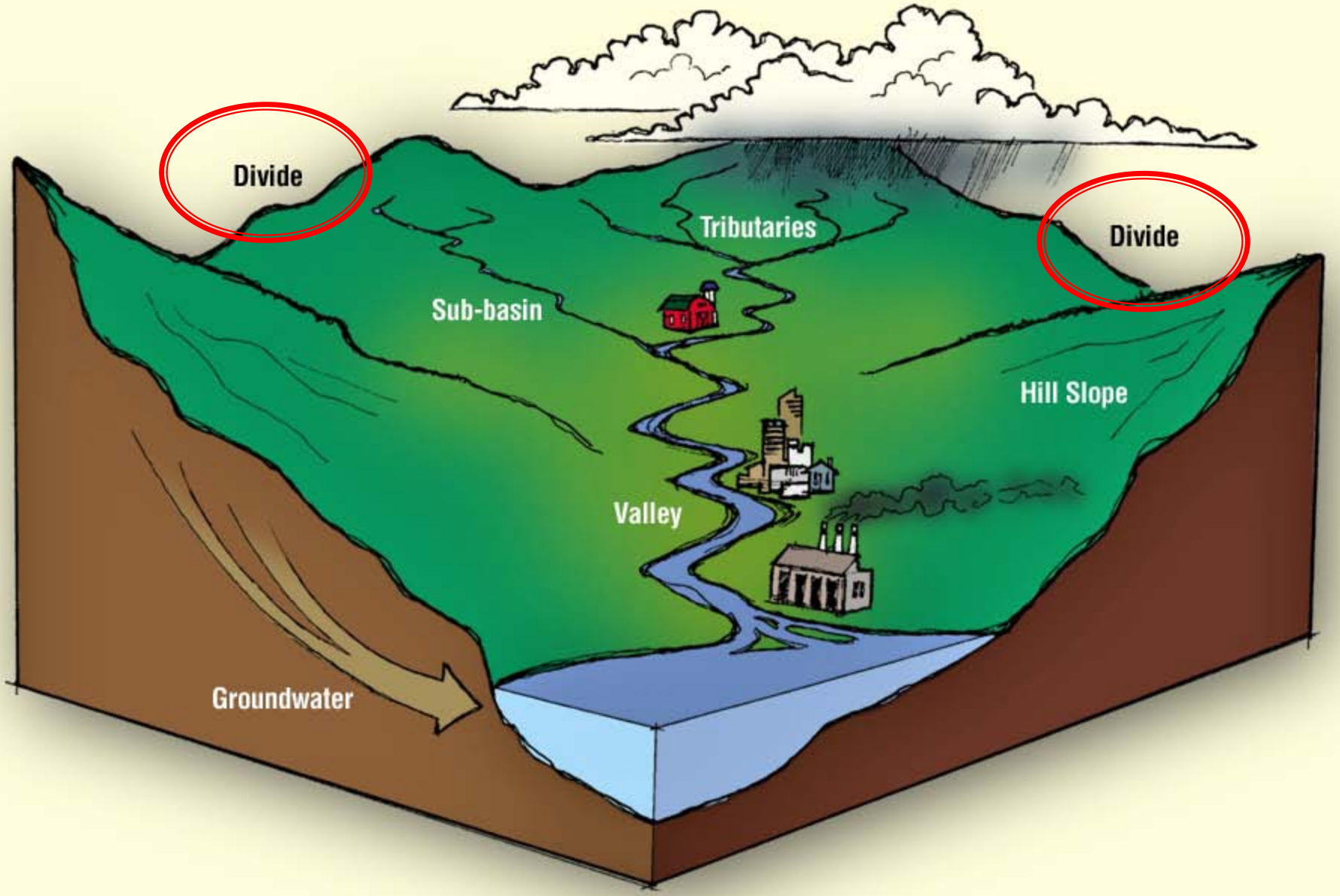
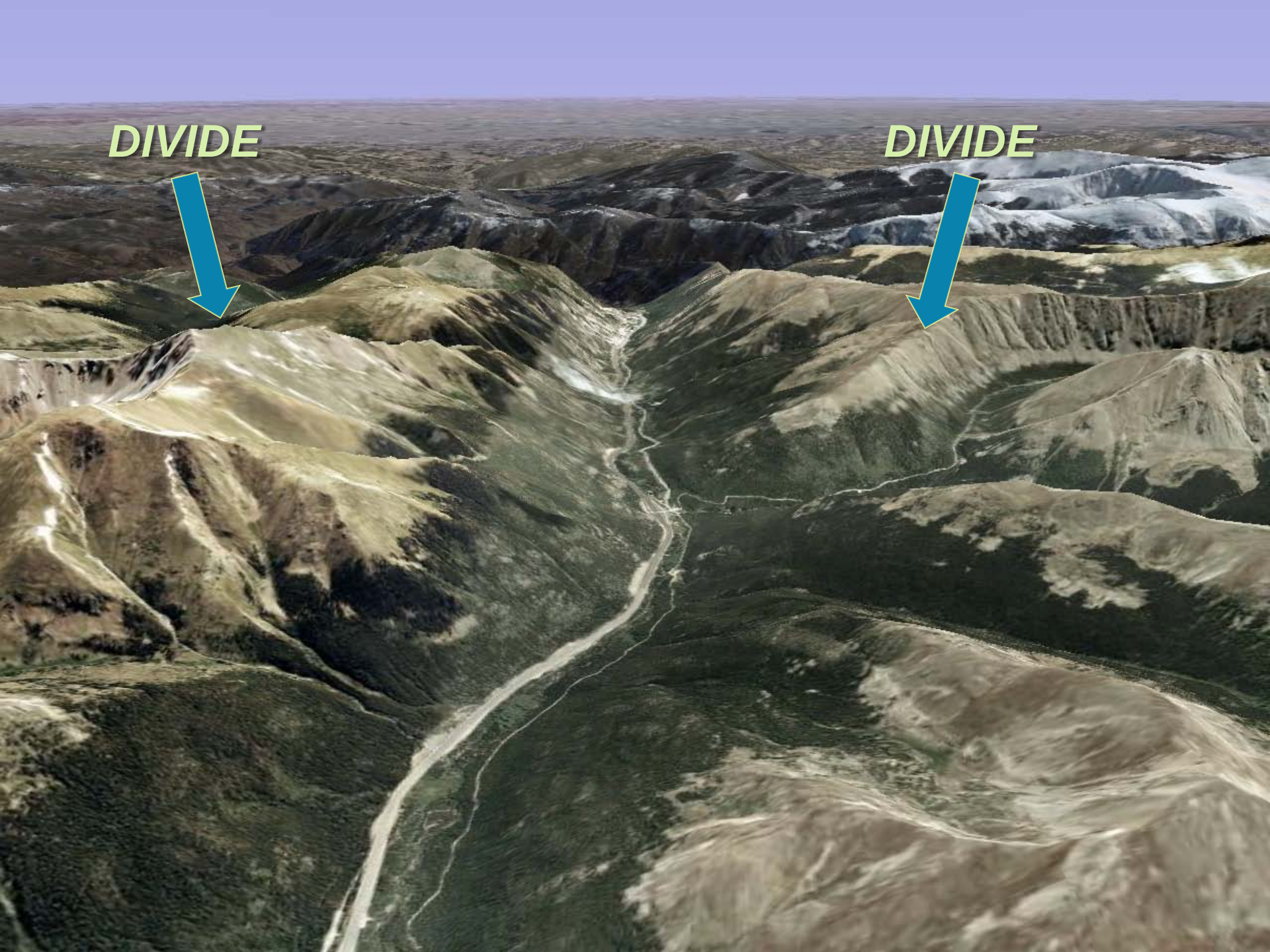
What is a Watershed?

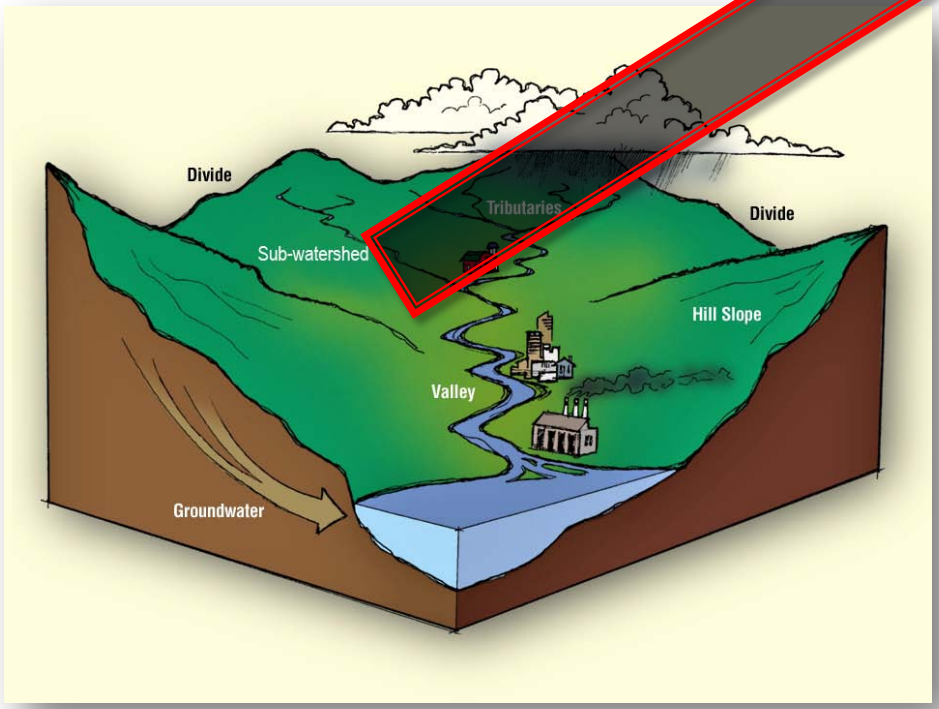
What is a Watershed?

