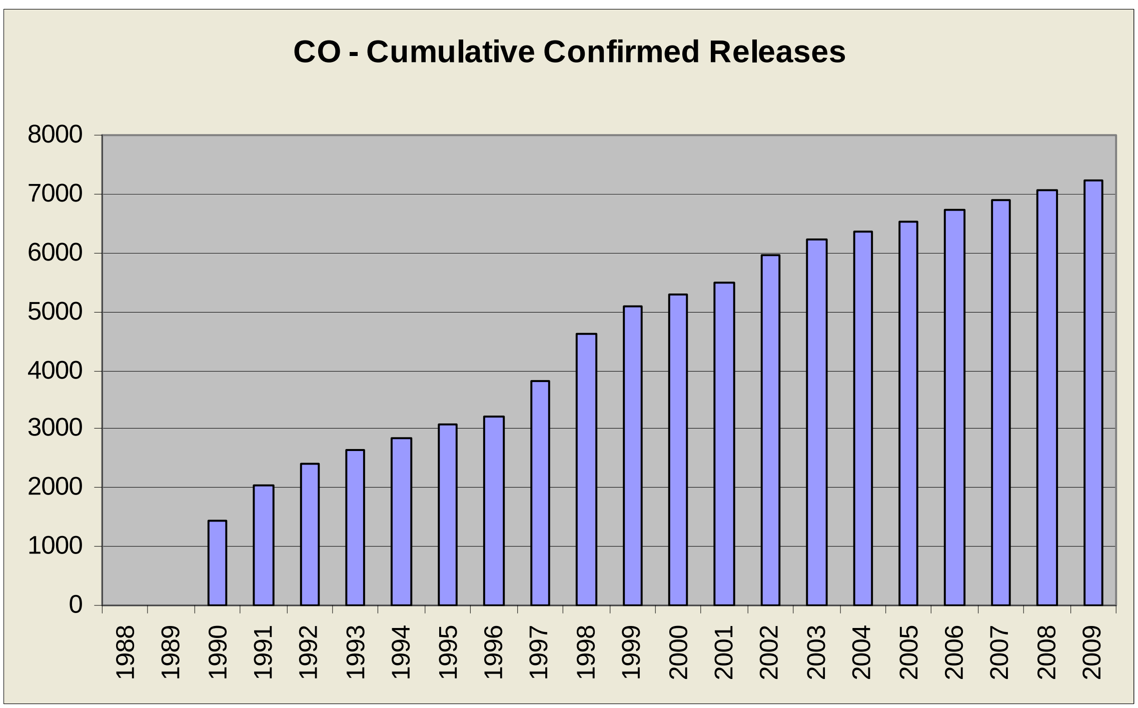
CO - Cumulative Confirmed Releases
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
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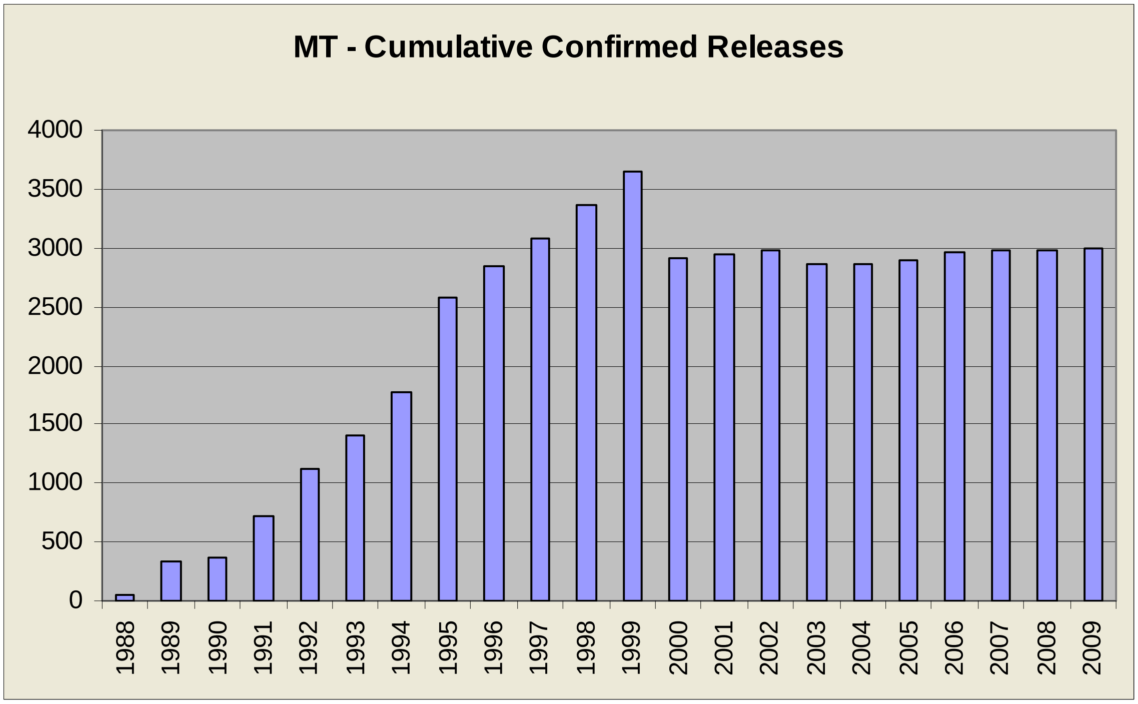
MT - Cumulative Confirmed Releases
4000
3500
3000
2500
2000
1500
1000
500
0
1988
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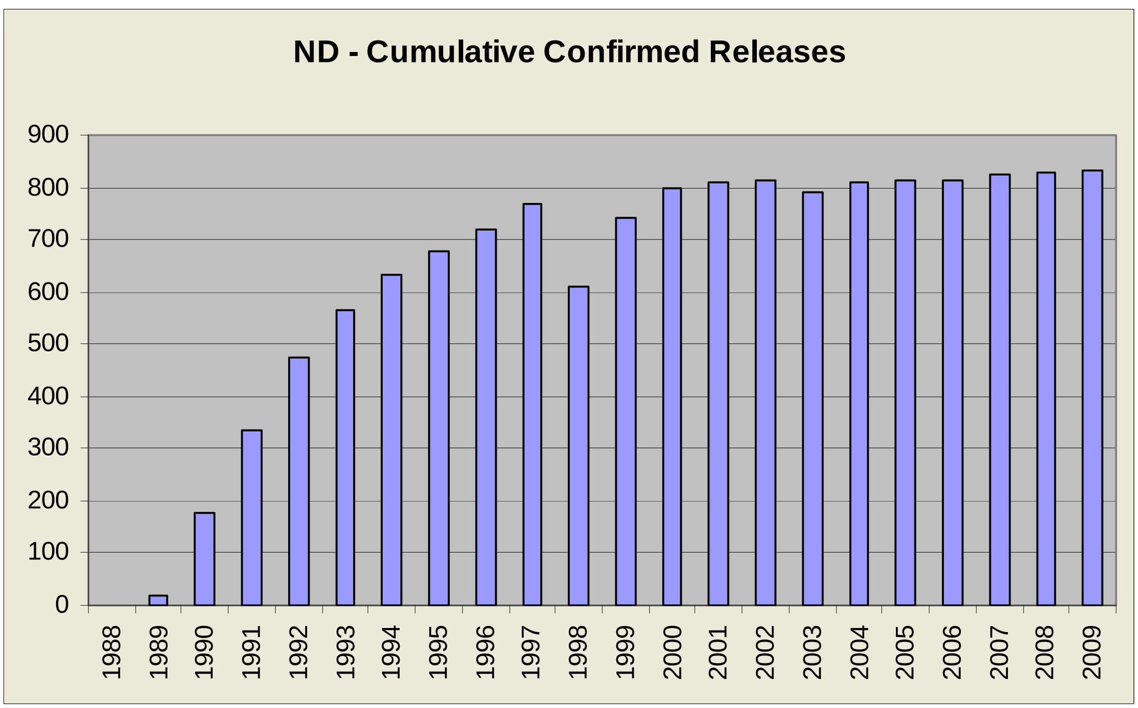
ND - Cumulative Confirmed Releases
900
800
700
600
500
400
300
200
100
0
1988
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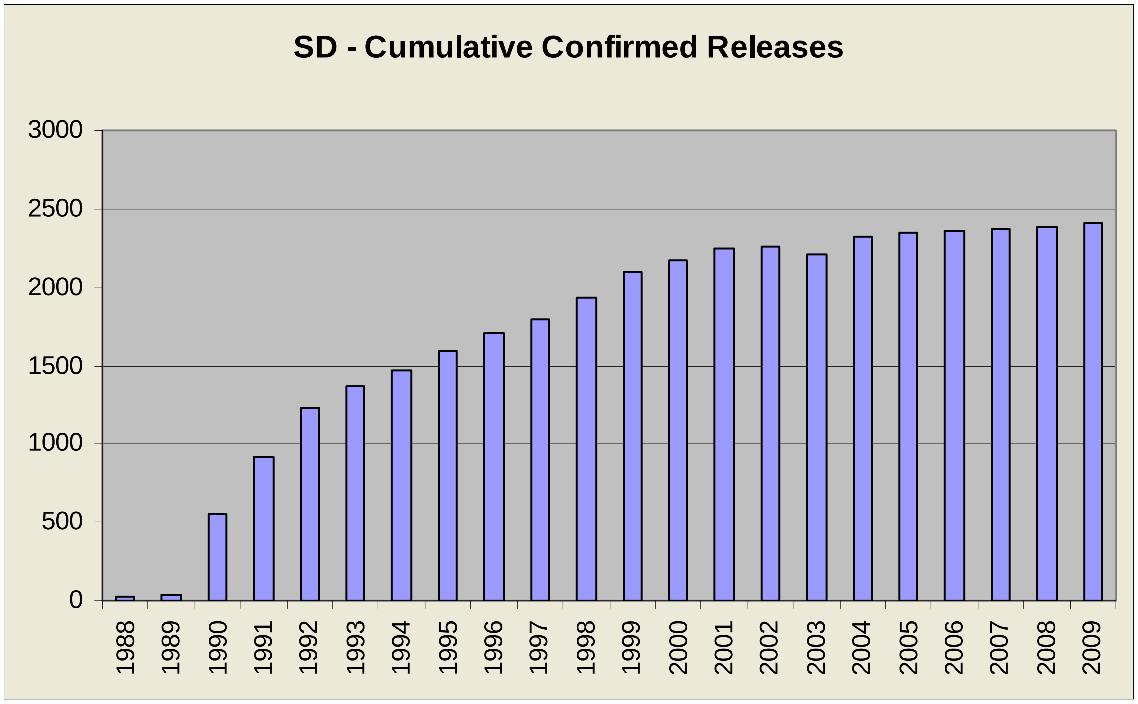
SD - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
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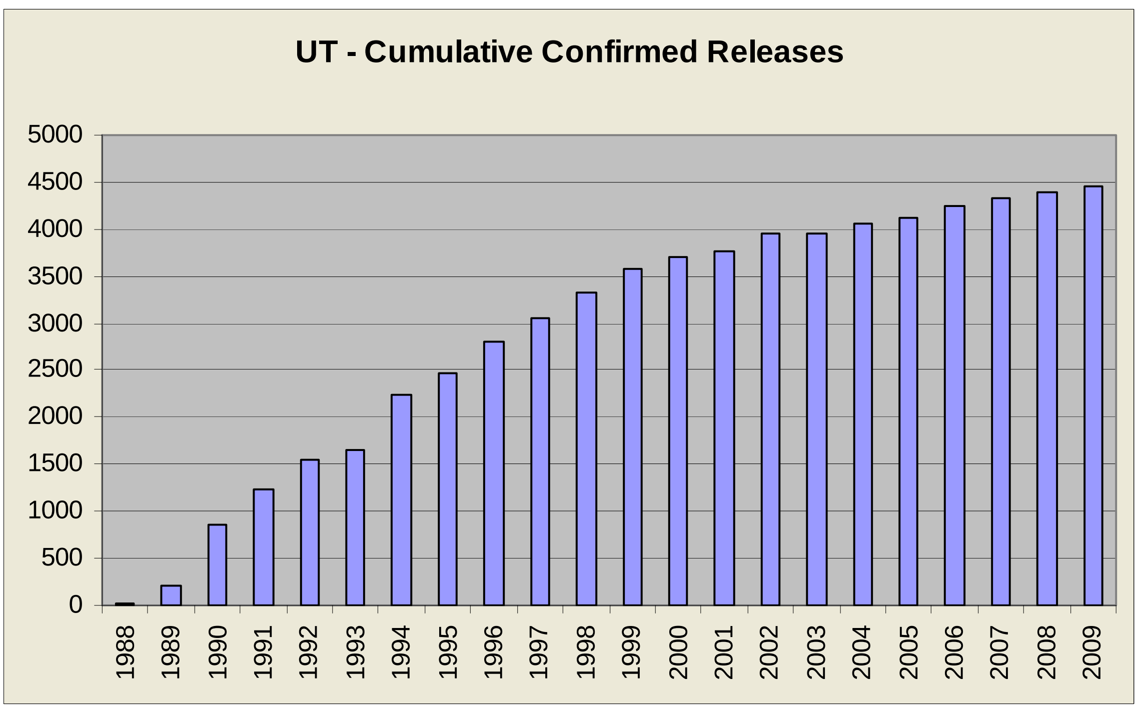
UT - Cumulative Confirmed Releases
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
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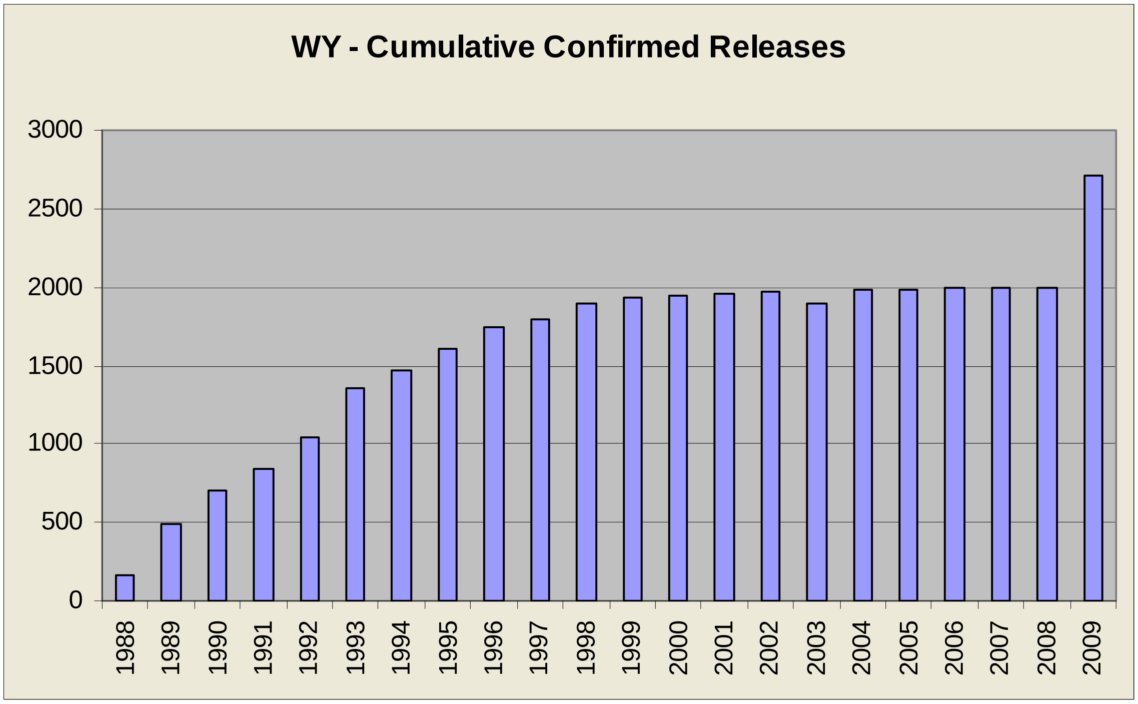
WY - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
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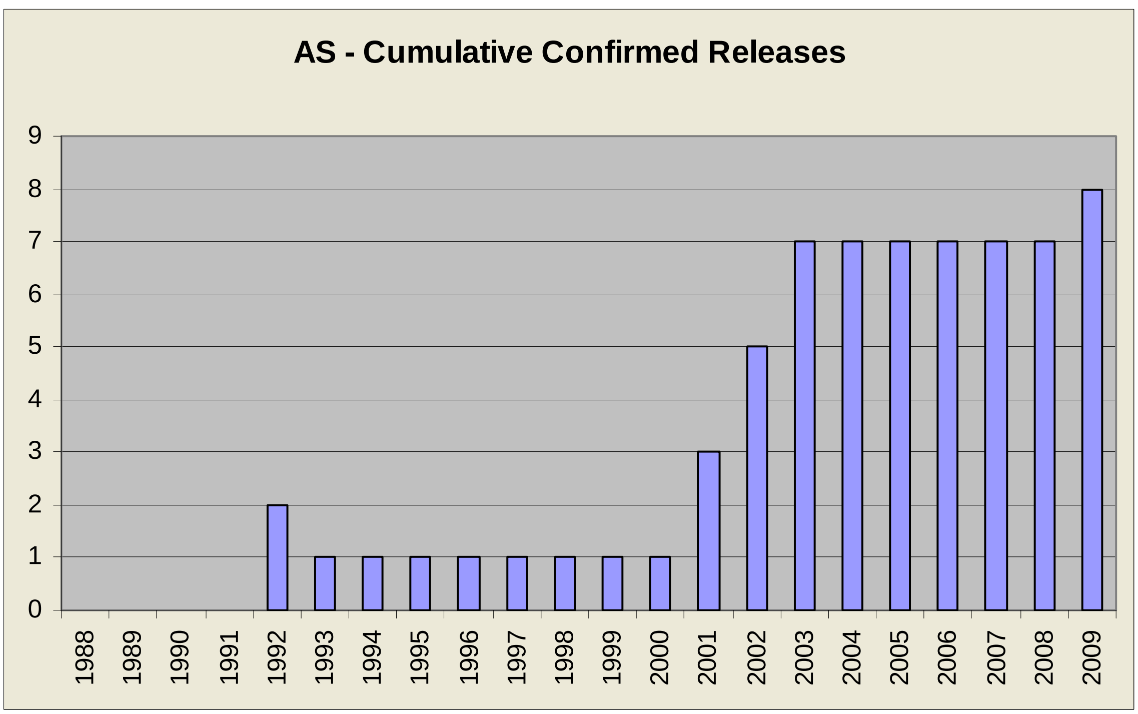
AS - Cumulative Confirmed Releases
9
8
7
6
5
4
3
2
1
0
1988
1989
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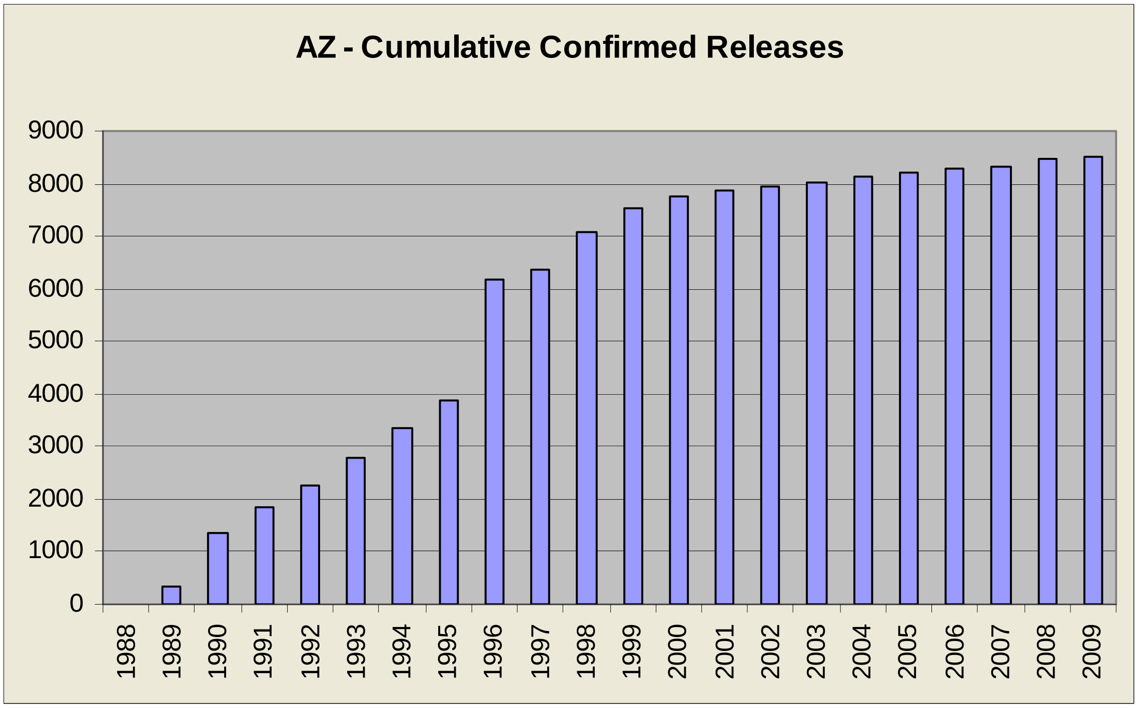
AZ - Cumulative Confirmed Releases
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
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1993
1994
1995
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1998
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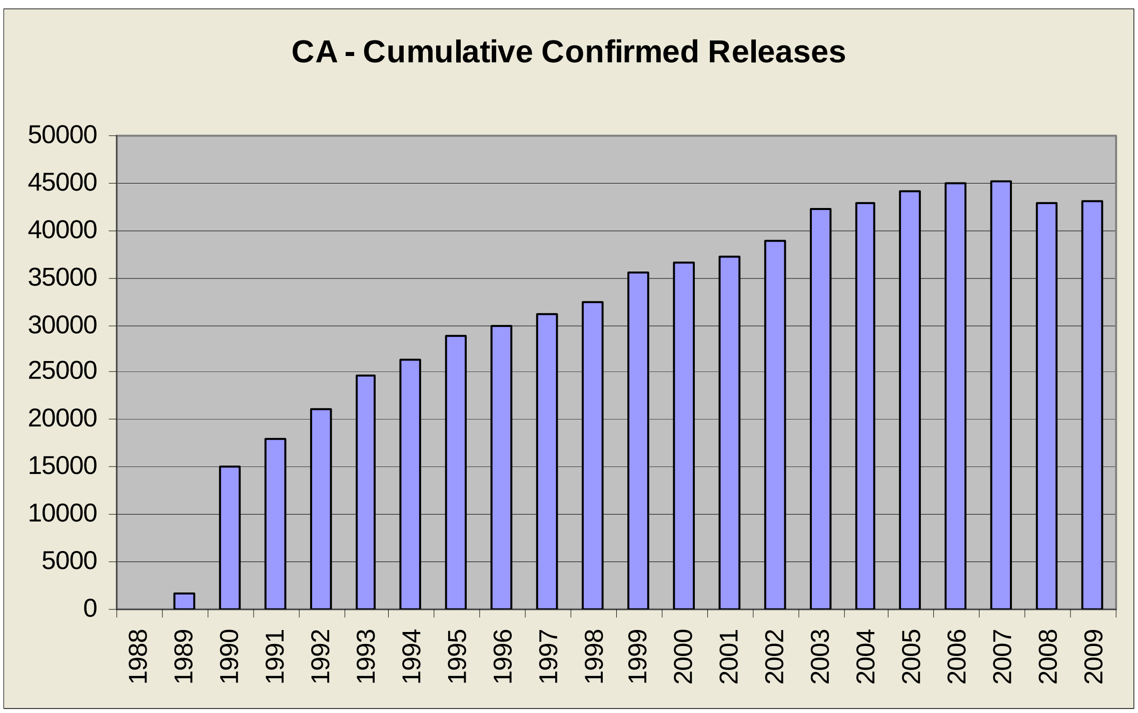
CA - Cumulative Confirmed Releases
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
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1992
1993
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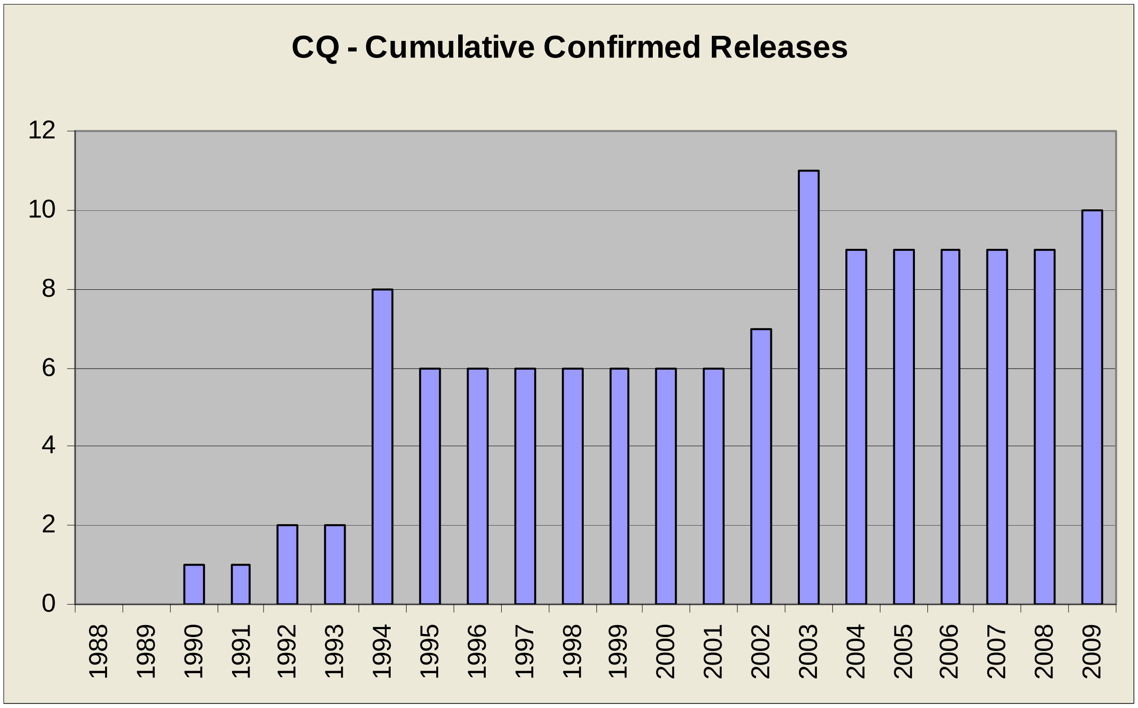
CQ - Cumulative Confirmed Releases
12
10
8
6
4
2
0
1988
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1998
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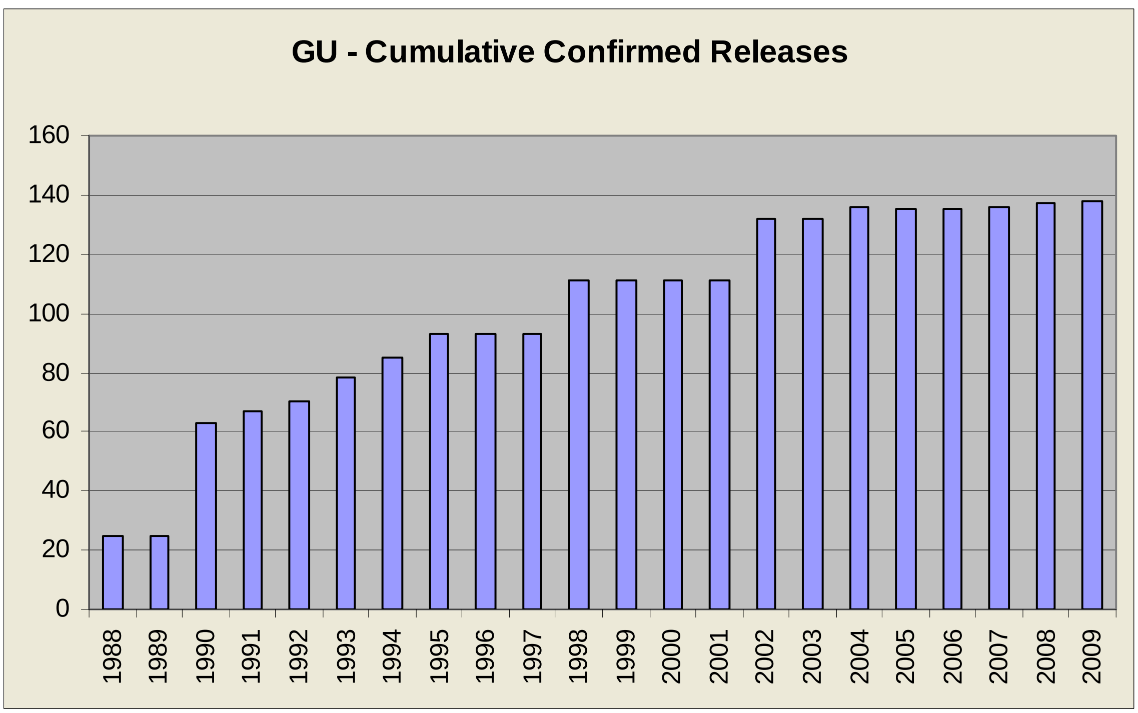
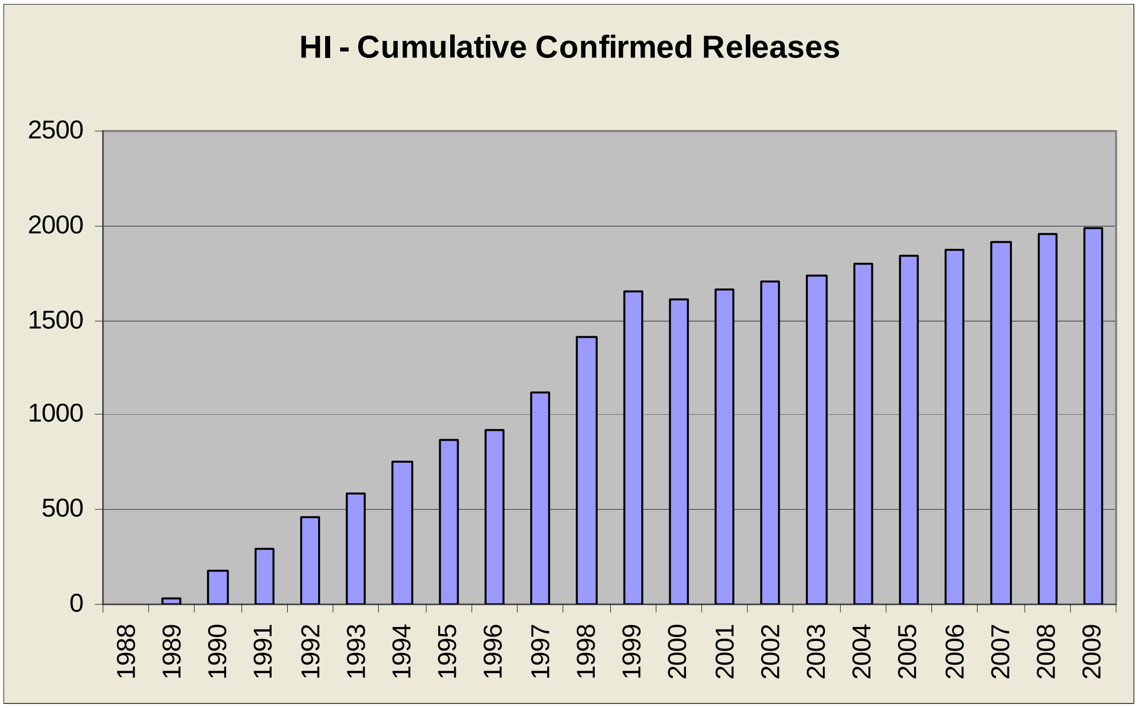
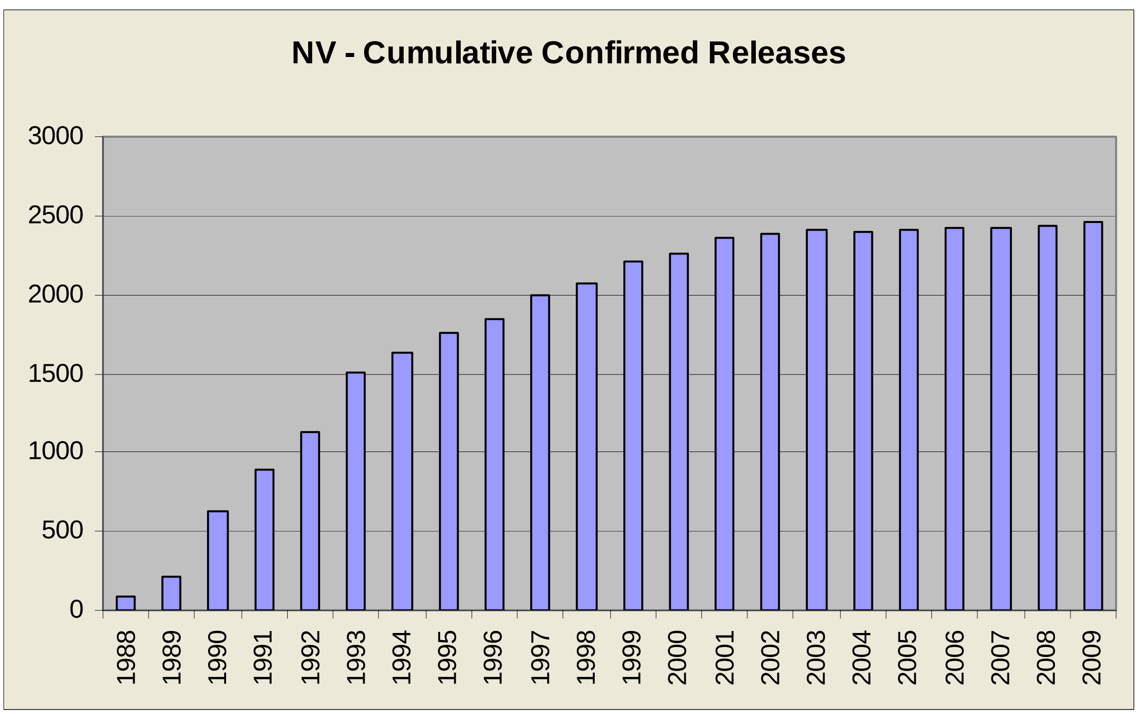
2009

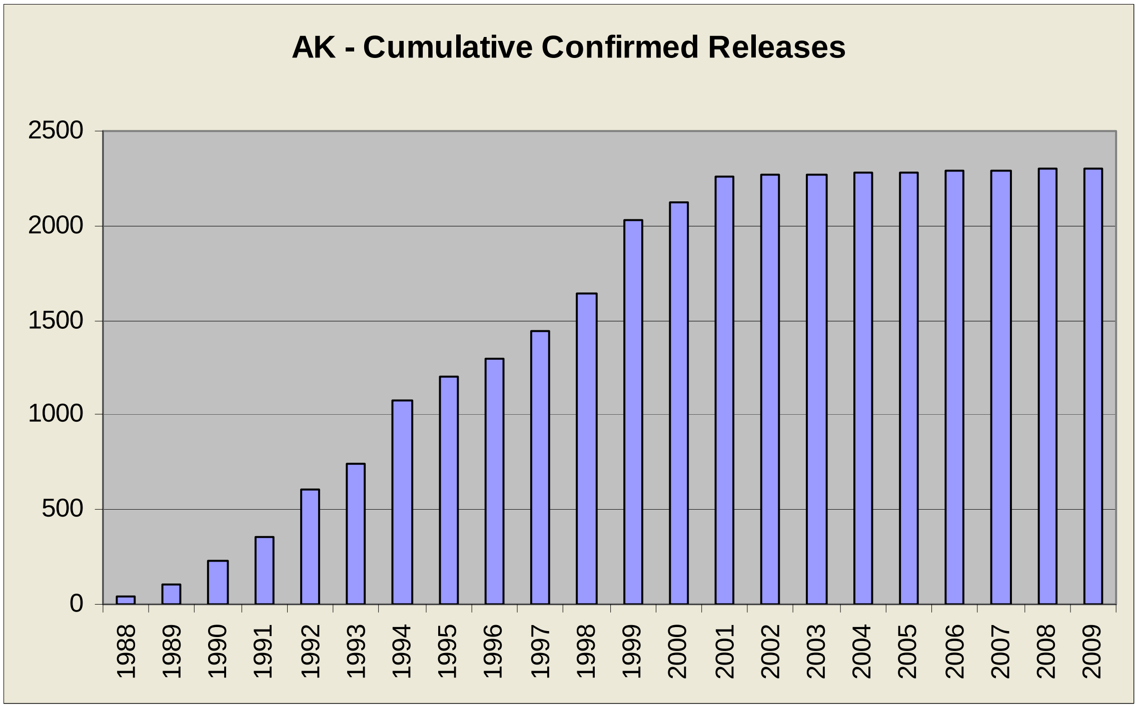

GU - Cumulative Confirmed Releases
160
140
120
100
80
60
40
20
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

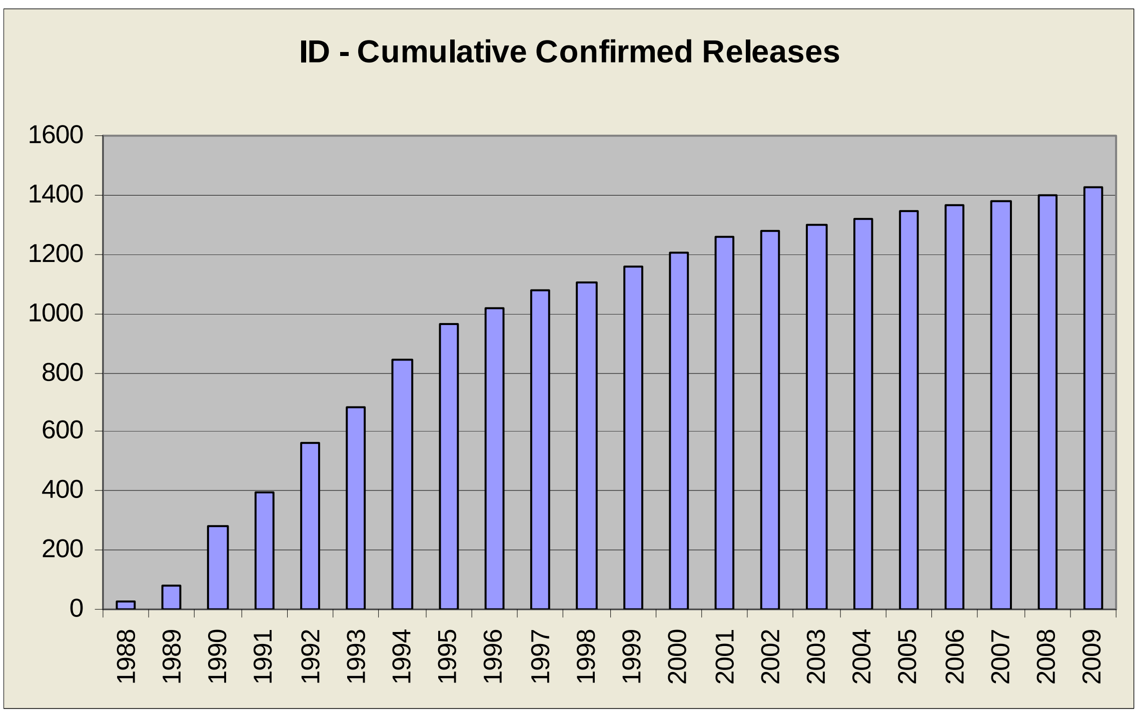


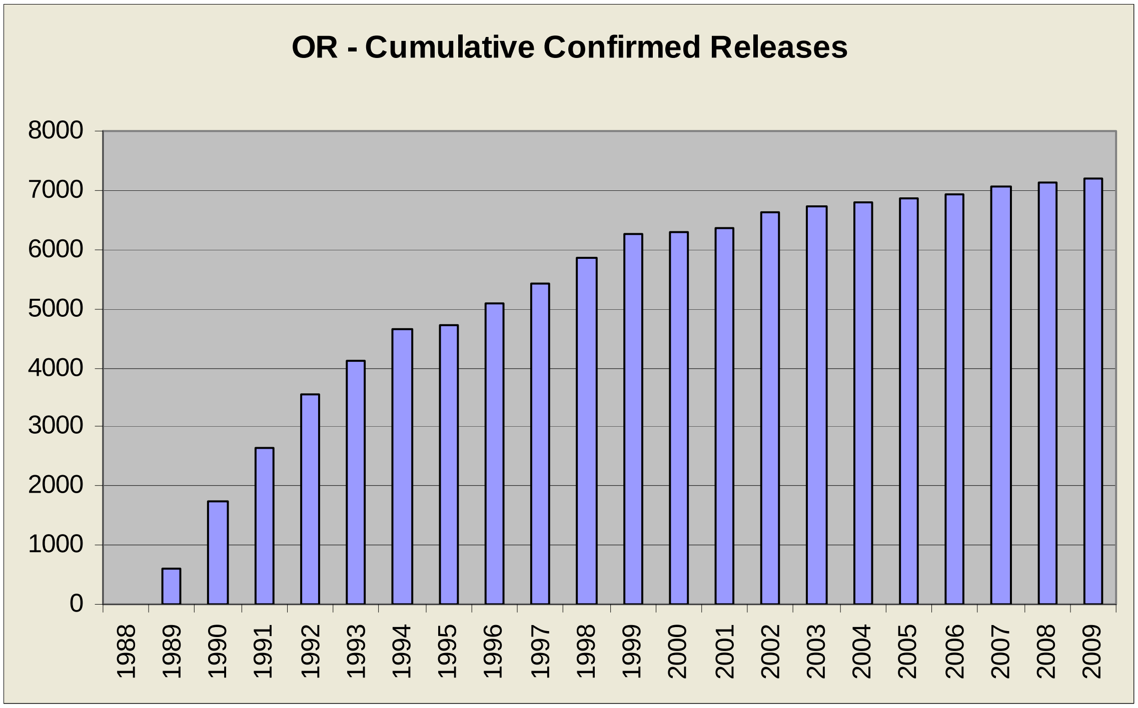
HI - Cumulative Confirmed Releases
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

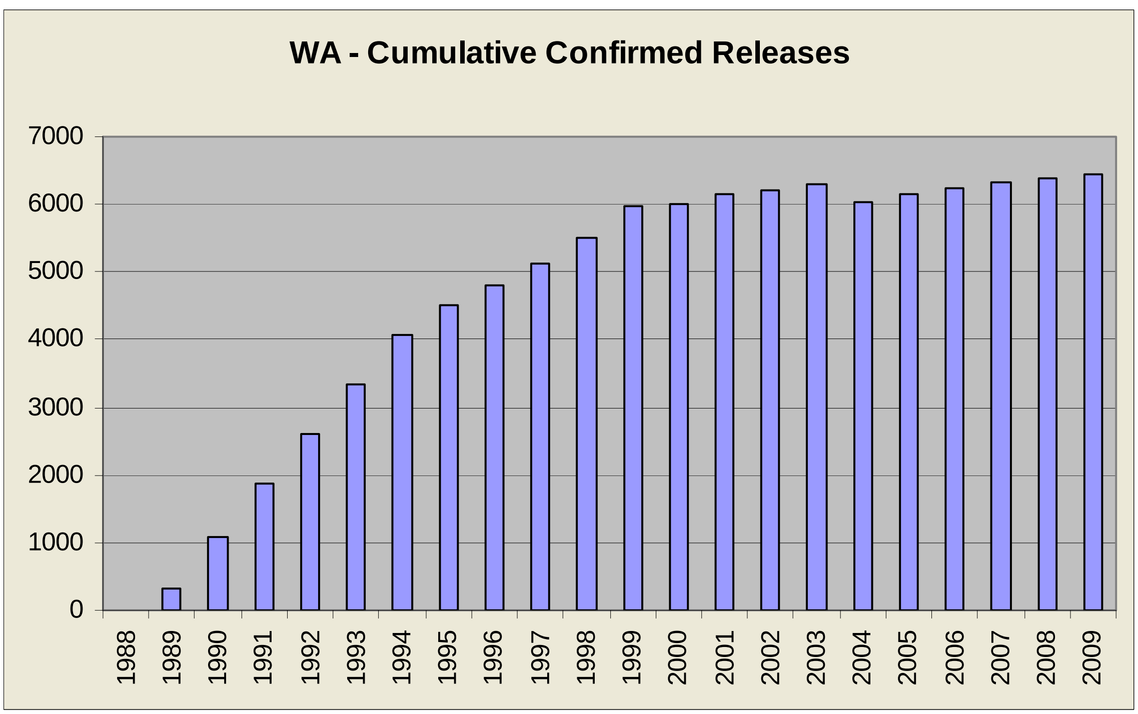


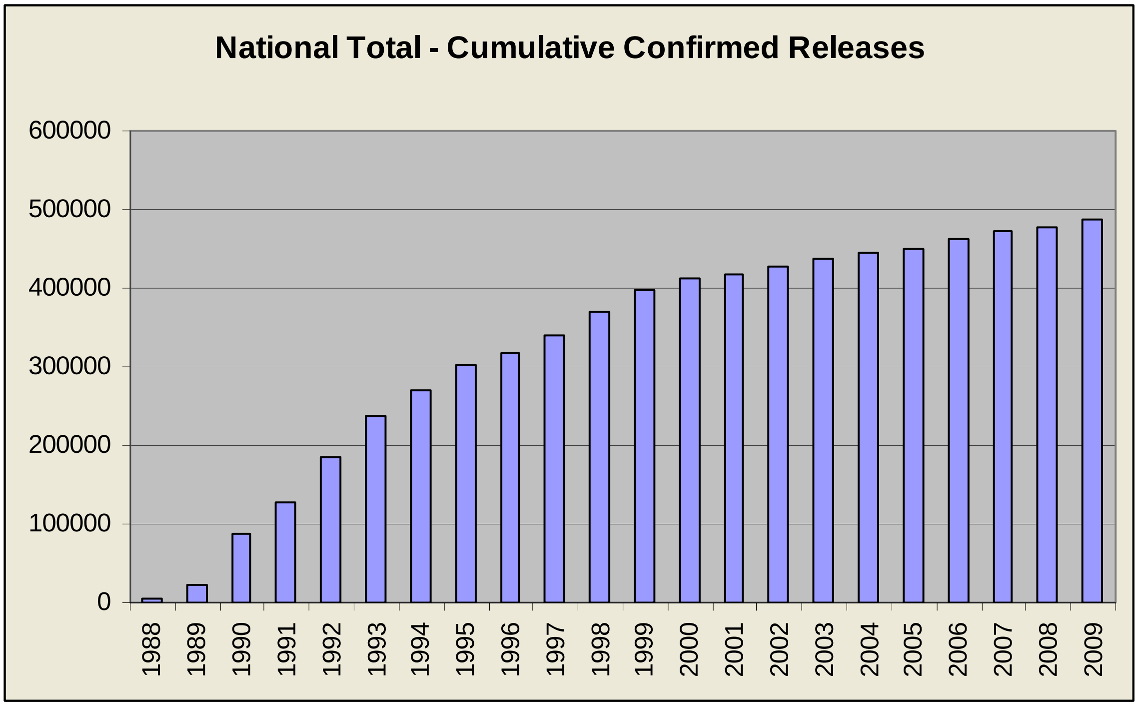
NV - Cumulative Confirmed Releases
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


AK - Cumulative Confirmed Releases
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


ID - Cumulative Confirmed Releases
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

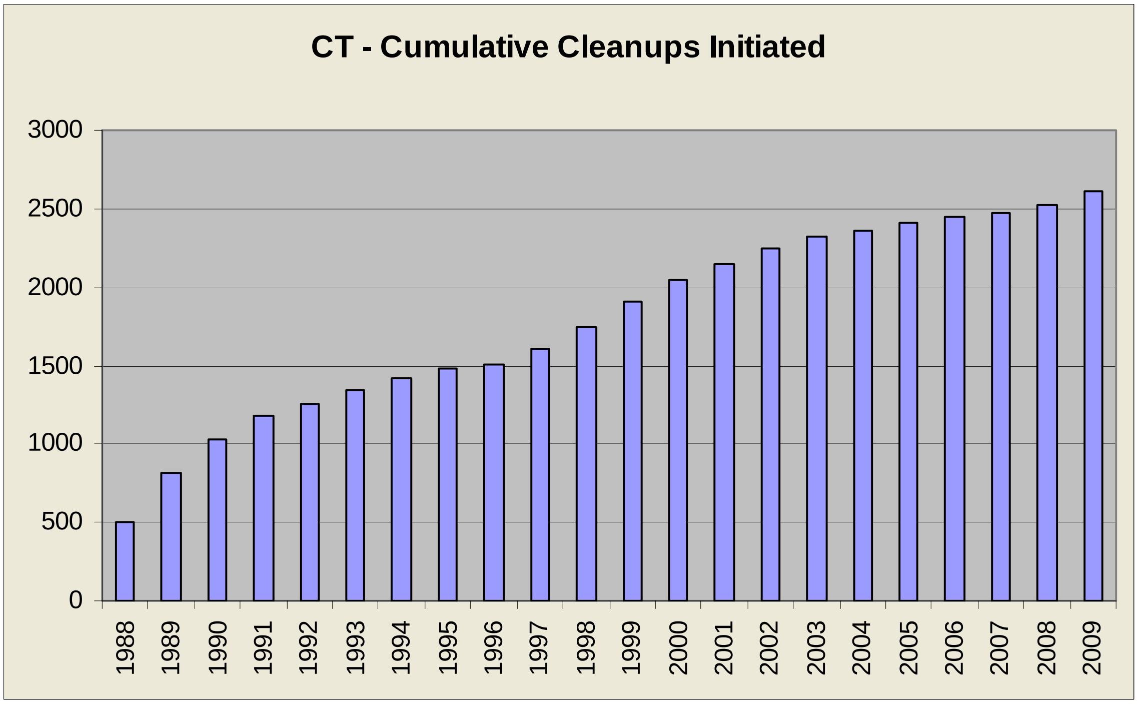

OR - Cumulative Confirmed Releases
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

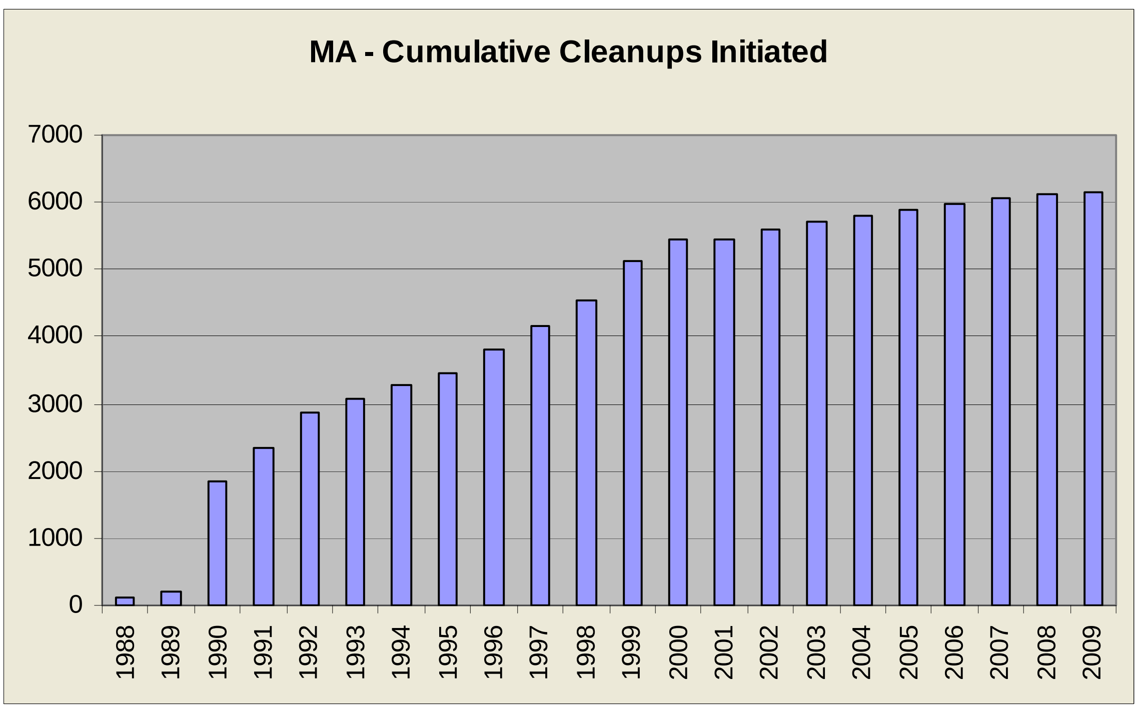

WA - Cumulative Confirmed Releases
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

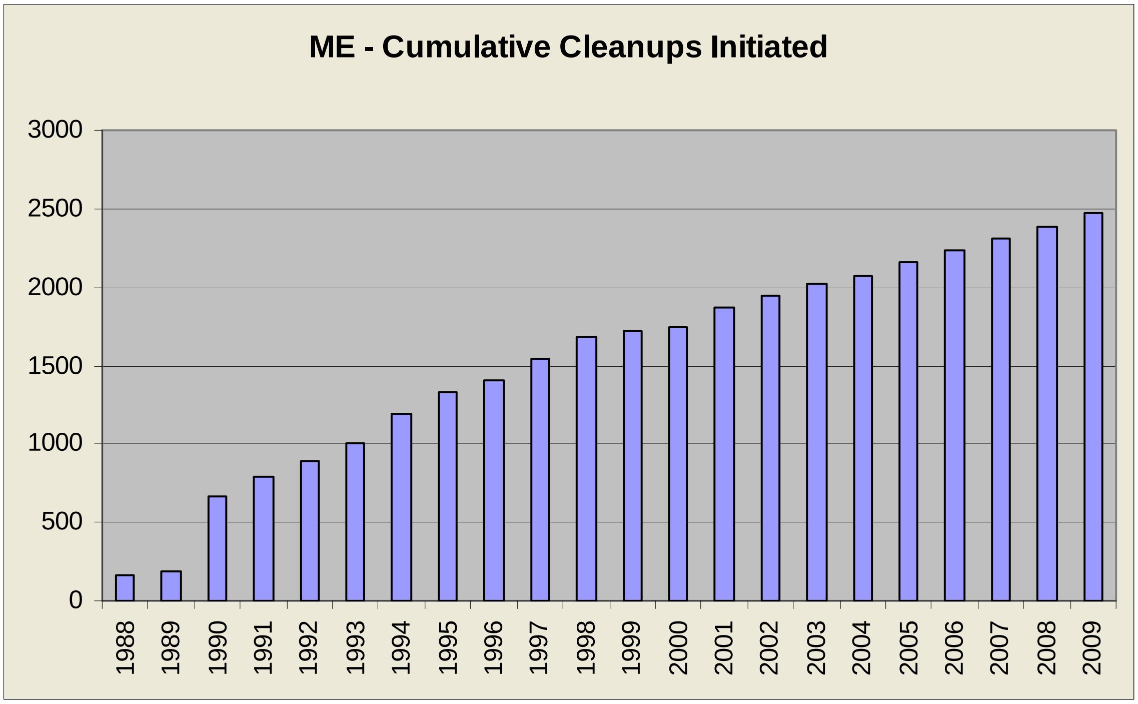

National Total - Cumulative Confirmed Releases
600000
500000
400000
300000
200000
100000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

