Hot Science Cool Talks

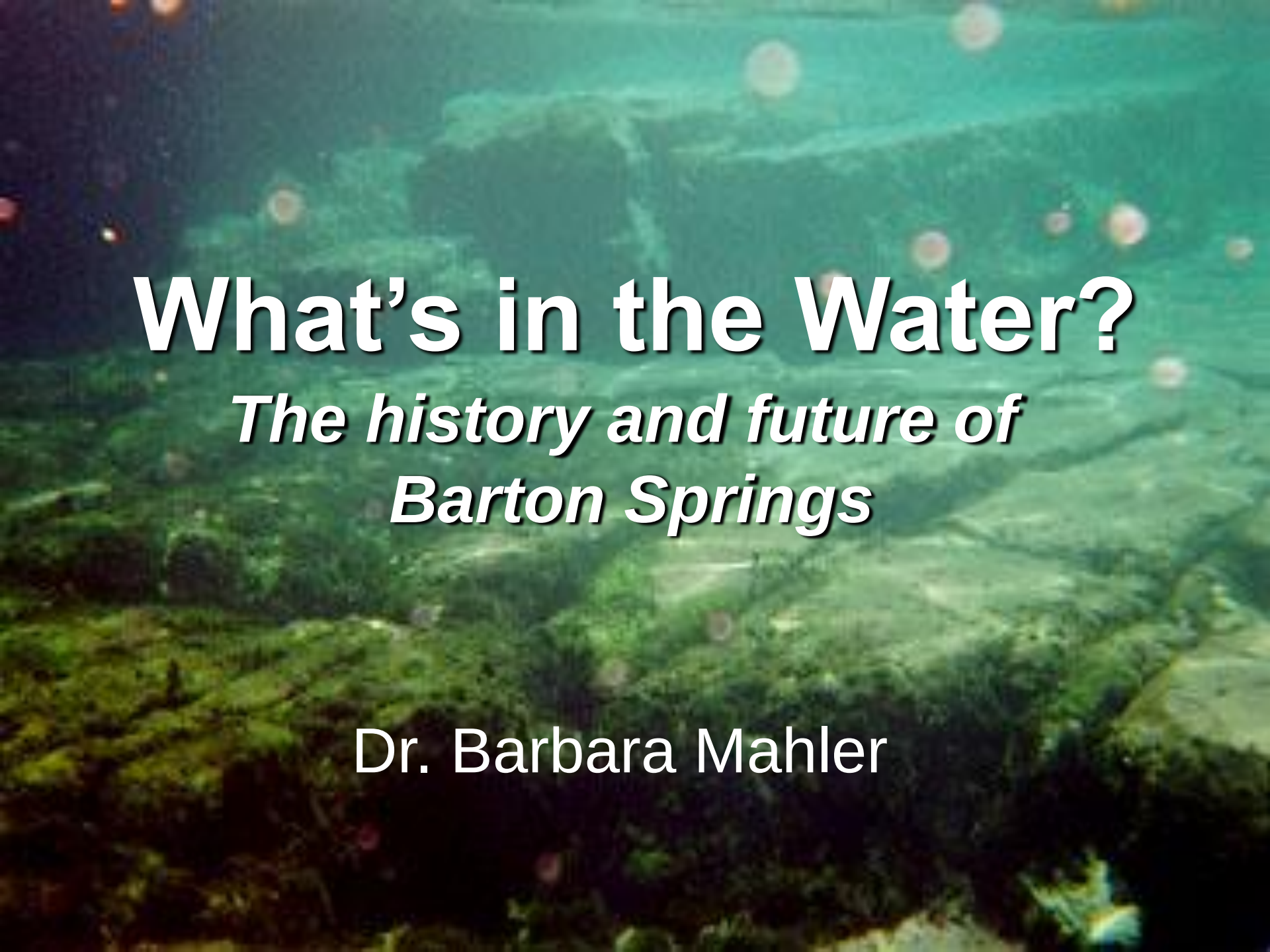
UT Environmental Science Institute

31

What's in the Water? The History and Future of Barton Springs

Dr. Barbara Mahler

September 10, 2004



What's in the Water?

