Investigation Tools: Epidemiology, Microbiology, and Toxicology

Shiaw-Fen Ferng, Indiana State University

Key concepts

Epidemiology

- Epidemiology is the study of the distribution and determinants of health.
- Local boards of health and health departments primarily rely on principles of epidemiology and observational studies to understand the factors behind disease incidence or outbreaks.
- The CDC WONDER database allows boards of health to examine their county's death rates for specific diseases and compare their rates with those of the state or the nation.
- Local health department staff plays an important role in disease outbreak investigations.

Microbiology

- Local health departments routinely use principles of microbiology in their disease prevention and control programs.
- One of the most important concepts in microbiology is the "chain of infection" through which diseases spread.

Toxicology

- Toxicology is the science dealing with the effects of biological, chemical, and physical agents on living organisms.
- Many factors influence the impact or effect of a toxin on a human.

Introduction

The disciplines of toxicology, epidemiology, and microbiology are important tools for investigating the causes of individual diseases and disease outbreaks. Principles of **epidemiology** are often used to organize a disease outbreak investigation, while the field of **microbiology** studies living microorganisms, including bacteria, viruses, yeasts, and molds. **Toxicology** examines the effects of chemical or physical agents on living organisms. Both microbiology and toxicology provide health departments with information about the possible illnesses that may result from exposure to disease organisms or environmental contaminants. In addition, whereas epidemiologic investigations usually are conducted by frontline public health workers, microbiology and toxicology investigations are usually conducted in a

laboratory. The relationship among these three sciences is depicted in Figure 1. This chapter will examine the basic principles of each of these fields, focusing on how they are used by public health investigators and local boards of health.

Epidemiology

Epidemiology is the study of the distribution and determinants of health events in a human population. The *determinants* or factors influencing health can be any interventions/ exposures occurring to individuals or communities, such as toxic substance exposure in a neighborhood, food poisoning, indoor air pollution, a health education program, and vaccinations. *Health events* are any health changes to a population, including changes in cancer occurrence, food poisoning, "sick building" symptoms, health behavior changes, and disease prevention and education.

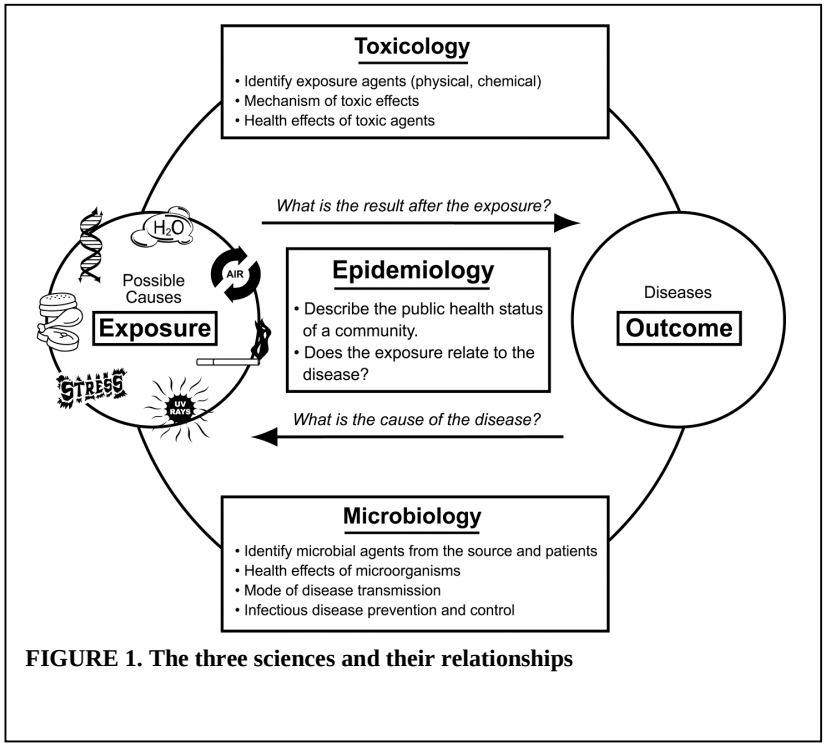

FIGURE 1. The three sciences and their relationships

The most common applications of epidemiology in public health are as follows:

1. Collecting and analyzing vital records (births and deaths) and disease records (morbidity);
2. Monitoring diseases or other community health problems;
3. Investigating outbreaks leading to control or prevention of epidemics and other community health problems;
4. Identifying public health problems and measuring the extent of their distribution, frequency, or effect on the public's health;
5. Evaluating health programs; and/or

6. Providing data necessary for health planning or decision making by health agency administrators or health policy makers.

Commonly Used Measurements in Epidemiology

Table 1 provides some of the common terms used in epidemiology.

TABLE 1
Common Terms and Definitions

Mortality rate (MR): An estimation of the proportion of a population that dies during a specific time period. Also called the *death rate.*
Prevalence rate (PR): The proportion of a population that has a specific disease at a specific point in time. For example, if the 2000 prevalence rate for a particular disease is 5 per 1,000, 5 people for every 1,000 people in the population will have the disease.
Incidence rate (IR): The proportion of a population that will get a specific disease over a period of time. This is also referred to as the *attack rate*.
Duration of the disease (D): The average duration of a disease is calculated by dividing a disease's prevalence by its incidence (D = prevalence rate/incidence rate).
Case Fatality rate: The risk among all persons who acquire a disease that they will subsequently die from. It is an indication of the severity of the disease.
Rate ratio (RR): The ratio of incidence rates between a group exposed to a disease-causing agent and a nonexposed group. It is used to measure the magnitude of the exposure's impact.
Odds ratio (OR): The ratio or odds of getting a disease between a group exposed to a disease-causing agent and a nonexposed group. It is used to measure the magnitude of association between exposure to an agent and a disease outcome.
Rate difference (RD): The difference of incidence rates between the exposed group and the nonexposed group. It is an indication of the proportional decrease in the incidence of a disease if the entire population were no longer exposed to the suspected etiological agent.

Although frequently used by health planners, prevalence rates should be interpreted cautiously. A low prevalence rate for a particular disease might reflect the low incidence and good cure rate of the disease; however, it might also be due to the disease's high fatality, i.e., people who have the disease may tend to die and, therefore, they would not be counted as cases. Moreover, a high prevalence rate might not be a bad thing either; it might be the result of better medication and surviving patients being counted as "existing cases" in the prevalence rate. In either event, the prevalence rate is a good indicator for determining the workload, facilities, and resources needed for community health services.

Identify an Epidemic Situation

The number of cases of a disease that occur in a community without a specific exposure or intervention is called the *baseline rate*. This is also often considered the *expected level* of the disease. For example, over the past five years the average number of new cases (the incidence rate**)** of Hepatitis A per year in Community A was 10 per every 10,000 people. The accepted or expected levels ranged from 8 to 12 cases per 10,000 people per year. When the incidence rate is greater than the expected level (12 per 10,000 per year), this indicates that a disease epidemic may be occurring.

The patterns of disease occurrences in communities vary. When a particular disease is consistently found in a specific community, and the disease occurs only in that limited geographical region or population, the disease is said to be **endemic**. In other words, endemic diseases tend to have relatively high rates in a specific location and/or population. For example, Lyme disease is endemic in the Northeast in the United States. When the occurrence of a disease within an area is clearly in excess of the expected level for a given time period, it is referred to as an **epidemic** or outbreak**.** When an epidemic spreads over several countries or continents and affects a large number of people, it is called a **pandemic**. For example, HIV/AIDS is an epidemic among intravenous drug users in the United States; HIV/AIDS is also considered to be pandemic because of its worldwide infection rates.

Epidemiology Triangle

There are three primary factors that influence if, when, where, and how disease occurs. These three factors are the disease agent and its characteristics; the human, plant, or animal "host" and its vulnerability to the disease; and the environment containing the agent and the host (Figure 2). These three factors are often described as the "epidemiology triangle" and all are important to examine when searching for a disease's cause(s). Table 2 offers examples or descriptions of each of these factors.

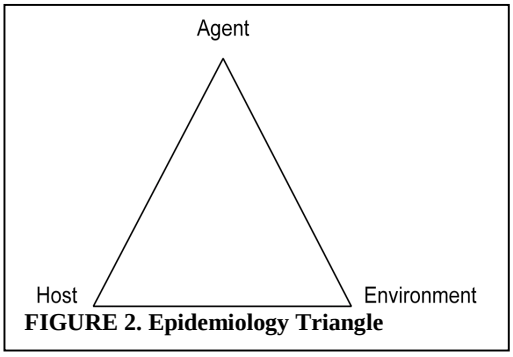

FIGURE 2. Epidemiology Triangle

The Centers for Disease Control and Prevention (CDC) is currently applying a "systems-based" approach to environmental health practice. Utilization of the systems approach will influence how environmental health services are delivered and how environmental health problems are solved. CDC has successfully integrated the systems approach into several recent investigations of environmentally-related diseases.

"Systems theory" is the science of wholeness. Rather than dissecting a complex process and studying the individual parts, systems theory focuses on understanding the complete system and the underlying interactions of all the forces that make up the system.

TABLE 2
Examples of the Three Epidemiology Triangle Factors

Types of Agents

Disease agents can be classified into three primary categories: biological, chemical, and physical. Examples of each are:

Biological: bacteria, virus, parasite, or other microbes
Chemical: pesticides, herbicides, metals, organic solvents, etc.
Physical: ionizing radiation, nonionizing radiation, noise, heat, vibration, etc.

Host Characteristics

Factors that affect an individual's susceptibility and response to causative agents include: age, gender, race, socioeconomic status, lifestyle (smoking, diet, exercise, sexual preference, drug abuse), and the status of an individual's immune system

Environmental Factors

External factors that affect the spread of agents and the opportunity of agents to contact and/or enter hosts include: local geology, climate, sanitation of living conditions, presence of vectors (flies, mosquitoes, ticks, mice, etc.) that can carry disease, and the availability of health services.

