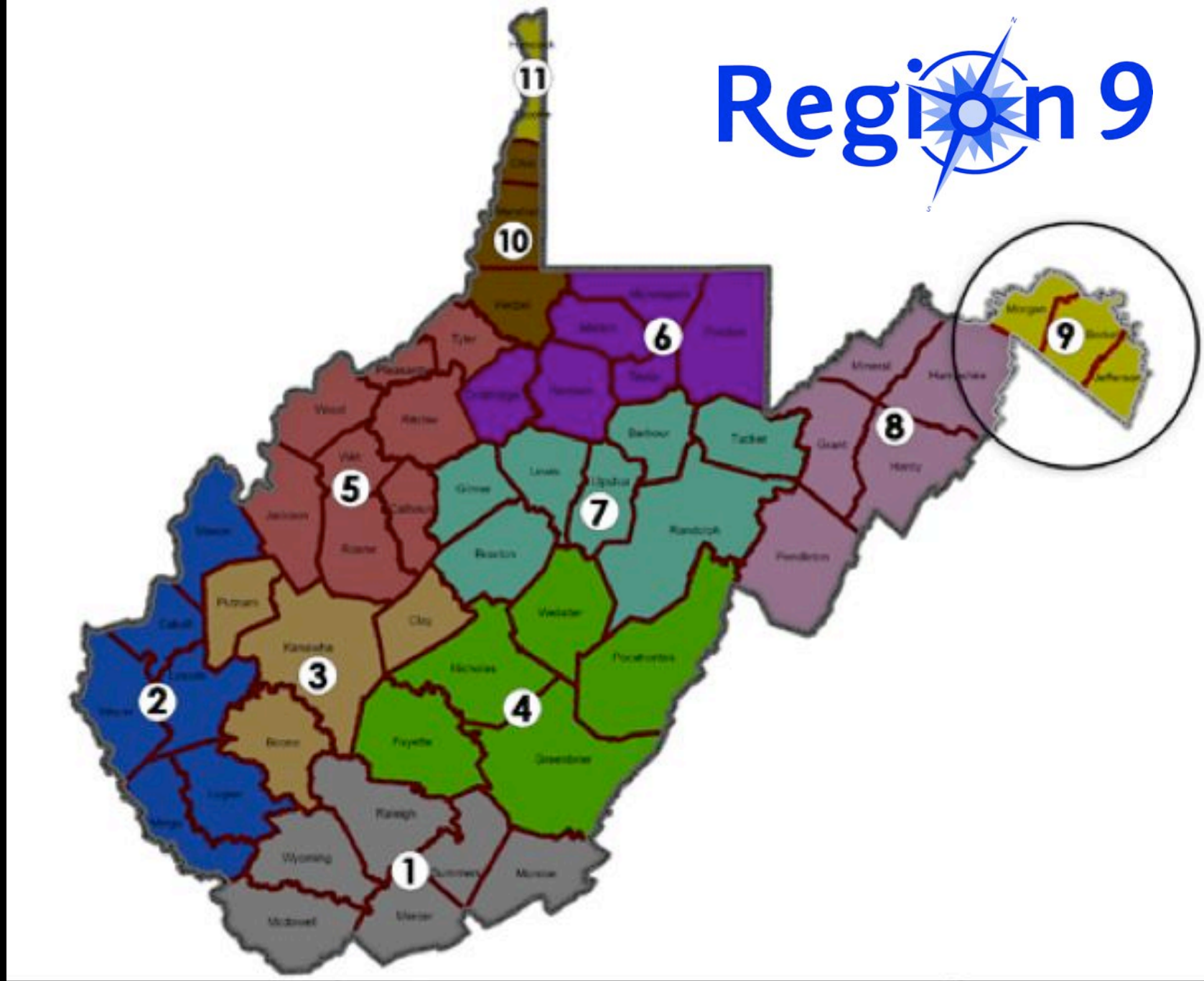
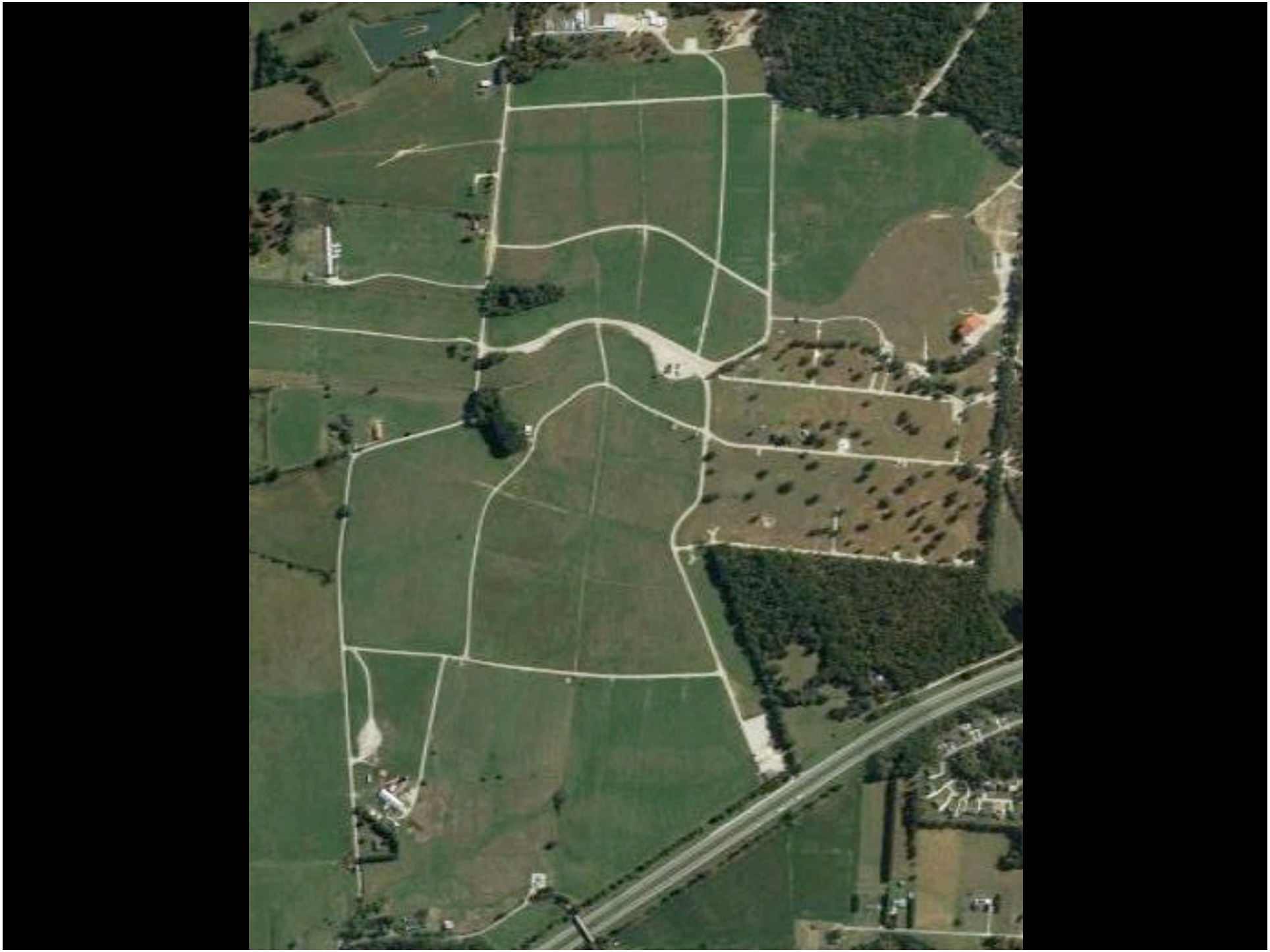
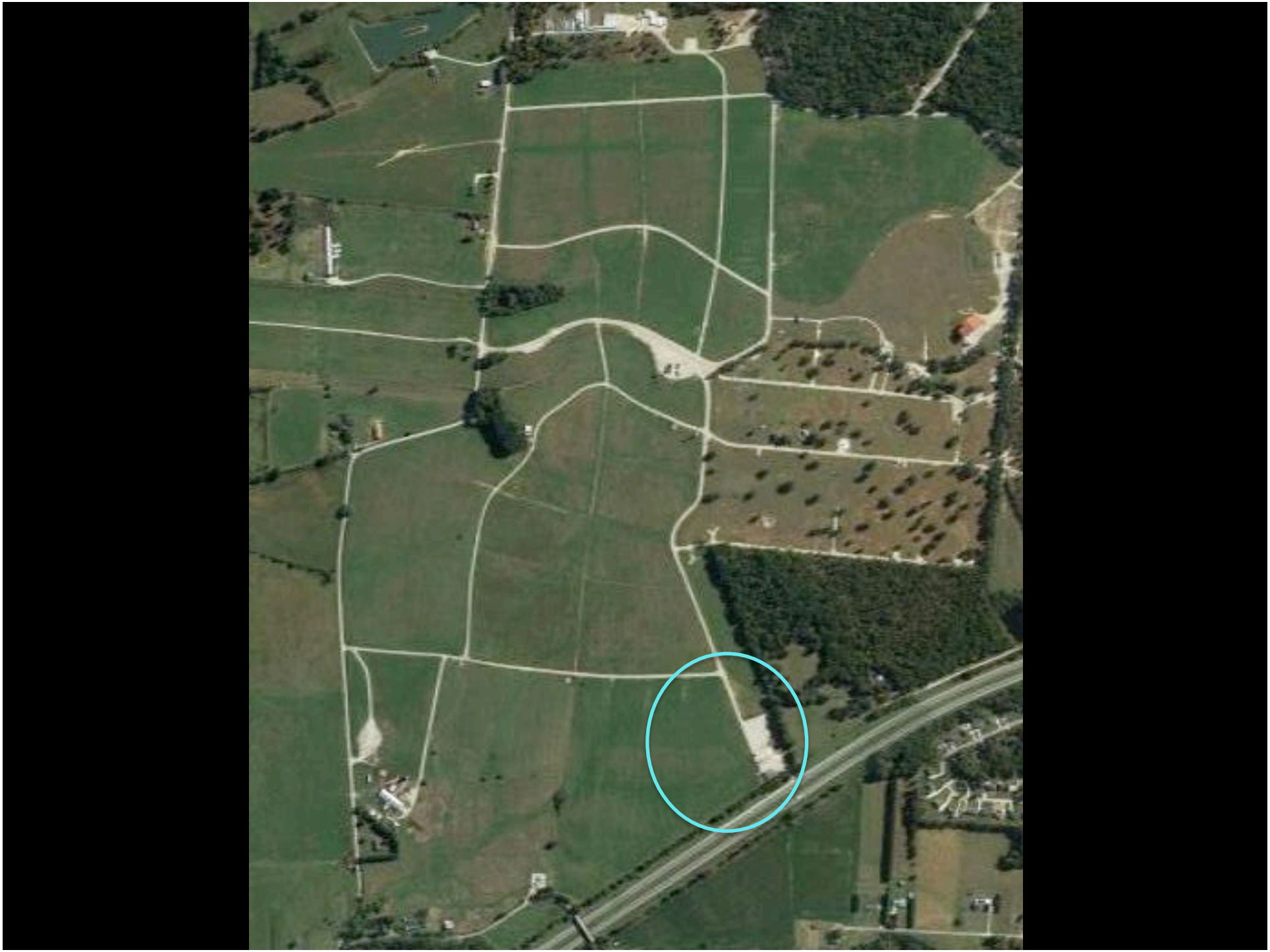
