Waterborne Disease and Outbreak Surveillance

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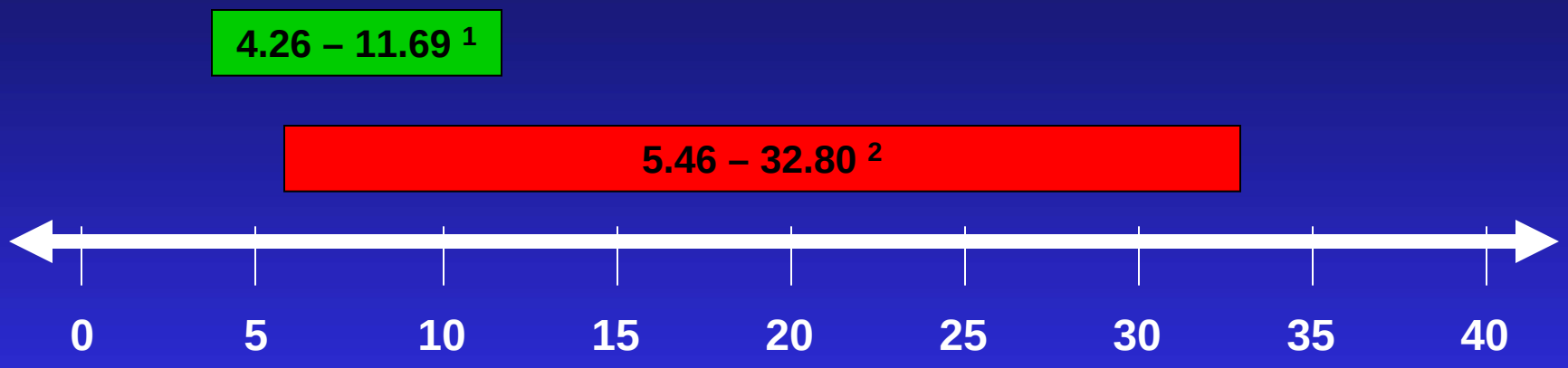
Estimates of Endemic Waterborne Disease



million cases of AGI per year from public drinking water systems

Estimates of total annual AGI illness range from 76 million to 183 million cases [3,4]

1 Colford et al. Journal of Water and Health, 2006.
2 Mesner et al. Journal of Water and Health, 2006.
3 Mead et al. Emerging infectious Diseases, 1999.
4 Jones et al. Epidemiology of Infectious Diseases, 2007.

Ideal Waterborne-Disease Surveillance

- All water-related pathogens and chemicals would be nationally notifiable
- Pathogens and chemicals of interest would only be transmitted by water

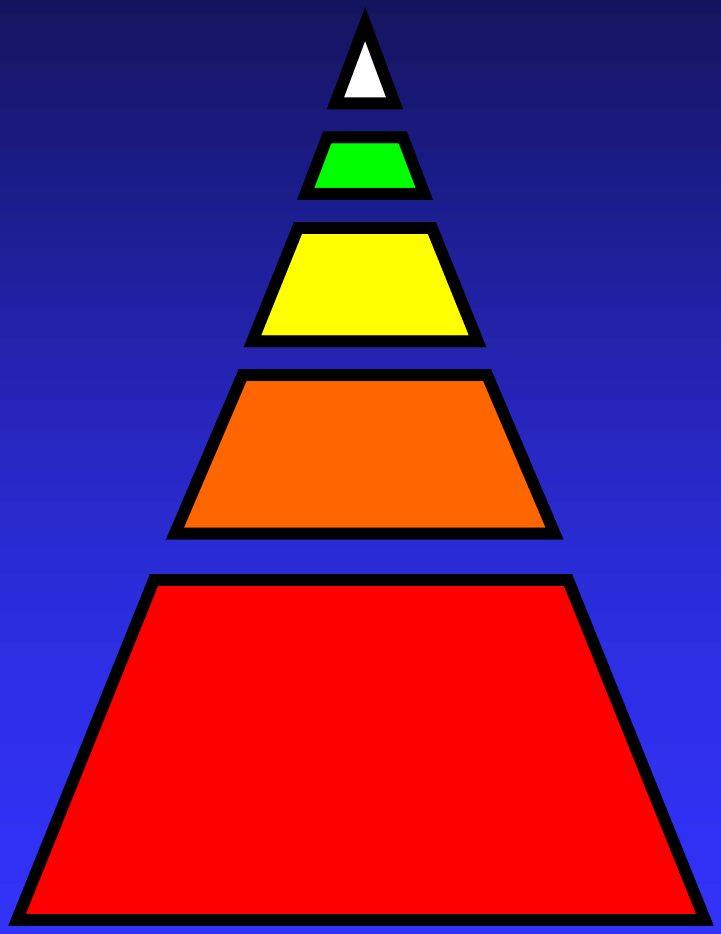
OR

- All cases would be investigated to determine mode of transmission
- All cases would be identified and reported

Real World Waterborne-Disease Surveillance

- Not all water-related pathogens and chemicals are nationally notifiable
- Most water-related pathogens and chemicals have multiple modes of transmission
- Most individual cases not investigated so mode of transmission unknown
- Reported cases represent only a small portion of the burden of disease

Case Reporting*



- Reported
- Laboratory-confirmed
- Lab test(s) requested
- Healthcare consultation
- No healthcare consultation

* Unlikely to include transmission mode

Waterborne Disease and Outbreak Surveillance System

- The primary ongoing source of data concerning the scope and effects of waterborne disease and outbreaks (WBDOs) among persons in the United States

Waterborne Disease and Outbreak Surveillance System

- WHO
  - Collaborative surveillance system of Council of State and Territorial Epidemiologists, CDC, EPA since 1971
  - State/local health departments have primary responsibility for detecting, investigating, reporting WBDOs

Waterborne Disease and Outbreak Surveillance System

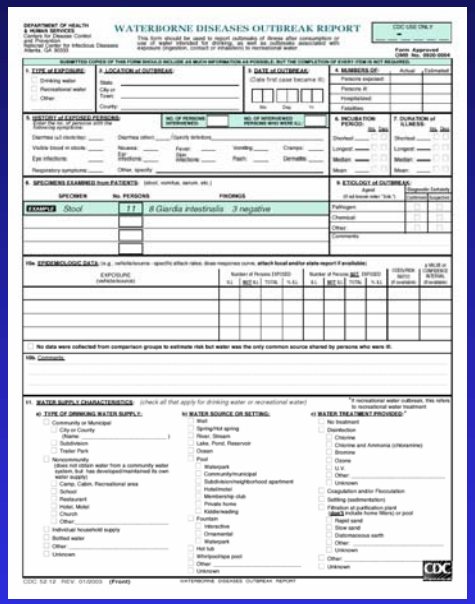
- WHAT
  - Passive surveillance
  - Paper-based system transitioning to electronic reporting
  - Waterborne outbreaks nationally notifiable (CSTE 2006)

Waterborne Disease and Outbreak Surveillance System

- **WHEN**
  - Annual solicitation of reports from state health departments
  - Data reviewed, cleaned, and analyzed
  - MMWR Surveillance Summary—every 2 years

Waterborne Disease and Outbreak Surveillance System

- Unit of analysis is typically an outbreak (N >2) rather than a case
  - Epidemiologically linked by
    - Location of exposure to water
    - Time
    - Illness


WATERBORNE DISEASES OUTBREAK REPORT

- Epidemiologic evidence must implicate water as the probable source of illness
  - Epidemiologic data required
  - Water quality data requested but optional

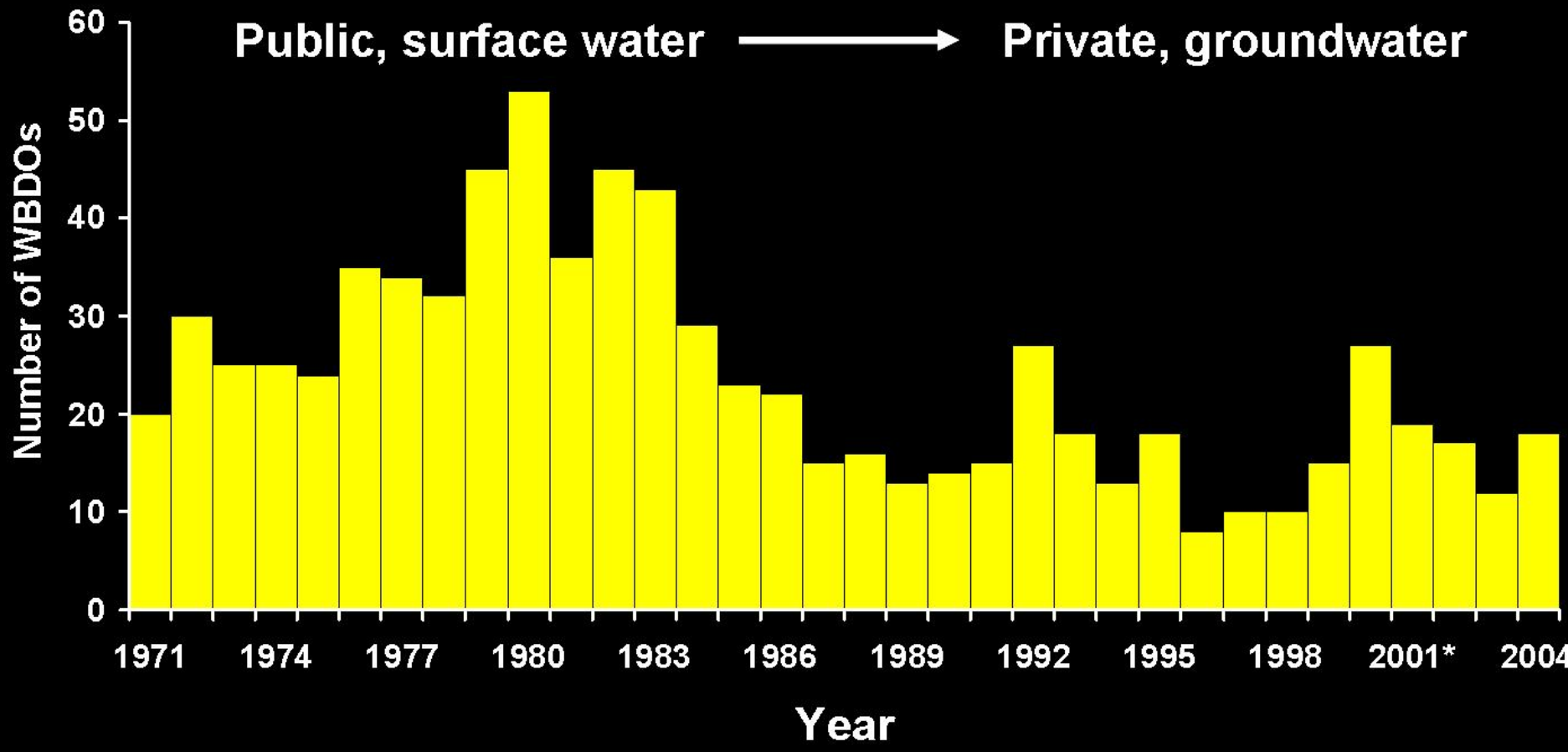
Waterborne Disease and Outbreak Surveillance System

- Single cases of waterborne disease
  - Lab-confirmed primary amebic meningoencephalitis (PAM, *Naegleria fowleri*)
  - Chemical / toxin poisoning
  - *Vibrio* infections and wound infections associated with recreational water use

CAUTION!

