### Sources of Exposure

- **General Populations**
  - The primary sources of exposure for the general population are pesticide products containing 2,4-D.
  - Dermal contact is also possible when entering grassy areas or swimming areas shortly after 2,4-D was sprayed to control weeds.
  - The general population is unlikely to be exposed to high levels of 2,4-D in food, drinking water, or soil.

- **Occupational Populations**
  - Workers involved in the production of 2,4-D may be exposed by inhalation and/or dermal contact.
  - Pesticide applicators may be exposed during mixing, loading, and application of 2,4-D products to control weeds.
  - Families of workers may also be exposed by home surfaces contaminated from contact with an applicator’s hands or clothing, and touching a person that has been applying 2,4-D very recently.

### Toxicokinetics and Normal Human Levels

- **Toxicokinetics**
  - 2,4-D is readily absorbed following oral exposure and likely following inhalation exposure; absorption through the skin is relatively low.
  - Absorbed 2,4-D is widely distributed in the body, but does not accumulate in tissues.
  - 2,4-D is not readily metabolized in the body.
  - 2,4-D is rapidly eliminated in the urine.

- **Normal Human Levels**
  - In the National Health and Nutrition Examination Survey (NHANES), mean 2,4-D levels were 0.193–0.521 ppb for urine samples collected during the years 2003–2004 and 2009–2010. However, mean levels for the years 1999–2002 and 2007–2008 could not be calculated because 2,4-D was not detected in many of the urine samples.

### Biomarkers / Environmental Levels

- **Biomarkers**
  - The most reliable biomarker of exposure is 2,4-D in urine.
  - There are no biomarkers of effects that would be specific to 2,4-D exposure.

- **Environmental Levels**
  - **Air**
    - Outdoor air: Up to 600 ppb near areas of heavy 2,4-D usage, but generally not detected otherwise.
  - **Sediment and soil**
    - Soil (range): 8–143 ppb
  - **Water**
    - Surface water (range): 0.003–37 ppb
    - Ground water (range): 0.33–50 ppb
    - Drinking water (range): 0.0011–58 ppb

### Reference

2,4-D is a Man-Made Chemical
- Pure 2,4-D (2,4-dichlorophenoxyacetic acid) is an odorless or slightly phenolic white to yellow crystalline powder.
- 2,4-D is the active ingredient in many herbicidal products. It also may be combined with other herbicides in commercial products.
- There are nine forms of 2,4-D that can be used as an herbicide; these forms include salts and esters of 2,4-D.
- 2,4-D is sold commercially as emulsifiable concentrate, wettable granules, wettable powder, emulsion (esters), and aqueous solution (salts).

2,4-D in the Environment
- 2,4-D can enter the air when it is manufactured or during spray applications.
- In air, 2,4-D can be broken down by reactions with other chemicals or can settle to the ground.
- 2,4-D enters aquatic systems when sprayed on nearby plants, from runoff and soil erosion, or when it is used on water plants.
- 2,4-D in air or soil does not usually stay in the environment long.
- 2,4-D in water breaks down slowly.
- 2,4-D does not bioconcentrate in aquatic systems.

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation
- No acute, intermediate-, or chronic-duration inhalation MRLs were derived for 2,4-D.

Oral
- No acute-duration oral MRL was derived for 2,4-D.
- An intermediate-duration (15–364 days) oral MRL of 0.2 mg/kg/day was derived for 2,4-D.
- A chronic-duration (≥365 days) oral MRL of 0.2 mg/kg/day was derived for 2,4-D.

Health Effects
- Respiratory and nervous system effects were seen in people who purposely or accidentally swallowed large amounts of 2,4-D. These serious effects are not likely to occur at the levels of 2,4-D that are found in the environment.
- Animals given large oral doses of 2,4-D exhibited adverse effects on the blood, liver, kidney, and thyroid gland. These doses were generally much higher than environmental levels.
- A few studies of farmers or professional applicators of herbicides containing 2,4-D reported increased risk of lymphatic system cancers, particularly Non-Hodgkin's lymphoma (NHL). These workers were exposed to higher amounts of 2,4-D than most people.
- The Environmental Protection Agency (EPA) assigned 2,4-D to Class D (not classifiable as to human carcinogenicity) based on inadequate human and animal data. The International Agency for Research on Cancer classified 2,4-D as possibly carcinogenic to humans (Group 2B).

Children’s Health
- Some studies of animals given 2,4-D during pregnancy found decreased weight of fetuses and young offspring and some changes in behavior of the offspring.