

# Air Toxics Risk Assessment: Overview of Methods

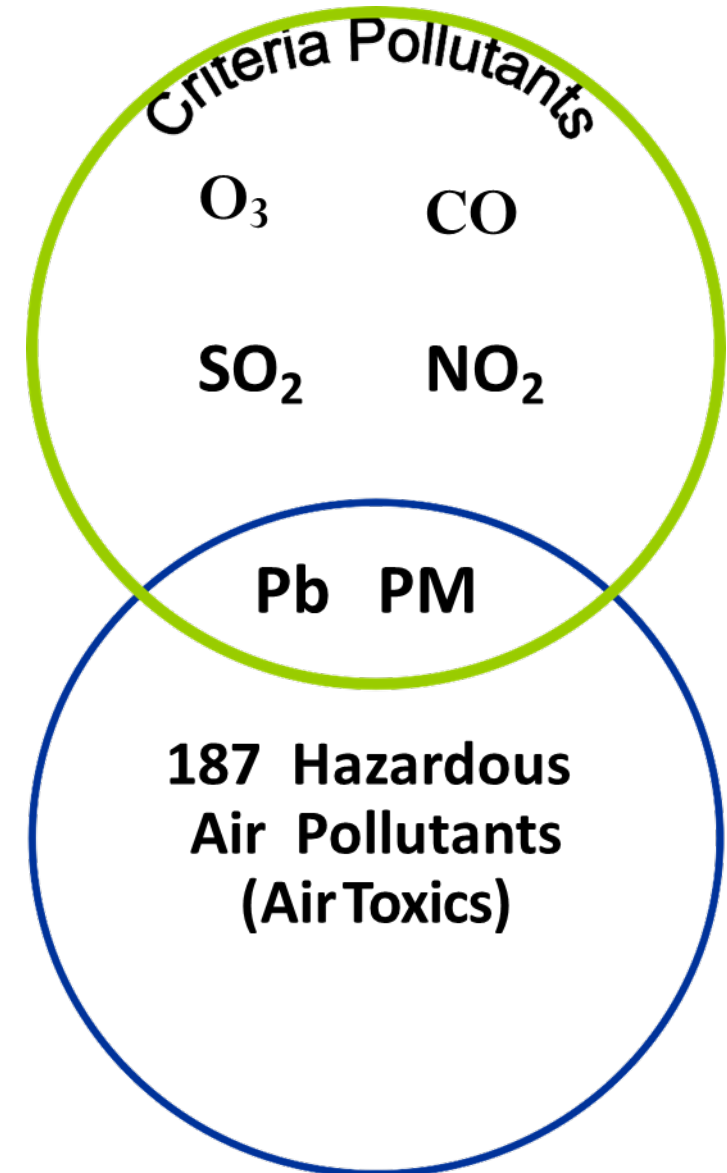
U.S.EPA

# Overview

- ▶ What are air toxics?
- ▶ What is a risk assessment?
- ▶ Risk assessment steps:
  - ▶ How does EPA determine someone's exposure?
  - ▶ What health effects are caused by the pollutant?
  - ▶ What is a risk characterization?
- ▶ How to read EPA's risk assessment results

# What are “Air Toxics”?

- ▶ Also known as Hazardous Air Pollutants (HAPs)
- ▶ 187 substances specified by Congress
- ▶ May cause cancer and other serious health effects
- ▶ Regulated differently than common, widespread pollutants like ozone or particulate matter, which are called “criteria pollutants”
  - ▶ Regulations limit *emissions* from sources





## Air Toxics May...

- ▶ Cause cancer or other serious health effects
- ▶ Have diverse physical and chemical characteristics
- ▶ Exposure possible multiple ways
- ▶ Have potential adverse environmental effects
- ▶ Persist in the environment and/or bioaccumulate
- ▶ Be transported locally, regionally, nationally or globally