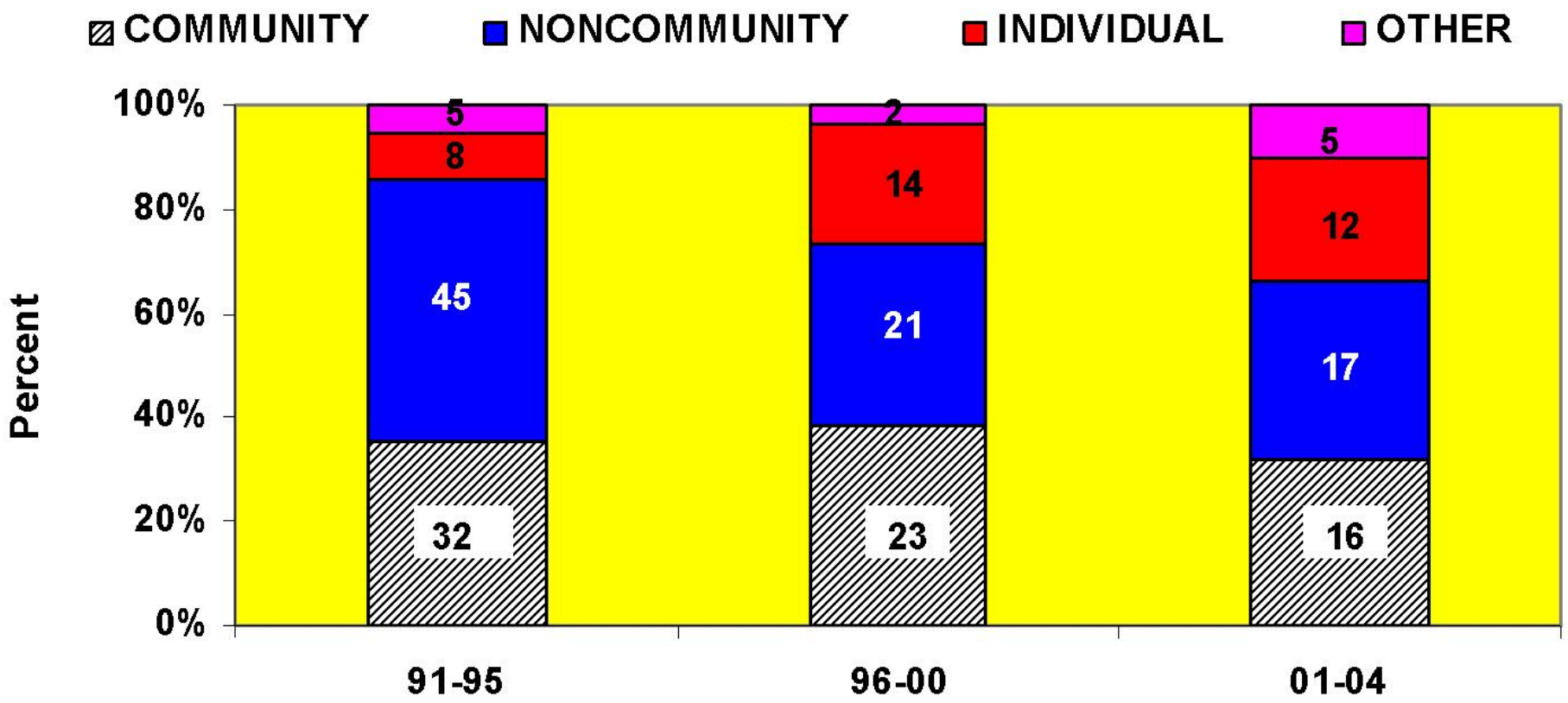
Preliminary Data

Number of WBDOs Associated with Drinking Water (n=803)*, by Year— United States, 1971–2004



* Beginning in 2001, Legionnaires' disease was added to the surveillance system. The data in this graph includes WBDOs associated with both public and private water systems.

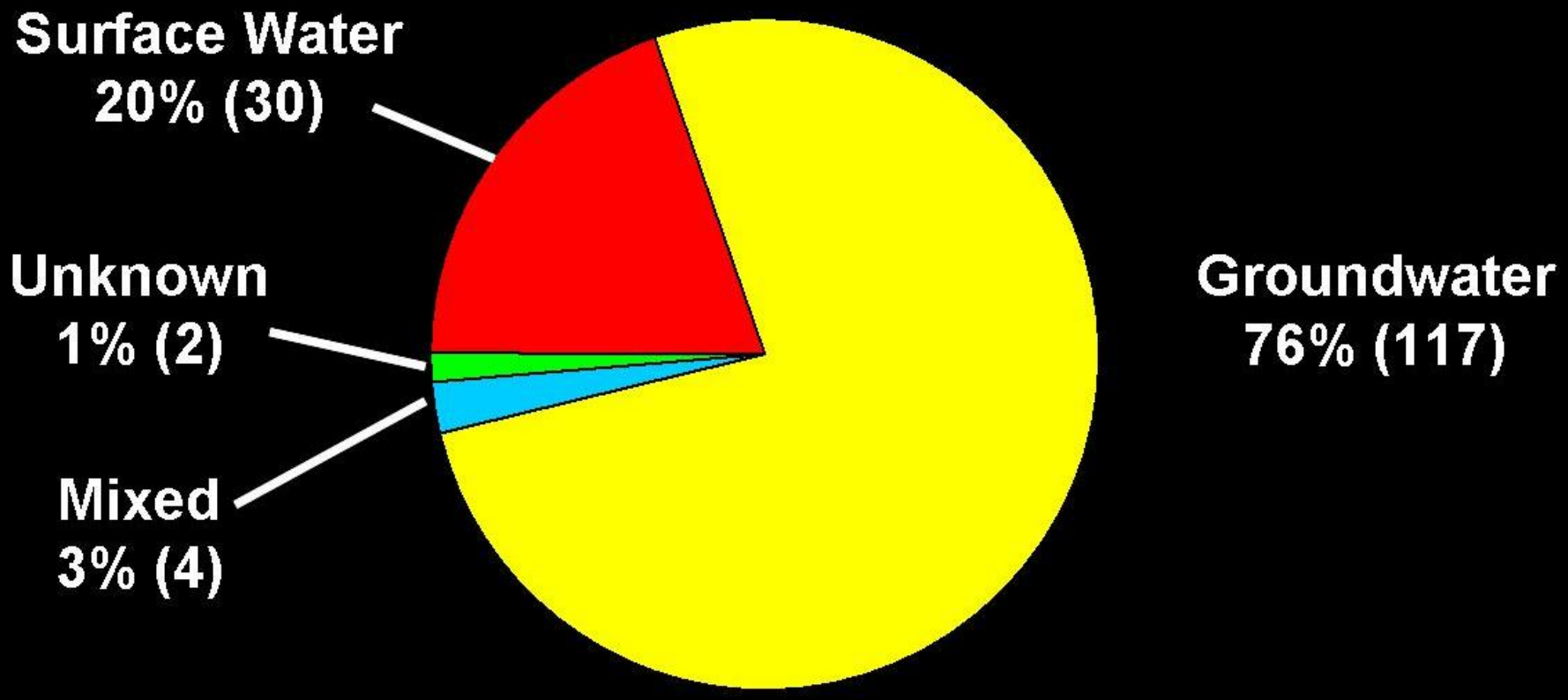
WBDOs Associated with Drinking Water*, by Type of Water Supply — United States, 1991–2004



N = 90 N = 60 N = 50

* No *Legionella*

WBDOs Associated with Public Water Systems* (n=153), by Water Source — United States, 1991–2004



* No *Legionella*

Deficiency

- Antecedent event or situation that results in exposure of persons to a disease-causing agent or agents
- One deficiency per outbreak
  - Deficiency without which outbreak would not have occurred

Historical Drinking Water System Deficiencies

1. Untreated surface water
2. Untreated groundwater
3. Treatment deficiency
4. Distribution system deficiency
5. Unknown or miscellaneous deficiency
   - Contaminated bottled water
   - Source water not intended for drinking

New WBDO Drinking Water Deficiencies

1. Untreated surface water intended for drinking
2. Untreated ground water intended for drinking
3. Treatment deficiency
4. Distribution system deficiency, including storage

New WBDO Drinking Water Deficiencies

5. *Legionella* spp. in water system
6. Plumbing system deficiency after water meter or property line
7. Deficiency in building/home-specific water treatment
8. Deficiency or contamination of equipment/devices using or distributing water
9. Contamination during commercial bottling
10. Contamination during shipping, hauling, or storage
11. Contamination at point of use

Original Deficiency 4 – Distribution System

- Pipes and storage infrastructure from point of treatment to point of use

New Deficiency 4 – Distribution System

CWS

- Pipes and storage infrastructure of water utility from point of treatment to water meter or property line

NCWS & PWS

- Pipes and storage infrastructure from point of treatment to point of entry into building or house

New Deficiency 6 – Plumbing

CWS

- Pipes and storage infrastructure after point of entry into building or house
- Service line leading to building or house from water meter or property line

