Waterborne Disease

NMED Drinking Water Bureau

Rob Pine and Megan Marsee

New Mexico Rural Water Association 33rd Annual Conference

April 11-14, 2011

What is a waterborne disease?

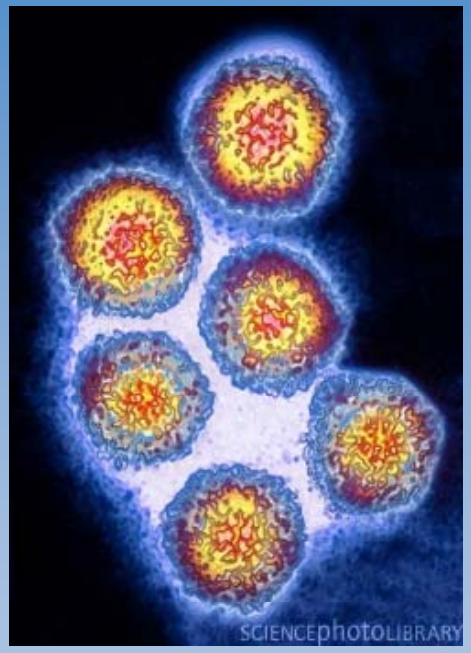
- Disease resulting from ingestion of contaminated drinking water
  - Disease agents can be microbial or chemical.
    - *Microbial pathogens* are generally acute contaminates (may cause serious health problems after one exposure).
    - *Chemicals* are generally chronic contaminants (may cause health problems after many years of exposure).

Microorganism groups

BACTERIA

Vibrio cholerae

VIRUSES



Hepatitis A

PROTOZOA

Giardia lamblia

Part I

History of Waterborne Disease

Objectives

1. Outline the history of 3 key waterborne diseases
2. Examine how our evolving understanding of waterborne disease has influenced drinking water treatment and regulation

Early water treatment

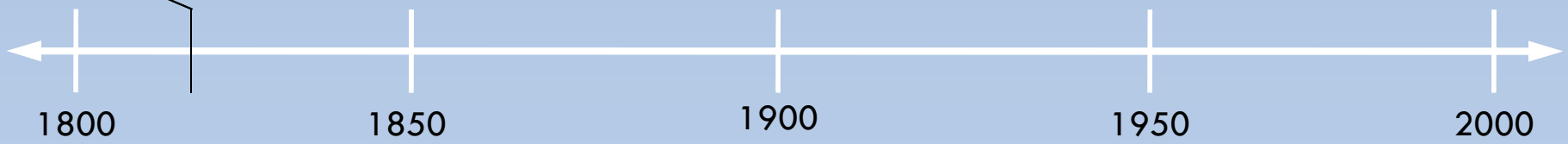
- Methods to improve drinking water quality recorded as early as 2,000 B.C.
- Treatment focused on aesthetic qualities of water.
- People relied on senses to judge water quality.

Egyptian clarifying device pictured in the tomb of Amenophis II at Thebes, 1450 B.C. (Baker, 1948)

1817

Cholera leaves India, initiating the first pandemic.

It spreads westward across Russia into Europe & the U.S. via trade routes.

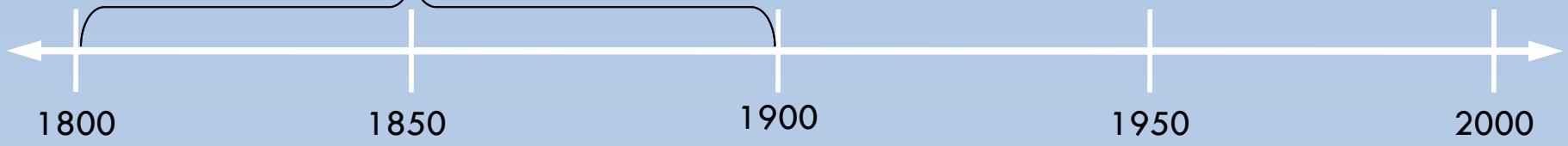


1800's

Cholera epidemics kill tens of millions worldwide.

The spread of cholera is initially attributed to miasmas, or poisonous air.

Cholera sufferer and stretcher, 1830s (Souzavez, 1833)

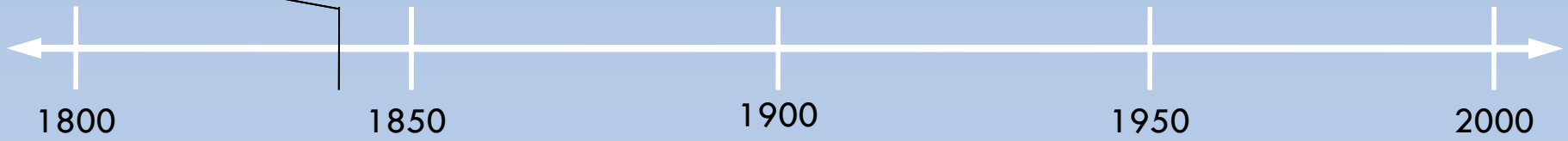


1842

The Sanitary Movement is founded in London.

It diverts waste to sewers that flow to the Thames River, the city's principle source of drinking water.

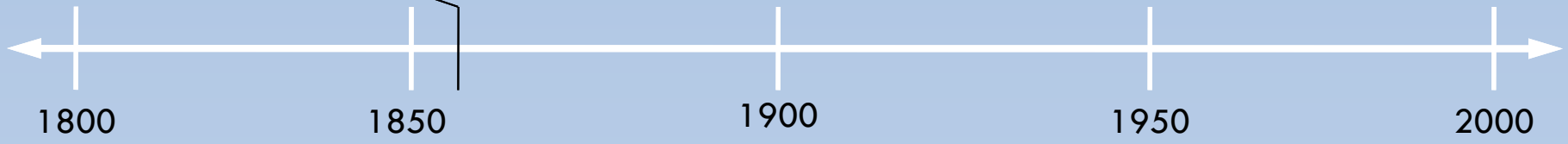
Flushing a London sewer (Mayhew, 1861)



1854

John Snow proves that cholera is a waterborne disease by linking an outbreak in London to a well contaminated with sewage.

Caricature of cholera infecting a well (1866)

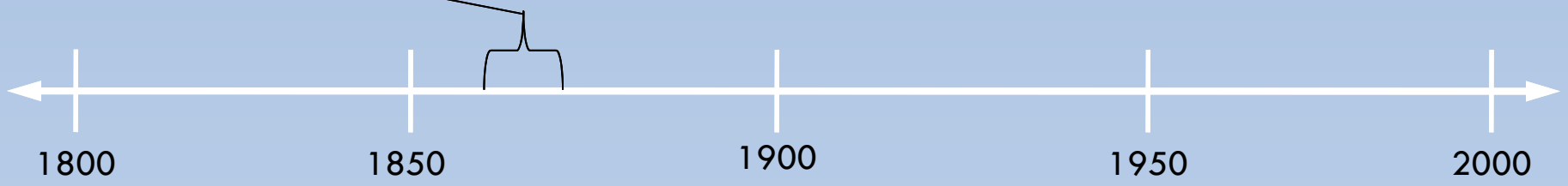


Late 1800's

Louis Pasteur's experiments lead to acceptance of the "germ theory of disease."