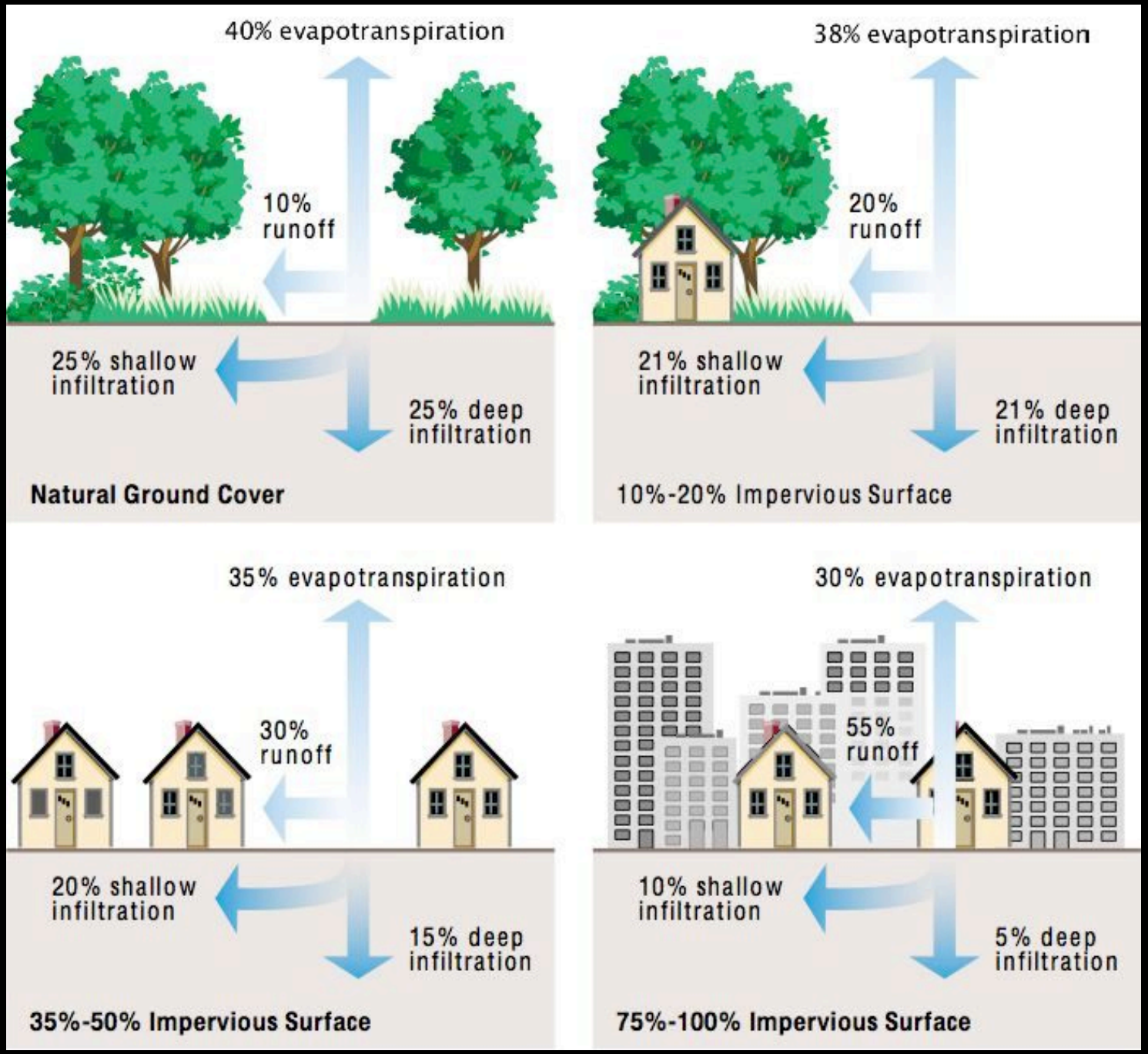
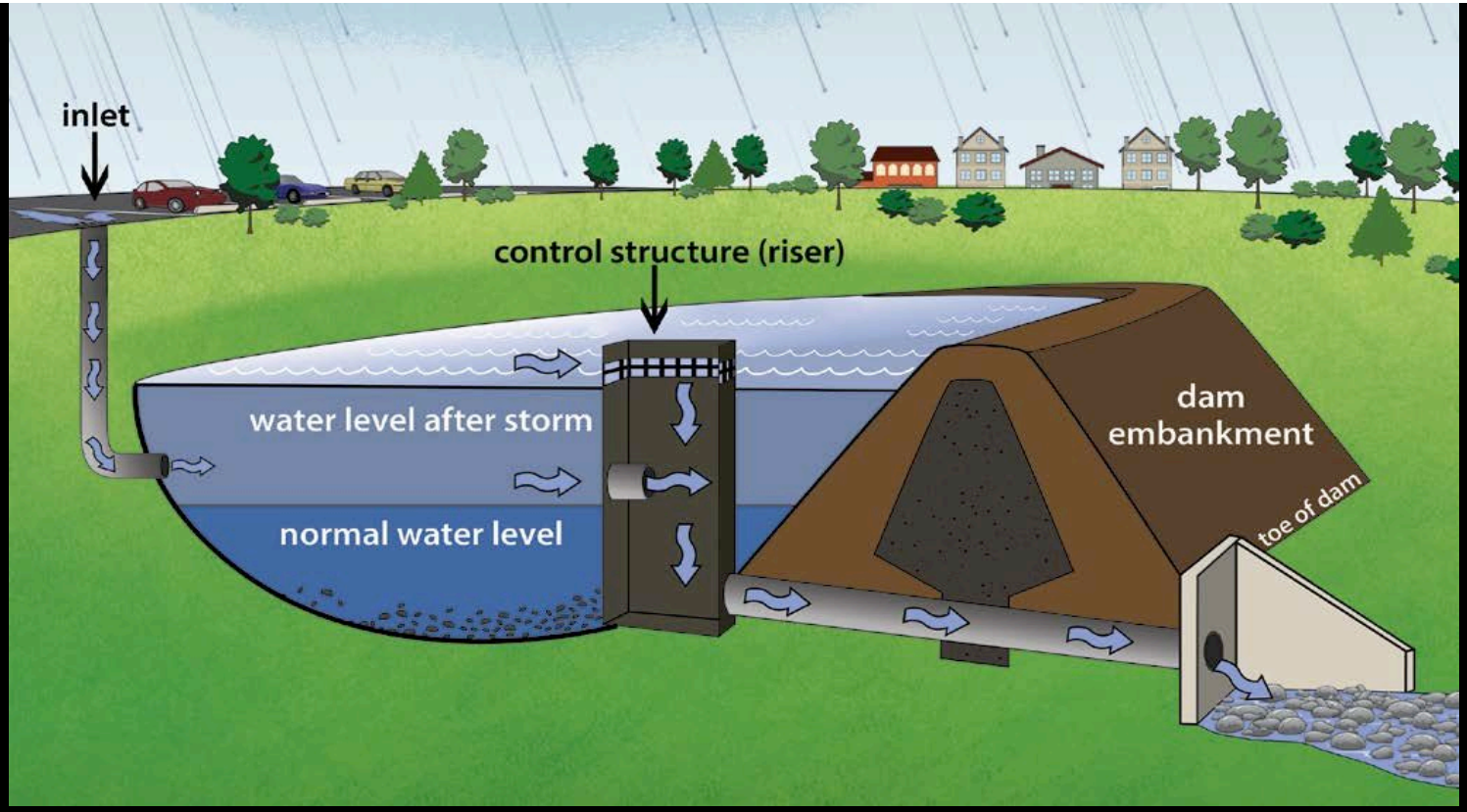