NCWS & PWS

- Pipes and storage infrastructure after point of entry into building or house

Deficiency by Water System Type

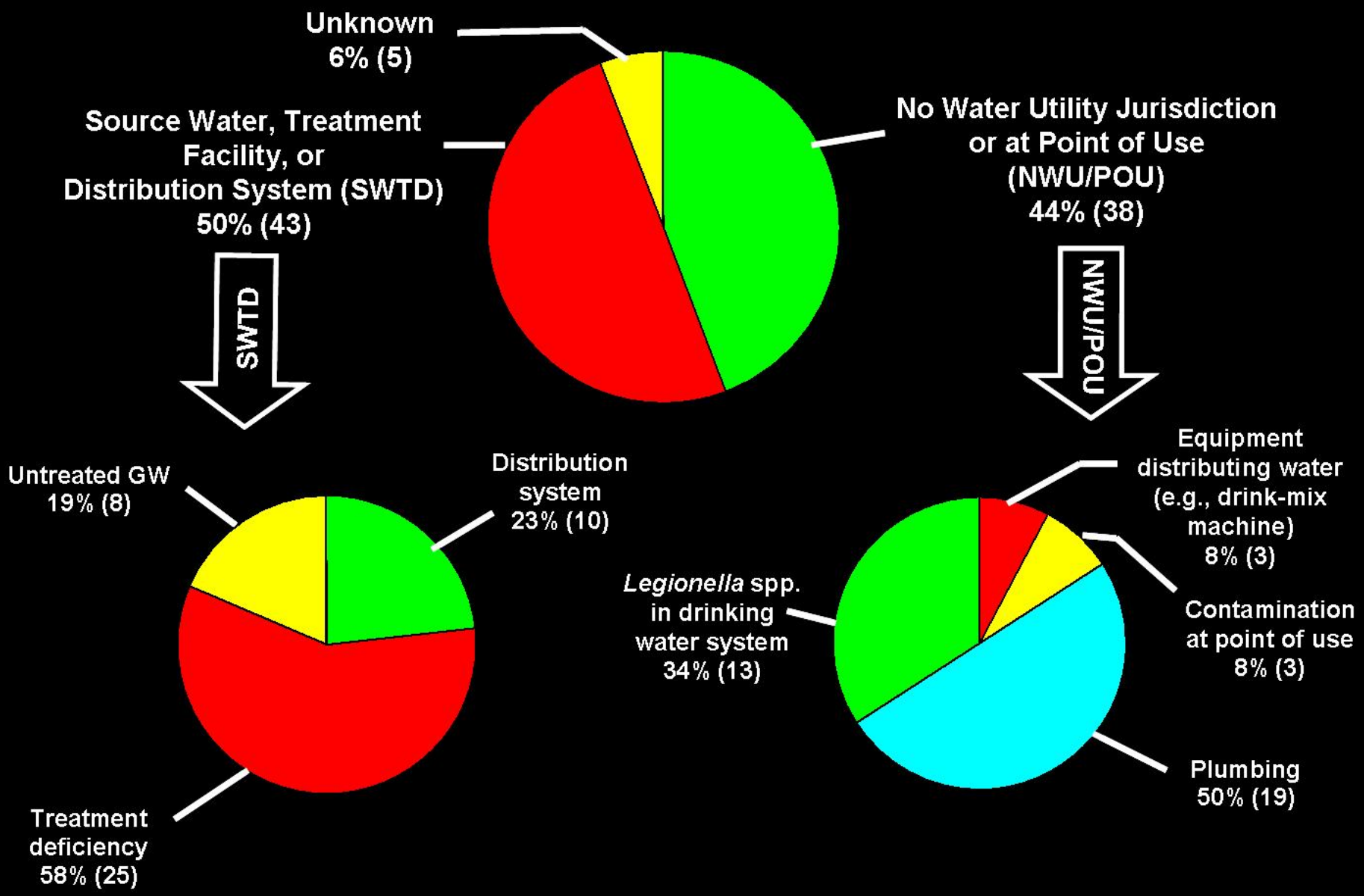
Water System Type	Deficiency 4 (Distribution System)	Deficiency 6 (Plumbing)
CWS	Before water meter or property line	After water meter or property line
NCWS	Before building or house	After building or house
PWS	Before building or house	Before building or house

TCR / Distribution System Questions

- Distribution system deficiencies versus source/treatment deficiencies
- Distribution system deficiencies over time
- Distribution system deficiencies within and outside utility jurisdiction

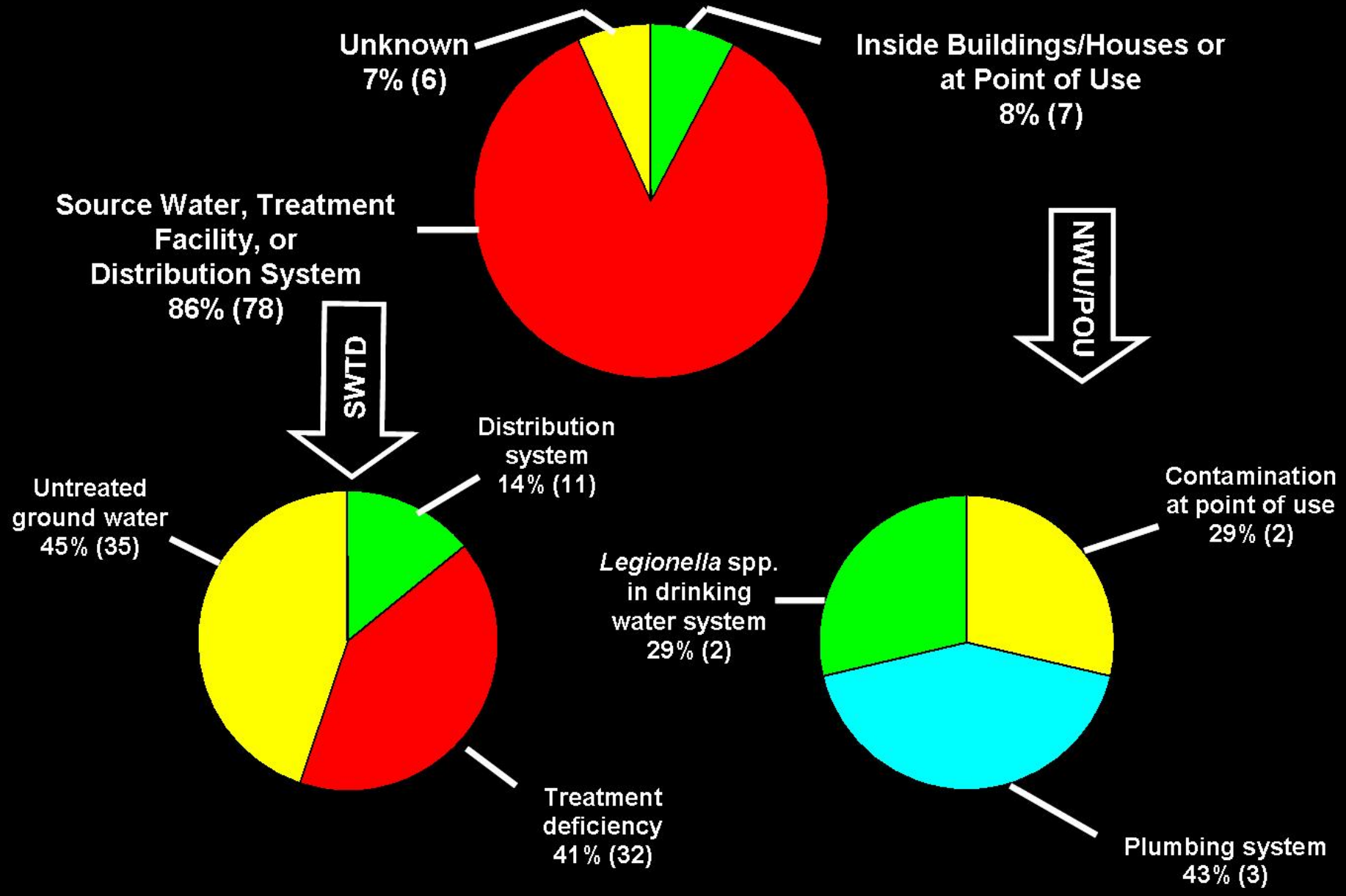
Drinking Water WBDOs in CWS by Deficiency — 1991–2004

All Deficiencies (n=86)



Drinking Water WBDOs in NCWS by Deficiency — 1991–2004

All Deficiencies (n=91)



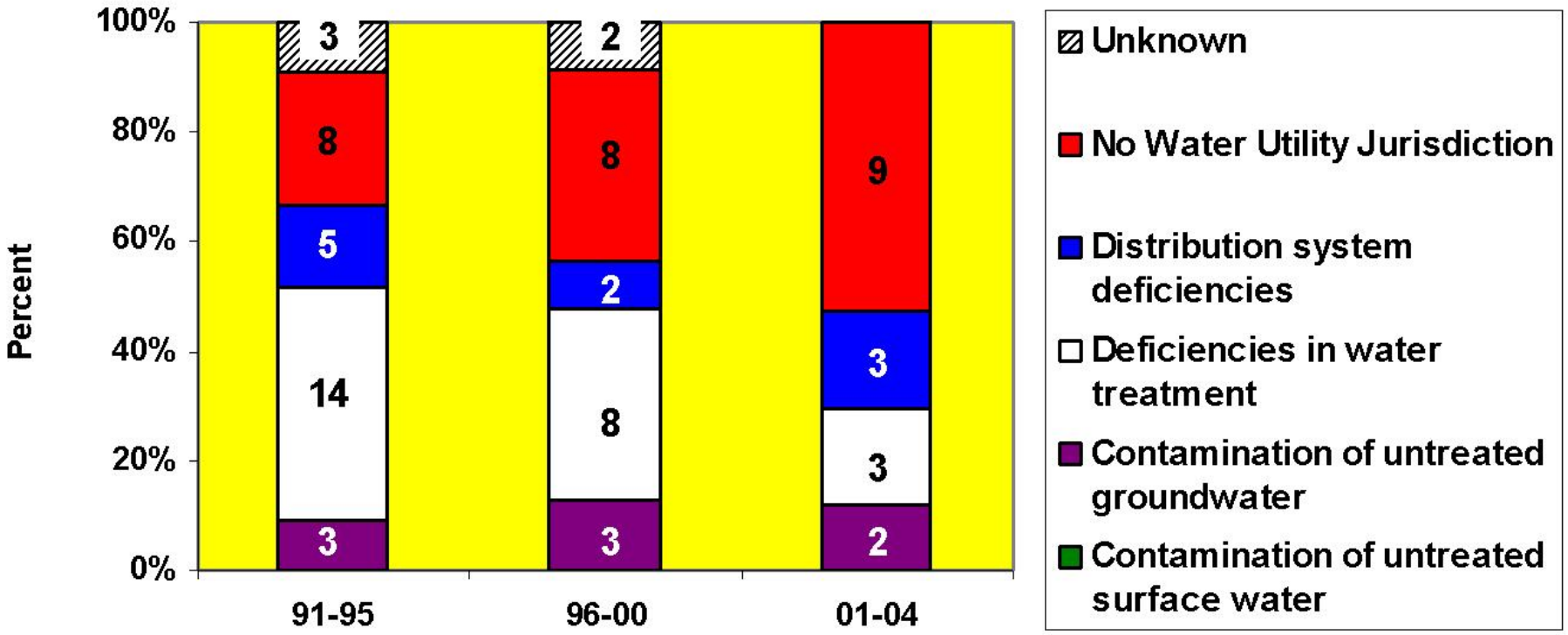
WBDOs Associated with Distribution System Contamination in Public Water Systems* — United States, 1991–2004