A food service establishment is an example of a system. The outcome of the system (food served to customers) is influenced by numerous factors that make up the system, such as ingredients, food workers, equipment, preparation/cooking processes and the economics of the establishment. The investigation of a foodborne illness in a food service establishment using the systems approach would not only look at the source of contamination and the pathogen involved, but would also determine the underlying factors in the system that allowed the outbreak to occur. An example would be a restaurant owner who would not allow a sick employee to go home due to a shortage of persons working in the kitchen. A standard investigation may reveal the source of the pathogen, but would not look at the underlying factors or "environmental antecedents" that allowed the pathogen to enter the system. Using the systems approach, the investigation would review underlying factors to reveal that a sick employee was not allowed to leave work because of a staffing shortage in the kitchen. The corrective action might involve working with the owner to change his policy regarding sick leave to ensure that sick employees are not involved in the food preparation process in the future.

Boards of health should encourage environmental health personnel to become familiar with the systems concept and to identify opportunities to study environmental health problems using a systems approach.

Systems education and training would provide environmental health program managers the information they need to incorporate systems thinking into the practice of environmental health.

Epidemiologic Observational Studies

The goal of epidemiology is to discover the relationship between agents, hosts, and the environment and their impact on the occurrence of disease. To understand these relationships, local boards of health and health departments primarily rely on observational studies. There are two main types of observational studies, descriptive studies and analytical studies.

Descriptive studies frequently consist of case reports of illness or death and cross-sectional surveys. Information is gathered on community or individual health characteristics (e.g., cancer incidence or mortality rates, incidence of lead poisoning, etc.) with respect to person, place, and time to estimate disease frequency, geographical clustering of illness, and time trends. The results from descriptive studies are often used by boards of health to develop disease prevention policies and to allocate resources.

One example of a descriptive study is a recent investigation of the rate of childhood cancer in the United States. Because of increasing public concern, data on 14,540 children under the age 15 who had been diagnosed with cancers between 1975 and 1995 were investigated. In particular, these data were examined to determine whether there was a change in the number of cancer cases that occurred in specific states and regions over time. The results showed that there was no substantial change in major childhood cancers, and the rates have remained relatively stable since the mid-1980s. The modest increases that were observed from brain/central nervous system cancers, leukemia, and infant neuroblastoma were confined to the mid-1980s (Linet et al. 1999). These results were used to help answer concerns about cancer risks.

Analytical studies include ecologic, **case-control**, and **cohort studies**. Such studies are designed to test hypotheses regarding the factors that cause a disease. The types of data used in ecologic epidemiology studies include exposure data (e.g., ozone levels in the outside air, the amount of arsenic in drinking water, soil lead levels), the per capita income of the community, smoking prevalence of a community, and disease data (e.g., the number of new disease cases or disease death rates).

Rate Comparisons in Epidemiologic Studies

To allocate local health resources, board of health members often need to compare disease distribution among communities. It is critical that boards choose correct and comparable rates when discussing different communities. Three types of information regarding illness that can be used to compare regions are presented in Table 3.

TABLE 3
Regional Illness Information

Rates	Application
Crude rate	• Calculates the rate for the entire population. • Provides the overall picture of a community.
Specific rate	• Calculates the rates for subgroups in a population. • Commonly seen specific rates: age, sex, socioeconomic class, residential area, or occupation.
Adjusted rates	• Summary measures of morbidity and mortality rates in a population in which statistical procedures have been applied to remove the effect of differences in composition of the various populations. Uses a third party's population distribution or disease rates to remove misleading results due to uneven distribution of certain demographic factors in the populations. • Age and/or sex distribution factors are commonly adjusted when doing rate comparisons.

An example of using direct adjusted rates for comparison: The following table shows the 1995 total cancer death rates of Florida and Indiana, using the 1970 U.S. population as a standard population for adjustment.

States	Crude cancer rate per 100,000	Age-adjusted cancer rate per 100,000
Florida	266.5	169.1
Indiana	219.9	182.1

If crude cancer death rates are compared directly, Florida's rate has 266.5 deaths per 100,000 individuals—21% more than Indiana. However, when the cancer mortality rates are adjusted by age, Florida's cancer death rate is 169.1 or 7% lower than Indiana's 182.1. The age-adjustment helps account for the differences in age distributions between the states, i.e., the large number of older adults who live in Florida. Thus, boards of health may be misled if they rely only on crude disease rates when comparing communities.

The CDC WONDER database can provide boards of health with adjusted death rates by county. Such information can allow boards of health to examine their county's death rates for specific diseases and compare their rates to the state or the nation.

Application of Statistics in Epidemiology

One of the best examples of how health investigators use statistics is a 1996 outbreak of *Plesiomonas shigelloides* and *Salmonella serotype Hartford* infections. Health authorities

were alerted to a problem when 30 of 189 party attendees developed diarrhea. The county health department conducted a study to find out whether consumption of particular food items was associated with diarrhea.

The statistical results of the study showed that several food items were associated with the diarrhea; however, only three food items—macaroni salad, potato salad, and baked ziti—had a statistically significant association with the disease. These findings led the investigation team to examine the water that was used for food preparation. Investigators determined that the untreated surface water was contaminated by *Salmonella serotype Hartford* and *P. shigelloides,* and this was the cause of the diarrheal illness outbreak. Immediately after the cause was recognized, public health measures were taken to stop further disease cases. These steps included prohibiting stores from preparing food and instructing people not to drink the water until an adequate water-treatment system that met drinking water standards could be provided.

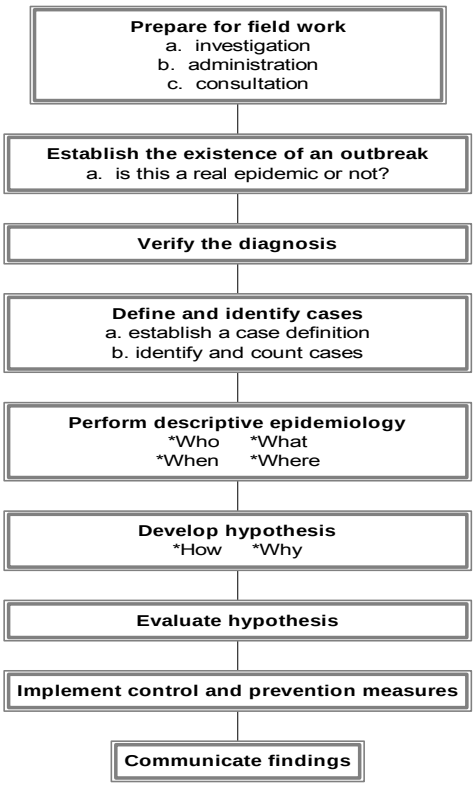

FIGURE 2. Outbreak investigation flowchart

Steps in Outbreak Investigations: A Case Study

As the example above indicates, local health department staff plays a very important role in disease outbreak investigations. The results of their investigations are critical for determining the appropriate control measures that will prevent further disease spread. Such investigations frequently are a legal responsibility of health departments and are an important component of health department health communications. The Centers for Disease Control and Prevention (CDC) has developed recommended standard procedures for outbreak investigations. These steps are shown in the flowchart in Figure 2.

An example of how this flowchart is implemented can be found in a 1999 *Escherichia coli* outbreak. In September 1999, a state department of health received reports of at least 10 children who were hospitalized in neighboring counties with bloody diarrhea or *Escherichia coli* O157:H7 infections. All of the children had attended the same county fair, which was held August 23–29, 1999. By September 15, 921 persons reported diarrhea after attending

this county fair. The state department of health began an investigation that included an attempt to locate all disease cases, epidemiologic and laboratory studies, and an environmental investigation of the county fairgrounds.

As diagnoses of the cases and the causal agents (*E. coli)* were verified, local board of health and health department administrators issued press releases and contacted hospital emergency departments to identify additional fair attendees with diarrhea. A descriptive epidemiologic report was compiled to characterize the persons who contracted the disease after attending the fair.

Subsequently, a case-control study was conducted to determine the risk factors for the infection. Through this study, investigators were able to develop and evaluate hypotheses on the source of the *E. coli* contamination. Researchers found that consumption of water or beverages made with water from a particular well were associated with illness. Fair attendees who drank water from the suspect well were 23.3 times more likely to develop the disease compared with people who did not drink water from that well. To prevent future outbreaks several public health measures were enacted:

1. Letters were sent to schools and day care centers emphasizing the need to exclude symptomatic children and practice careful handwashing to prevent the further transmission of infections;
2. Letters were sent to nursing homes and hospitals with recommendations regarding employees and residents with diarrhea;
3. Information to the public focused on how to prevent secondary infections from the outbreak; and
4. The state health commissioner issued an order requiring county fairgrounds to use disinfected water when hosting public events; the health commissioner began a review of all laws and regulations applicable to fairs.

Microbiology

Microbiology is the study of living microorganisms, including bacteria, viruses, yeasts and molds, protozoa, and other forms of life. Microbiological studies have led to great advances in the ability to control many infectious diseases. As a result of investigations in microbiology, current sewage disposal and drinking water treatment now virtually eliminate epidemics of typhoid fever and cholera. Another example of the contribution of microbiology to disease control is the complete elimination of smallpox and the major reduction of paralytic polio through the use of mass immunization.

The staff of local health departments is the frontline workers who use principles of microbiology to prevent and control diseases. Local health departments routinely use microbiology in

- *Disease prevention:* vaccination programs, food establishment inspection (food preparation techniques, general environment sanitation), swimming pool monitoring (residual chlorine, water sample for total bacterial counts), and vector-control programs (mosquitoes, rodent control program, etc.); and
- *Disease control:* infectious disease outbreak investigation, quarantine, etc.