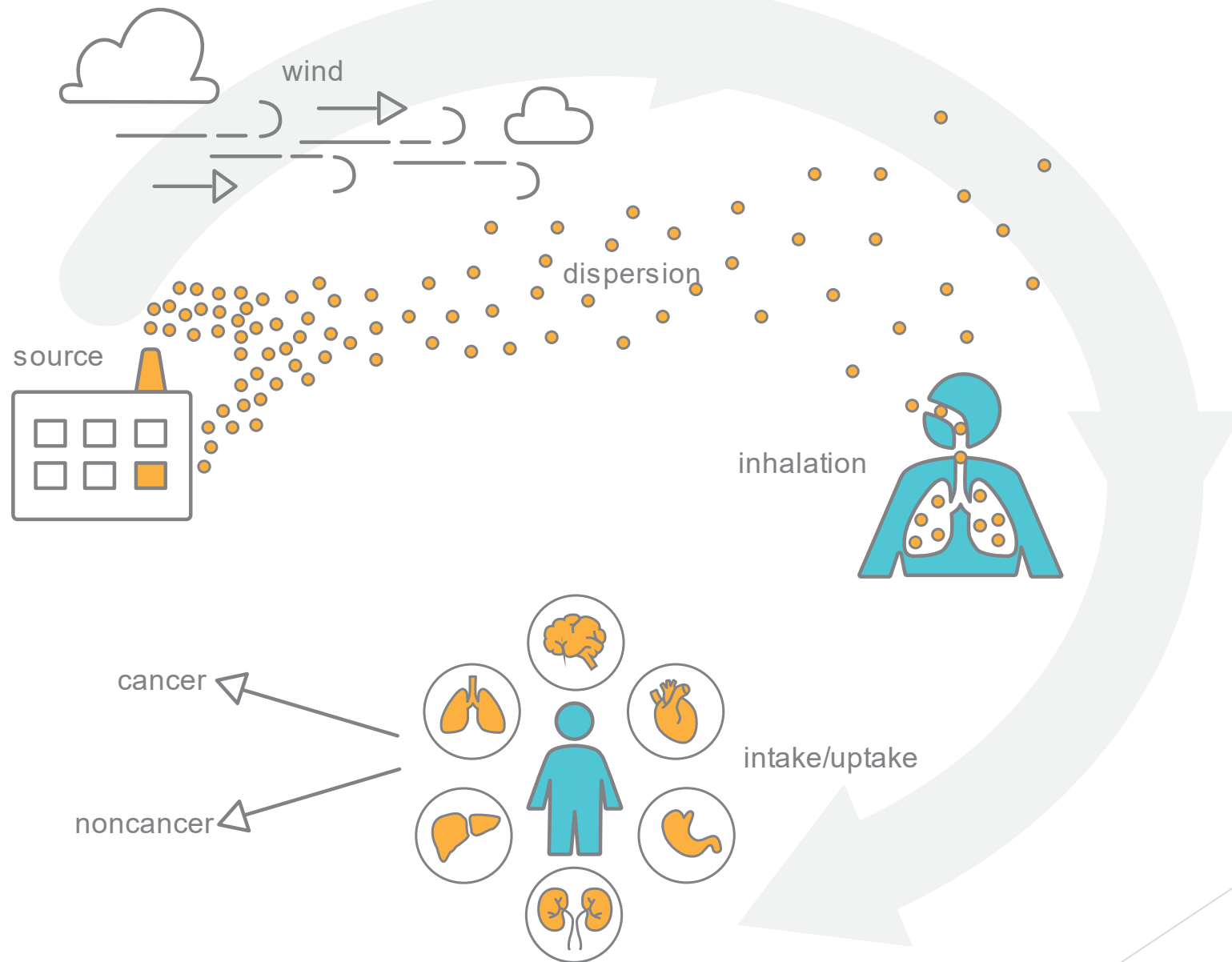
## What is a risk assessment?

- ▶ A risk assessment is a systematic process of evaluating the potential risks that may result from an activity.
- ▶ EPA uses risk assessment to characterize the nature and magnitude of health risks to humans and the environment from air pollutants and other stressors.

## What is cancer risk?

- ▶ Cancer risk refers to the probability, or chance, that exposure to a hazardous substance will develop cancer.
- ▶ When EPA assesses the risk of getting cancer, we typically estimate the risk from a 70-year exposure to pollutants from a facility. That risk is in addition to our overall risk of getting cancer.
  - ▶ This is referred to as “lifetime excess risk”

# How people are exposed to air pollution



# Risk Assessment Steps

## Exposure Assessment

- How much of the pollutant are people exposed to during a specific time period?