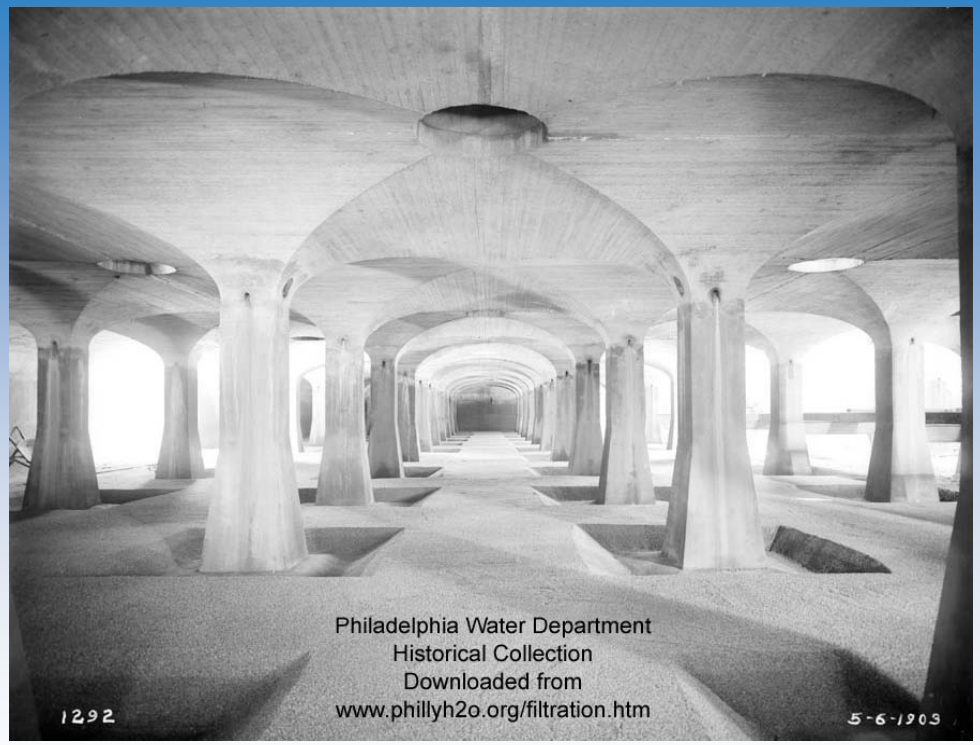
Robert Koch develops methods to isolate bacteria.

Pasteur demonstrates bacteria grow in broth when exposed to air.

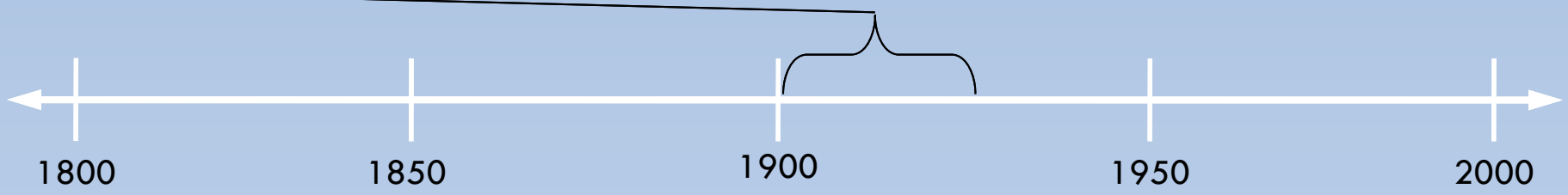


Early 1900's

Water treatment and disinfection are widely adopted by water systems.

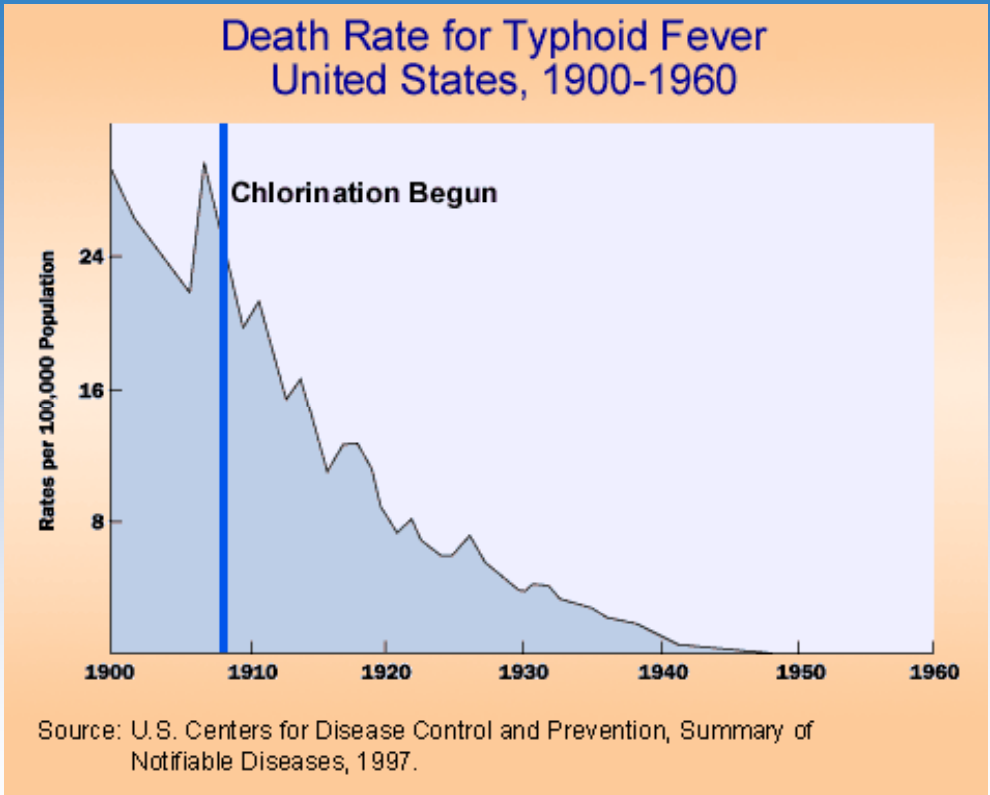


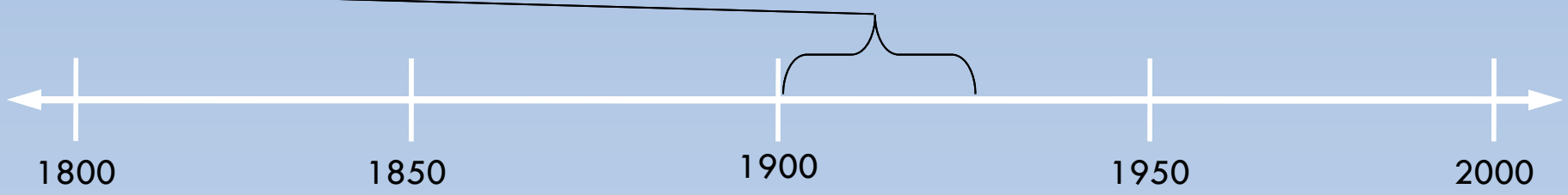
Newly completed vaulted concrete work and filter beds, Philadelphia. Philadelphia was the first U.S. city to provide filtered water to all its customers in 1909.



Early 1900's

Cholera and typhoid virtually eliminated in the U.S.

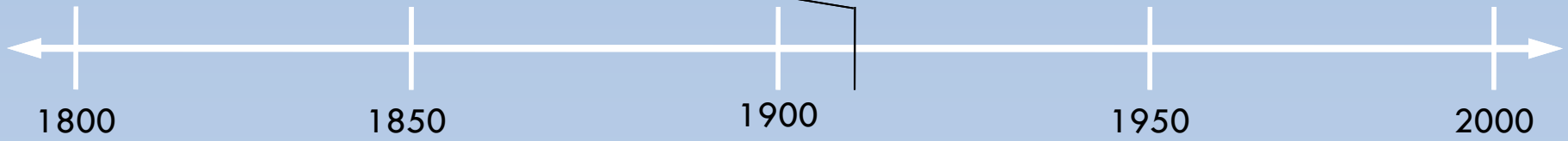




1914

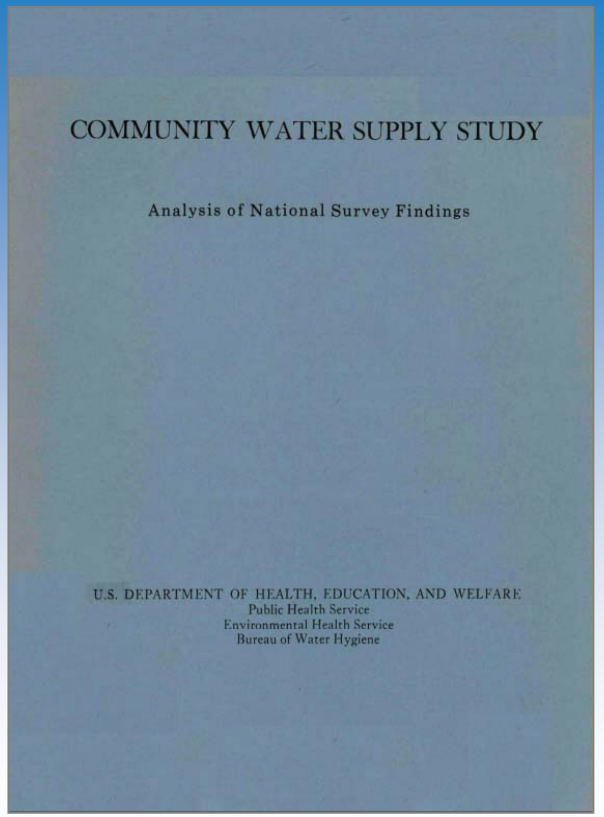
First federal drinking water regulations adopted by U.S. Public Health Service.