Region 9
11
10
9
6
8
5
7
3
2
4
1

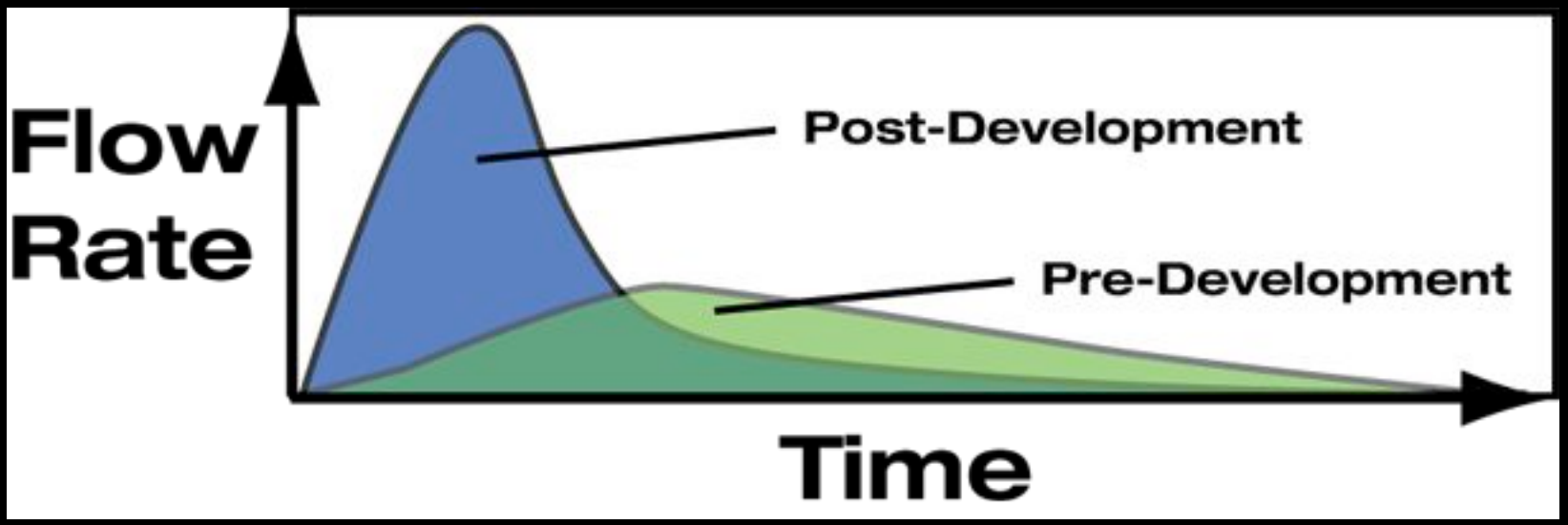
What Is Infrastructure?






40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
38% evapotranspiration
20% runoff
21% shallow infiltration
21% deep infiltration
10%-20% Impervious Surface
35% evapotranspiration
30% runoff
20% shallow infiltration
15% deep infiltration
35%-50% Impervious Surface
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Surface


inlet
control structure (riser)
water level after storm
normal water level
dam
embankment
toe of dam