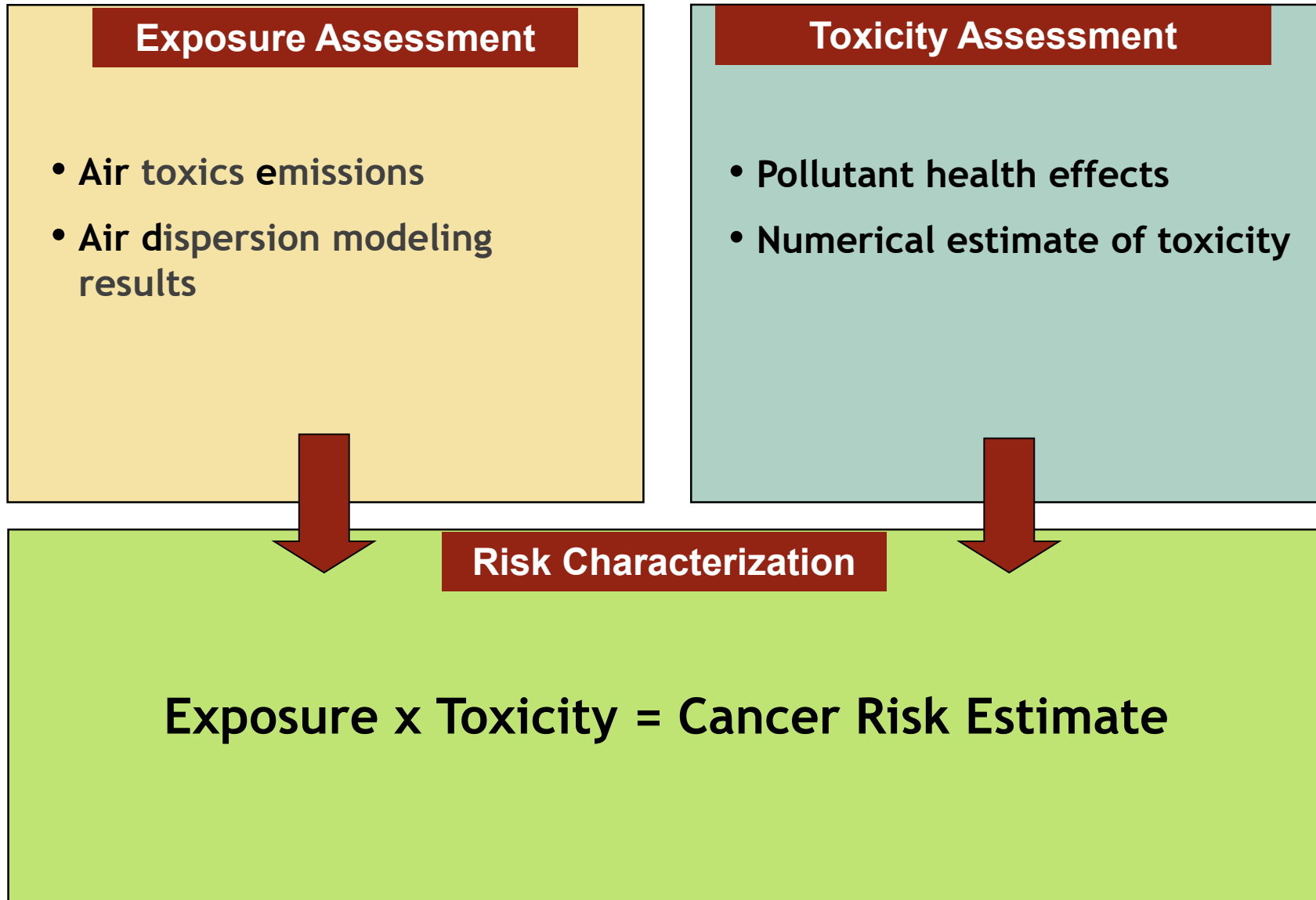
## Toxicity Assessment

- What health problems are caused by the pollutant?  
*(hazard identification)*
- What are the health problems at different exposures?  
*(dose-response relationship)*