They apply only to interstate carriers, but most states & local governments adopt them as guidelines.



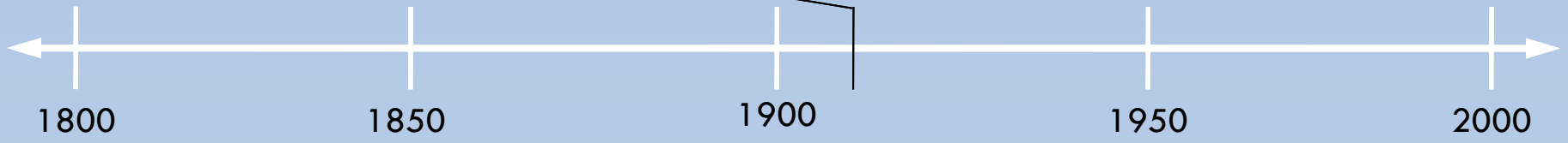
1970

A national survey reveals that only 59% of water systems deliver drinking water that meets U.S. Public Health Service standards.


COMMUNITY WATER SUPPLY STUDY

Analysis of National Survey Findings

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Water Hygiene



Early 1970's

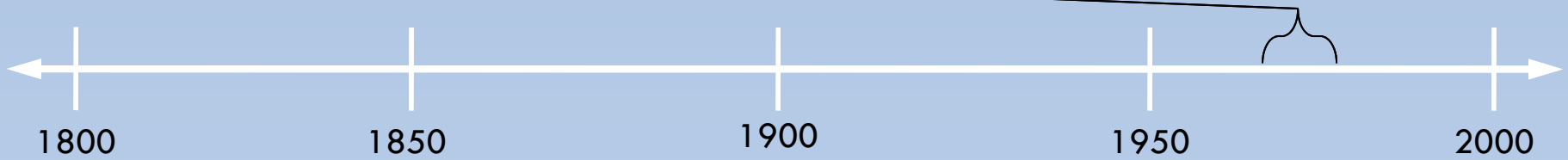
Early research on carcinogens in drinking water receives national attention.

Drinking Water: Another Source of Carcinogens?

As if life were not already hazardous enough, there is now one more environmental alert with which we have to contend: Drinking water may cause cancer. Lost in most accounts of this

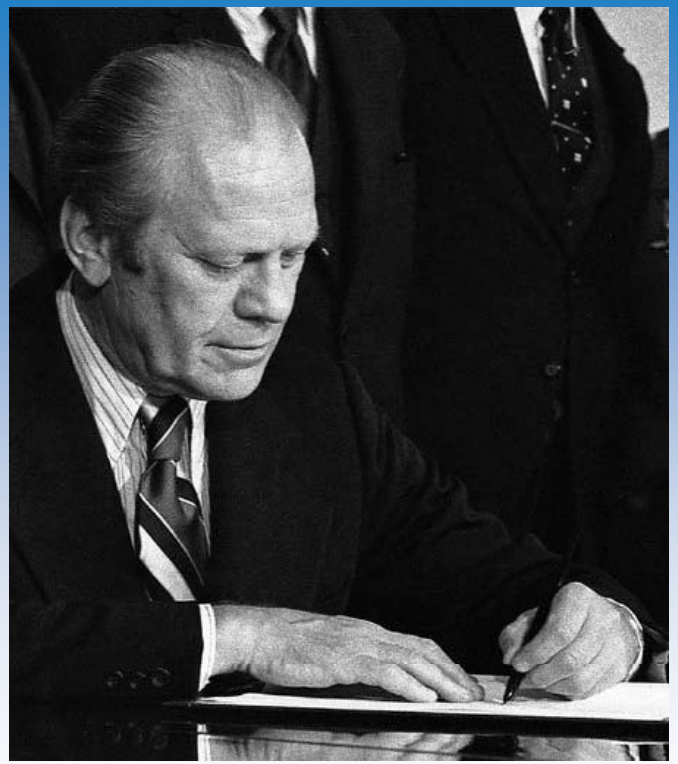
for the Future, Inc., indicated that the cancer mortality rate was 15 percent higher among white males who drank water from the Mississippi than among those who obtained their water from

Mississippi River at New Orleans and 1974 article in *Science* magazine.

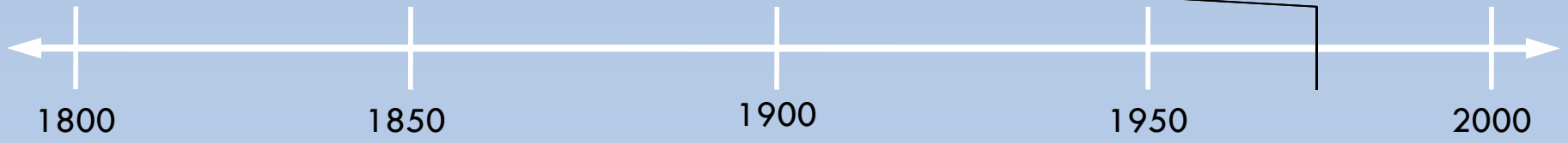


1974

Safe Drinking Water Act signed into law.



President Ford signed the Safe Drinking Water Act on December 16, 1974.



1993

Cryptosporidium causes largest waterborne disease outbreak in U.S. history in Milwaukee, WI.

Raging virus hits hard at area schools

Pharmacies short of supplies

By JOE MANNING
Sentinel staff writer

A rampaging virus closed one school, threatened to force others to close and clogged hospital emergency rooms with hundreds of patients seeking treatment for diarrhea and vomiting, officials said Monday.

The Milwaukee Health Department sent viral kits to hospital emergency rooms Monday asking physicians to take samples from the first 10 people who came in with the typical symptoms of the disease — diarrhea, dehydration, abdominal cramping and vomiting.

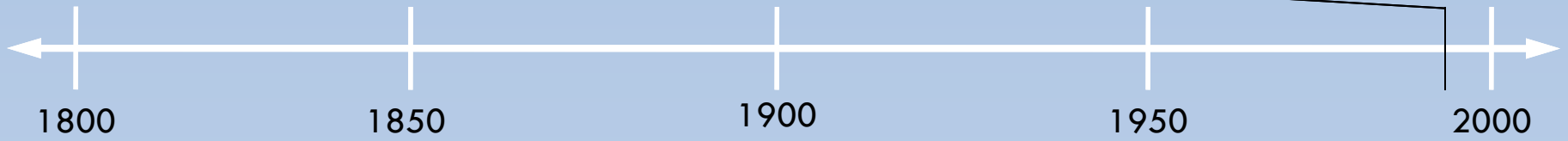
Health officials said the cause of the outbreak remained unknown, but it was possibly caused by a common adenovirus or rotavirus. Officials were amazed at how widespread the illness seemed to be.

St. Adalbert's Parish School, 1913 W. Becher St., closed Monday when not enough substitute teachers could be found to replace the sick members of the faculty, a school official said. A third of the students were out.

West Allis School District Administrator Harold Sloan said the district was able to deal with

See Virus / 11A

Milwaukee Sentinel article, April 6, 1993.



April 3-4

Hospitals flood with patients complaining of severe gastrointestinal illness.