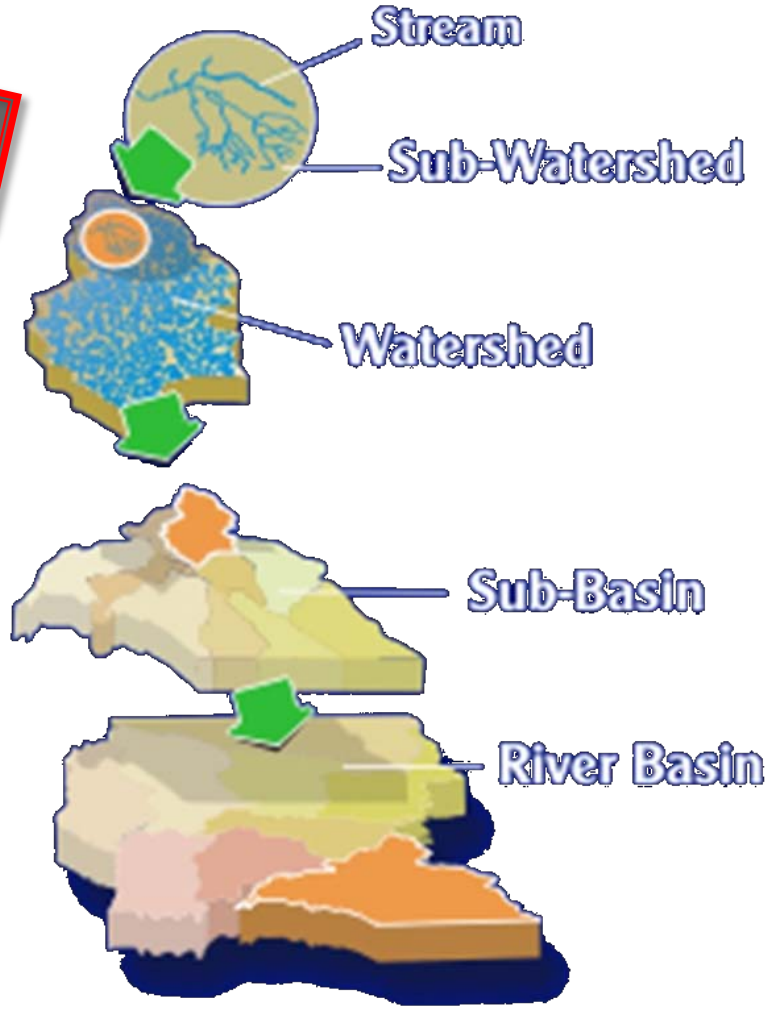
- An area of land that water flows across, through, or under on its way to a stream, river, lake, ocean or other body of water.
- A watershed is lik
one big bathtub...


Divide
Tributaries
Divide
Sub-basin
Hill Slope
Valley
Groundwater

WATERSHE
D


DIVIDE
DIVIDE


Divide
Tributaries
Divide
Sub-watershed
Hill Slope
Valley
Groundwater


Stream
Sub-Watershed
Watershed
Sub-Basin
River Basin

WATERSHED

What Do Watersheds Look Like?

- Watersheds come in many different shapes and sizes:
  - Can include farmland, rangeland, small towns, or big cities.
  - Can have hills, mountains, or be nearly flat.
  - Can range from a few acres to millions of square miles.

Where Are Watersheds Found?

We find watersheds *EVERYWHERE*.

ALL land area is part of a watershed.

We *ALL* live in a watershed.

Where Does Precipitation Go?

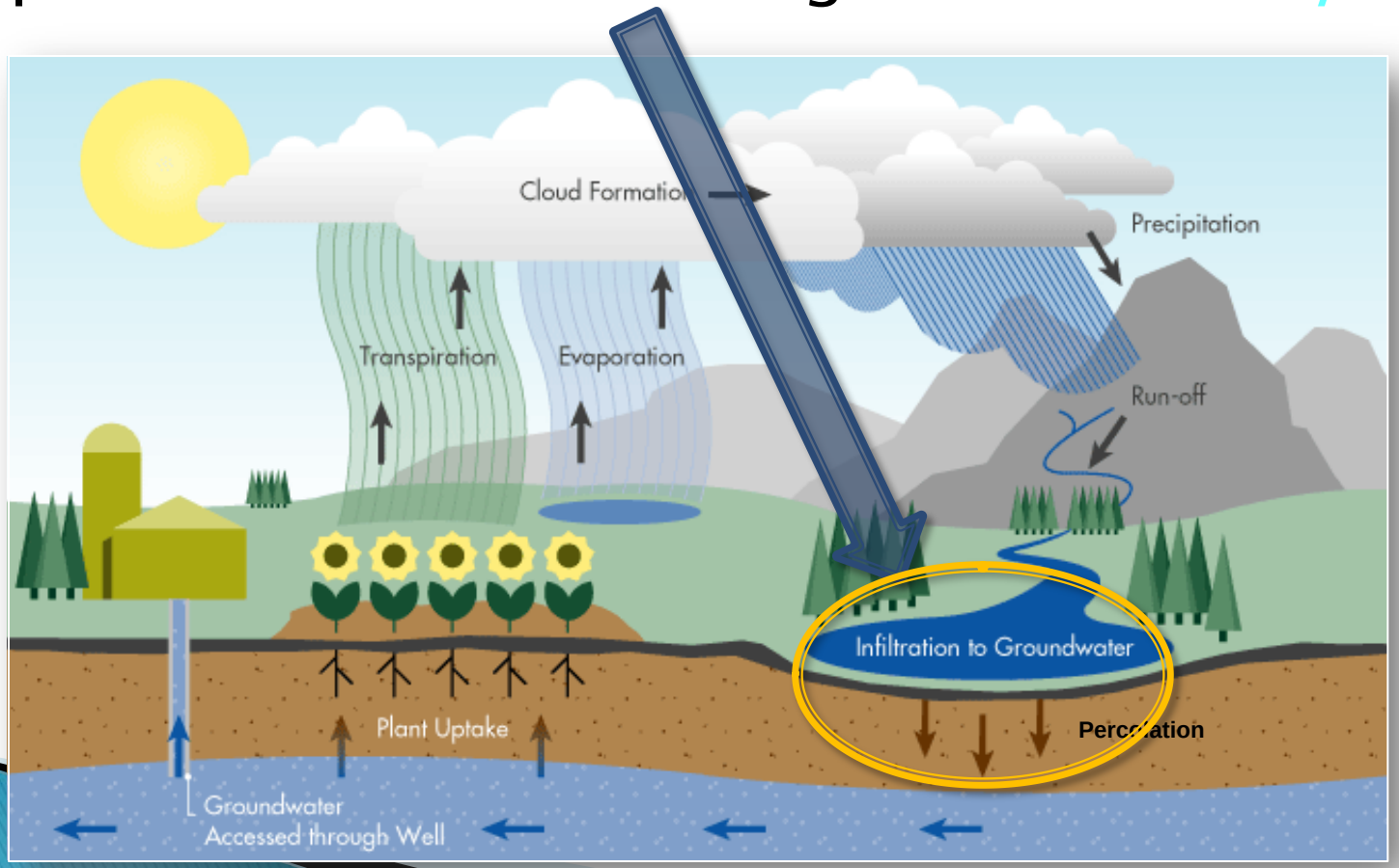
1. It can *run off*

Where Does Precipitation Go?

2. It can be absorbed by plants and used for photosynthesis and other biological

Where Does Precipitation Go?

3. It can *infiltrate* through the soil surface and percolate downward to groundwater *aquifers*

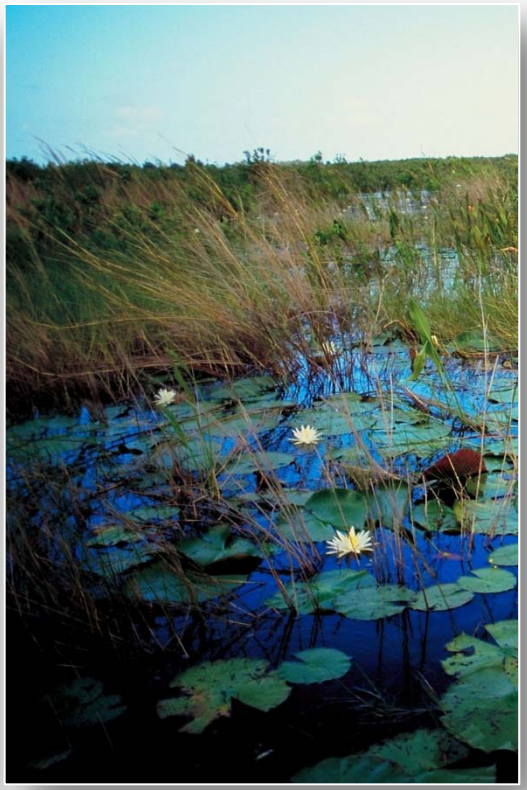
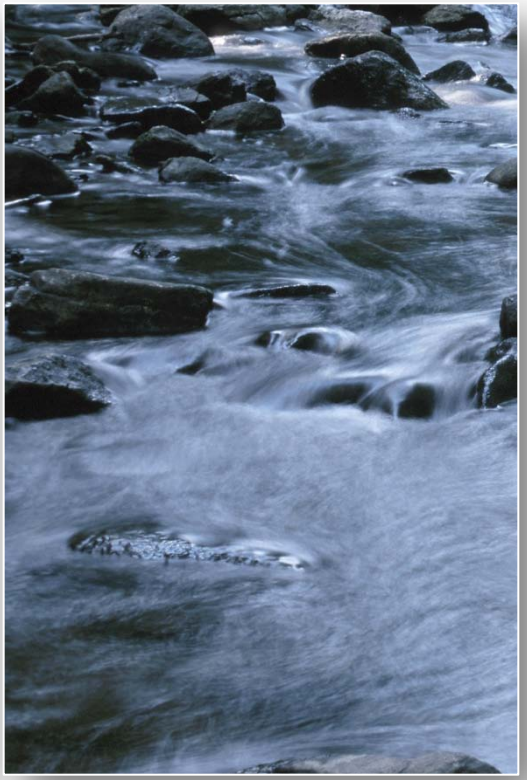


Where Does Precipitation Go?