## Risk Characterization

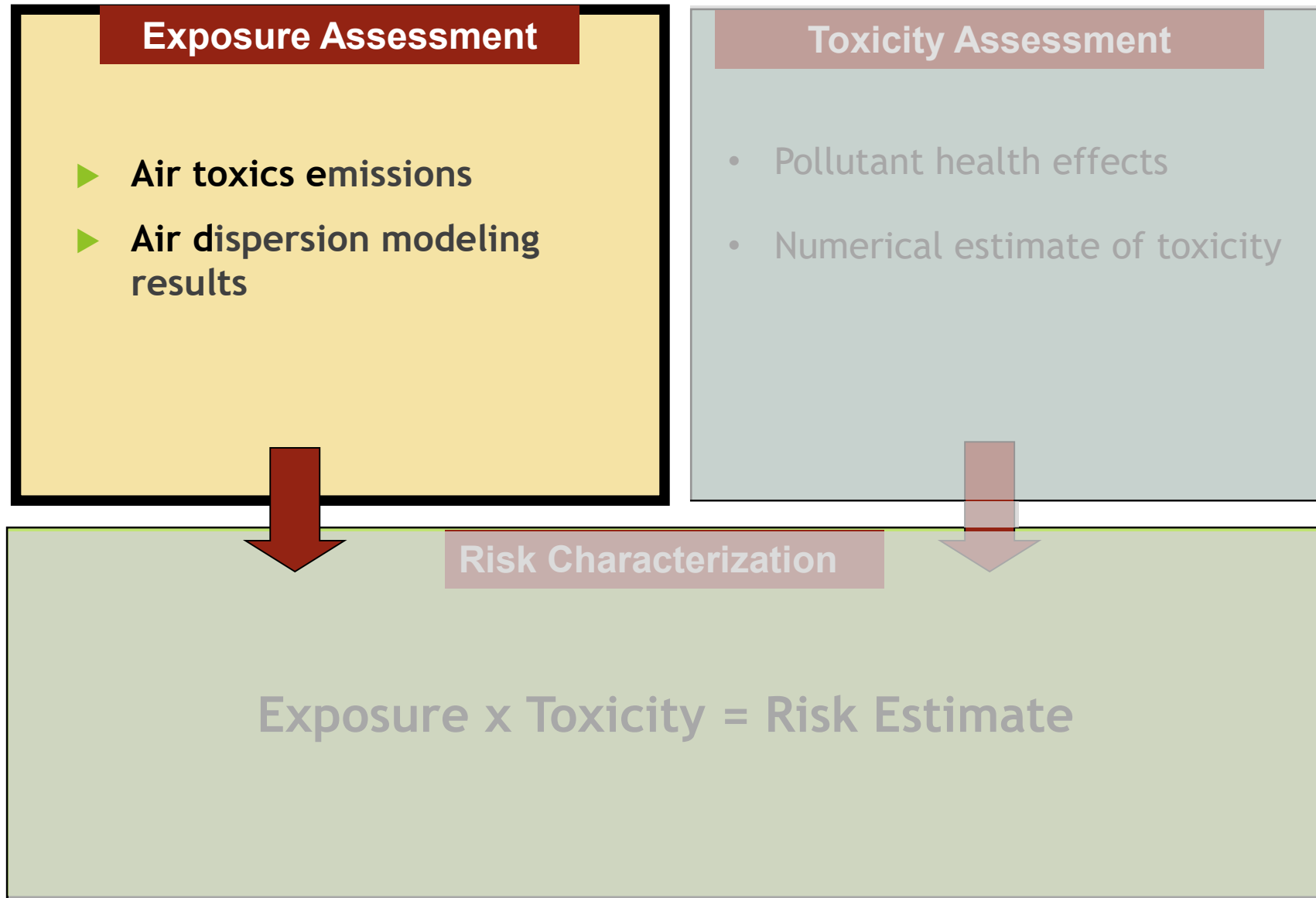
- What is the extra risk of health problems in the exposed population?

# Key Inputs/Analyses/Outputs for a Risk Assessment





# Key Inputs/Outputs for a Risk Assessment



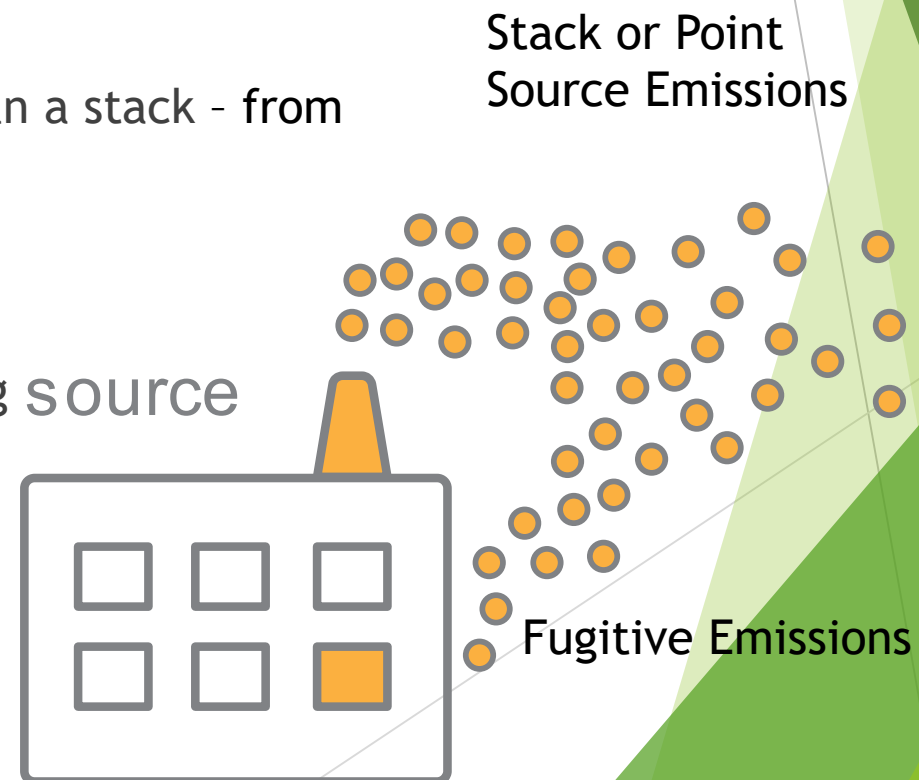
# Air Toxics Emissions

## ▶ Stack (Point Source) Emissions

- ▶ Usually elevated above ground
- ▶ Emissions *estimated* using operating data and emission factors or *measured* using monitoring techniques