Flow
Rate
Post-Development
Pre-Development
Time

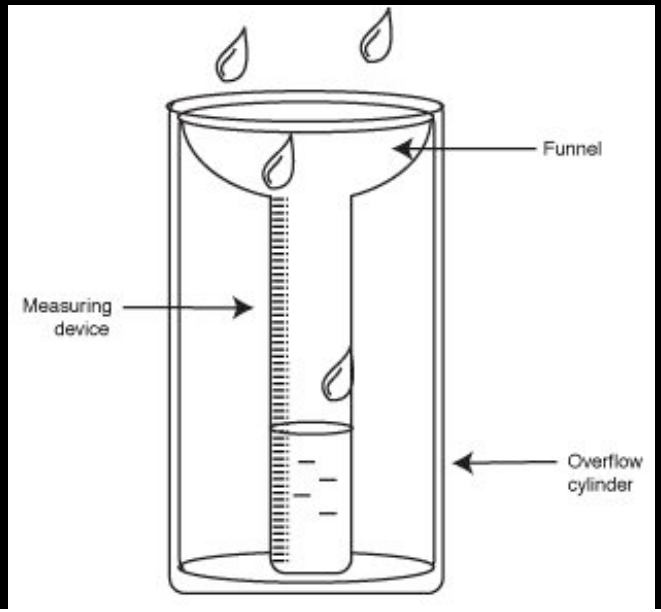
Annual Runoff Volume

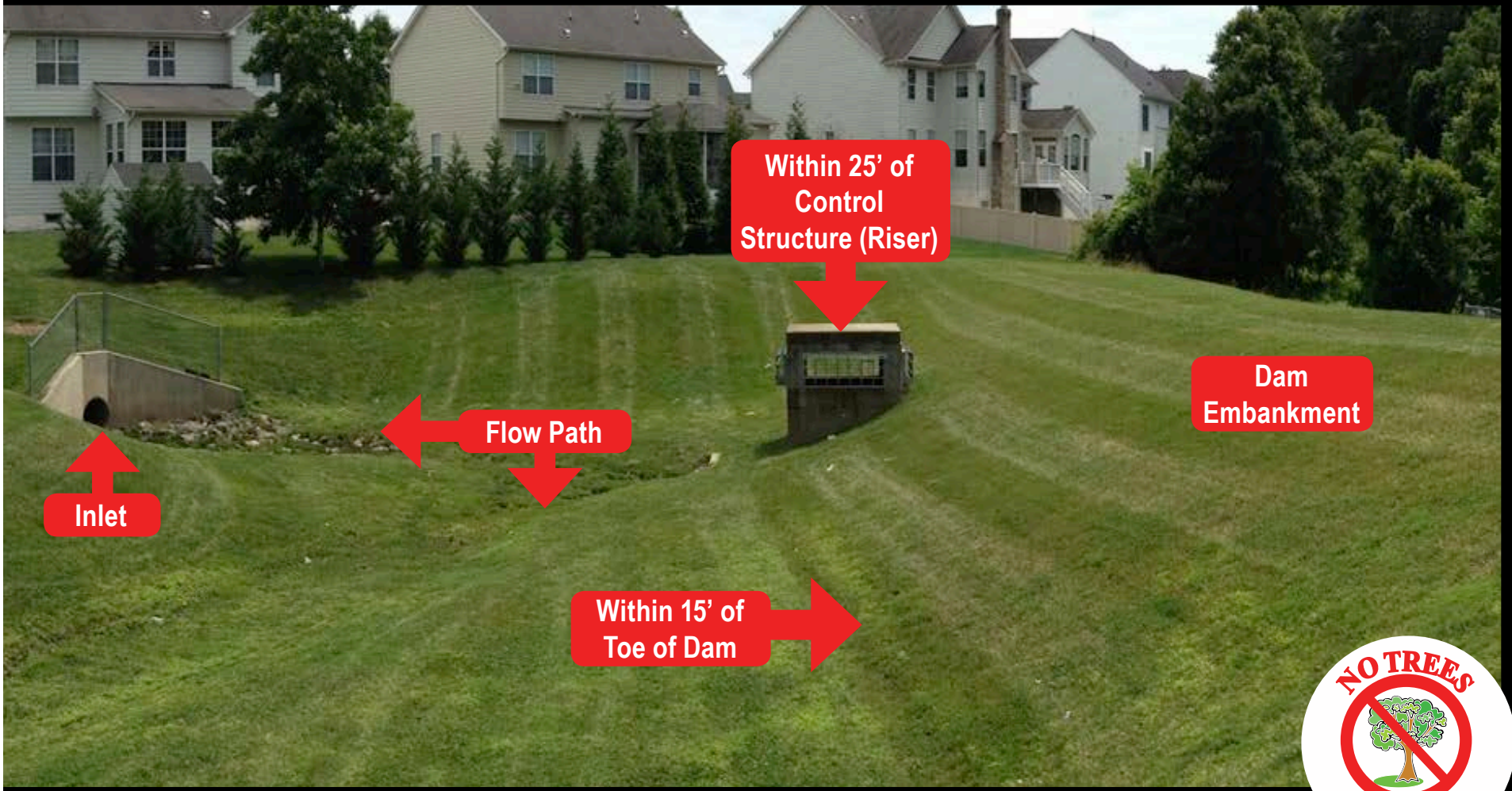
1 **Meteorology**

2 **Soils / Land Cover**

NOAA Based Data

NRCS / USDA Field Survey Based Data





Areas shown in red are off-limits for trees and shrubs.