Raging virus hits hard at area schools

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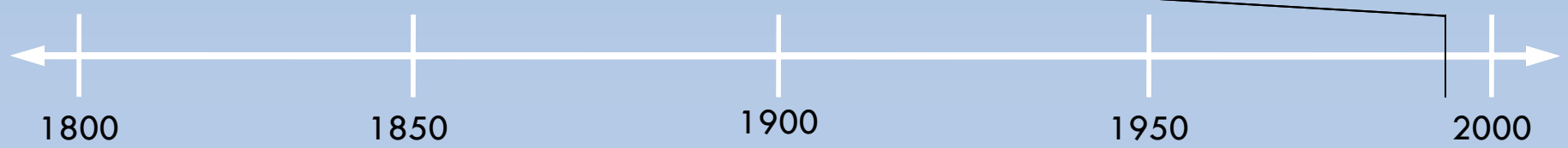
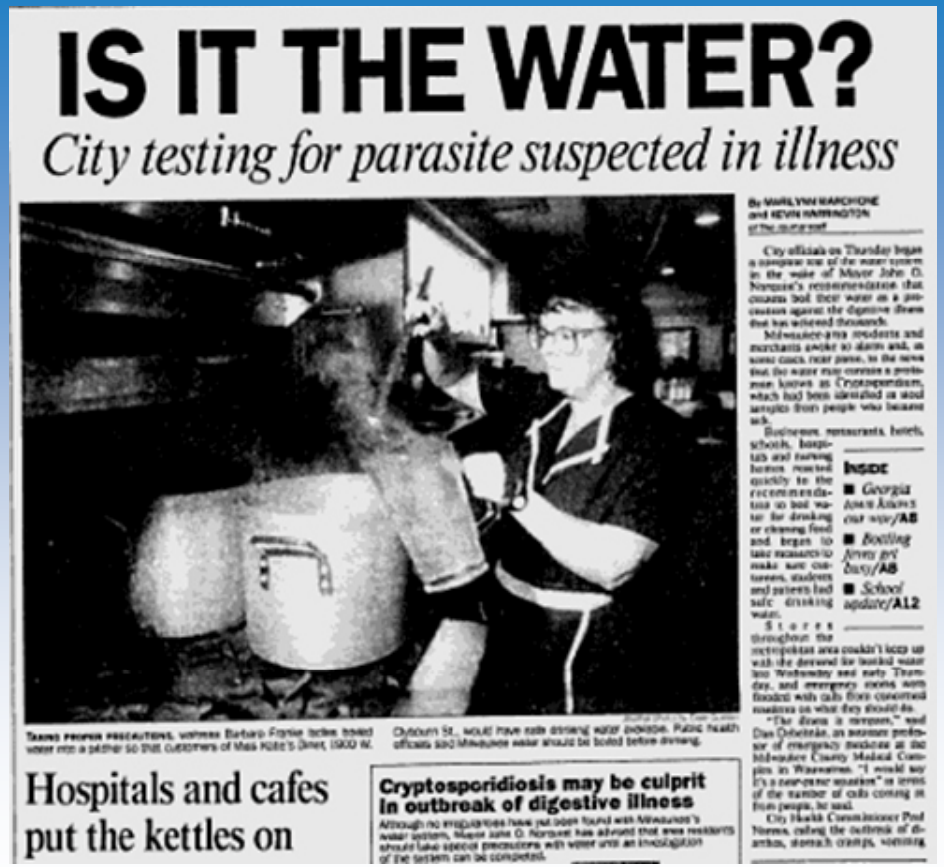


April 5

Clinical and epidemiological characteristics of outbreak lead officials to suspect it is waterborne.



IS IT THE WATER?

City testing for parasite suspected in illness

By MARILYNN MARCHIONE and KEVIN HARRINGTON of the Journal staff

City officials on Thursday began a complete test of the water system in the wake of Mayor John O. Norquist's recommendation that citizens boil their water as a precaution against the digestive illness that has sickened thousands.

Milwaukee-area residents and merchants awoke to alarm and, in some cases, near panic, to the news that the water may contain a protozoan known as Cryptosporidium, which had been identified in stool samples from people who became sick.

Businesses, restaurants, hotels, schools, hospitals and nursing homes reacted quickly to the recommendation to boil water for drinking or cleaning food and began to take measures to make sure customers, students and patrons had safe drinking water.

Stores throughout the metropolitan area couldn't keep up with the demand for bottled water late Wednesday and early Thursday, and emergency rooms were flooded with calls from concerned residents on what they should do.

"The illness is rampant," said Dan Ochiltree, an assistant professor of emergency medicine at the Milwaukee County Medical Complex in Wauwatosa. "I would say it's a near-panic situation" in terms of the number of calls coming in from people, he said.

City Health Commissioner Paul Nieves, calling the outbreak of diarrhea, stomach cramps, vomiting

INSIDE

■ Georgia town knows our way/A8

■ Bottling firms get busy/A8

■ School update/A12

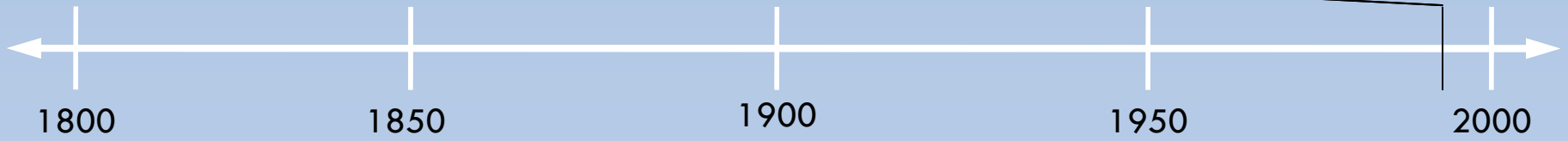
TAKING PROPER PRECAUTIONS, witness Barbara Frazier boils bottled water into a pitcher so that customers of Max Kade's Diner, 1500 W. Clybourn St., would have safe drinking water outside. Public health officials said Milwaukee water should be boiled before drinking.

Hospitals and cafes put the kettles on

Cryptosporidiosis may be culprit in outbreak of digestive illness

Although no organisms have yet been found with Milwaukee's water system, Mayor John O. Norquist has advised that area residents should take special precautions with water until an investigation of the system can be completed.

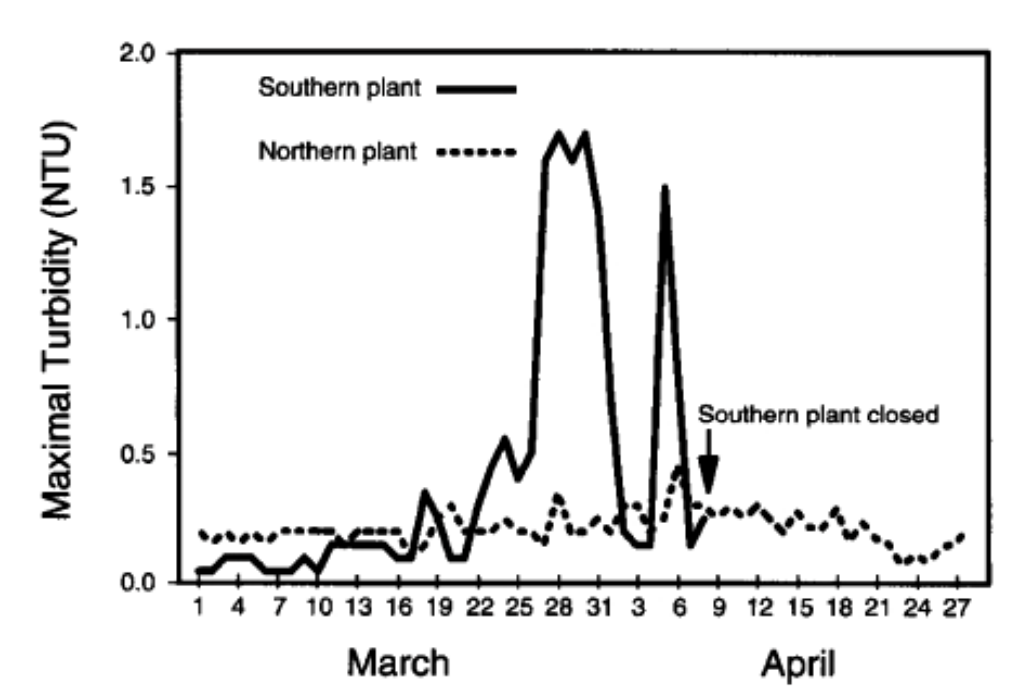
Milwaukee Journal headlines, April 8.



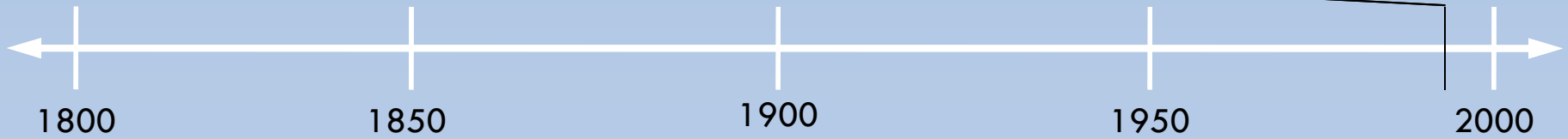
April 6

Records show a spike in turbidity in finished water at southern water treatment plant.