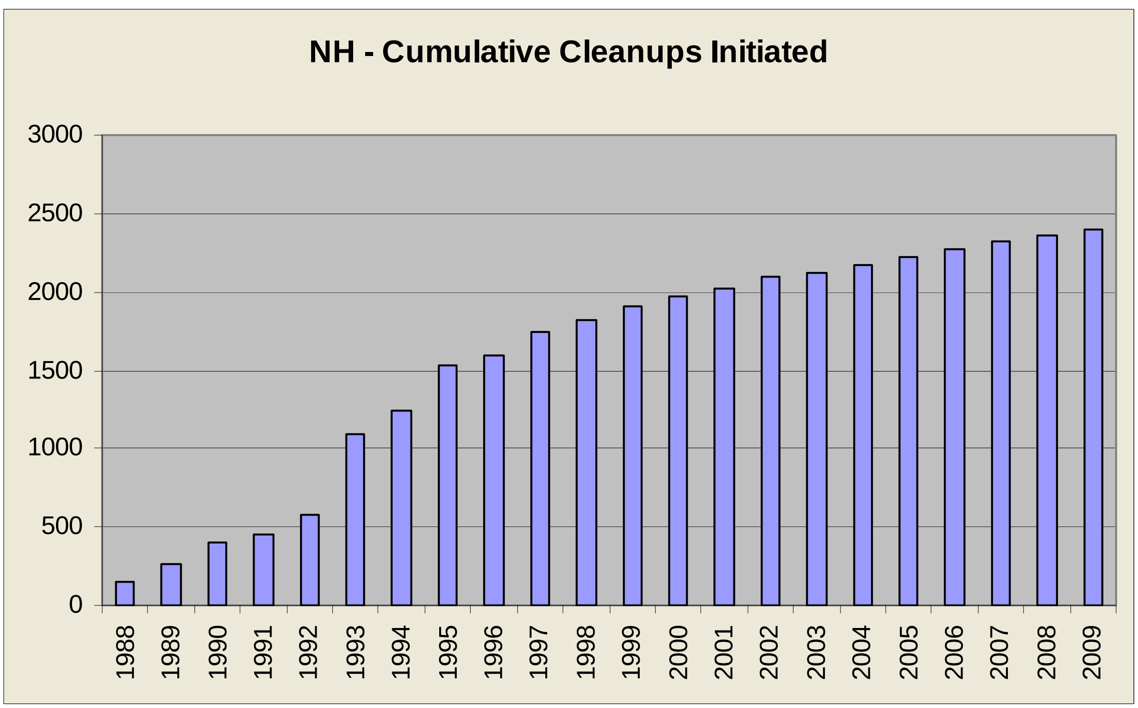
APPENDIX E

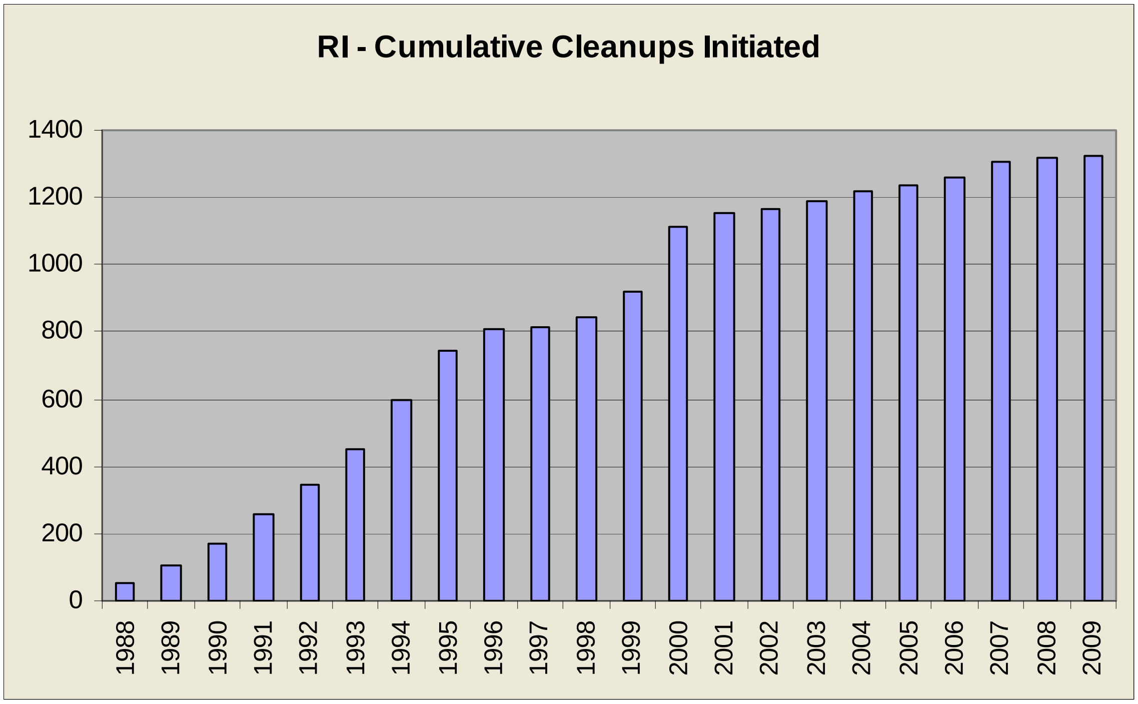
Graphs of Cumulative Cleanups Initiated for all 56 States for the Period 1988 through 2009

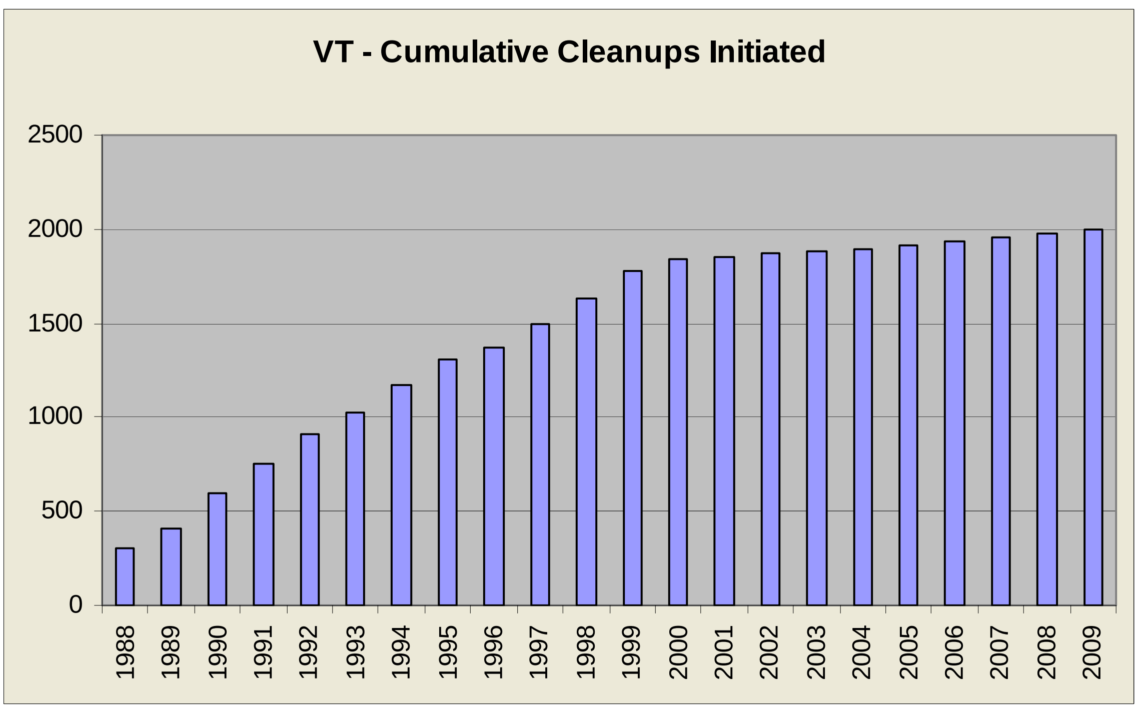

CT - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

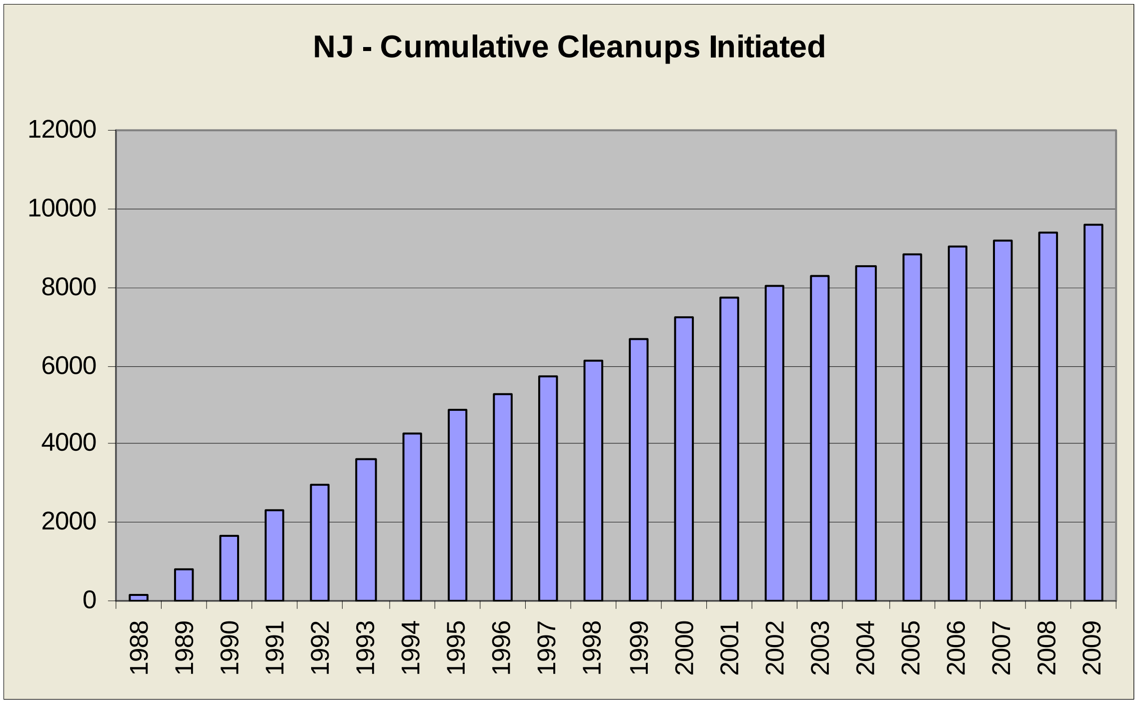

MA - Cumulative Cleanups Initiated
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

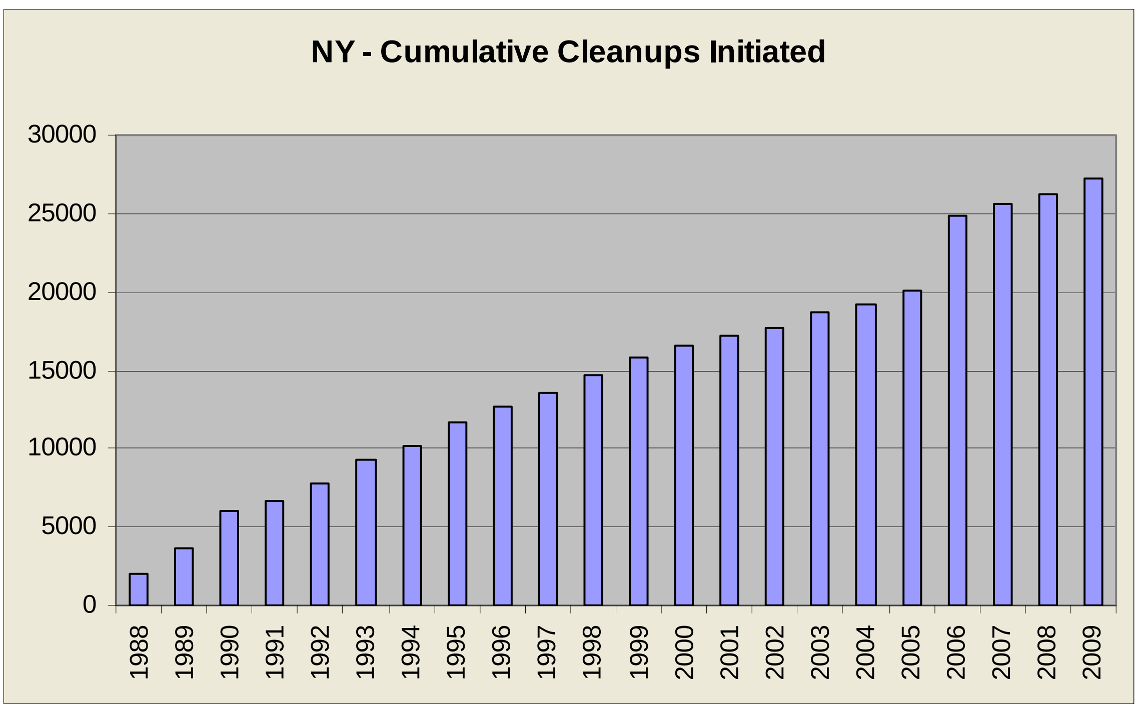

ME - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

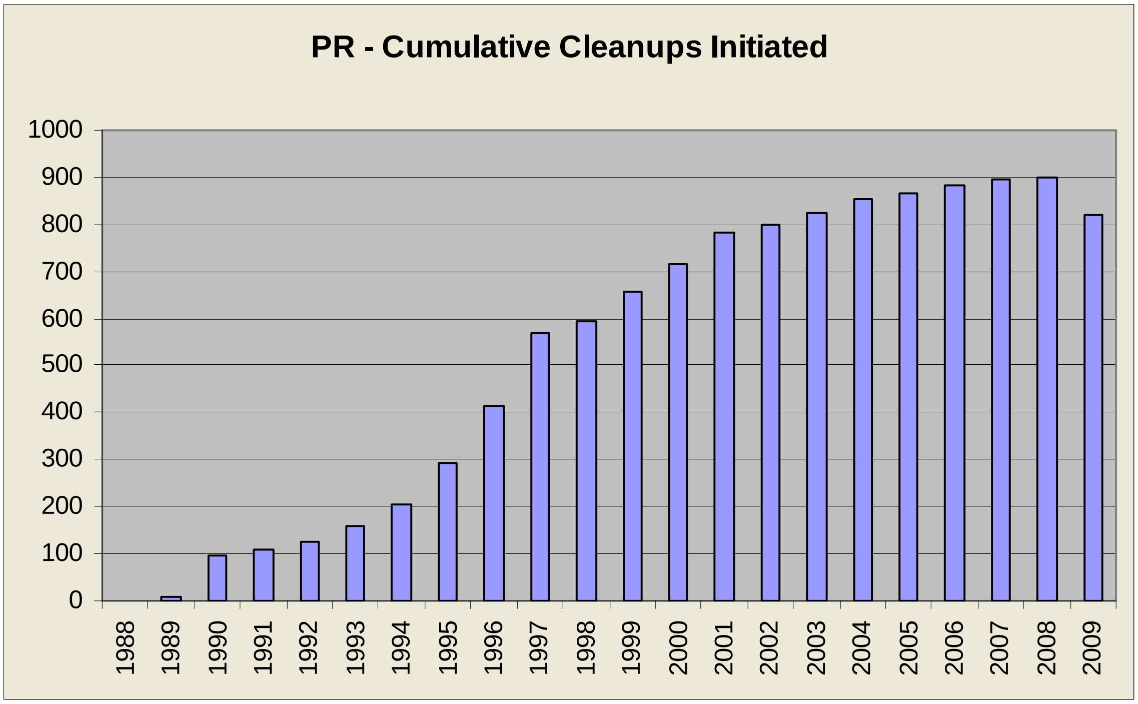

NH - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

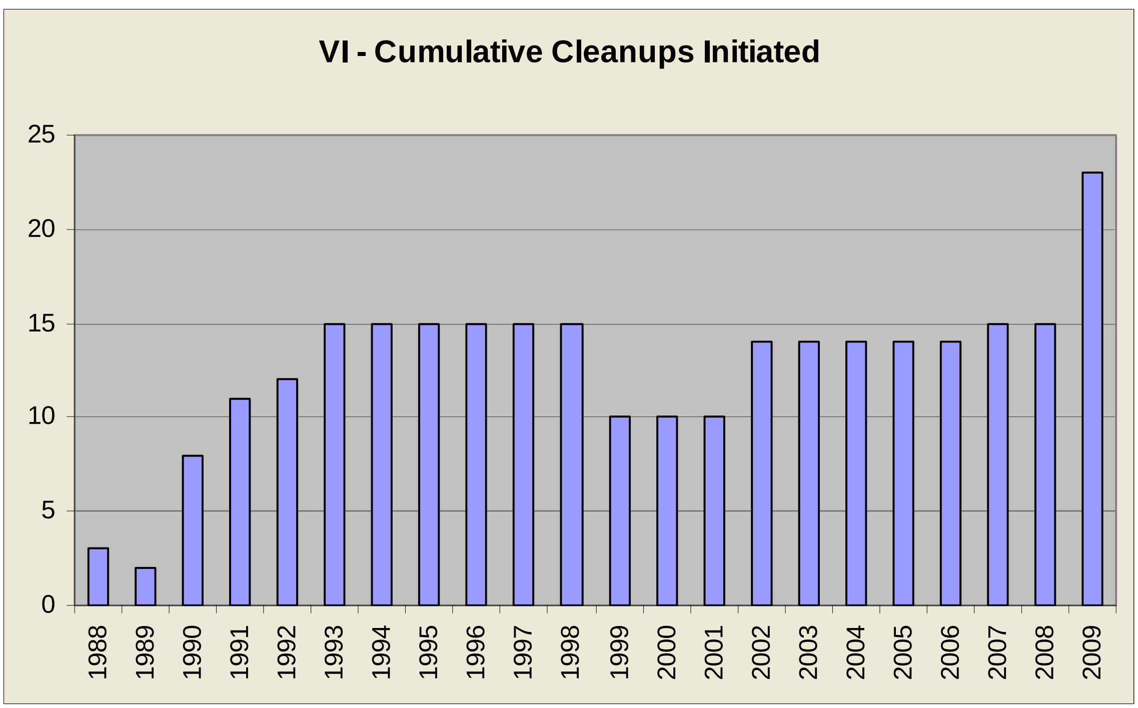

RI - Cumulative Cleanups Initiated
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

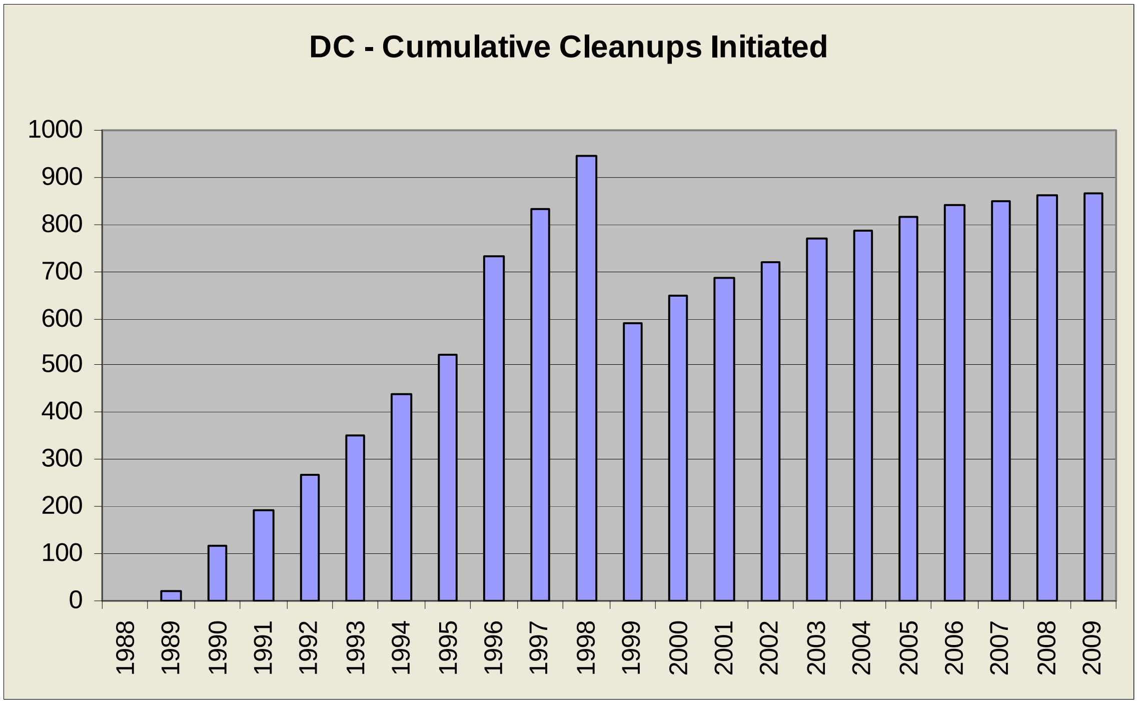

VT - Cumulative Cleanups Initiated
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

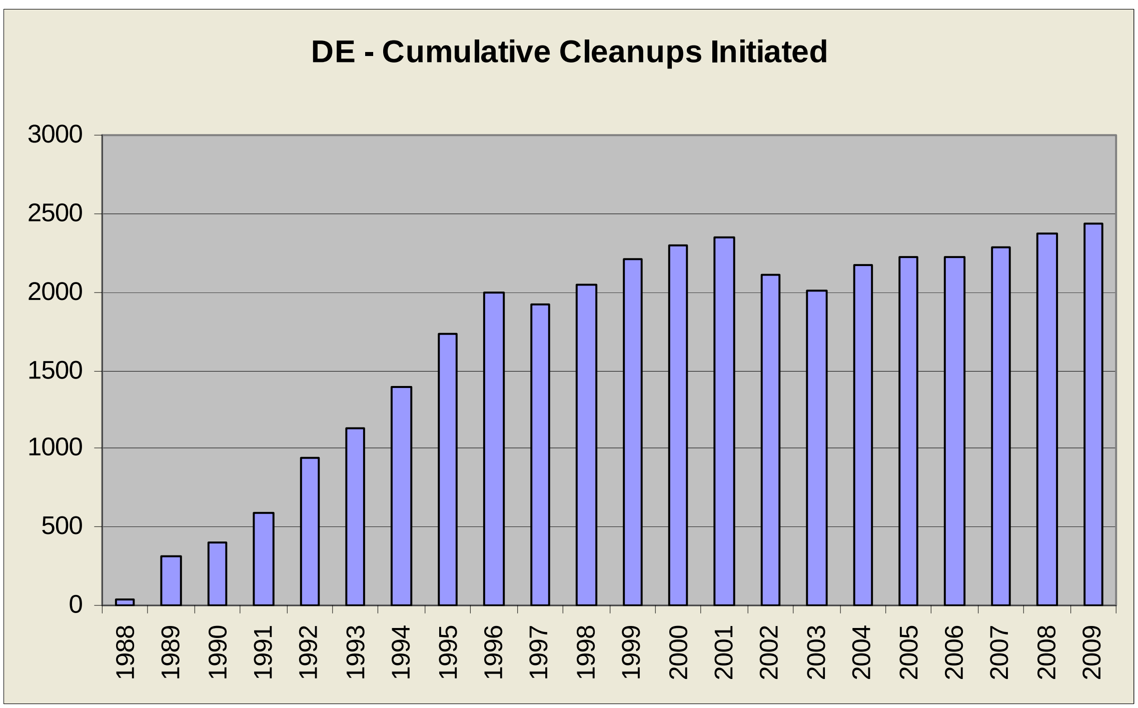

NJ - Cumulative Cleanups Initiated
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

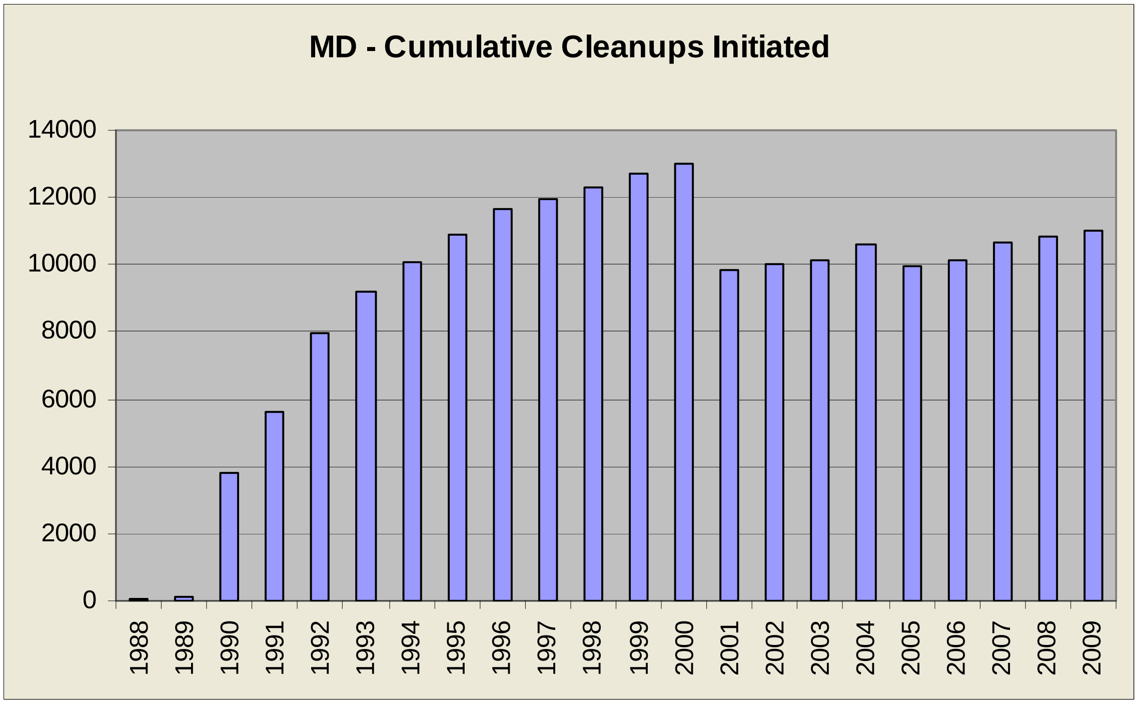

NY - Cumulative Cleanups Initiated
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

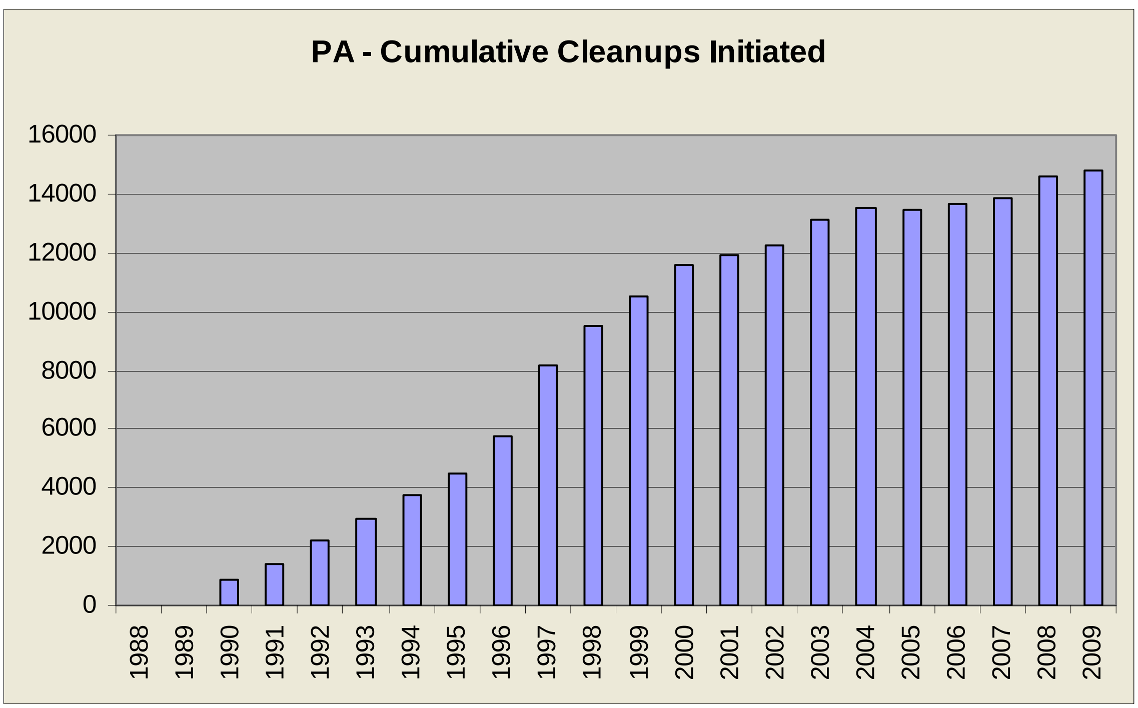

PR - Cumulative Cleanups Initiated
1000
900
800
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

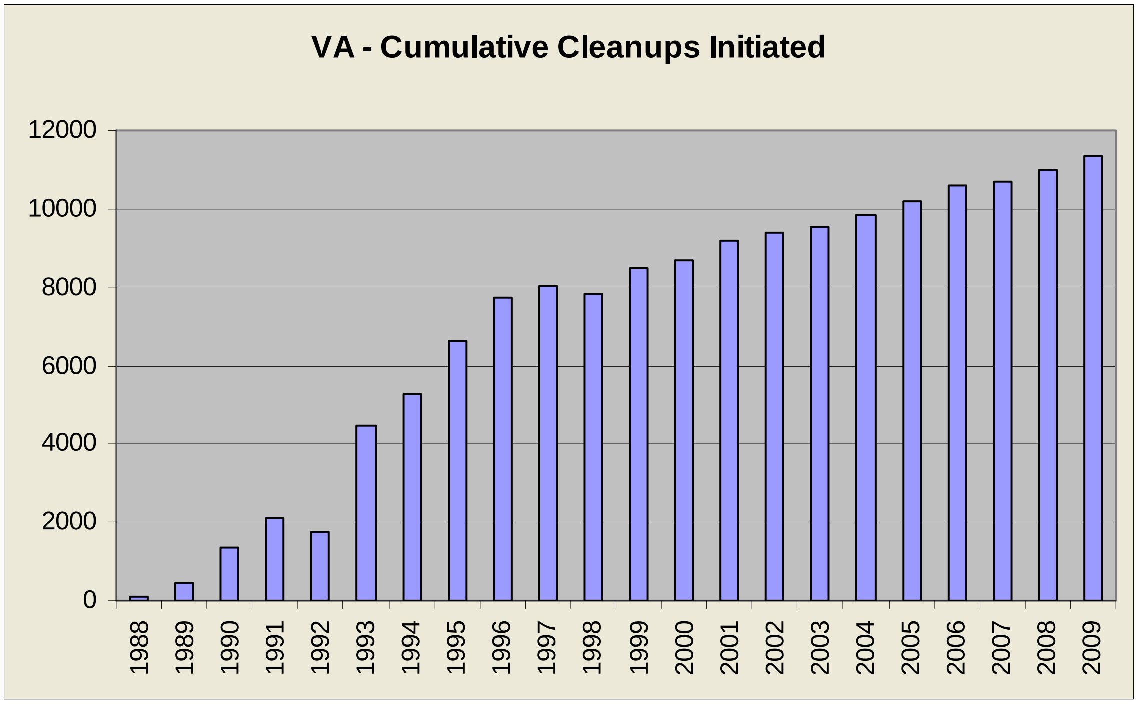

VI - Cumulative Cleanups Initiated
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

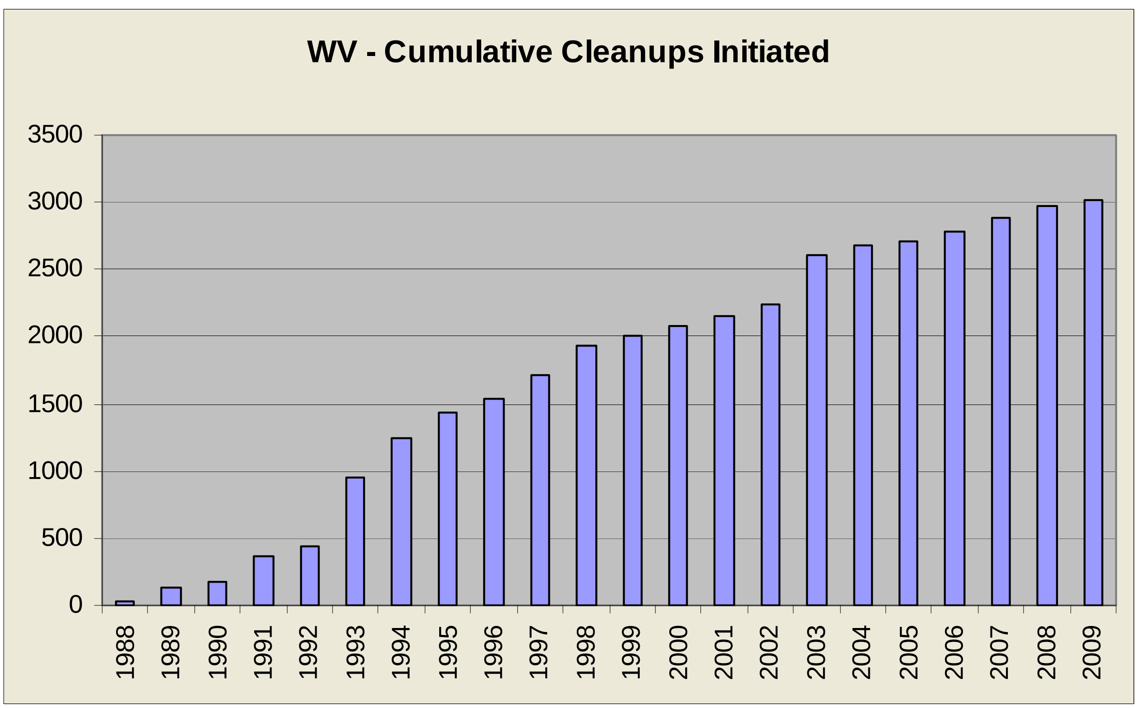

DC - Cumulative Cleanups Initiated
1000
900
800
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

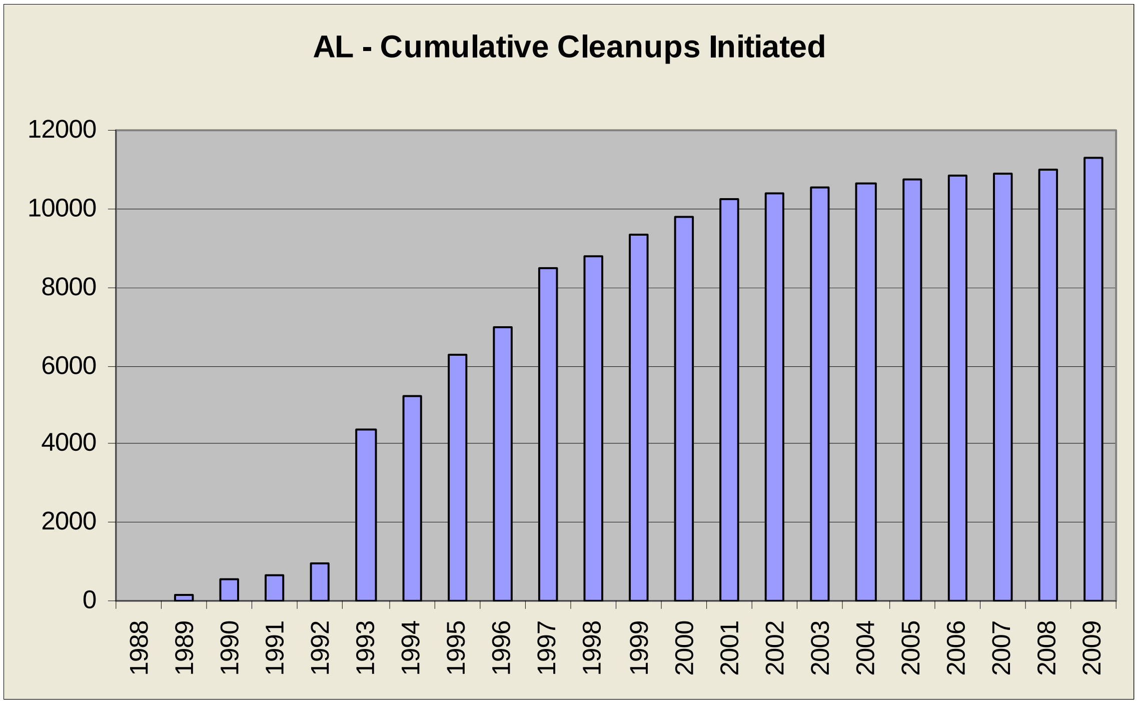

DE - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

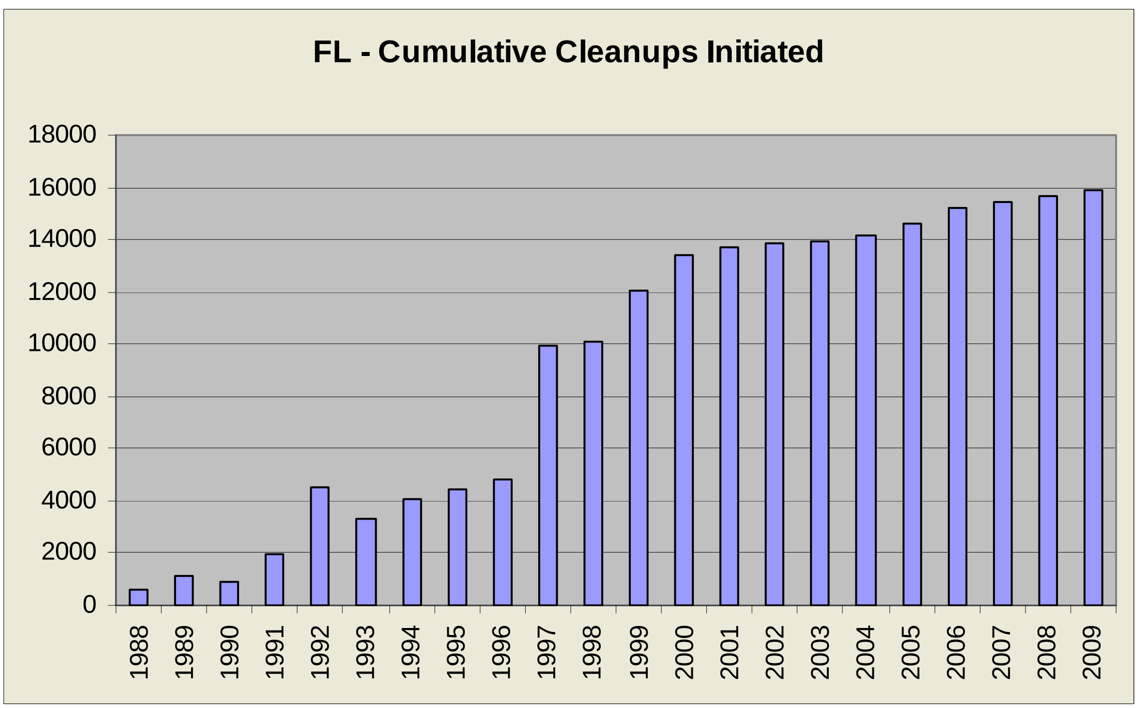

MD - Cumulative Cleanups Initiated
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

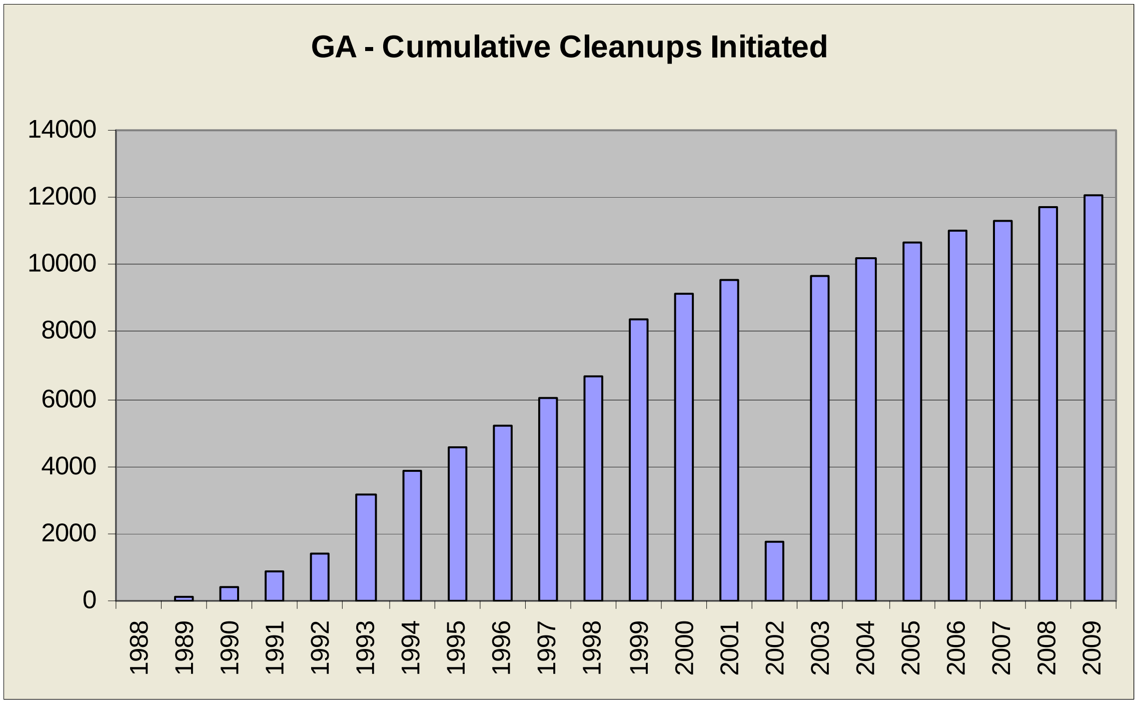

PA - Cumulative Cleanups Initiated
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

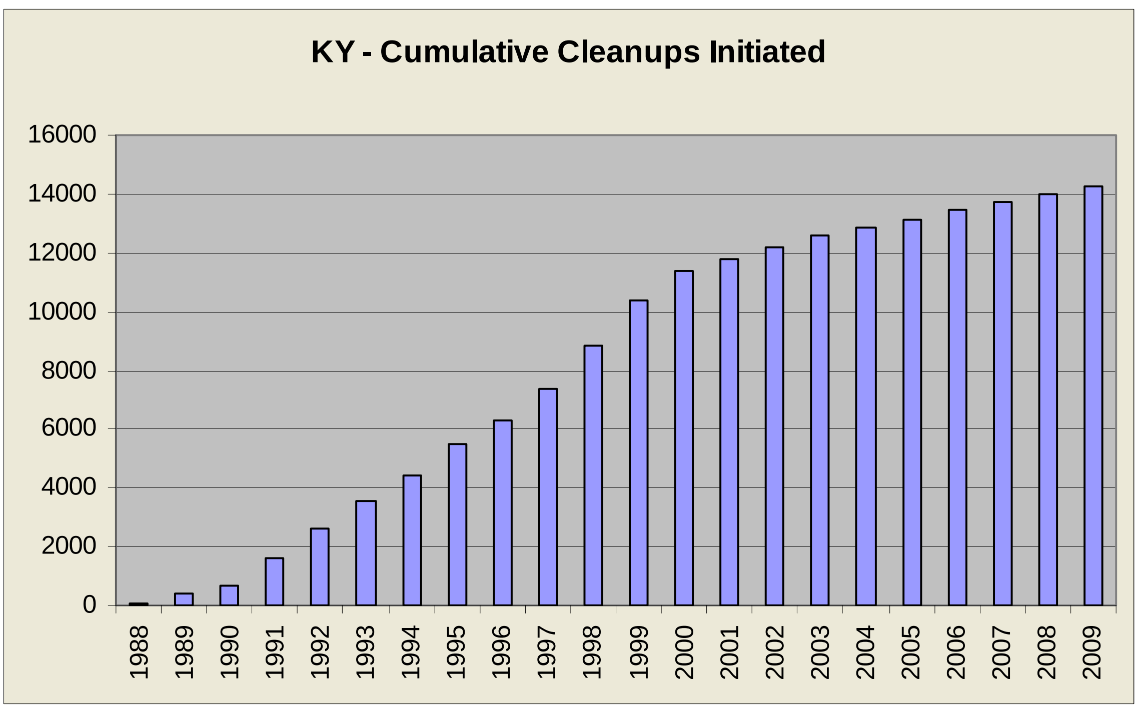

VA - Cumulative Cleanups Initiated
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

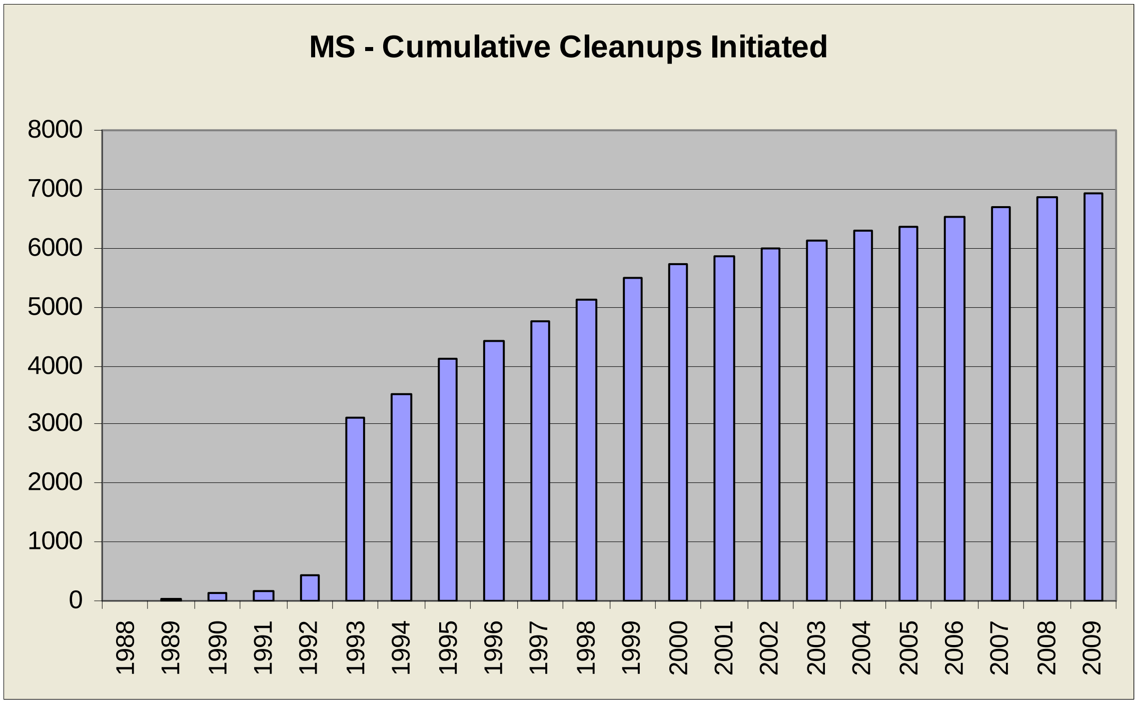

WV - Cumulative Cleanups Initiated
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

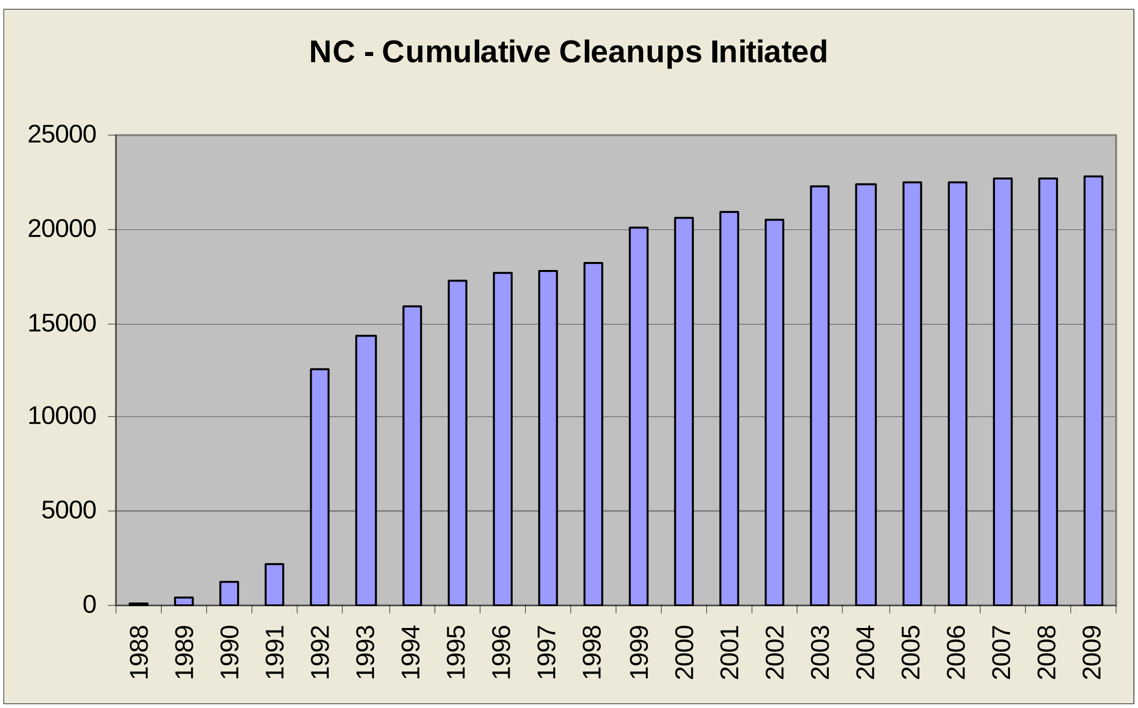

AL - Cumulative Cleanups Initiated
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

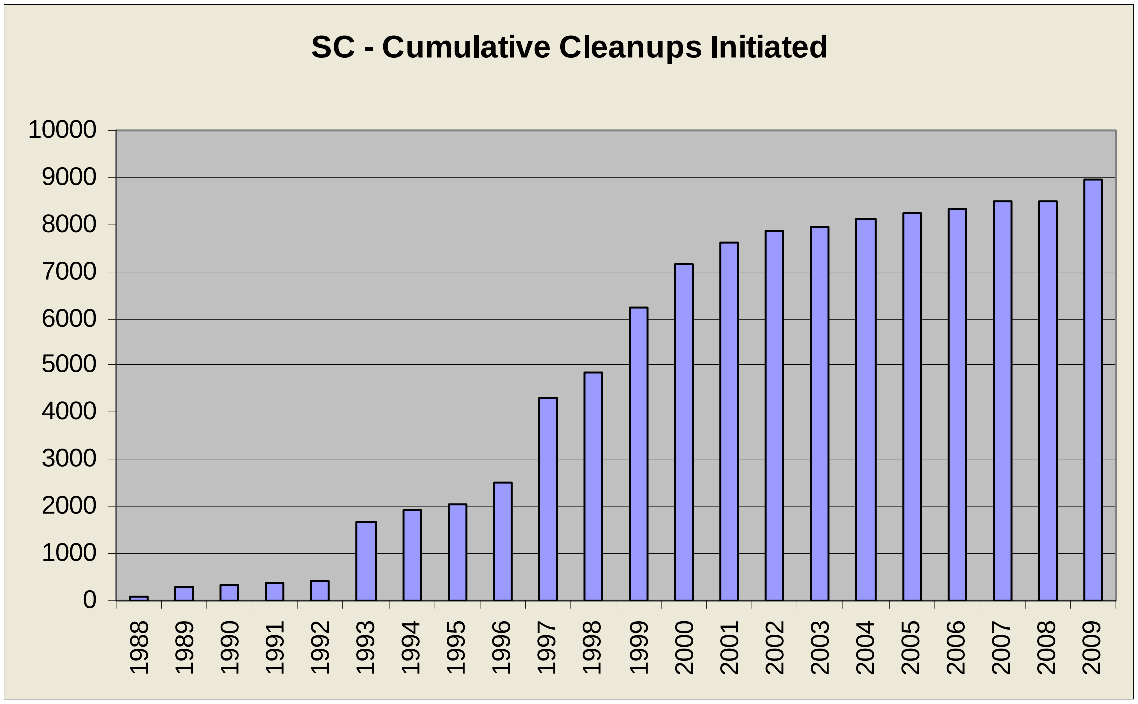

FL - Cumulative Cleanups Initiated
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

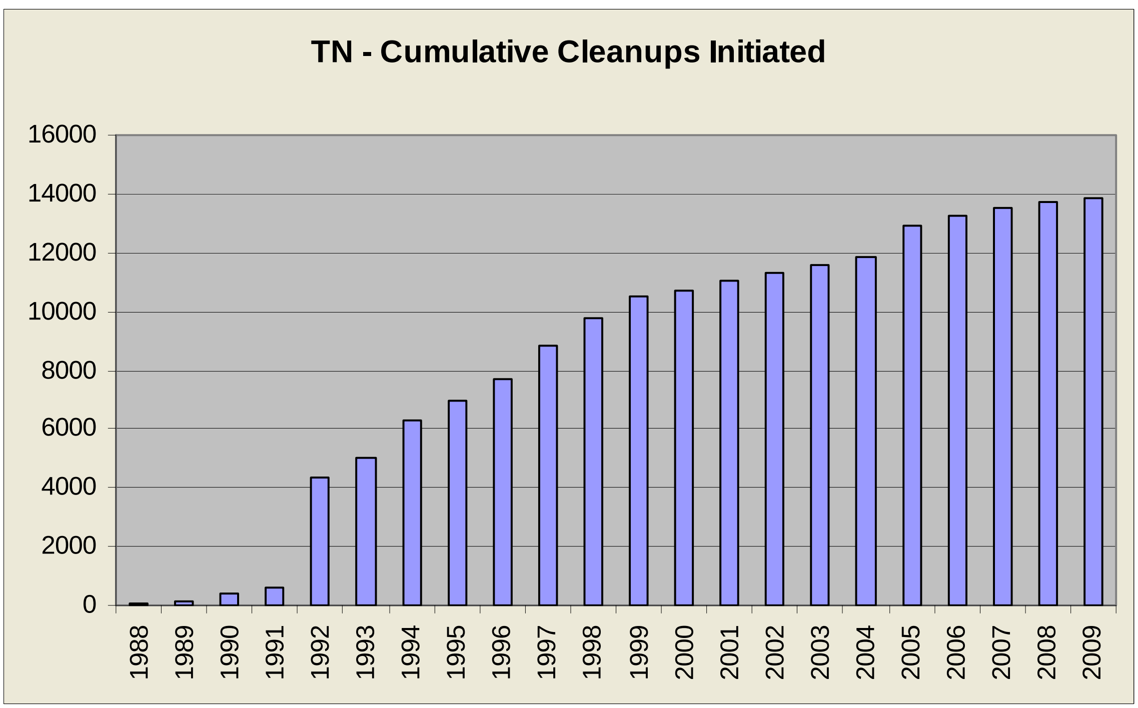

GA - Cumulative Cleanups Initiated
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

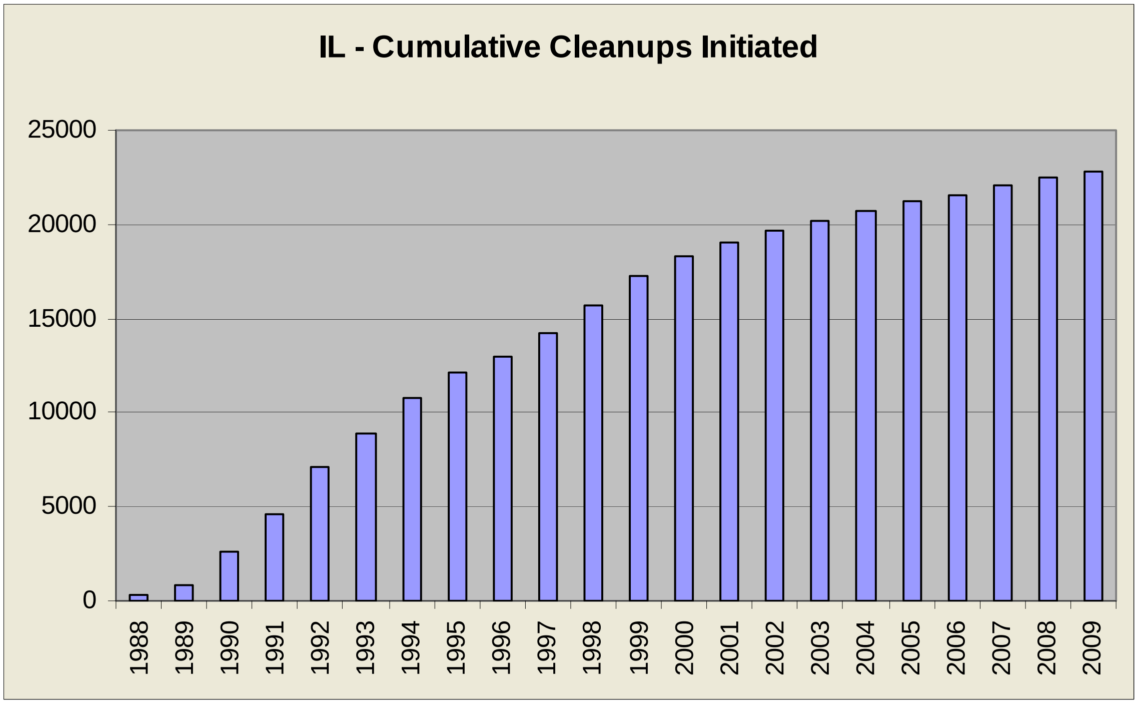

KY - Cumulative Cleanups Initiated
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

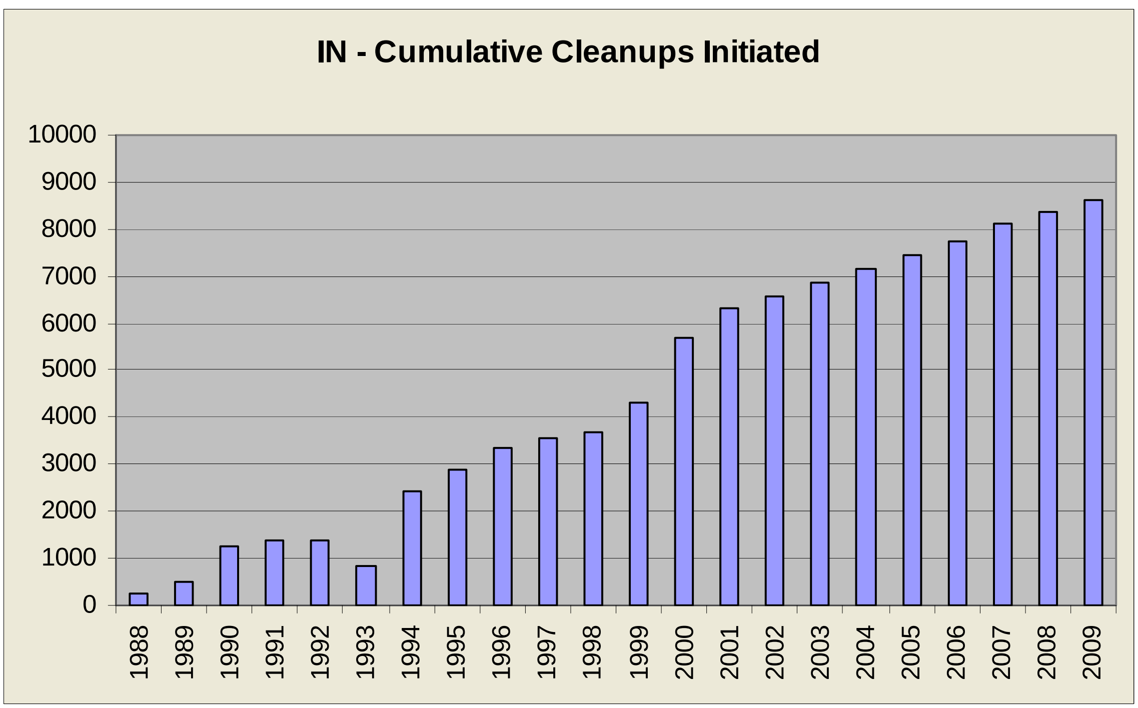

MS - Cumulative Cleanups Initiated
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

