

CHAPTER 6: Human Health Impacts of CSOs and SSOs

Stakeholder Meeting

June 24-25, 2003



Overview

- **Congressional language requiring this chapter**
- **Key research questions**
- **Methods & data sources**
- **Data & analytical observations**
- **Summary**

Congressional directive

The Administrator of the Environmental Protection Agency shall transmit to Congress a report summarizing:

... the extent of the human health impacts caused by municipal CSOs and SSOs

Key Questions

- **What are the potential human health impacts associated with CSOs and SSOs?**
 - ▶ **What constituents of CSOs and SSOs cause human health impacts?**
 - ▶ **Of what consequence are these impacts?**

Key Questions

- Which exposure pathways are the most significant and what populations are most sensitive?
- How do the impacts associated with exposure to CSOs & SSOs compare to other kinds of human health impacts?

Key Questions

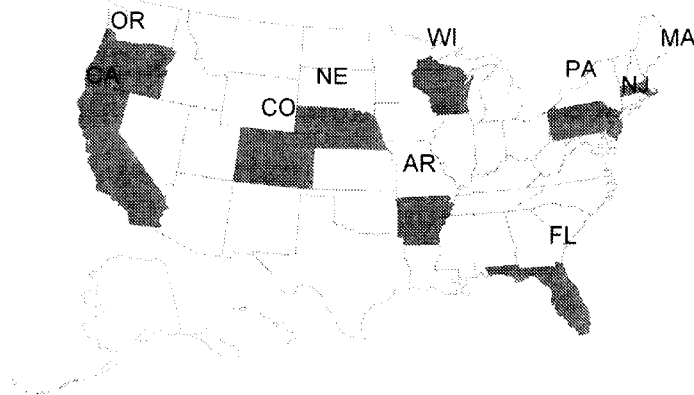
- What are the impediments to understanding the linkages between CSOs & SSOs, exposures, and human health impacts?
- What is the institutional framework to assess and address potential human health impacts of CSOs and SSOs?

Approach

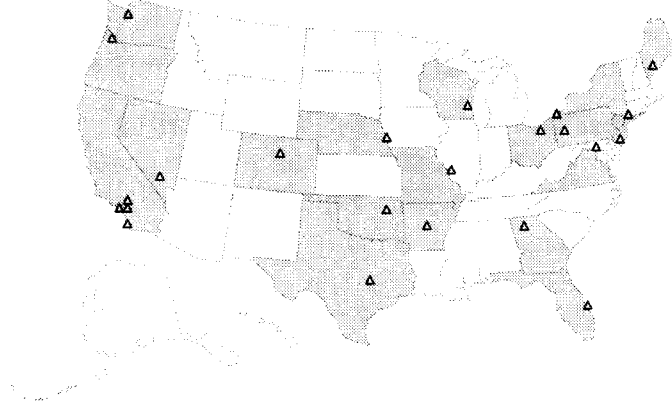
● Major methodological steps:

- ▶ Literature review;
- ▶ Experts workshop;
- ▶ State and community interviews;
- ▶ Analysis.

State Interviews



Community Interviews



**What are the potential
human health impacts
associated with CSOs and
SSOs?**



Potential Health Threats

- CSOs & SSOs present a health risk to humans who come in contact with them.
- The pathogens and pollutants with the potential to impact human health that may be present in CSOs and SSOs include:
 - ▶ Bacteria
 - ▶ Viruses
 - ▶ Parasites
 - ▶ Toxics

Pathogens & Pollutants in Sewage

Bacteria	Viruses	Parasites	Toxics
<i>Campylobacter jejuni</i>	Hepatitis A	<i>Cryptosporidium parvum</i>	Arsenic
<i>Enterococcus spp.</i>	Hepatitis C	<i>Giardia lamblia</i>	Lead
Pathogenic <i>E. coli</i>	Hepatitis E	<i>Cyclospora cayetanensis</i>	Mercury
<i>Vibrio cholerae</i>	Adenoviruses	<i>Entamoeba histolytica</i>	Copper
<i>Pseudomonas spp.</i>	Rotavirus	Microsporidia	Zinc
<i>Salmonella spp.</i>	Enteroviruses	<i>Toxoplasma gondii</i>	Cadmium
<i>Salmonella Typhi</i>	Norwalk virus and Norwalk-like viruses	<i>Isospora belli</i> and <i>Isospora hominis</i>	PCBs
<i>Shigella spp.</i>	Astrovirus	<i>Ascaris lumbricoides</i> (intestinal roundworm)	Pesticides
<i>Yersinia spp.</i>	Poliovirus	<i>Ancylostoma duodenale</i> (hookworm)	
		<i>Schistosoma haematobium</i>	
		<i>Trichuris trichiura</i> (human whipworm)	