System Type	Reported WBDOs *	Reported Deficiencies *	Distribution System Deficiencies ** n (%)
Community Systems (CWS)	71	73	10 (14%)
Noncommunity Systems (NCWS)	82	89	11 (12%)
Total	153	162	21 (13%)

* No *Legionella*.

** For CWS, all deficiencies occurred before the property line/water meter. For NCWS, all deficiencies occurred before the building.

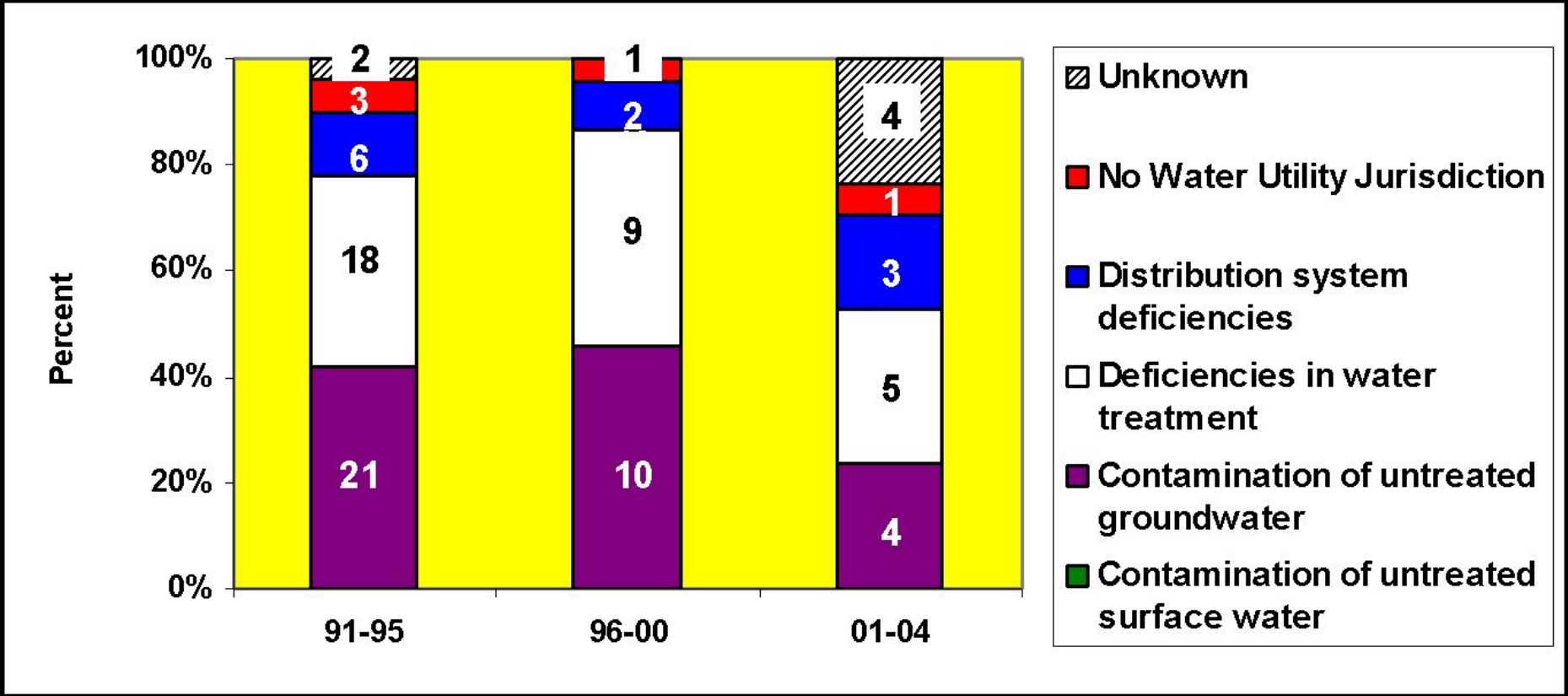
Deficiencies Associated with CWS* — United States, 1991–2004



	91-95	96-00	01-04
Number of Deficiencies	33	23	17
Number of WBDOs*	32	23	16

* No *Legionella.* Total deficiencies = 73. Total WBDOs = 71.

Deficiencies Associated with NCWS* — United States, 1991–2004



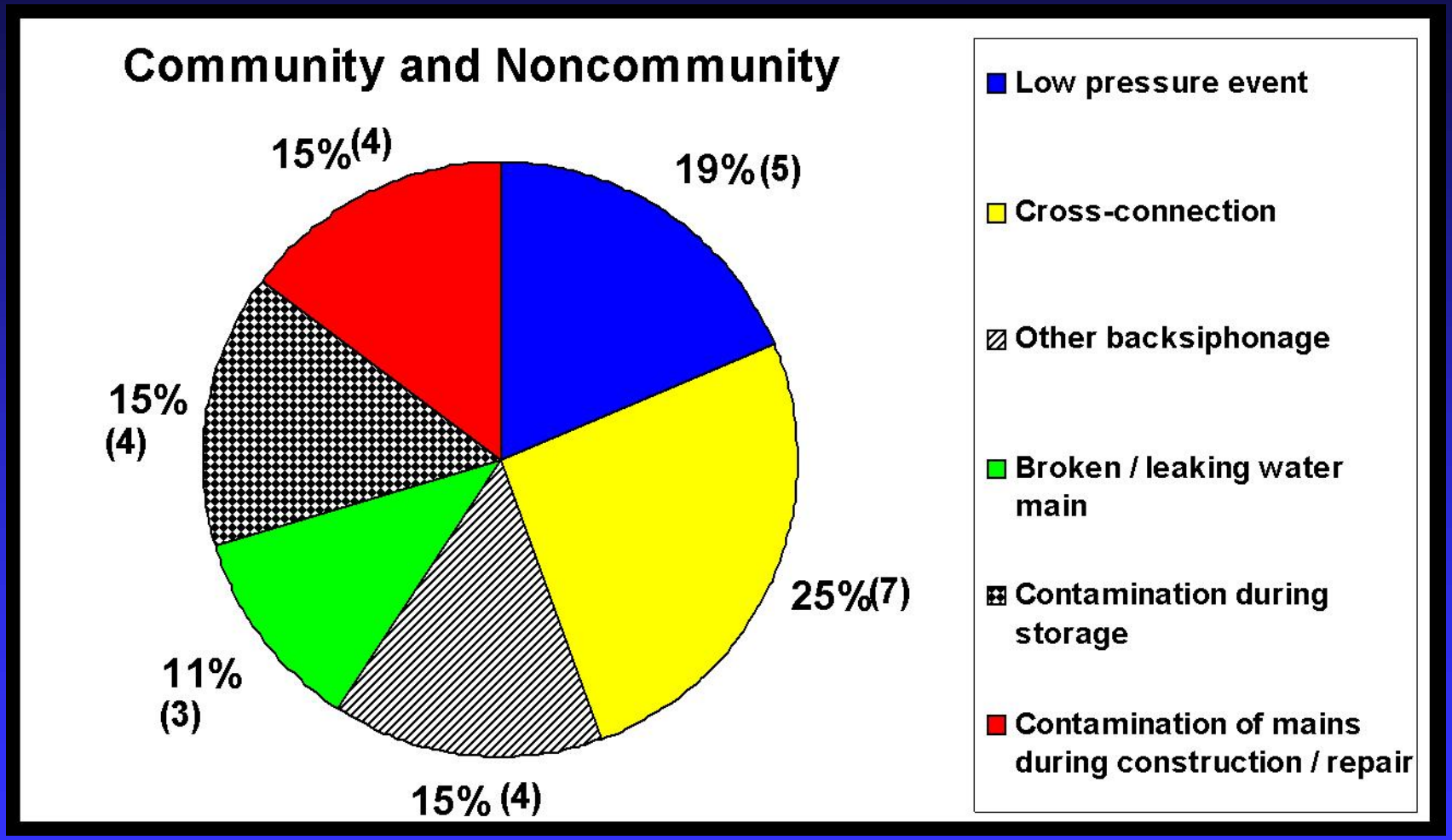
	91-95	96-00	01-04
Number of Deficiencies	50	22	17
Number of WBDOs*	45	21	16

* No *Legionella.* Total deficiencies = 89. Total WBDOs = 82.