NO TREES ON DAMS

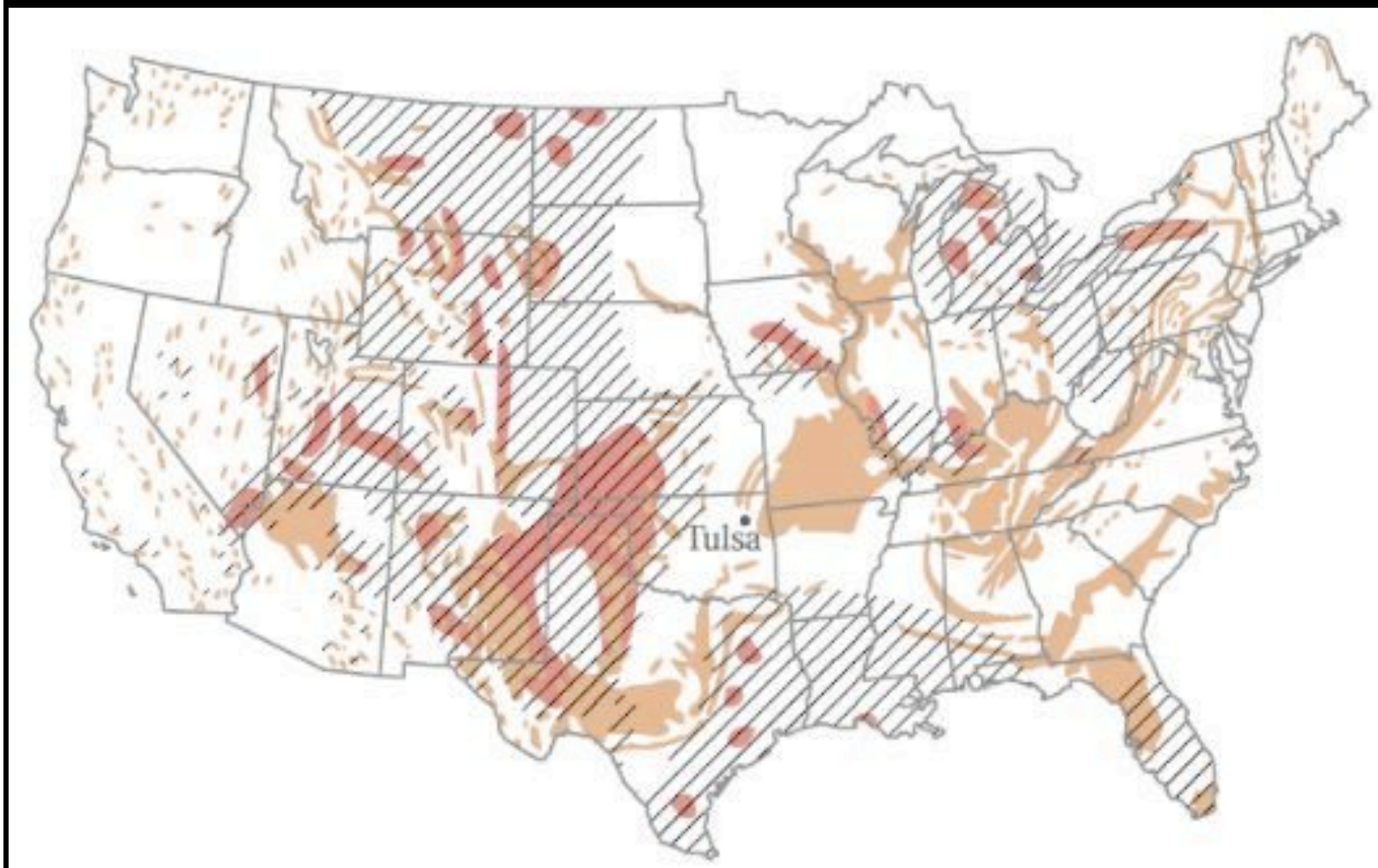

Shading
Trees planted south of pond can reduce discharged water temperatures

Naturalized Basins

Increased habitats and plants for pollinators

Naturalized Basins

Naturalized Basins

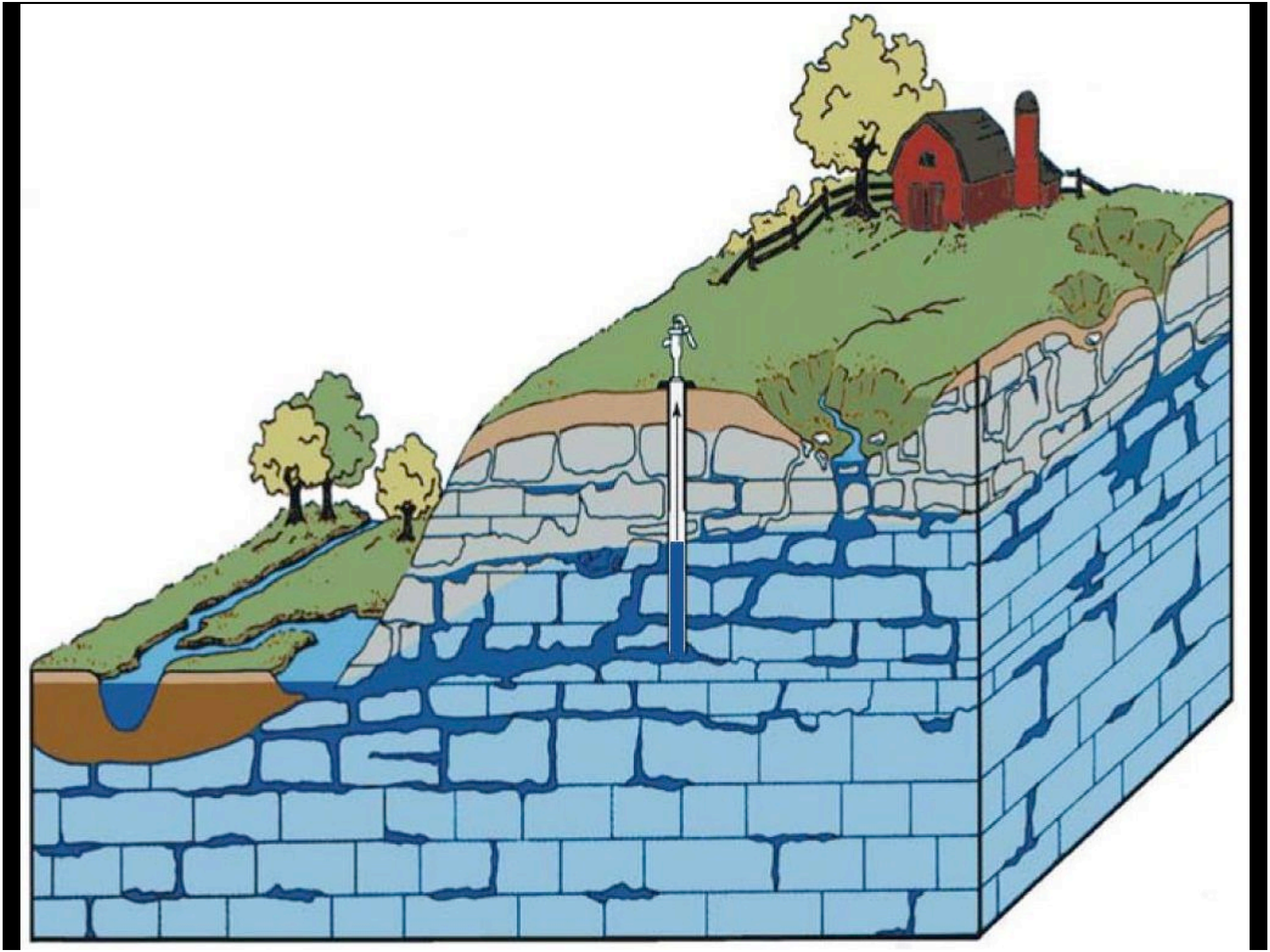


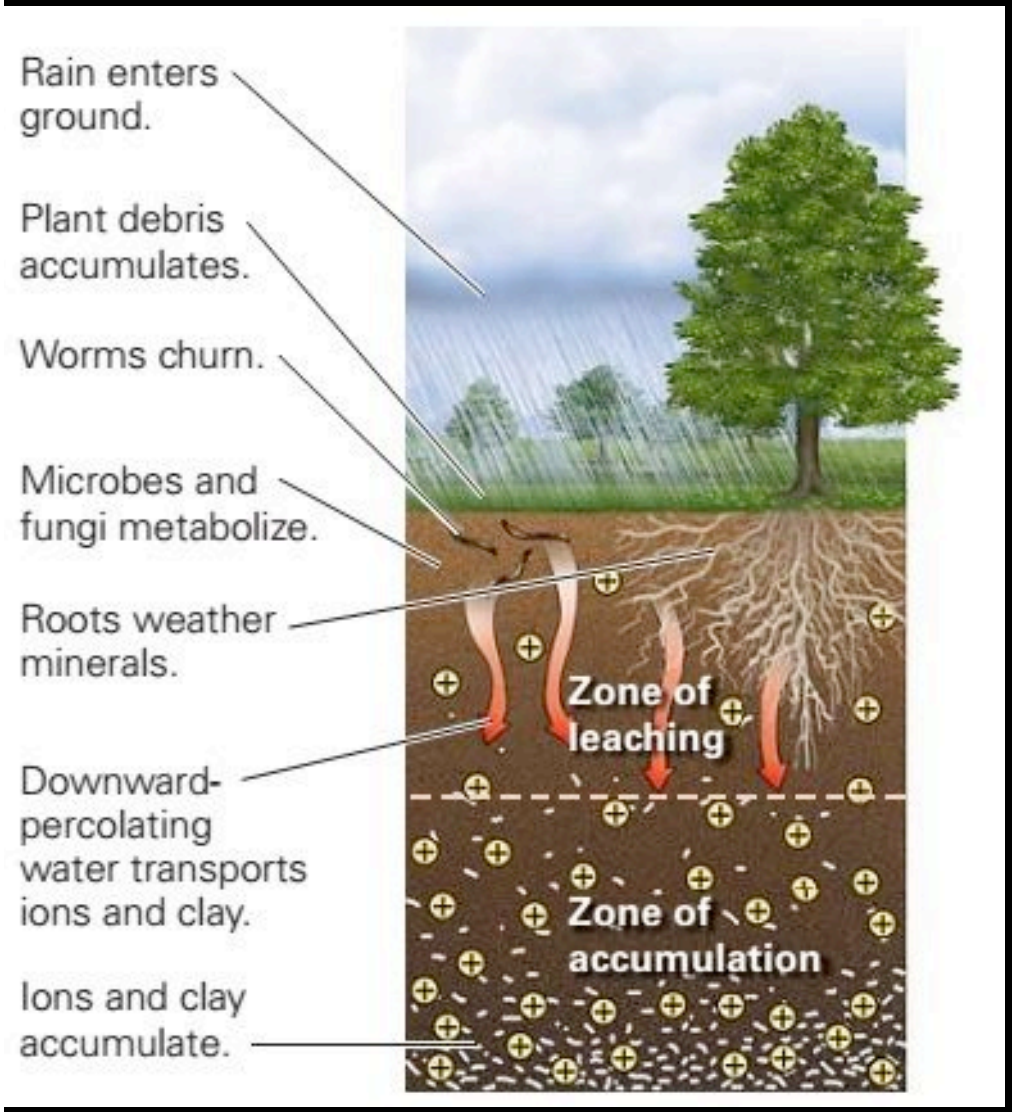
Evaporite rocks—salt and gypsum

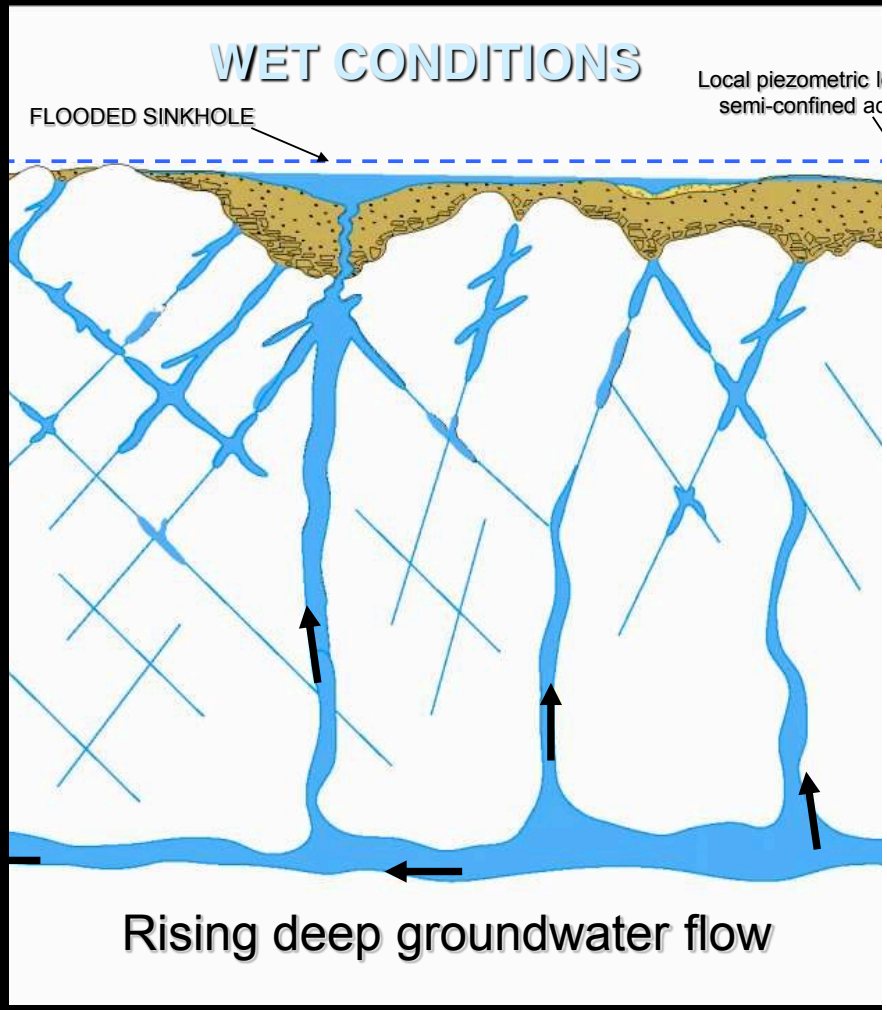
Karst from evaporite rock

Karst from carbonate rock

(modified from Davies and Legrand, 1972







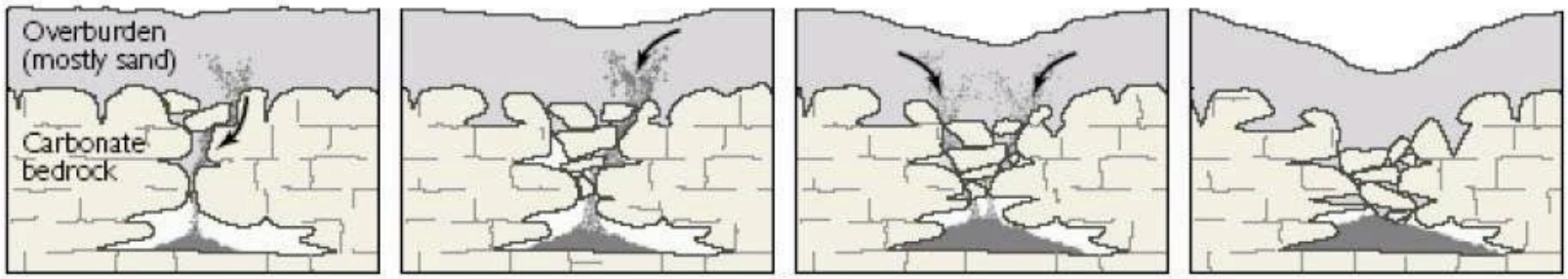
Rising deep groundwater flow

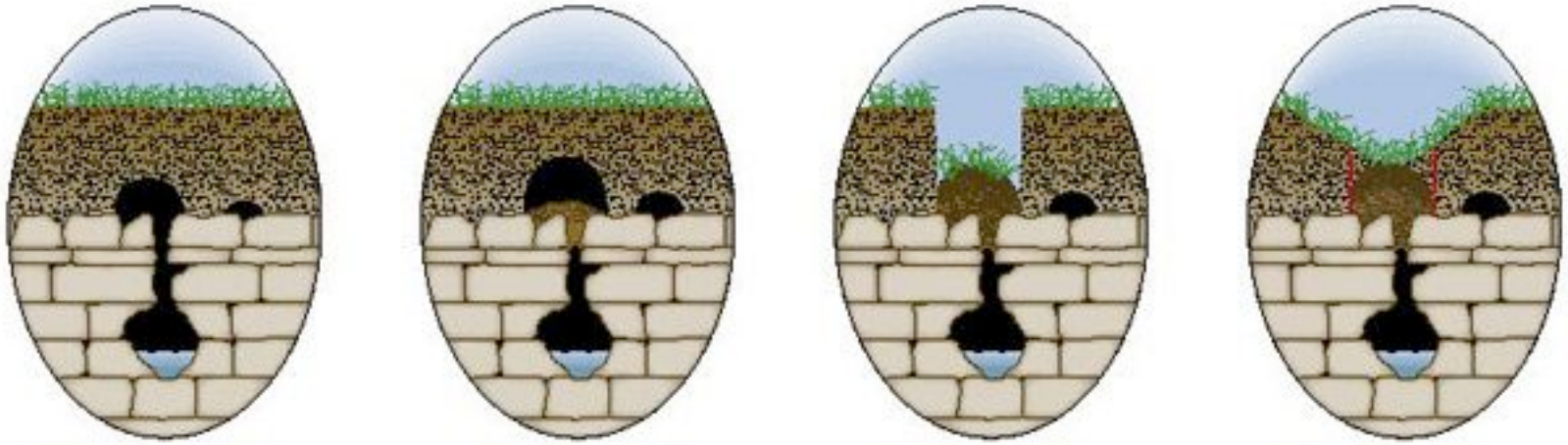
Granular sediments spall into secondary openings in the underlying carbonate rocks.

A column of overlying sediments settles into the vacated spaces (a process termed "piping").

Dissolution and infilling continue, forming a noticable depression in the land surface.

The slow downward erosion eventually forms small surface depressions 1 inch to several feet in depth and diameter.





Initially, a sinkhole forms as soil collapses into a crevice and is carried away through a conduit by water.

Then the soil roof of the developing sinkhole falls into the hole to form a cylindrical cavity.

Further collapse of the soil cover from below causes circular cracks to develop at the surface.

Erosion by water flowing into this new drain hole smooths the hole's sharp edges to form the typical inverted cone- or bowl-shaped depression.