Related topics in microbiology will be presented in the following sections.

Spectrum of Diseases

Disease occurs after exposure to disease-causing agents (e.g., *E. coli*) or after the factors that are capable of causing disease (hardening of the arteries) accumulate in a susceptible human. The period of subclinical or inapparent pathologic changes in the body following exposure to a disease agent is called the **incubation period.** The incubation period usually ends with the onset of symptoms; for chronic diseases, this period is usually called the **latency period**. This incubation time period varies by disease, and investigators use knowledge of incubation periods to narrow the possible causes of a disease outbreak.

Quarantine is one approach to prevent the transmission of infectious diseases. To be successful, however, a quarantine must completely or partially restrict the activities of healthy persons or animals who have been exposed to an individual or animal with an infectious disease during its incubation period. Extensive quarantines can be a difficult undertaking.

A person who is capable of transmitting an infectious agent to another person without an apparent disease is called an **asymptomatic carrier.** Carriers commonly transmit disease because they do not recognize that they are infected and consequently take no special precautions to prevent transmission. For example, persons with measles or hepatitis A become infectious a few days before the onset of symptoms. Persons infected with hepatitis B virus might be asymptomatic carriers unknowingly for years and transmit the disease to susceptible individuals during that time. As a result of the range in incubation periods and the potential for asymptomatic carriers, the control of infectious diseases that are spread by carriers is one of the hardest tasks facing public health professionals.

Pathogens in the Environment

Unlike chemical toxins (which may be produced by biological substances), disease organisms, also known as **pathogens**, exist only in the environment (e.g., food, water, air, and soil) as long as conditions are suitable for their survival. The environment's temperature, moisture, ultraviolet light, and pH all may influence the survival of pathogens. Temperature is probably one of the most important factors. In general, the lower the temperature, the longer a microorganism will survive. Freezing temperatures, however, usually result in the death of certain bacteria and protozoan parasites. Viruses, however, can remain infectious for a long time at freezing temperatures. By making environmental conditions unsuitable for the survival of pathogens, much of the threat to humans can be reduced.

Chain of Infection

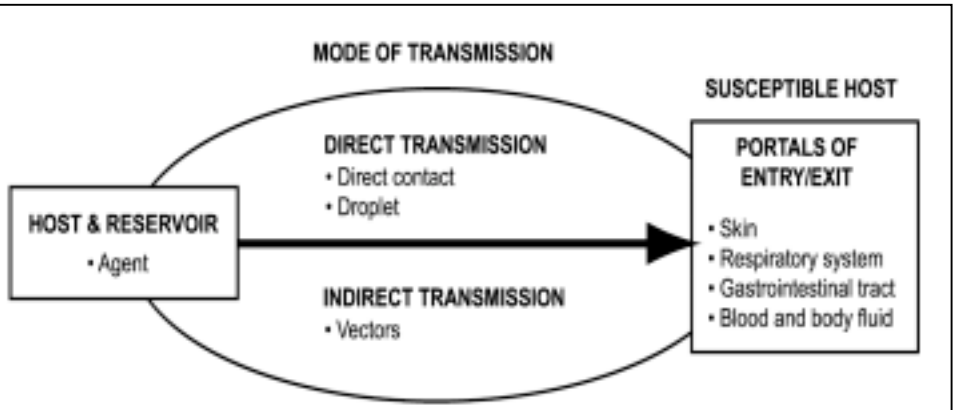

FIGURE 3. Infectious disease transmission.

Figure 3 presents a model of infectious disease transmission. This is commonly called the **chain of infection**. Understanding a disease's chain of infection is critical to control or prevent the spread of the disease successfully—an infectious disease cannot spread when one of the connections in the chain is broken. Two examples of diseases for which local boards of health and health departments can break the chain of infection are St. Louis encephalitis and Lyme disease. By reducing the mosquito population in a community, boards can prevent the transmission of St. Louis encephalitis. By controlling the number of deer ticks, boards can reduce the spread of Lyme disease.

Toxicology

Toxicology, the "science of poisons," is the study of the effects of chemical or physical agents on living organisms. Since the 1970s (following the passage of the National Environmental Policy Act and the Occupational Safety and Health Act), much attention has

been directed toward understanding the health effects of chemical and physical agents that are found in the workplace as well as in other indoor and outdoor environments. The mission of toxicologists is to anticipate, prevent, recognize, evaluate, and control human and ecosystem exposure to toxic agents.

Toxic or Nontoxic

When determining whether a substance is toxic or nontoxic, the following expression is useful, "sola dosis facit vennum" or "only the dose makes the poison" (Paracelsus, 1493–1541). In other words, any chemical, when administered in sufficient quantities, is capable of evoking adverse effects. Therefore, even chemicals thought to be innocuous, such as water or oxygen, may produce adverse human health effects at certain doses or concentrations. For example, exposure to low levels of oxygen may result in severe hypoxia and exposure to high levels may result in pulmonary edema. Therefore, the safety of chemical substances, whether in air, food, soil, water, or the workplace, can be defined as a condition of exposure under which there is a "acceptably low risk" that no harm will result to exposed individuals throughout their life.

Dose-Response Relationship

Humans have a "dose-response" relationship to many toxins. This means that the intensity of a human's reaction or response to a chemical exposure is dependent on the amount (or dose) of the exposure. A larger dose generally produces a greater adverse effect than a smaller dose, although there is a limit to which a biological system will respond. The following terms are used to describe dose-response relationships:

- **Threshold:** The highest dose of a toxic substance below which no measurable adverse health effects will occur for lifetime exposure.
- **Nonthreshold:** Exposure to any amount of toxic agents will produce some measurable adverse health effects.
- **LD_{50}:** Lethal dose, the concentration of a particular toxic substance that, administered to all animals in a test, is lethal to 50% of the animals.
- **LC_{50}:** Lethal concentration, the concentration of a toxic agent in the air or water, which animals breathe or live in, that causes death to 50% of the animals within a certain period of time.

- **TD_{50}:** Toxic effect dose, the concentration of a particular toxic substance that, administered to all animals in a test, has a toxic effect, such as liver injury, to 50% of the animals.

Measurement of Exposure and Dose

Humans can be exposed to the same toxic substance in different **environmental media** (air, water, soil, or food) and through different **exposure routes** (ingestion, inhalation, skin contact). The **exposure concentration** is the amount of a substance present in the environmental media with which a human has contact. The exposure concentration for a toxic substance in water is presented as milligrams of chemical per liter of water (mg/L). In air, the exposure concentration is expressed as milligrams of chemical per cubic meter of air (mg/m^3), and in food or soil it is milligrams of chemical per gram of solid food or soil (mg/g). Examples of the ways in which humans can have multiple exposures to the same toxic substances are that an individual can both drink and breathe certain volatile organic compounds in tapwater and air; children can drink lead in water, eat lead in food and paint chips, and breathe it in the air.

The **total dose** is the amount of the chemical that the body receives via all routes of exposure. The terms *dose* and *dosage* have been used nearly interchangeably to describe levels of exposure to toxicants. However, **dose** commonly refers to the amount of a chemical administered, and **dosage** refers to the amount of chemical administered per unit of body weight of the recipient (mg/kg). Due to absorption, distribution, excretion, and storage, the amount reaching the target organ is much less than the exposure dose. **Exposure frequency** (how many times per year) and **duration** (how many years) are other important factors to consider when determining the total dose of an individual's exposure to a toxic substance.

Toxicokinetics of Toxic Substances

There are four major variables that determine the final amount of toxin reaching a target organ or an organ that will be impacted by the toxin. The flow chart in Figure 4 summarizes these variables. **Absorption** is defined as the passage of a chemical across a membrane and into the blood stream. It can occur in the gastrointestinal tract, in the lungs, and through the skin. **Distribution** refers to the movement of a chemical throughout the body. Liver, kidney, fat, bone, and plasma proteins are main **storage** locations for toxic substances. The process of **biotransformation**, also known as *metabolizing*, increases the water solubility of the toxic substance. Metabolization reduces the ability of a chemical to be stored in the fat and increases the rate the body eliminates the chemical. **Excretion** is to eliminate toxic substances from the body. The major routes of excretion in mammals are the

kidneys (via urine) and the gastro-intestinal track (via feces for any toxic substance that is not absorbed or is not secreted in saliva or into the bile). The lungs, sweat, saliva, and milk are other ways of excreting toxic substances.

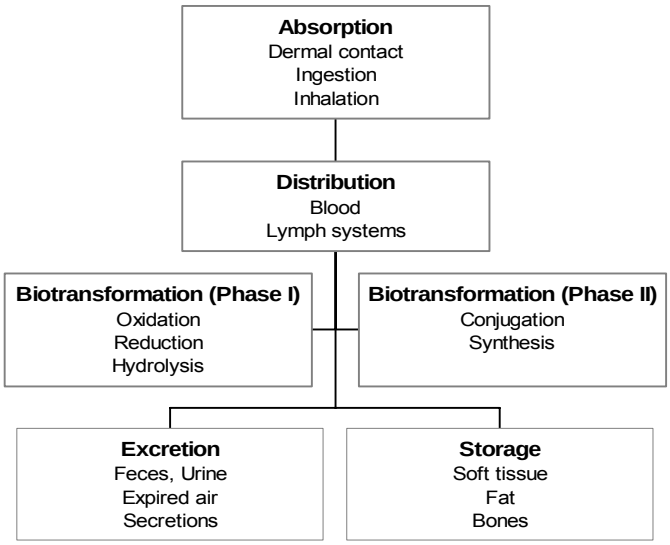

Figure 4. Toxicokinetics of toxic substances

To use lead as an example of this process, lead can be absorbed through ingestion and inhalation. It is then transported by blood to all of the body's organs and tissues. Nearly 90% of the total human body burden of lead is stored in bone, with the remaining 10% entering the kidneys and liver. The main target organs of lead are the central nervous, gastrointestinal, and reproductive systems—these are the organs that can be heavily damaged by toxic doses of lead. Bone, the main storage site for lead, however, is not a target organ. Lead can be excreted through the kidney. Lead can also transfer through a placenta to a fetus.