## ▶ Fugitive Emissions

- ▶ Usually emitted much lower to the ground than a stack - from vents, windows, etc.
- ▶ No single point at which to measure
- ▶ Emissions *estimated* using operating data and emission factors or *measured* using monitoring techniques

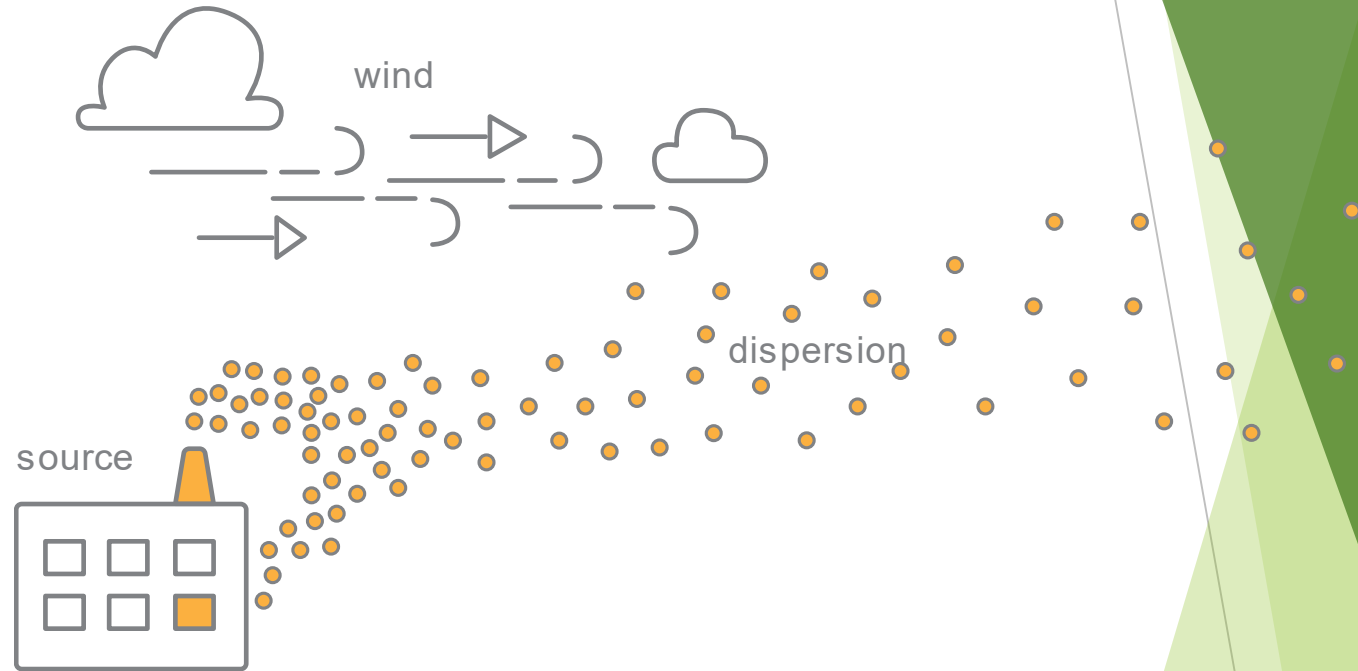


# What is an Air Dispersion Model?

- ▶ A computer simulation of the movement of a pollutant through time and space

- ▶ Inputs:

- ▶ Emission and stack/fugitive information
- ▶ Pollutant chemical information
- ▶ Meteorological data
- ▶ Topography



- ▶ Outputs:

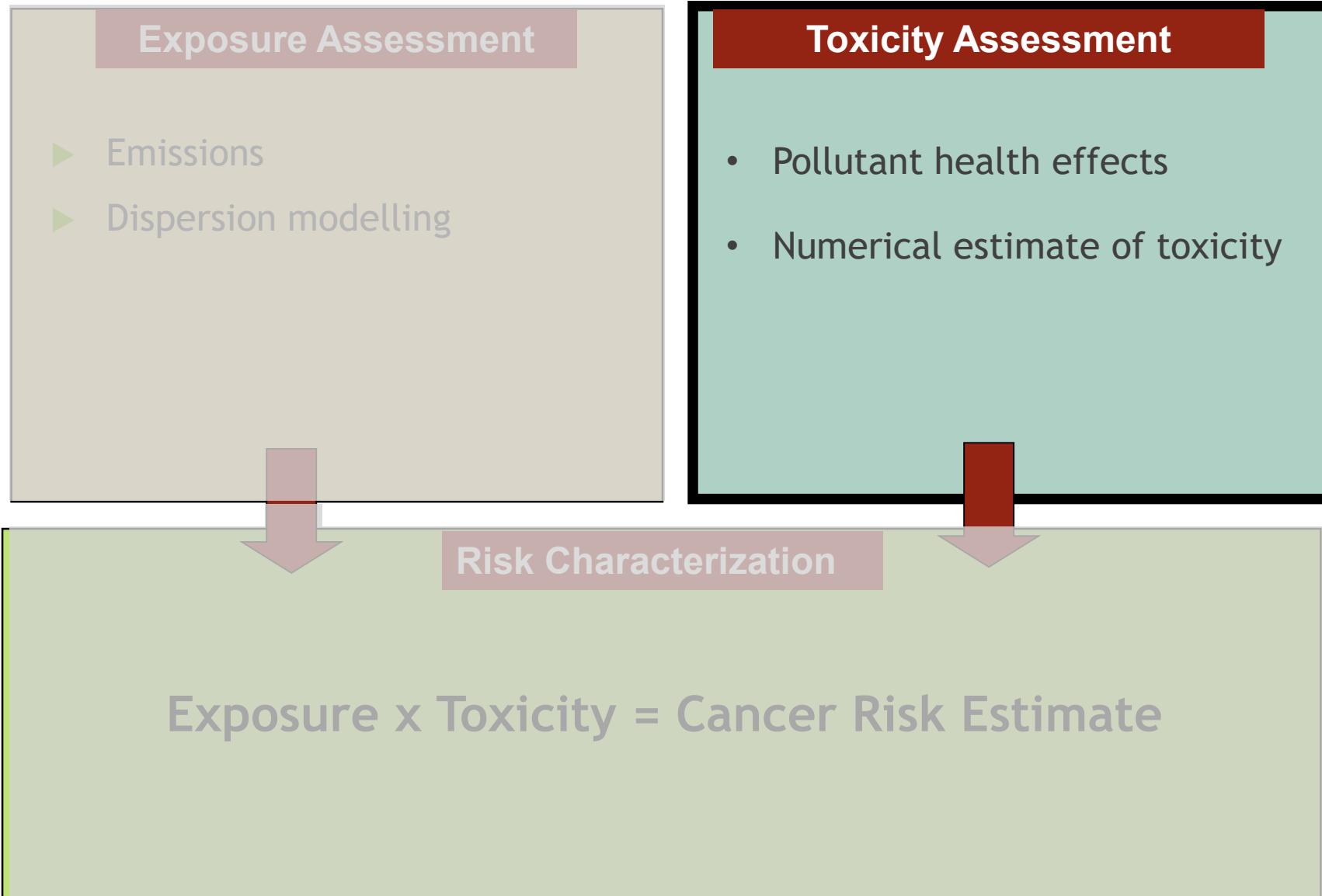
- ▶ Outdoor air concentrations at predetermined distances (receptors), reflecting 1-hour values which can be averaged to longer periods.

# Why EPA Uses Dispersion Models

- ▶ Predict both short-term and long-term chronic pollutant levels in the outdoor air
- ▶ Predict levels in the outdoor air at many locations - wherever you place a 'receptor'
- ▶ Predict levels under a wide range of weather conditions - typically over a full year (or more)