Managing Flooding Risks

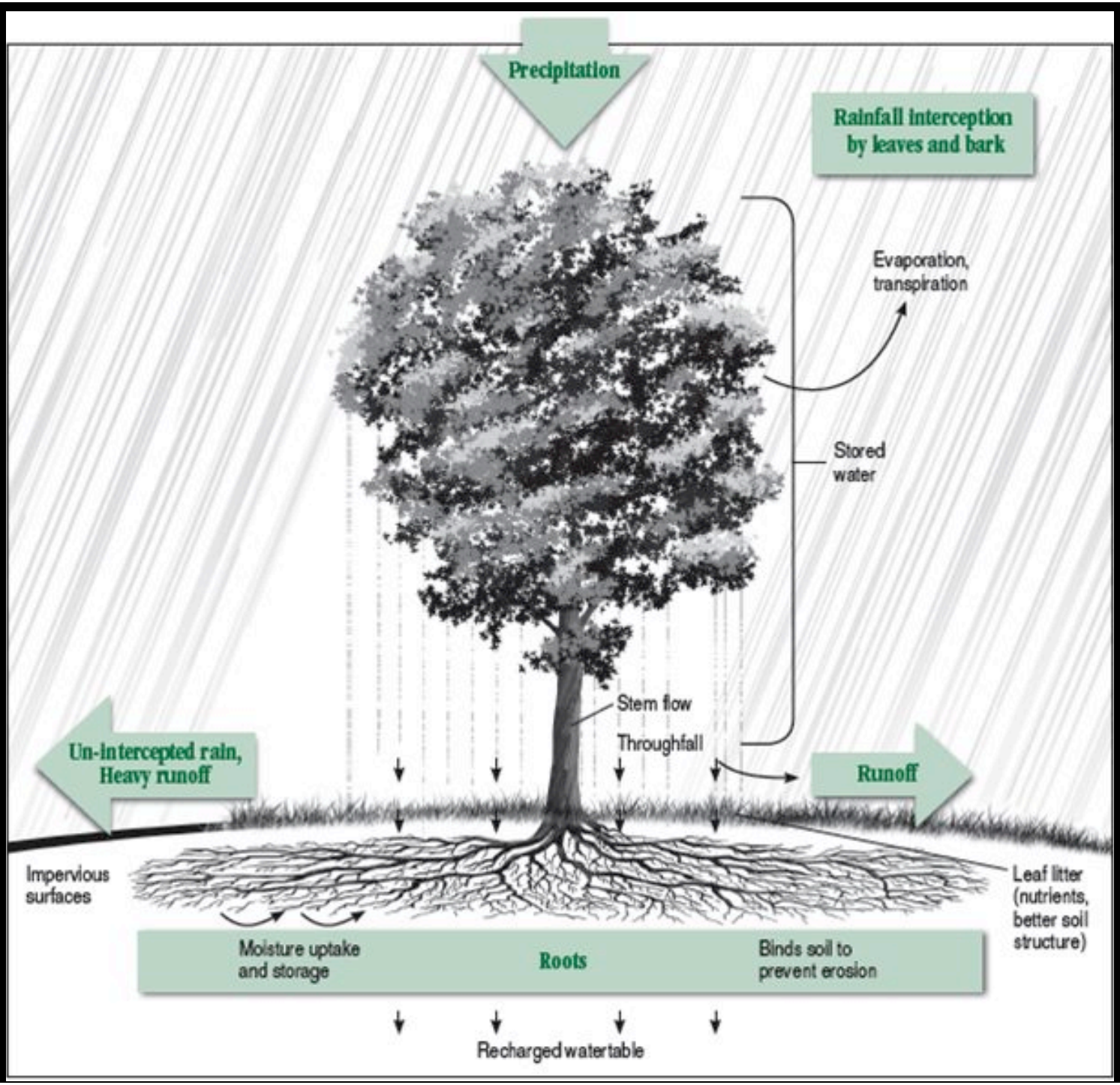

Precipitation
Rainfall interception by leaves and bark
Evaporation, transpiration
Stored water
Stem flow
Throughfall
Un-intercepted rain, Heavy runoff
Runoff
Impervious surfaces
Leaf litter (nutrients, better soil structure)
Moisture uptake and storage
Roots
Binds soil to prevent erosion
Recharged watertable

Table 1.1
Annual Rainfall Interception in Gallons from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
Rainfall Interception	292 gallons	1,129 gallons	2,162 gallons

Trapping
Rain
Eliminating
Excessive
Stormwater

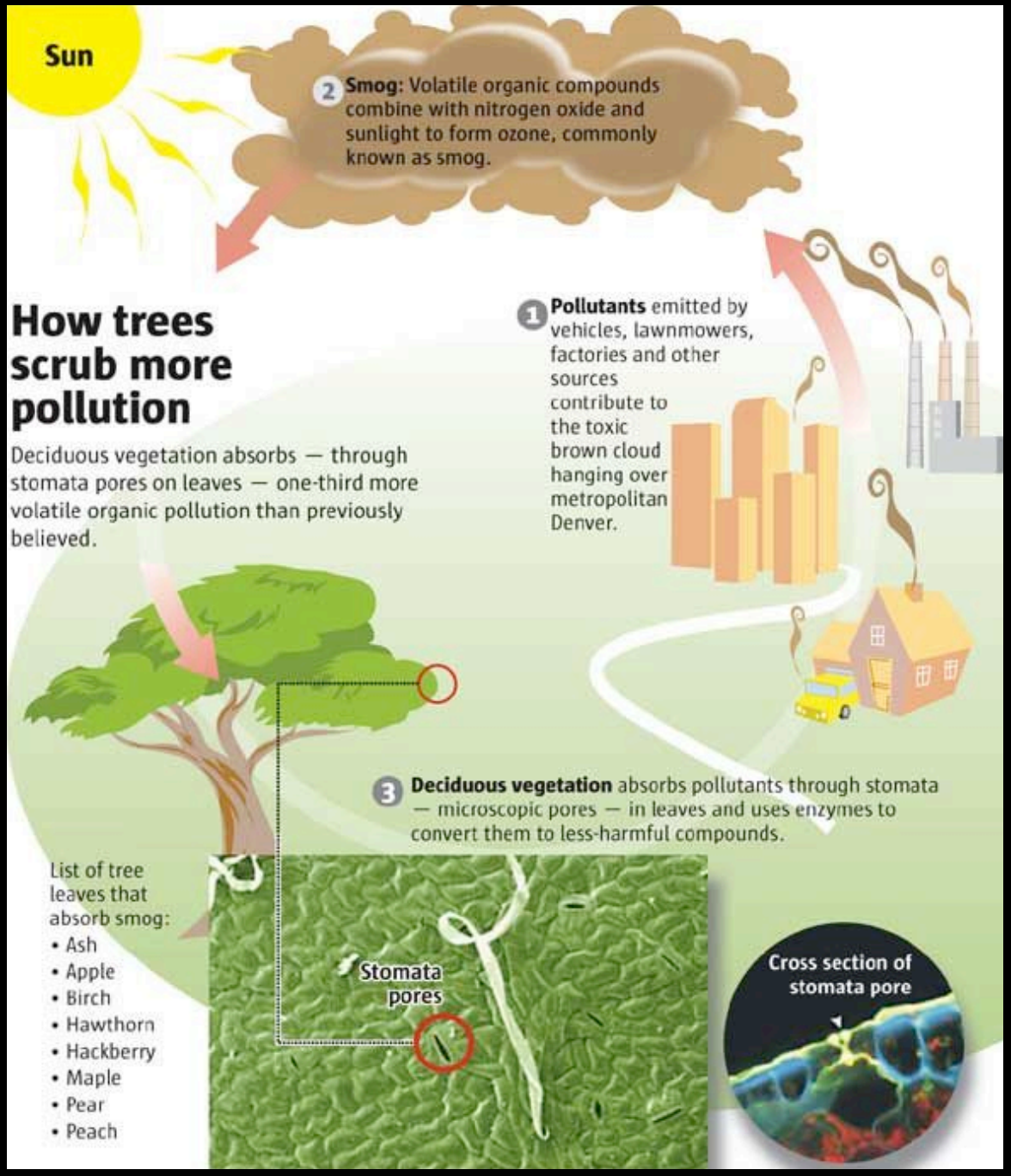

Clean
Water

Tangled
Root Systems
Ease
Erosion and
Sedimentation

Air Quality

Imagine If Trees Gave Off Wifi Signals, We Would Be Planting So Many Trees

Too Bad They Only Produce The Oxygen We Breathe.


Sun
2 Smog: Volatile organic compounds combine with nitrogen oxide and sunlight to form ozone, commonly known as smog.
How trees scrub more pollution
Deciduous vegetation absorbs — through stomata pores on leaves — one-third more volatile organic pollution than previously believed.
1 Pollutants emitted by vehicles, lawnmowers, factories and other sources contribute to the toxic brown cloud hanging over metropolitan Denver.
3 Deciduous vegetation absorbs pollutants through stomata — microscopic pores — in leaves and uses enzymes to convert them to less-harmful compounds.
List of tree leaves that absorb smog:
• Ash
• Apple
• Birch
• Hawthorn
• Hackberry
• Maple
• Pear
• Peach
Stomata pores
Cross section of stomata pore

	Small tree: Crabapple	Medium tree: Red Oak	Large Tree: Hackberry
NO2 Uptake and Avoided	0.39 lbs	0.63 lbs	1.11 lbs
SO2 Uptake and Avoided	0.23 lbs	0.42 lbs	0.69 lbs
O3 Uptake	0.15 lbs	0.2 lbs	0.28 lbs
PM-10 Uptake and Avoided	0.17 lbs	0.26 lbs	0.35 lbs

- **NO2 = $3.34/lb**
- **O3 = $3.34/lb**
- **SO2 = $2.06/lb**
- **PM-10 = $2.84/lb**