4. It can evaporate

Where Does Precipitation Go?

5. It can be stored in ice caps, glaciers, lakes, reservoirs and other surface bodies of water

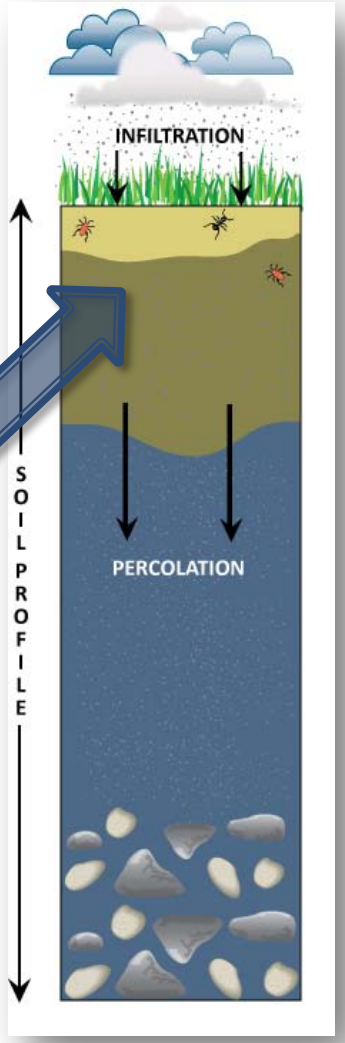




Natural Watershed Functions

- <u>Hydrological Functions</u>
  - Water capture
  - Water storage
  - Water release
- Provide diverse sites for *biogeochemical* reactions
- Provide habitat for plants and animals

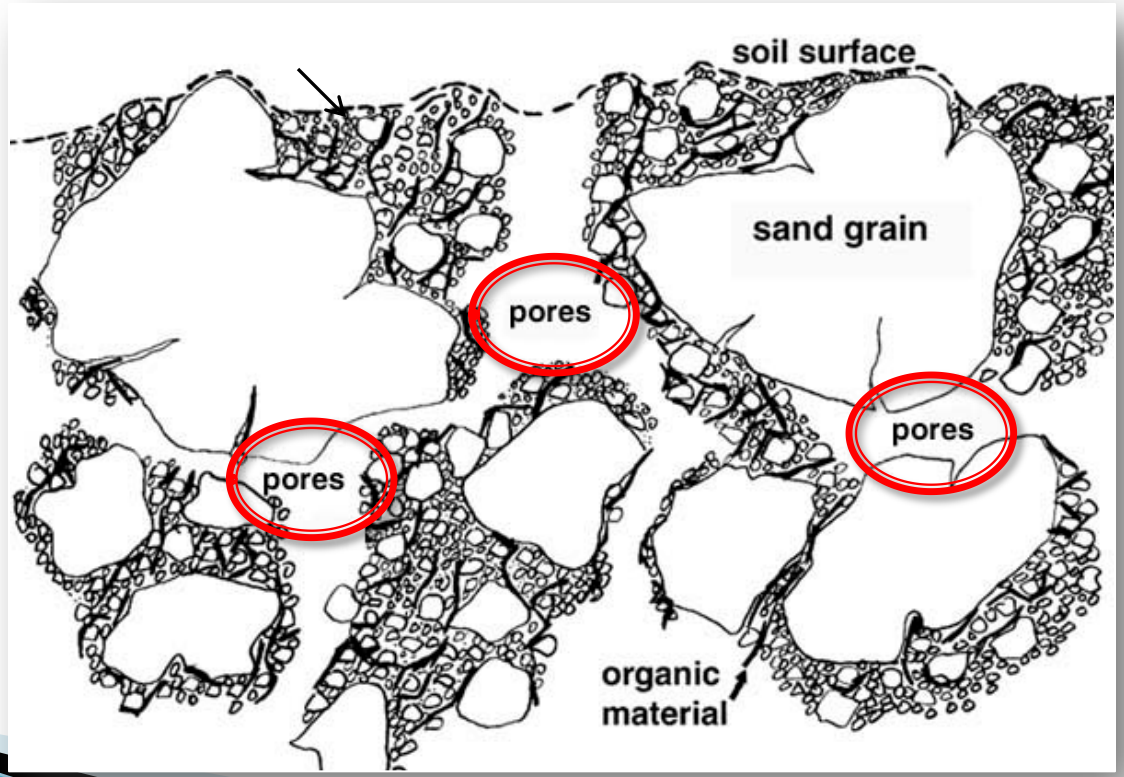
Hydro Function #1: Water Capture

- H_2O is transferred from atmosphere and is "captured" in the soil
- H_2O can then infiltrate through soil surface and percolate downward into *soil profile*



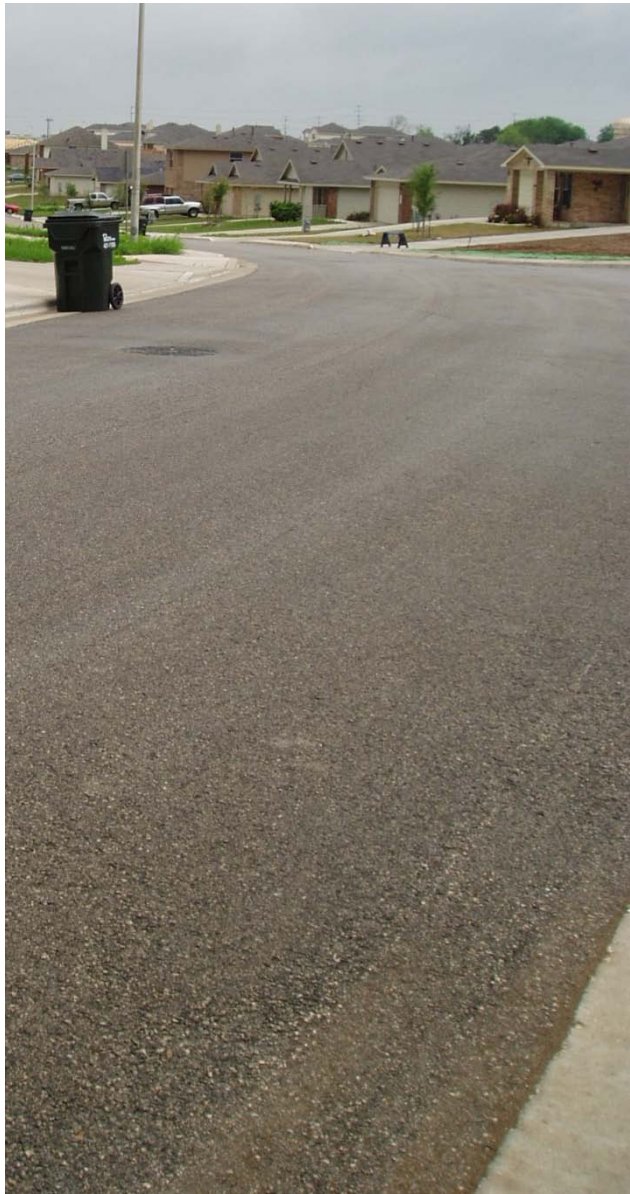
Hydro Function #2: Water Storage

- Water is stored in the pores (air spaces) between soil particles in the soil profile.