The history and future of Barton Springs

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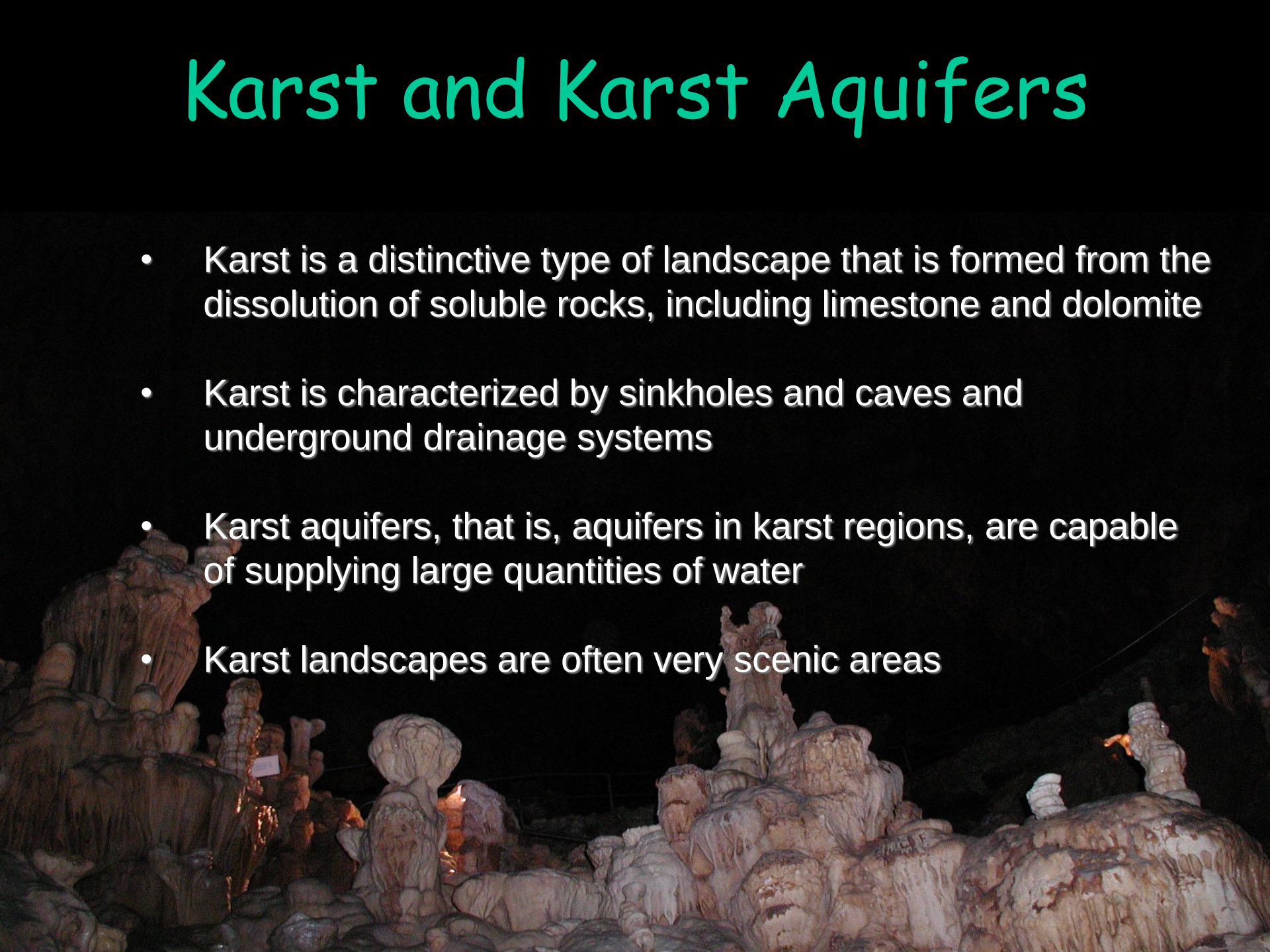
NO DIVING

Karst and Karst Aquifers

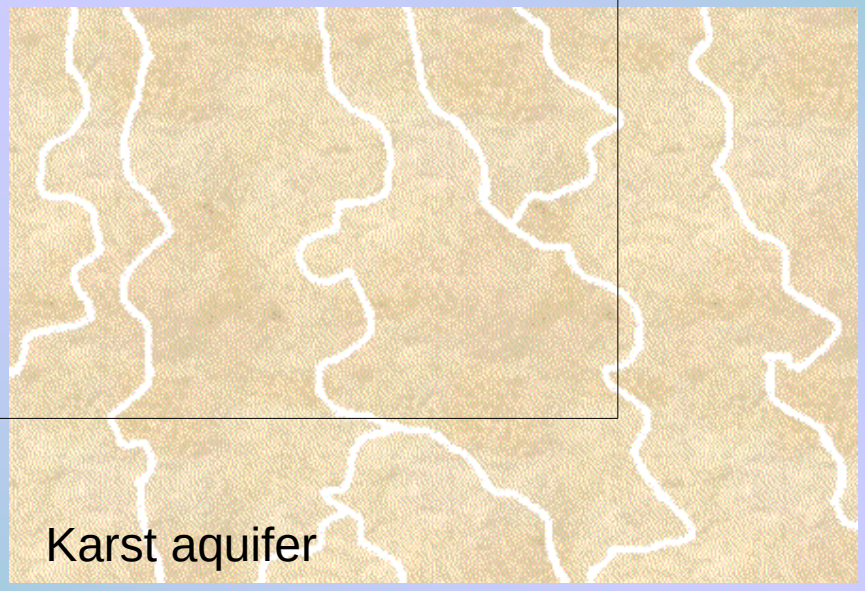
- Karst is a distinctive type of landscape that is formed from the dissolution of soluble rocks, including limestone and dolomite
- Karst is characterized by sinkholes and caves and underground drainage systems
- Karst aquifers, that is, aquifers in karst regions, are capable of supplying large quantities of water
- Karst landscapes are often very scenic areas