But water quality did not exceed standards.



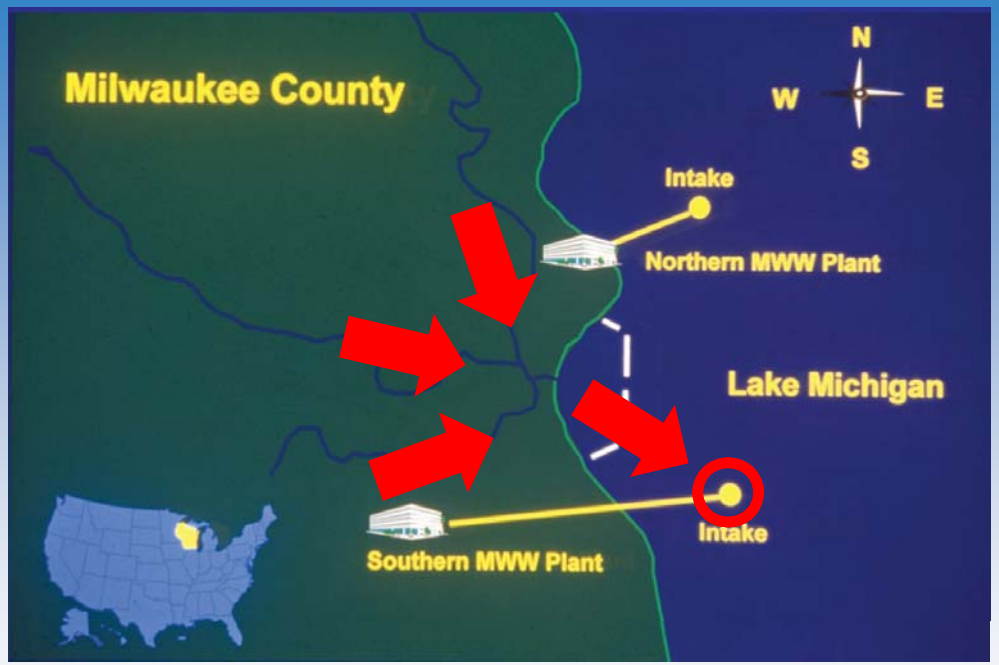
Maximal turbidity of treated water at the northern and southern water treatment plants (MacKenzie et al, 1994)



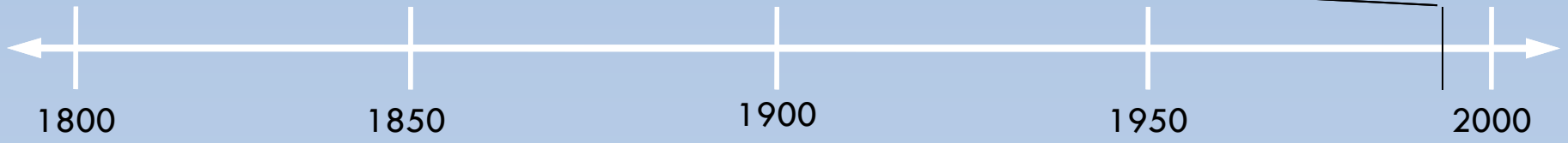
April 6

Three rivers converge at Milwaukee and flow into Lake Michigan.

Prevailing flow is toward southern intake grid.



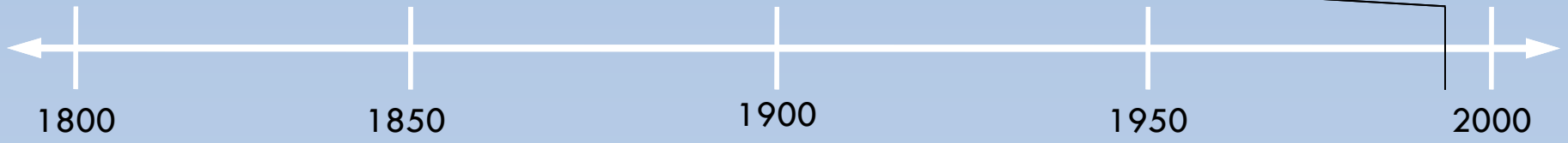
Three rivers converging at Milwaukee, the breakfront protecting the harbor, water treatment plants & their intake grids (Davis et al, 2009)



April 6

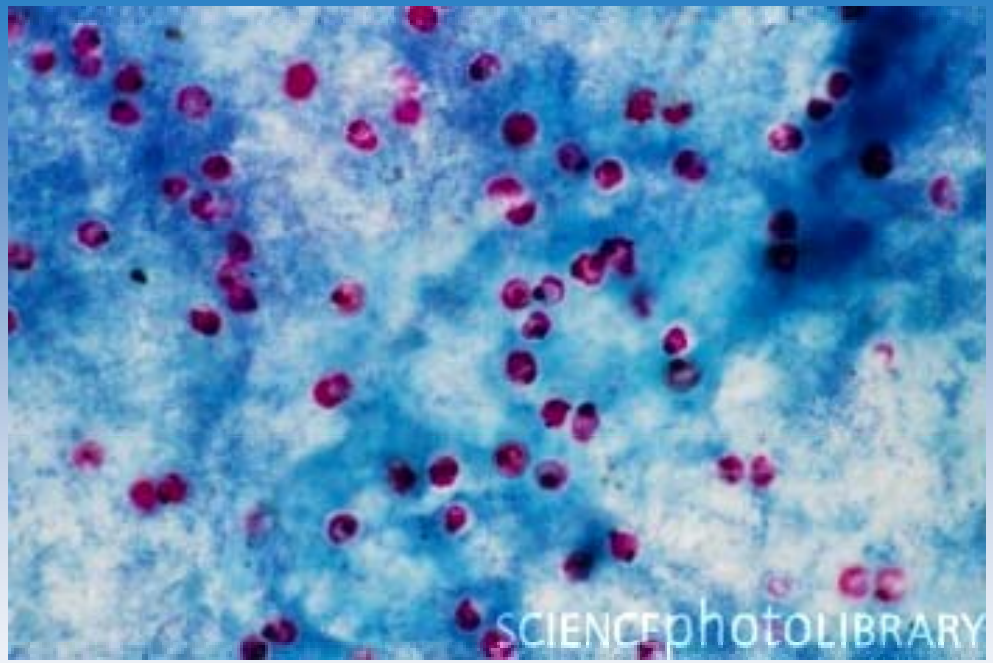
Water in rivers contributing to Lake Michigan was highly turbid due to spring snowmelt and heavy rains.

Milwaukee River emptying into the Lake Michigan harbor during a period of high flow (Davis et al, 2009)

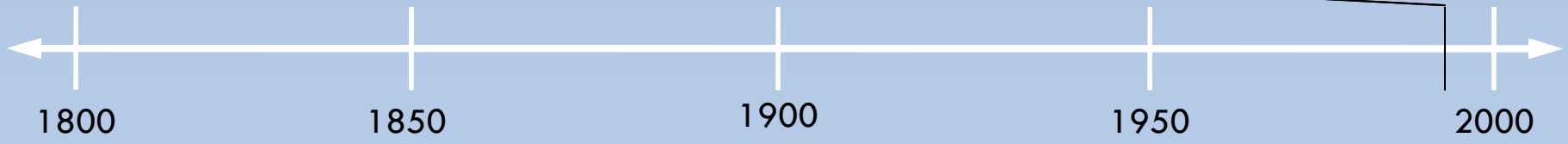


April 7

Hospital technician identifies hundreds of cryptosporidium oocysts in patient stool sample.



Cryptosporidium oocysts



April 7

Milwaukee residents ordered to boil water.

Southern treatment plant is taken offline.

Milwaukee Sentinel

Packer Plus
Free sample inside

THURSDAY MORNING APRIL 8, 1993

EDITION

Boil water, mayor says

Safety of drinking supply probed in wake of mystery epidemic

By GRETCHEN SCHULDT

PHARMACY-FOOD MART
WE HAVE
IMODIUM A-D
OPEN EASTER

Bottled water buyers deluge stores

By JAMES E. CAUSEY

8A Do's, don'ts
How long to boil; what not to use

Milwaukee Sentinel headlines, April 8.