Tolerate and
Retain
Emissions,
Exhaust, and
Small Particulates

Reducing Utility Costs

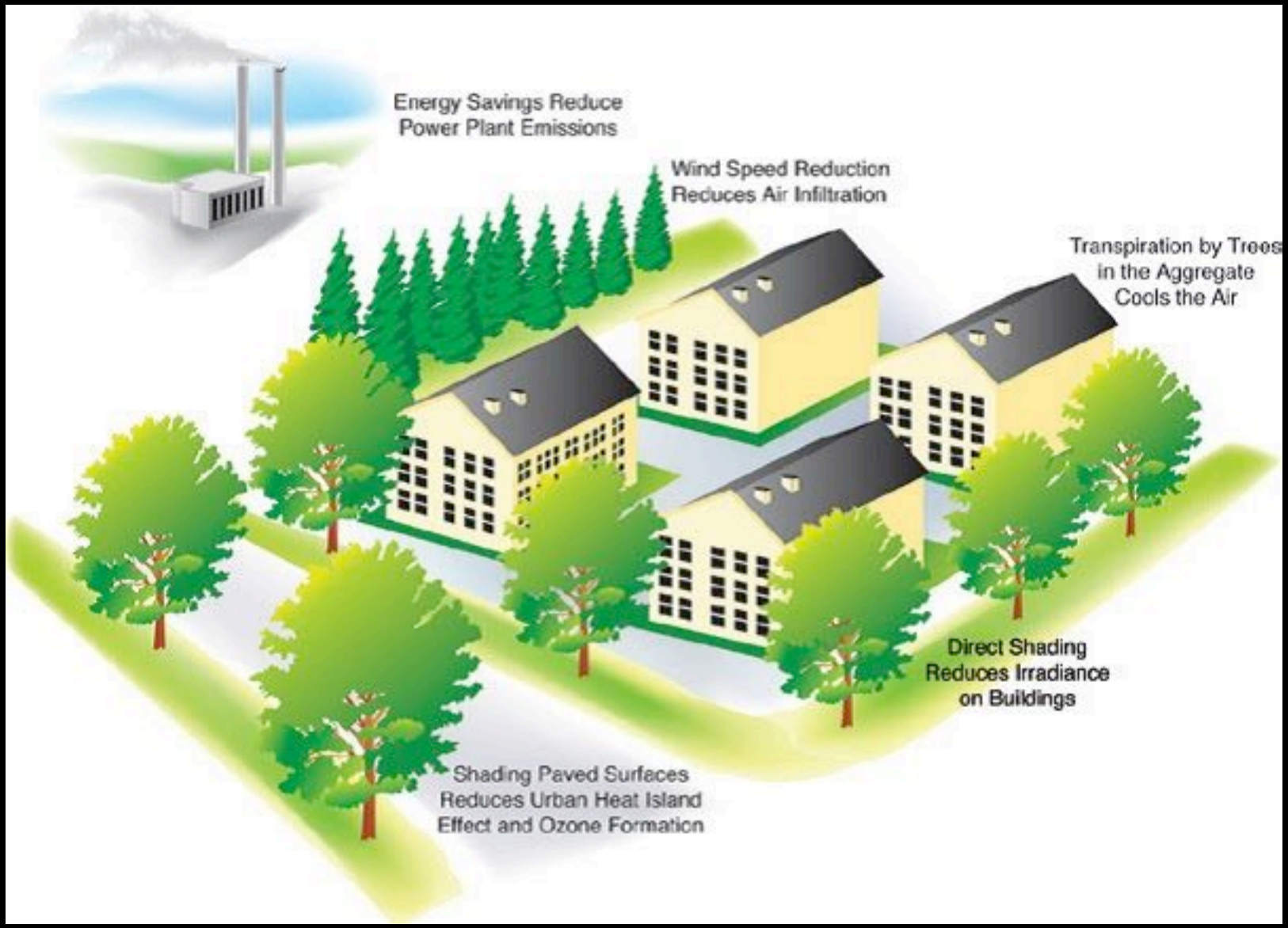

Energy Savings Reduce
Power Plant Emissions
Wind Speed Reduction
Reduces Air Infiltration
Transpiration by Trees
in the Aggregate
Cools the Air
Direct Shading
Reduces Irradiance
on Buildings
Shading Paved Surfaces
Reduces Urban Heat Island
Effect and Ozone Formation

Table 2.1: 40-year Average Electricity Savings from Trees in the Midwest Region

	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	96 kWh	54 kWh	68 kWh	48 kWh
Medium tree: Red Oak (40 ft tall, 27 ft spread)	191 kWh	99 kWh	131 kWh	67 kWh
Large tree: Hackberry (47 ft tall, 37 ft spread)	268 kWh	189 kWh	206 kWh	136 kWh

Source: McPherson, E. et al. 2006

Current Rate = $0.09 / KwH

Range = $4 - $25 /Tree

Temperature

Regulating

Energy

Efficiency

Systems

Reducing Sewage Treatment Costs

Terminate

Raw

Effluent

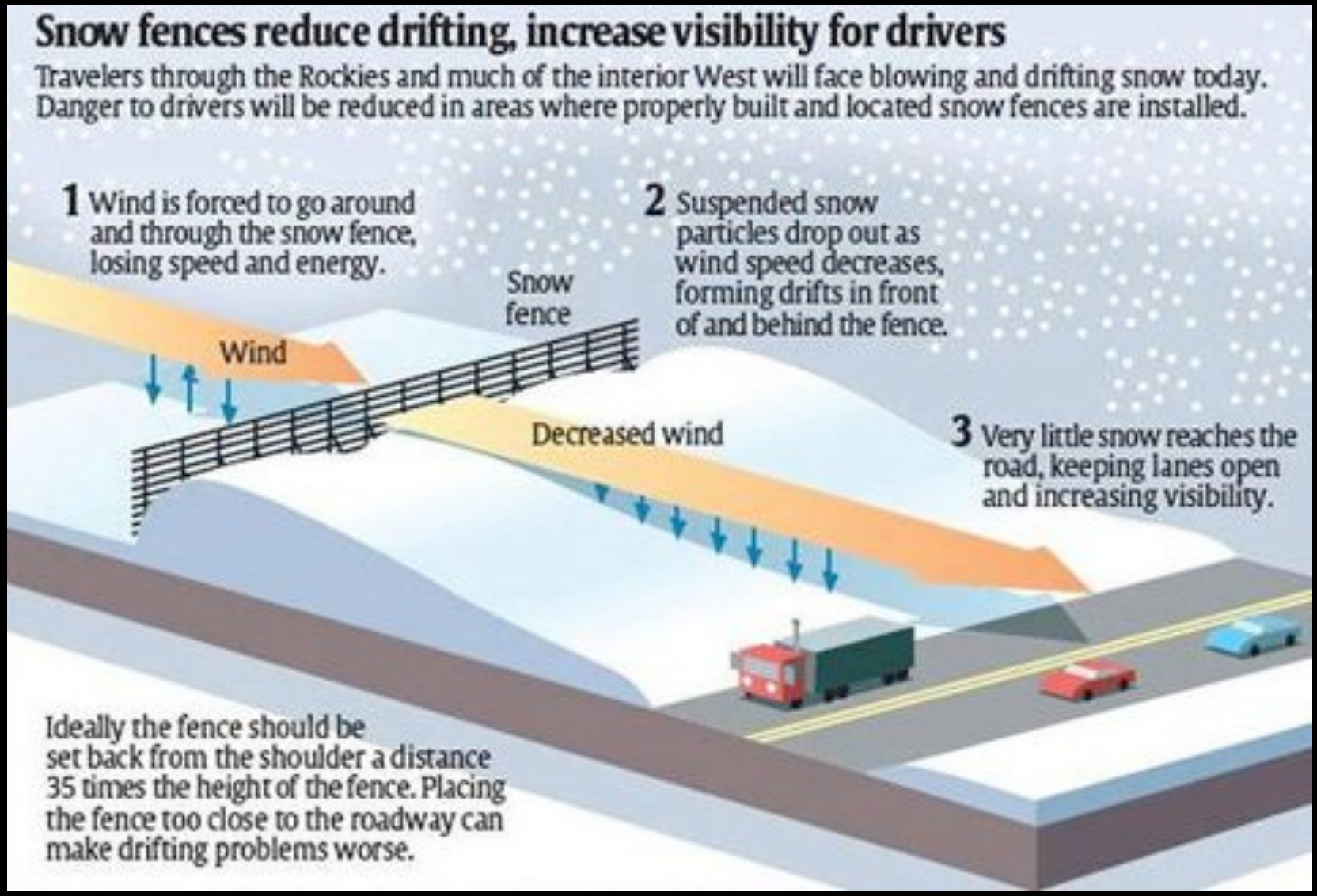
Entering

Streams

Winter

Snow fences reduce drifting, increase visibility for drivers

Travelers through the Rockies and much of the interior West will face blowing and drifting snow today. Danger to drivers will be reduced in areas where properly built and located snow fences are installed.




Living Snow Fences
New York State Department of Transportation


McHenry County
Division of Transportation
Living
Snow Fence
Tom Lewandowski
Eagle Scout Project October 2011

Terminate

Re-plow

Events

Enhancing

Snow Safety

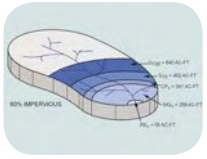
Urban Subwatershed Restoration Manual Series

3

Urban Stormwater Retrofit Practices

Version 1.0

August 2007



CENTER FOR WATERSHED PROTECTION

Manual 3