TCR / Distribution System Questions

- Causes of distribution system deficiencies

WBDOs Associated with Distribution System Deficiencies* — United States, 1991–2004



* No *Legionella*

TCR / Distribution System Questions

- Distribution system deficiencies by etiologic agent

Etiology of WBDOs Caused by Distribution System Deficiencies — United States, 1971–2004

Etiology	Community Systems		Noncommunity Systems	
	Outbreaks	Percent	Outbreaks	Percent
Chemical	44	37	4	14
Unidentified	31	26	11	40
Legionella *	13	11	2	7
Giardia	10	8	5	17
Campylobacter	5	4	1	3
Salmonella	4	3	1	3
Shigella	3	3	1	3
Norovirus	3	3	2	7
E. Coli	2	2	0	0
Cryptosporidium	2	2	1	3
Hepatitis A	1	1	0	0
S. Typhi	1	1	0	0
Cyclospora	1	1	0	0
V. Cholera	0	0	1	3

* *Legionella* added in 2001

Chemical Etiology of WBDOs Caused by Distribution System Deficiencies — United States, 1971–2004

Chemical	Community	Noncommunity
Copper	22	3
Chlordane	3	0
Nitrate	3	0
Unidentified Herbicide	3	0
Ethylene Glycol	3	0
Oil	1	1
Fluoride	1	0
Lead	1	0
Chromium	1	0
Sodium, Hydroxide	1	0
Chlorine	1	0
Liquid Soap	1	0
Ethyl Acrylate	1	0
Morpholine	1	0
Chemical Outbreaks	44	4

TCR / Distribution System Questions

- Distribution system deficiencies by source water

Water Source in WBDOs Caused by Distribution System Deficiencies — United States, 1991–2004

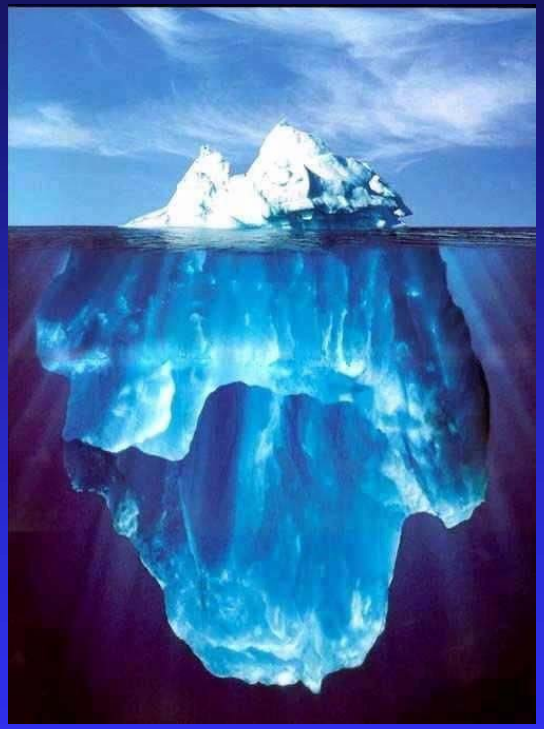
Water Source	WBDOs in Community Systems n (%)	WBDOs in Noncommunity Systems n (%)
Groundwater	8 (80%)	11 (100%)
Surface Water	1 (10%)	0 (0%)
Mixed	1 (10%)	0 (0%)

Usefulness of the Surveillance Data

- Disease control
  - Identify contaminated water sources
- Knowledge of disease causation
  - Identify etiologic agents (old and new)
- Trend identification
  - Etiologic agents, water sources, deficiencies
- Administrative guidance
  - Evaluate the adequacy of current technologies for providing safe water
  - Establish research priorities
  - Assess effectiveness of water regulations

Limitations of WBDO Surveillance Data

- Data represents only a portion of the burden of illness associated with water exposure
- Data does not include cases of endemic waterborne disease
- No reliable estimates of the number of unrecognized WBDOs and associated cases of illness are available



NOT an indicator of magnitude of problem

Limitations of WBDO Surveillance Data

National Estimate

4.3 to 32.8 million AGI cases per year in public water systems

WBDOs

1,918 reported AGI cases in 2004 in public water systems

0.04%

Factors Influencing WBDO Detection, Investigation, and Reporting

- Awareness
- Communication
- Availability of laboratory testing
- Reporting requirements
- Availability of resources for surveillance and investigation

Opportunities for Improvement

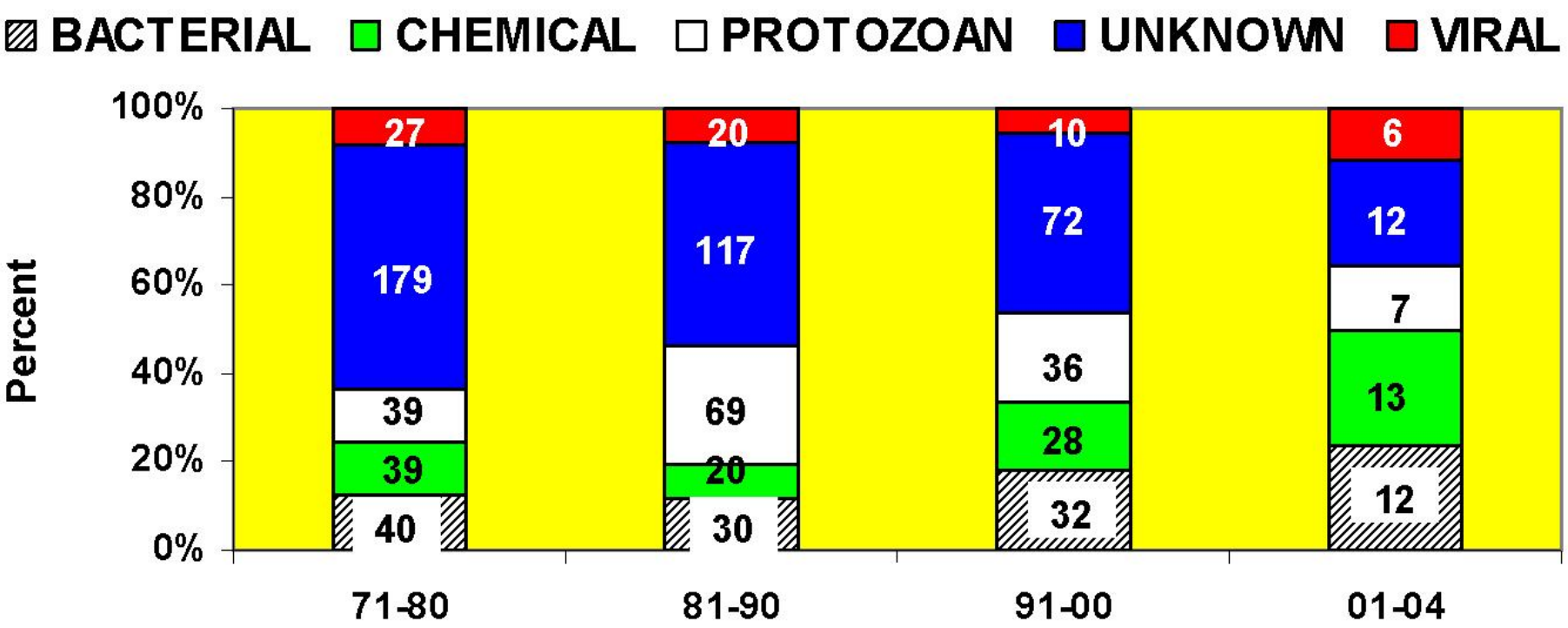
- CSTE 2006 position paper, WBDOs reportable
- EPA/CDC 2006 workshop to develop ideas for improving detection, investigations, reporting
- Expand reporting partners
- Make reporting electronic
- Better risk factor data collected
  - Low pressure events, corrosion/leaching
- Connect data with other databases
  - SDWIS? Pulsenet?
- Improve communication between groups

Newly Required Disclaimer From the Department of Health and Human Services

(Please Interpret as You See Fit)

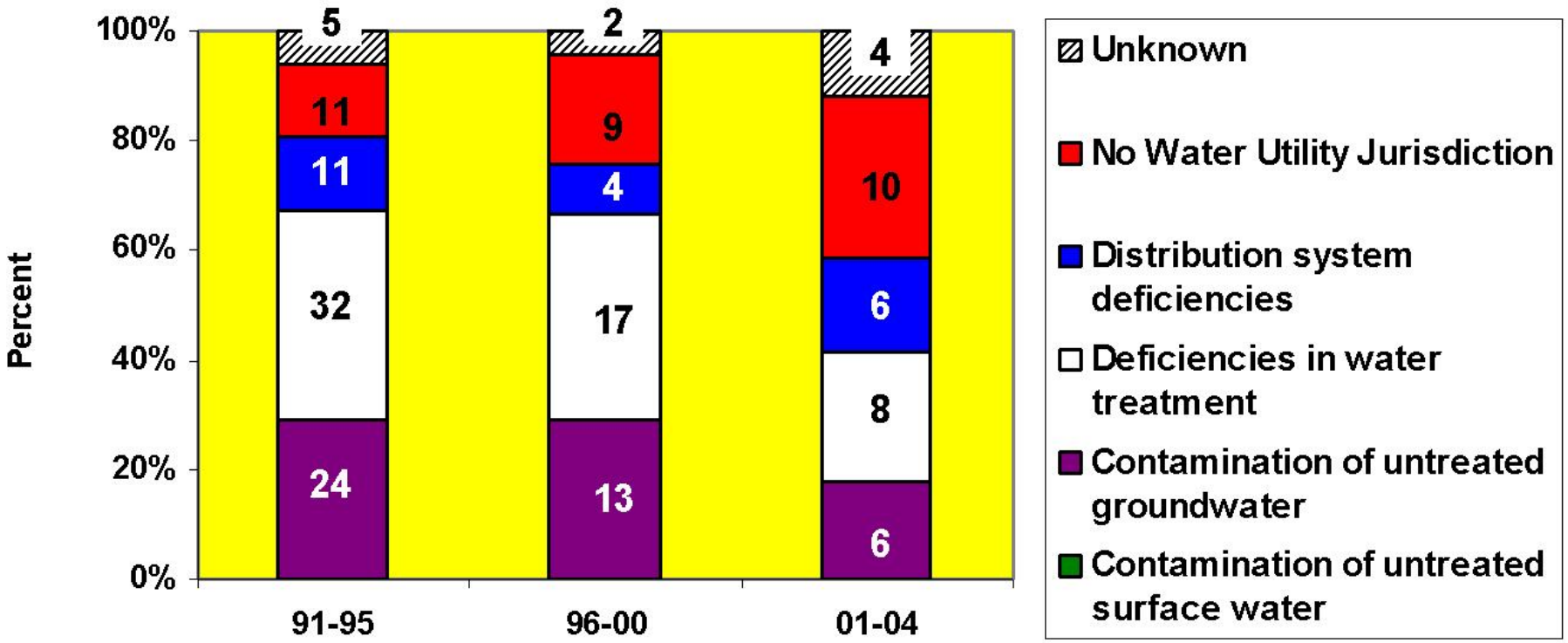
"The findings and conclusions in this presentation have not been formally disseminated by CDC and should not be construed to represent any agency determination or policy“