1800 1850 1900 1950 2000

Lessons from history

- Our approach ensuring safe drinking water has evolved in parallel to our understanding of waterborne disease.
- Emerging pathogens will pose new challenges in the future.

Part 2

Disease Surveillance in the U.S.

Objectives

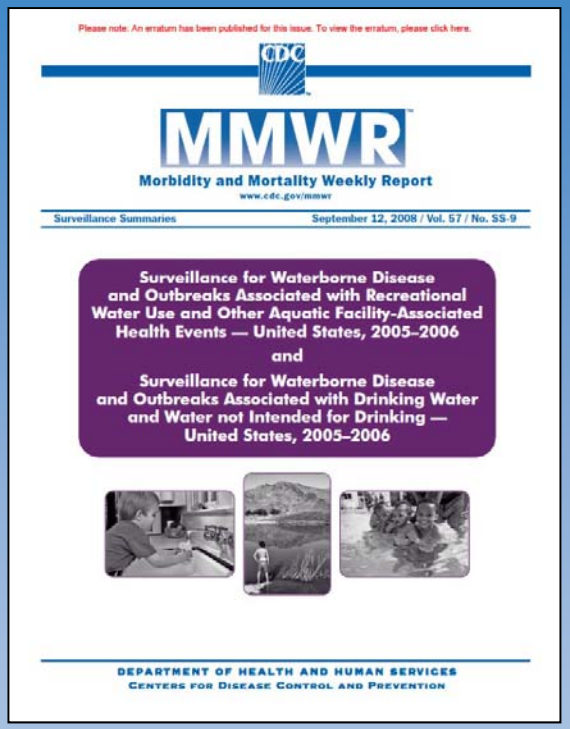
1. Describe current disease surveillance efforts in the U.S.
2. Provide data on recent waterborne disease outbreaks in the U.S.

Disease surveillance

- Surveillance refers to the tracking of waterborne disease outbreaks (WBDOs).
- Surveillance includes:
  - Characterization of the epidemiology of WBDOs;
  - Identifying trends in the etiologic (disease-causing) agents and other risk factors associated with WBDOs;
  - Identifying major deficiencies in providing safe drinking water;
  - Encouraging public health personnel to detect and investigate WBDOs; and
  - Fostering collaboration among local, state, federal, and international agencies on prevention.

Disease surveillance

- Since 1971, the Centers for Disease Control (CDC) has published Surveillance Summaries for drinking water.
- CDC now publishes reports every 2 years.


Please note: An erratum has been published for this issue. To view the erratum, please click here.

CDC

MMWR

Morbidity and Mortality Weekly Report

www.cdc.gov/mmwr

Surveillance Summaries | September 12, 2008 / Vol. 57 / No. SS-9

Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water Use and Other Aquatic Facility-Associated Health Events — United States, 2005–2006

and

Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2005–2006

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

- www.cdc.gov/healthywater/statistics/wbdoss/surveillance.html

Disease surveillance

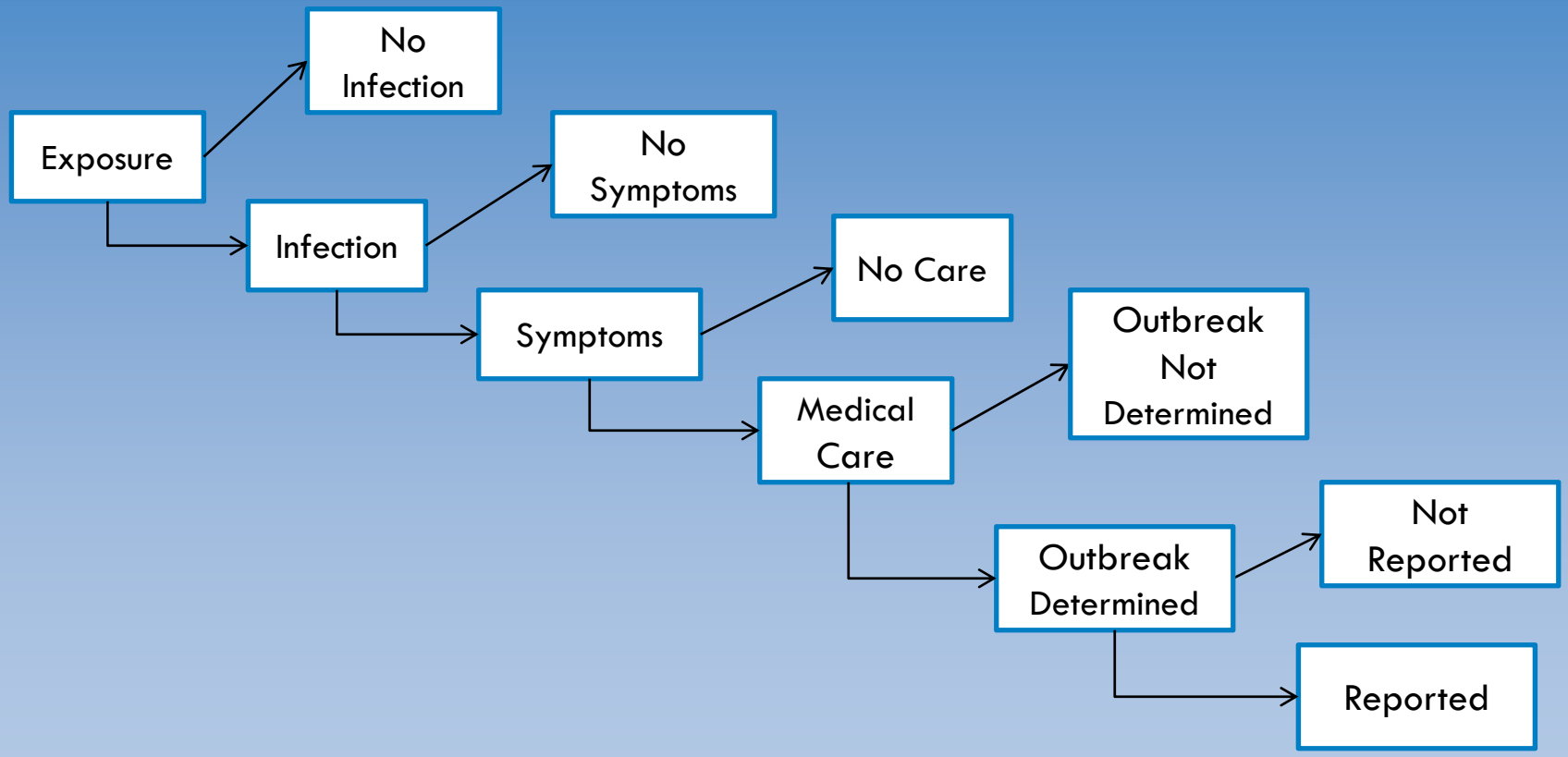
Total outbreaks & illnesses, 1971-2006

System Type	# Outbreaks	Cases of Illness
Total	780	577,094
PWS	680	573,296
CWS	338	518,091

Source: Craun et al, 2010

Disease surveillance

Pathway from disease exposure to reporting as outbreak

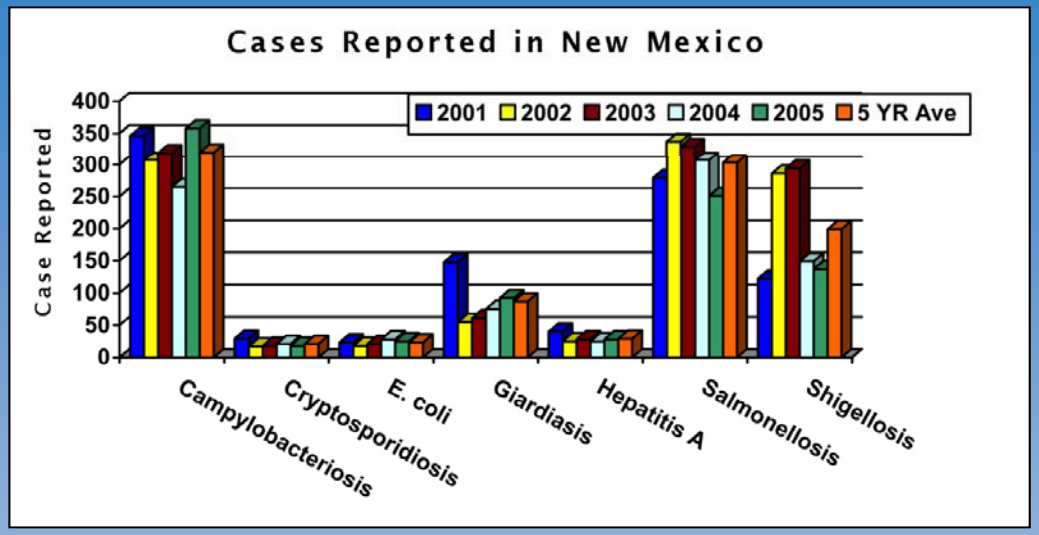


Disease surveillance

- Surveillance is passive.
  - State, territorial, and local public health agencies have the responsibility of investigating WBDOs.
  - These agencies voluntarily report WBDOs to the CDC.
- Actual number of outbreaks and cases of illness are unknown.
- One 1995 estimate:
  - ~500,000 cases/year of moderate to severe disease (Ecoli, Campylobacter, Salmonella)
  - ~400,000 cases/year of mild to moderate disease (Giardia, Crypto, viruses)