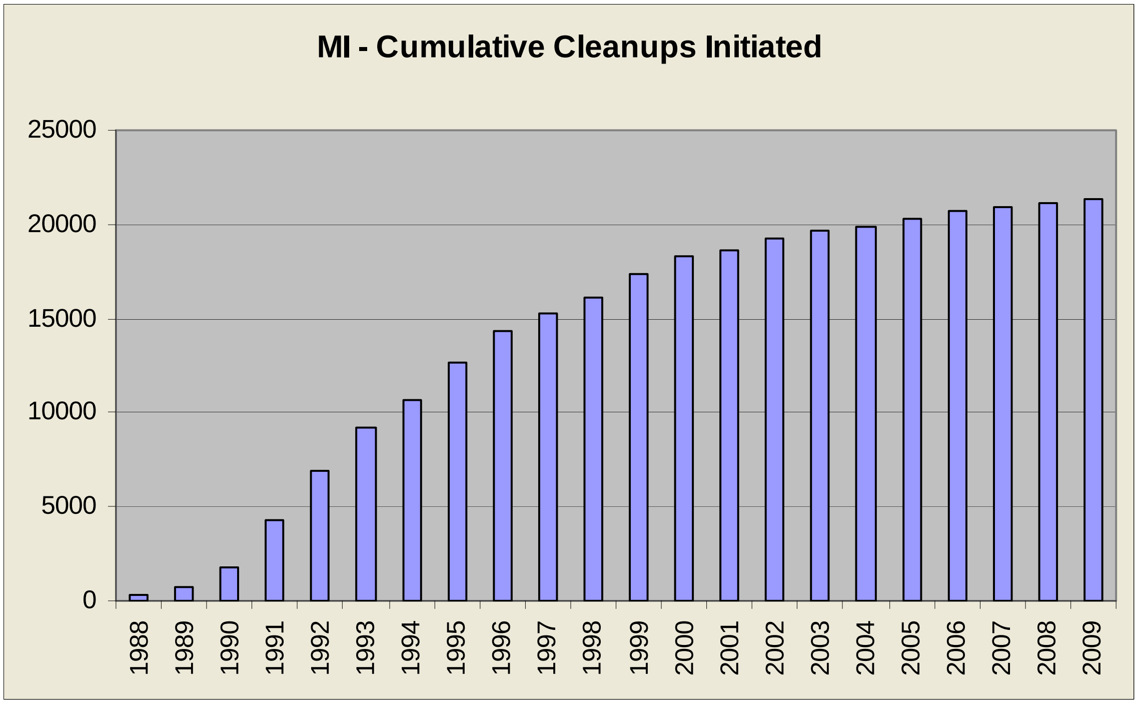

NC - Cumulative Cleanups Initiated
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

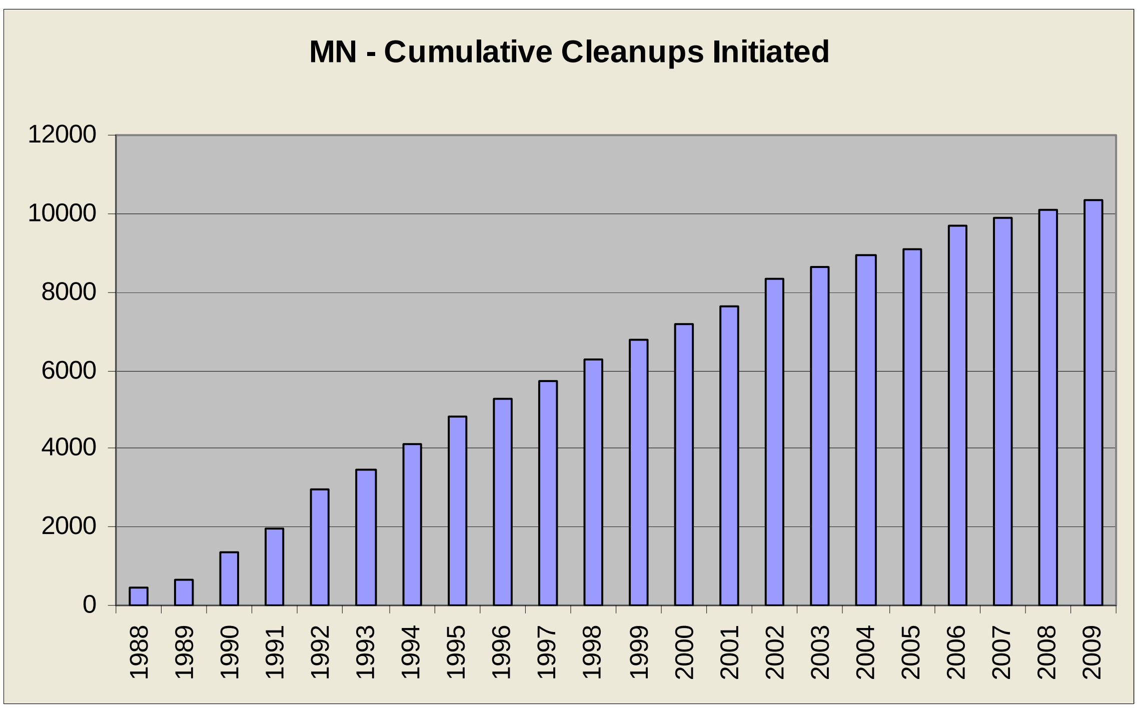

SC - Cumulative Cleanups Initiated
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

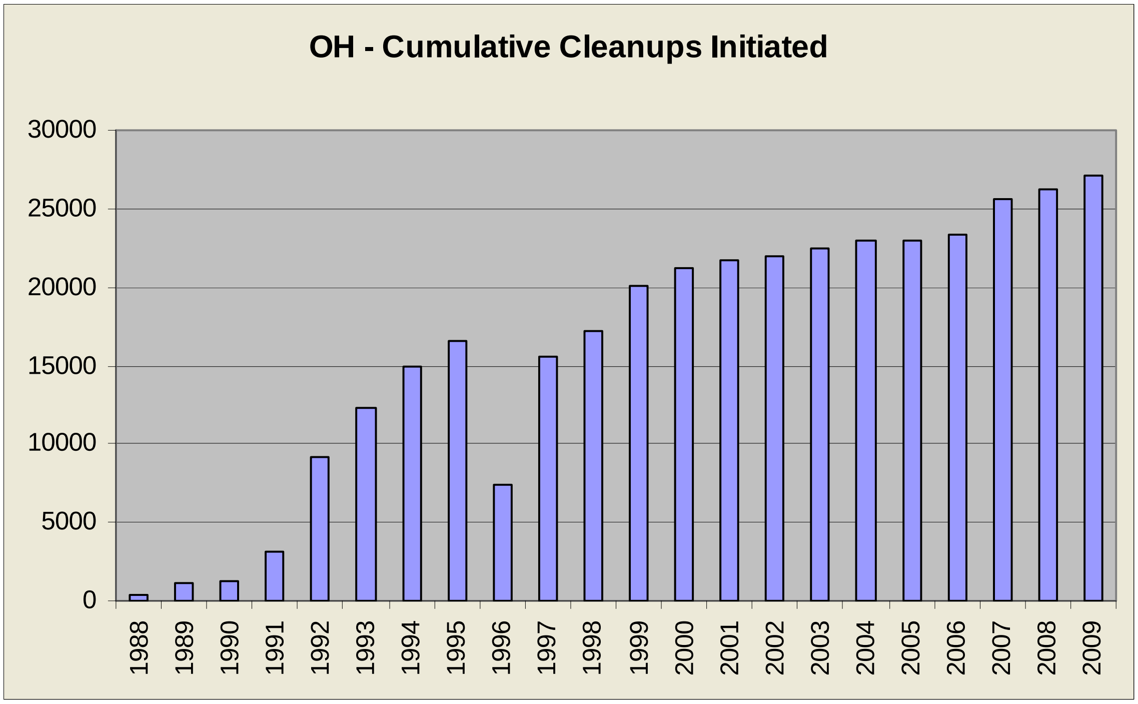

TN - Cumulative Cleanups Initiated
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

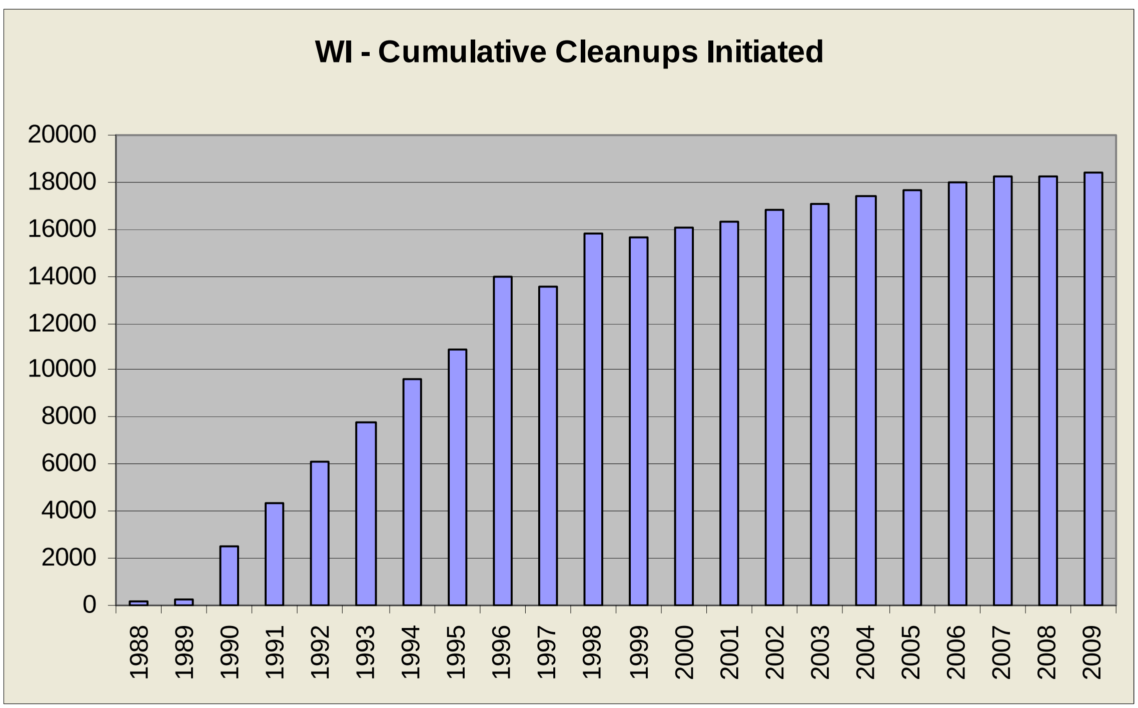

IL - Cumulative Cleanups Initiated
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

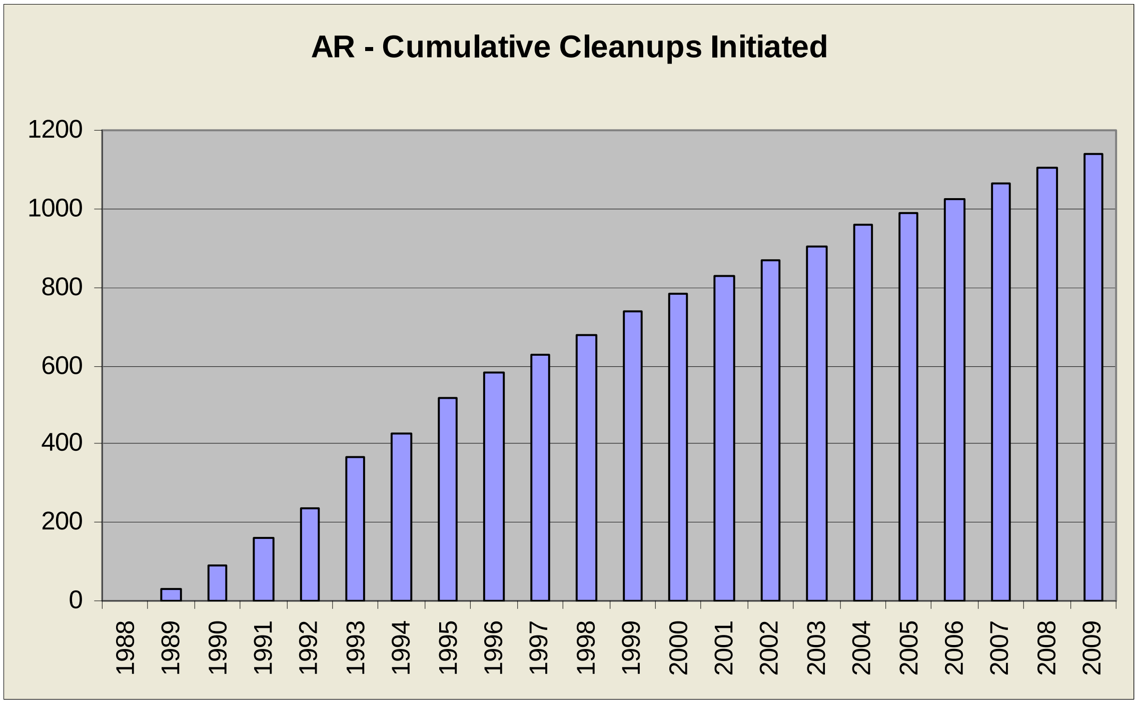

IN - Cumulative Cleanups Initiated
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

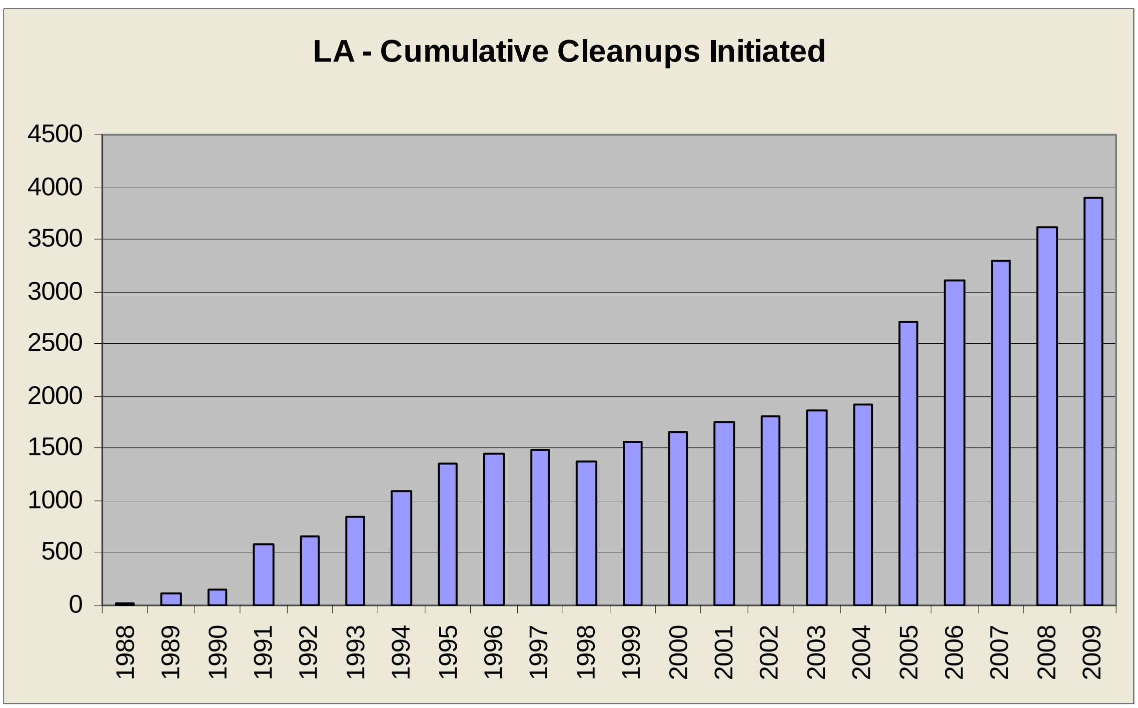

MI - Cumulative Cleanups Initiated
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

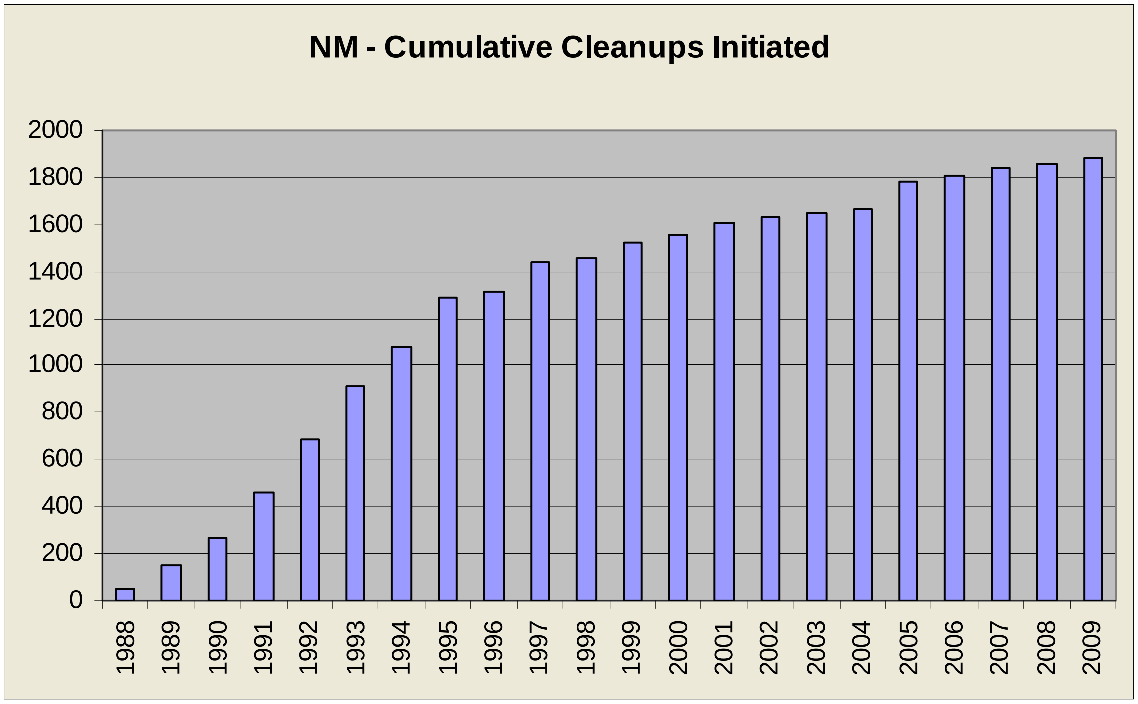

MN - Cumulative Cleanups Initiated
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

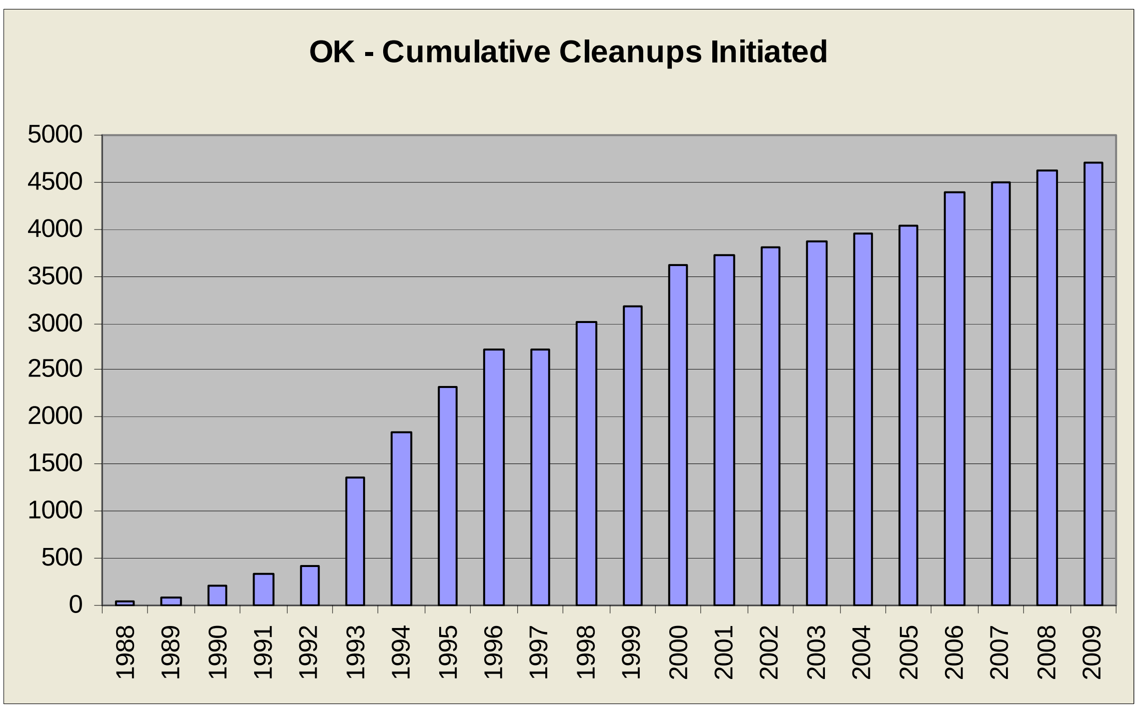

OH - Cumulative Cleanups Initiated
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

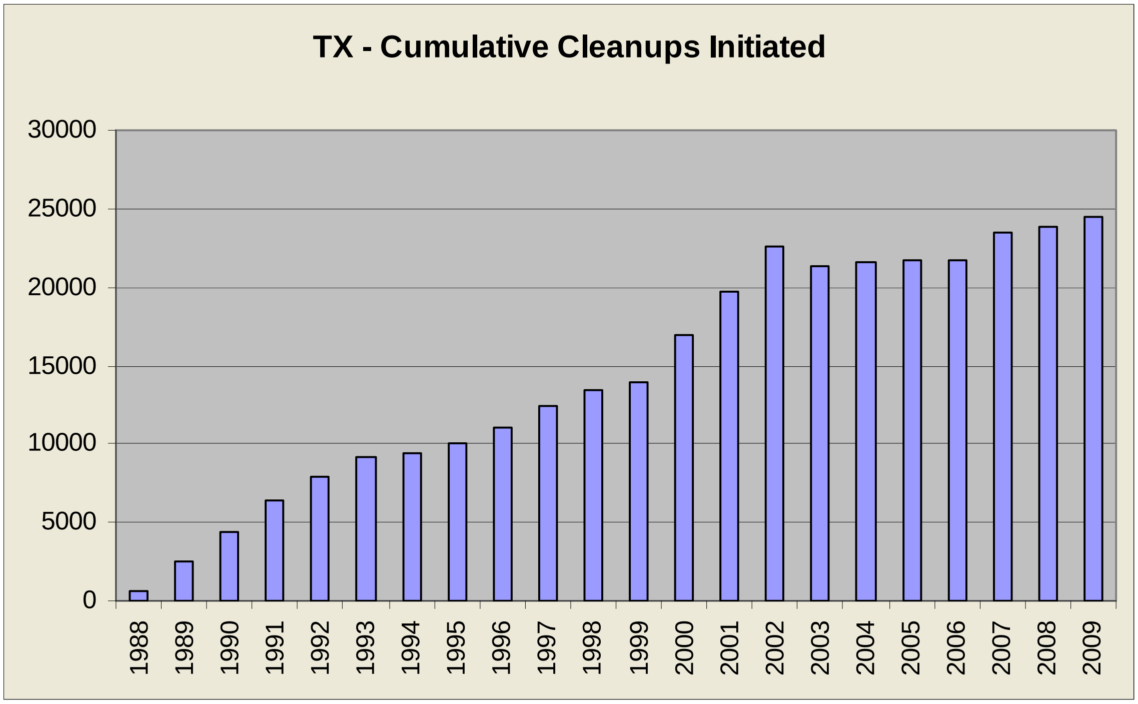

WI - Cumulative Cleanups Initiated
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

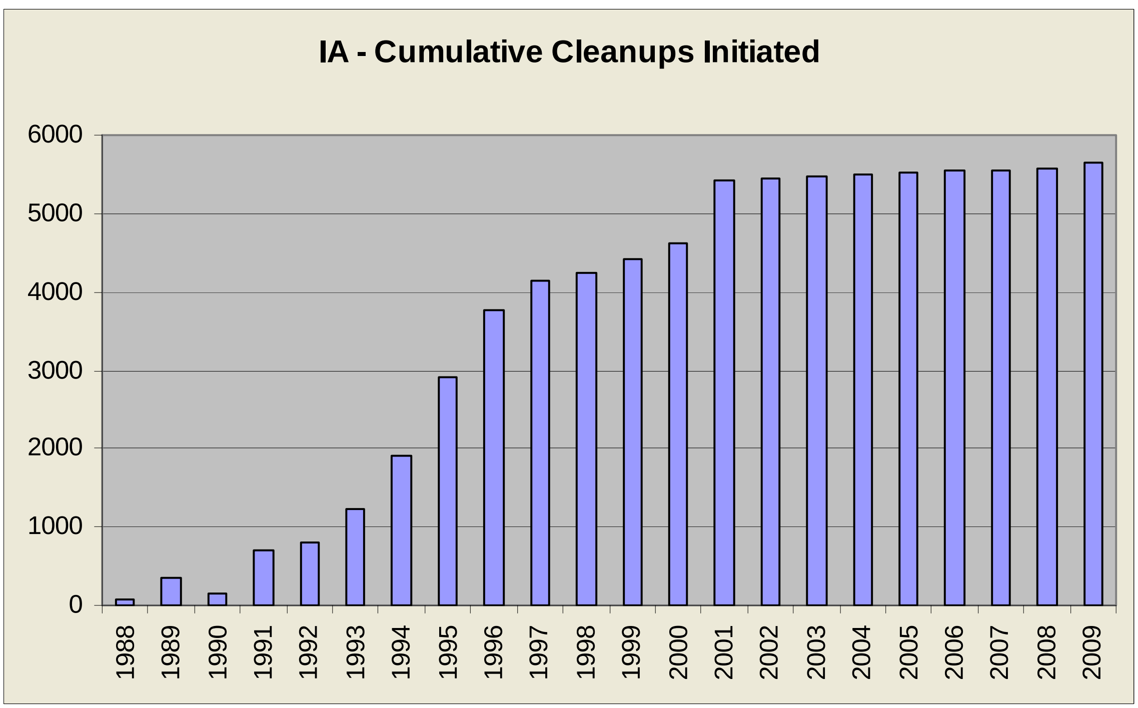

AR - Cumulative Cleanups Initiated
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

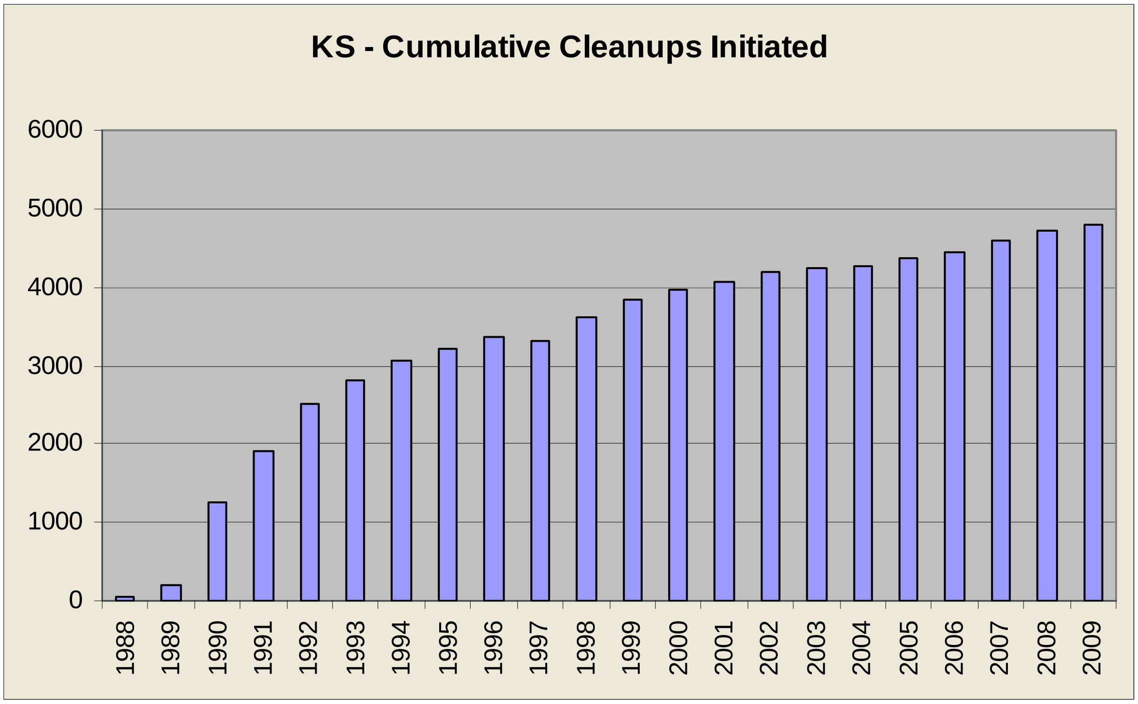

LA - Cumulative Cleanups Initiated
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

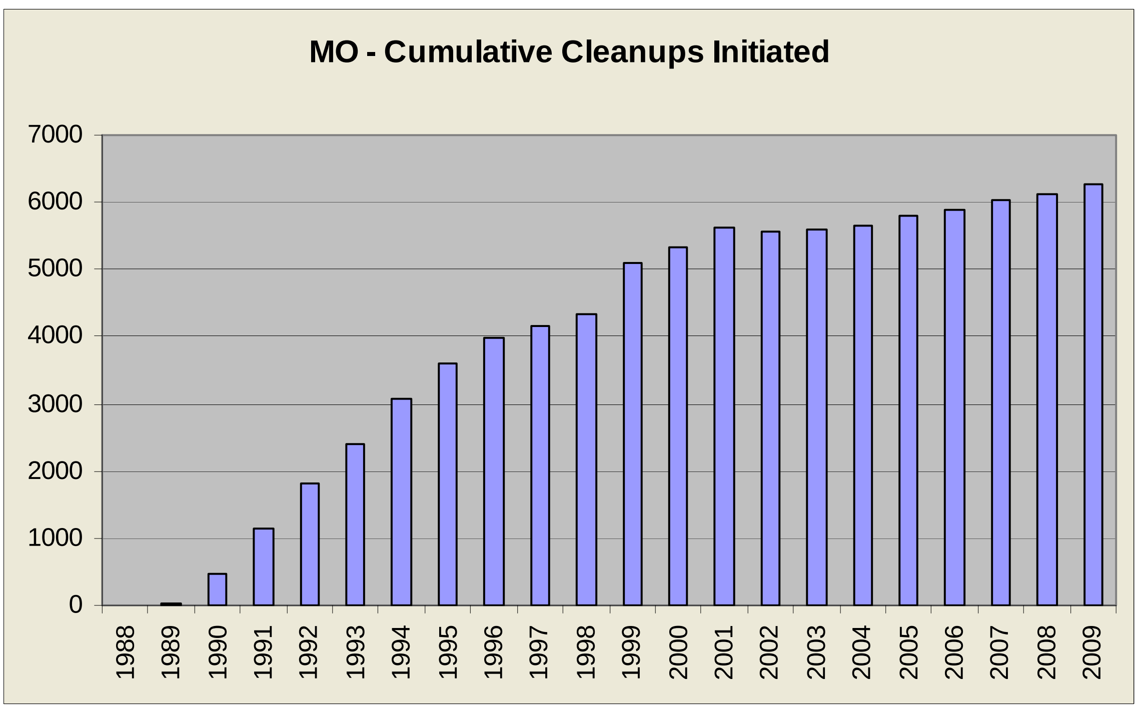

NM - Cumulative Cleanups Initiated
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

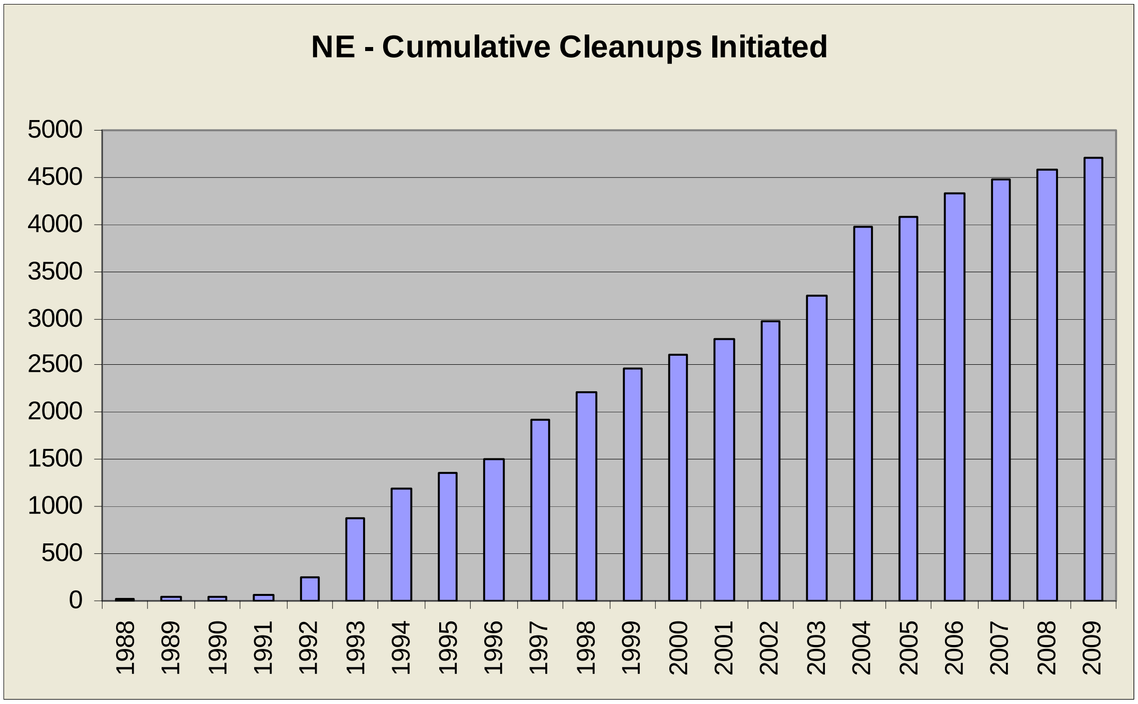

OK - Cumulative Cleanups Initiated
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

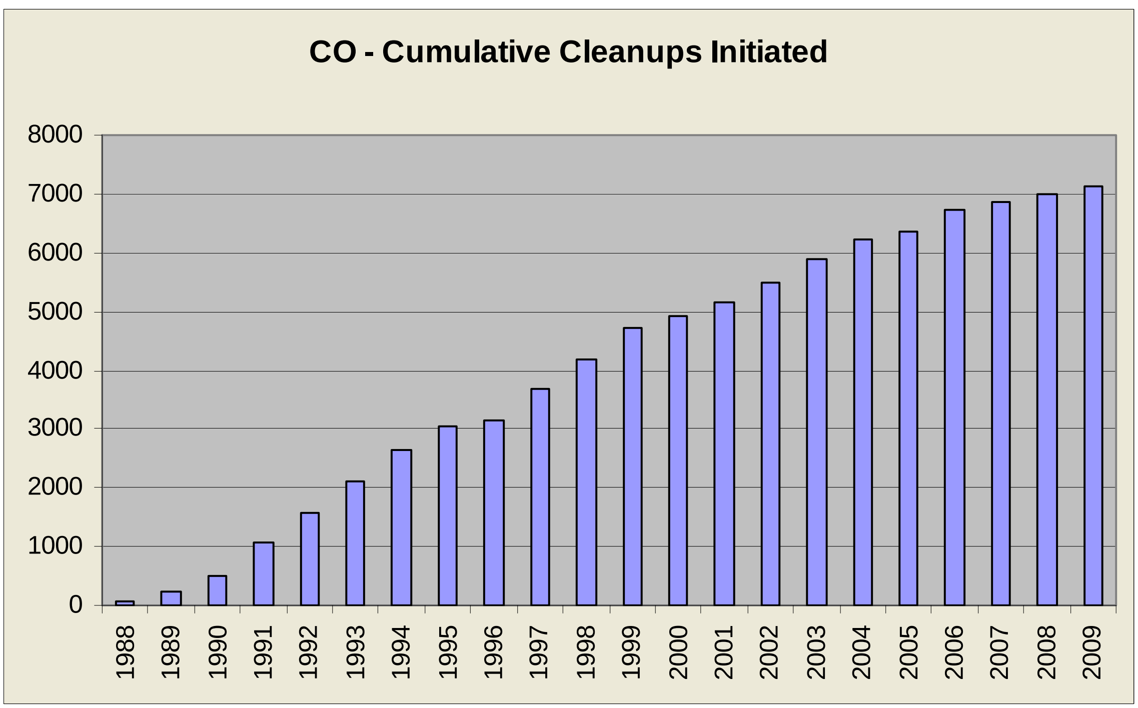

TX - Cumulative Cleanups Initiated
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

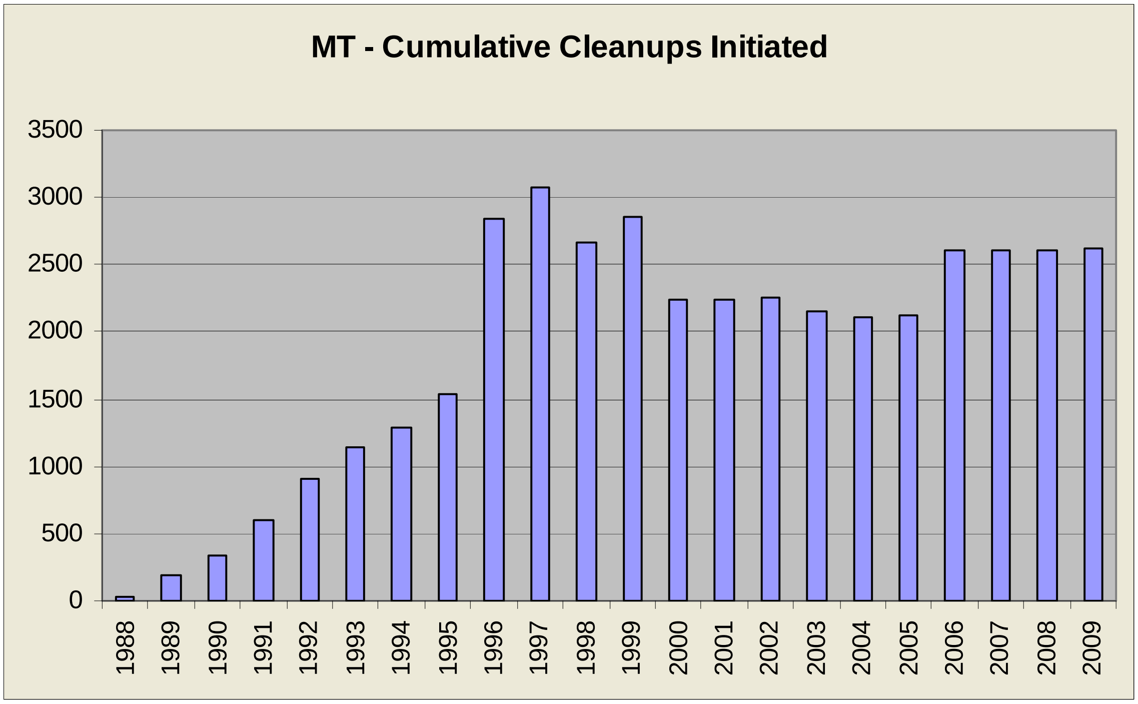

IA - Cumulative Cleanups Initiated
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

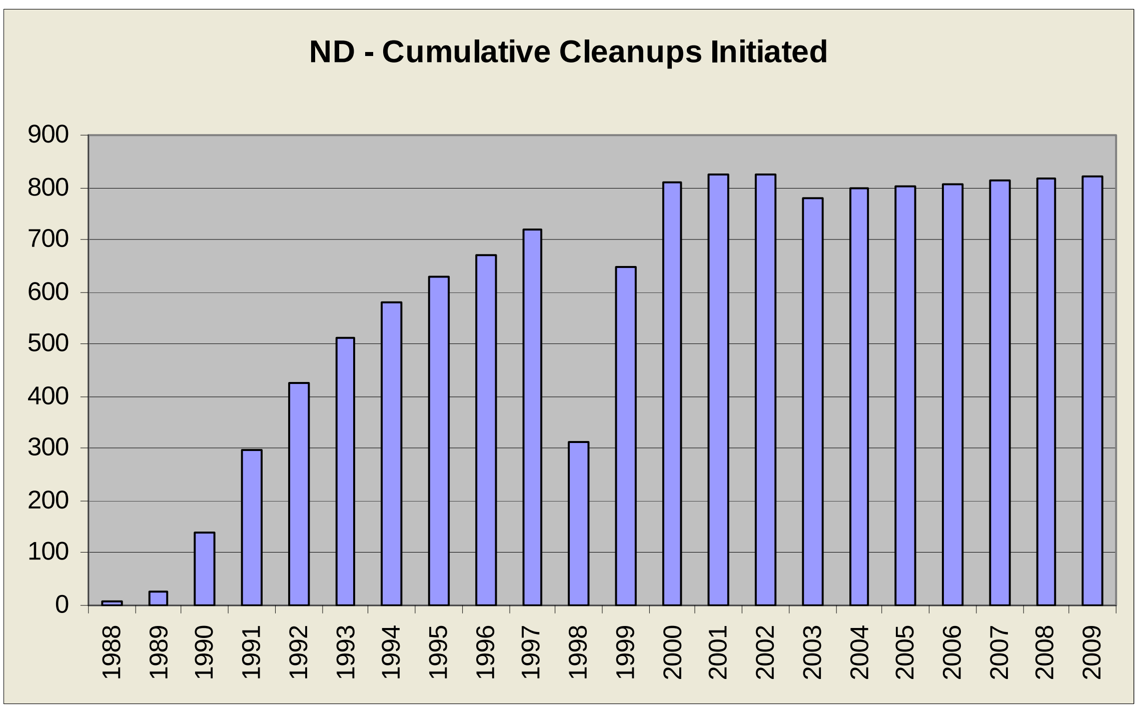

KS - Cumulative Cleanups Initiated
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

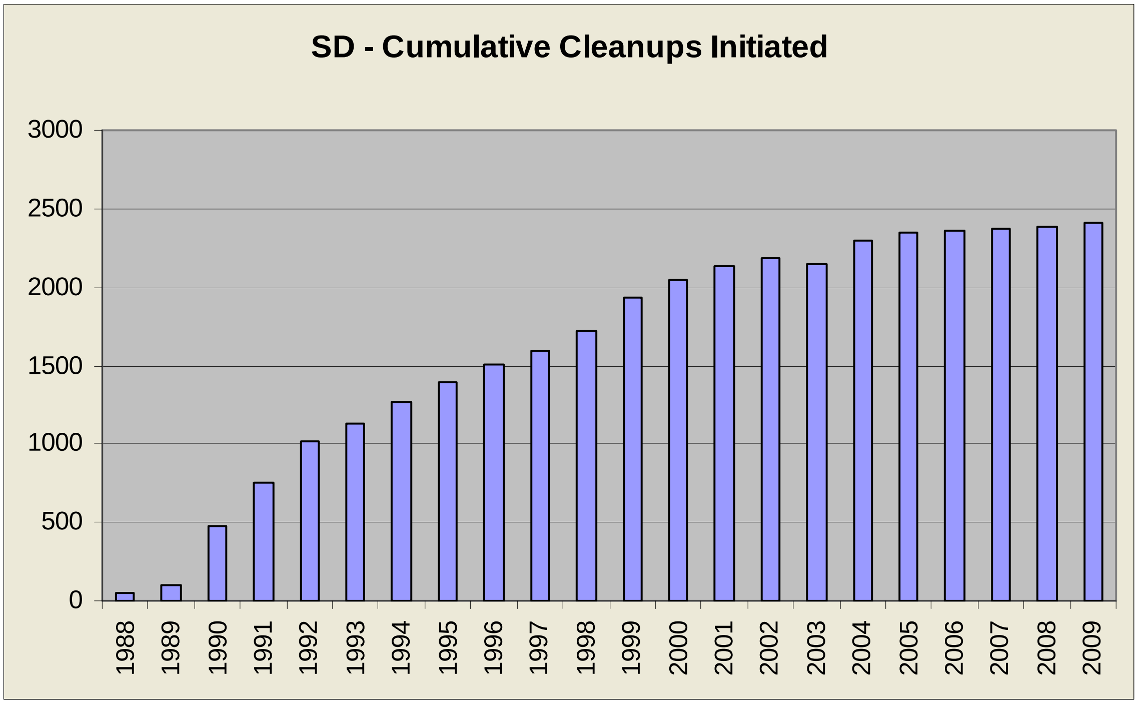

MO - Cumulative Cleanups Initiated
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

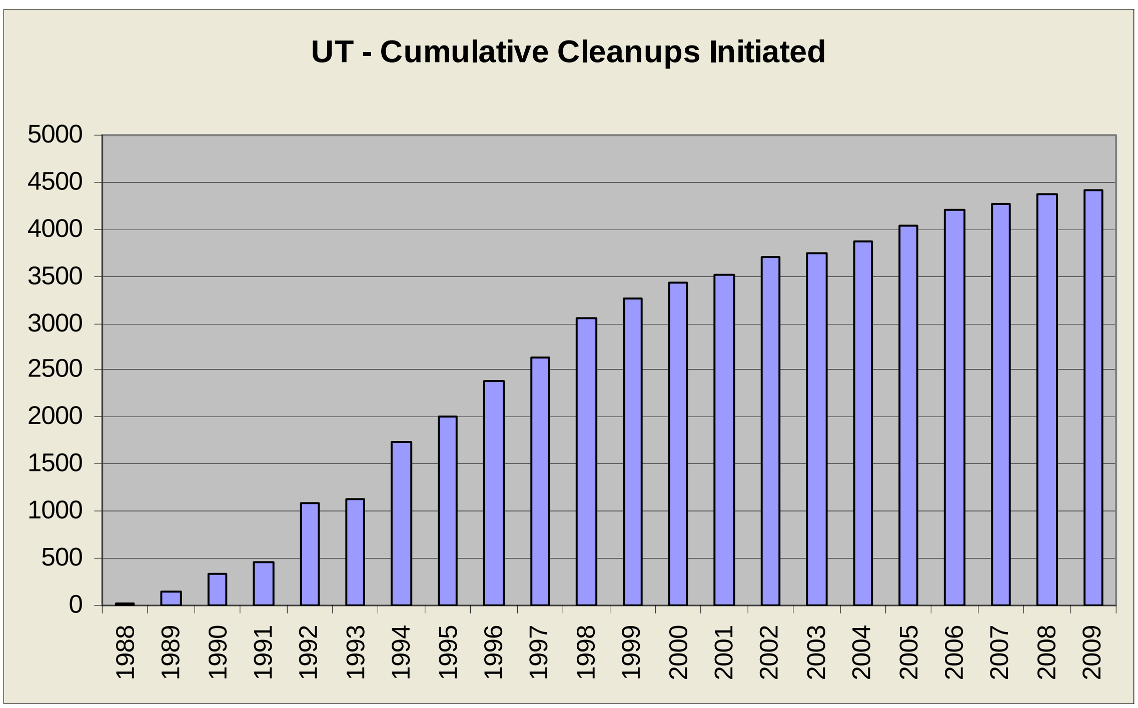

NE - Cumulative Cleanups Initiated
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

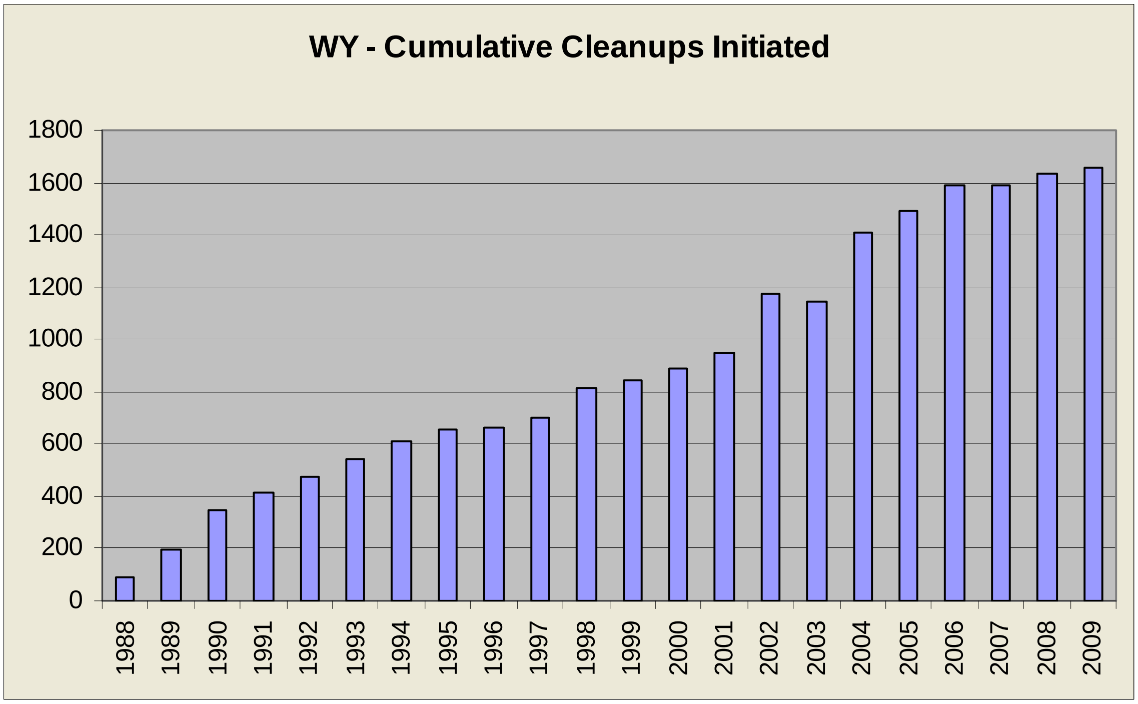

CO - Cumulative Cleanups Initiated
8000
7000
6000
5000
4000
3000
2000
1000
0
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

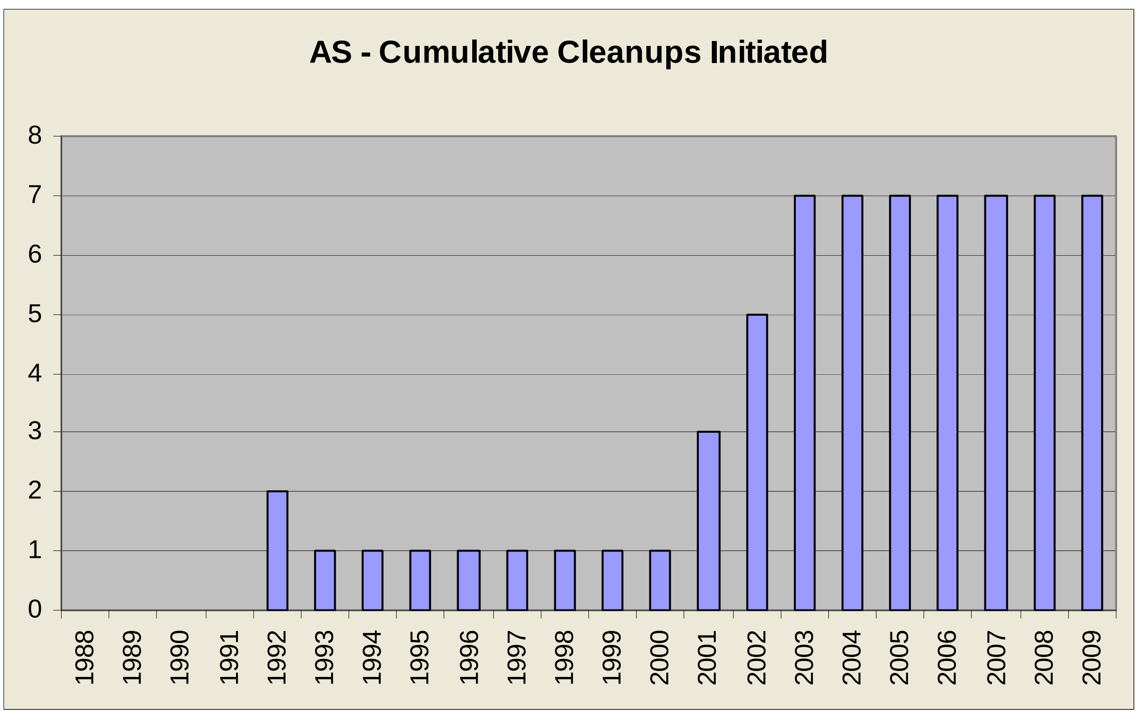

MT - Cumulative Cleanups Initiated
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

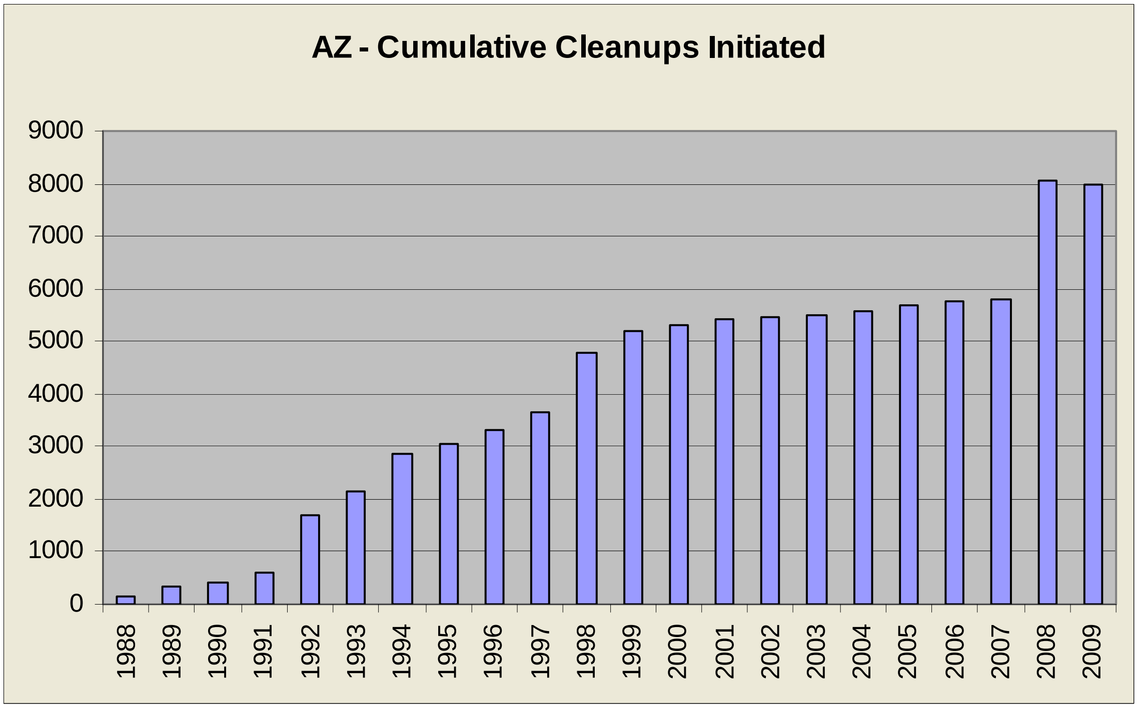

ND - Cumulative Cleanups Initiated
900
800
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