# Key Inputs/Outputs for a Risk Assessment



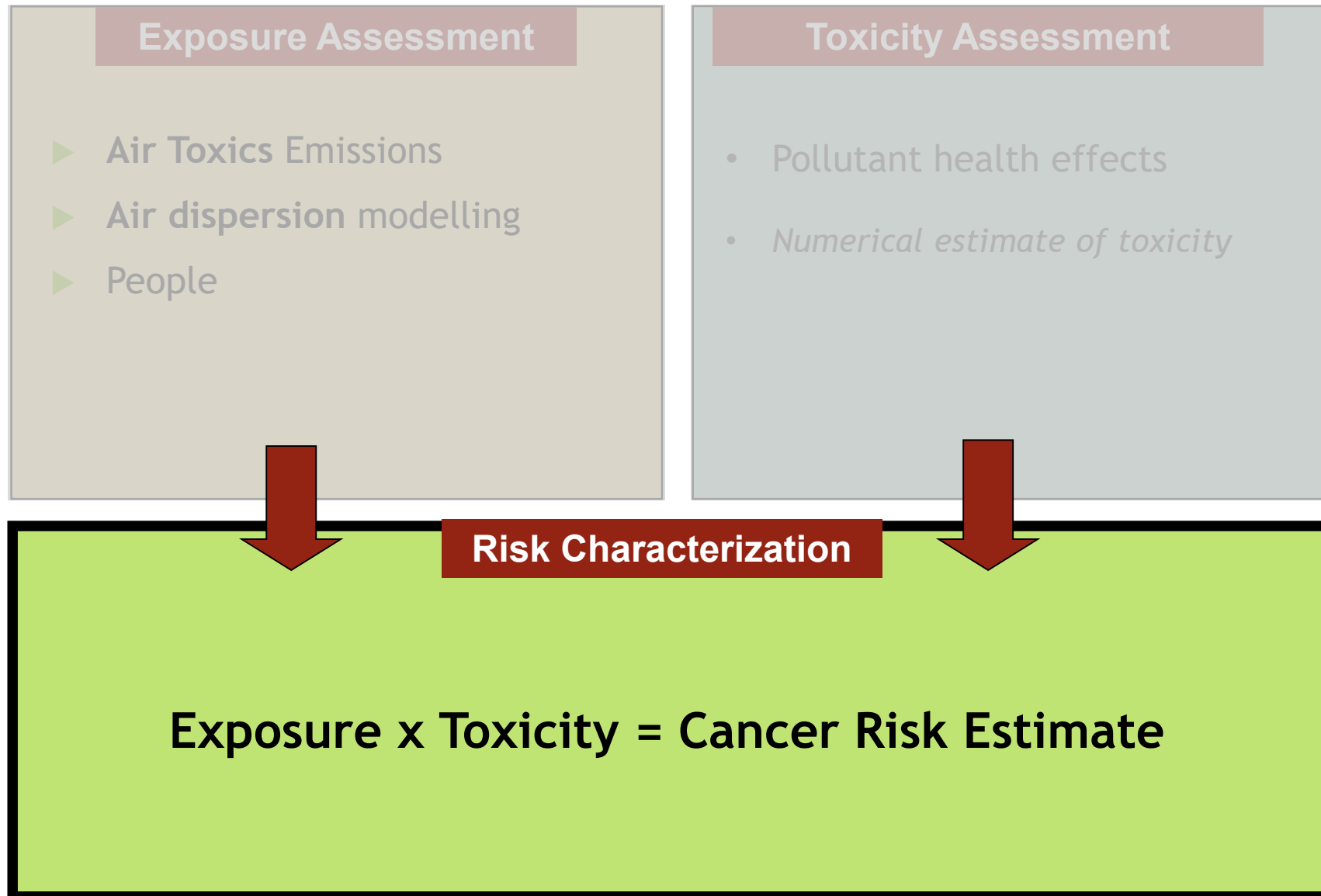
# What Health Effects Are Caused by the Pollutant?

- ▶ Does the pollutant cause noncancer effects?
- ▶ Is the pollutant a carcinogen?
  - Several agencies, such as the EPA and the International Agency for Research on Carcinogens (IARC), classify substances based on their potential for causing cancer/the likelihood that they cause cancer
  - Classification is based on evidence from animal studies and, if available, data for humans, such as studies of workers.
- ▶ What type or types of cancer are associated with exposure to the pollutant?

# Numerical Estimate of Toxicity

- ▶ To calculate risk, EPA needs to have a numerical estimate of how toxic a chemical is. For a carcinogen, we use a number called a “Unit Risk Estimate,” or “URE.”
- ▶ A URE is an estimate of the increased cancer risk from inhaling a concentration of  $1 \mu\text{g}/\text{m}^3$  of a chemical for a lifetime.
- ▶ A URE is developed by looking at all the toxicity studies about a chemical - both animal studies, and human studies (usually of worker exposure), if any exist.
- ▶ Because the exposures in the studies are usually much higher than what we breathe in the outdoor air, EPA uses mathematical models to extrapolate from the higher doses in the studies to the doses we see around facilities.
- ▶ If the pollutant is “mutagenic” (causes changes to the genetic material in a cell, usually DNA), we add an age-dependent adjustment factor (ADAF) to the URE.

# Key Inputs/Outputs for a Risk Assessment





# Risk Characterization - Cancer

## Exposure Concentration x Unit Risk Estimate = Cancer Risk

- ▶ For our cancer risk assessments, EPA typically assumes that a person is exposed for 70 years. We use 70 years to represent a lifetime.
- ▶ EPA calculates three metrics:
  1. The Maximum risk: the increase in the lifetime cancer risk at a location with the highest concentration where people live. We call this the maximum individual risk, or MIR.
  2. Numbers of people in the modeled area at different risk levels:
    - ▶ For example: equal to or greater than 1-in-1 million, 10-in-1 million, 100-in-1 million etc.
  3. Incidence: estimates of possible cancer cases per year, and over 70 years

# Example Cancer Risk Calculation

- ▶ URE for Chemical X is  $1 \times 10^{-4}$  per  $\mu\text{g}/\text{m}^3$ 
  - ▶ Certain pollutants are considered mutagenic. In these cases age-dependent adjustment factors should be applied when assessing risk for ages younger than 16 years.
  - ▶ Applying the ADAF changes the URE to  $1.6 \times 10^{-4}$
- ▶ To get cancer risk, EPA multiplies the URE by the long-term average concentration in air in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ )
- ▶ Example:
  - long-term average concentration of Chemical X =  $0.56 \mu\text{g}/\text{m}^3$
  - $0.56 \mu\text{g}/\text{m}^3 \times 1.6 \times 10^{-4} \text{ per } \mu\text{g}/\text{m}^3 = 0.00009$ , or expressed as a probability of 90-in-1 million
- ▶ This results in an estimate of the increase in the excess lifetime cancer risk of an individual who is exposed to Chemical X for 70 years.