Disease Surveillance

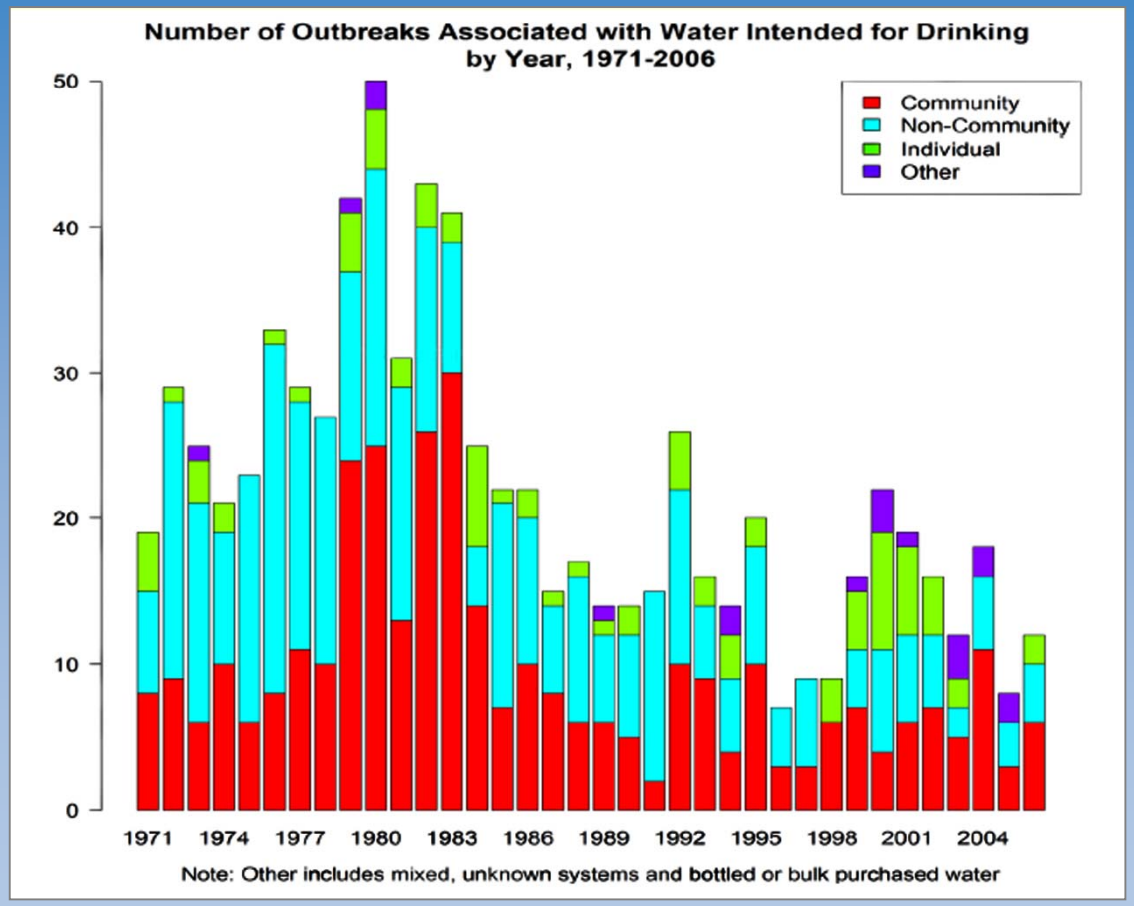
- Thousands of cases were reported in NM 2001 – 2005. None were definitively connected to water.



- CDC estimates are that ~2/3 of cases of illness from waterborne/foodborne pathogens are likely foodborne.

Number of outbreaks by year

- Number of outbreaks has deceased, especially for non-community systems.
- Peak around 1980 thought to be artifact of improved surveillance.



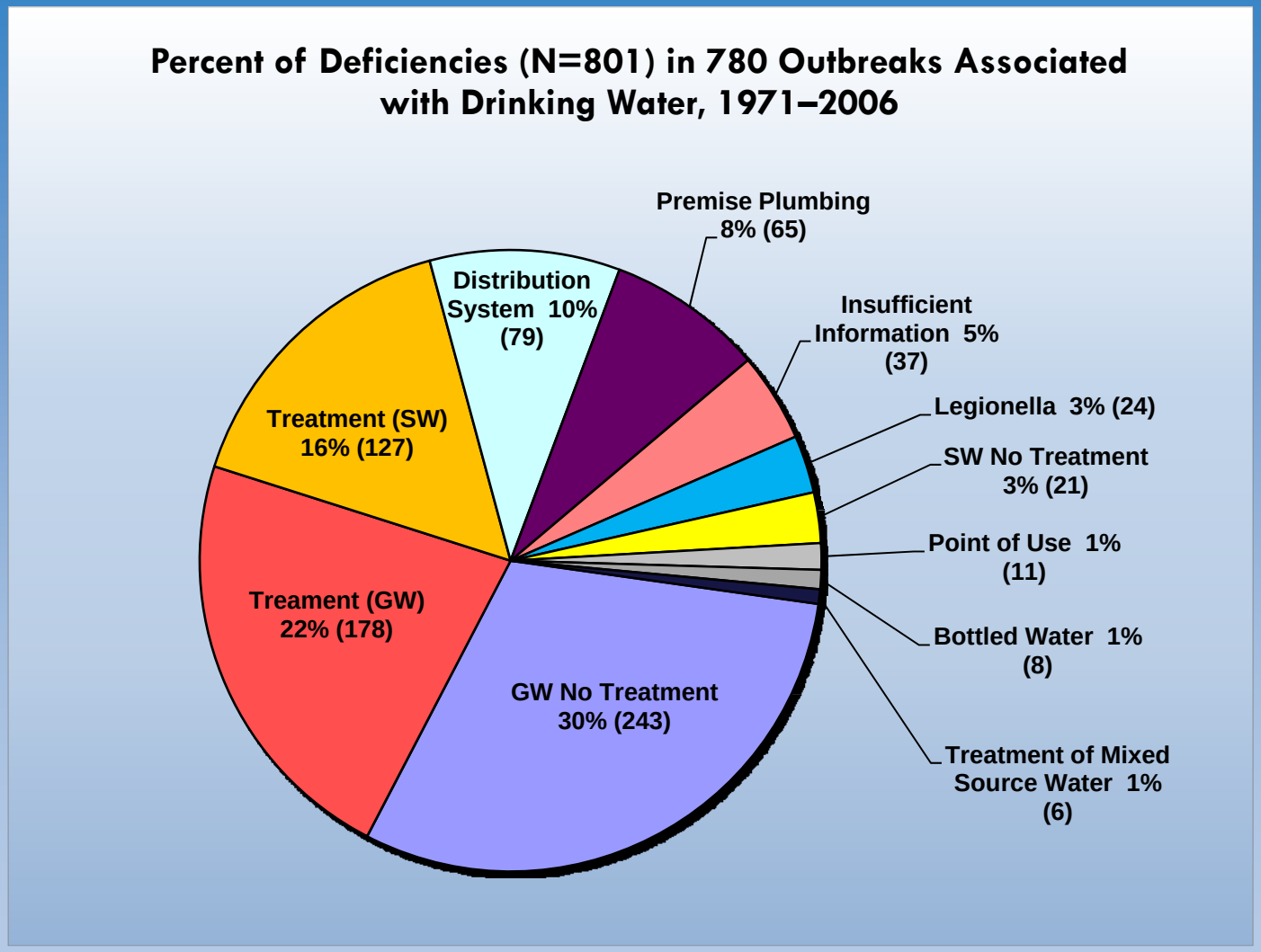
Source: Craun et al, 2010

Microbial etiologic agents

Agent	Type	Number Outbreaks CWS	Number Outbreaks Non-CWS
Giardia	Protozoa	84	28
Cryptosporidium	Protozoa	10	2
Shigella	Bacteria	14	23
Salmonella (typhoid)	Bacteria	11 (1)	5 (1)
Campylobacter	Bacteria	11	0
E. coli	Bacteria	5	2
Hepatitis A	Virus	10	9
Norovirus	Virus	10	24
Rotovirus	Virus	1	0