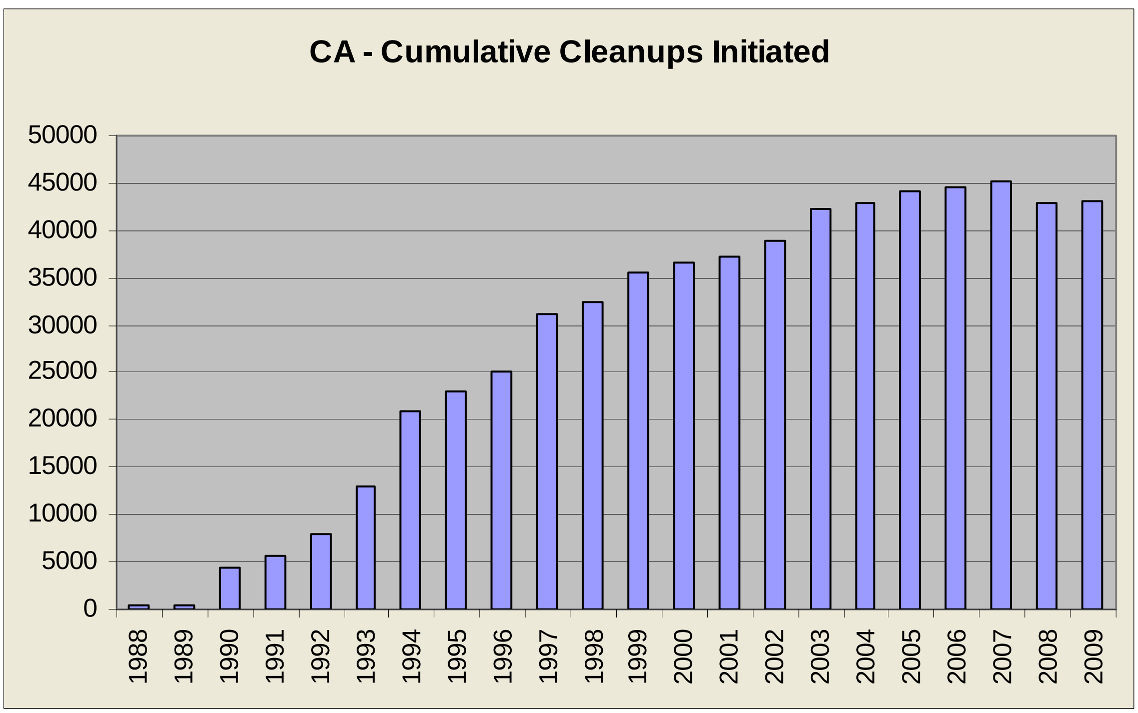

SD - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

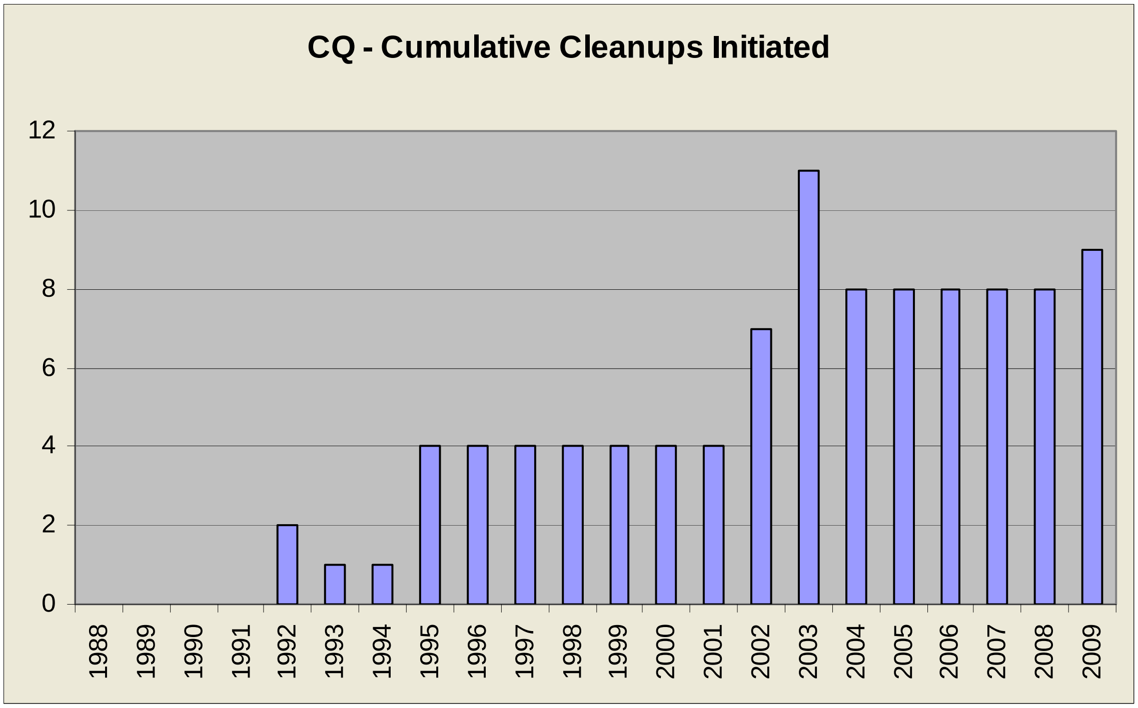

UT - Cumulative Cleanups Initiated
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

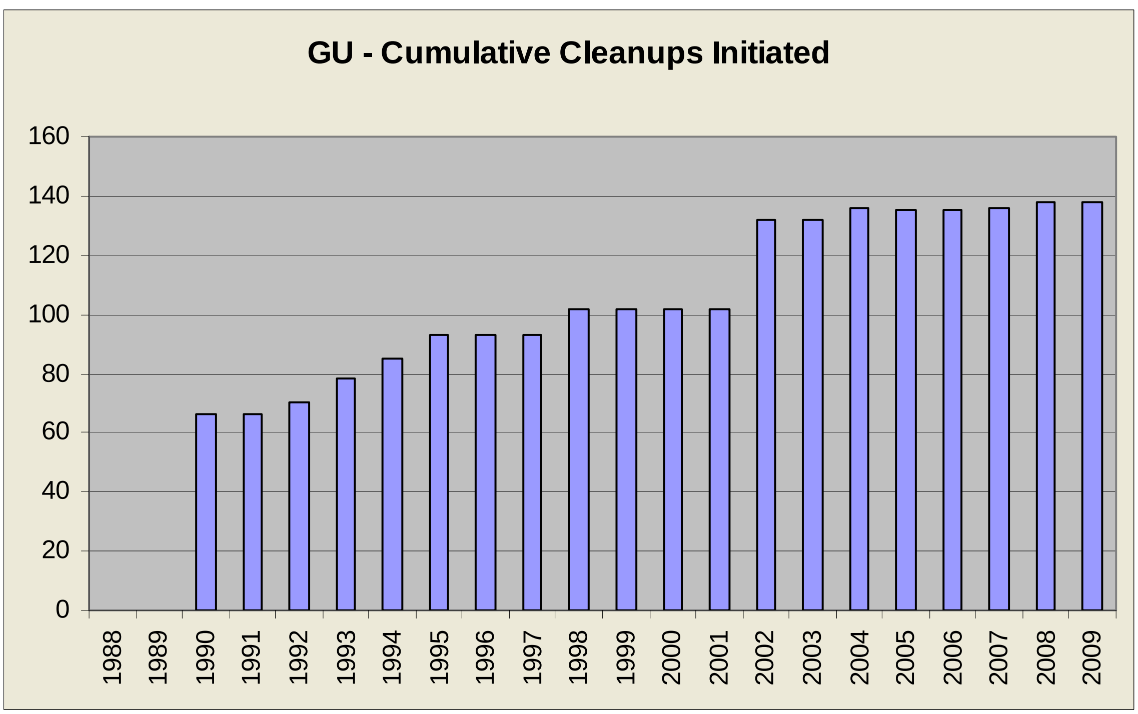

WY - Cumulative Cleanups Initiated
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

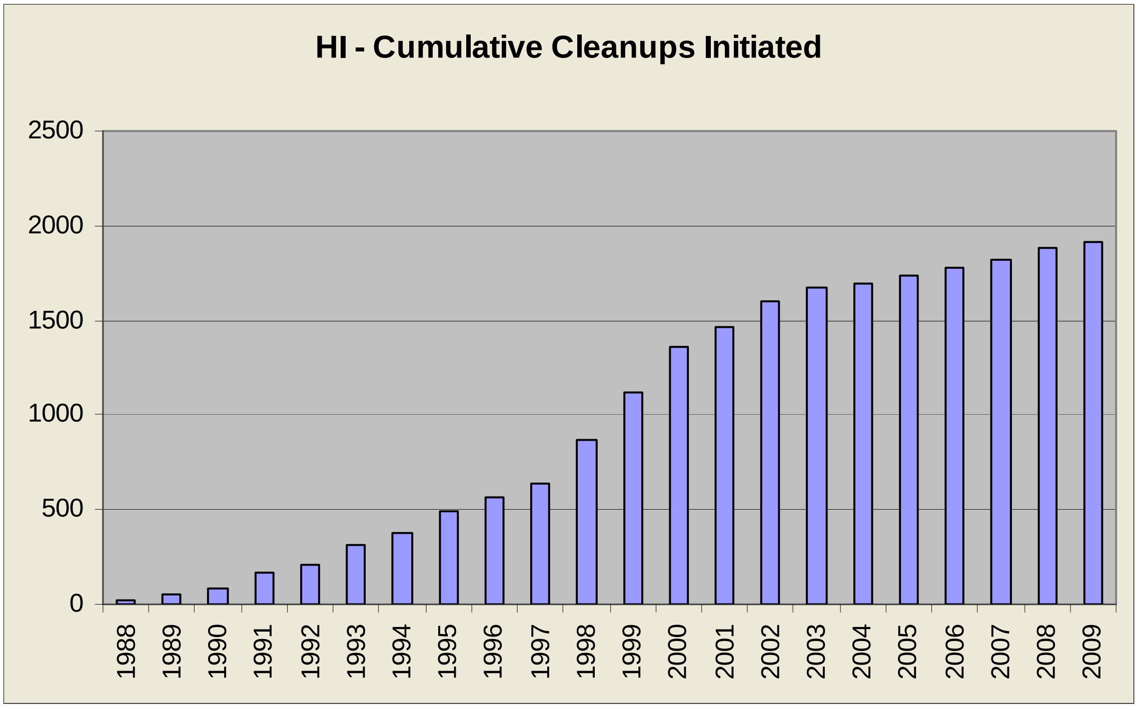

AS - Cumulative Cleanups Initiated
8
7
6
5
4
3
2
1
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

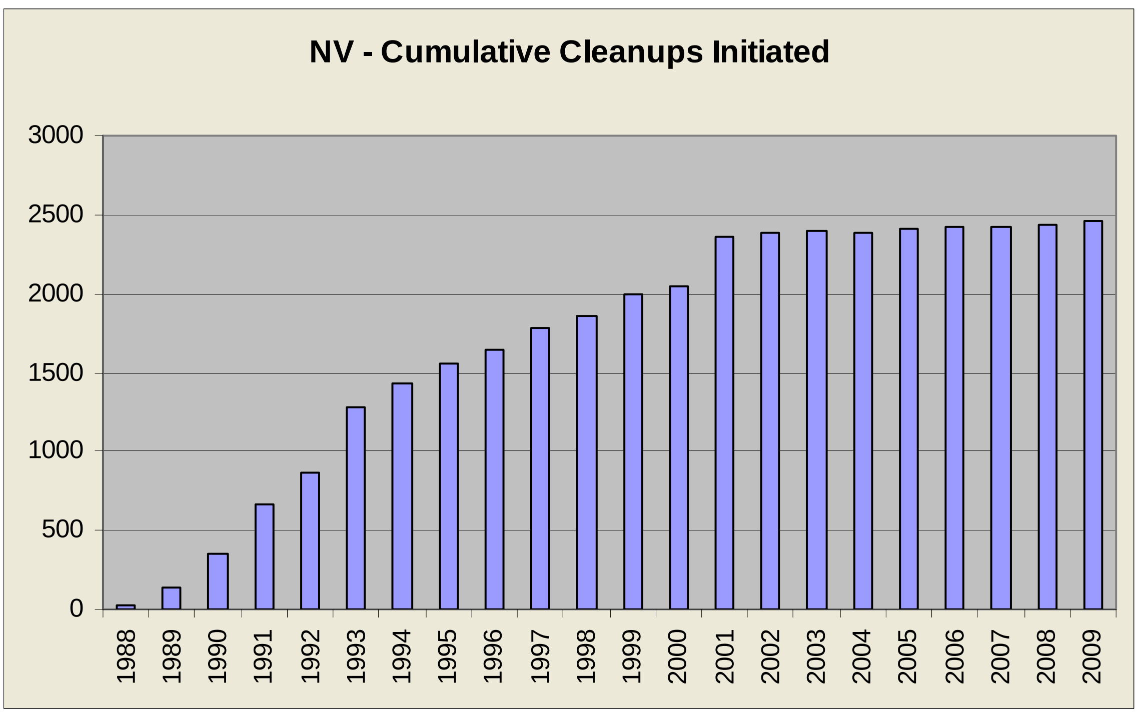

AZ - Cumulative Cleanups Initiated
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

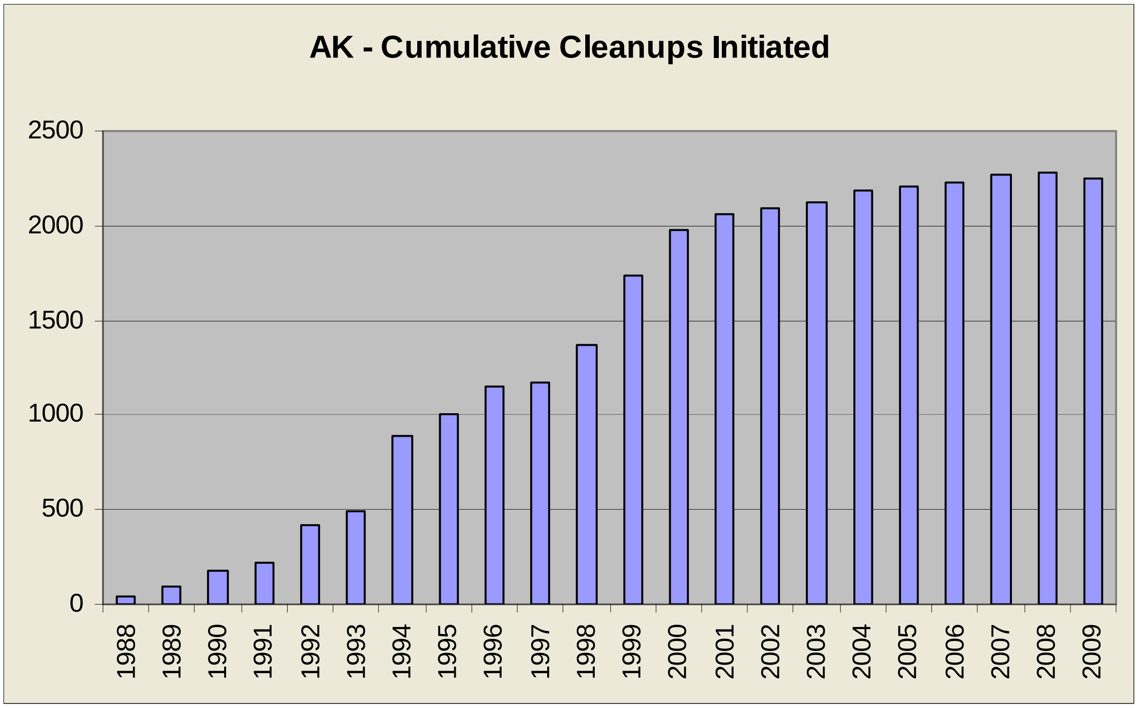

CA - Cumulative Cleanups Initiated
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

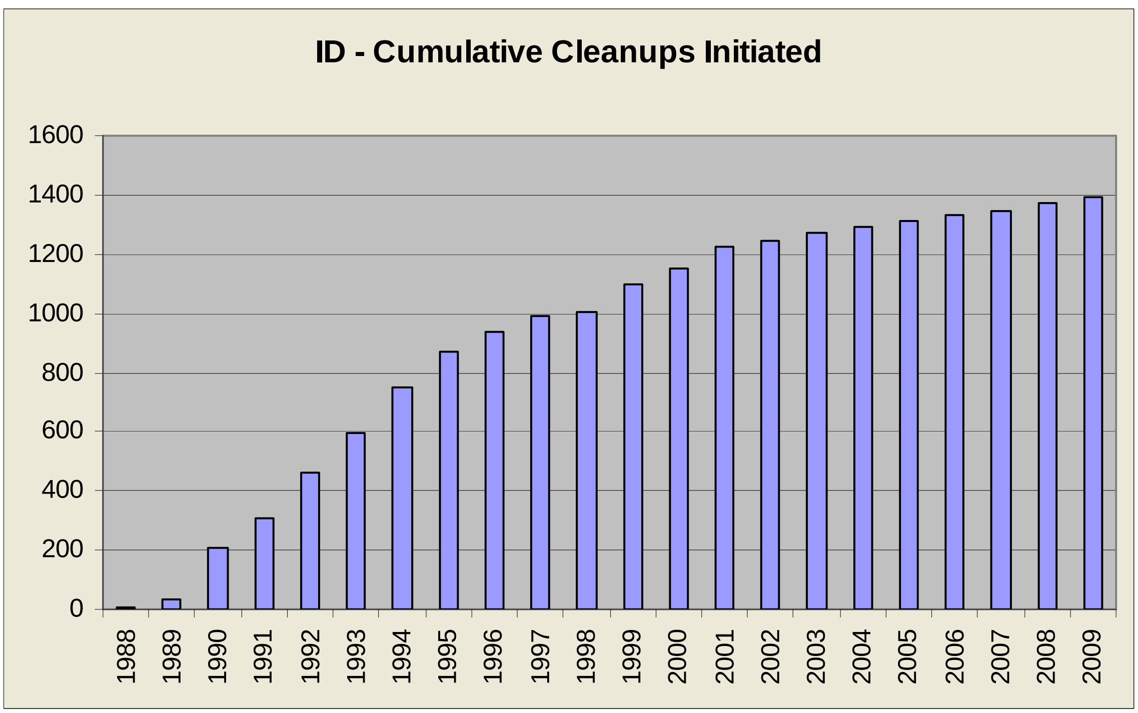

CQ - Cumulative Cleanups Initiated
12
10
8
6
4
2
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

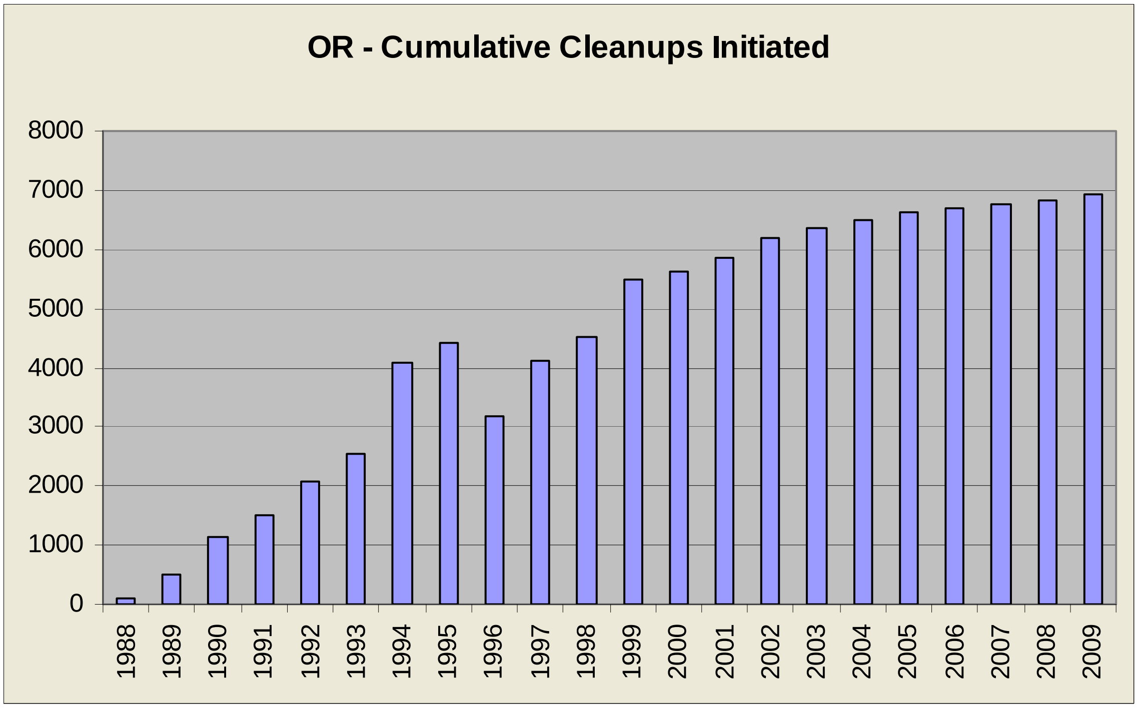

GU - Cumulative Cleanups Initiated
160
140
120
100
80
60
40
20
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

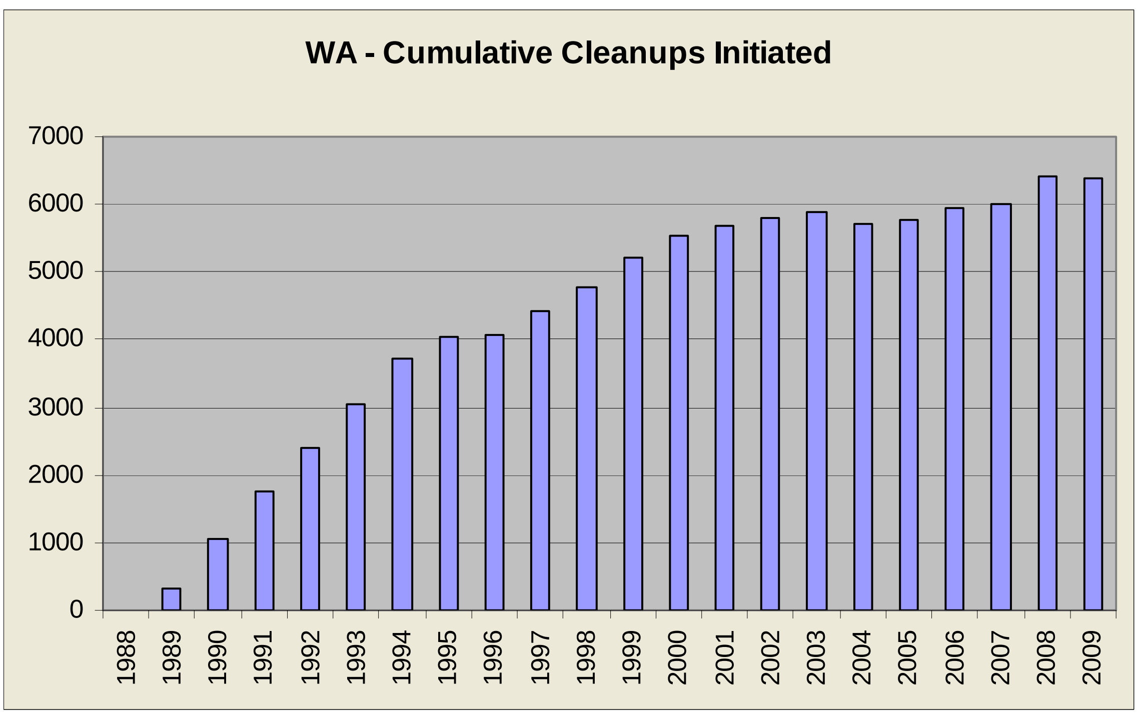

HI - Cumulative Cleanups Initiated
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

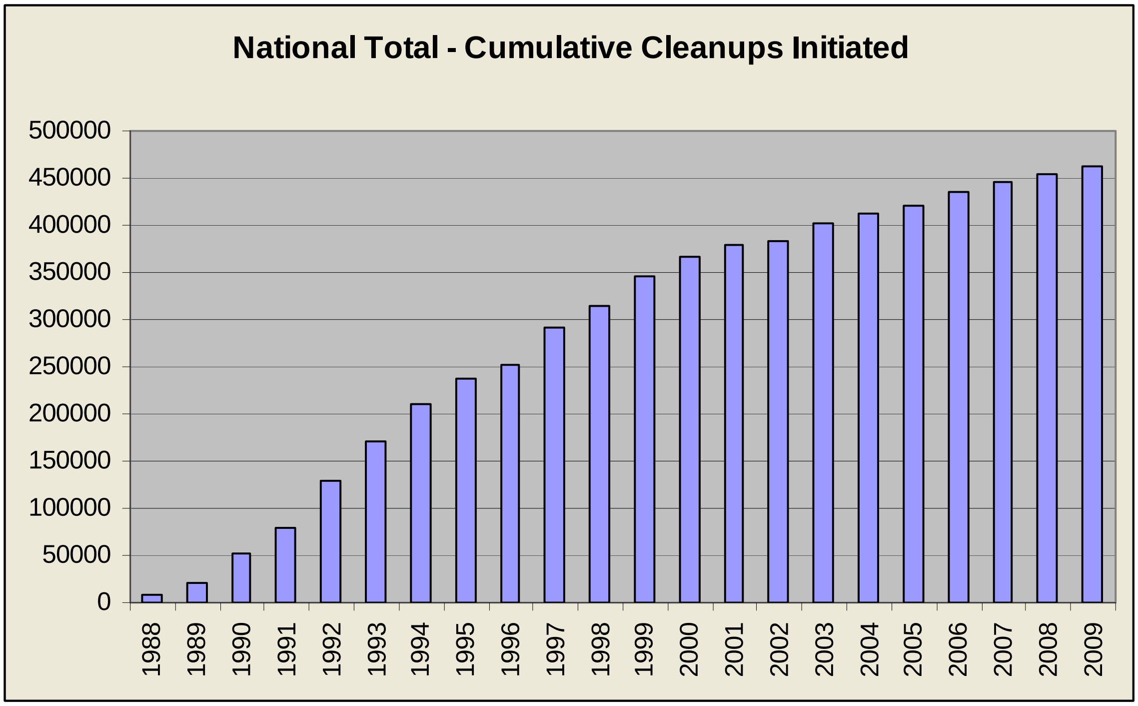

NV - Cumulative Cleanups Initiated
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


AK - Cumulative Cleanups Initiated
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


ID - Cumulative Cleanups Initiated
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

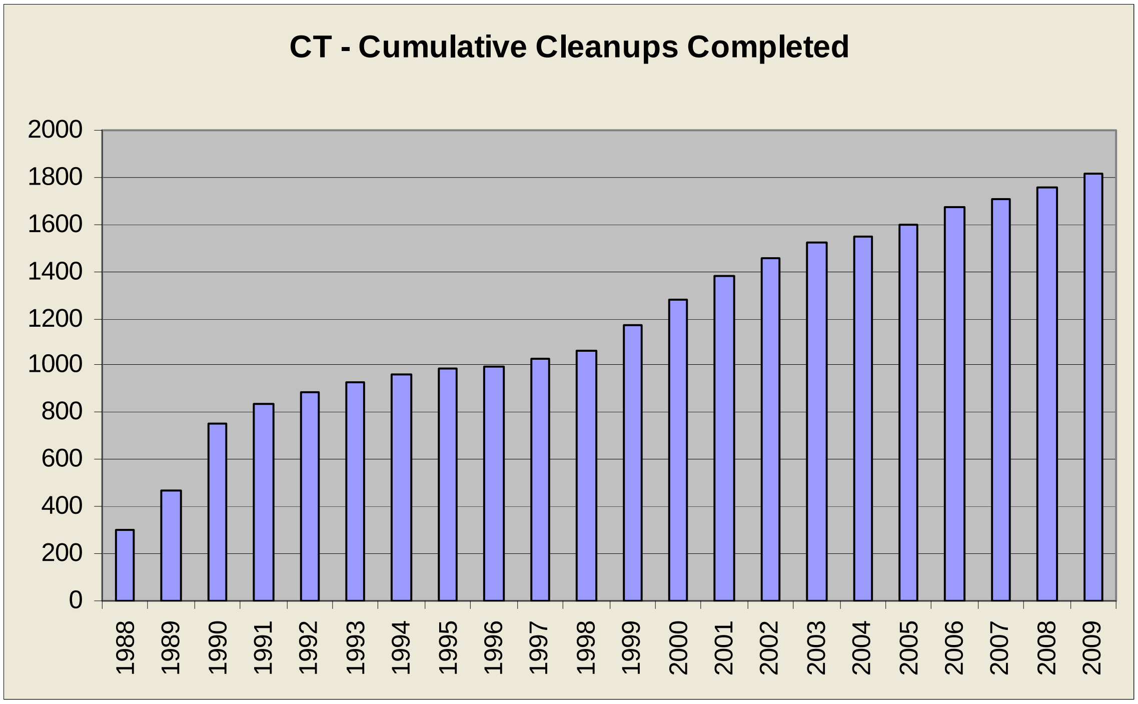

OR - Cumulative Cleanups Initiated
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

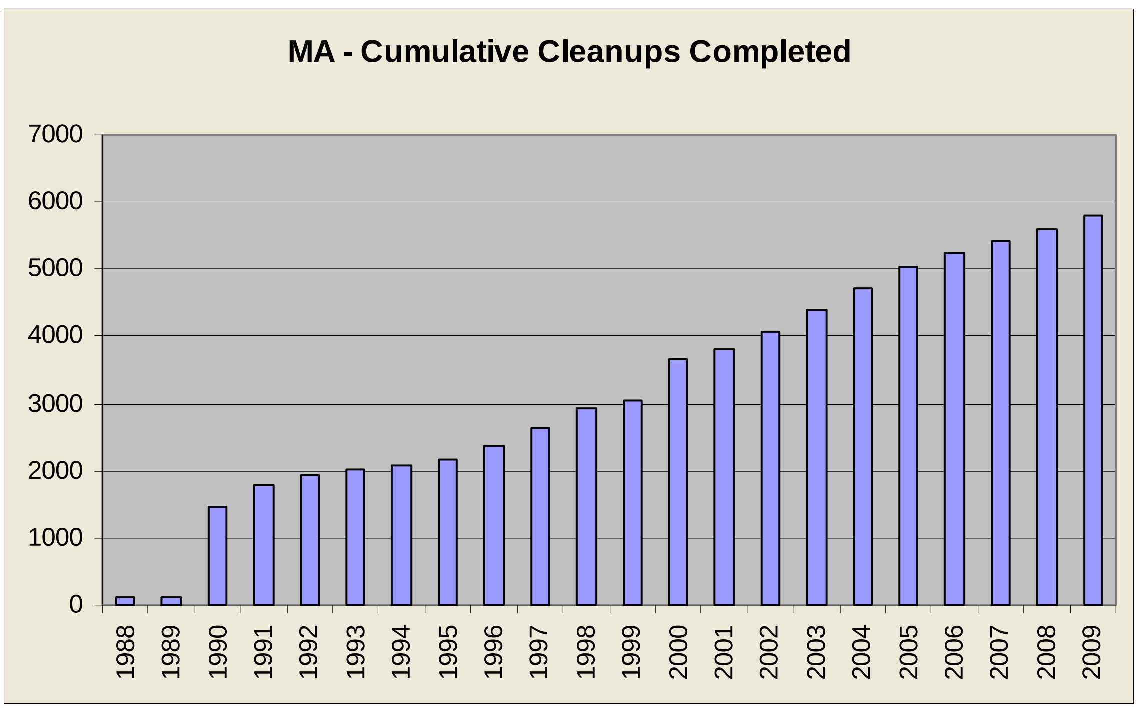

WA - Cumulative Cleanups Initiated
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

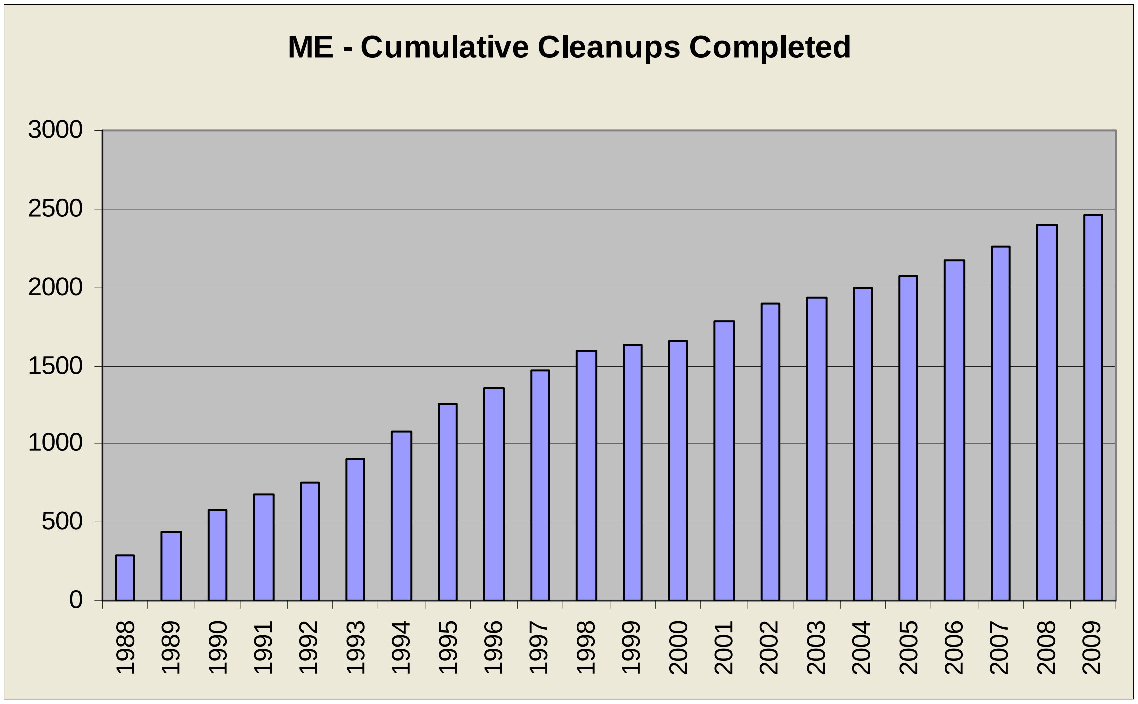

National Total - Cumulative Cleanups Initiated
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

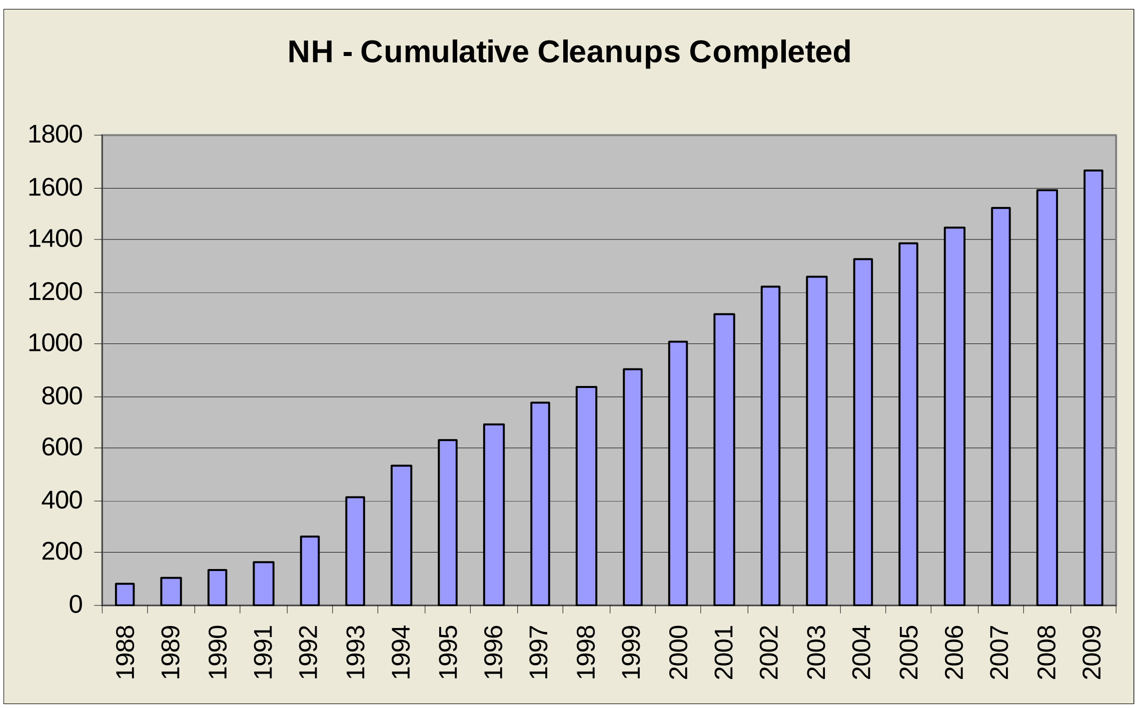
APPENDIX F

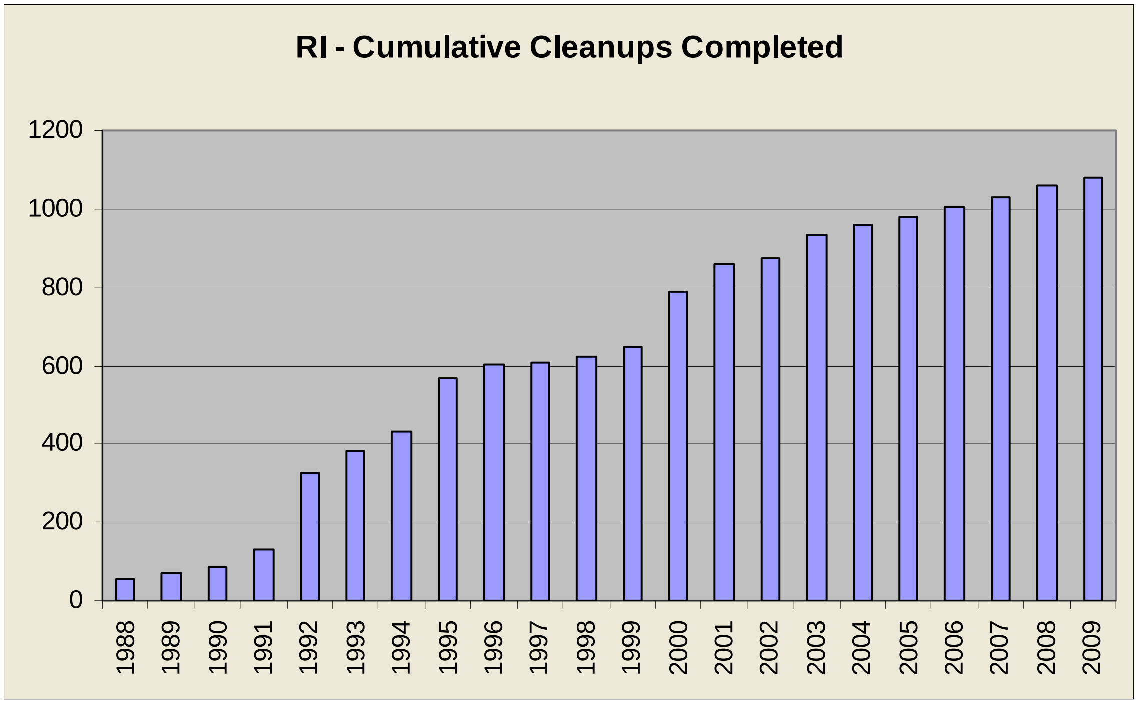
Graphs of Cumulative Cleanups Completed for all 56 States for the Period 1988 through 2009

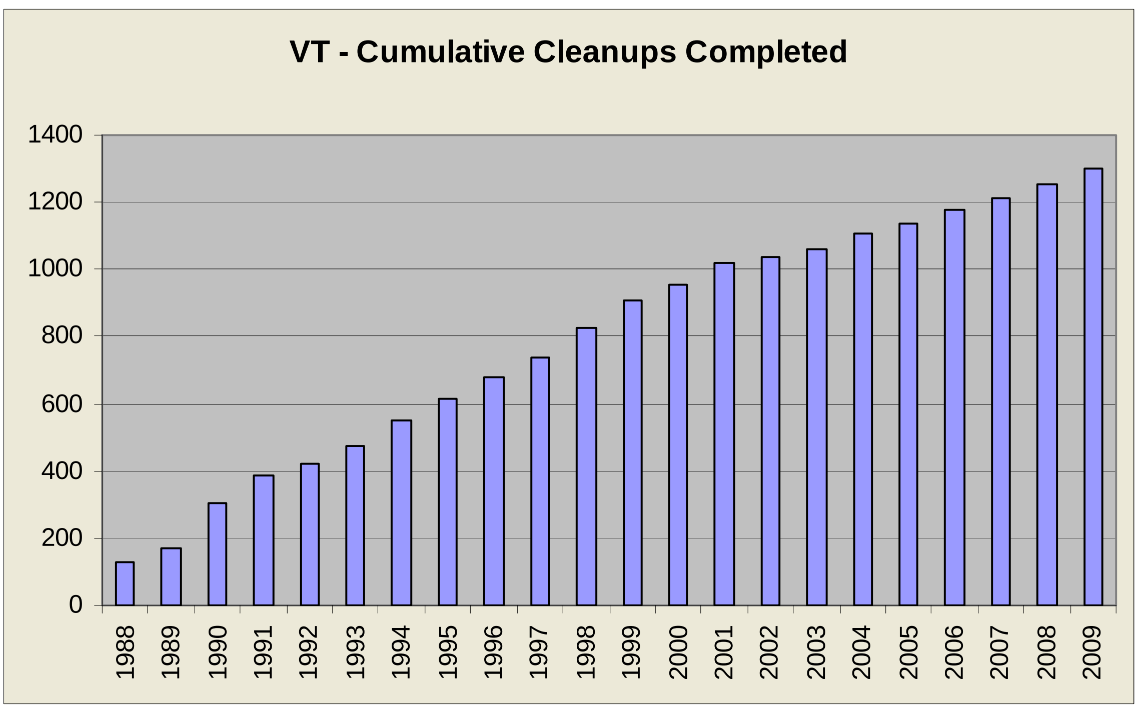

CT - Cumulative Cleanups Completed
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

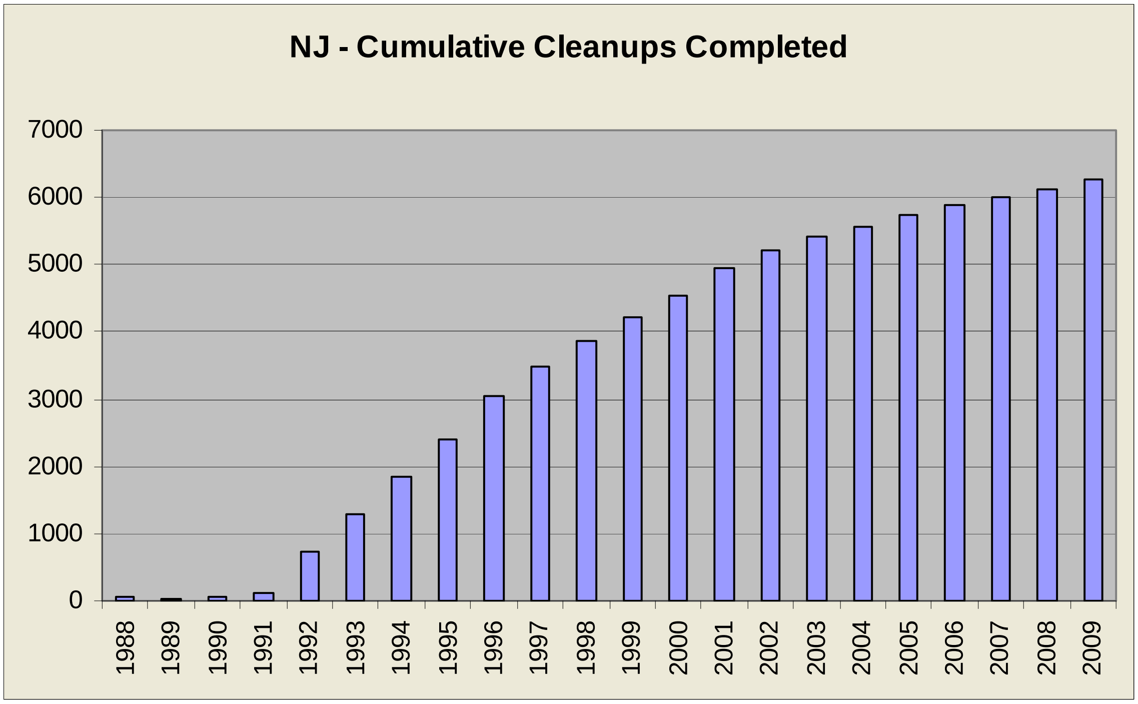

MA - Cumulative Cleanups Completed
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

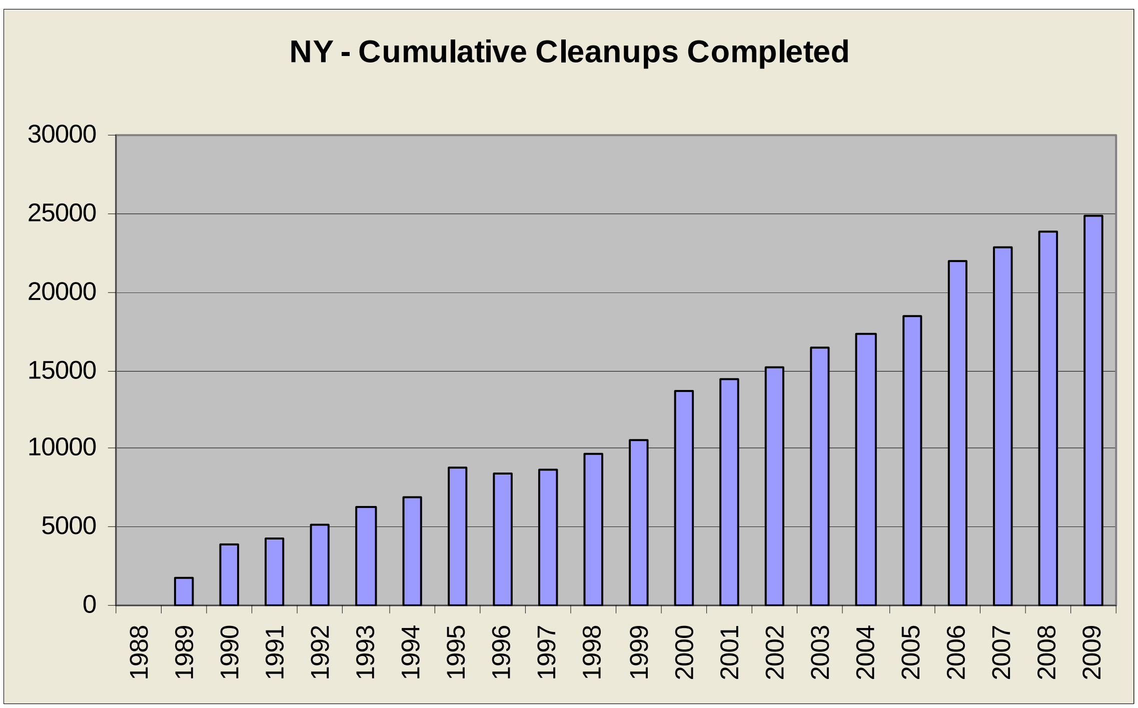

ME - Cumulative Cleanups Completed
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

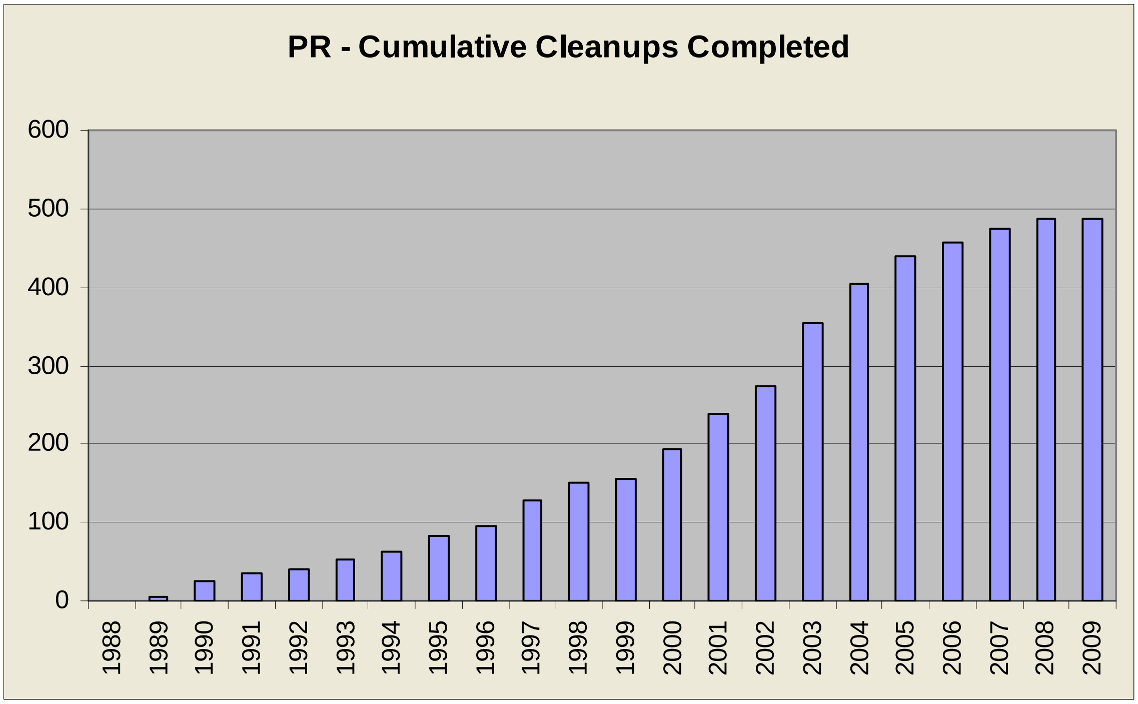

NH - Cumulative Cleanups Completed
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

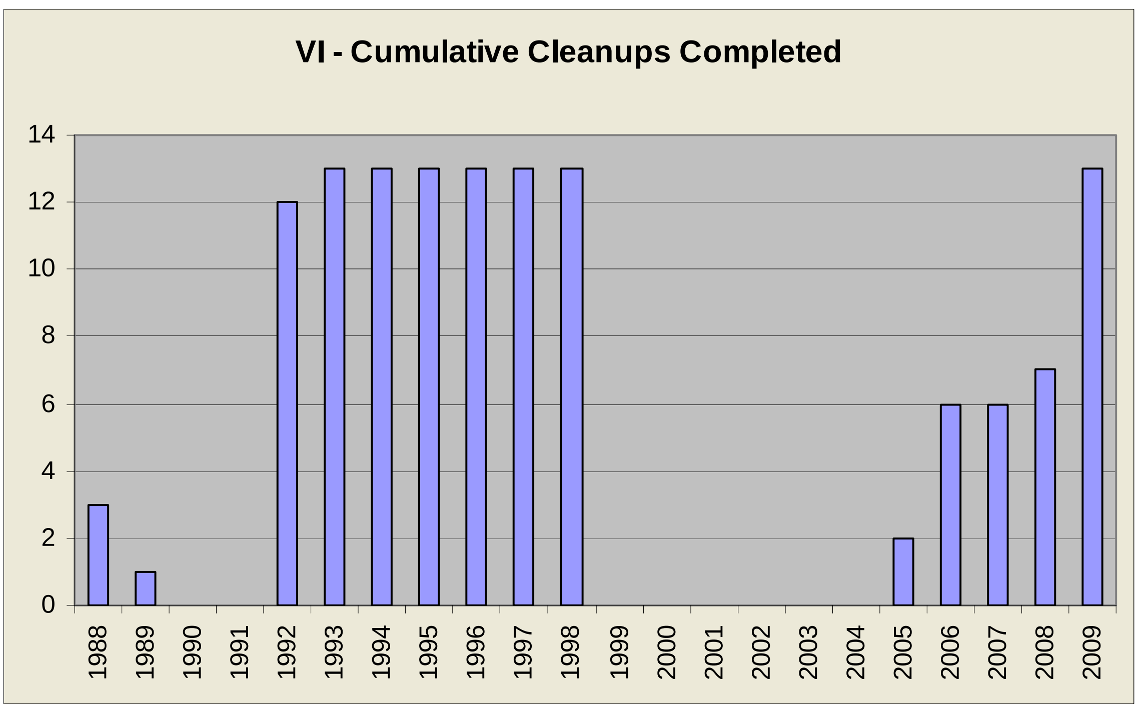

RI - Cumulative Cleanups Completed
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

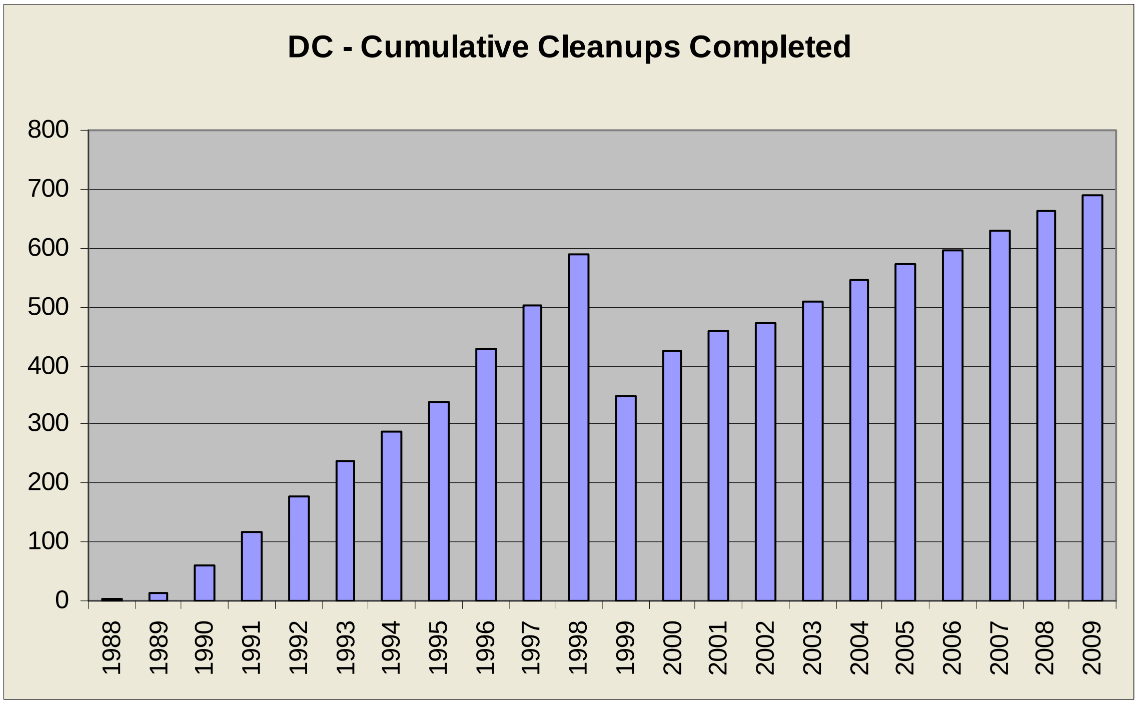

VT - Cumulative Cleanups Completed
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

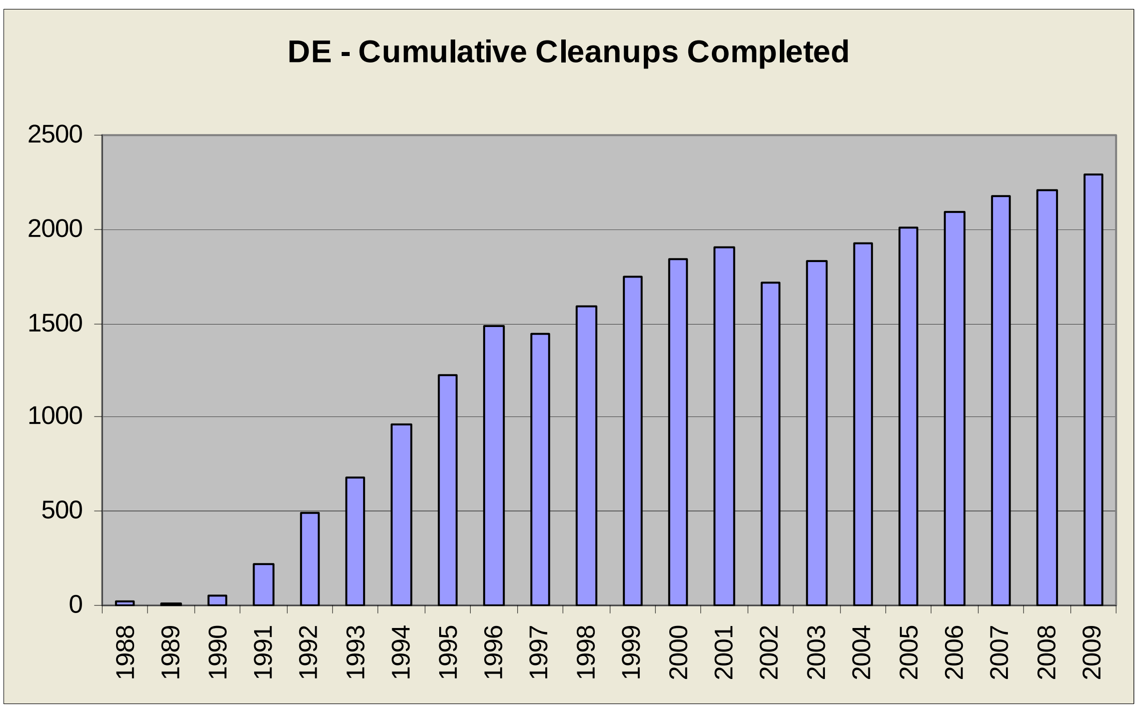

NJ - Cumulative Cleanups Completed
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

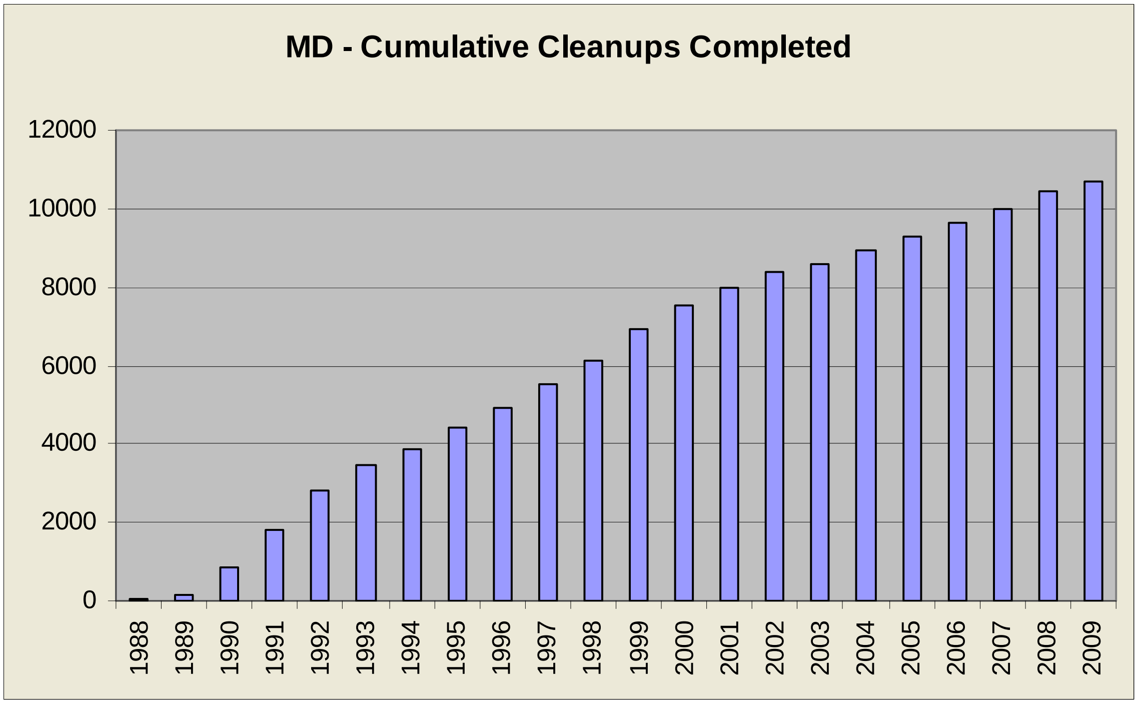

NY - Cumulative Cleanups Completed
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