# How to Read a Risk Assessment

Inhalation Cancer Risk				
Maximum Individual Risk (MIR) (in-1 million)	Risk Driver	Cancer Incidence (cases per year)	Population $\geq$ 10-in-1 million	Population $\geq$ 1-in-1 million
90	Chemical X	0.05	4,000	100,000

Highest estimated risk



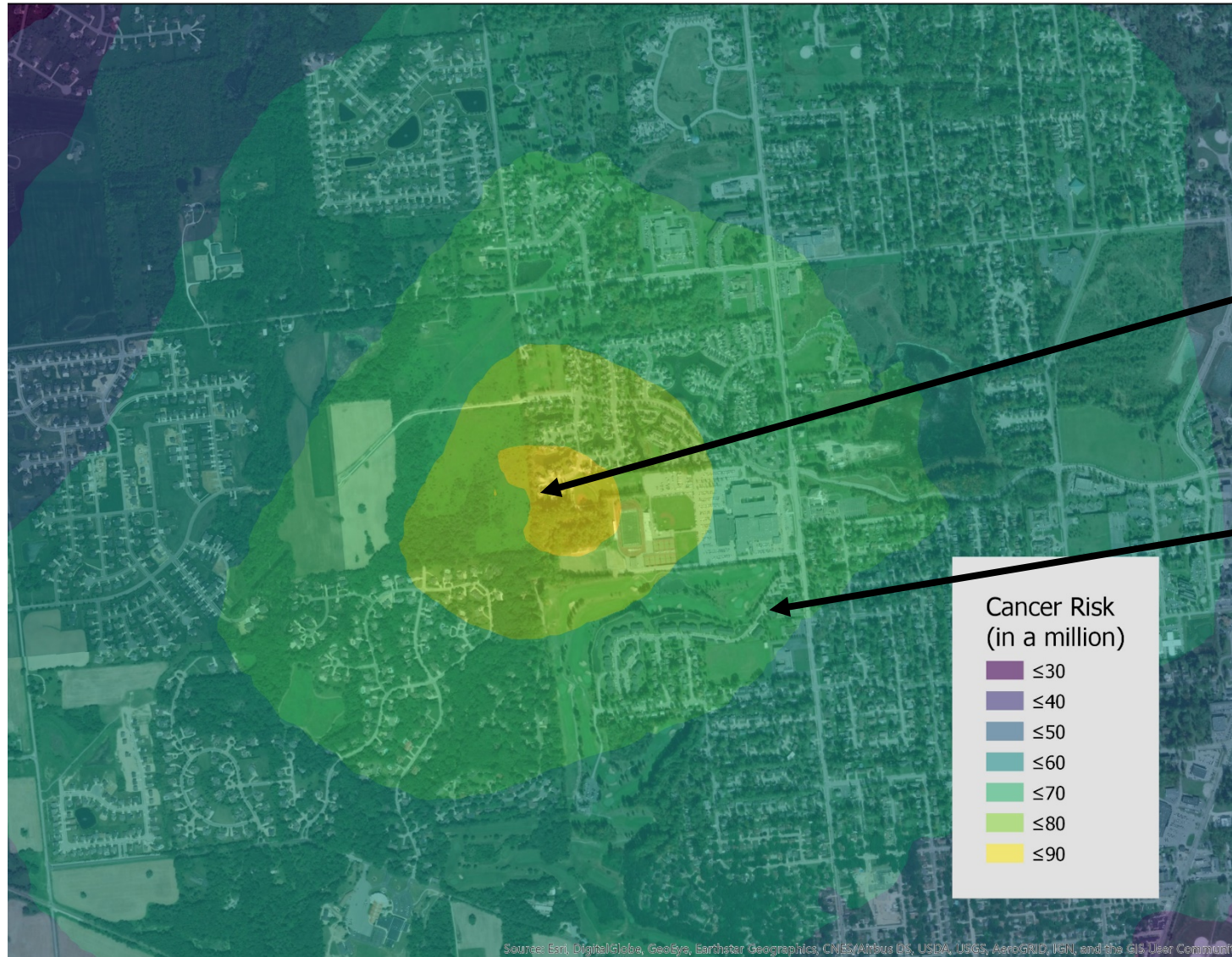
Expected number of excess cancer cases per year



Population exposed at different risk levels



# How to Read a Risk Assessment



**MIR Location**

**Different colors indicate different cancer risk levels**