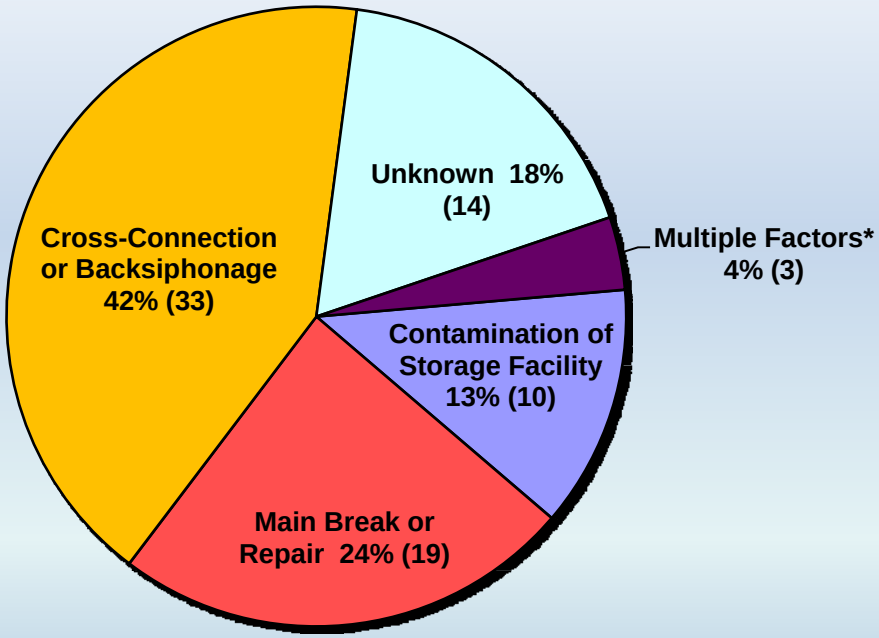
Source: Craun et al, 2010

Deficiencies identified in outbreaks



Source: Craun et al, 2010

Distribution system deficiencies



* Main break and contamination of storage facility (1); Main break and cross-connection (1); Cross-connection and contamination of storage facility (1)

Source: Craun et al, 2010

Part 3

Global Picture

Objective

1. Provide overview of global challenges posed by waterborne disease

Global picture

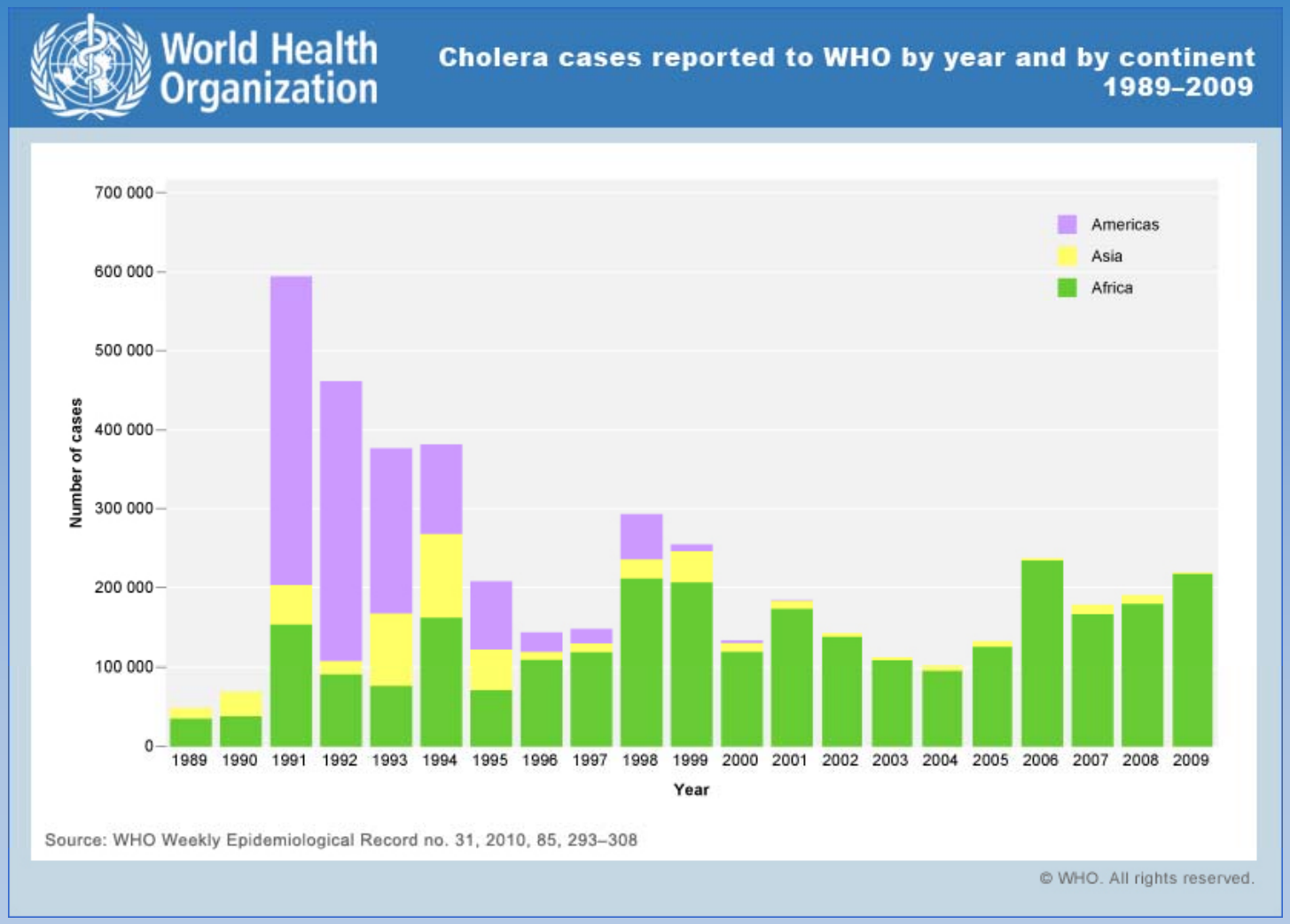
- Almost 1 billion people lack access to an improved water supply; more than ¾ of these live in an urban environment.

- Cities in developing countries grow by 5 million residents each month.

Global picture

- More than 80% of sewage in developing countries is discharged untreated into rivers, lakes, and coastal areas.
- In the developing world, 24,000 children under the age of five die every day from preventable causes contracted from unclean water.
- More than 50 countries still report incidents of cholera to the World Health Organization.

Global picture



Global picture

- Typhoid fever (water and food borne) affects ~21 million people in the developing world every year, with approximately 600,000 deaths.
- In developing countries, persistent diarrhea is the leading cause of death in children younger than five years of age. Cryptosporidium accounts for 30% to 50% of those deaths.

Part 4

Conclusions

Future risk of waterborne disease

- Source waters continue to be contaminated by agricultural, industrial, and municipal waste.
- Water infrastructure is aging and deteriorating.
- There is always a potential for infrastructure failure or operator error.
- Our understanding of waterborne disease is incomplete.
- Microbes are constantly evolving.

Preventing waterborne disease

- Improve source water protection
- Use multiple barriers to waterborne disease
- Replace aging infrastructure
- Effectively train operators and administrators
- Support research on waterborne disease and water treatment technologies
- Support efforts to make safe drinking water universally available

References

PART I: History of waterborne disease

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