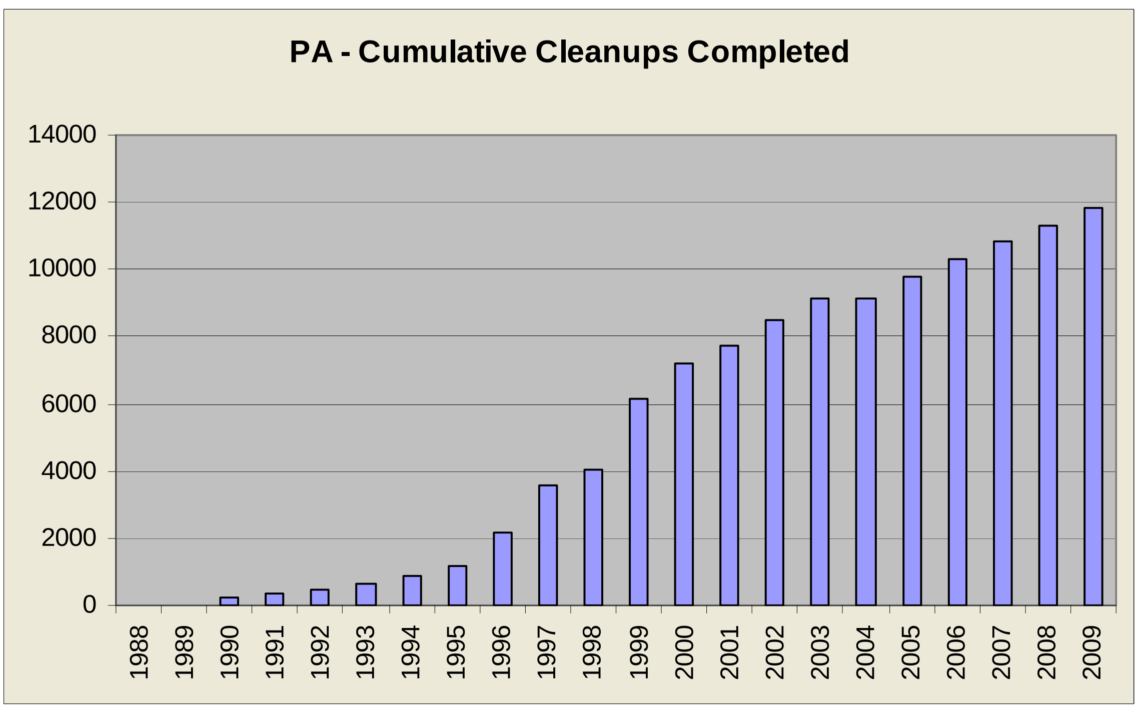

PR - Cumulative Cleanups Completed
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

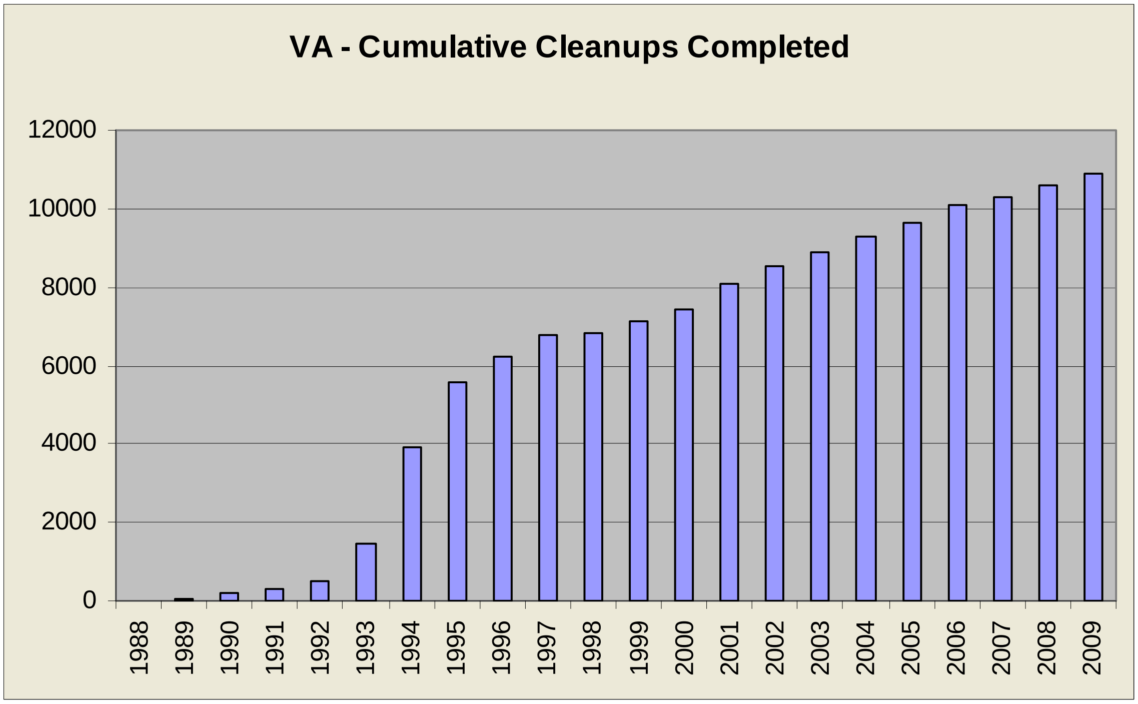

VI - Cumulative Cleanups Completed
14
12
10
8
6
4
2
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


DC - Cumulative Cleanups Completed
800
700
600
500
400
300
200
100
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


DE - Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


MD - Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


PA - Cumulative Cleanups Completed
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


VA - Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1988
1989
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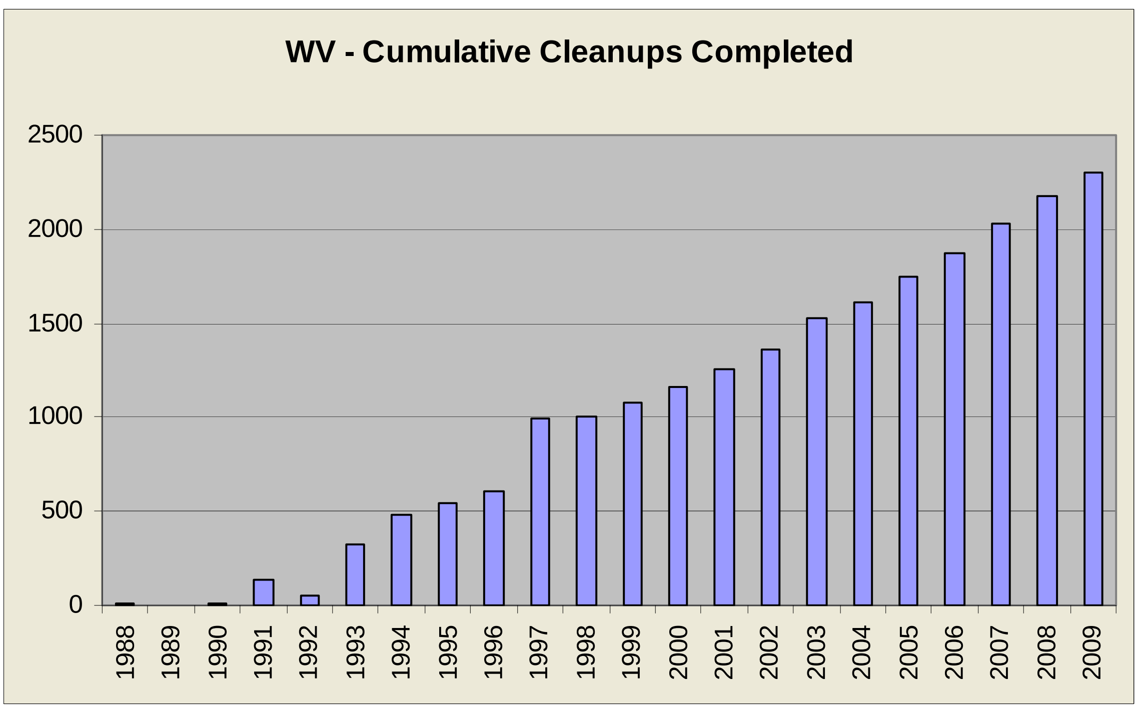
WV - Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1988
1989
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1999
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2001
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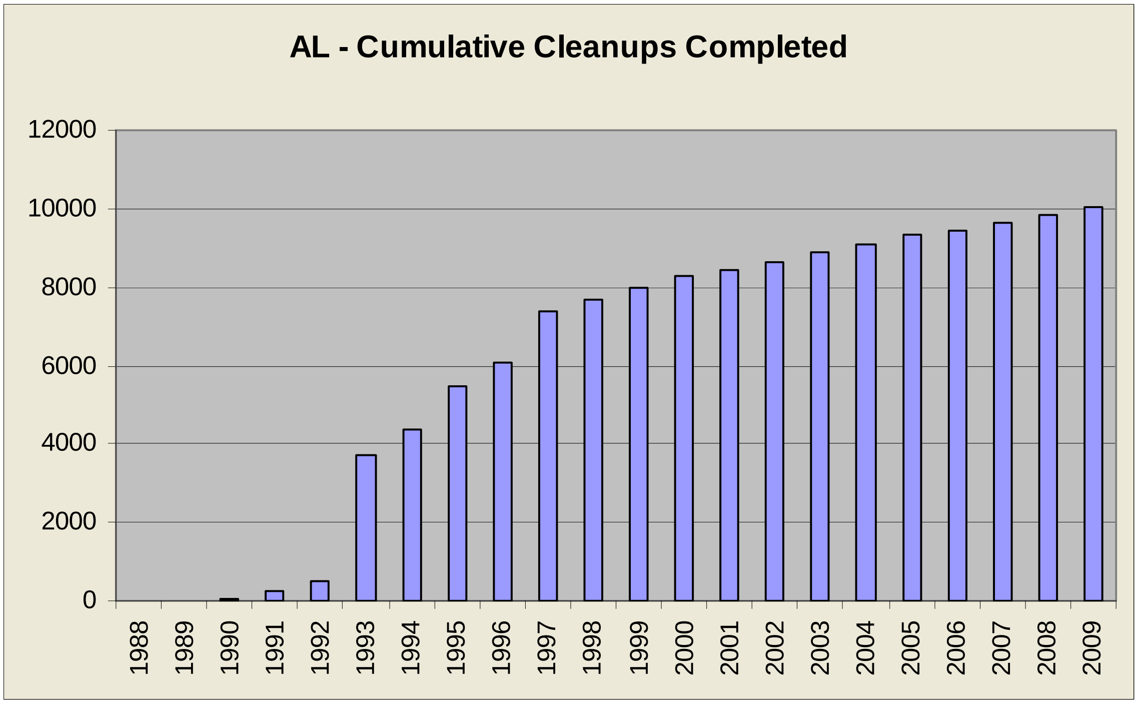
AL - Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
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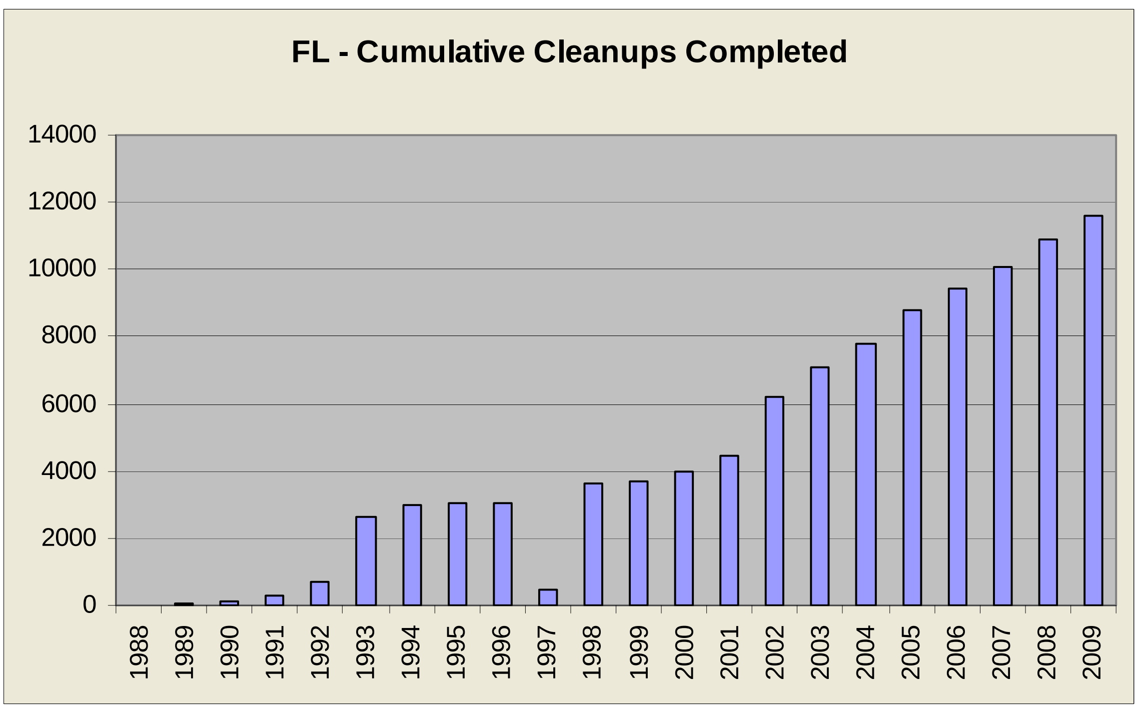
FL - Cumulative Cleanups Completed
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
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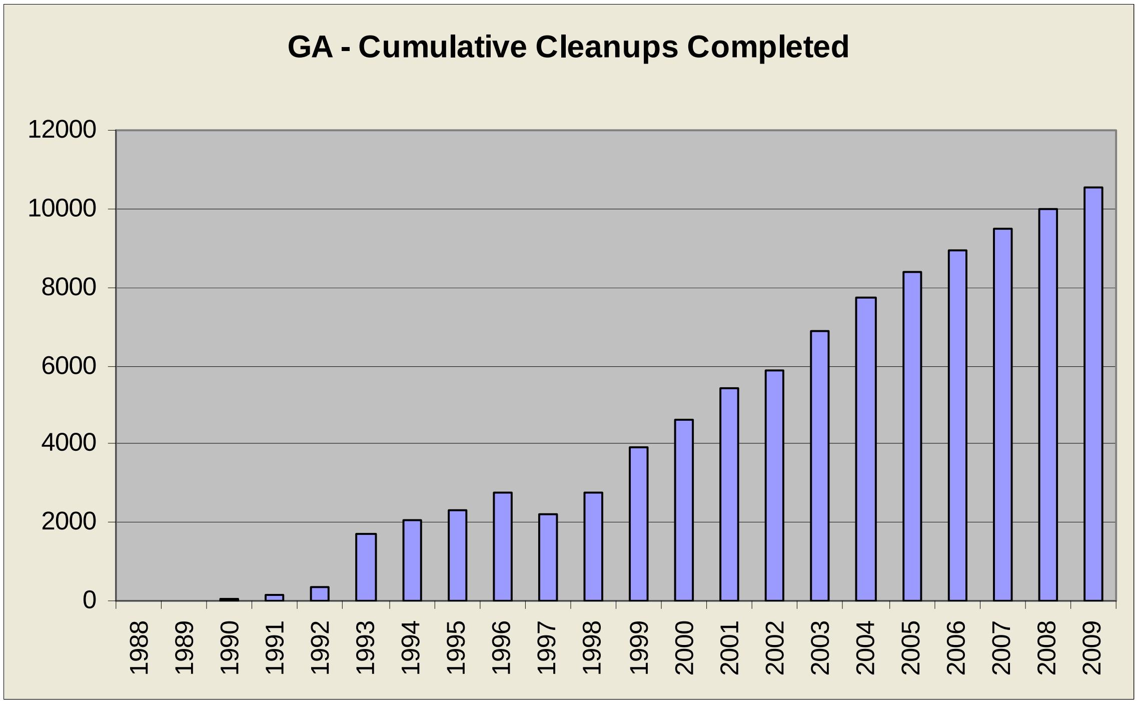
GA - Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
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1992
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1998
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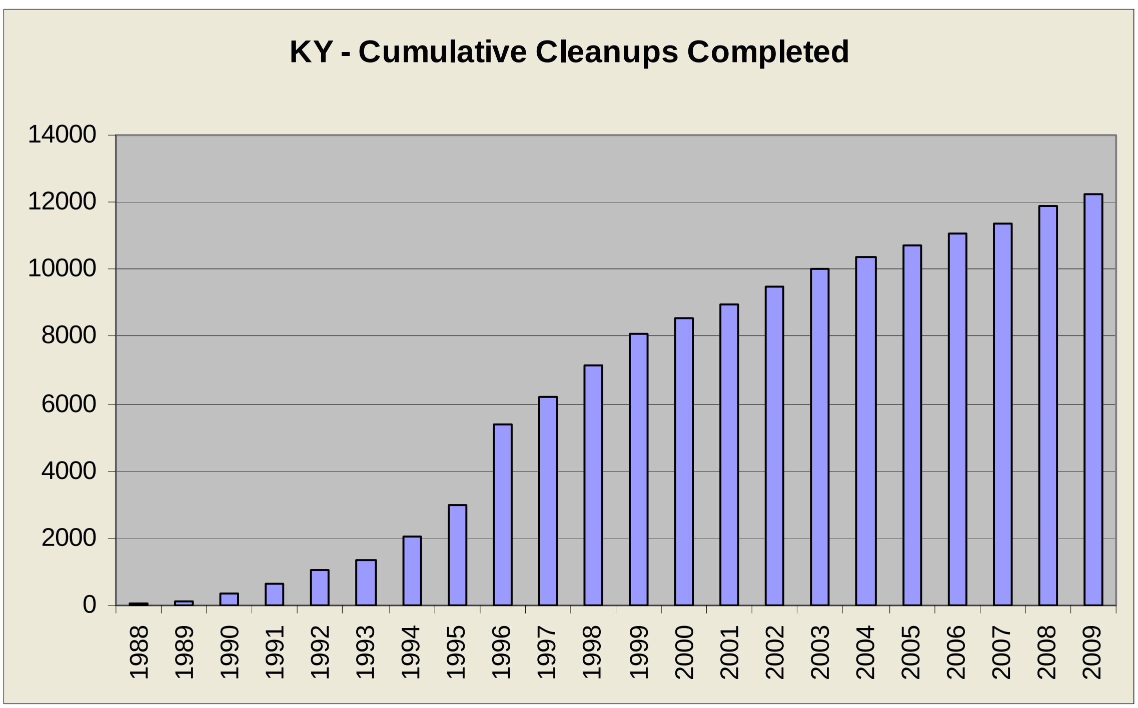
KY - Cumulative Cleanups Completed
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
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1992
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1995
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2002
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2004
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2006
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2008
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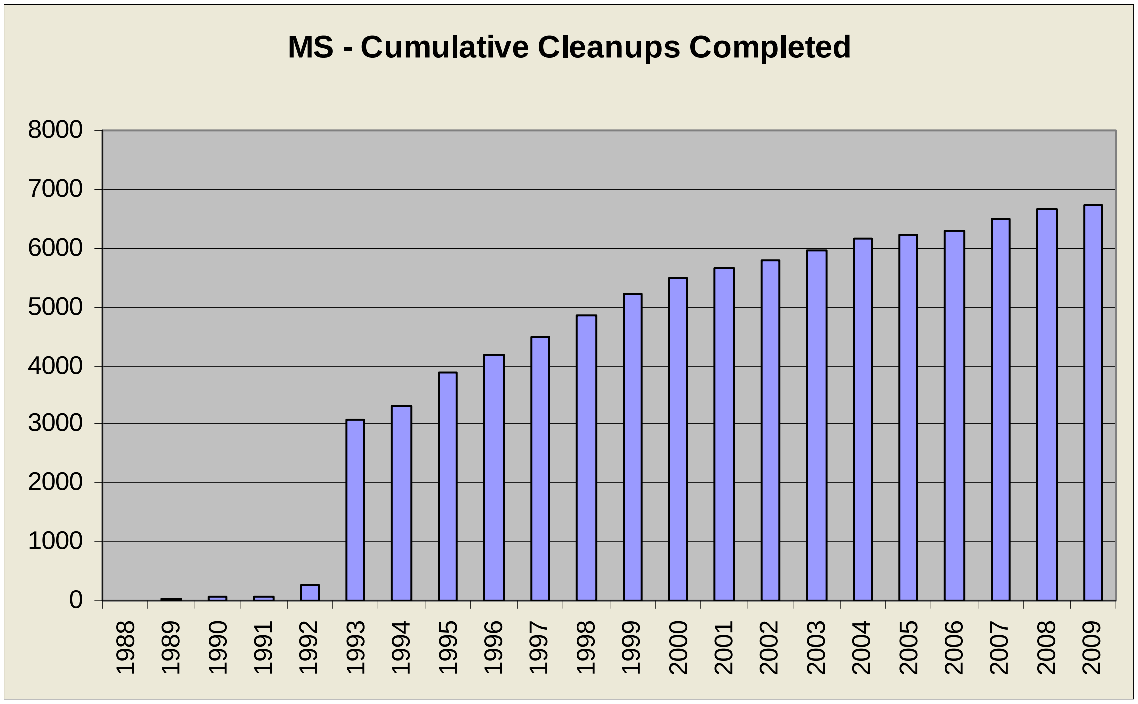
MS - Cumulative Cleanups Completed
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
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1999
2000
2001
2002
2003
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2005
2006
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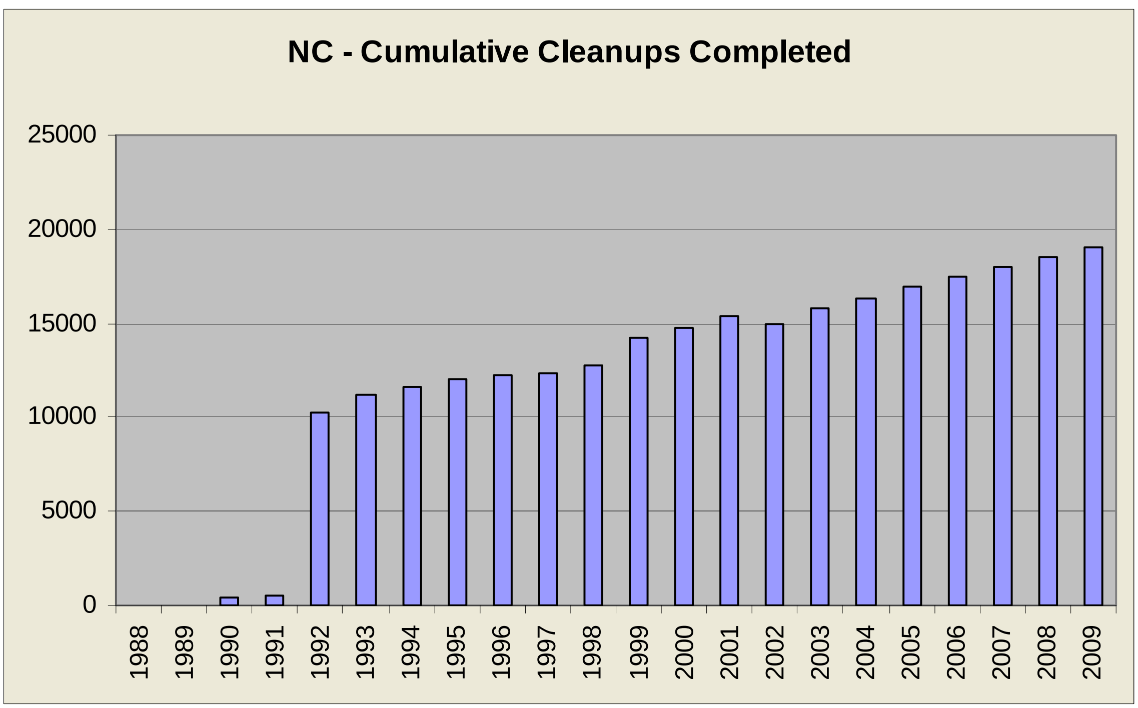
NC - Cumulative Cleanups Completed
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
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1997
1998
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2001
2002
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2006
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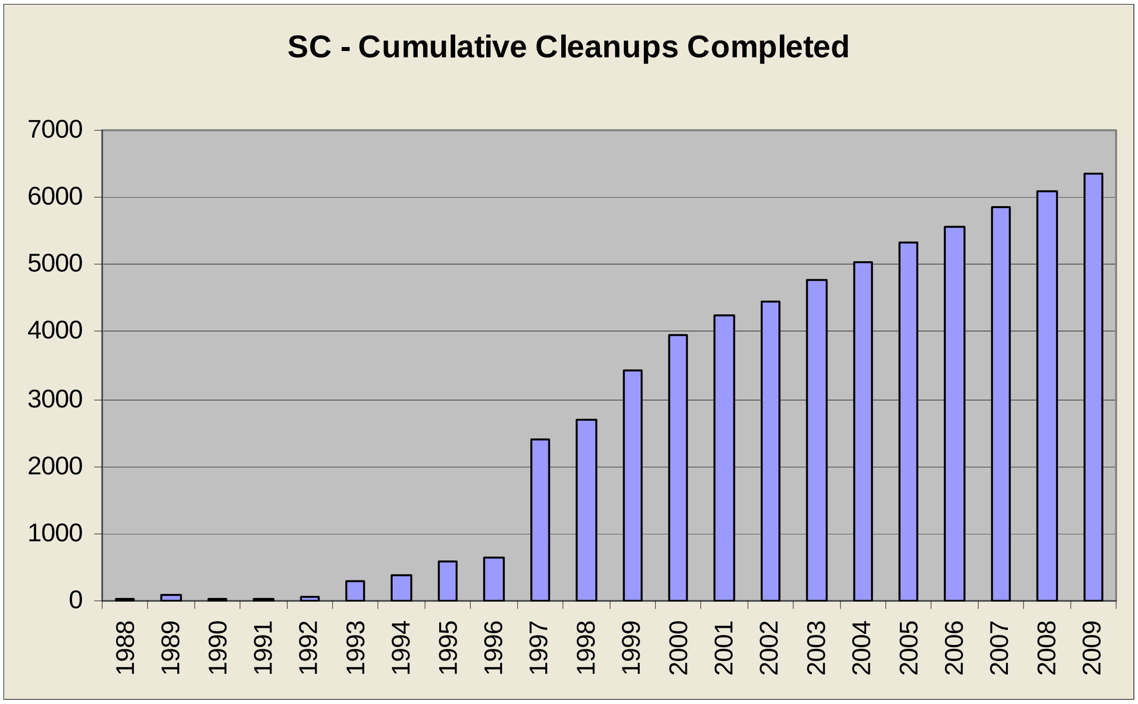

SC - Cumulative Cleanups Completed
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
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2005
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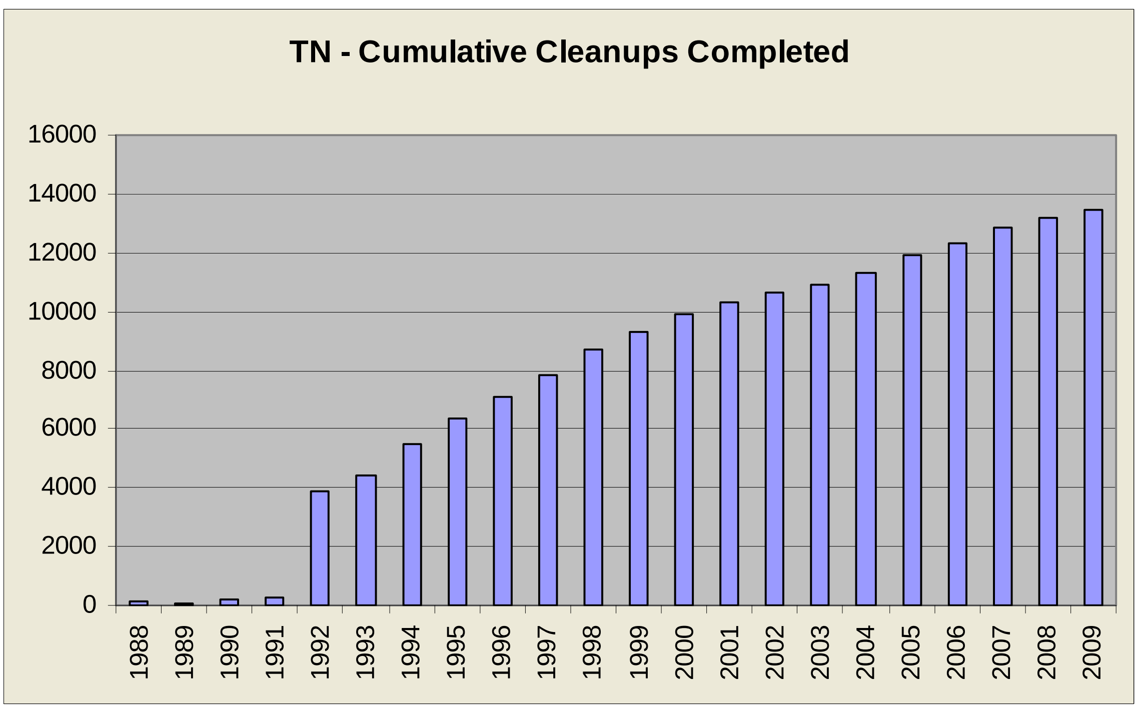

TN - Cumulative Cleanups Completed
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
1990
1991
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1994
1995
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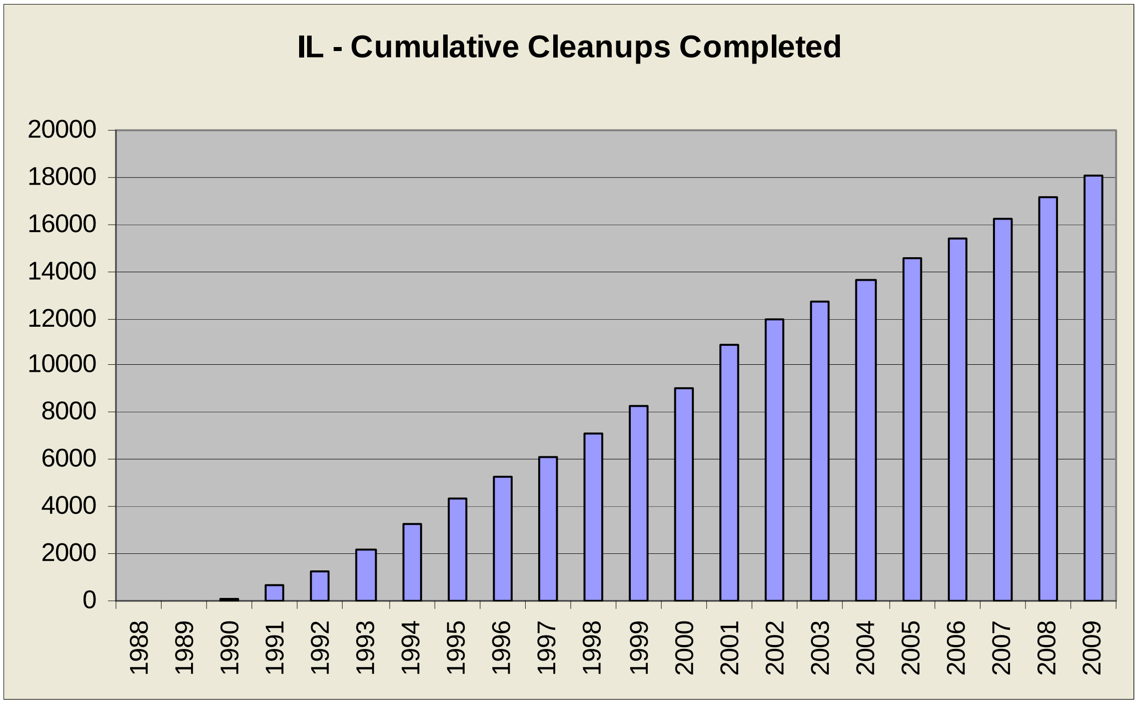
IL - Cumulative Cleanups Completed
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
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1991
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1995
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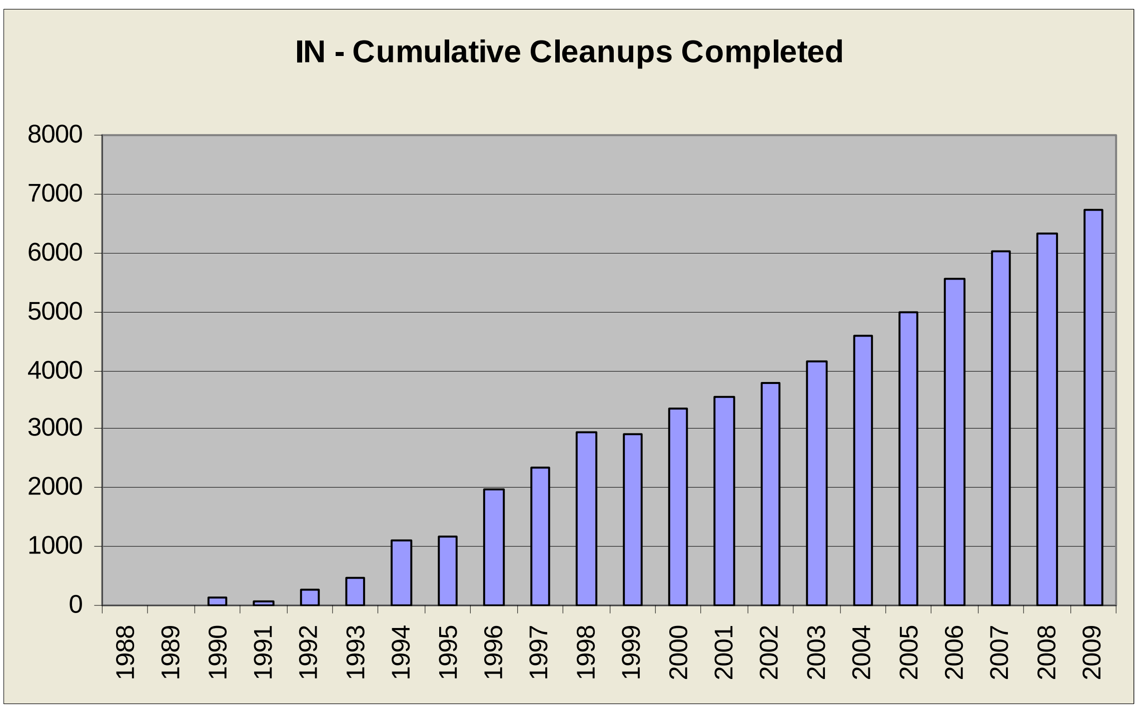
IN - Cumulative Cleanups Completed
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
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1994
1995
1996
1997
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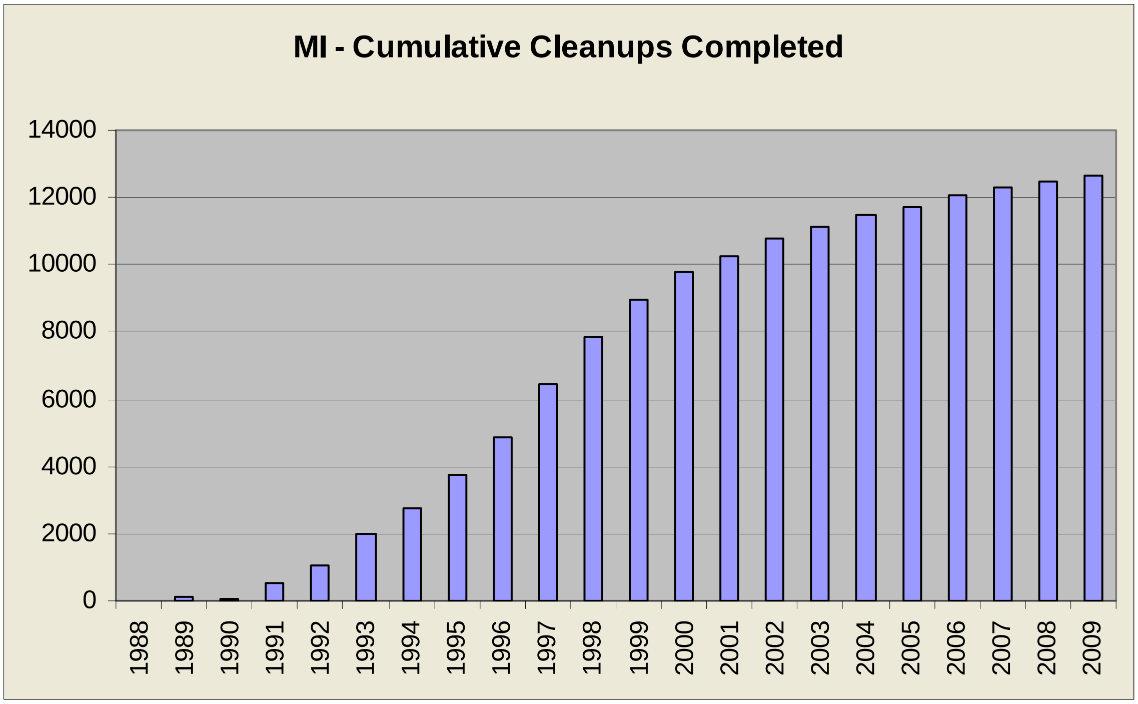
2006
2007
2008
2009


MI - Cumulative Cleanups Completed
14000
12000
10000
8000
6000
4000
2000
0
1988
1989
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1997
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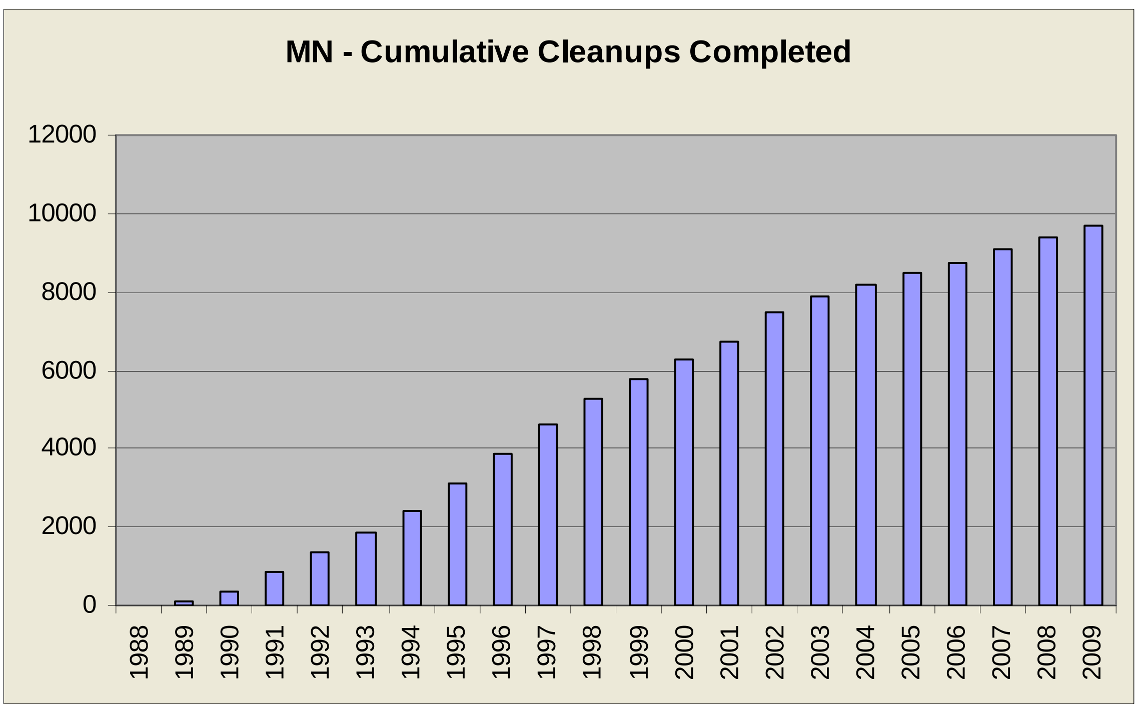
2009


MN - Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1988
1989
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1998
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2007
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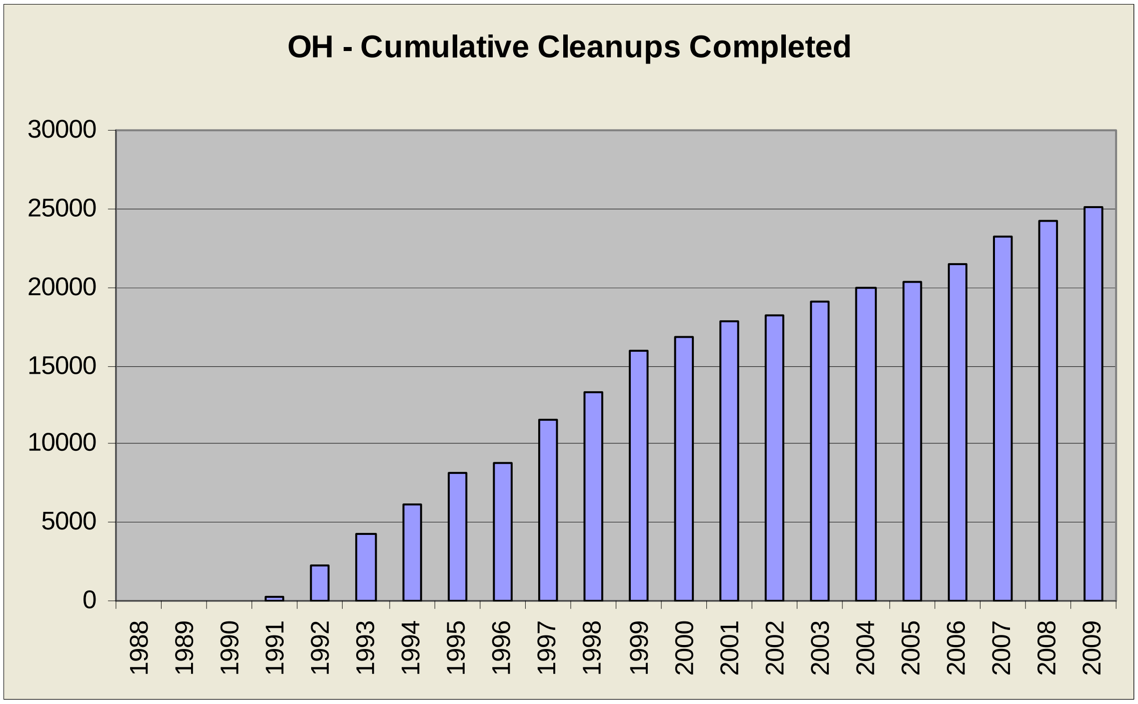
2009