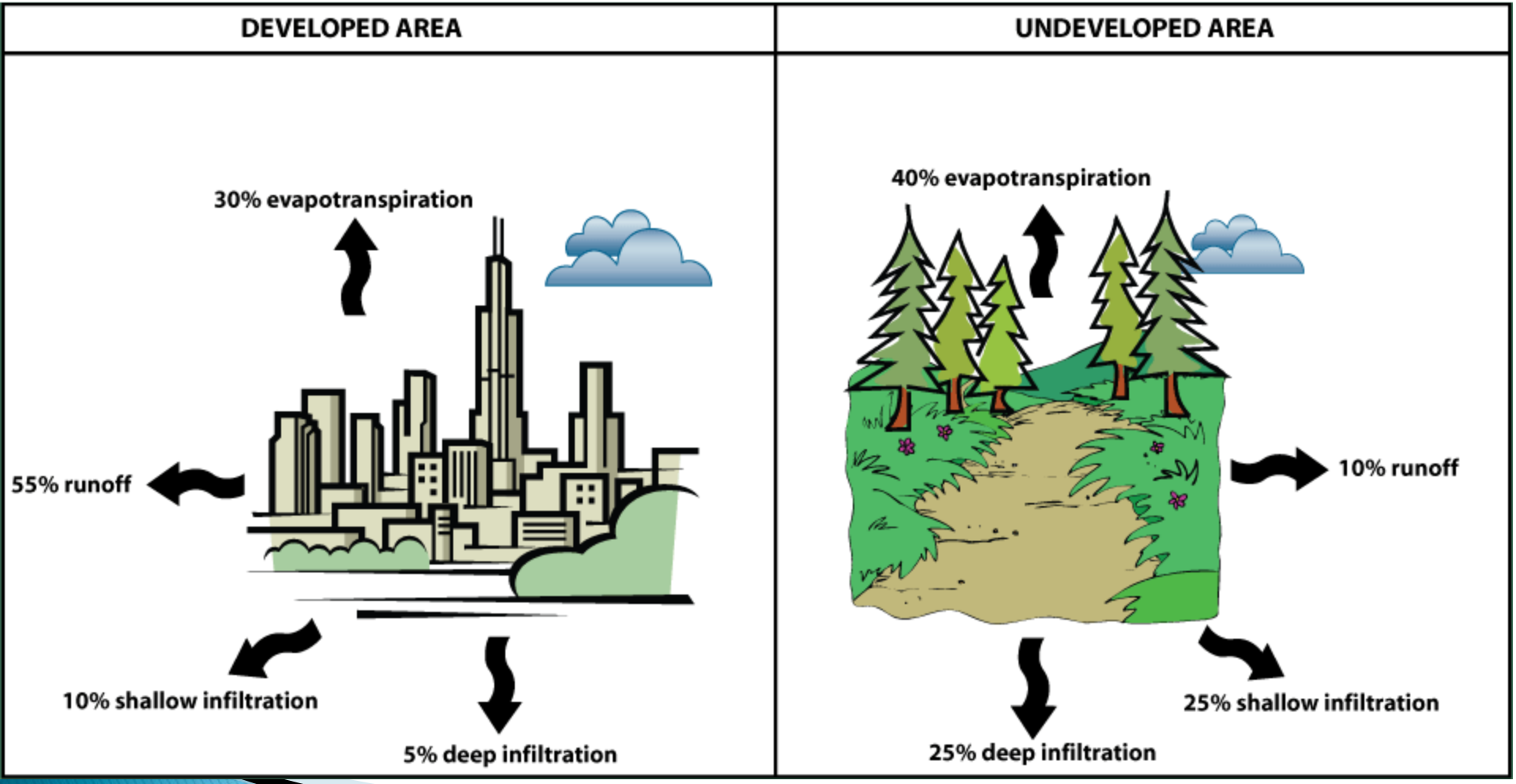


Department of Primary Industries, Australia

Hydro Function #2: Water Storage

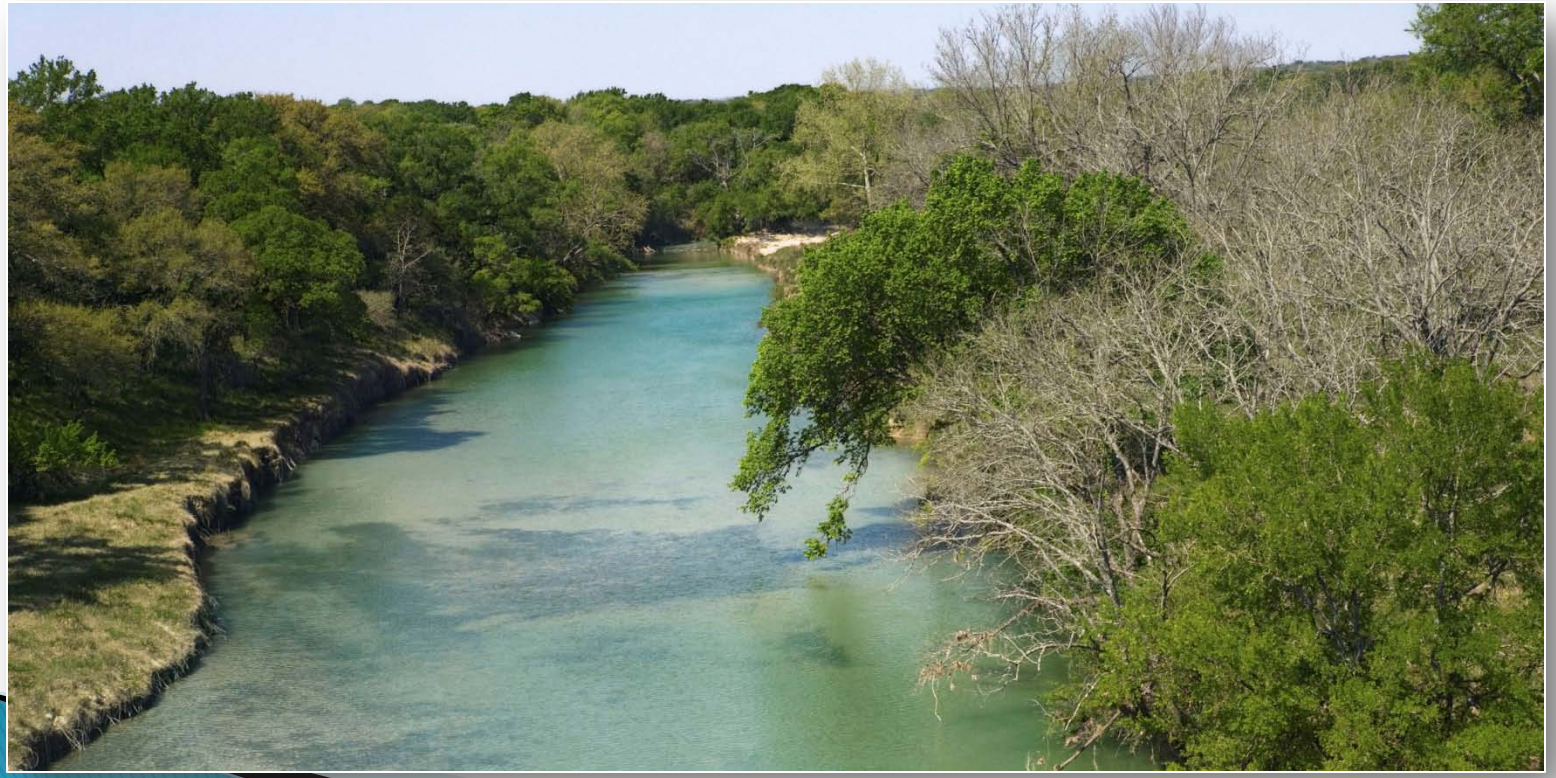


Hydro Function #2: Water Storage



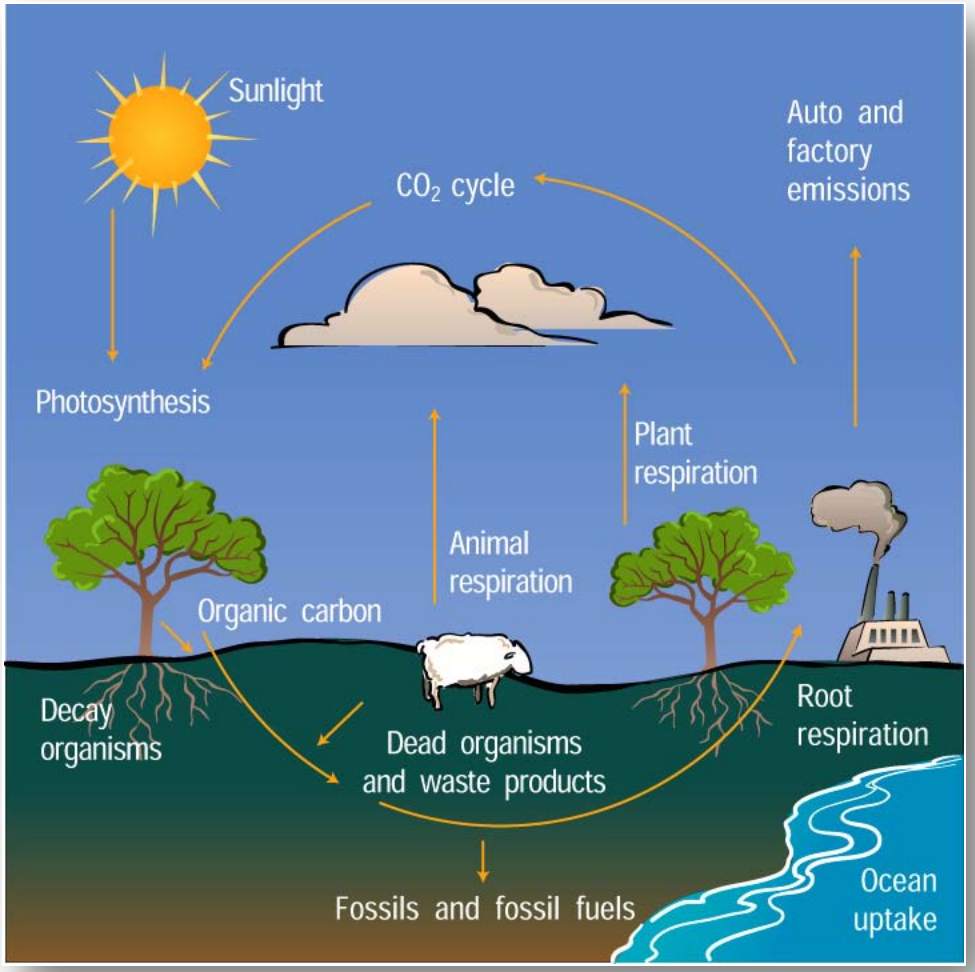
Hydro Function #3: Water Release

- Water moves underground, through the soil profile, or across the land surface as runoff



Eco Function #1: Biogeochemical Reactions

- *Biogeochemical cycling* = the biological, physical and chemical transformations of nutrients that are found in soil, water, and air.
- Very complex interactions that help maintain plant and microbial



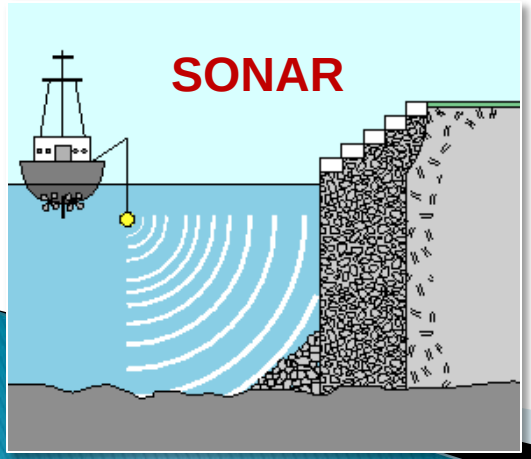
University Corporation for Atmospheric Research (UCAR)