Symptoms & Health Impacts Associated with Pathogens and Pollutants in CSOs & SSOs

- ◆ *Cryptosporidium parvum*
 - ▶ diarrhea, stomach cramps, fever
- ◆ *Giardia lamblia*
 - ▶ diarrhea, upset stomach, weight loss and dehydration
- ◆ Pathogenic *E. coli*
 - ▶ severe diarrhea, kidney damage, high blood pressure
- ◆ Hepatitis E
 - ▶ abdominal pain, weight loss, fever, jaundice, nausea, and vomiting
- ◆ Norwalk-like viruses
 - ▶ vomiting, diarrhea, dehydration
- ◆ Mercury
 - ▶ developmental disorders, neurological damage

Indicators of Potential Human Health Threats

- ◆ Indicators of human health risks from contaminated waters are proxies and are evolving.
- ◆ EPA's 1986 bacteriological criteria:

Indicator	Geometric Mean Density	Single Sample Max. (Designated Beach)
Freshwater		
Enterococci	33	62
E. coli	126	235
Marine water		
Enterococci	35	104

Bacterial Densities in CSOs

- **Bacterial densities in CSOs and SSOs range from untreated domestic sewage to urban storm water.**

Which exposure pathways are the most significant and what populations are most sensitive?



Exposure Pathways

- **The most common exposure pathways include:**
 - ▶ **recreational contact;**
 - ▶ **drinking water;**
 - ▶ **fish or shellfish;**
 - ▶ **direct contact (basement backup, flooding); and**
 - ▶ **secondary transmission.**

The Nature of Exposures

- **Exposures to CSOs and SSOs and resulting illnesses or disease outbreaks are generally diffuse and difficult to identify.**
- **A lack of information on illnesses from exposure to CSOs and SSOs limits the ability to develop a national estimate.**

Demographics of Exposures

- **Groups facing the *most frequent exposures* include:**
 - ▶ swimmers/bathers/waders;
 - ▶ children;
 - ▶ subsistence fishers (e.g., Native American groups & urban poor).

Demographics of Exposures

- **Groups *most sensitive to waterborne illnesses* include:**
 - ▶ pregnant women;
 - ▶ children;
 - ▶ immunocompromised;
 - ▶ elderly; and
 - ▶ those without prior immunity (e.g., tourists).

How do the human health impacts associated with exposure to CSOs & SSOs compare to other kinds of impacts?



What proportion of illnesses are related to CSOs or SSOs?

● During 2000:

- ▶ Reported *E. coli* O157:H7 4,528 cases
 - ✦ Centers for Disease Control and Prevention. Summary of notifiable diseases, United States, 2000. *MMWR* 2000;49(No. 53):[3].
- ▶ Foodborne *E. coli* O157:H7 2,725 cases
 - ✦ Mead, P.S., et al. Food-Related Illness and Death in the United States. *Emerging Infectious Diseases*; 5(No.5).
- ▶ Waterborne *E. coli* O157:H7 841 cases
 - ✦ Centers for Disease Control and Prevention. Surveillance Summaries, November 22, 2002. *MMWR* 2002;51(No. SS-8).

Cryptosporidiosis in the U.S.

- In industrialized countries, approximately 0.4% of the population pass *Cryptosporidium* oocysts at any given time.
- Among patients admitted to hospitals for diarrhea, 2-2.5% have Cryptosporidiosis.
- Further 30-35% of the U.S. population has antibodies for *Cryptosporidium parvum*, evidence that they have been exposed to the parasite.

▶ Source: Upton, S.J. 2001.

Waterborne Disease Outbreaks (WBDOs)

- What constitutes a waterborne-disease outbreak (WBDO)?
 - ▶ At least 2 people with similar symptoms and
 - ▶ Illness traced to drinking or recreational water by epidemiologic evidence.

Reported WBDOs

- From 1985-2000, CDC reported a total of 517 WBDOs, involving 480,604* cases.
 - ▶ drinking water: 234 outbreaks, 459,637* cases
 - ✦ 54 drinking water outbreaks (raw water from rivers, streams, lakes); 444,715* cases
 - ▶ recreational water: 254 outbreaks, 17,951 cases
 - ✦ 75 recreational water outbreaks associated with open water bodies; 5,619 cases
 - ▶ sewage contamination specifically named in 13 outbreaks; 6,097 cases
- *Approximately 403,000 cases were from the 1993 Milwaukee, WI Cryptosporidiosis outbreak.