WBDOs Associated with Drinking Water, by Etiologic Agent* — United States, 1971–2004



* No *Legionella*

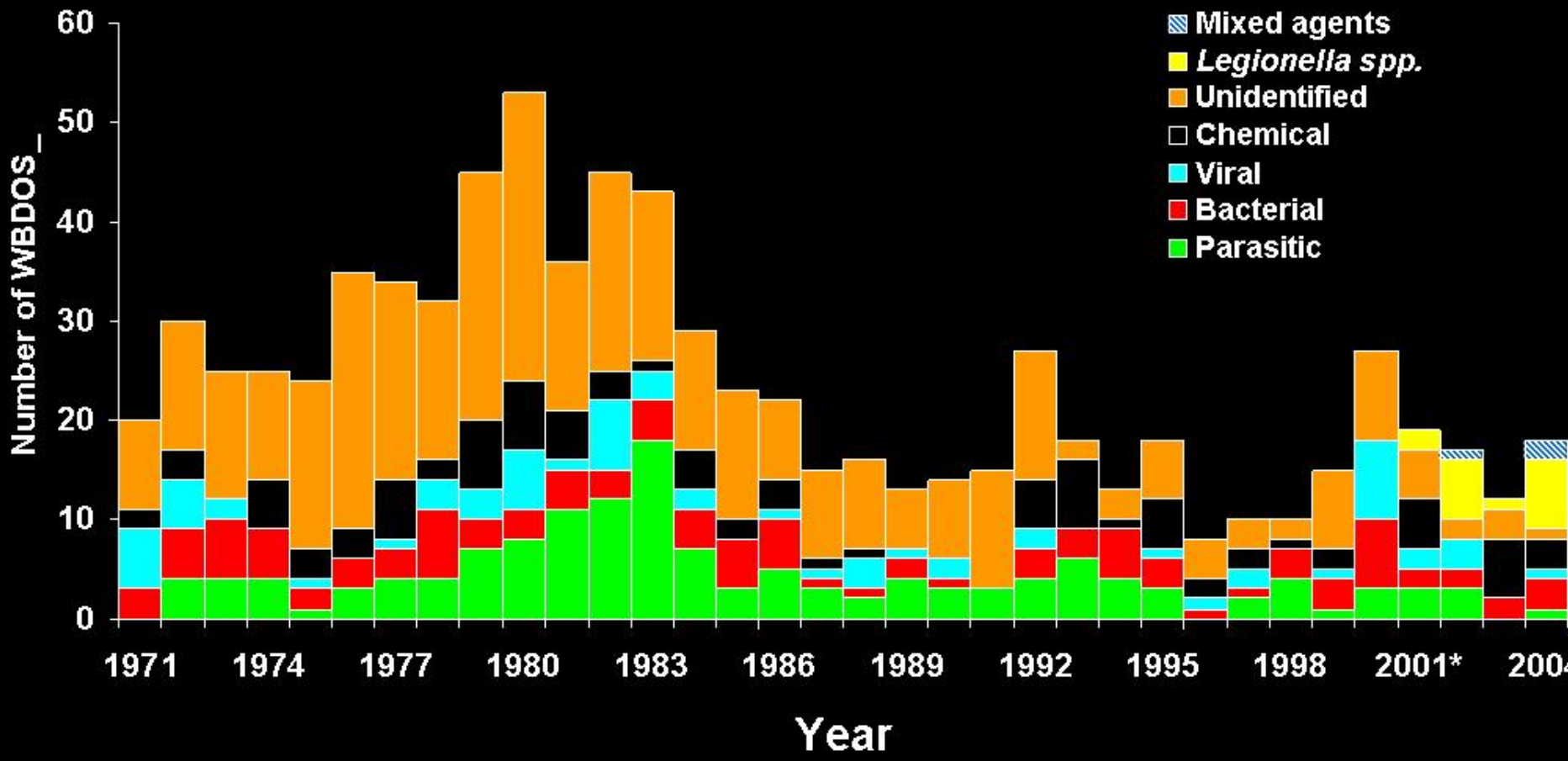
Deficiencies Associated with Public Water Systems* — United States, 1991–2004



	91-95	96-00	01-04
Number of Deficiencies	83	45	34
Number of WBDOs*	77	44	32

* No *Legionella.* Total deficiencies = 162. Total WBDOs = 153.

Number of WBDOs Associated with Drinking Water (n=803), by Year and Etiologic Agent — United States, 1971–2004



* Beginning in 2003, mixed agents of more than 1 etiologic agent type were included in the surveillance system. However, the first observation is a previously unreported outbreak in 2002.

† Beginning in 2001, Legionnaires' disease was added to the surveillance system, and *Legionella* species were classified separately in this figure.

Environmental Health Services (EHS)-Net Water Goals

- EHS-Net Water
  - Environmental health assessments started in FoodNet system
  - First step towards creating a Water-Net
  - 5 sites (NY, TN, MN, CA, GA)
- Improve surveillance for outbreaks
- Identify underlying outbreak environmental factors using a systems-based approach
- Evaluate existing interventions
- Translate into improved prevention efforts

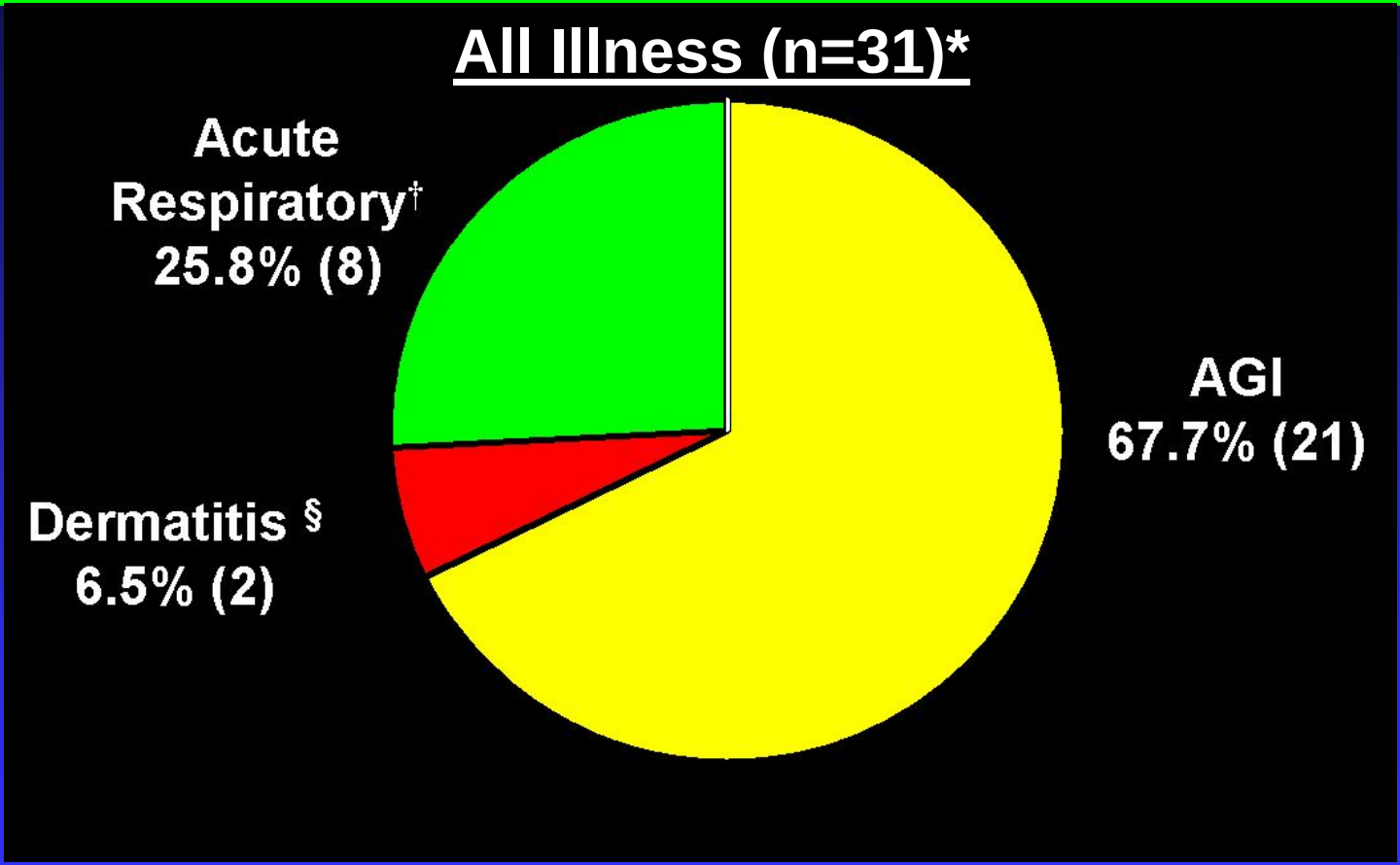
EHS-Net Tennessee Results: What Happens With a Focus on Water?