Eco Function #2: Habitat

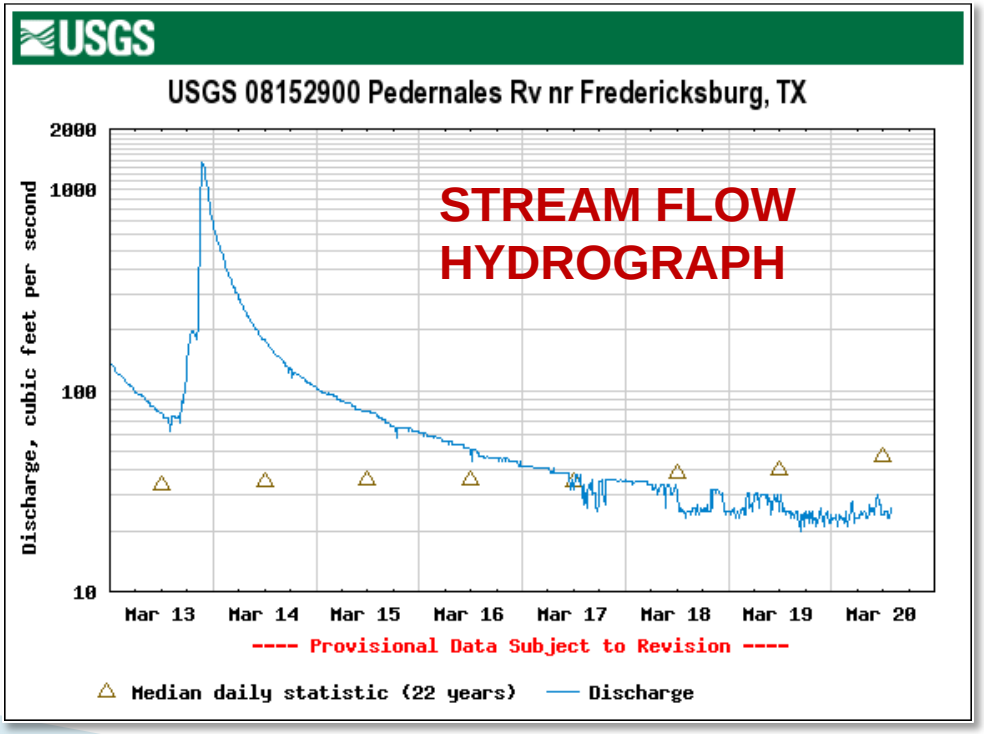
- *Habitat* = "home"
- Watersheds provide critical habitat for all kinds of plants and animals

Water Quantity and Quality

- *Water Quantity* = volume of water available
- How do we know how much water is available?
  - Streamflow hydrograph
  - Sonar devices
  - Complex flow models



usgs.gov

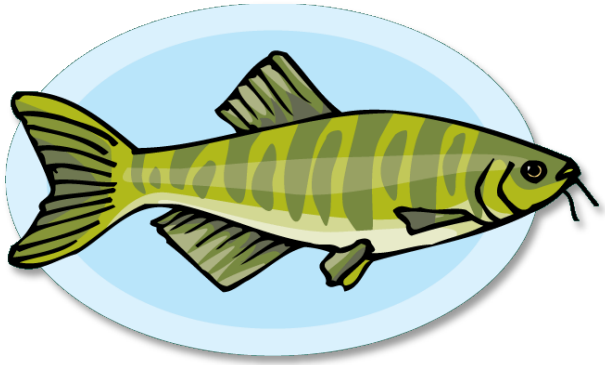


Water Quality

- *Water Quality* = chemical, physical, and biological characteristics of water with respect to its suitability for a particular purpose or designated use.

Chemical

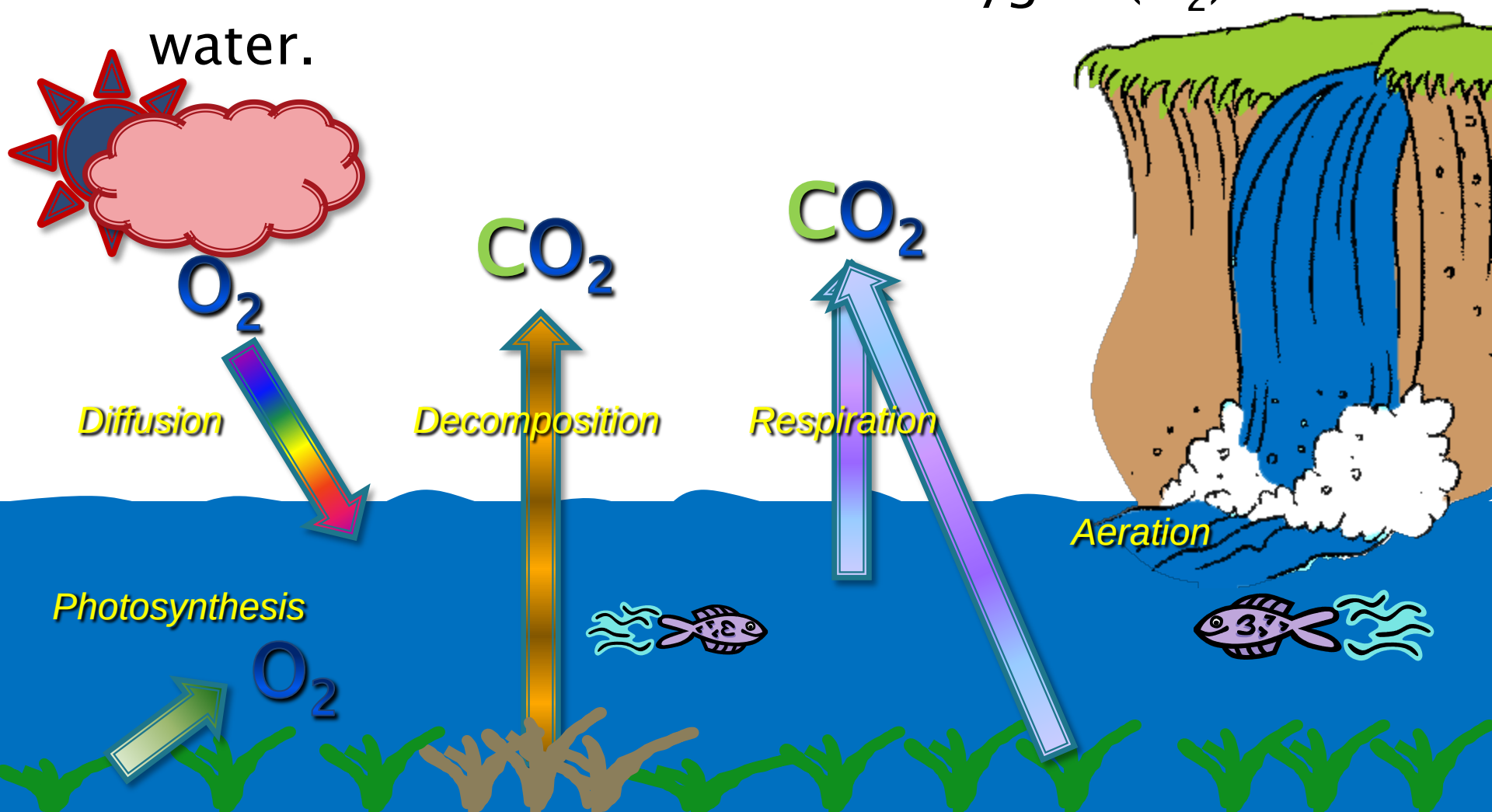
Physical



Biological

Dissolved Oxygen

- *DO* = measure of dissolved oxygen (O_2) in water.



- **< 0.5 mg/L *Anoxic*** – *Oxygen dependent animals die*
- **< 3 mg/L *Hypoxic*** - *Most aquatic organisms cannot survive*
- **4-5 mg/L** *Aquatic organisms become stressed*
- **6-9 mg/L** *Optimal for many aquatic organisms*
- **> 10 mg/L** *Oxygen saturation*

Fecal Bacteria

- Microscopic organisms found in feces of humans and other warm-blooded animals
- Not all are harmful by themselves
- *Indicator* organisms: indicate presence of *pathogenic* bacteria, viruses, parasites
- Fecal coliform and *E.*

Streamflow

- *Streamflow* = Volume of water that moves over a point during a fixed period of time.
  - *Measured in cubic feet per second (cfs)*

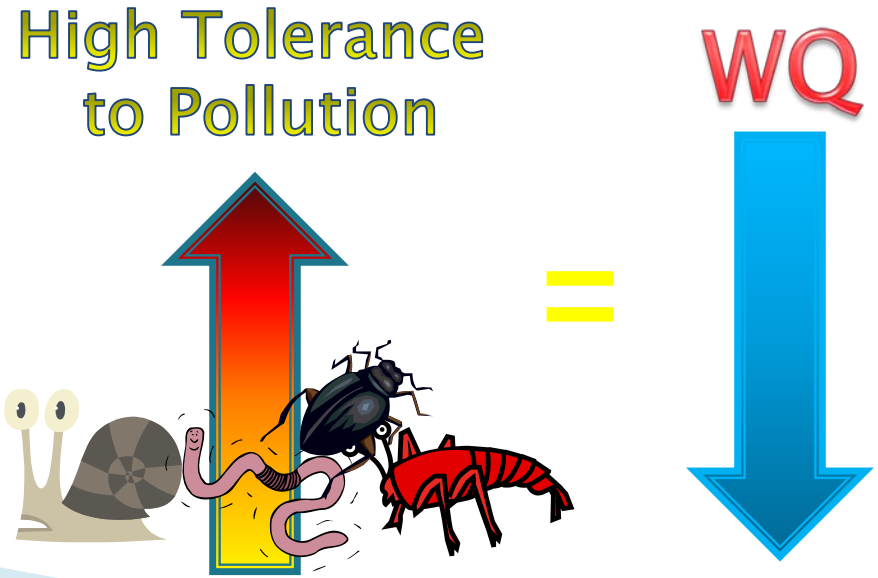
- Varies depending on rainfall and runoff.
- Affects water temperature, turbidity, and concentrations of DO and pollutants.