Biomarkers

Biological monitoring is the process of analyzing body fluids such as blood, urine, or exhaled air after exposure to chemical or physical agents. **Biomarkers** indicate how sensitive an individual is to the chemical or the amount of the toxic substance that is retained in the body. When a biomarker of an exposure exists it has advantages over using environmental measurements alone to estimate total exposure to pollutants because it accounts for exposures from multiple routes (inhalation, ingestion, skin), multiple environmental media (air, water, food), and the metabolic processes in the body.

In general, three types of measurements can be used for biological monitoring:

1. Measurement of the chemical contaminant itself, e.g., the amount of lead, cadmium, or mercury contained in body fluids;
2. Measurement of a metabolite of the chemical, e.g., testing the blood for carboxyhemoglobin to determine methylene chloride exposure or testing the urine for phenol to determine benzene exposure; and

3. Measurement of enzyme activities, e.g., testing for the level of aryl hydrocarbon hydroxylase (AHH), an enzyme in the metabolism of polycyclic aromatic hydrocarbons (PAHs) that increases the risk of lung cancer.

Classification of Toxic Agents

No single classification system can adequately distinguish all known toxicants. The commonly seen classification schemes for toxic agents are listed in Table 4.

TABLE 4
Classification of Toxic Agents

Classification	Categories
Toxic agent	Heavy metals, pesticides, solvents, vapors, food additives, radioactive materials
Target organs	Dematotoxins (skin, e.g., organic solvents), hematotoxins (blood, e.g., carbon monoxide, arsin, benzene, lead, nitrites, nitrates), hepatoxins (liver), nephrotoxins (kidney, e.g., cadmium, mercury, lead,), neurotoxins (nervous systems, e.g., organic solvents), pulmonotoxins (lungs, e.g., chemical vapors and metal fumes), reproductive toxins (e.g., lead, cadmium, halogenated pesticides, carbon disulfide, vinyl chloride, x-ray radiation)
Effects	**Carcinogens** (cause cancers, e.g. arsenic, asbestos, benzene, chromium, vinyl chloride monomer, etc.), **mutagens** (DNA damage, might trigger cancer growth), **teratogens** (malformation of fetus, e.g., thalidomide)
General sources	Air pollutants, water pollutants, industrial toxicants

Conclusion

The fields of epidemiology, microbiology, and toxicology provide local boards of health and health department staff with important tools for determining the causes of diseases and the programs and policies that are needed to prevent and control disease. Although studies of disease outbreaks are usually conducted by trained professionals, boards of health have a responsibility to ensure that the health department has determined baseline disease rates in the community, is watchful for changes in disease patterns, and has the resources to investigate disease outbreaks when needed. The CDC has many tools, including the CDC WONDER database, to allow boards of health to understand how the disease burden in their community compares with rates in other communities nationwide. Depending on the situation, boards of health may also have a responsibility to inform the public of changes in disease patterns or disease outbreaks, along with communicating the steps being taken to protect the public.

Resources for Additional Information

Agency for Toxic Substances and Disease Registry (ATSDR) ToxFAQs. <www.atsdr.cdc.gov/toxfaq.html>.

Centers for Disease Control and Prevention (CDC). <www.cdc.gov/>.

---. National Center for Environmental Health. Environmental Hazards and Health Effects. <www.cdc.gov/nceh/divisions/ehhe.htm>.

---. WONDER database. <http://wonder.cdc.gov/>.

Environmental Defense Scorecards. <www.scorecard.org>.

National Library of Medicine: <www.nlm.nih.gov>.

National Library of Medicine Toxicology Data Network. <http://toxnet.nlm.nih.gov>.

National Public Health Performance Standards Program (NPHPSP): <www.phppo.cdc.gov/nphpsp>.

United States Environmental Protection Agency . Office of Pollution Prevention and Toxics. Chemical Fact Sheets. <www.epa.gov/chemfact/>.

---. Environmental Quality Website. <http://www.epa.gov/ceisweb1/ceishome/sitemap.html>.

---. Terminology Reference System. <www.epa.gov/trs/index.htm>.

---. Toxic Release Inventory. <www.epa.gov/tri/>.

---. Window to My Environment. <www.epa.gov/enviro/wme/>.

Management Tools: Environmental Policy, Law and Administration

Owen Seiver, California State University, Northridge

Key Concepts

- The most effective way to limit public health risk is through prevention.
- The prevention of disease and the achievement of a better quality of life require an implementation of viable environmental health policies and programs.
- Environmental programs should be risk based in establishing priorities and implementing policies.
- Policy analysis is a valuable tool and should be used before policy advocacy.
- English Common Law provides the use of precedent-setting decisions.
- Legal liability can be limited by recognizing personal limitations.
- Communication should include dialog with the community in both a one-way and a two-way manner.

Introduction

Environmental health professionals emphasize prevention as the primary tool in protecting public health. Prevention includes the implementation of programs and policies that are based on risk assessment and risk management by local health departments. *Risk assessment* is the process of gathering factual data about a problem, while *risk management* uses the data to aid in policy decisions.

For example, a hair found in the chili of a popular restaurant may warrant a complaint to the local health department. Through the process of risk assessment, the health department determines that the risk this hair presents to public health (although aesthetically undesirable) is minimal. Maintaining the correct temperature of the chili is far more important in protecting the public's health. Effective risk management would implement a policy that directs agencies to focus on the higher risk elements first. Using a grading system to communicate risk to the public, a hair in the chili would not significantly lower the restaurant's grade, but a serious temperature violation would.

Risk assessment and risk management are tools that can be used to assure the public's health and help boards of health make collective decisions. These tools can assist board members in their communication with each other, the local health department and other agencies, and the communities they serve. Risk assessment and management tools can also

assure that boards use and understand their legal authority. Proper use of these tools improves both the effectiveness of a board and, by extension, the health of the community.

Decision Making, Management, and Process

The challenges that face board of health members are complex because they require not only an understanding of the field of public health, but they also carry the responsibility of decision-making, policy analysis, and communication. If done properly, the board will gain respect and support of other agencies and the public.

The hardest part of any project is actually getting started. Whether in an advisory role or one of authority, the first task in problem solving is deciding how to proceed. A decision made by the board will always be the outcome of numerous combined choices made by individuals interacting at various levels, a process known as "group dynamics." It is sometimes frustrating working with a group that is trying to accommodate multiple opinions, ideas, and perceptions. However, the time-consuming process of a board meeting is a form of "brain-storming" and can result in some of the best ideas from the combined efforts of individuals.

Before choosing a decision-making process by which a board can proceed, here are some rules of working in a group setting:

- *Check emotions at the door!* Emotion is action without thought. Strong emotions may cause people to say or do things they do not really mean and may make them lose credibility with others in the group. Be patient and keep your cool while others are losing theirs.
- *Listen to the ideas of others!* Another member may just say something that provides a completely new perspective.
- *Beware of the paralysis of analysis!* One of the best stall tactics is to send a plan back for more study. Sometimes further study is necessary, but often it is a way of delaying the inevitable.
- *It is irrational to attempt to be rational with the irrational!* If a rare moment develops and an individual becomes highly charged and irrational, remember: "Never argue with a fool or the fool will be arguing with one too!"

The Decision Process

Board of health members are asked to share their perspectives, opinions, knowledge, and judgments in making critical decisions that may have widespread consequences. They are actually involved in the process of creating new or revising existing public policy. The

degree of involvement will depend on whether the member's role is advisory or authoritative, but the results will be the same: impacting the health and well-being of the community. This is the basis of policy analysis and policy advocacy.

- *Policy analysis*—Investigates how and why policies are proposed or implemented.
- *Policy advocacy*—Makes recommendations for the best course of action.

Most public health problems can be managed by following a simple process for policy development. This process must begin with a thorough investigation of existing laws and regulations, combined with existing policy. If these are found to be inadequate, or inappropriate, new policies must be developed.

CASE STUDY:
LOS ANGELES RESTAURANT GRADING SYSTEMS

Restaurant sanitation was the last thing on the public's mind when it came to their individual problems. At times, environmental health specialists wanted to post restaurant grades but there was resistance to the idea and the policy never developed. Then, a trigger event occurred! Local television exposed horrible conditions in some retail food establishments. Whether legitimate or not, the public perceived a problem and demanded action. Within weeks, a new policy requiring the posting of a food establishment's grades was established.

Step 1: Problem definition. Somewhere an existing problem needs a solution based on a board of health's expertise, perceptions, and judgment. Worried about their daily lives, the public does not perceive most problems as a concern. Citizens are not usually called to arms unless an event occurs that mobilizes them to demand action. Called **trigger** events, these mobilizing events require an immediate response from the board.

Trigger events are reported frequently on newscasts: A plane crash leads to a new policy on plane inspections; an oil spill leads to a new policy on tanker safety; a shooting leads to demand for gun control. Issues without public support or recognition are often harder to deal with than issues surrounding a trigger event. When defining the problem, remember that problems are perceived differently by different people. After defining the problem, the focus becomes finding the solution.

Suppose that a power plant on the edge of town is creating pollutants that could cause long-term health effects. If that plant is running problem free, it will be difficult to rally public support for improving conditions. If, however, an unfortunate event occurs, such as an explosion that immediately releases toxins into the air or some other trigger event, the public will now rally and support the board's decision to correct the problem.

It is important to know whether the public views the issue being decided as a major priority or not. If it is not a major priority, the board should determine what the best action is and try to convince the public and other officials to take that action or the board can decide to

table it. The mistake that often occurs following a trigger event is a rush to policy adoption, without spending time on a thorough policy analysis.