OH - Cumulative Cleanups Completed
30000
25000
20000
15000
10000
5000
0
1988
1989
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1991
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1995
1996
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2008
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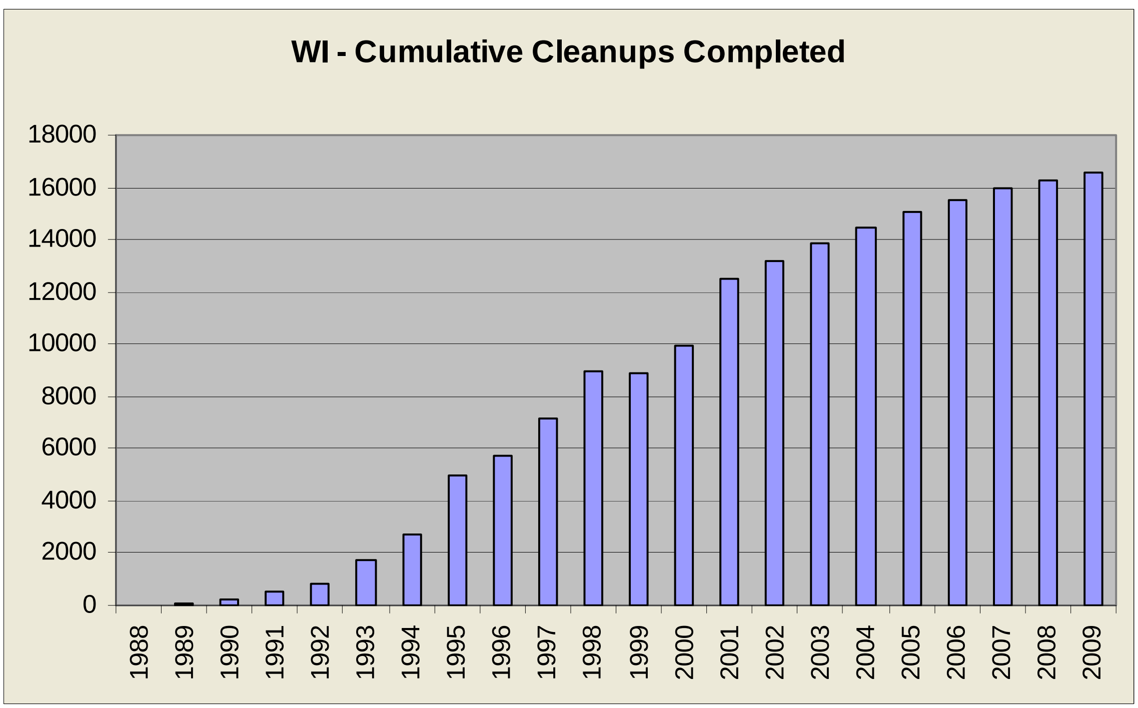
WI - Cumulative Cleanups Completed
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1988
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2008
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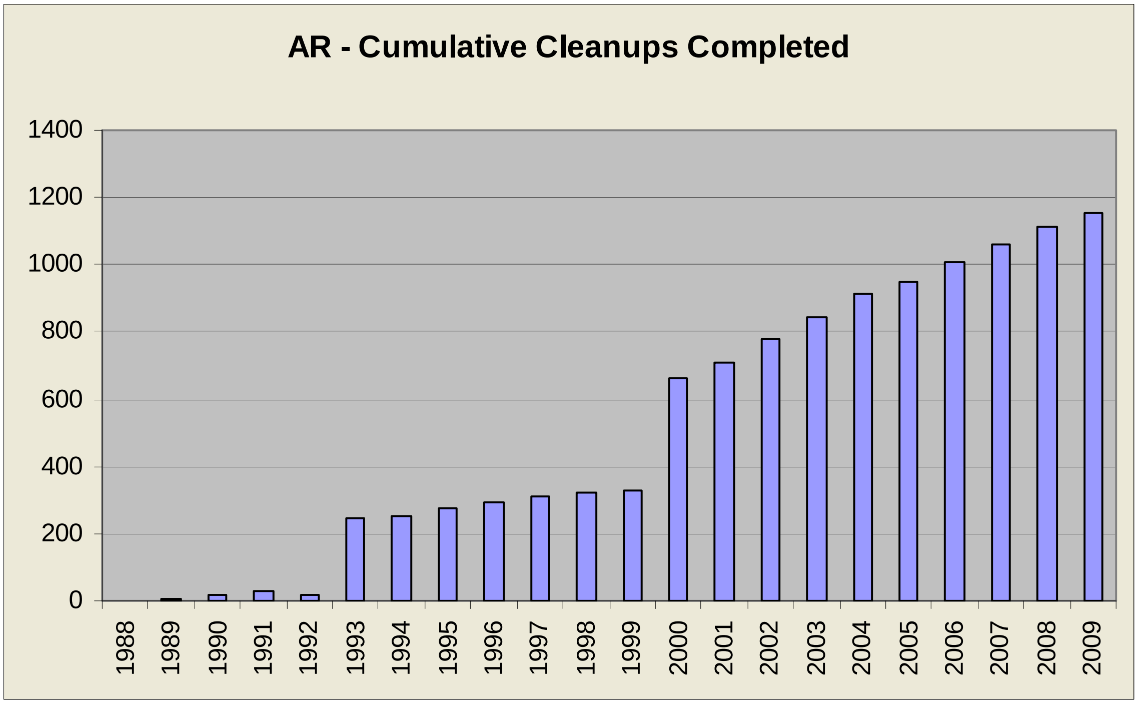
AR - Cumulative Cleanups Completed
1400
1200
1000
800
600
400
200
0
1988
1989
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1991
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2008
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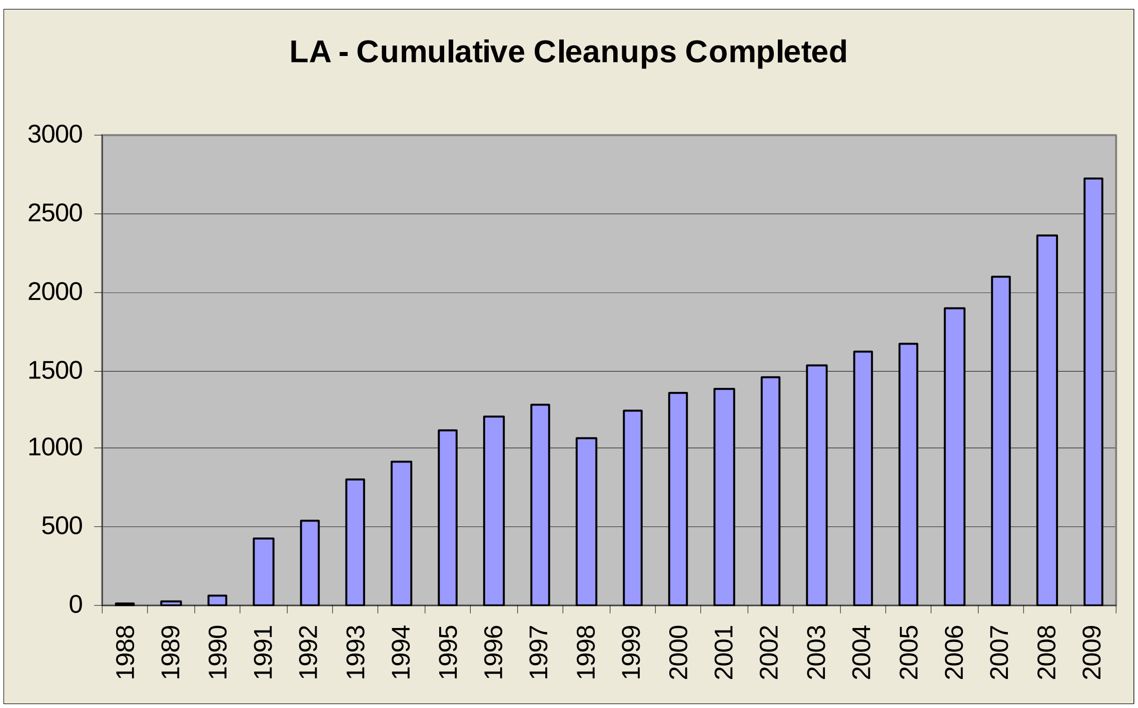
LA - Cumulative Cleanups Completed
3000
2500
2000
1500
1000
500
0
1988
1989
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1992
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2006
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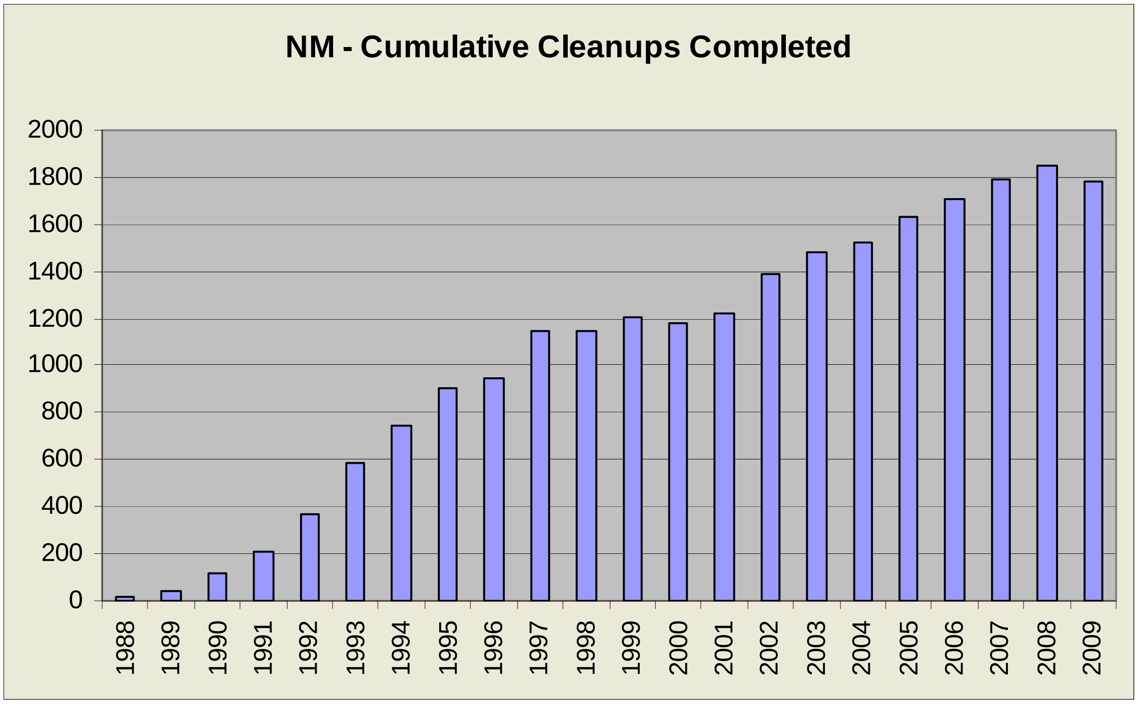
NM - Cumulative Cleanups Completed
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
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2008
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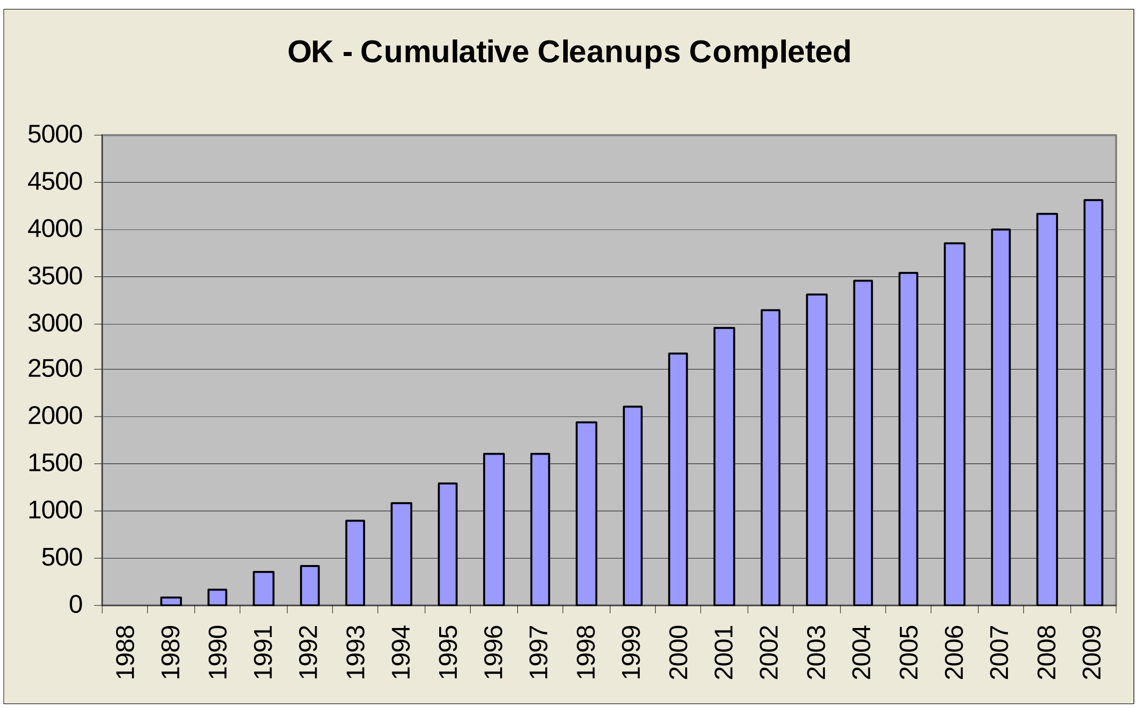
OK - Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
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1993
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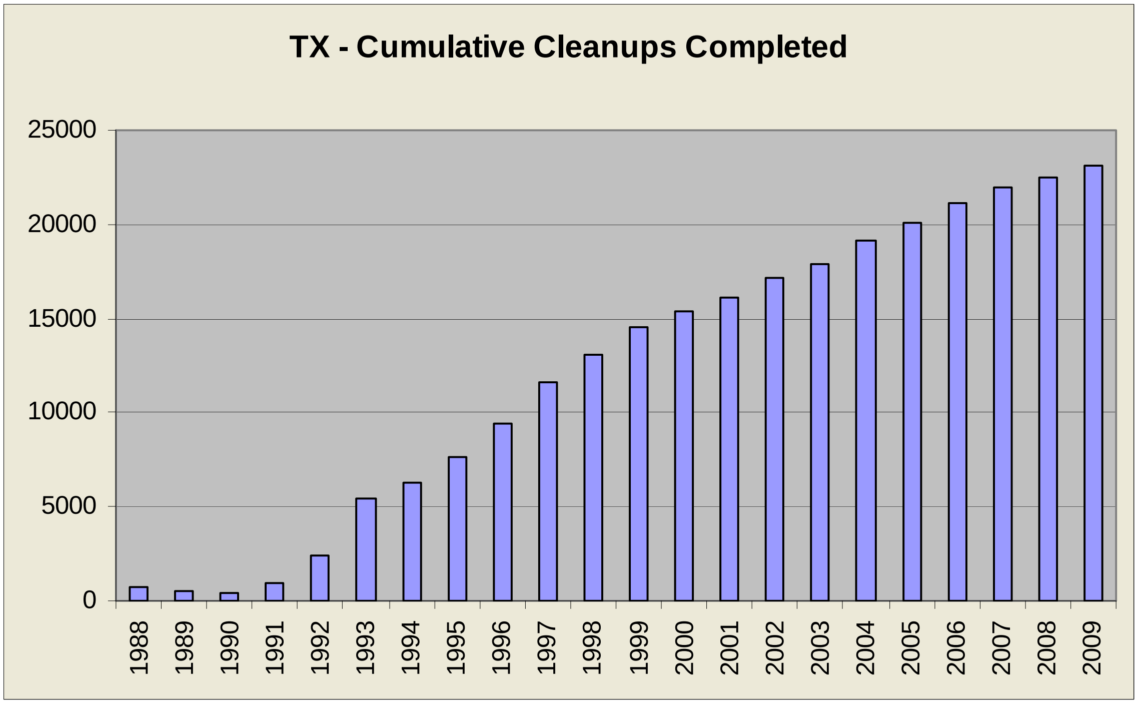
TX - Cumulative Cleanups Completed
25000
20000
15000
10000
5000
0
1988
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2006
2007
2008
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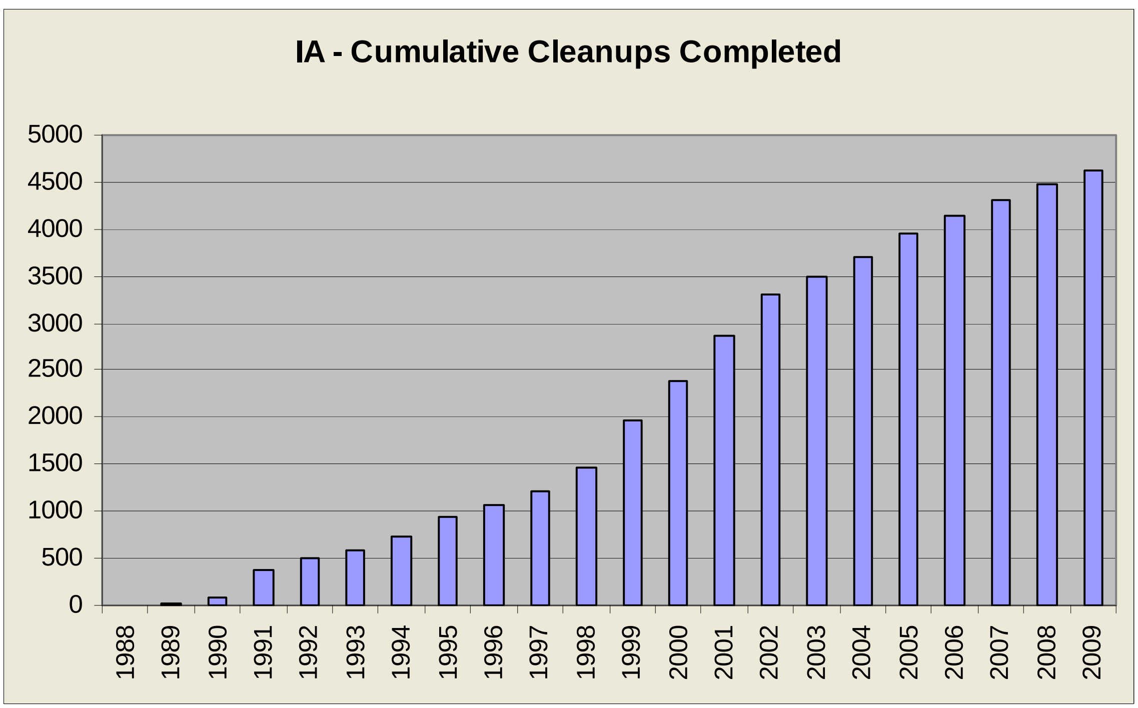
IA - Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
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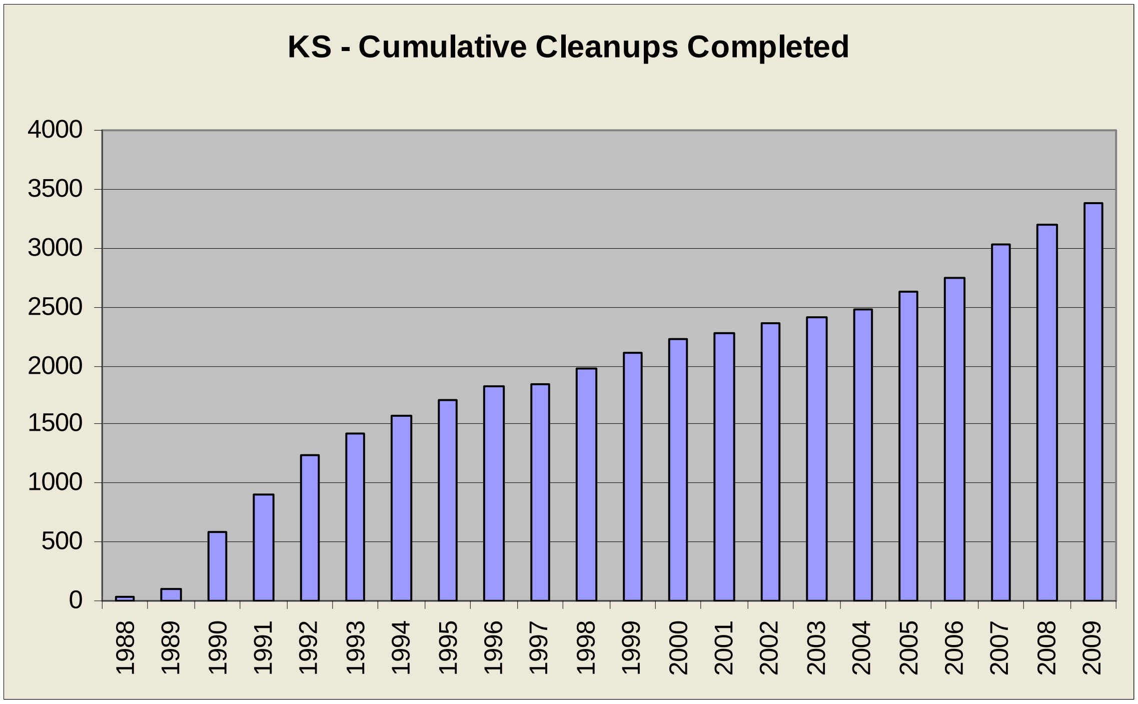
KS - Cumulative Cleanups Completed
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
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1995
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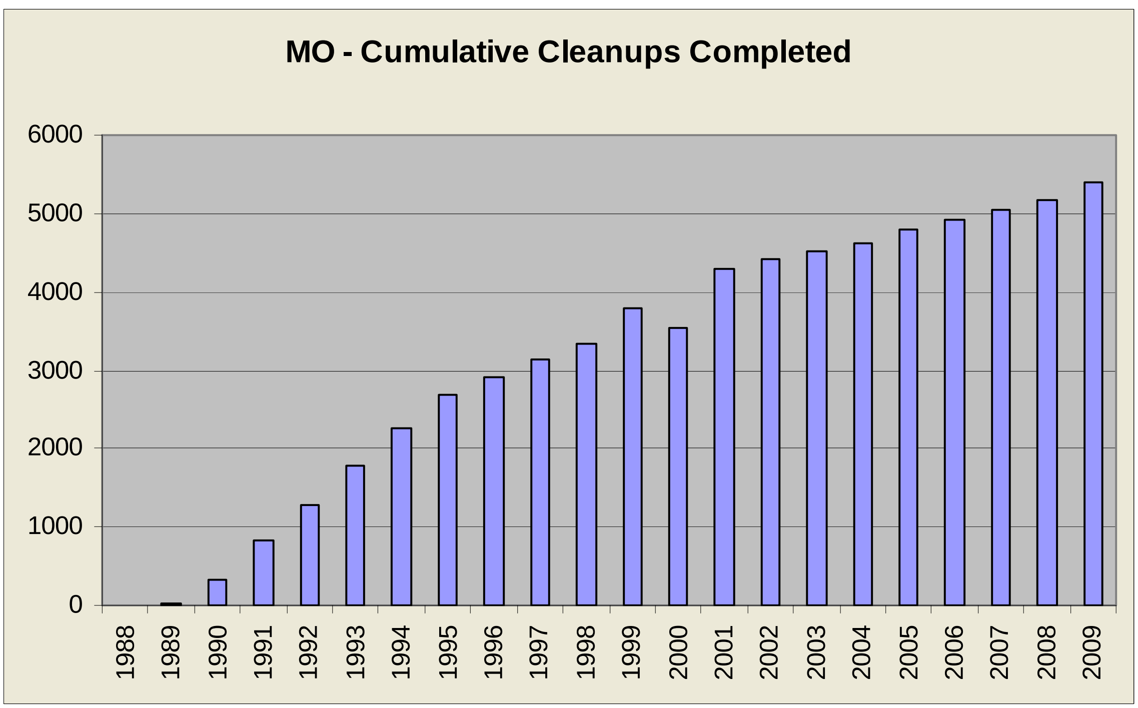
MO - Cumulative Cleanups Completed
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
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1994
1995
1996
1997
1998
1999
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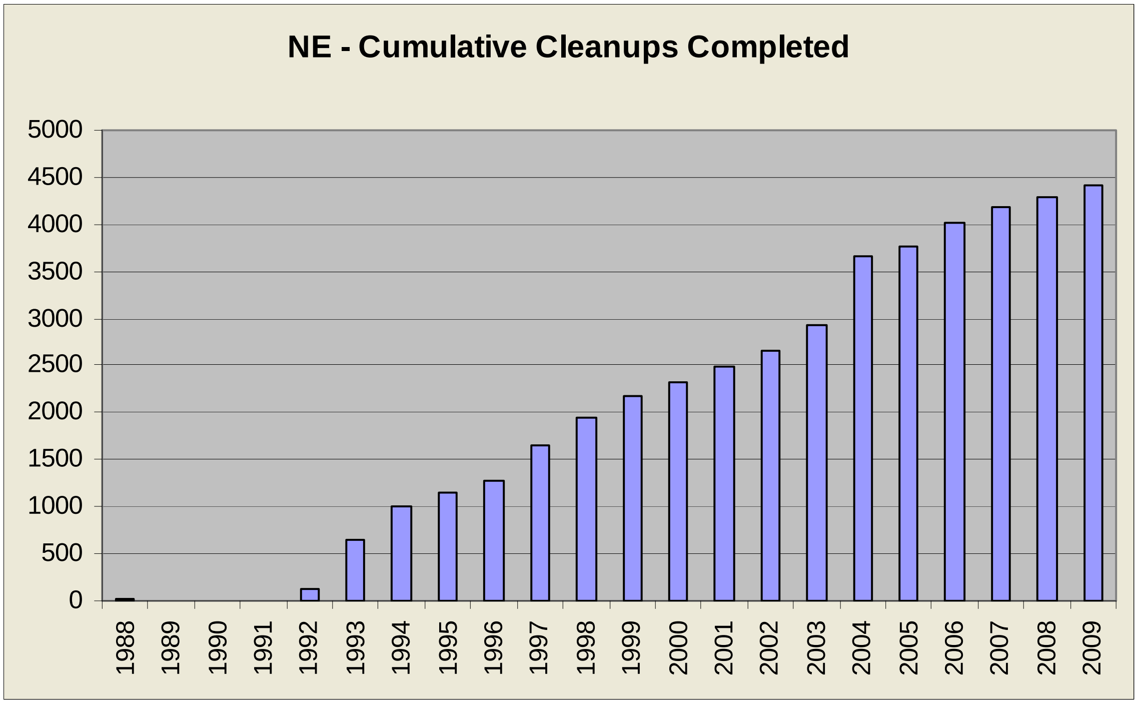
NE - Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
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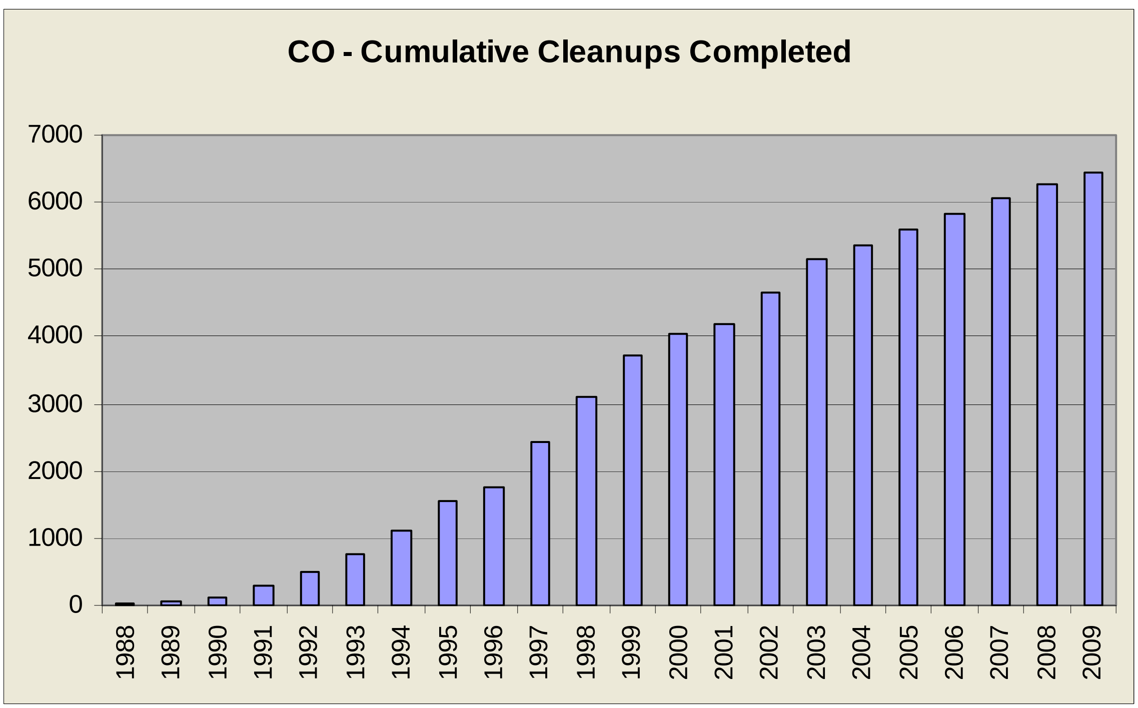
CO - Cumulative Cleanups Completed
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
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1991
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1997
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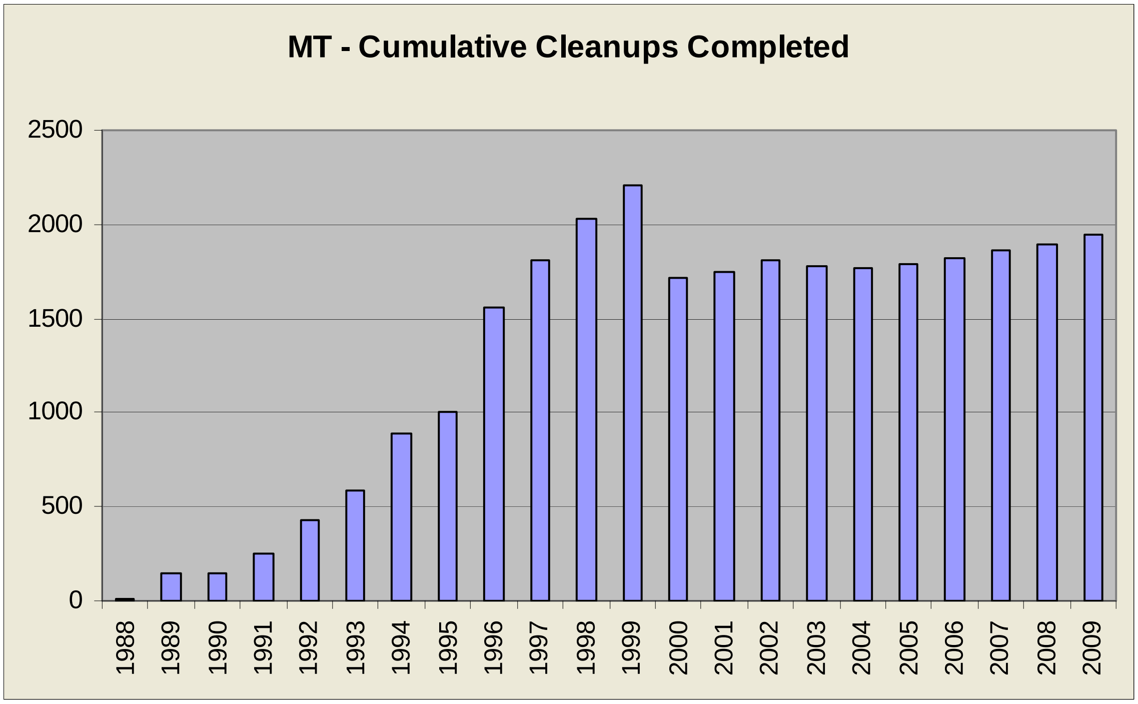
MT - Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1988
1989
1990
1991
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1993
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1999
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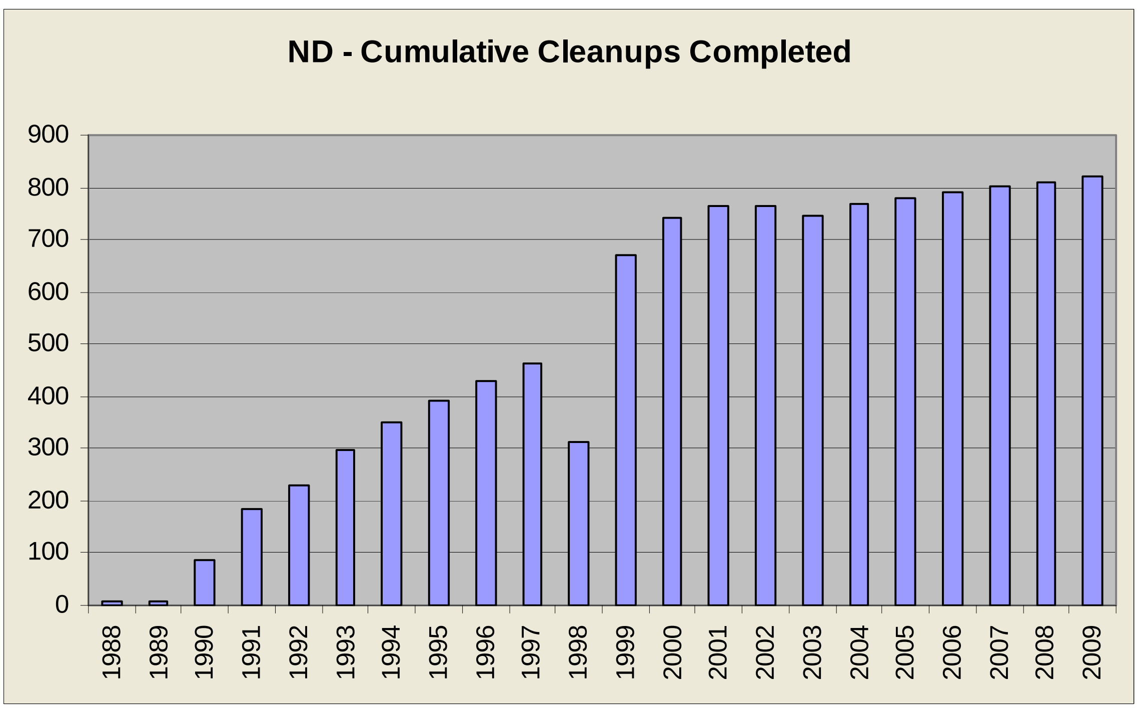
ND - Cumulative Cleanups Completed
900
800
700
600
500
400
300
200
100
0
1988
1989
1990
1991
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1993
1994
1995
1996
1997
1998
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2006
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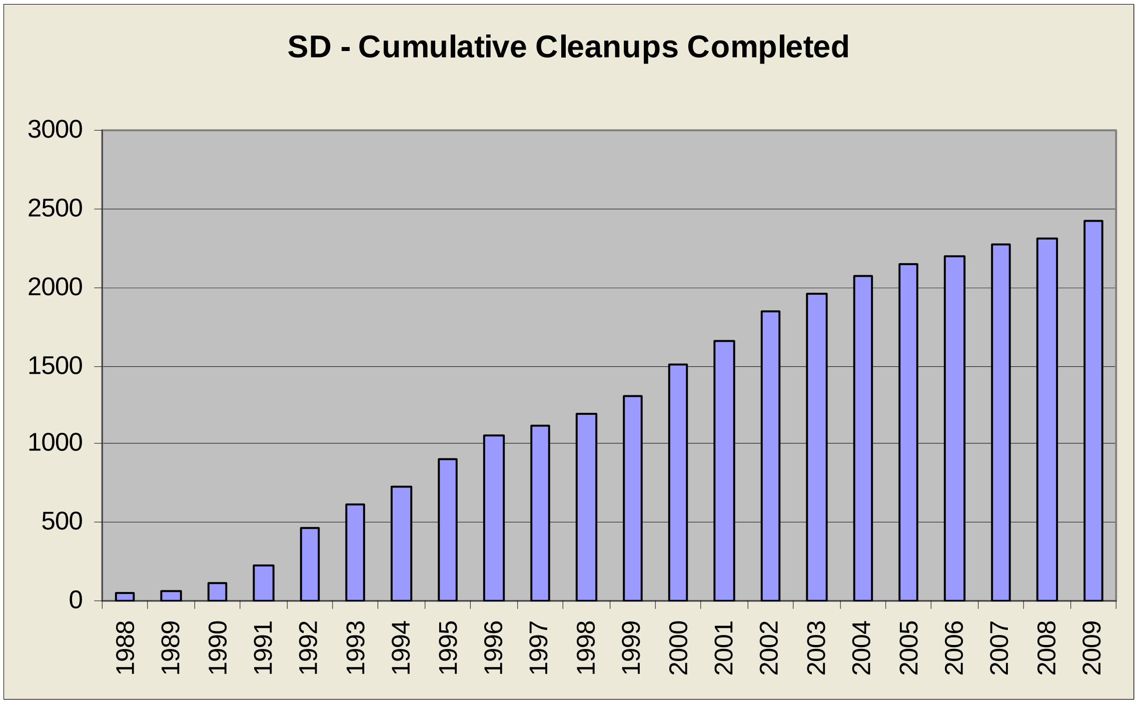
SD - Cumulative Cleanups Completed
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
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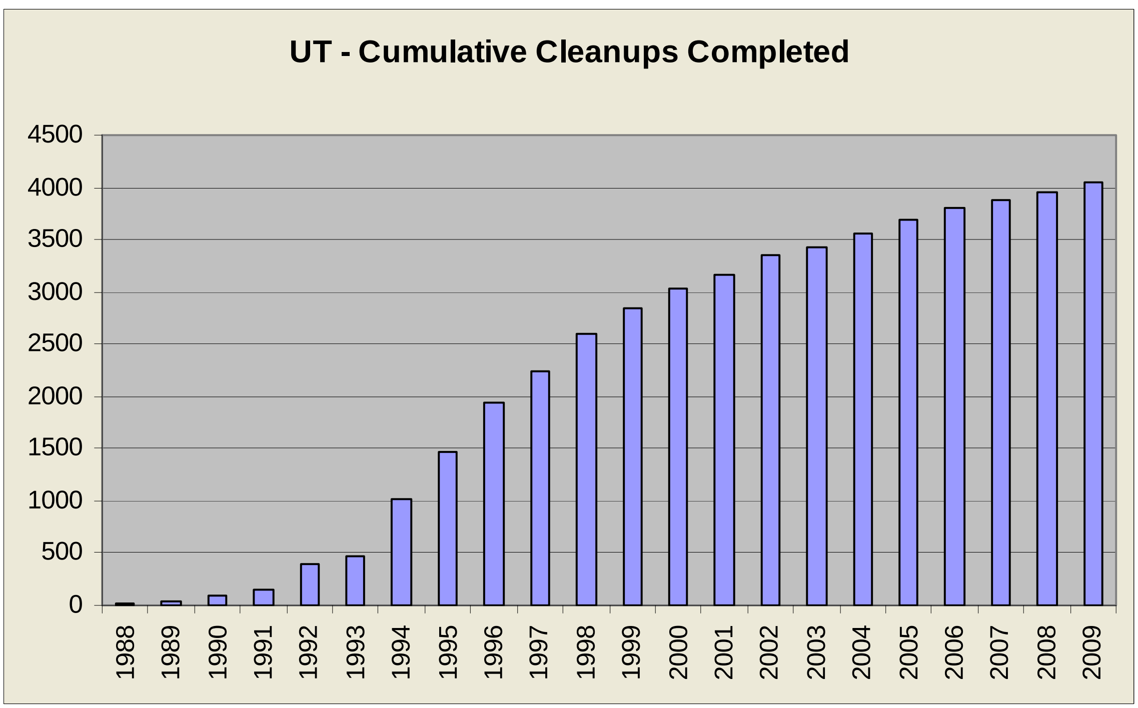
UT - Cumulative Cleanups Completed
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
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1992
1993
1994
1995
1996
1997
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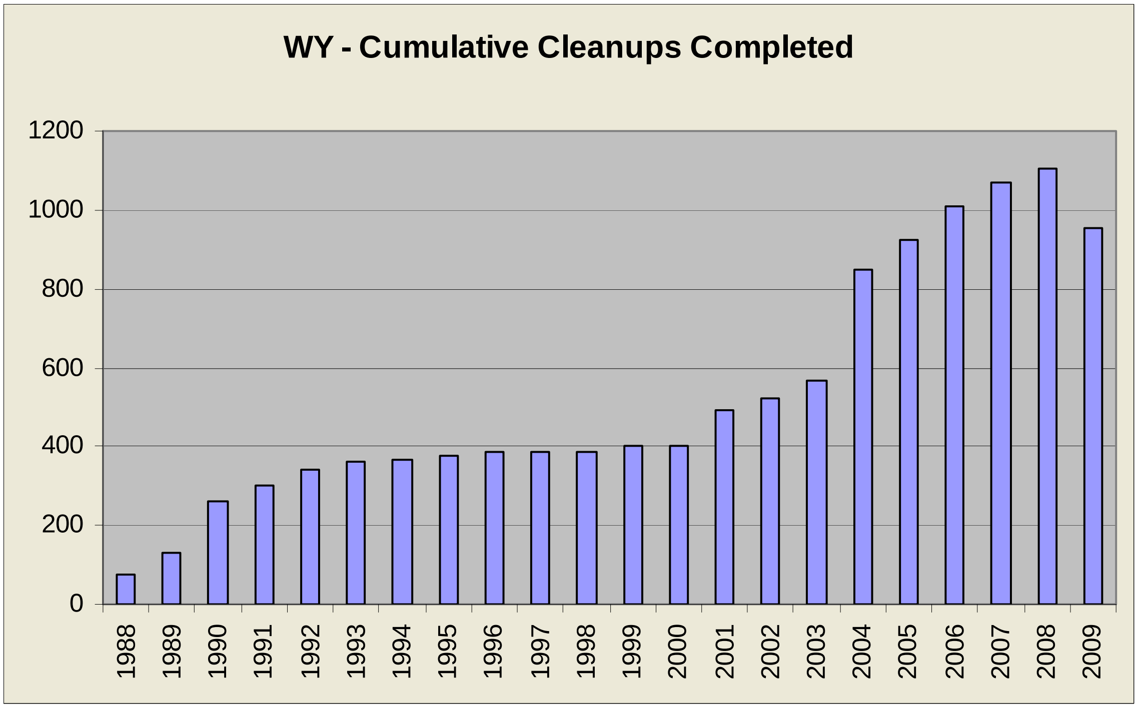
WY - Cumulative Cleanups Completed
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
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2005
2006
2007
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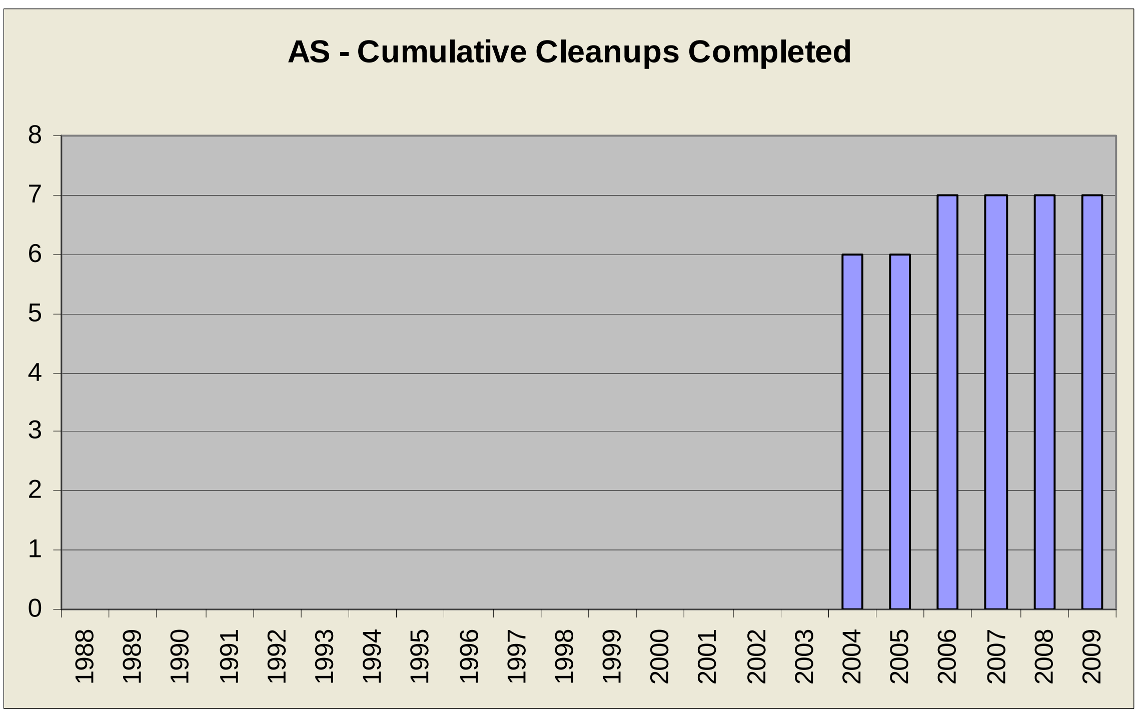
AS - Cumulative Cleanups Completed
8
7
6
5
4
3
2
1
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
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2002
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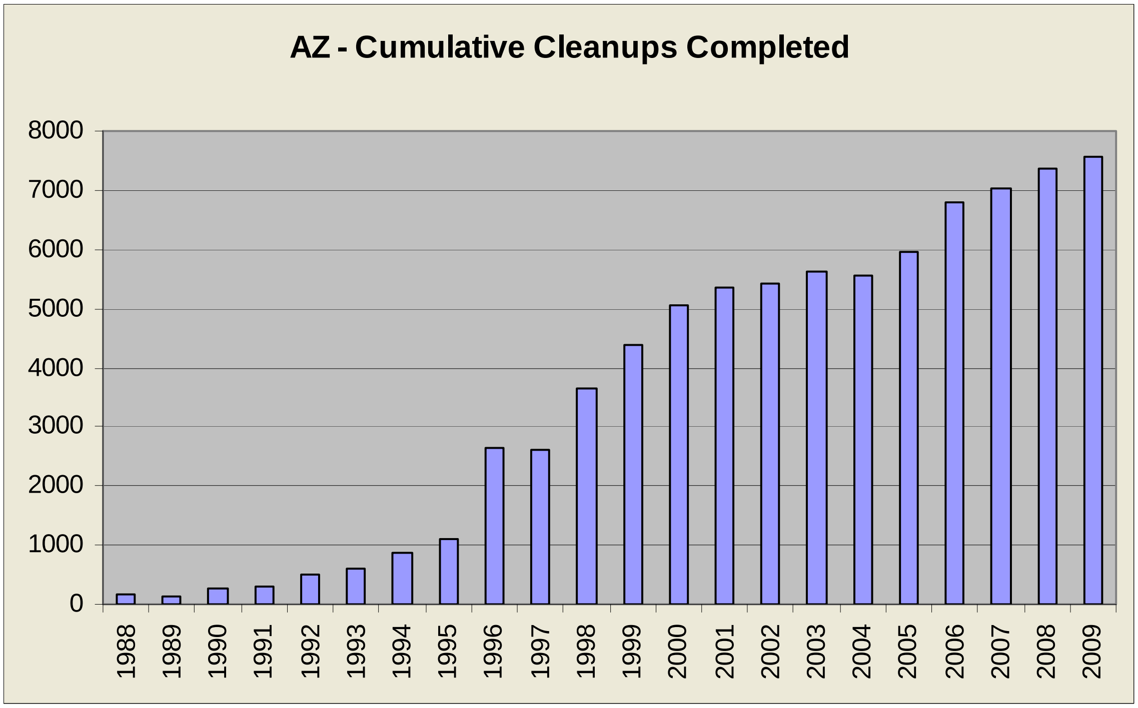
AZ - Cumulative Cleanups Completed
8000
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
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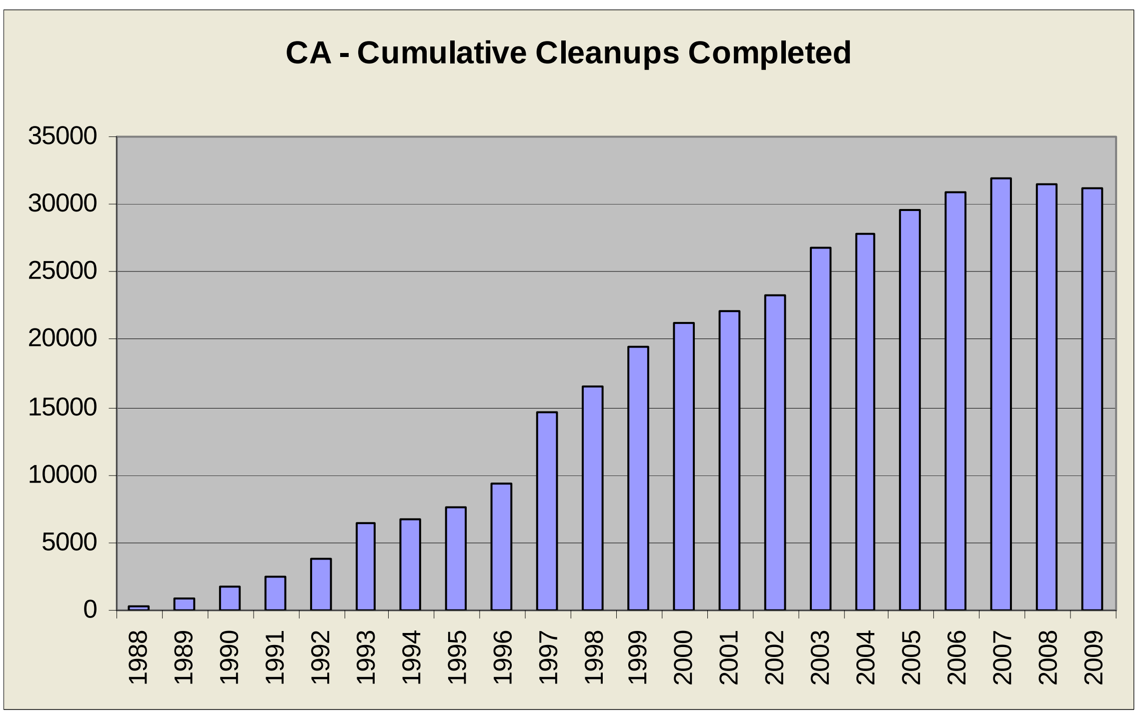
CA - Cumulative Cleanups Completed
35000
30000
25000
20000
15000
10000
5000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
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1999
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2006
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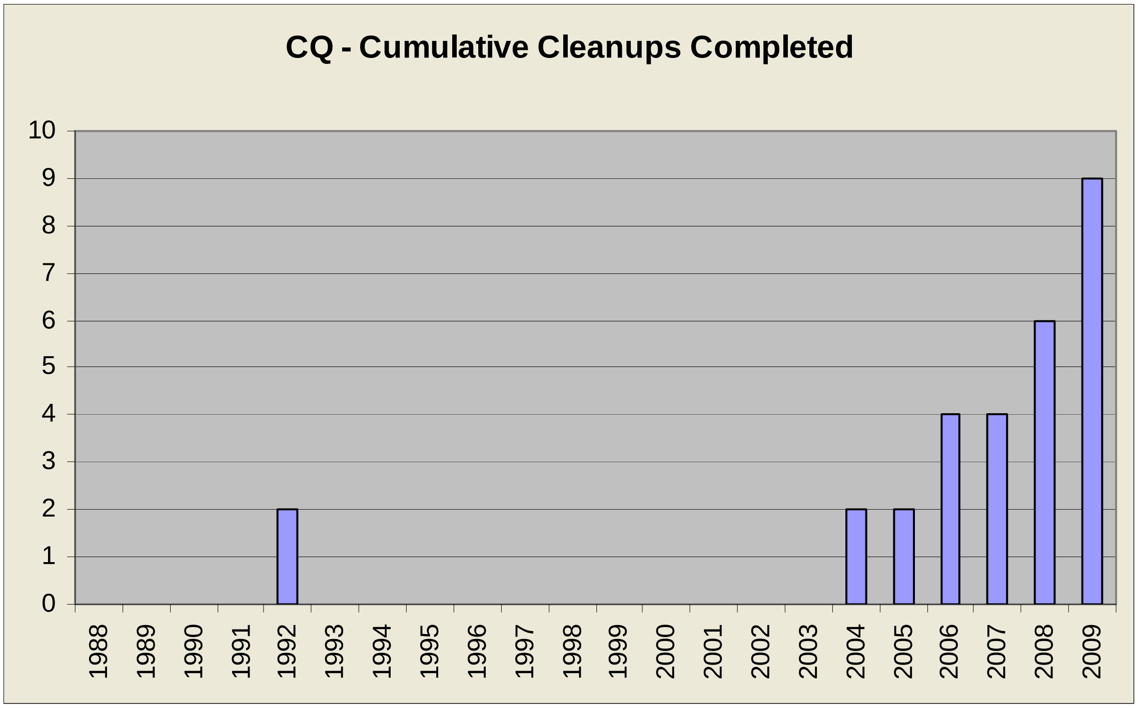
2008
2009


CQ - Cumulative Cleanups Completed
0
1
2
3
4
5
6
7
8
9
10
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
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2000
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2002
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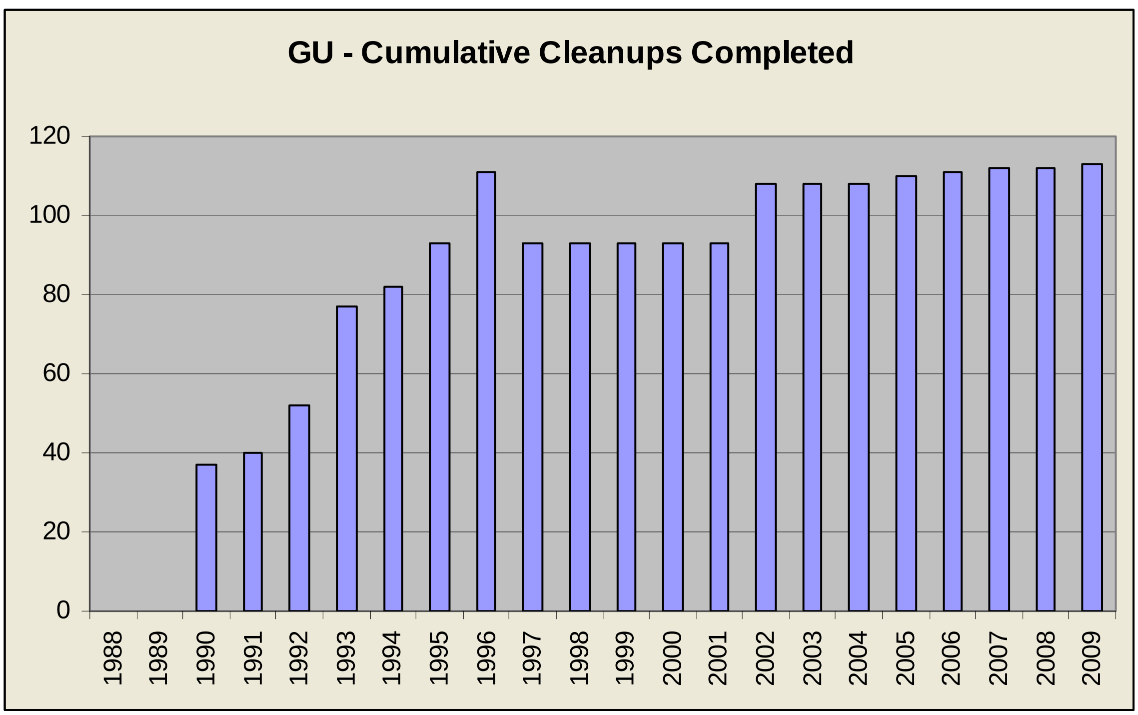
2004
2005
2006
2007
2008
2009


GU - Cumulative Cleanups Completed
0
20
40
60
80
100
120
1988
1989
1990
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1992
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1994
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1996
1997
1998
1999
2000
2001
2002
2003
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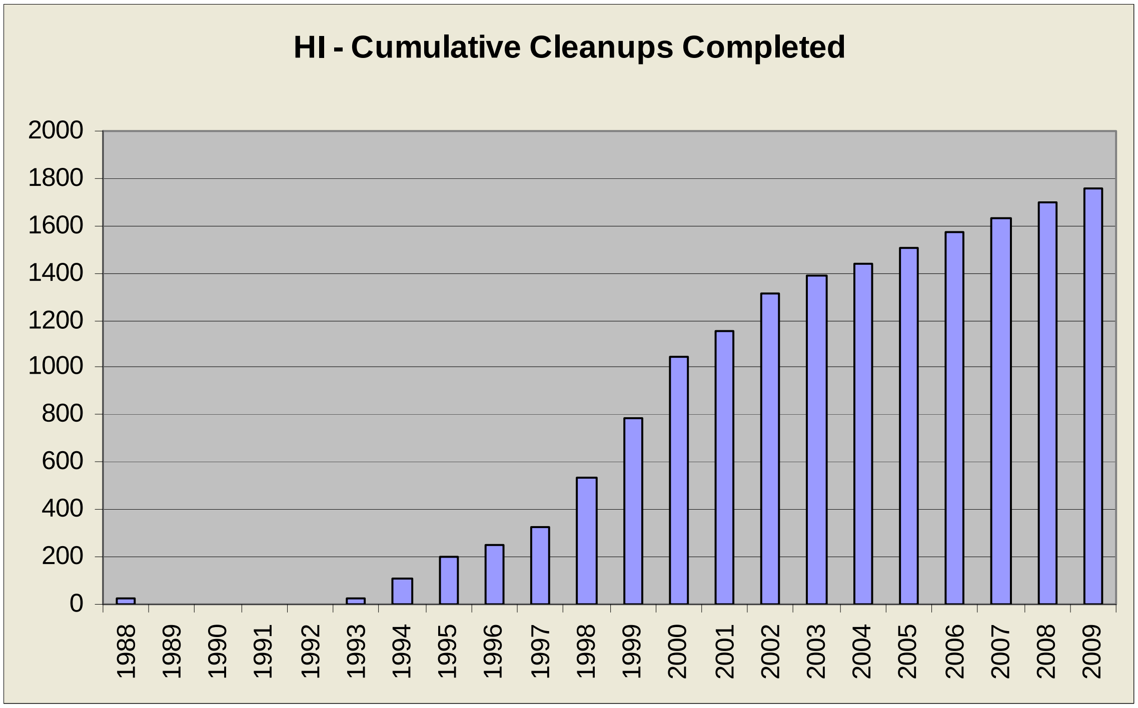
2005
2006
2007
2008
2009


HI - Cumulative Cleanups Completed
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
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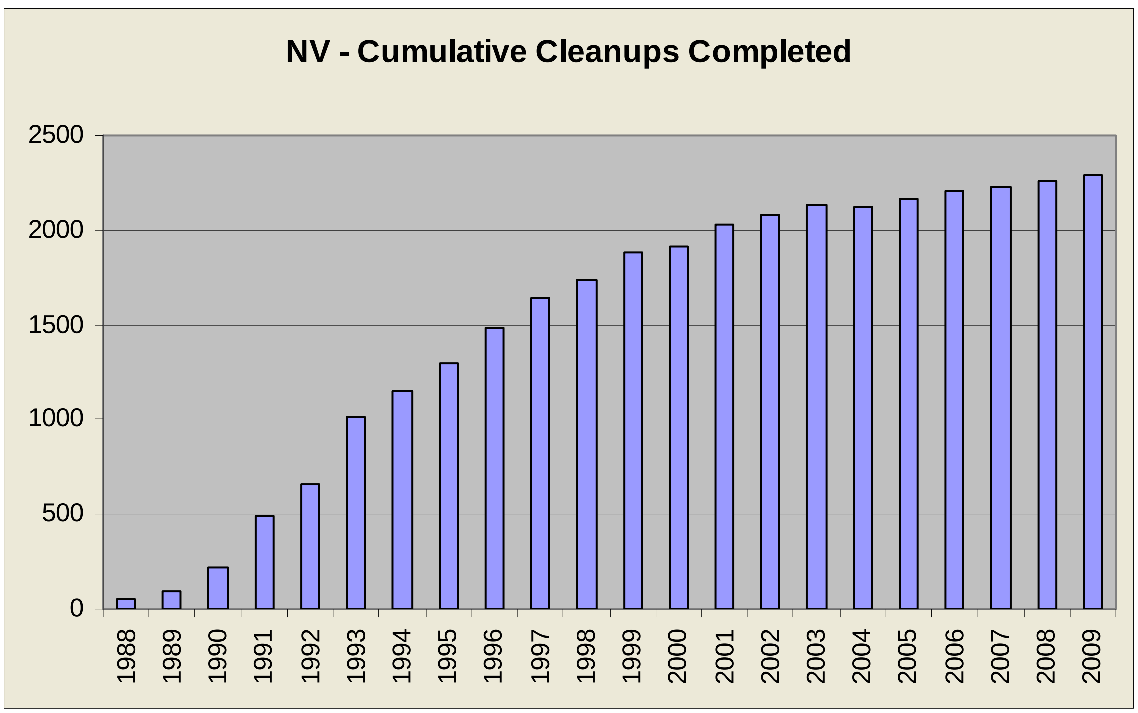
2005
2006
2007
2008
2009


NV - Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
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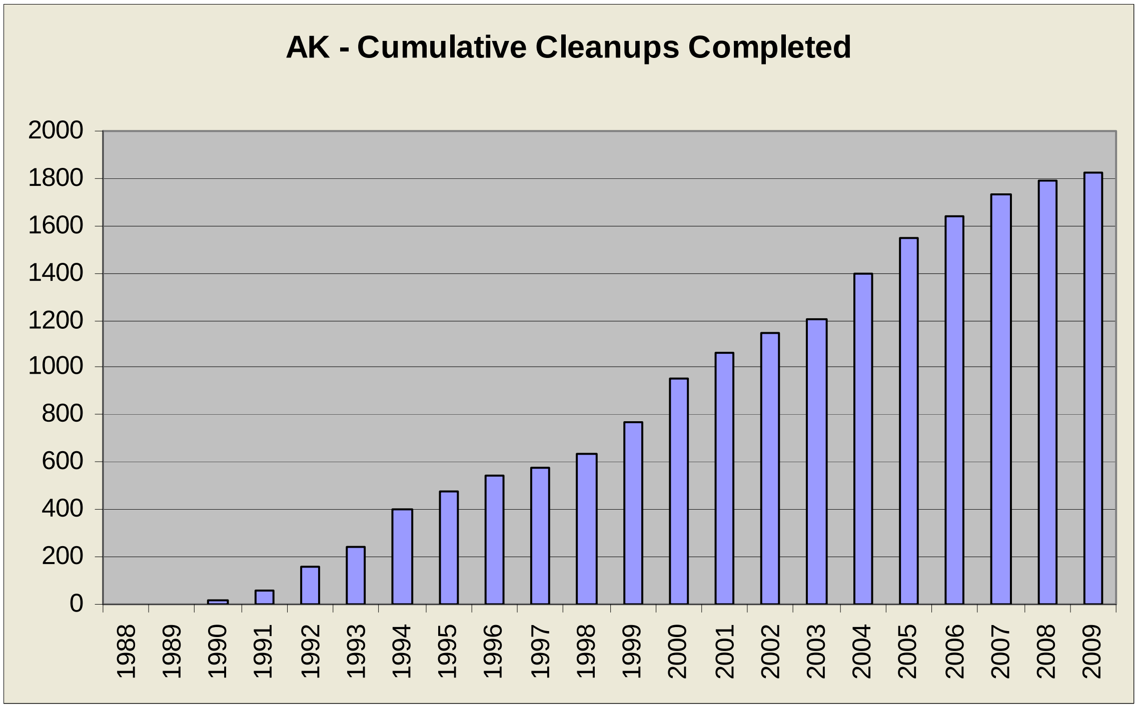
2005
2006
2007
2008
2009



AK - Cumulative Cleanups Completed
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
1993
1994
1995
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2006
2007
2008
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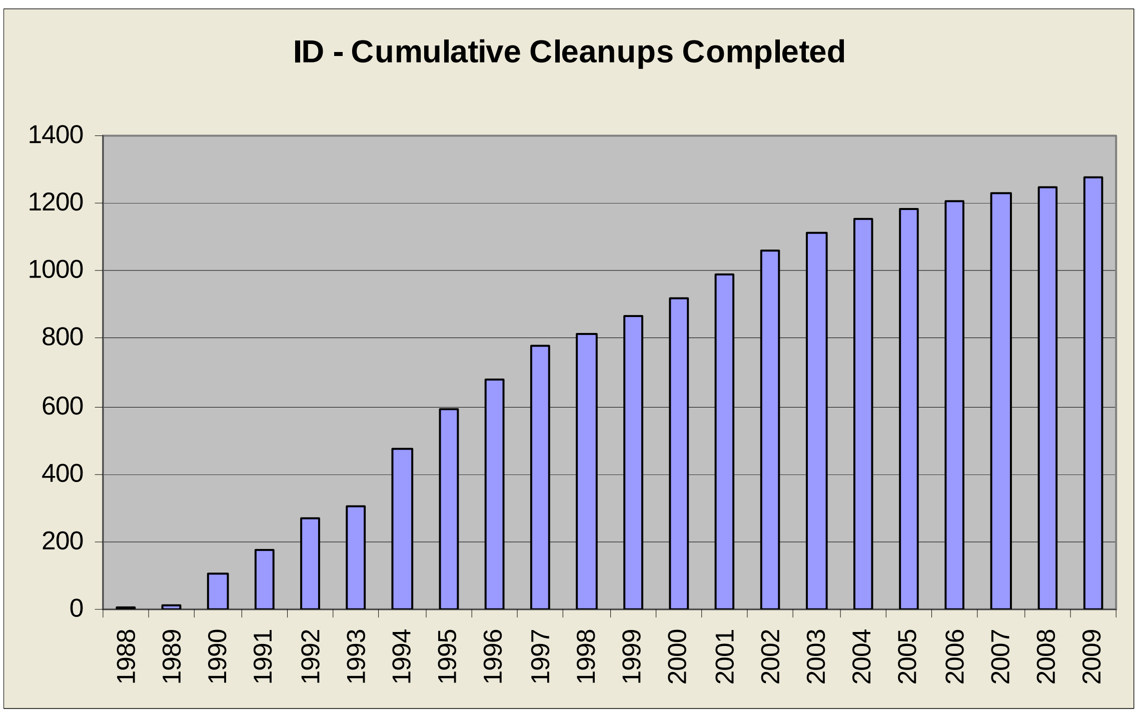

ID - Cumulative Cleanups Completed
1400
1200
1000
800
600
400
200
0
1988
1989
1990
1991
1992
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1995
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1998
1999
2000
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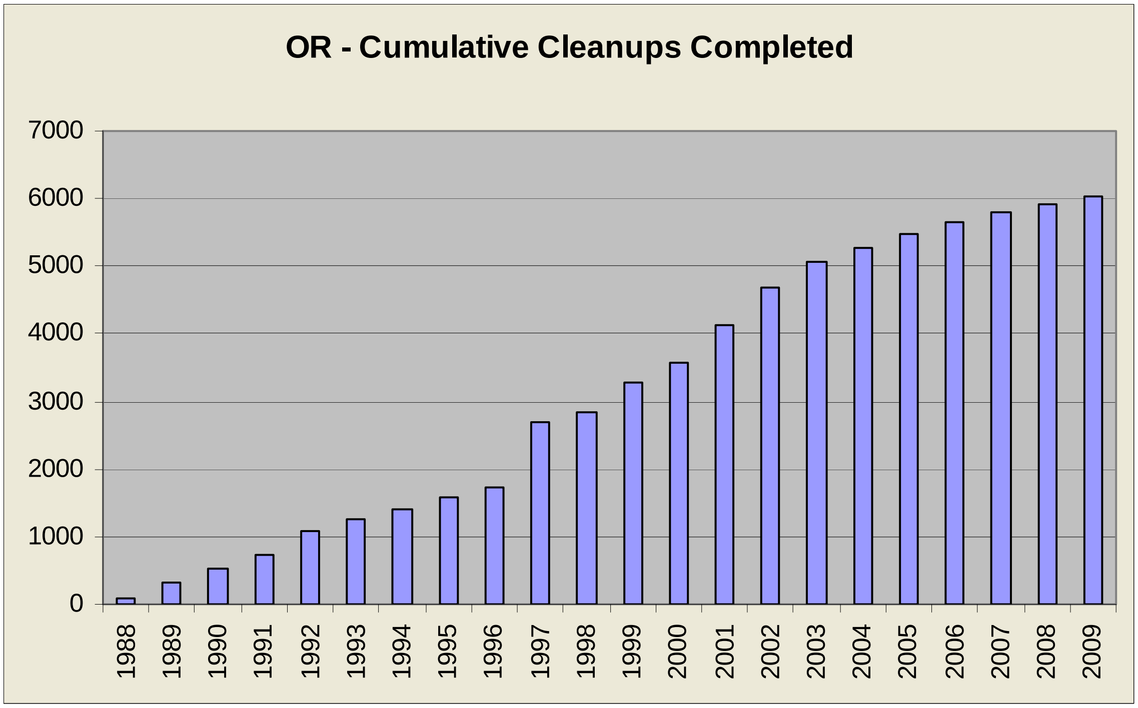
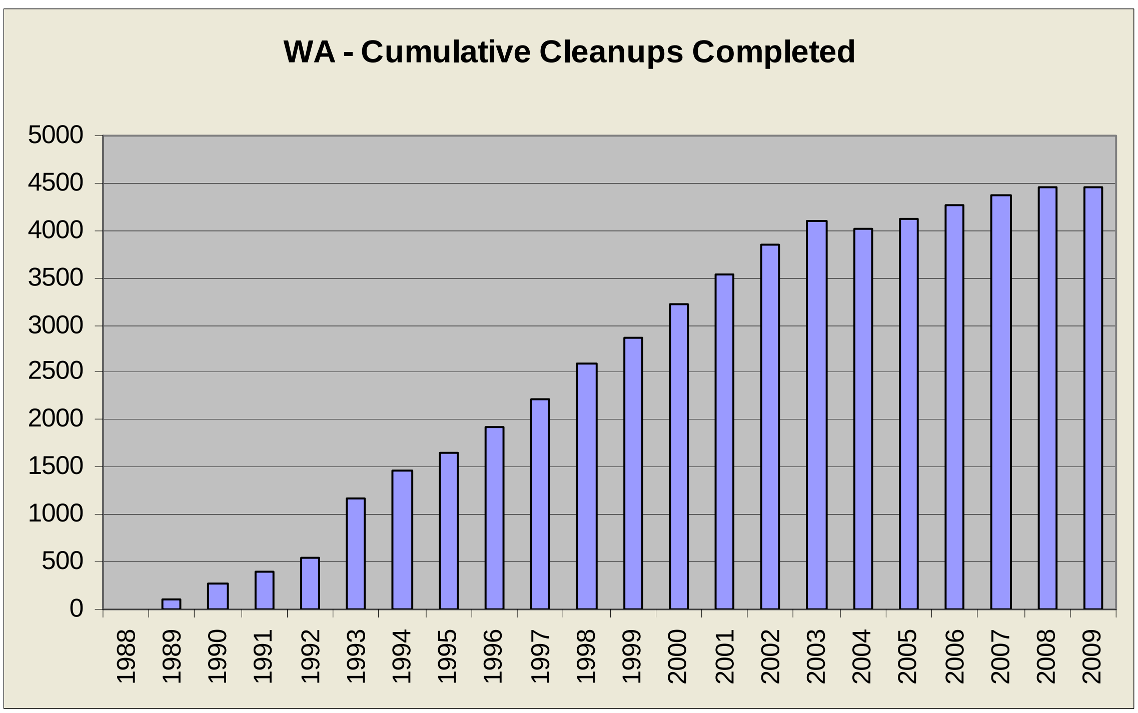
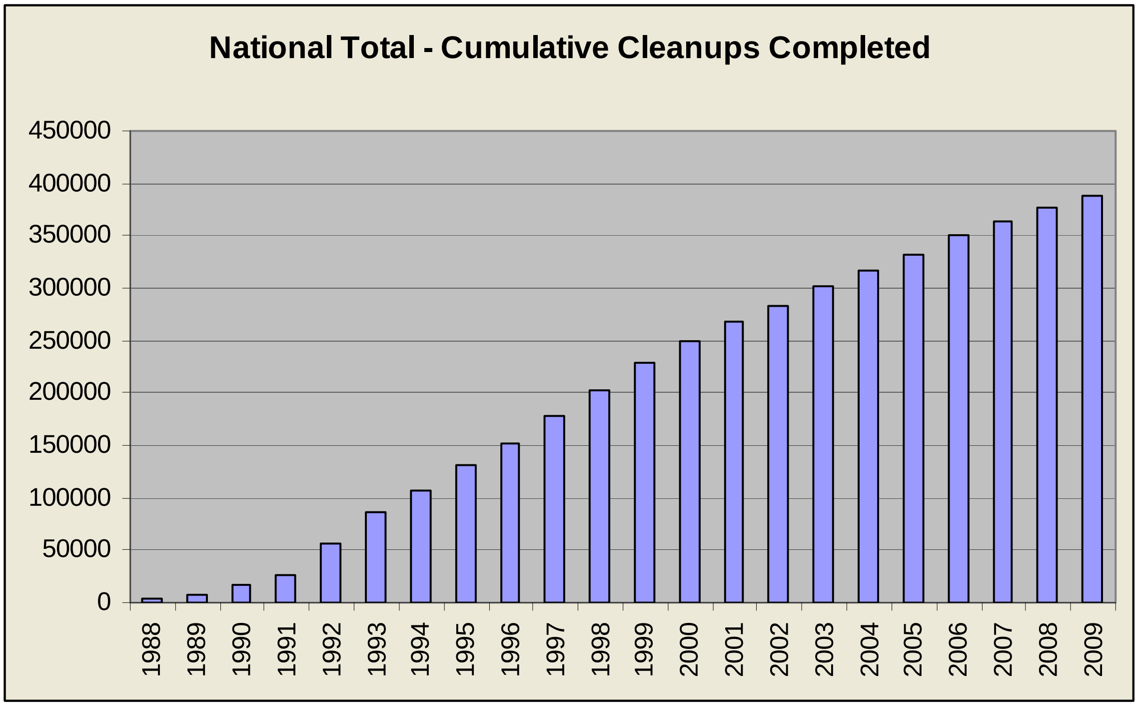
2008
2009