Benthic Macroinvertebrates

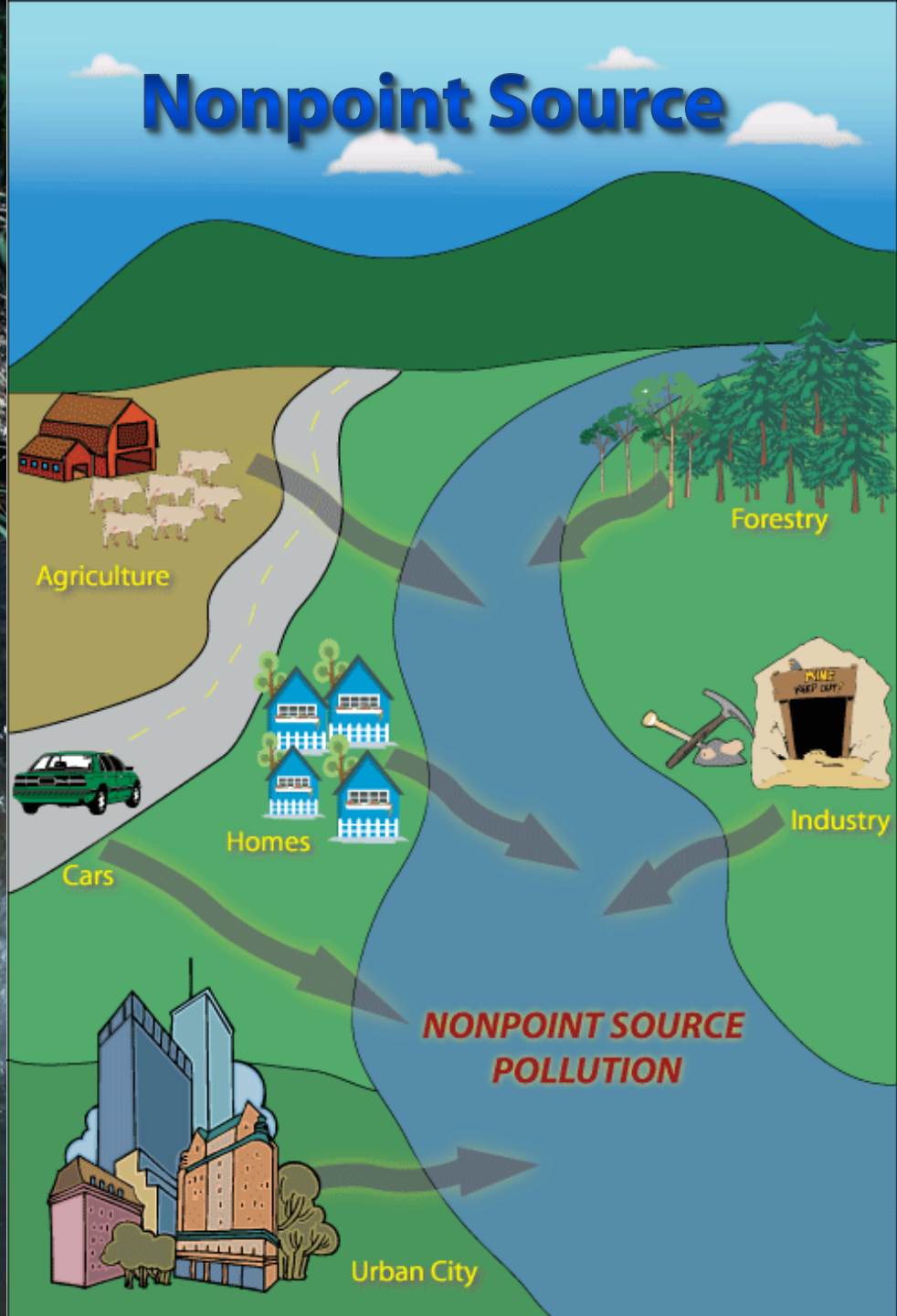
- *Benthic* = bottom-dwelling
- *Macro* = large enough to be seen with the naked eye
- *Invertebrate* = no backbone

Benthic Macroinvertebrates

- Indicator species:
  - Have specific tolerances to pollutants
  - React to changes in water quality

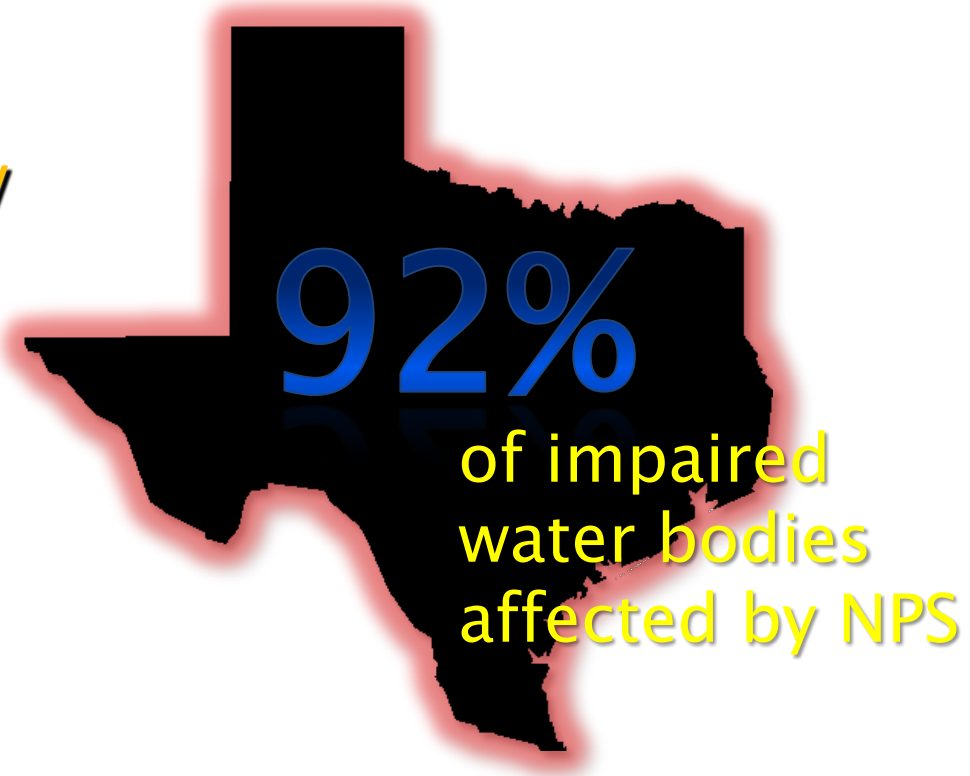



Point Source


Nonpoint Source
Agriculture
Forestry
Homes
Cars
Industry
NONPOINT SOURCE
POLLUTION
Urban City

Point and Nonpoint Source Pollution

- *ALL* of Texas' river and coastal basins, estuaries, coastal wetlands, and bays have been impacted by point and/or nonpoint source pollution.
- Nonpoint source pollution is the primary cause of water quality problems in Texas!