Step 2: Issue formation. Keeping in mind that there are always two sides to an argument, there are at least two sides to every issue. For example, if an electrical power plant is polluting the air on the outskirts of a city, two or more opposing issues could result. One view could be that the emissions are dangerous to health, and the plant needs to be shut down. In addition, no new plants should open in the future. Another view could be that the plant is a valuable source of electrical power, and more plants should open to keep electrical costs low. Obviously, each view has valid arguments, and a personal decision should be based on ethical and ideological perspectives. These, however, are just the opposing views. There must be more options from which to choose.

Step 3: Alternative proposals. The advantage of working with a group is the exchange of ideas, compromise, and the gradual, even social, give and take. There is an opportunity to develop alternative proposals that may be more acceptable to the board and the public. In the power plant example, here are some alternatives:

1. Open no new plants; retrofit existing plants with air pollution controls.
2. Open some new plants with controls; retrofit existing plants.
3. Close existing plant, open new plants with air pollution controls
4. Close all existing plants when alternative energy plants are opened.
5. Keep existing plant working, and replace equipment as it breaks down.

Step 4: Adopt a policy. Next, decision makers select from their policy agenda. A policy statement is then issued that cites laws, regulations, or ordinances that support the policy. Incorporated into the decision-making process are the impacts on the community (for example, power outages, increased utility costs, or health concerns) and a list of all possible outcomes.

Step 5: Policy implementation. When deciding about implementing a policy, boards of health must ask questions such as: Do we have the money to spend on the policy? Do we have

CASE STUDY:
CRIMINAL LEAF BLOWERS, GONE WITH THE WIND!

Los Angeles politicians voted to outlaw the use of gasoline powered leaf blowers on the streets. They are noisy, pollute the air, and blow dust and leaves all over the neighborhood. The policy was inconsistent and lacked sufficient study. It still allowed gasoline mowers (noise and pollution), electric blowers (dust), and most of all lacked enforcement. A policy without sanction is worthless. Were the police supposed to answer emergency calls and arrest the gardener for using a gasoline blower? It didn't take long before a moratorium was declared and the policy was forgotten. Perhaps the issue should have gone directly to a board of health for a proper policy analysis.

the people to enforce the policy? They also need a plan of action to establish how to implement the policy. Here is where the policy lives or dies. Policy not backed by sanction (enforcement) is useless.

Step 6: Policy evaluation. The most important step for the board to take in the decision-making process is to evaluate the impact the policy has had on the community and society. Only implemented policies can be evaluated. Skipping this step may result in more of the policies and procedures and laws and regulations that are of no value to society. Evaluation affords the opportunity to revise policy, delete policy, or celebrate success stories.

Understanding the Law

Board of health members often face the difficult task of advising and creating policy that has widespread interest and impacts throughout the community. Therefore, it is important that board members understand the workings, nature, and substance of environmental law.

English Common Law

The United States uses a system of justice derived from *English Common Law*. English Common Law was developed in thirteenth-century England when kings appointed royal judges to settle disputes; clerks recorded the judges' decisions. Using his own perceptions, prejudices, and moral values, a judge made rulings that ultimately resulted in different penalties for the same crime. Stealing an orange could have resulted in a prison sentence for one person and a slap on the wrist for another. Alerted to the discrepancies in rulings, the king decided to make them more "common" (or equal) and required judges who deviated from the norm or "precedent" to justify their position in writing. This soon led to a system of law that was common to the entire country.

In the American legal system, when a ruling is made by a judge it becomes precedent and can be used in another case to demonstrate how one judge ruled. For example, in the trial of O.J Simpson, the prosecution asked to give a second opening statement. Granted by Judge Ito, the ruling set the precedent for others to request the same privilege. Researching precedents relative to a case and the ability to cite them in the courtroom is why past cases relative to environmental law are important to cite as case studies.

Along with precedent as a tool of law, we have other sources of American law: statutes, ordinances, rules and regulations, and the Constitution (see Table 1).

A *statute* is any act passed by Congress or state legislators. Statutes often include federal and state water and air pollution laws. An *ordinance* is a law passed by a city or county government.

TABLE 1
Types of Laws and Their Sources

Type of law	Source	Example
Ordinance	County/City	Restaurants/local housing
Statutes	States/Congress	State wildlife laws
Rules and Regulations	Agencies	Toxic substance control act
Constitutional	Constitution	Zoning/eminent domain

Because lawmakers may not be experts in a particular field, Congress has delegated some of their authority to federal agencies, such as the Environmental Protection Agency (USEPA), and the executive branch of the government to make laws. These laws are called *rules and regulations*. Rules and regulations allow for a nonpolitical approach to making tough laws regarding our environment and public health. Many politicians often prefer to have these tough decisions made by the executive branch. Other members of Congress feel it is unconstitutional for anyone outside the legislative branch to make laws at all. Because people do not elect the personnel of federal agencies, many feel agency duties should be returned to Congress. Still others applaud the efficiency and accomplishments of federal agencies in managing an increasingly polluted world.

The *Constitution* reaches far into the field of public and environmental health. It is the foundation by which local, state, and federal governments are able to regulate public activities if they threaten the health of the population. For example, governments are not able to deprive someone of life, liberty, and property without following "due process." The governments are, though, allowed to take an individual's property for the general good of the public (such as to preserve wildlife land, wetlands, or to build a freeway) in a process known as **eminent domain**. So, while the Constitution provides local, state, and federal governments with the ability to make decisions for the good of the public, there are checks and balances (e.g., due process) to prevent abuse of power.

Administrative Law

Although technically only elected officials can make federal laws, an agency's rules and regulations are legitimate and have the same status as any legislation passed by the legislature as long as they follow due process. There are two types of due process: Procedural due process requires the agency to follow the correct procedures in making a law. Substantive due process means the agency is operating within its jurisdiction. The USEPA, for example, cannot create rules and regulations on local speed limits. Its boundary is limited to environmental law. The Administrative Procedures Act (APA) passed in 1946 governs the

actual legislative function of the agency. Agencies must follow the APA when issuing new rules and regulations.

The APA was proposed as a way of providing checks and balances for any agency. In 1935, the American Bar Association first pressed for a method to monitor the executive branch of government by aiding in the passage of the Federal Register Act. This provides for a daily record of all the administrative activities of the executive branch and all proposed rules and regulations. Before becoming effective, a new rule must be published in the *Federal Register*. The Administrative Procedures Act, divided into six major areas, extends the reach of the Federal Register Act (see Table 2).

TABLE 2
The Administrative Procedures Act

Section of APA	Provides for:	Importance
Definition of terms	Common language	Universal understanding of law
Fair information practices	Freedom of Information	Allows public access to government information
Rule making	Guidelines for the agency to make rules and regulations	Following due process makes the rules and regulations legitimate
Administrative adjudication	Hearing to resolve conflicts	Allows public to challenge rulings
Liability of public officials	Protection from lawsuits	Protects individuals acting in good faith
Judicial review	Power of Court to determine legality	Checks and balances

The following are some of the more important concepts relative to the APA that may affect the decision-making process of board of health members.

Fair information practices. This section of the APA led to the passing of the Freedom of Information Act of 1966 (FOIA). The FOIA provides a useful means for gaining access to public material that the government does not make available to the public. For example, information can be obtained about the extent of involvement that environmental groups or industry have had in the formation of new regulations. Documents may be requested from an agency with the FOIA. Agency personnel cannot ignore FOIA requests, and must respond with 10 days. Most

CASE STUDY:
BIVENS VS. SIX FEDERAL AGENTS

Federal agents stormed into the home of an alleged drug dealer, busted down the door, found illegal drugs and weapons and arrested the occupant. Only problem was they had no warrant. The suspect sued the agents for damage to his home and integrity. The court found that the arrest was inappropriate without the warrant but the agents were not held individually responsible because they were acting in good faith.

agencies have an FOIA officer to whom requests should be sent. Obviously, documents that relate to national security do not have to be released.

Rule making. New rules and regulations must be published in the *Federal Register* before they can go into effect. The rule-making procedure normally allows for comment from individuals, boards of health, and others before a rule's final enactment. Often agencies will issue statements to help the public understand the rules. Called *interpretive rules*, these statements often have the same status in a courtroom as the original law.

Liability of public officials. What is a board of health member's liability relative to his or her role on a board of health? The issue is very complex. Under ancient common law doctrine, there is the process of sovereign immunity, which stated that government employees were immune from prosecution for actions related to government functions. It has its origin in the "Divine Right of Kings" (e.g., God ordains the King; God can do no wrong; therefore, the King can do no wrong).

CASE STUDY:
"HE SHOULD HAVE KNOWN ABOUT FAIR INFORMATION PRACTICES!"

A local television station received a complaint about restaurant sanitation in a major city in California. The reporter called the local health department and asked to see data on restaurant inspections. The environmental health specialist explained to the reporter that the information is confidential and could not be released. WRONG!!! The reporter knew better and it raised his suspicions that the local health department was trying to hide something. This led to a hidden camera exposé on restaurant sanitation and an embarrassment for the local health department. The reporter then got the information he had originally requested through the FOIA.

Today, most individual liability cases against government advisors and employees come down to "acting in good faith." If officials are conscientious about doing their jobs and carry them out without malice, then they generally have some protection. However, under section 1983 of the Federal Civil Rights Act, individuals may sue state officials if they feel that officials operating under state law have violated their federal civil rights.

The biggest mistake that a board of health official can make is giving advice in an area that is outside of his or her expertise. For example, assume that a home's water supply system is in need of repair, and the board of health official requests an "abatement," which means the homeowner has the responsibility for making the repairs. The board member recommends re-piping with galvanized pipe. Legal action could result if the homeowner follows the recommendation and then discovers that copper pipe would have been better suited for the repairs. The law is dynamic and open to interpretation by judges. Even though the official acted in good faith, he acted outside of his area of expertise (unless, of course, he was a licensed plumber). The better advice would be to recommend the repair and advise the homeowner to seek professional assistance in meeting all codes and regulations.