OR - Cumulative Cleanups Completed
7000
6000
5000
4000
3000
2000
1000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

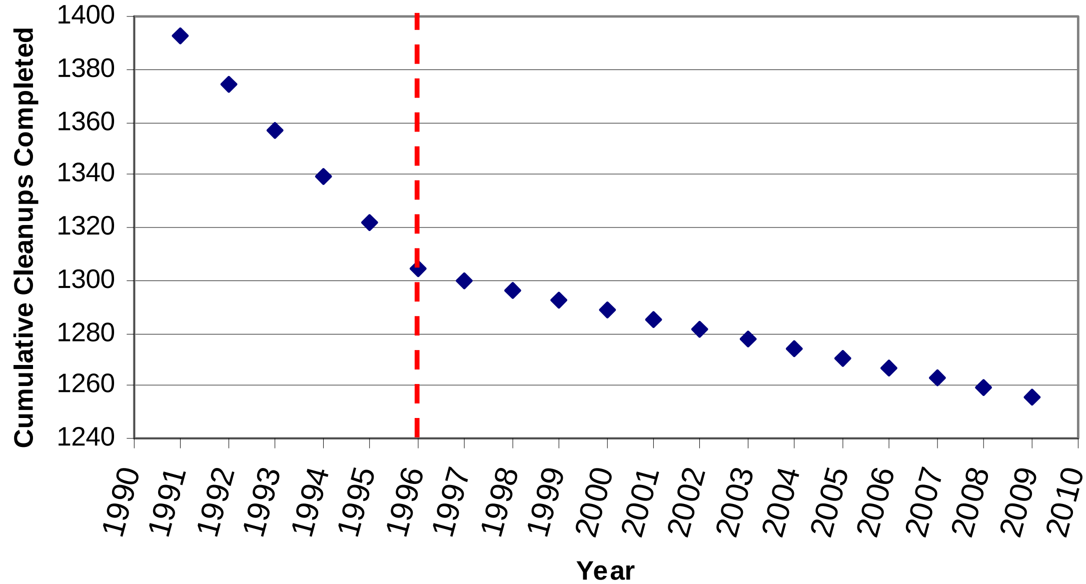

WA - Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009


National Total - Cumulative Cleanups Completed
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

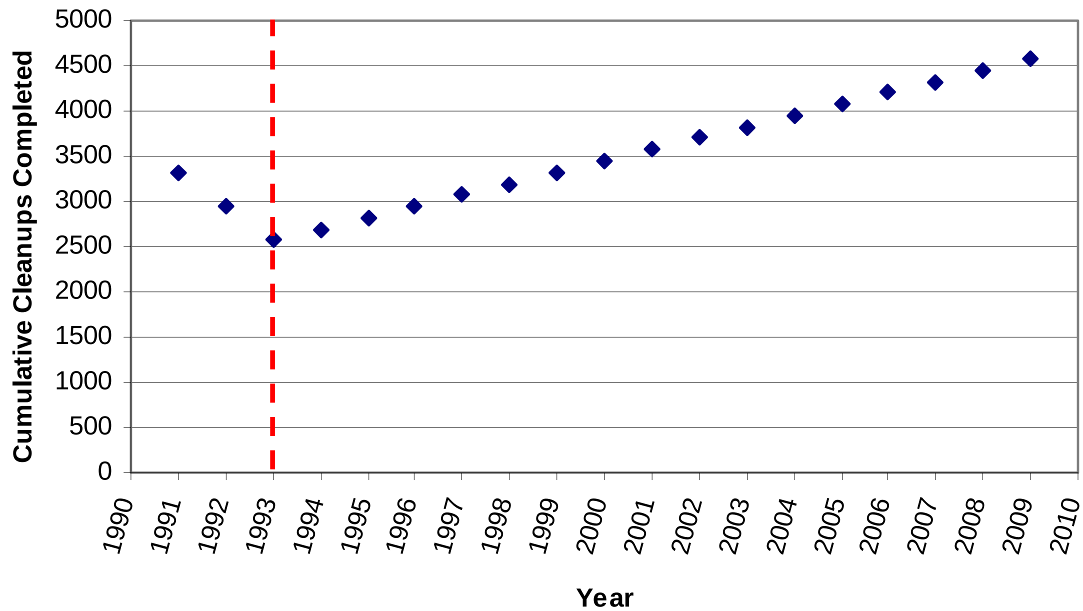
APPENDIX G

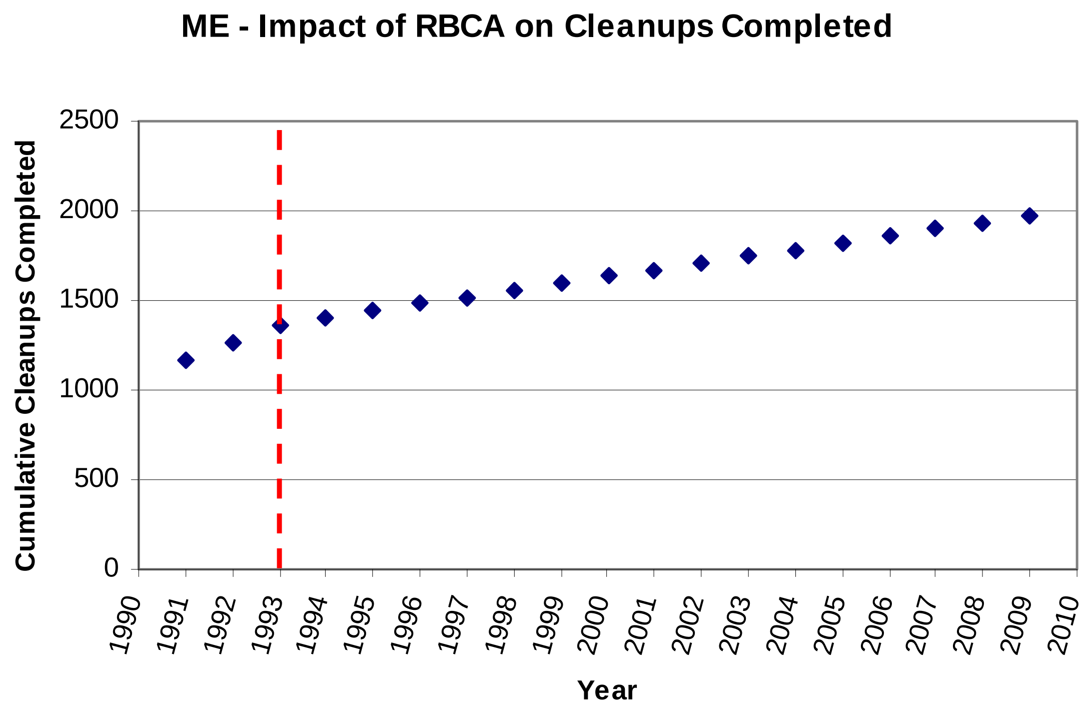
Graphs of Trends in Cumulative Cleanups Completed for 52 States for the Period 1991 through 2009 Based on Statistical Modeling of Effectiveness

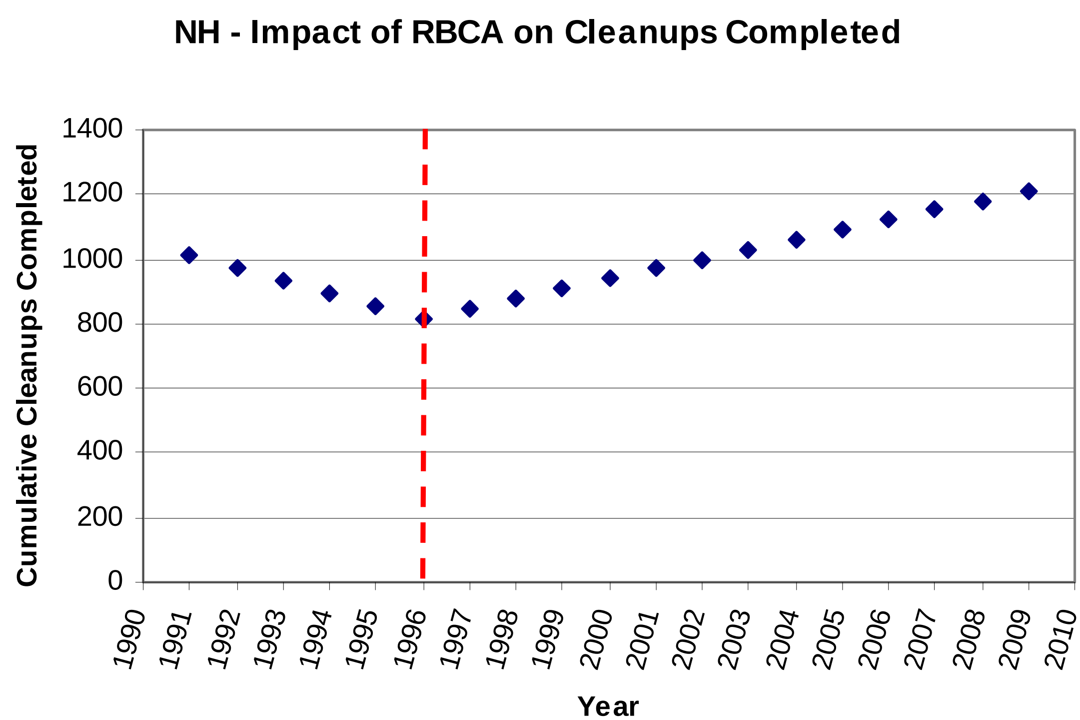
CT - Impact of RBCA on Cleanups Completed



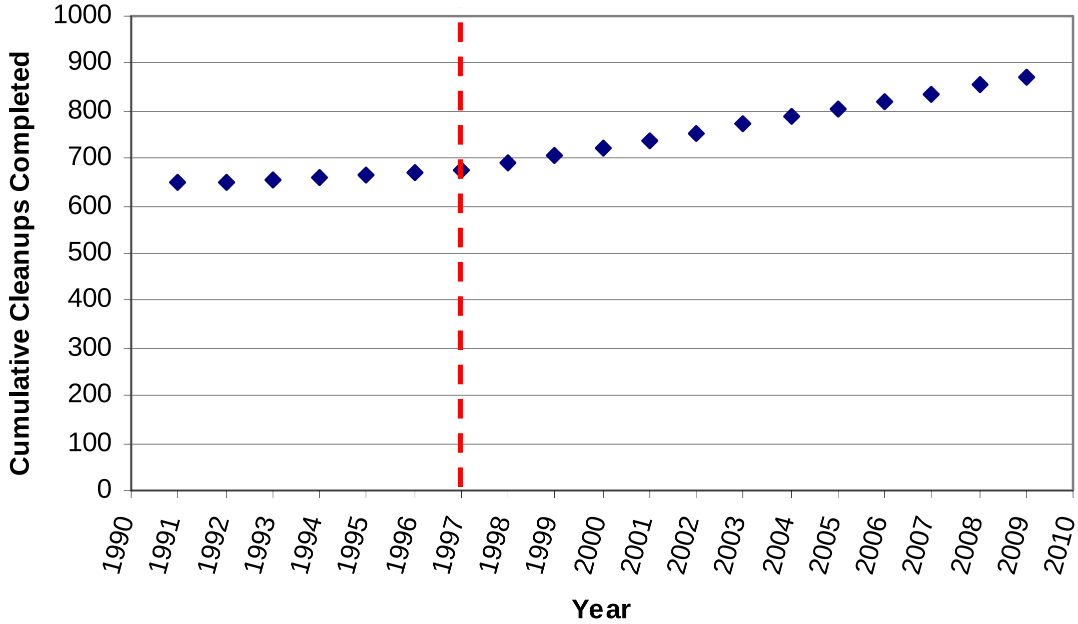
MA - Impact of RBCA on Cleanups Completed



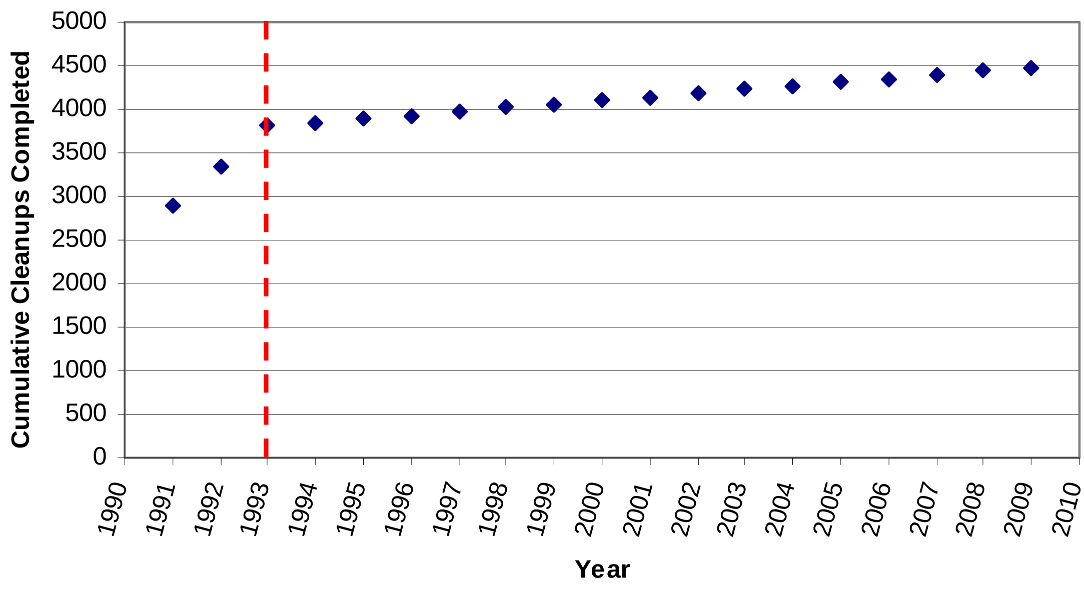

ME - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


NH - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
1400
1200
1000
800
600
400
200
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

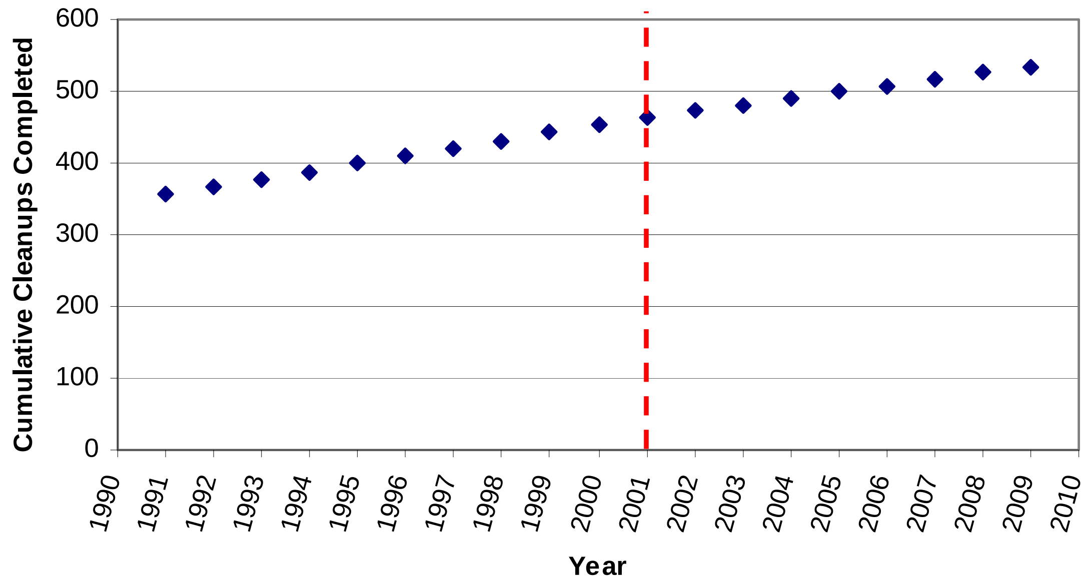
RI - Impact of RBCA on Cleanups Completed



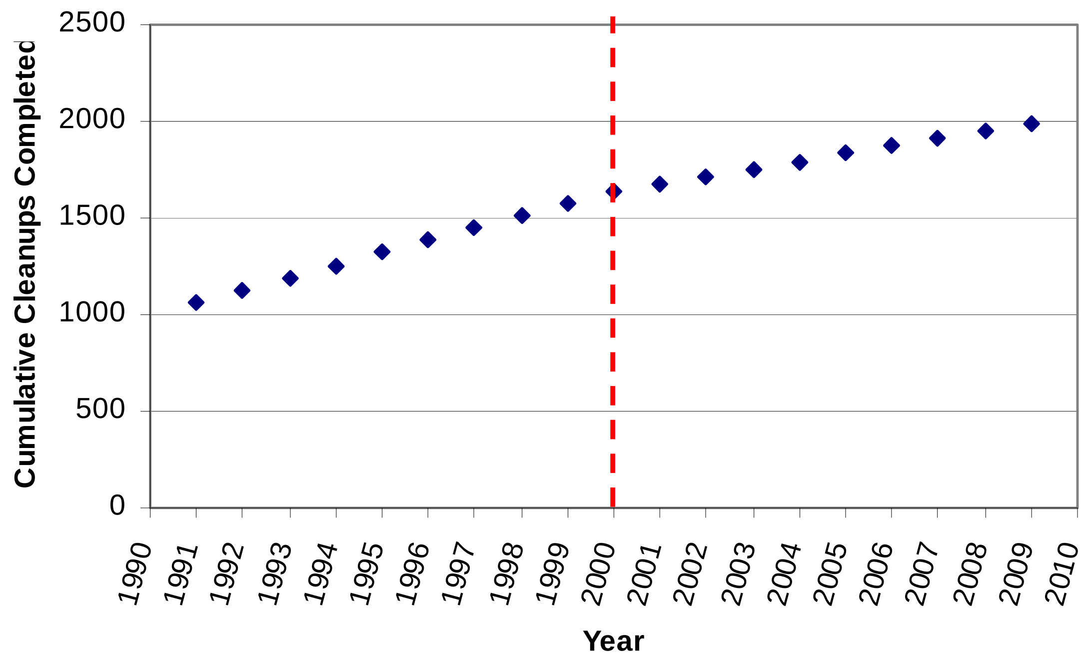
NJ - Impact of RBCA on Cleanups Completed



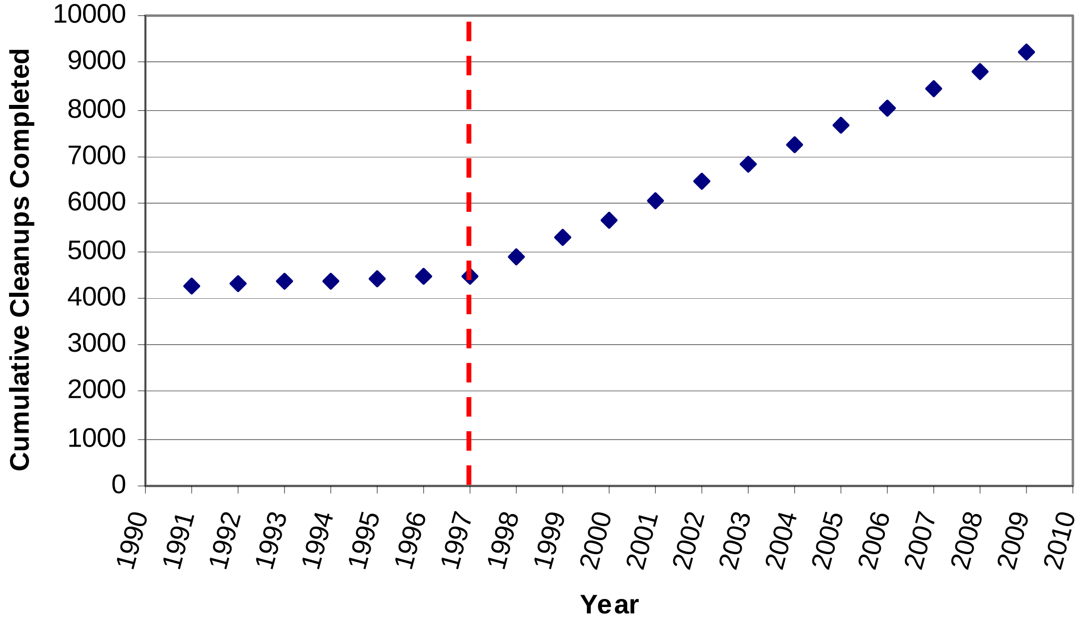
DC - Impact of RBCA on Cleanups Completed



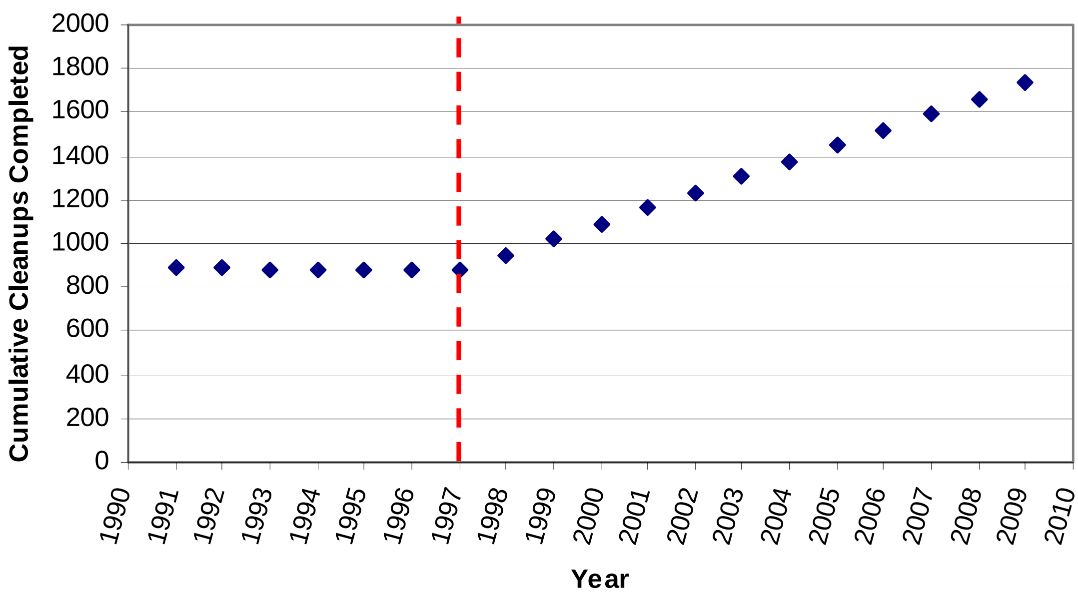
DE - Impact of RBCA on Cleanups Completed



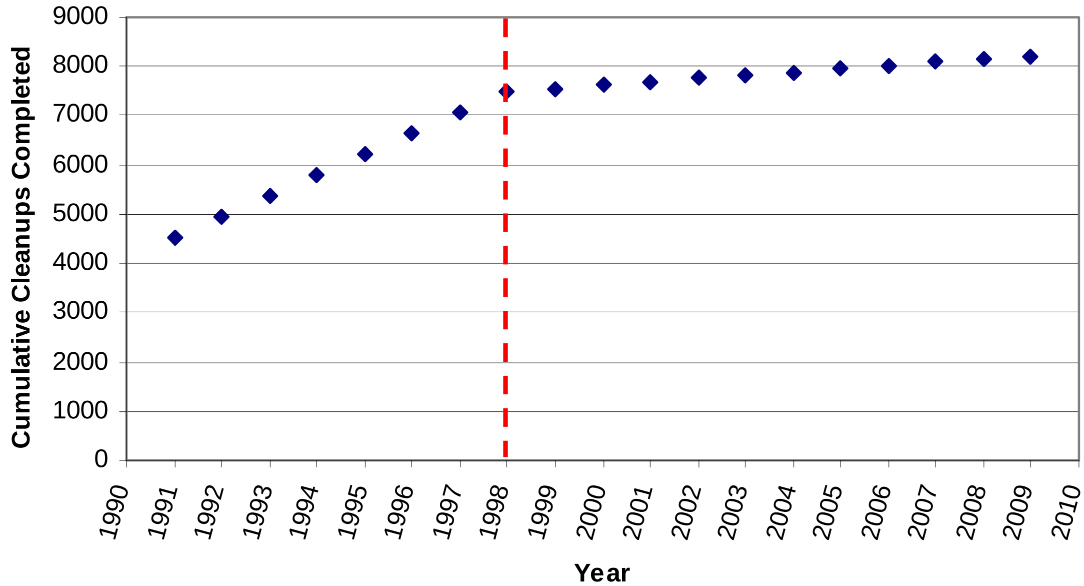
PA - Impact of RBCA on Cleanups Completed



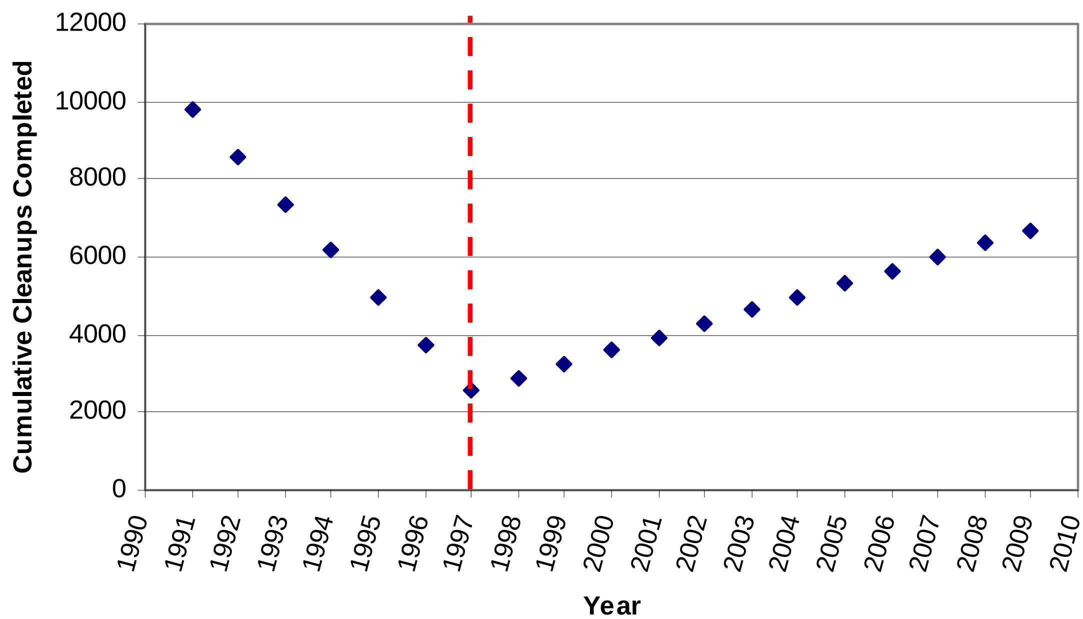
WV - Impact of RBCA on Cleanups Completed



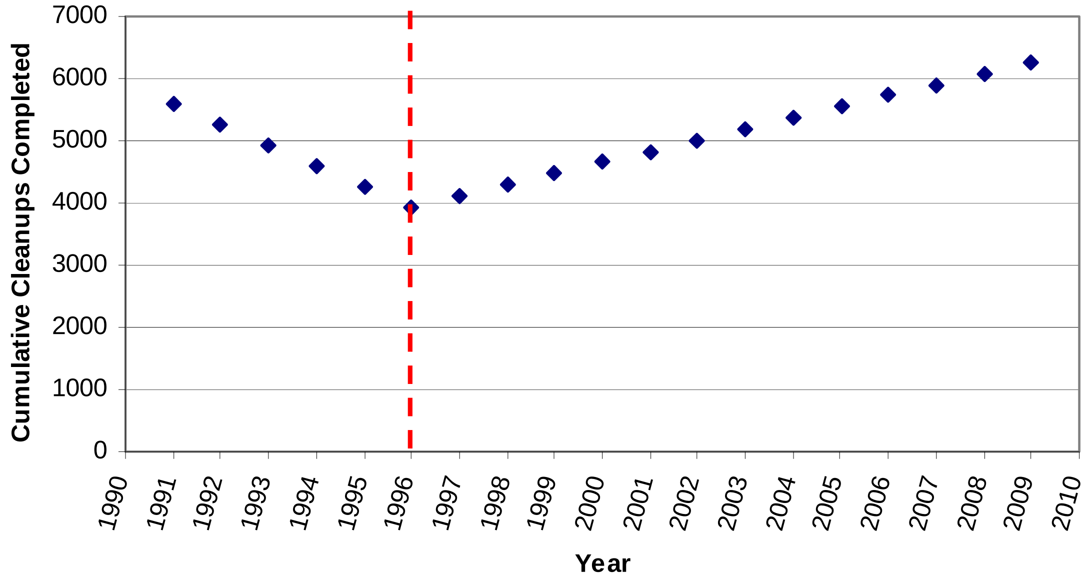
AL - Impact of RBCA on Cleanups Completed



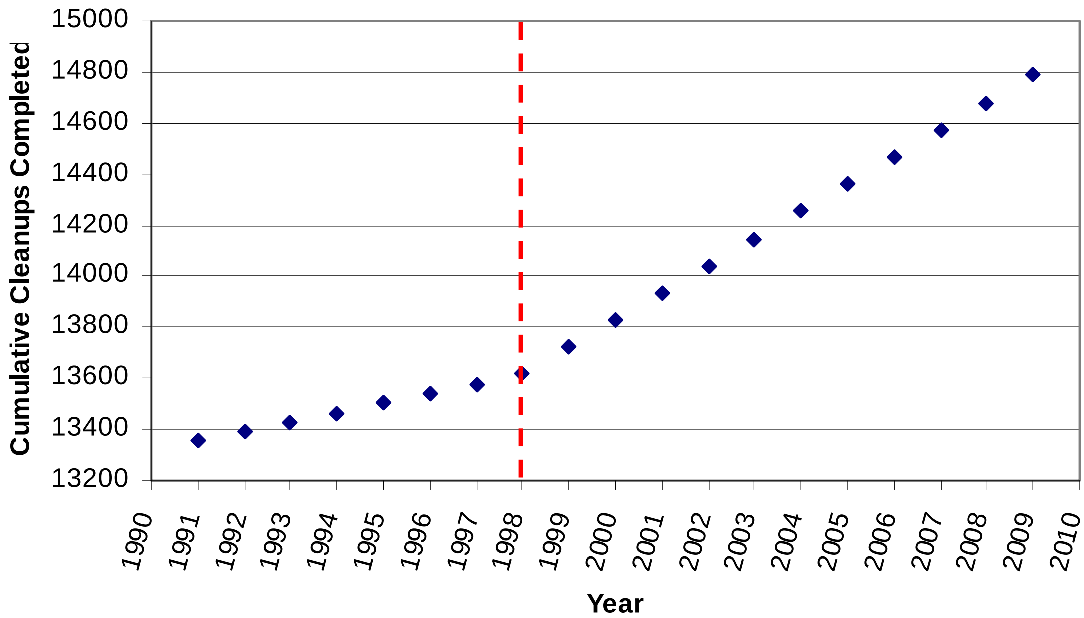
FL - Impact of RBCA on Cleanups Completed

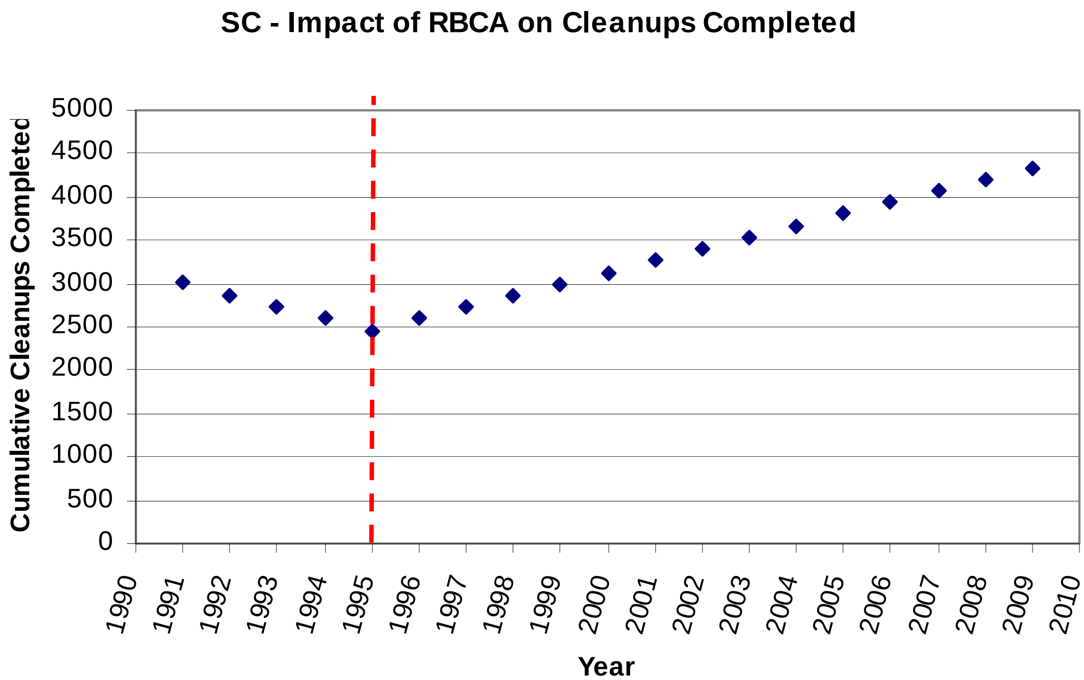


GA - Impact of RBCA on Cleanups Completed

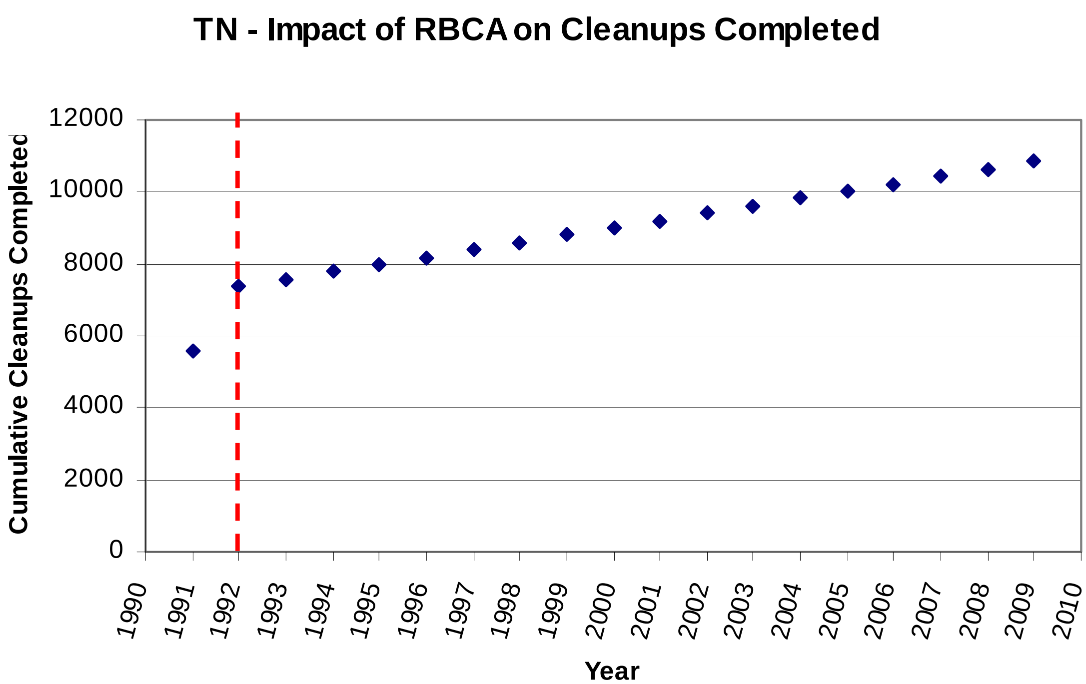


NC - Impact of RBCA on Cleanups Completed

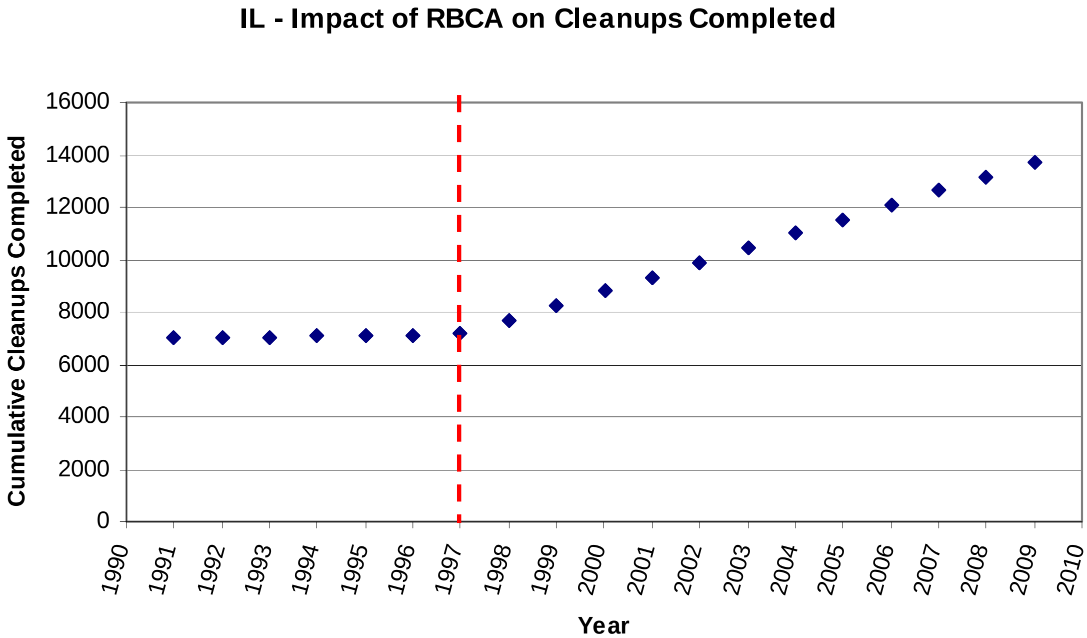


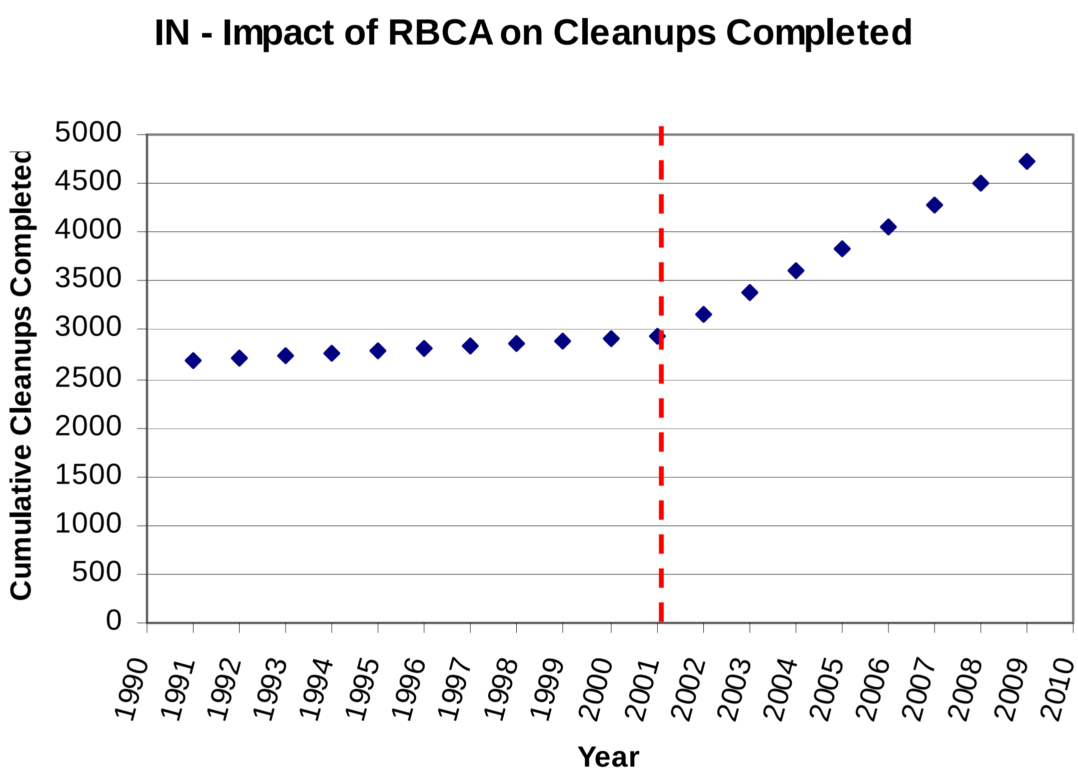


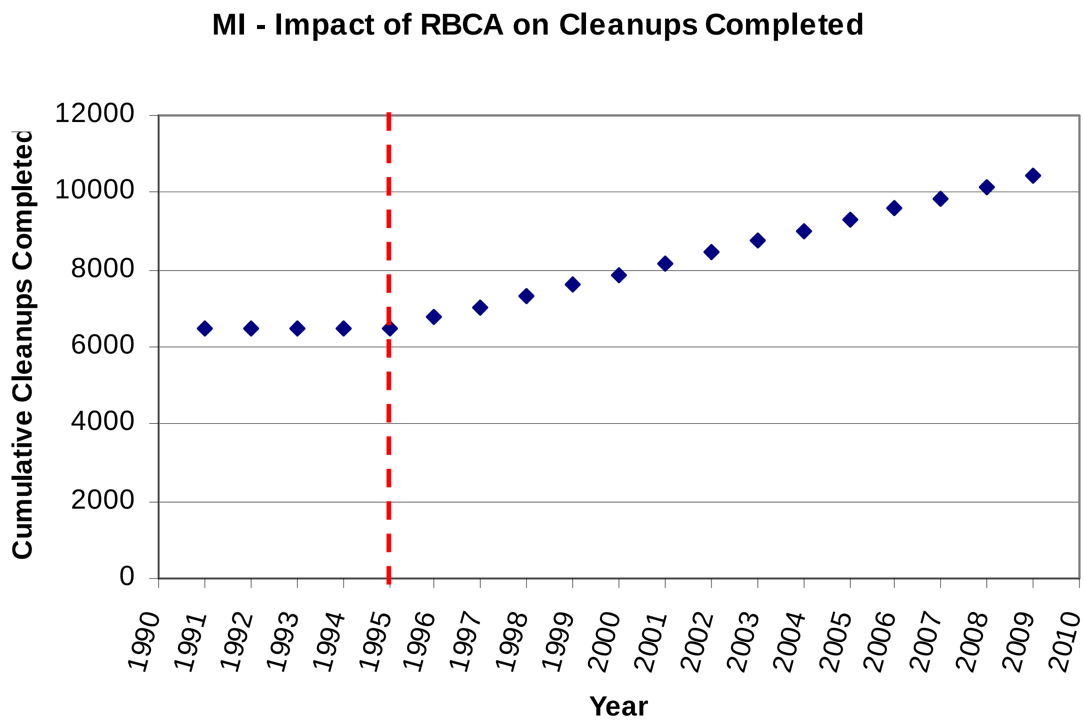
SC - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year

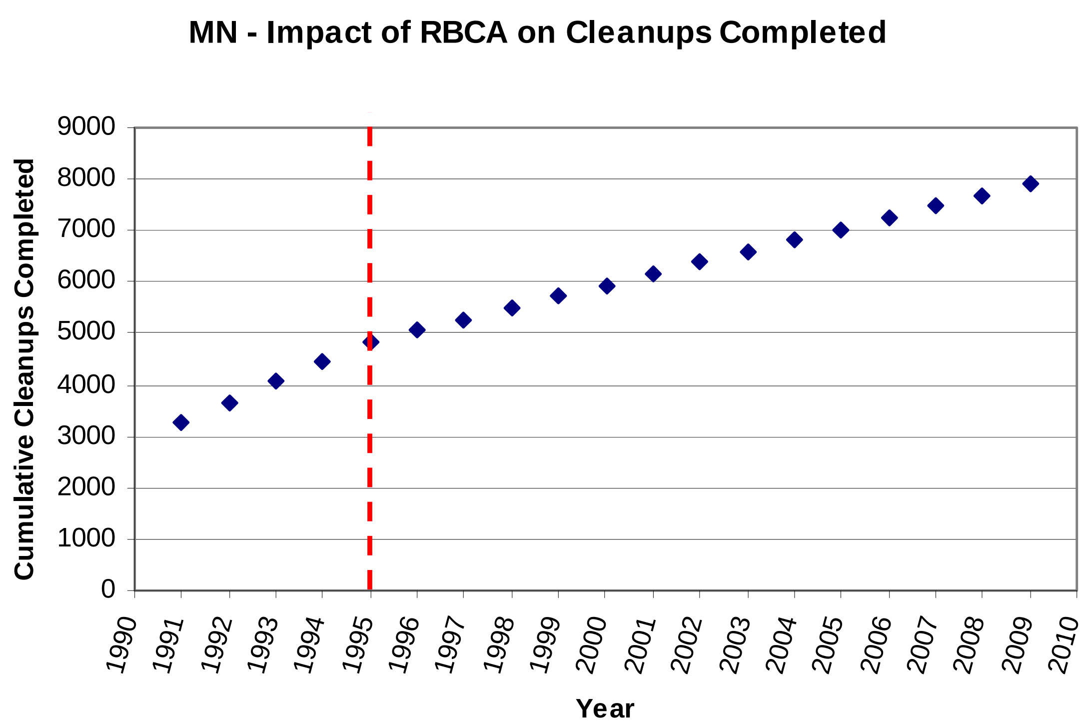


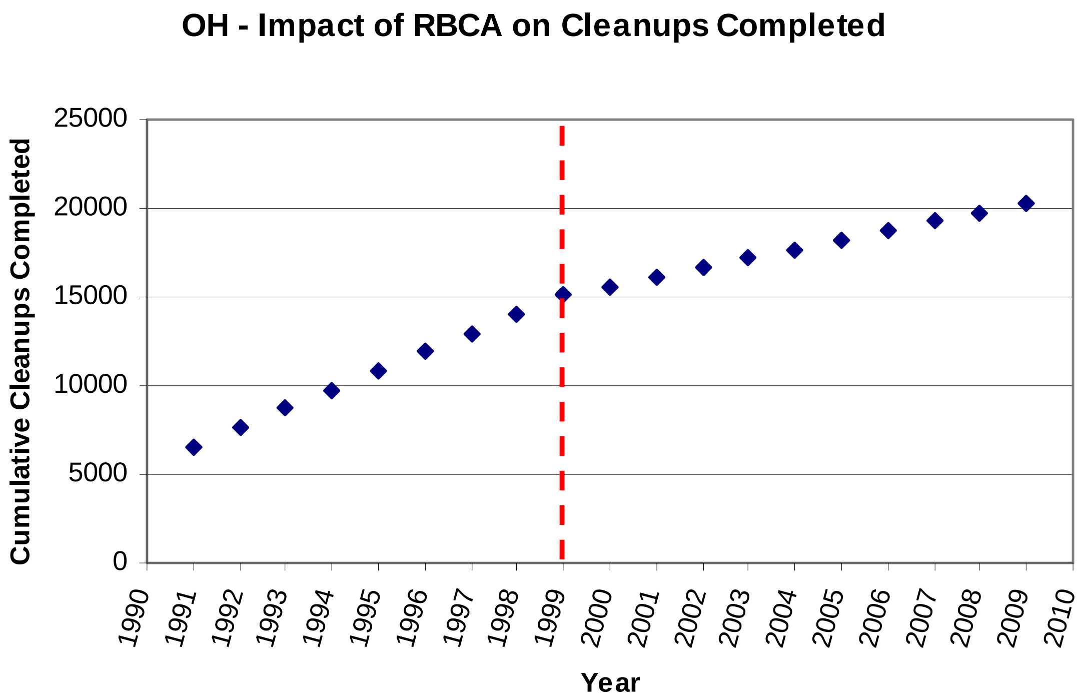
TN - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year

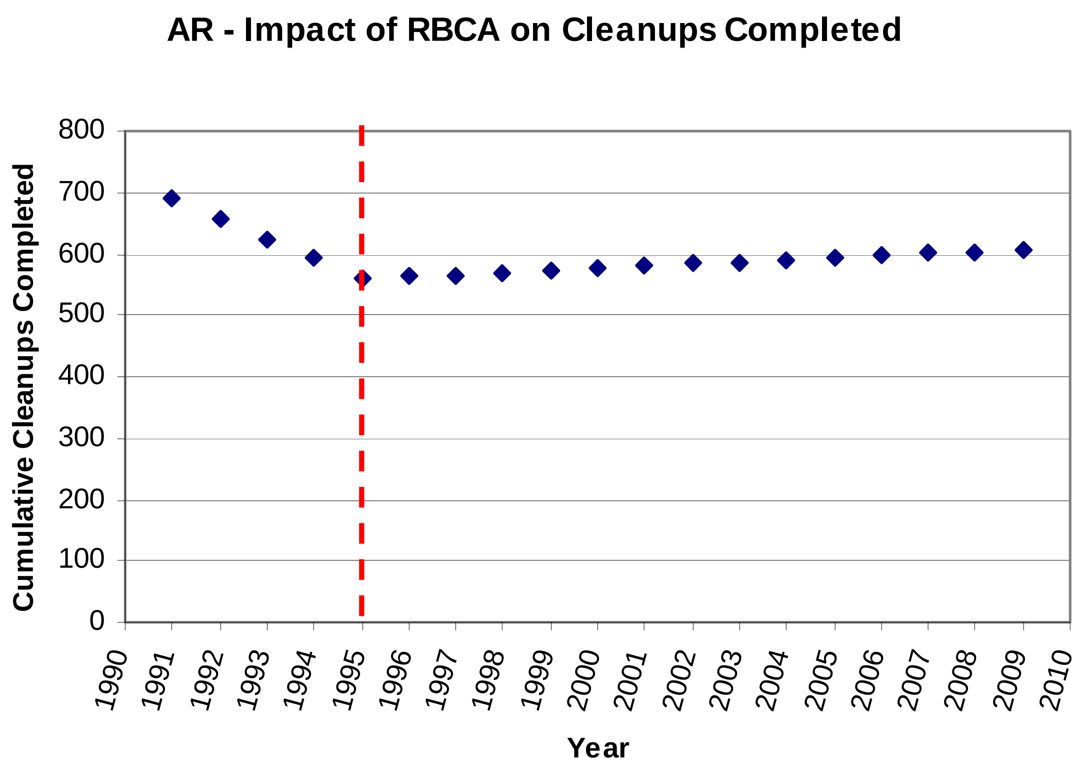

IL - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
16000
14000
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


IN - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

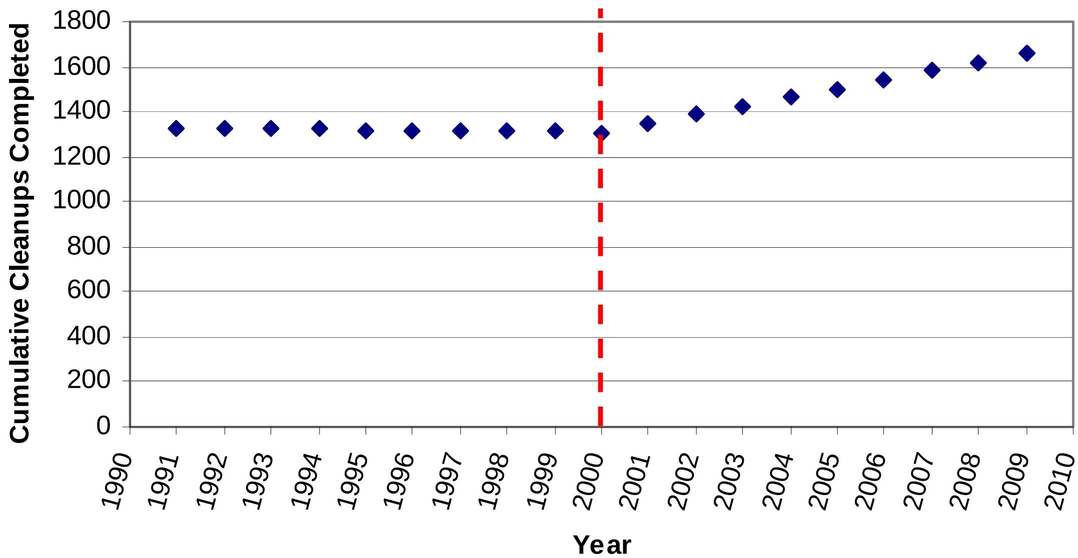

MI - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


MN - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

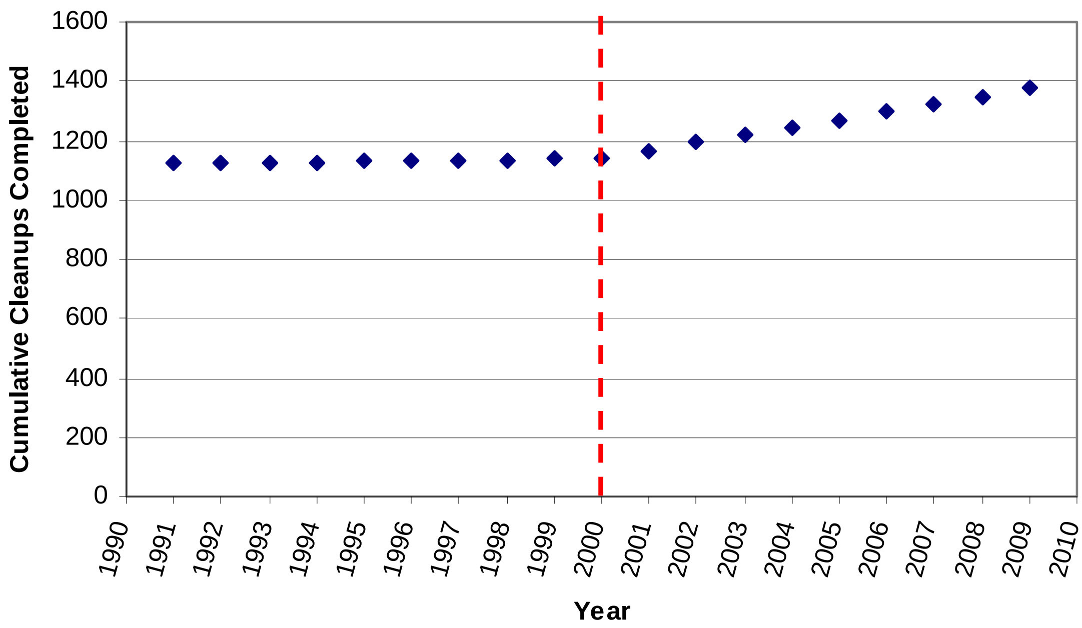

OH - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
25000
20000
15000
10000
5000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

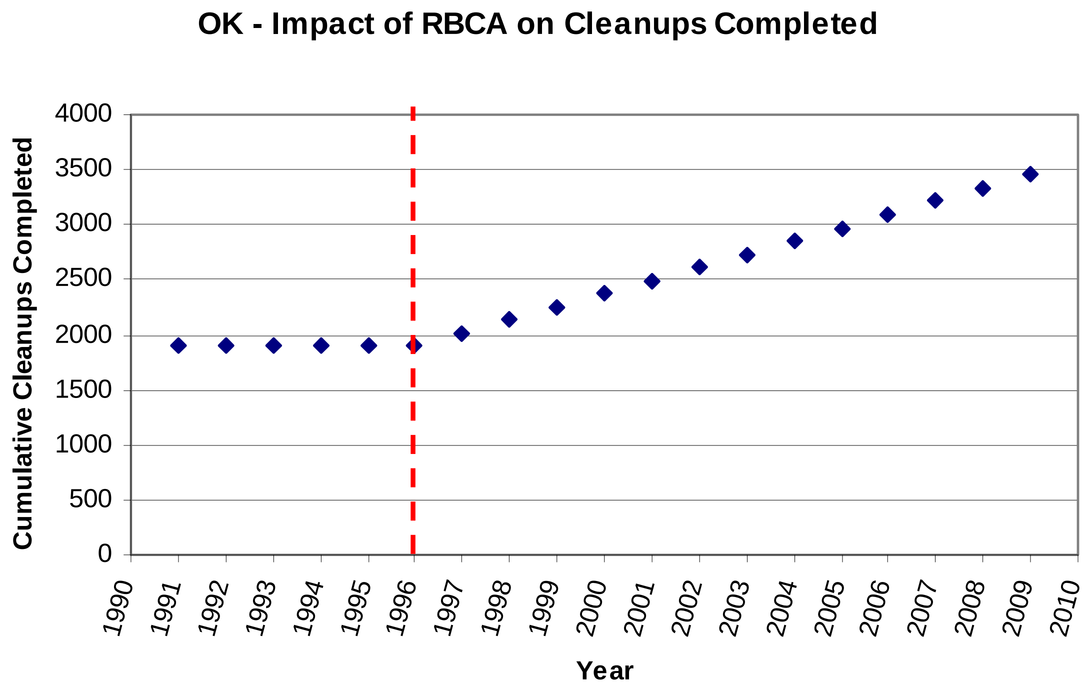

AR - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
800
700
600
500
400
300
200
100
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