- 1972-2002
  - 12 WBDOs reported
- 2007
  - "Shaking the bushes"
  - 11 previously unreported WBDOs found

Grading System for WBDOs

1. Strong epidemiology, strong environmental
   - Data on exposed/unexposed with RR/OR ≥ 2 or $p \leq 0.05$
   - Water testing data or historical information
2. Strong epidemiology, weak environmental
3. Weak epidemiology, strong environmental
4. Weak epidemiology, weak environmental

WBDOs Associated with Drinking Water, by Illness — United States, 2003–2004

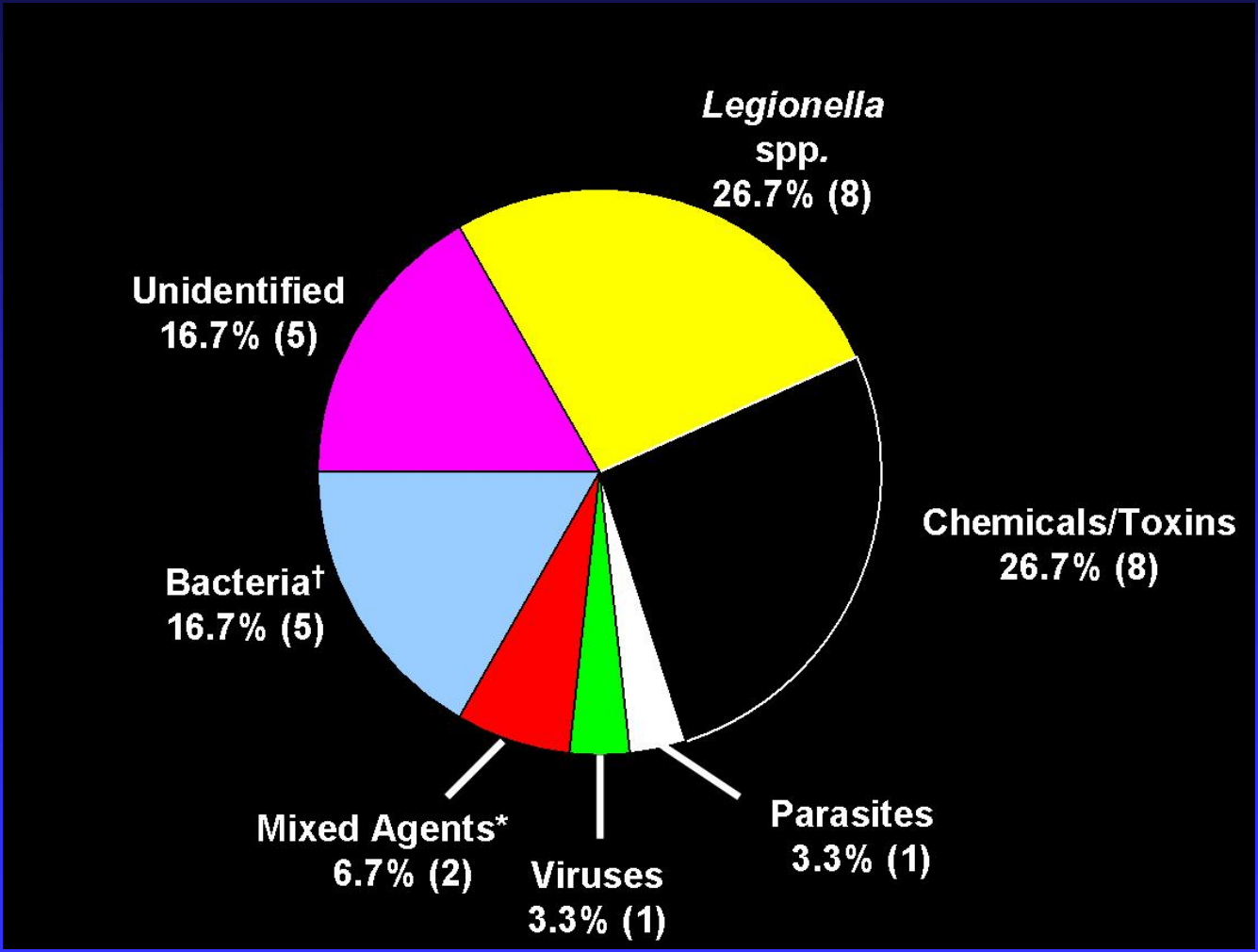


* One of the WBDOs had two predominant illnesses: acute respiratory illness and gastroenteritis

† All acute respiratory illness was attributed to *Legionella* spp.

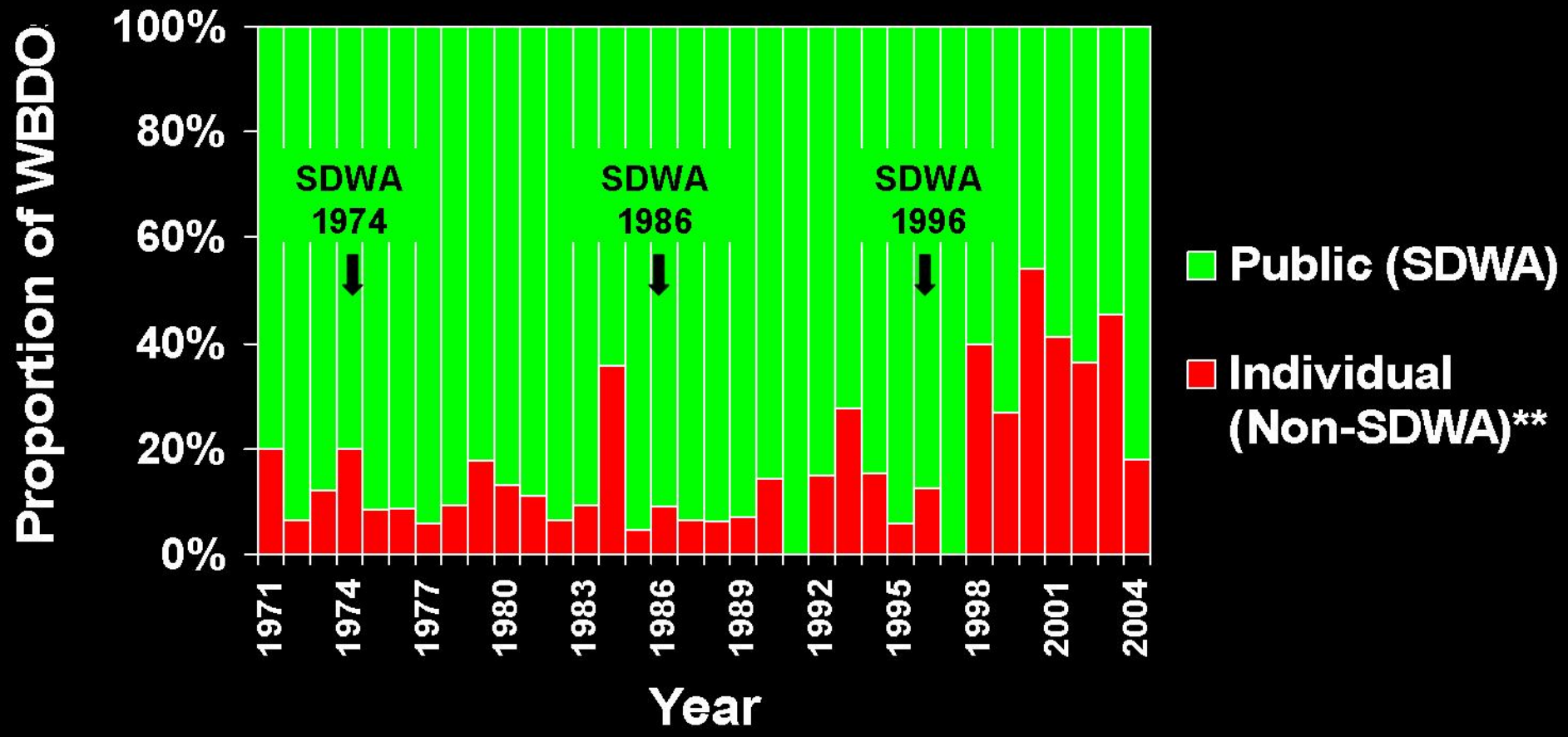
§ All dermatitis was attributed to chemicals/toxins

WBDOs Associated with Drinking Water (n=30), by Etiologic Agent — United States, 2003–2004



* Each WBDO involves more than one etiologic agent.
† Other than *Legionella* spp.

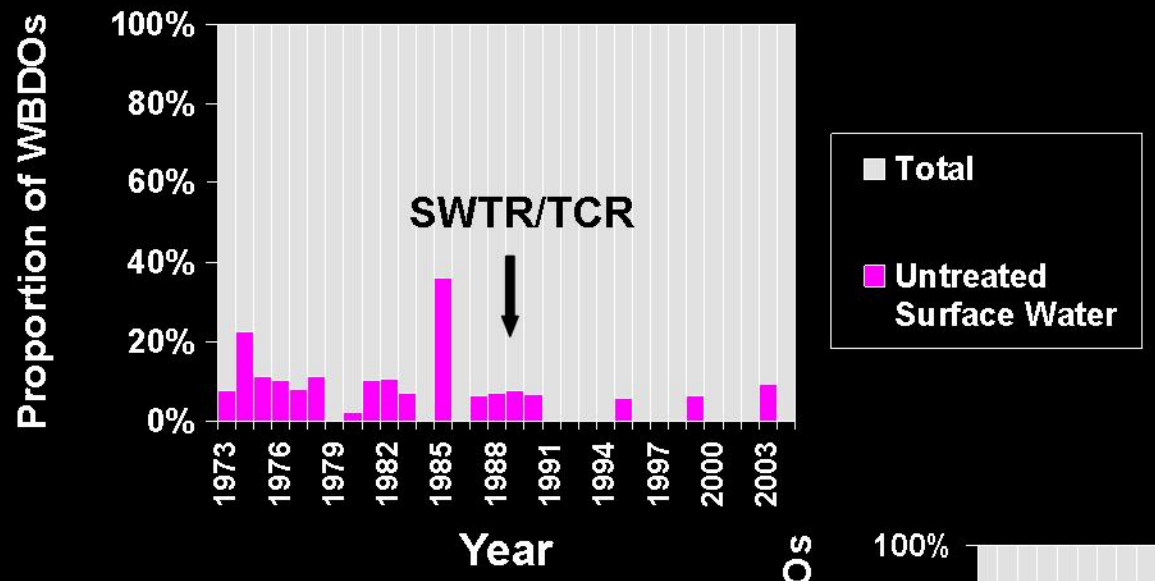
Reported WBDOs Associated with Drinking Water (N=787)* by Type of Water System — United States, 1971–2004