The legal aspect of dealing with conflicts that arise regarding agencies is the practice known as **administrative law**. An estimated 80 to 90% of all disputes concerning the federal environmental laws and regulations are administrative law issues. Familiarity with administrative procedures will help in improving effectiveness in dealing with the law. See Table 3 for important aspects of administrative law.

TABLE 3
Important Aspects of Administrative Law

- Agencies have no real authority unless it is "delegated" to them by statutes enacted by Congress. An agency cannot act beyond the scope of its delegated authority
- Agencies' opinions and interpretations of their actions are often accepted as legal (interpretive rules)
- Agencies must follow their own rules
- Agency actions may not be "arbitrary," that is based on opinion or prejudice
- Agency decisions can be appealed in court if you have "standing"

Legal Concepts in Environmental Law

Board of health members often face controversial decisions that may eventually lead to conflict resolution by means of the courtroom. Members need to be aware of some of the concepts by which people sue.

The first concept is **standing**. This is the right to have a case heard and to stand before a judge. For an individual to go to court, there must be a violation of some law before standing is granted. Courts seem to be very liberal in their granting of standing for environmental cases.

A **nuisance** is using personal property to impair the right of another. A private nuisance is when an individual is prevented from the use or enjoyment of one's land. An example of a nuisance is when people in the house next door are playing loud music and it interferes with normal activities.

A *public nuisance* is any activity that adversely affects the public's health, morals, safety, welfare, or comforts. Nuisance law is normally under the jurisdiction of local, state, or federal government agencies. An industry's pollution of homes in an area would be treated as a violation of nuisance laws. The advantage is that the homeowner would rely on the government to fix the problem, and individual citizens would not have to bear the expense or time in fighting the large corporation or industry.

What if someone moves to the end of an existing racetrack and complains that the noise is too much to handle? There is a part of nuisance law called "coming to the nuisance." If an individual was aware of problems and moved there anyway, he or she would have to bear some or all of the responsibility.

Property Law

Property law has the longest history of any environmental law and dates back to 450 B.C. when governments set laws, known as "set-back laws," on where houses could be built relative to public streets. Some of the bitterest battles in the courtroom have been over the use of property. Public health advisors need to understand a few of the basic concepts of property law.

Eminent domain is the right of the government to take land for public purposes. If the government wants to build a county road or federal highway where a home is located, the government can take the property as long as the homeowner is provided with due process. Due process includes a hearing and the payment of "just compensation," or what a willing buyer would pay a willing seller of the property.

Easement is a legal right to use or traverse someone else's land. For example, power lines often traverse a homeowner's property through an easement.

Covenants are restrictions on property that "run with the land." Legal covenants include prohibiting children in a retirement community or attempting to restrict the type of exterior decor in a condominium. Some have attempted to restrict the parking of boats or recreational vehicles on the streets, as is the case in some Las Vegas communities. Illegal covenants are restrictions on selling a home based on race or religion.

Zoning is a government activity that affects property use. It is a legitimate power usually governed by statutes. The government has the right to restrict the use of certain property. For example, no one wants a department store in a residential area. Denying construction of the store is a legal activity and is valid as long as it is not unreasonable or arbitrary (based on one's own opinions or prejudice).

Anytime the government secures private property, or if zoning restrictions prevent adequate use of the property, it is called a "taking." A taking is decided at a hearing that is part of normal due process. Anytime the government takes property, a hearing is required. The judge will decide if the action is a "taking" and if just compensation is required.

Communicating With the Public

Essential Public Health Service number three from the U.S. Public Health Service's publication, *The Public Health Workforce: An Agenda for the 21st Century*, requires the board of health to "inform, educate, and empower people about health issues." However, there are no set criteria for selecting communication tools that can be applied to all segments of the general population. Each community has its own level of interest and concern, social structure, demographic make-up, and culture.

With cases of controversial environmental issues (for example, a hazardous waste site), board members could conduct phone interviews or in-person interviews with members of the effected community to identify its concerns and devise a communication strategy.

Two communication tools are *one-way communication and two-way communication.* One-way communication tools are a way of getting information out to the public so that community members may contribute to the decision-making process. These include public outreach programs, fact sheets, newsletters, information brochures, press releases, and public service announcements that inform the public regarding current or upcoming issues or decisions. Videotapes have also proven very successful as a method of getting information to the public.

Two-way communication promotes an interactive environment. It includes face-to-face open discussions, public information telephone lines, visitor centers, focus groups, and citizen advisory groups. Whereas one-way communication communicates the process, two-way communication gets the public involved. Advisory boards are a good example of two-way communication. Public opinion can greatly affect the decision-making process. It is important to check the pulse of the community using adequate two-way communication.

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Glossary

Acid rain—rain made more acidic than normal from sulfur and nitrogen emissions, typically from coal-fired power plants.

Active immunity—People develop antibodies in response to infection, vaccine, or toxoid.

Adjusted rate—Applying statistical summarizing procedures to minimize the bias due to uneven distribution of certain demographic factors among communities while doing comparison.

Administrative law—law that deals with the administrative process and the agencies that create rules and regulations.

Agency for Toxic Substances and Disease Registry (ATSDR)—An agency within the United States Department of Health and Human Services that works to prevent exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment. One of the many important functions of this agency is response to emergency releases of hazardous substances.

Air Quality Index (AQI)—a USEPA-prescribed method for reporting to the public the air quality in areas with populations > 350,000.

Allergen—Any biological substance that causes people to react adversely, exhibiting a range of effects from simple runny nose and watery eyes to potentially fatal anaphylactic shock.

Ambient air—outdoor air.

Ambient concentration—level of air pollution.

Amplifying host—a host in which the agent grows and multiplies in number before if can be transmitted to the next host.

***Anopheles*—**a genus or group of mosquitoes responsible for the transmission of malaria.

Aquifer—geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is

usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses.

Arboviruses—a group of viruses transmitted to people by mosquitoes and ticks.

Area source—an area that can be considered a source as the result of many small emission sources within that area.

Arthropods—animal with a hard, jointed exoskeleton plus paired jointed legs.

Asymptomatic—showing or causing no symptoms.

Asymptomatic carrier—A person without apparent disease who is capable of transmitting an infectious agent to another person

At-risk population—Any subset of the community that, by nature of disease, age, mental ,or other physiologic condition, has an increased risk of experiencing an ill effect or injury as compared with most members of the community as a whole.

Attractive hazards—Hazardous sites, conditions, or equipment that has a special fascination for a particular group of people (e.g., cranes or bulldozers parked on a nonfenced construction site accessible to preteenage youths playing in the immediate area).

Backflow: A reverse flow condition created by a difference in water pressures that causes water to flow back into the distribution pipes of a drinking water supply from any source other than the intended one.

Bioaccumulation—The retention and concentration of a substance by an organism.

Biochemical oxygen demand (BOD)—a measure of the capacity of wastes to deplete dissolved oxygen concentrations in an aquatic system.

Biodegradation—a natural process that breaks down components of wastes using micro- and macroorganisms.

Biohazard—A material from bacteria, fungi, or other biological sources capable of causing disease in humans.

Biological monitoring—Analyzing specific chemical concentration in body fluid such as blood, urine, or exhaled air to reflect the impact of absorption of hazardous material.

Biological transmission—requires the disease agent to either multiply or undergo a sequence of developmental stages inside the vector prior to passage to a human or animal.

Biomarkers—Indicators used in biological monitoring.

Black water—residential wastewater generated from bathrooms that may contain fecal matter and/or urine.

Building-related illness (BRI)—a specific illness resulting from an exposure to a specific stressor in an indoor air quality environment.

Carcinogens—Cancer-causing agents.

Case-control studies—An observational study design. Participants, with or without the disease of interest, are asked to recall their history of toxic substance exposure. These are also called *retrospective studies.*

Chain of infection—The complete circle of infectious disease transmission.

Clean Water Act (CWA)—the 1972 federal legislation that regulates wastewater contaminant levels and treatment processes.

Cohort studies—An observational study design. Exposed and non-exposed participants , free from the disease of interest, are compared.. Their health status will be observed during a certain period of time. These are also called *incidence*, *longitudinal*, *follow-up*, or *prospective studies*.

Coliform—a group of bacteria used to indicate fecal contamination of water. Fecal coliform are a subgroup of total coliform. ***Escherichia (E.) coli*** is a more specific indicator of human fecal waste contamination of water.

Combined sewers—systems in which general wastewater and stormwater runoff are collected together.

Common law—A legal system that relies on historical decisions from the court.

Common source outbreak—A group of persons is exposed to the same source of toxic agent, and those susceptible hosts develop disease at the end of the incubation period.

Coming to the nuisance—Establishing a business or residence near an existing nuisance or problem.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—also known as Superfund.

Concentration—an expression of how much pollutant is in the air.

Confined spaces—Spaces that are not normally occupied and from which emergency escape may be difficult without special equipment. Such spaces may contain hazardous gases, insufficient oxygen, or other life-threatening hazards.

Contingency plan—A document setting an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous waste from a TSDF or a generator's facility that could threaten human health or the environment (from RCRA).

Corrosivity—A solid waste characterized as either an aqueous material with a pH less than or equal to 2.0 or greater than or equal to 12.5, or a liquid that corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55 ºC (130 ºF).

Covenant—Restrictions placed on the use of property, for example, preventing children from living in a singles only apartment

Criteria pollutants—a set of key pollutants that the USEPA uses to characterize the general air quality of an area.

Critical control point—a systematic process of placing operational safeguards at particular food preparation stages to minimize contamination of foods from disease-causing agents.