Sources of Bacteria

HUMANS

Sources of Bacteria

DOMESTIC ANIMALS

Sources of Bacteria

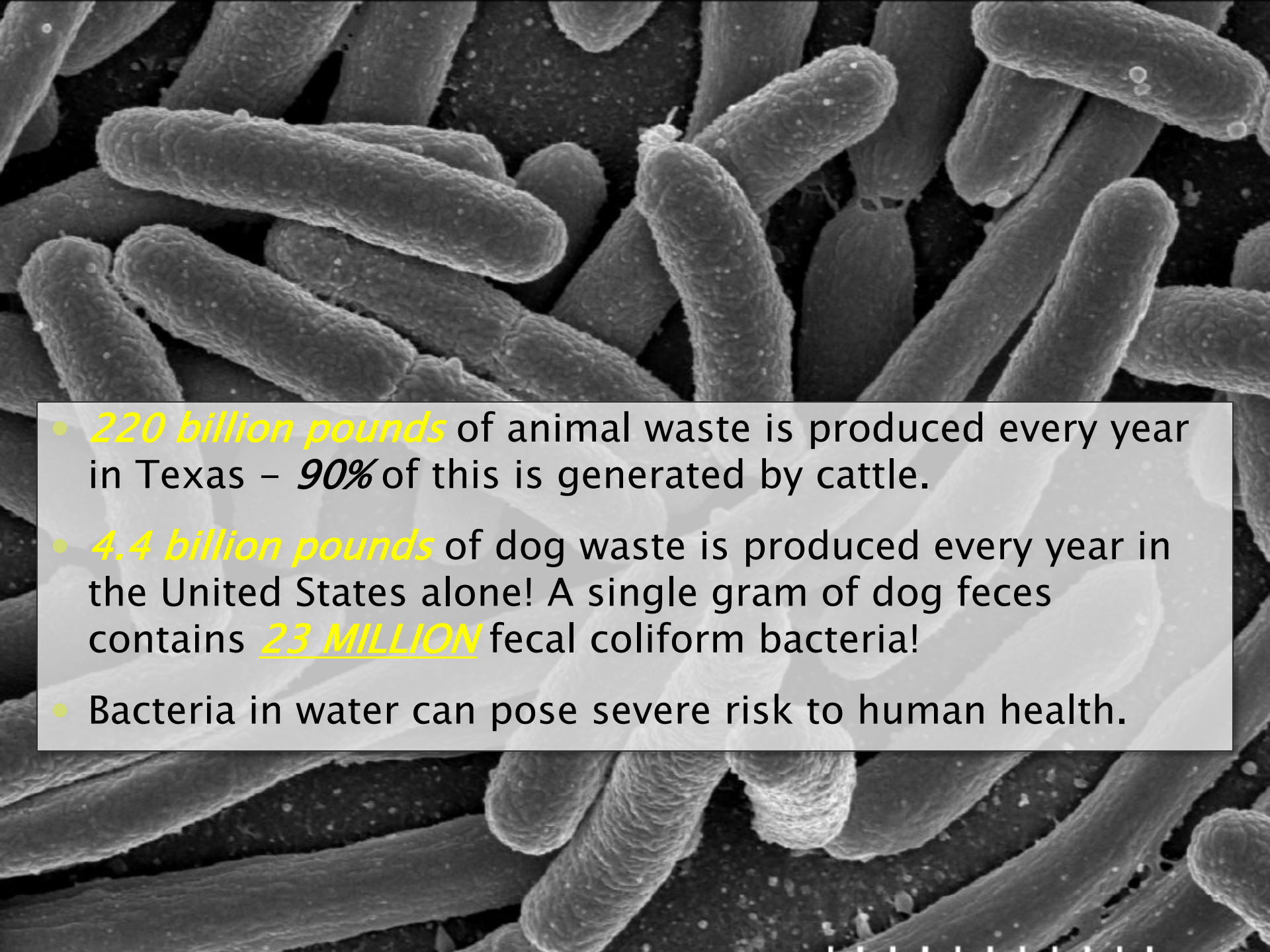
FERAL HOGS

Sources of Bacteria

LIVESTOCK

Sources of Bacteria

WILDLIFE AND OTHER NON-DOMESTIC ANIMALS



- *220 billion pounds* of animal waste is produced every year in Texas – *90%* of this is generated by cattle.
- *4.4 billion pounds* of dog waste is produced every year in the United States alone! A single gram of dog feces contains *23 MILLION* fecal coliform bacteria!
- Bacteria in water can pose severe risk to human health.

Nutrients

- Nitrogen
- Phosphorus

Sources of Nutrients

FERTILIZER

Sources of Nutrients

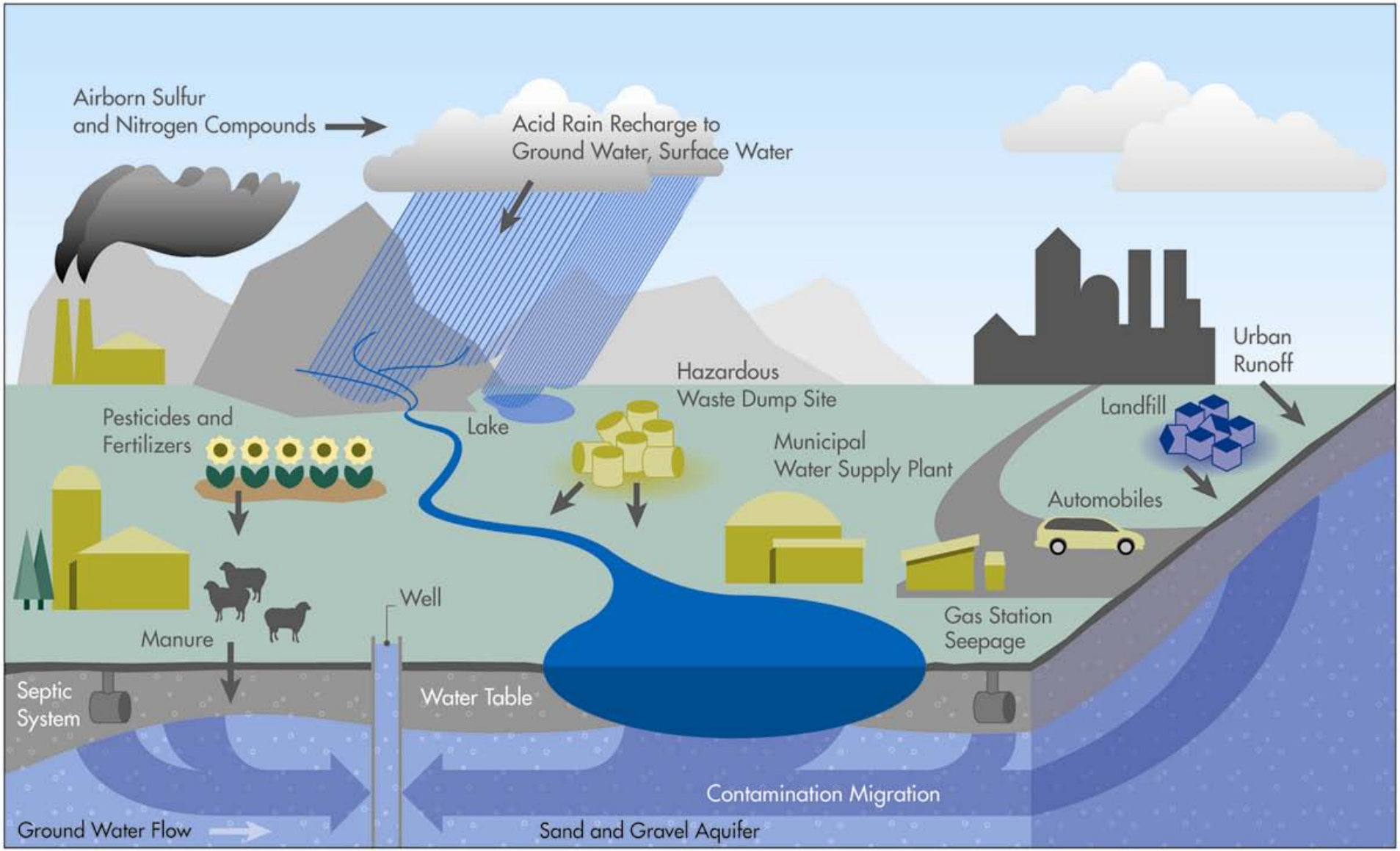
ANIMAL WASTE

Sources of Nutrients

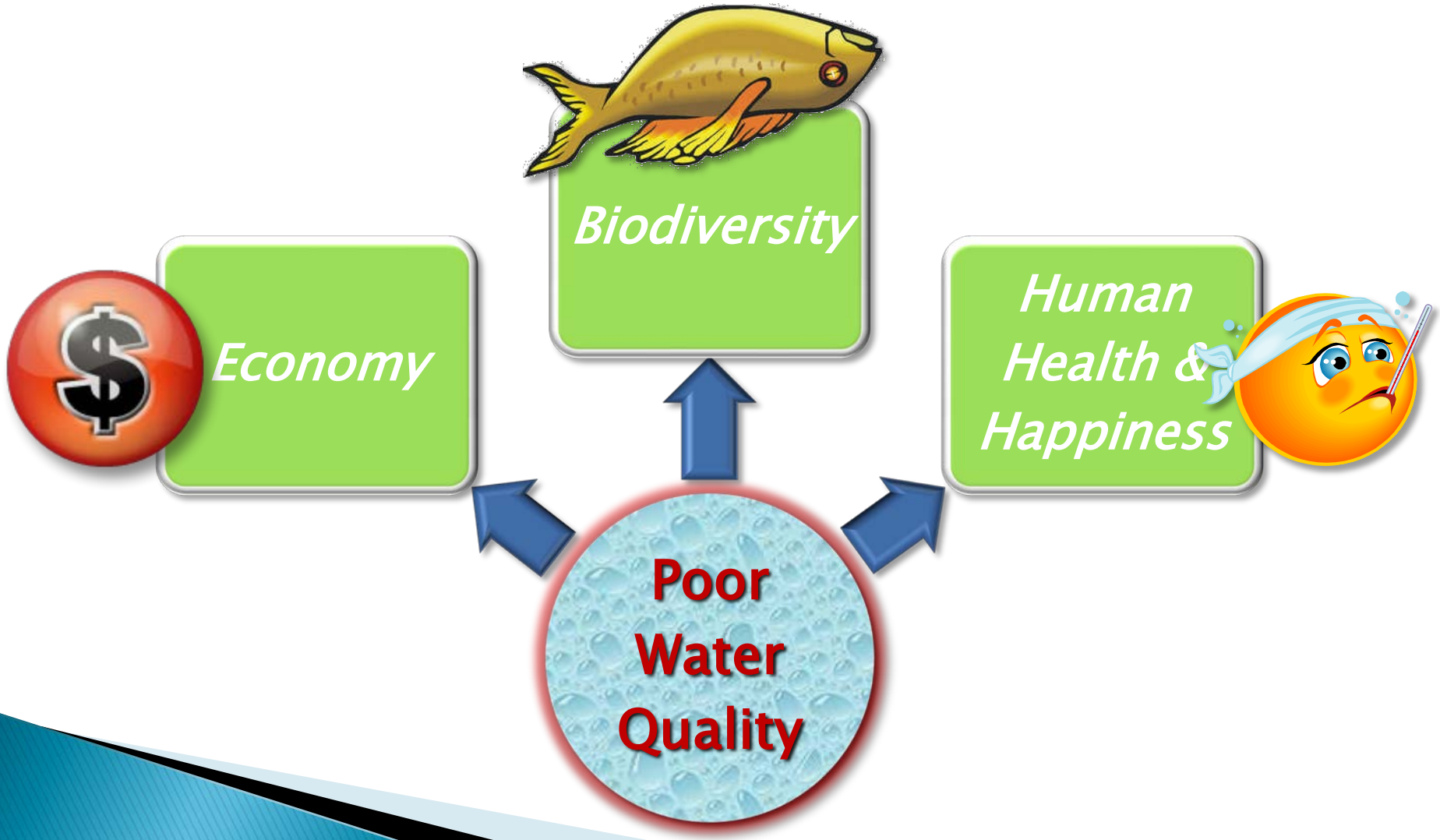
HUMANS

Sources of Nutrients

Human Activities Can Impair WQ



Consequences of Impaired WQ




Economy
770-560-3694
HITACHI
Millions spent annually to control and fix damage of point/nonpoint source pollution

Biodiversity

- Pollution can destroy valuable habitat
- It can also eliminate desirable/beneficial species of plants and animals that have low tolerances to pollution.
- At the same time, it can lead to an increase in undesirable species.