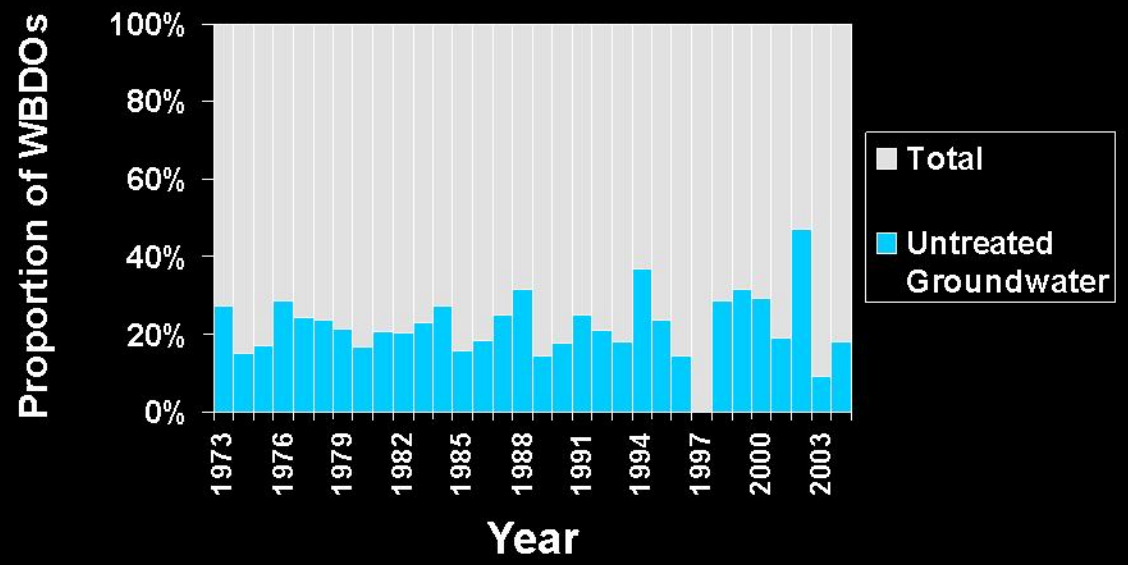


* Excludes outbreaks of Legionnaires disease

** Includes private water supplies and commercially-bottled water

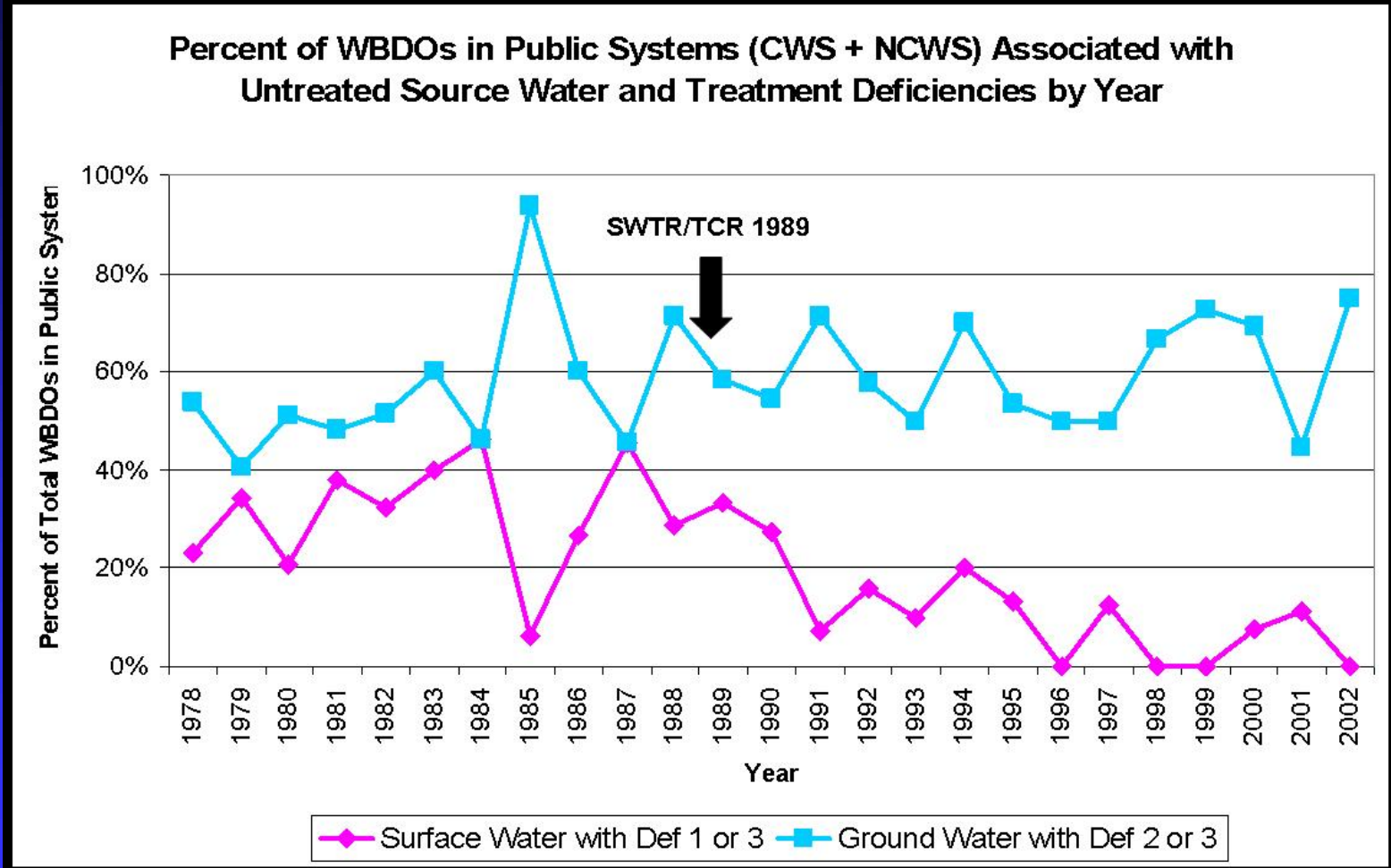
Drinking Water WBDOs Associated with Untreated Surface Water and Groundwater — United States, 1973–2004 (N=751)*





* Excludes outbreaks of Legionnaires disease

Drinking Water Outbreaks in Public Water Systems With Deficiencies 1–4, United States 1978–2002 (N=401)*



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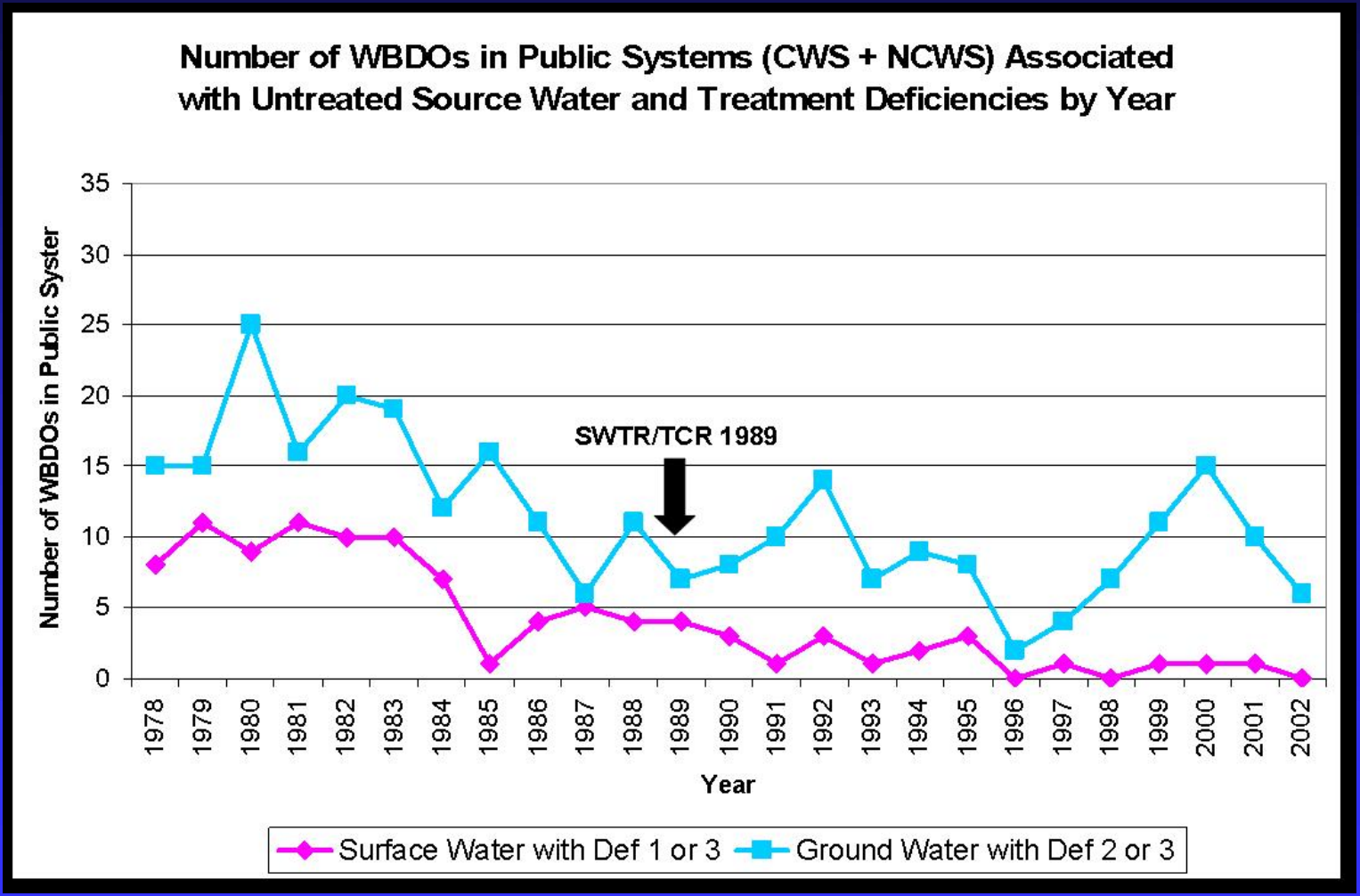
Drinking Water Outbreaks in Public Water Systems With Deficiencies 1–4, United States 1978–2002 (N=401)*



* Excludes outbreaks of Legionnaires Disease

WBDOs Caused by Distribution System Contamination*, Public Water Systems — United States, 1971–2004

	Reported WBDOs	Distribution Deficiencies
Community Systems	326	32.8%
Non-community Systems	361	7.5%
Total	687	19.5%

* Old deficiencies. No *Legionella*