Criticality incident—A radioactive emergency in which control of radioactive material is lost, risking fire, release, or other catastrophes at nuclear reactor or waste storage facilities.

Cross-sectional studies—Any study that collects both exposure and disease status of individuals simultaneously is a cross-sectional study.

Crude rate—Calculates the rate for the entire population.

***Cryptosporidium*—**a microorganism commonly found in lakes and rivers that is highly resistant to disinfection. *Cryptosporidium* has caused several large outbreaks of gastrointestinal illness, with symptoms that include diarrhea, nausea, and/or stomach cramps. People with severely weakened immune systems (that is, severely immunocompromised) are likely to have more severe and more persistent symptoms than healthy individuals.

Dead zone—an area in the Gulf of Mexico with depleted dissolved oxygen and aquatic life.

Deadend host—also known as an "accidental host," this host has no role in the propagation or transmission of the pathogen.

Decentralized wastewater treatment systems—on-site wastewater treatment systems (as opposed to centralized wastewater treatment facilities or POTWs). Other names include septic systems, small-waterborne treatment systems, and private sewage disposal systems.

Dermal—relating to the skin.

Direct transmission—An agent is transferred immediately from a reservoir to a susceptible host through direct contact or droplet spread.

Disinfection—killing of vegetative cells of potentially pathogenic microorganisms.

Dissolved oxygen (DO)—oxygen that is available for use in water by aquatic organisms.

Dissolved solids—the weight of matter, including both organic and inorganic matter, in true solution in a stated volume of water.

Dose—The amount of the chemical administered to the recipient.

Dosage—The amount of chemical administered per unit body weight of the recipient.

Dose response—The intensity of responses elicited by a chemical is a function of the administered dose.

Due process—The obligation that government has to follow protocols and procedures in support of the law.

Duty to act—A legal concept, assigning a person or group of persons the responsibility to take action. In the public health context, action may avert a community health threat, remove a hazard, or institute controls to minimize or remove a threat to the public's well being.

Easement—The right to have limited use of property, for example, running cable or power lines through a privately owned property.

Ectoparasite—a parasite that lives on the outside of the body of the host.

Effluent—wastewater discharged after use and usually following some treatment.

Emergency Planning and Community Right-to-Know Act (EPCRA)—Title III of the Superfund Amendments and Reauthorization Act (SARA), passed by Congress in 1986. This major law gave the public significant new rights to find out about the dangerous chemicals stored, used, and released throughout the country. In particular, Section 313 of Title III created the Toxics Release Inventory (TRI) to provide the public with data on "routine" chemical releases from industries across the nation. See also **toxic release inventory**.

Emerging (pathogens)**—**pathogens that are of increased (or new) public health significance. Pathogens may also be **re-emerging** after formerly being thought to be under control.

Eminent domain—The right of the government to take private land for public use.

Encephalatides—plural of encephalitis, signifying in this case zoonotic pathogens that cause an inflammation of the brain.

Endemic—the usual presence of a disease in a geographic area.

Engineering controls—controls that use technology to either reduce the amount of pollution created during a process or reduce the amount of pollution emitted into the air.

Enriched uranium—Uranium ore that has been highly refined to an extremely concentrated (and hazardous) radioactive state, for use in nuclear reactors.

Environmental media— Air, water, soil, or food in which toxic substances exist.

Epidemic—When the occurrence of a disease within an area is clearly in excess of the expected level for a given time period. It is also referred to as an *outbreak***.**

Epidemiological investigation—the process of studying the distribution and determinants of disease within populations in an effort to determine the causes of illness.

Epidemiology—The study of the distribution and determinants of health events in a population.

Epidemiology triangle—An external agent, a susceptible host, and a suitable environment that brings the host and agent together are the three necessary components for the disease occurrence.

Epizootic—extraordinary occurrence of disease in animals.

***Escherichia coli* (*E. coli*)—**a common type of bacteria that is usually harmless, but is capable of causing mild to severe illness in humans.

Eutrophication—a natural process that results in increased organic load and solids of an aquatic system over many years. Cultural eutrophication is the speeding up of this process through introduction of human-made wastes.

Evaluation—Determining the outcomes of a policy with the impacts on the community.

Exposure concentration—The amount of a substance present in various media in which a human has contact.

Exposure duration—Period of time a person has been exposed to the toxic substance.

Exposure frequency—Number of times during a specific period a person has been exposed to the toxic substance.

Exposure routes—Routes by which a toxic substance enters into human body. For example, via ingestion, inhalation, or skin contact.

Case Fatality rate—measure of the frequency of deaths due to a particular disease among those people who have the disease.

Fecal (feces)—solid animal digestive waste.

Federal Register—A government publication that prints the proposed decisions and announcements of the executive branch of government, including agencies.

Foodborne illness—any type of illness resulting from the consumption of food. Defined as two or more people becoming ill from a common food eaten at the same time and/or place, except in the case of botulism or chemical or physical illness when one case is considered an outbreak. Cases of illness make up outbreaks of foodborne disease.

FoodNet—the Foodborne Diseases Active Surveillance Network, a principal foodborne disease component of CDC's Emerging Infections Program.

General wastewater—wastewater that is generated from bathrooms and other facilities that may contain fecal matter and urine.

Generator—The person or facility who, by nature of ownership, management, or control, is responsible for causing, or allowing to be caused, the creation of hazardous waste.

Geographic Information Systems (GIS)—Computer-based systems for storing and manipulating demographic, geologic, and other geographic information, including health data for a defined geographic area.

Gray water—residential wastewater generated from sources other than bathrooms (e.g., washing machines) that should not contain fecal matter and/or urine.

Groundwater—Water beneath the earth's surface that fills in and flows through spaces in rocks and soil.

HACCP system—hazardous analysis critical control point approach to food safety surveillance. A system developed by the Pillsbury Company, the National Aeronautical and Space Administration. and the U.S. Army and Air Force in an effort to guarantee a 100% assurance that safe disease-free foods would be provided to the astronauts. A system that is totally prevention-based looking at the safety of food production through all phases of preparation.

Hazard—A source of risk that does not necessarily imply potential for occurrence. A hazard produces risk if an exposure pathway exists and if exposure creates the possibility of adverse consequences.

Hazard analysis—a comprehensive review of all steps in the preparation of a food item to determine the processes that pose the most risk of contaminating a food item with a disease-causing agent.

Hazardous Air Pollutants (HAPs)—a list of pollutants defined by federal law that produce specific toxic effects and are regulated by the USEPA at the source.

Hazardous waste—Any solid waste that is characterized as ignitable, corrosive, reactive, or toxic and/or has been listed in the RCRA regulations.

Healthy People 2000 and 2010—a national health promotion and disease prevention initiative that brings together national, state, and local government agencies; nonprofit, voluntary, and professional organizations; businesses; communities; and individuals to improve the health of all Americans, eliminate disparities in health, and improve years and quality of healthy life. Initiatives for food safety are listed as national goals.

***Hematophagous*—**adjective for blood-sucking arthropods.

Host—a living organism that serves as a blood source for blood-feeding arthropods.

Ignitability—A solid waste characterized as a nonaqueous liquid having a flash point less than 140 ºF (60 ºC) or a nonliquid capable under standard temperature and pressure of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard, or an ignitable compressed gas or an oxidizer.

Incidence rate—measure of the frequency of a disease in a population.

Incubation period—the time period between exposure to a pathogen and the development of disease symptoms.

Indirect transmission—An agent is transferred from a reservoir to a susceptible host through mechanical or biologic transmission.

Ingestion—eating or drinking.

Inhalation—breathing in.

Ionizing radiation—High-energy particles or waves that cause molecules to ionize; includes alpha, beta, and neutron particles and gamma and x-rays. Nonionizing radiation includes microwaves, ultraviolet light, and lasers.

Large quantity generators (LQGs)—Facilities that generate 1,000 kg (2,200 lbs) or more of hazardous waste or more than 1 kg (2.2 lbs) of acutely hazardous waste in any month. Generators of hazardous waste are regulated under the Resource Conservation and Recovery Act (RCRA).

LC_{50}—Lethal concentration, the concentration of a toxic agent in the air or water, which animals breathe or live in, that causes death to 50% of the animals within a certain period of time.

LD_{50}—Lethal dose, the concentration of a particular toxic substance that, administered to all animals in a test, is lethal to 50% of the animals.

Leachate—liquid that has percolated through solid waste or other medium and has extracted, dissolved, or suspended materials from solid waste; a solution formed by leaching.

Leachfield—the most common type of subsurface seepage system used for an on-site wastewater treatment system.

Liability—Justly or legally responsible, as for payment.

Listed waste—Wastes listed as hazardous under RCRA.

Mandate—an authoritative command or instruction; a requirement, order, or law.

Mechanical transmission—a passive method by which the infectious agent is carried on the surface of the vector's body or by ingestion of the organism.

Mobile source—a nonfixed source of air pollution, usually vehicles.

Morbidity—a state of disease or illness.

Mortality—death.

Multiple unit dwelling—Any residential structure that shelters or is occupied by more than one distinct and separate family unit.

Municipal solid waste (MSW)—waste produced by individuals in both urban and rural areas.

Mutagens—Agents that cause inheritable changes in DNA.

National Ambient Air Quality Standards (NAAQS)—the allowed level of exposure to a pollutant within a geographic area.

National Pollution Discharge Elimination System (NPDES)—a component of the Clean Water Act that regulates and permits levels of contaminants and volumes of wastewater discharges.

National Priorities List (NPL)—The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The list is based primarily on the score a site receives from the Hazard Ranking System. The USEPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the trust fund for remedial action.

National Response Center—Part of the United States Coast Guard that coordinates emergency response to spills or accidental releases of hazardous substances.