More Outbreaks

- Between 1971 and 1994, 20-40% of reported WBDOs associated with extreme precipitation (Rose et al 2000).

Brushy Creek, Texas

- **July 1998, lightning caused power failure at a sewer lift station**
- **167,000 gallons of sewage spilled into Brushy Creek**
- **Contamination of municipal drinking water supply**
- **Complaints of nausea, diarrhea, and cramps**
- **Estimated 1,300 cases of Cryptosporidiosis**

Ocoee, Florida

- **Repeated sewer overflows (1988-89) associated with wet weather events**
- **Residents exposed to flooding and standing water**
- **39 cases of hepatitis A**
- **Symptoms: diarrhea, abdominal pain, fetal death**
 - ▶ **some symptoms persisted for 2 years**

What are the impediments to understanding the linkages between CSOs & SSOs, exposures, and human health impacts?



Challenges for Monitoring

- **Lack of connectivity in the monitoring & reporting systems for CSO and SSO events, human exposures, and human health impacts.**

Challenges for Monitoring

- **Confounding factors include:**
 - ▶ **Linking pathogens to CSOs or SSOs**
 - ▶ **Attribution of disease outbreaks to CSOs or SSOs**
 - ▶ **Outbreak reporting to CDC is voluntary**
 - ▶ **Many people who become ill do not seek treatment**
 - ▶ **Inconsistent diagnosis within the health care system**
 - ▶ **Underreporting**

Surveillance

- **Increased surveillance identifies more outbreaks.**
 - ▶ **From 1971 to 1985, 5 states, with 9.7% of the U.S. population, reported 42% of all WBDOs.**

What is the institutional framework to assess and address potential human health impacts of CSOs and SSOs?



Protecting Human Health

- **Response actions to minimize human exposure once CSOs and SSOs occur include:**
 - ▶ **water quality monitoring programs;**
 - ▶ **beach warnings and closures;**
 - ▶ **fish and shellfish advisories and closures;**
 - ▶ **boil water advisories;**
 - ▶ **public service announcements;**
 - ▶ **posting of CSO outfalls.**

Beach Closures, 2002

- **From EPA's 2002 BEACH Watch Program:**
 - ▶ Data gathered on 2,823 beaches
 - ▶ 709 beaches (25%) had at least 1 closing
 - ▶ 75% of closings due to elevated bacteria levels
 - ▶ 2% of closures with known cause due to CSOs
 - ▶ 11% of closures with known cause due to SSOs

Warning!

- **Not all warnings of unsafe recreational water are effective in conveying actual risks.**
 - ▶ Lag time between sampling, results, and posting.
 - ▶ Violation of standard is not necessarily intelligible or relevant to general public.

Responsibilities

- **Many different agencies, at local and state levels, are involved.**
 - ▶ **City, county, or state health departments**
 - ▶ **City, county, or state environmental agencies**
 - ▶ **Drinking water agencies**
 - ▶ **POTWs**
 - ▶ **Sanitation districts**
 - ▶ **Public works departments**

Fish & Shellfish Advisories

- **Roughly 70% of the coastline in the lower 48 under advisories (EPA 2002 NLFWA)**
 - ▶ **92% of the Atlantic Coast**
 - ▶ **100% of the Gulf Coast**
 - ▶ **Portions of Pacific Coast**
- **CSOs listed as source of impairment for 7% of shellfish beds (NOAA 1995)**

Innovative Programs

- **Boston, Massachusetts**
 - ▶ Active surveillance program for *Cryptosporidium* and *Giardia*
- **Austin, Texas**
 - ▶ Predictive model for rainfall-based closures at Barton Springs pool
- **San Diego, California**
 - ▶ Ocean Illness Survey
 - ▶ Pathogen source investigations
 - ▶ Analysis of effectiveness of beach closings

Summary



**The pathogens and
pollutants in CSOs and
SSOs have human health
impacts.**



**Exposures to the pathogens
and pollutants resulting
from CSOs and SSOs occur,
but are difficult to quantify.**



**Human health impacts from
waterborne diseases are
underreported.**



**Responsibilities for
protecting human health
from waterborne illnesses
are distributed among many
agencies and institutions.**