Human Health & Happiness

- Contaminated water can cause rashes, ear aches, pink eye, respiratory infection, hepatitis, encephalitis, diarrhea, vomiting, and worse…
- Toxic chemicals in water can cause birth defects, cancer, neurological disorders, and kidney ailments.








Simple Pollutant Load Models

Flow Duration Curve
Load Duration Curve

Flow Duration Curves

- What are they?
  How do you make one?

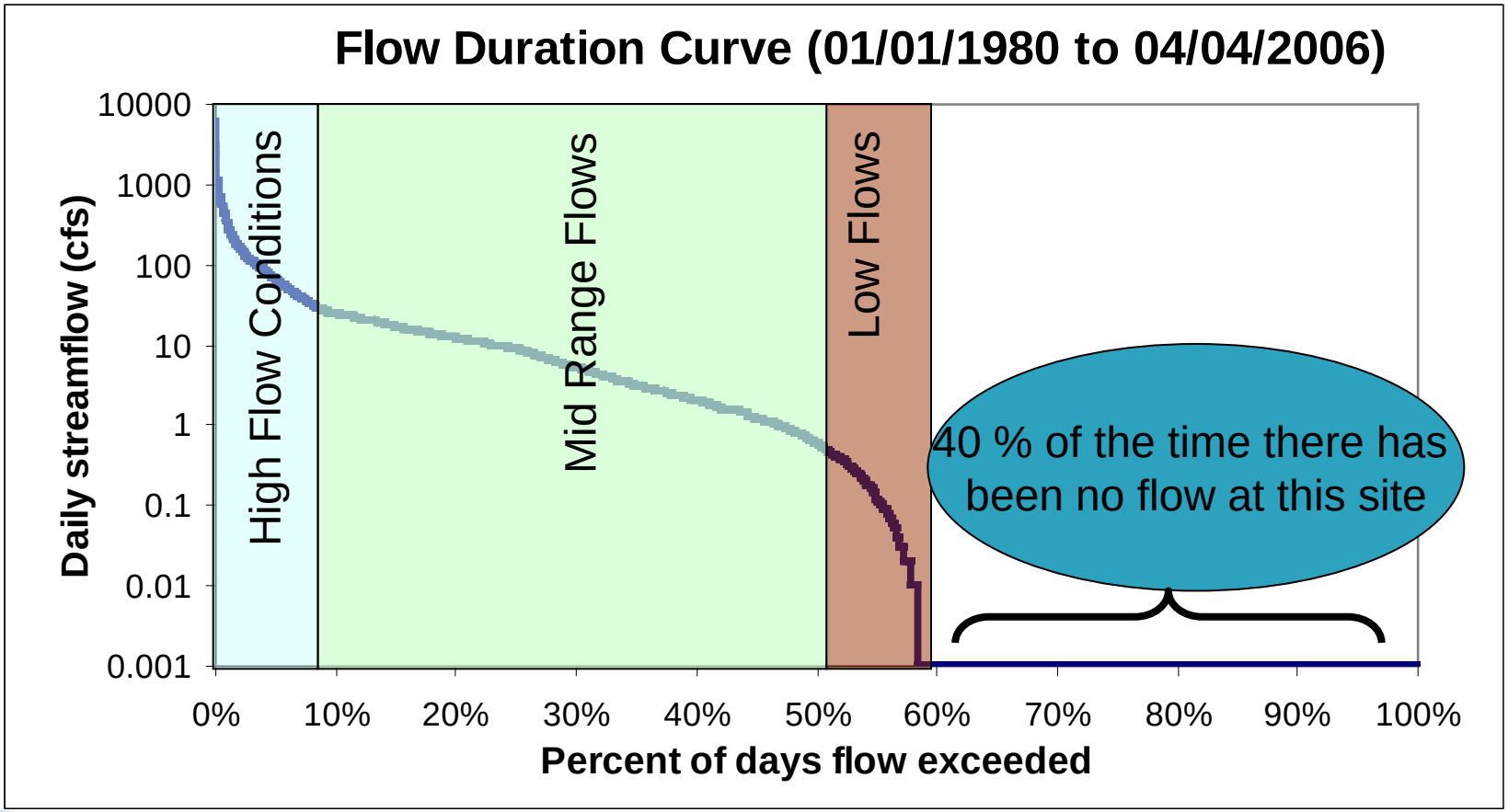
What is a Flow Duration Curve?

- Describes the percent of time a flow rate is met or exceeded
- Cumulative frequency of flow data over a period of time

Making a FDC

- Gather daily flow data
- Load data into a spreadsheet
- Sort the flows from largest to smallest
- Calculate percentage of days flow was exceeded

FDC—Plum Creek Watershed



Load Estimation

- How do you estimate how much pollution is in the stream?

Flow, Concentration, and Load

- Load is calculated using flow rate and concentration:

$$load = flow\ rate \times concentration \times conversion\ factor$$

- A conversion factor makes the units match (# bacteria, pounds of N, etc.)

Load Duration Curves

- What are they?
  How do you make one?

LDCs Defined

- A graph showing the percentage of time a pollutant load meets or exceeds a target level
- The percentage of time a water quality parameter exceeds the published standard
- Can include a “margin of safety”

Observed Data

- How do you calculate observed loads?

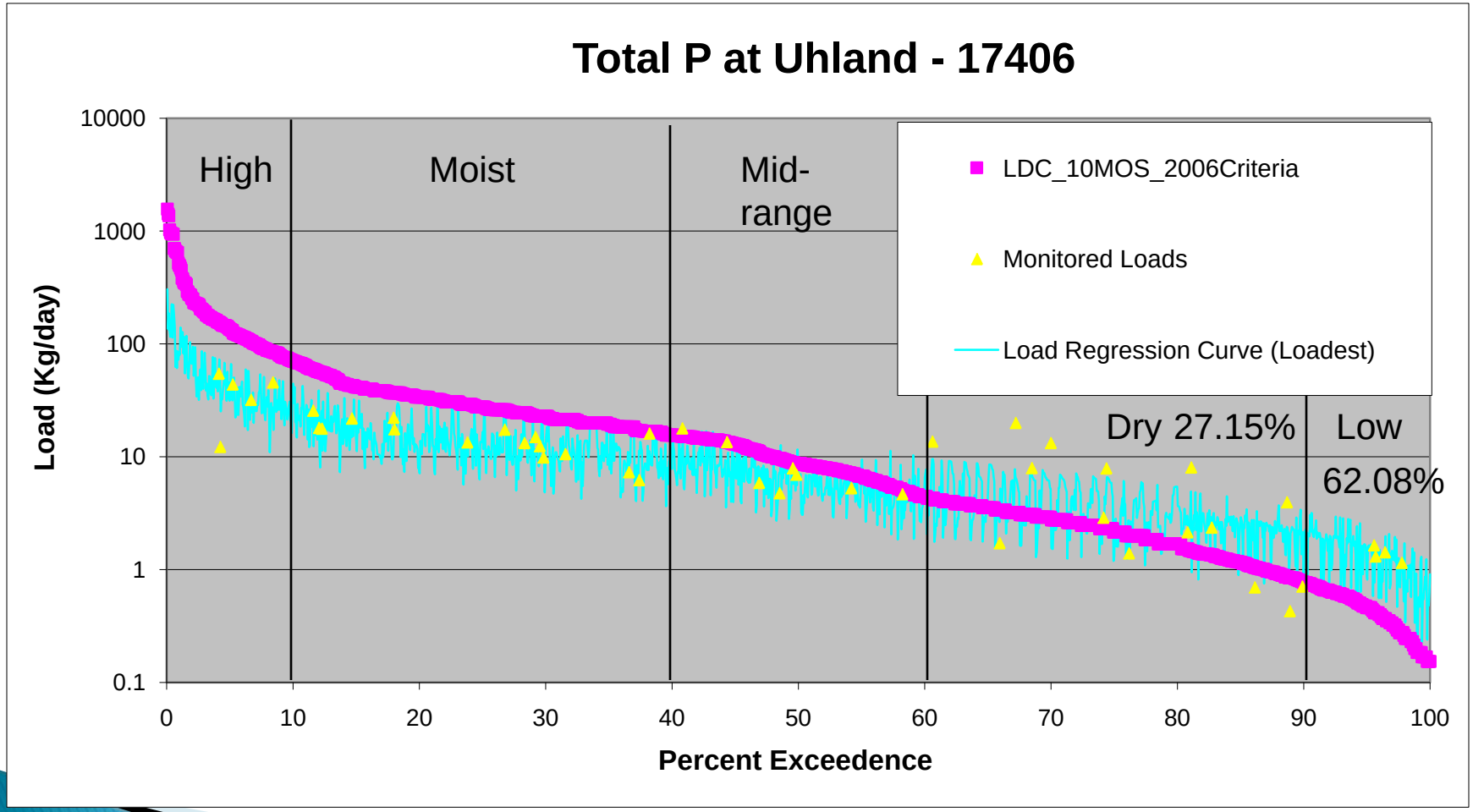
Daily Load Estimates

- Use daily flow rates and observed concentration to get daily load estimates

$$load = flow\ rate \times concentration \times conversion\ factor$$

- Repeat for all observed concentration data

LDC Plum Creek near Uhland



Interpretation

- Pollutant loads above the Load Duration Curve show the target level has been exceeded
- Clusters of data may help identify when problems occur— (e.g. high loads occur primarily during low flows or during high flow periods)

LDC Uses

- Easy-to-understand display of water quality
- Helps cull extreme condition data
  - Percentage of 0-10% may represent extreme floods that are almost impossible to control
  - Percentage of 90-100% may be associated with extreme drought
- May help identify nonpoint or point source issues

LDC Uses

- May help identify seasonal trends
- Allows comparison of different locations
- May help develop water quality goals
- Can help identify additional sampling needs

LDC Plum Creek near Uhland