National Response Team—Representatives of 15 federal agencies that, as a team, coordinate federal policy relating to nationally significant incidents of pollution, such as an oil spill, a major chemical release, or a Superfund response action. The team provides advice and technical assistance to the responding agency or agencies before and during a response action.

Nonpoint source pollution—pollution that cannot be traced to one source.

Nonthreshold—Exposure to any amount of toxic agents will produce some measurable adverse health effects.

Nuclear reactor—A naturally occurring or man-made site where radioactive materials are brought close enough together that a chain effect is created. This chain effect

generates intense heat and additional radioactivity, causing serious or lethal effects if not controlled.

Nuclear Regulatory Commission—Agency responsible for regulating sources of ionizing radiation in the United States.

Null hypothesis—A statistical hypothesis suggesting that there is no relationship between exposure and outcome.

Nuisance—Any action that impairs the rights of another property owner.

Odds ratio—The ratio of disease odds between exposure and non-exposure groups. It is used to measure the magnitude of health effects from exposure.

Pandemic—When an epidemic spreads over several countries or continents and affects a large number of people.

Parameter—the measurable properties of an entity.

Pathogen—a microorganism capable of causing illness in other organisms.

Permeability—the ability of soils to allow movement of wastewater through soil pore spaces.

pH—a 0–14 logarithmic scale used to measure acidity or alkalinity.

Point source—a source of air pollution that has a clearly identifiable release location, such as a smoke stack.

Pollution prevention—The active process of identifying areas, processes, and activities that create excessive waste byproducts for the purpose of substitution, alteration, or elimination of the process to prevent waste generation. **Potentially hazardous food—**any food that is susceptible to the rapid multiplication of pathogenic organisms to the level sufficient to cause illness when consumed. Generally any meat or meat product, poultry or poultry product, pork or pork product, fish or shellfish product, egg, milk and dairy products, or any food that is relatively high in moisture and is not too acidic or basic.

Portals of entry—The portal of entry provides agents access to the host's tissues in which agents can multiply or a toxin can act.

Prevalence —. The number of cases of a disease, infected persons, or persons with some other attribute present during a particular interval of time. It is often expressed as a rate (for example, the prevalence of diabetes per 1,000 persons during a year).

Primary standards—NAAQS to protect public health, including the health of "susceptible" groups, such as the young, old, and ill.

Proactive—an activity or process that anticipates problems or other occurrences before the fact and acts to prevent or limit them.

Propagated outbreak—A disease spreads gradually from person to person.

Publicly owned treatment works (POTWs)—systems designed to treat wastewater prior to discharge into the environment, may also be called wastewater treatment facilities or water reclamation districts.

Putrefy—to decompose; to cause decay.

Quarantine—One of the approaches used to prevent the infectious disease transmission by completely or partially restricting the activities of well persons or animals who have been exposed to a case of communicable disease during its incubation period.

Radioactive—Materials that spontaneously emit submicroscopic particles or rays, some of which may be hazardous to human health.

Rate difference—The difference of incidence rates between the exposed group and the nonexposed group. It is an indication of the proportional decrease in the incidence of a disease if the entire population were no longer exposed to the suspected etiological agent.

Rate ratio—The ratio of incidence rates between the exposed group and nonexposed group. It is used to measure the magnitude of health effects caused by the exposure.

Reactive—A solid waste characterized as unstable and that readily undergoes violent change without detonating; forms potentially explosive mixtures with water, generating toxic gases, vapors, or fumes so as to present a danger to human health or the environment.

Recycling—Reuse of byproducts, or components of byproducts, that might otherwise be disposed of in the environment.

Reference doses —RfD, the intake or dose of a substance per unit body weight per day (mg/kg/day) that is likely to pose no appreciable risk to human population after lifetime exposure.

Regulatory controls—laws that regulate the allowable levels of emissions.

Reservoir—the normal habitat in which an agent lives, multiplies or grows.

Resource Conservation and Recovery Act (RCRA)—Federal "cradle-to-grave" regulations affecting hazardous and nonhazardous (garbage) solid waste.

Resource recovery—The beneficial reuse of a waste product in ways different from their original use.

Reuse—In general, reuse refers to a substance that is reintroduced at the front end of a production process from which it was originally generated as a byproduct.

Right-to-know—A term usually referring to a series of laws, regulations, or databases that provide industry-related information to the public.

Risk—The probability that something will cause harm, combined with the potential severity of the harm.

Risk assessment—Predicting the likelihood that a problem will occur.

Risk communication—Soliciting public involvement in the process of risk assessment and risk management in order to facilitate a broad-based community understanding of the hazards and risks and participation in improving environmental and public health.

Risk management—Identifying and evaluating intervention strategies to eliminate or minimize the problem.

Sanitization—the process of rendering food contact equipment and utensils free of disease-causing organisms usually through the use of chemicals (chlorine) or hot water (180º F or greater).

Secondary standards—NAAQS to preserve public welfare issues, such as maintaining visibility and decreasing plant, animal, and structural damage.

Secondary pollutants—pollutants that are not emitted directly from a source and are formed in the atmosphere as a result of chemical reactions.

Separated sewers—systems in which general wastewater and stormwater runoff are collected separately.

Septic tank—a component of an on-site wastewater treatment system that retains and anaerobically biodegrades settleable solids.

Sick building syndrome (SBS)—term used to describe the situation when a building's occupants experience a variety of health effects that are difficult to link to a specific source.

Small quantity generators (SQGs)—Persons or enterprises that produce 220–2,200 pounds per month of hazardous waste. This is the largest category of hazardous waste generators, and includes automotive shops, dry cleaners, photographic developers, and many other small businesses.

Smog—a hazy mixture of smoke and fog that results from the sun's action on certain pollutants in the air, especially those from automobile exhaust and factories. It may also be any air pollution problem that reduces visibility.

Specific rate—Calculates the rate for a subgroup in a given population.

Standing—The legal right to have a case heard in front of a judge.

Stormwater—wastewater generated from runoff from precipitation events.

Superfund Amendments and Reauthorization Act (SARA)—A 1986 federal law amending the original "Superfund" law. Title III of this law is called the Emergency Planning and Community Right-to-Know Act (EPCRA). Section 313 of EPCRA contains the Toxics Release Inventory (TRI) requirements.

Suspended solids—solids that are not in true solution and that can be removed by filtration. Suspended solids usually contribute directly to turbidity.

Symbiotic—adjective describing a mutually beneficial relationship.

Stationary source—an air pollution source with a fixed location.

Temperature control/temperature danger zone (TDZ)—the temperature range, from 40º F to 140º F, in which foods, if left for a period of time, will allow harmful disease-producing organisms to grow.

Teratogens—Agents that cause physical defects in the developing fetus when a pregnant female is exposed to them.

TD_{50}—Toxic effect dose is the concentration of a particular toxic substance that, administered to all animals in a test, produces a toxic effect, such as liver injury, to 50% of the animals.

Threshold—The highest dose of a toxic substance below which no measurable adverse health effects will occur for lifetime exposure.

Time weighted average—The average concentration of a toxic material in air, as measured over a typical work shift, to which a worker is exposed

Total maximum daily load (TMDL)—a proposed limit on the cumulative amount of waste that can be discharged to a river based on NPDES permit levels.

Total suspended solids (TSS)—smaller wastewater solids that do not settle or settle very slowly due to gravity.

Toxic—Any substance that can cause chemical harm to living organisms if given in sufficient dose. Medical researchers believe all things are toxic if given in great enough quantities.

Toxicity—The ability of a substance to cause damage to living tissue, impairment of the central nervous system, severe illness, or in extreme cases, death when ingested, inhaled, or absorbed through the skin.

Toxicokinetics—The dynamic absorption, distribution, and excretion of a toxic substance after it enters a human's body. It decides the final dose of the substance in the body.

Toxicology—The study of poisons or the harmful effects of chemicals.

Toxins—chemicals that may cause illness in exposed organisms.

Treatment, storage, or disposal facility (TSDF)—A facility permitted under RCRA to receive hazardous waste for treatment, storage, or disposal.

Trigger event—A widely publicized event that encourages further changes in existing policy.

Turbidity—the amount of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Thus, turbidity makes the water cloudy or even opaque in extreme cases. Turbidity is measured in nephelometric turbidity units (NTU).

Trihalomethanes (THMs)—a group of organic chemicals formed in water when chlorine used as a disinfectant reacts with natural organic matter, such as humic acids from decayed vegetation. THMs are suspected of being carcinogenic.

Vector—a carrier of a disease producing organism, used in conjunction with both arthropods and mammals. Often used when part of the organism's natural life cycle takes place in the vector.

Waste reduction—Practices or techniques that reduce or eliminate the volume and/or toxicity of wastes generated. This includes in-plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and the environment. This includes only actions taken during the waste-generating process. Treatment, concentration, or recycling of wastes after they are generated is not included.

Waste stream—The total flow of waste from homes, businesses, institutions, or manufacturing plants.

Wastewater—Water that has served its original purpose and is intended for treatment and/or disposal.

Years of Potential Life Lost (YPLL)—A calculation showing years of life lost from the population due to early-age fatalities from injuries or disease.

Zoonotic disease—under natural conditions it is a disease that can be spread from vertebrate animals to humans.

National Association of Local Boards of Health

1840 East Gypsy Lane Road
Bowling Green, Ohio 43402
Ph: (419) 353-7714 Fax: (419) 352-6278
E-mail: nalboh@nalboh.org Website: www.nalboh.org

The National Association of Local Boards of Health (NALBOH) represents the interests of local boards of health in the United States. NALBOH is nationally recognized as the voice of local boards of health.

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National Environmental Health Science & Protection Accreditation Council

PO Box 15266
Portland, OR 97293
Ph: (503) 235-6831 Fax: (206) 543-8123
E-mail: atres@aehap.org Website.www.ehacoffice.org

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