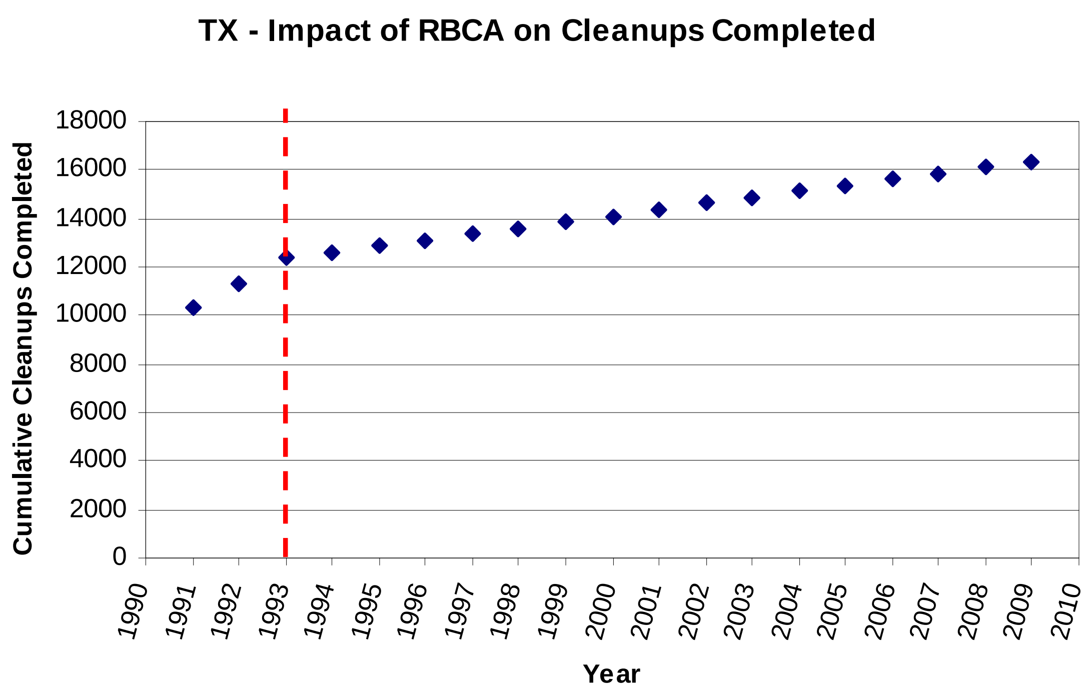
LA - Impact of RBCA on Cleanups Completed



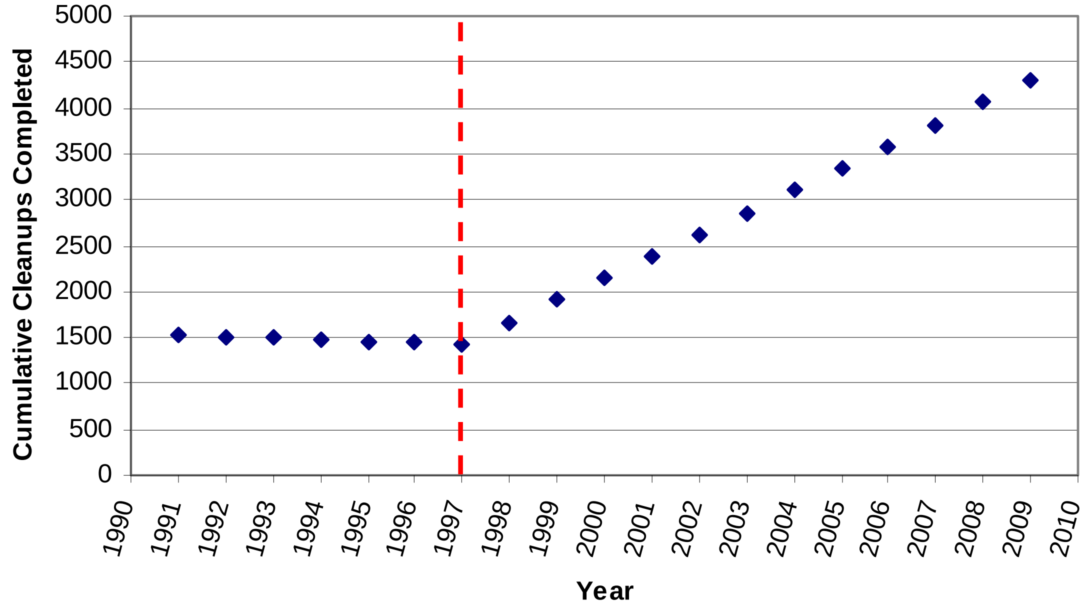
NM - Impact of RBCA on Cleanups Completed



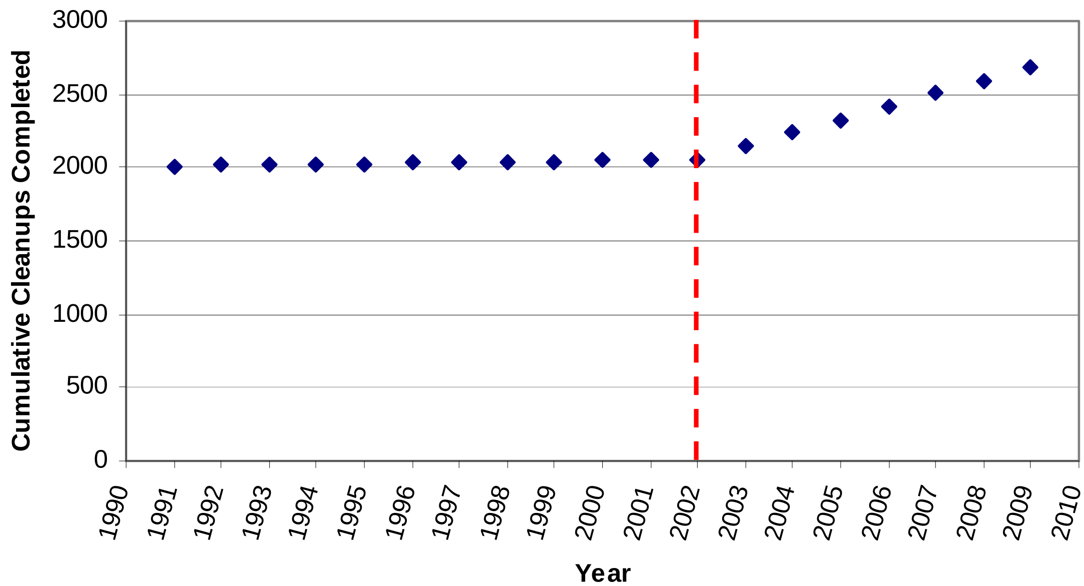

OK - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

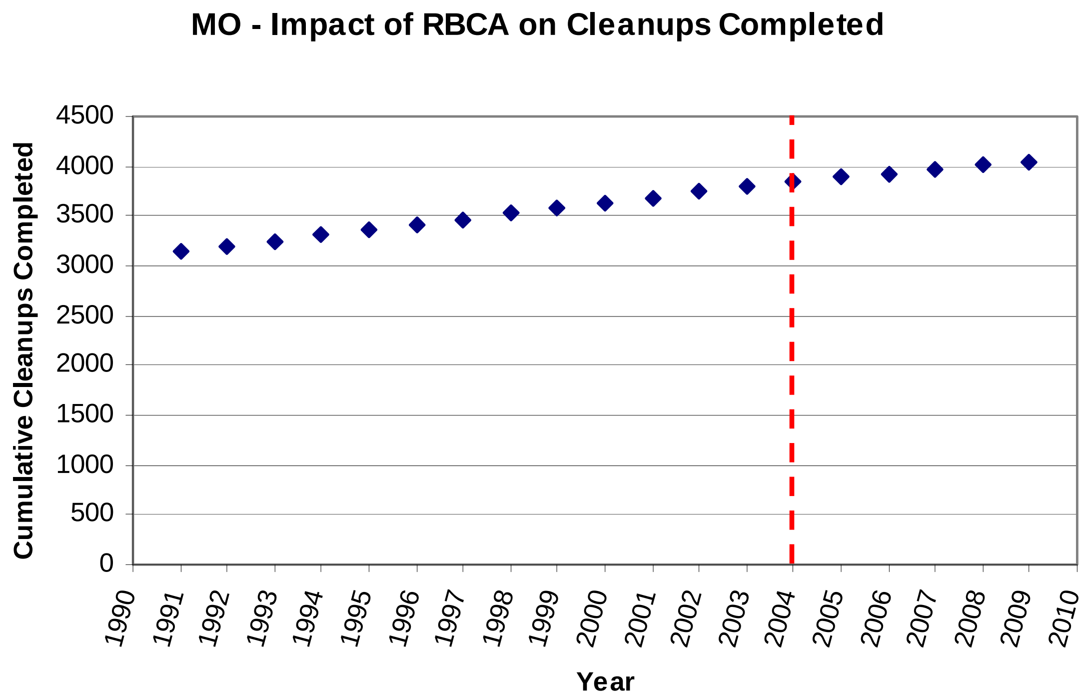

TX - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

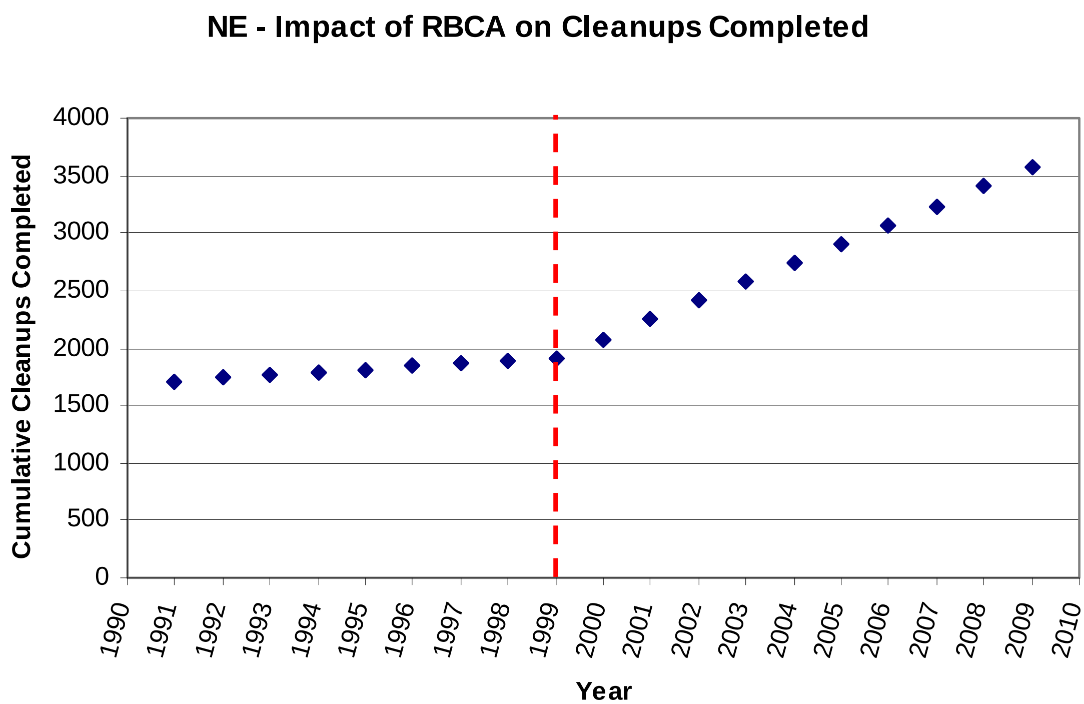
IA - Impact of RBCA on Cleanups Completed

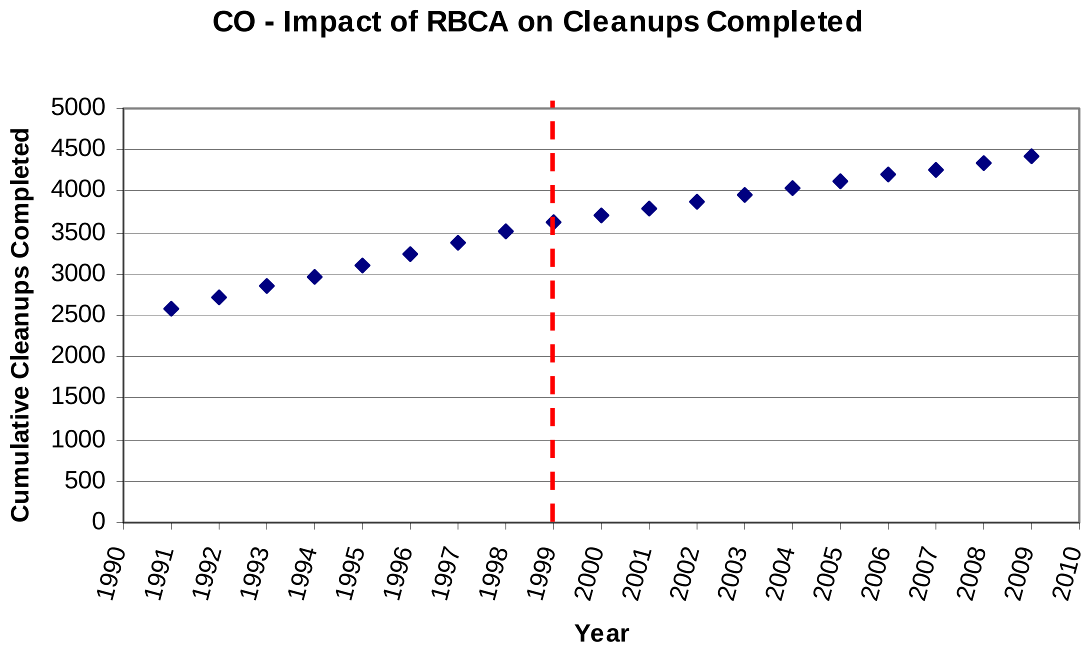


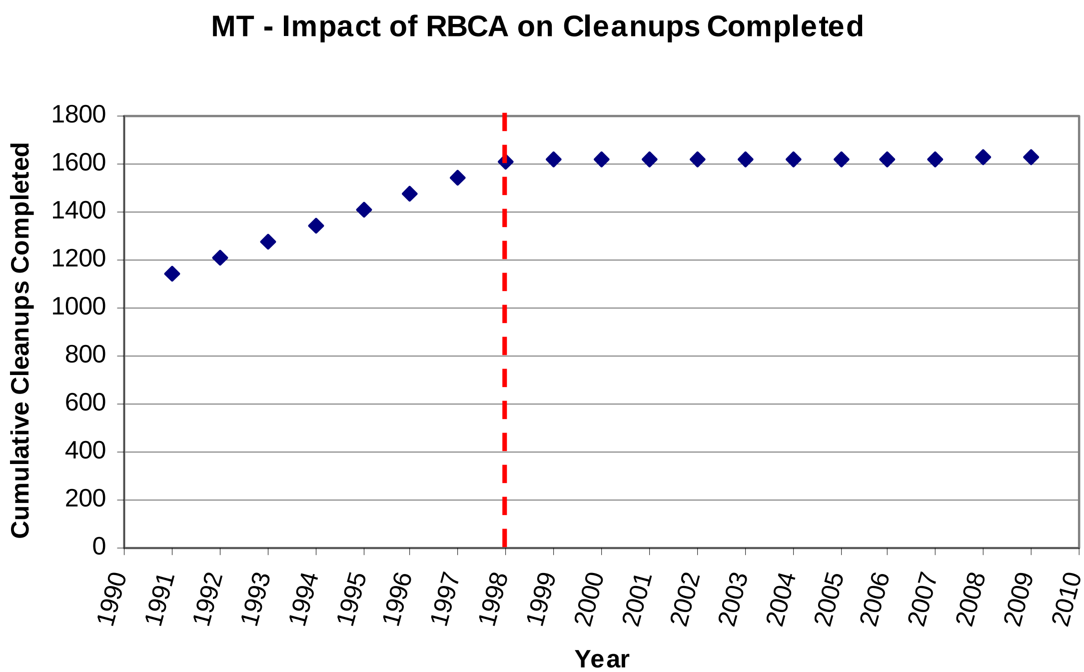
KS - Impact of RBCA on Cleanups Completed

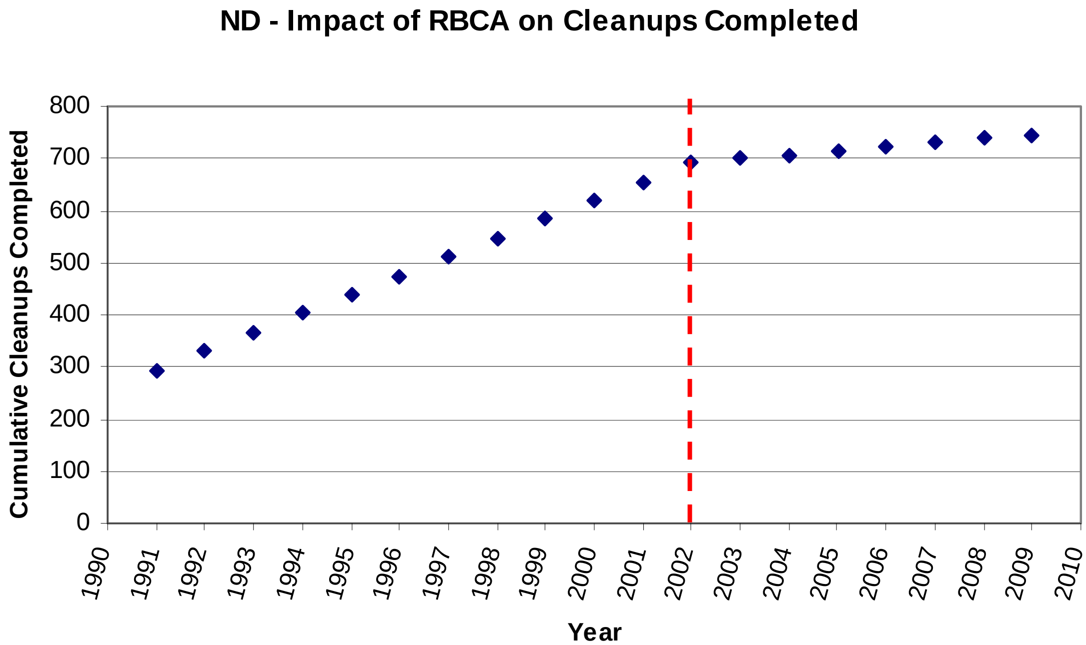


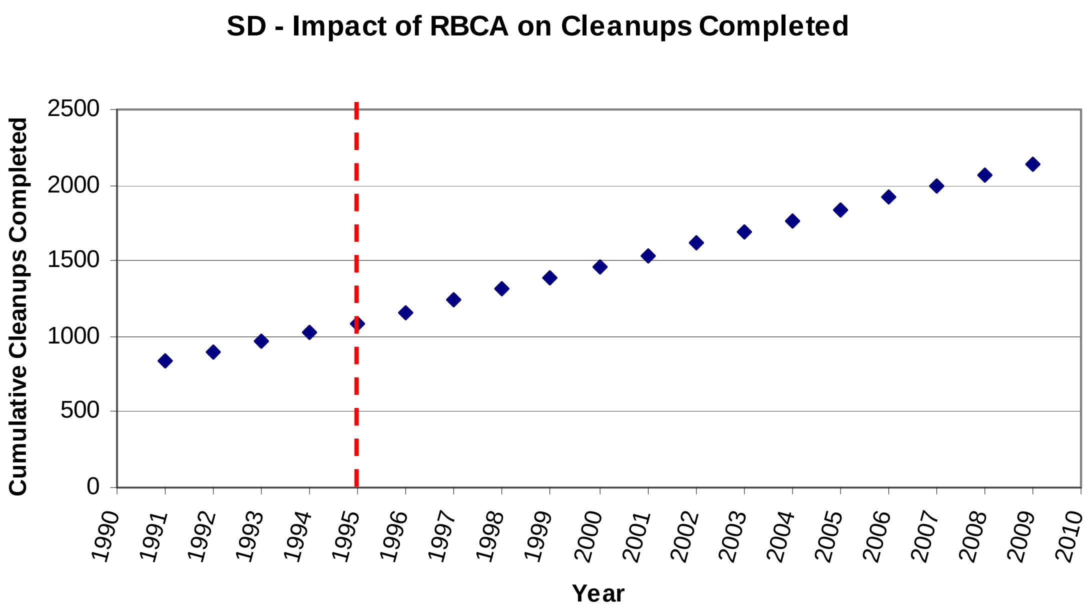

MO - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


NE - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

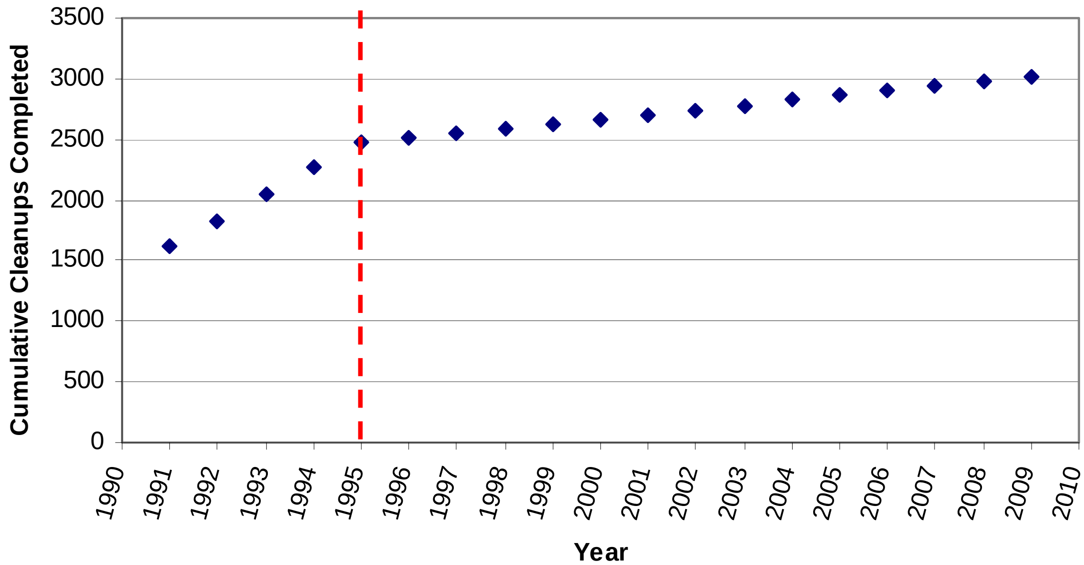

CO - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


MT - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
0
200
400
600
800
1000
1200
1400
1600
1800
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

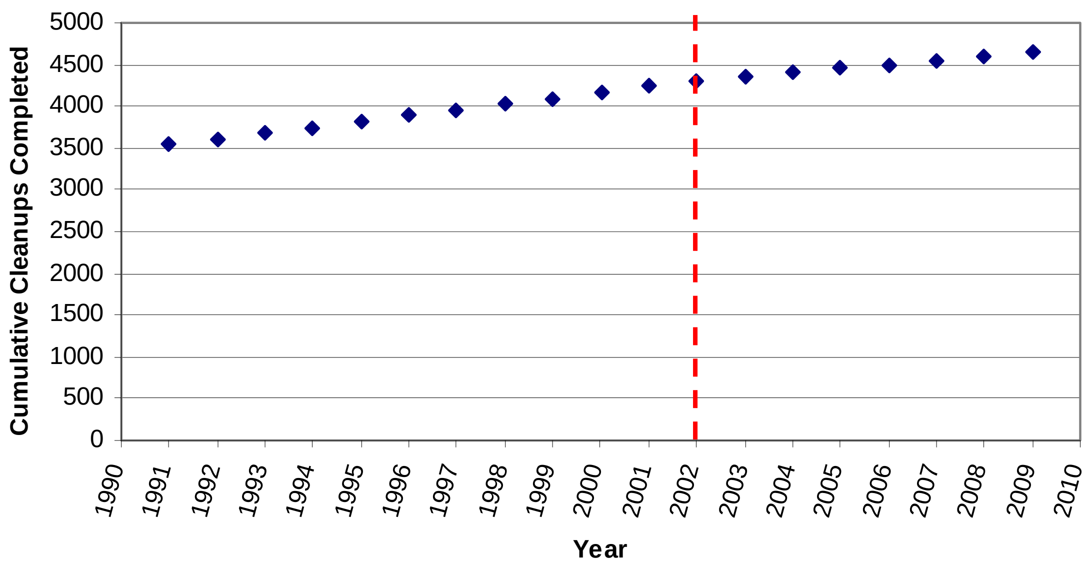

ND - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
800
700
600
500
400
300
200
100
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


SD - Impact of RBCA on Cleanups Completed
Cumulative Cleanups Completed
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

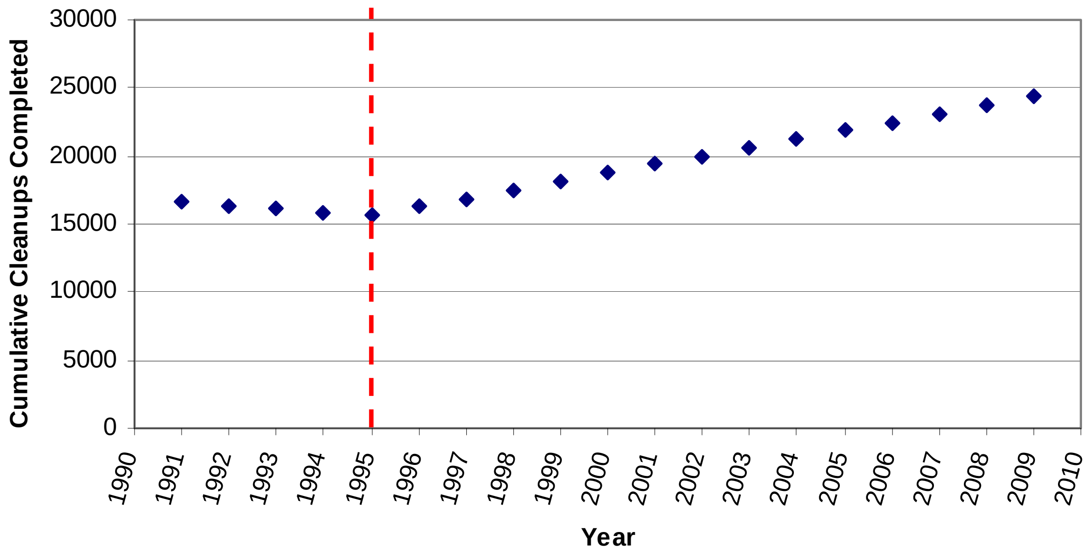
UT - Impact of RBCA on Cleanups Completed



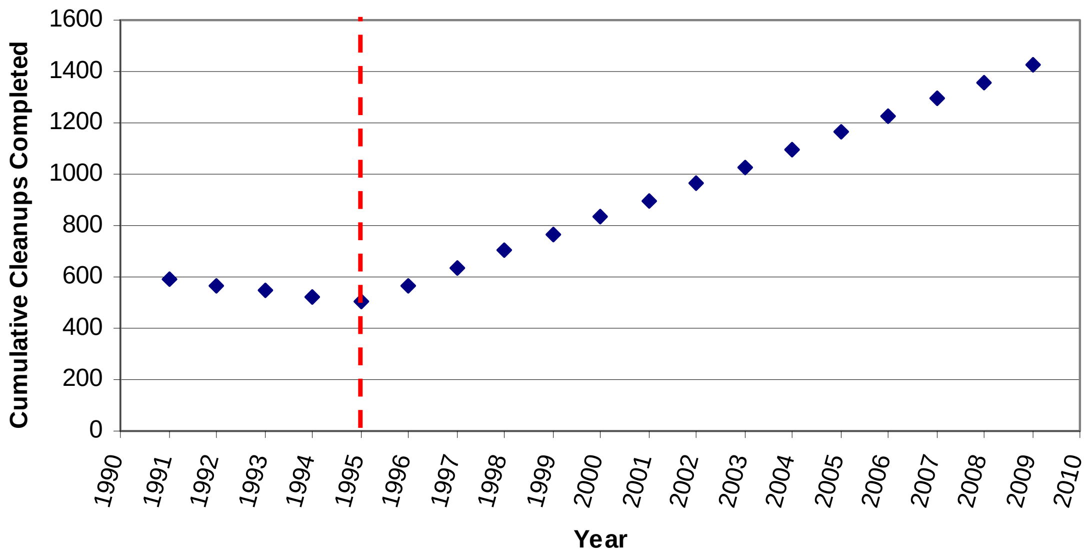
AZ - Impact of RBCA on Cleanups Completed



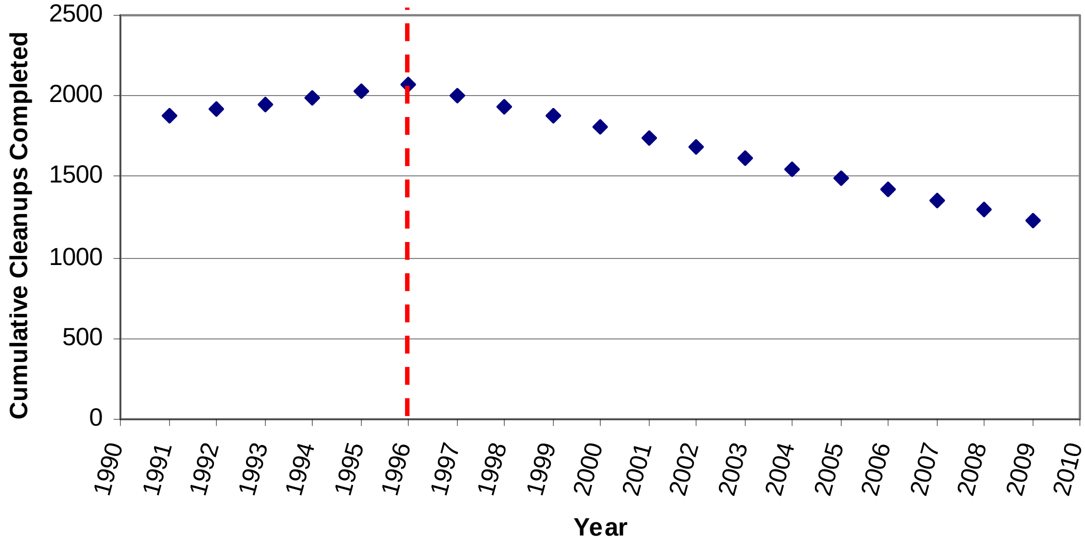
CA - Impact of RBCA on Cleanups Completed



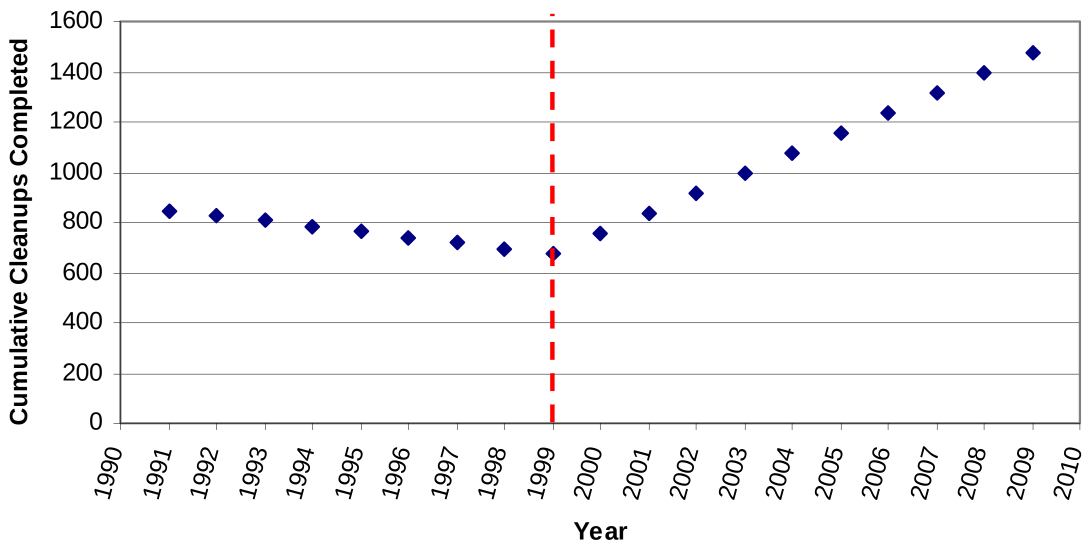
HI - Impact of RBCA on Cleanups Completed



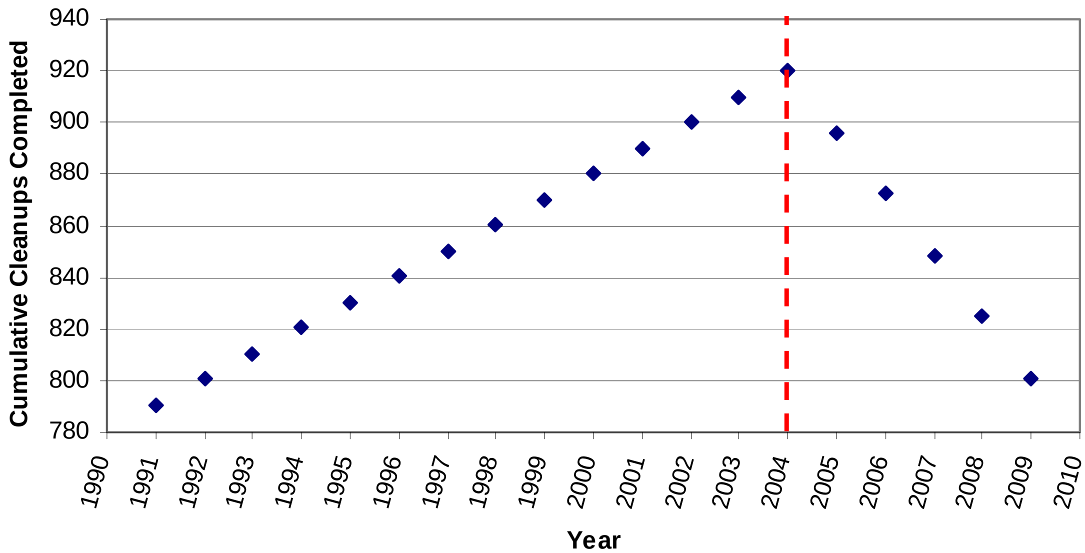
NV - Impact of RBCA on Cleanups Completed



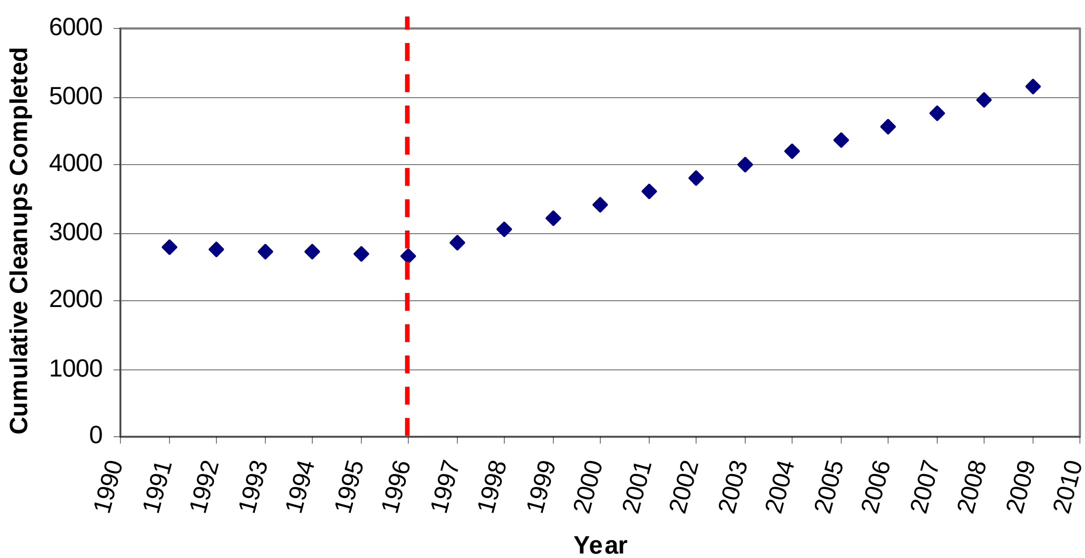
AK - Impact of RBCA on Cleanups Completed

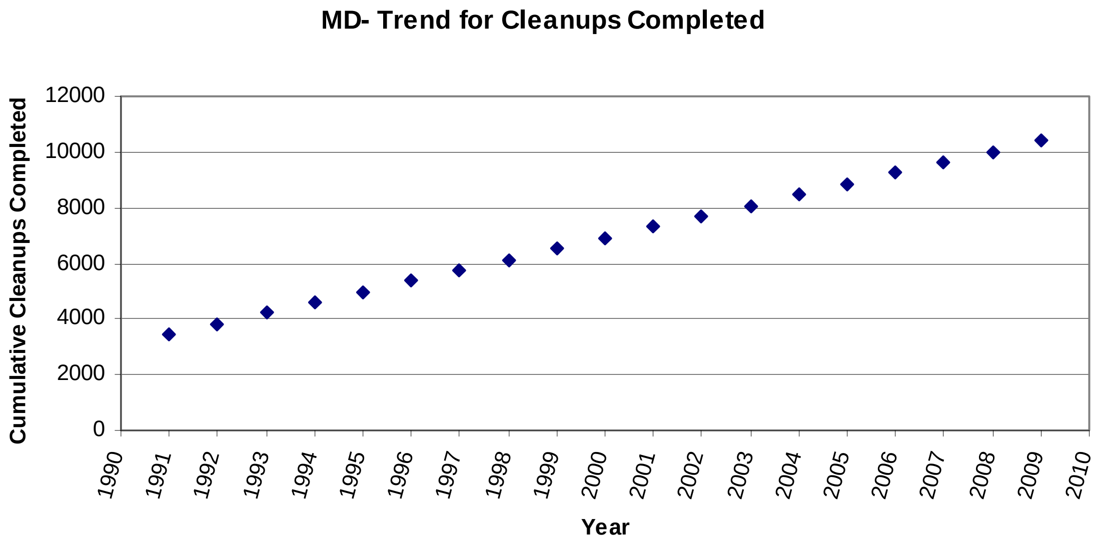


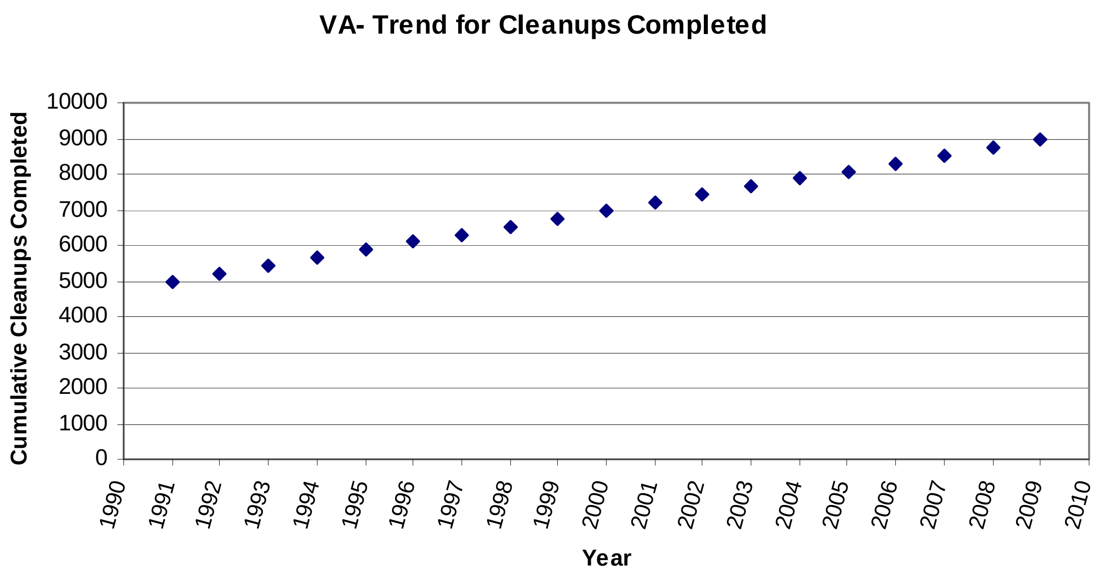
ID - Impact of RBCA on Cleanups Completed



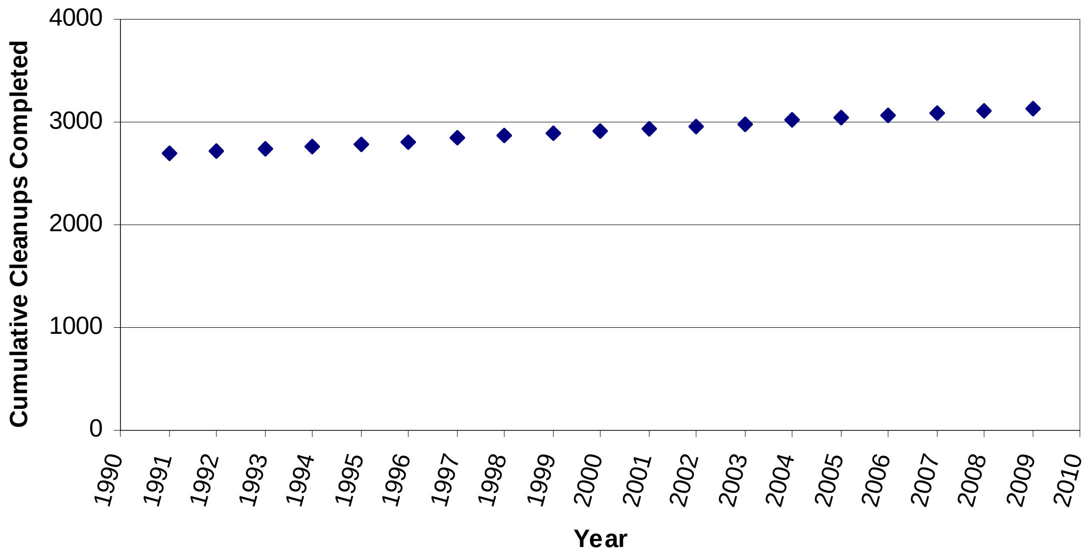
OR - Impact of RBCA on Cleanups Completed



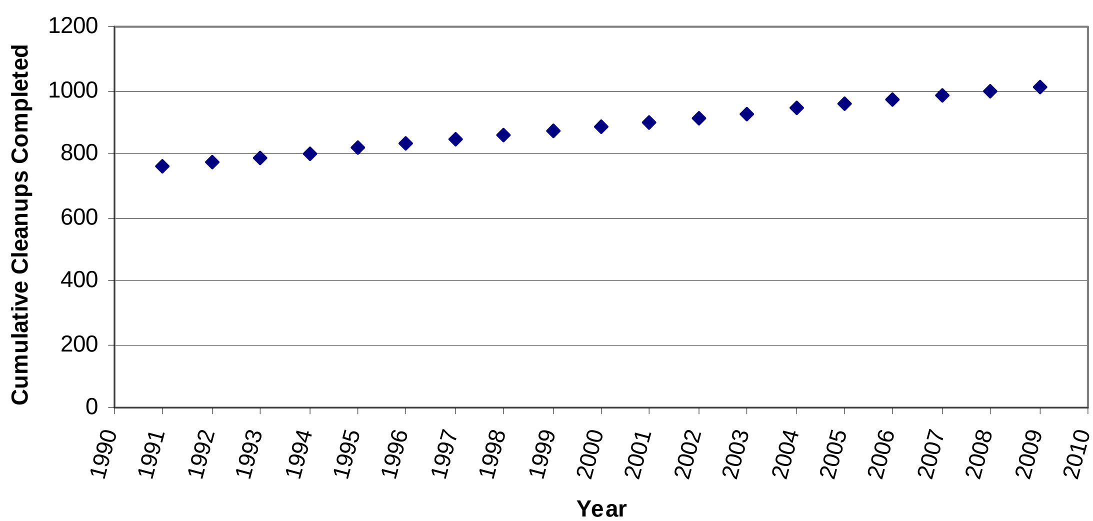

MD- Trend for Cleanups Completed
Cumulative Cleanups Completed
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year


VA- Trend for Cleanups Completed
Cumulative Cleanups Completed
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

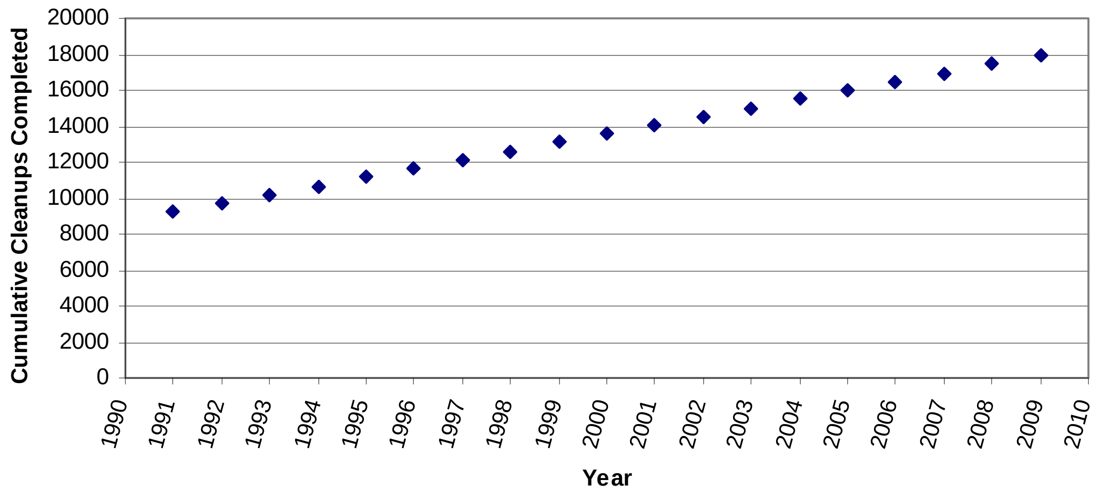
WA - Trend for Cleanups Completed



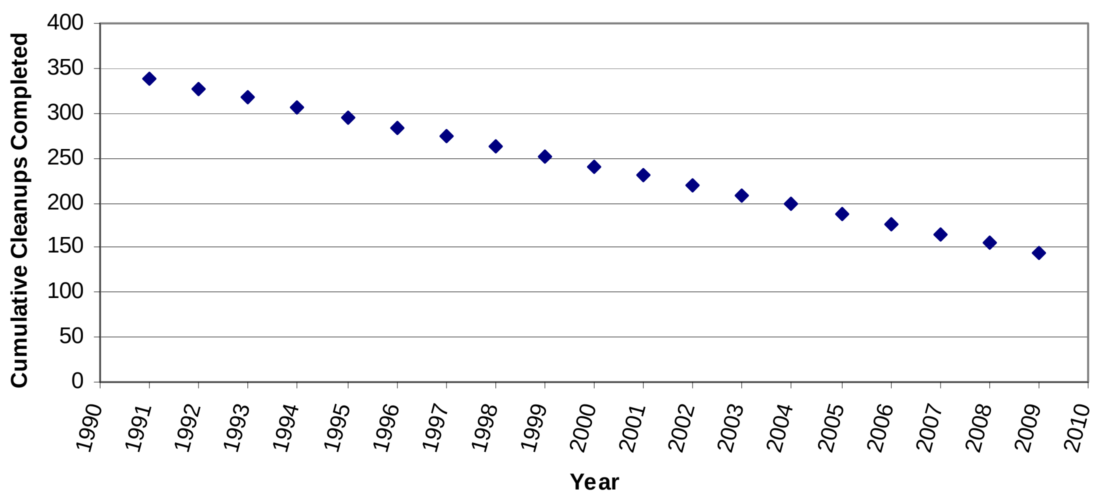
VT- Trend for Cleanups Completed



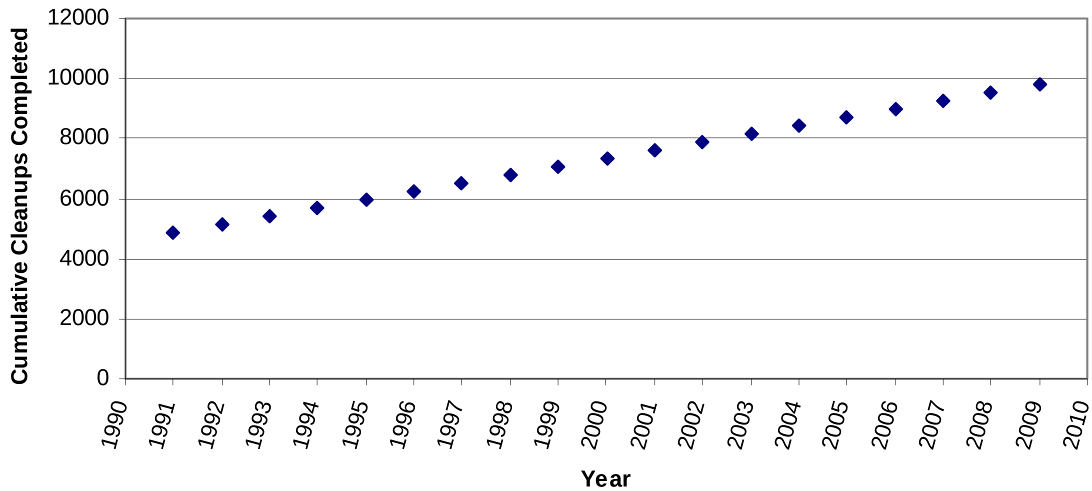
NY- Trend for Cleanups Completed



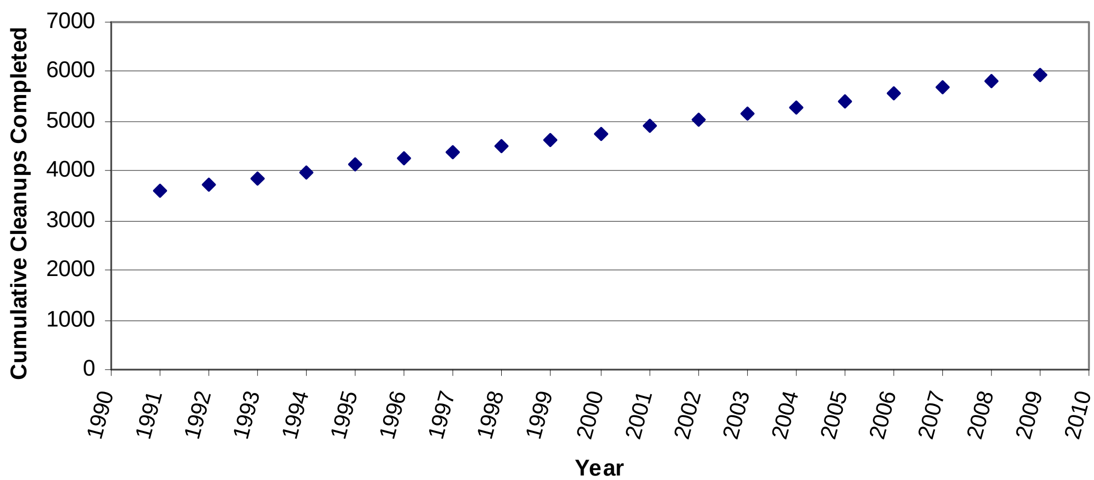
PR- Trend for Cleanups Completed

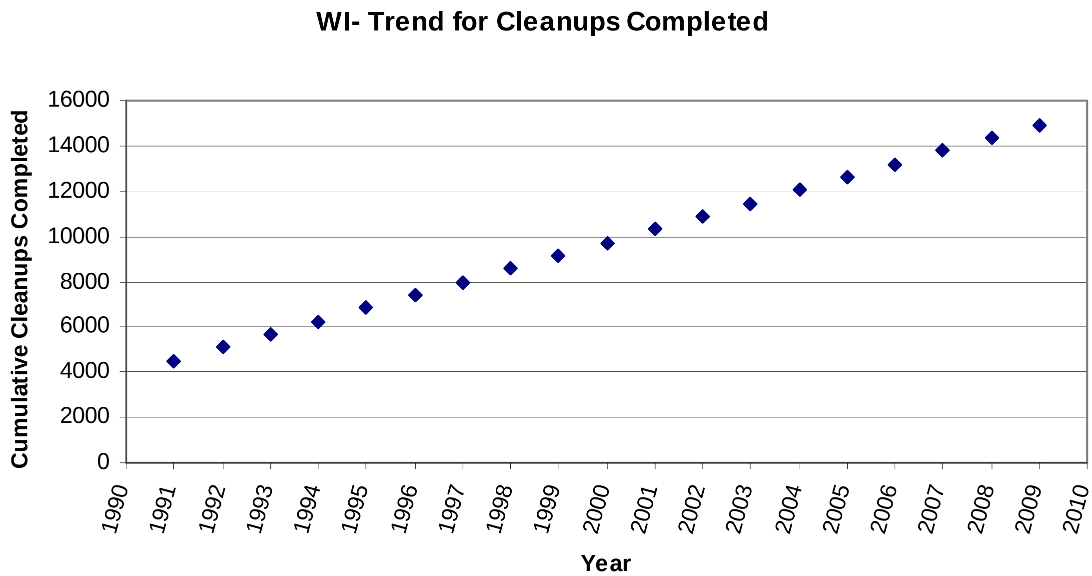


KY- Trend for Cleanups Completed



MS- Trend for Cleanups Completed




WI- Trend for Cleanups Completed
Cumulative Cleanups Completed
16000
14000
12000
10000
8000
6000
4000
2000
0
1990
1991
1992
1993
1994
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1996
1997
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1999
2000
2001
2002
2003
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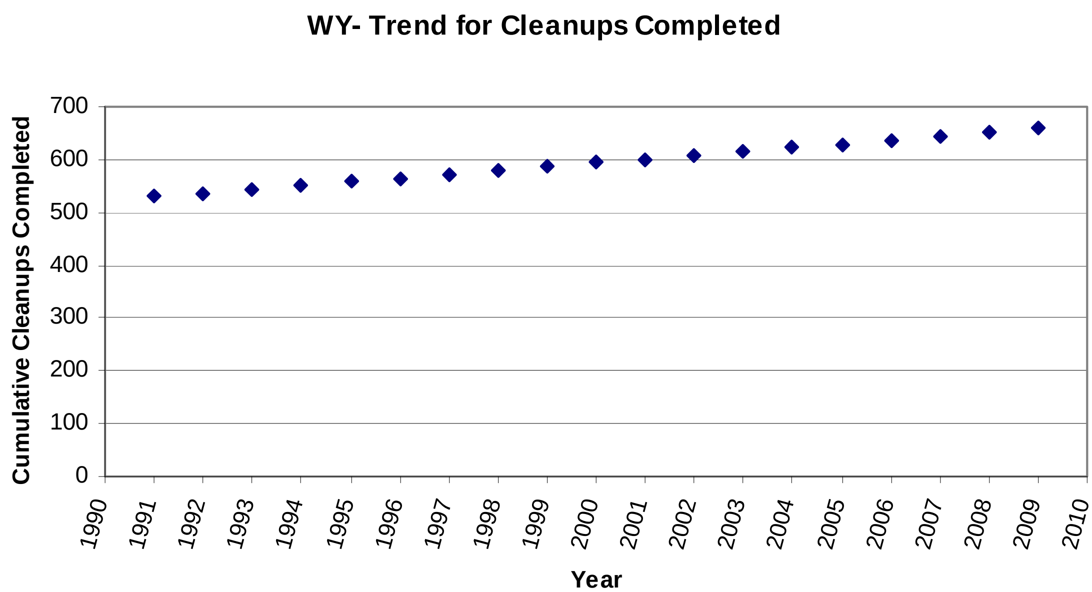
2005
2006
2007
2008
2009
2010
Year


WY- Trend for Cleanups Completed
Cumulative Cleanups Completed
700
600
500
400
300
200
100
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

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Harold O. White, Jr. was born on January 17, 1958, in Moscow, Idaho. He graduated from Washington-Lee High School in Arlington, Virginia, in June of our Nation's bicentennial year. He earned the degree of Bachelor of Science in Geology, at the College of William and Mary in1980. In December, 1984, he completed the requirements for the degree of Master of Science in Geology at Oklahoma State University. He was then employed for nearly a decade as a consulting Hydrogeologist. In March, 1994, he began full-time employment with the U.S. Environmental Protection Agency, Office of Underground Storage Tanks. In June 1997 he completed the requirements for his second M.S. degree, this in Environmental Sciences and Engineering from Virginia Tech. In fall 2003, he began taking classes in Environmental Science and Policy at George Mason University and was formally accepted into the doctoral program in fall 2004. Finally, in spring 2011 he completed his dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Environmental Science and Public Policy from George Mason University in Fairfax, Virginia.