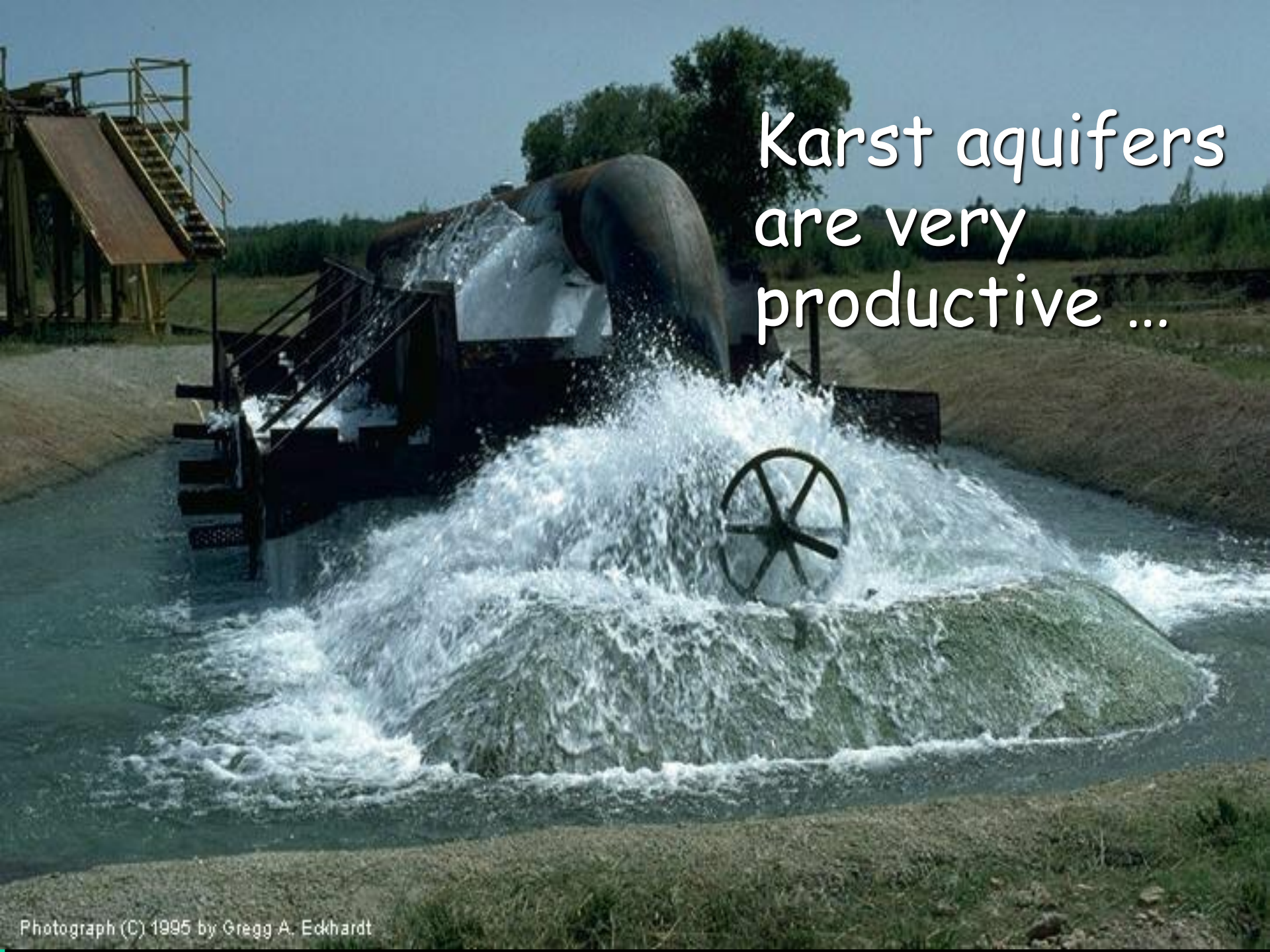
Karst aquifers are different from other aquifers (such as sandstone) in that:

- Water doesn't flow similarly in all parts of the aquifer (Inhomogeneous)
- Water flows preferentially in one direction rather than another (Anisotropic)

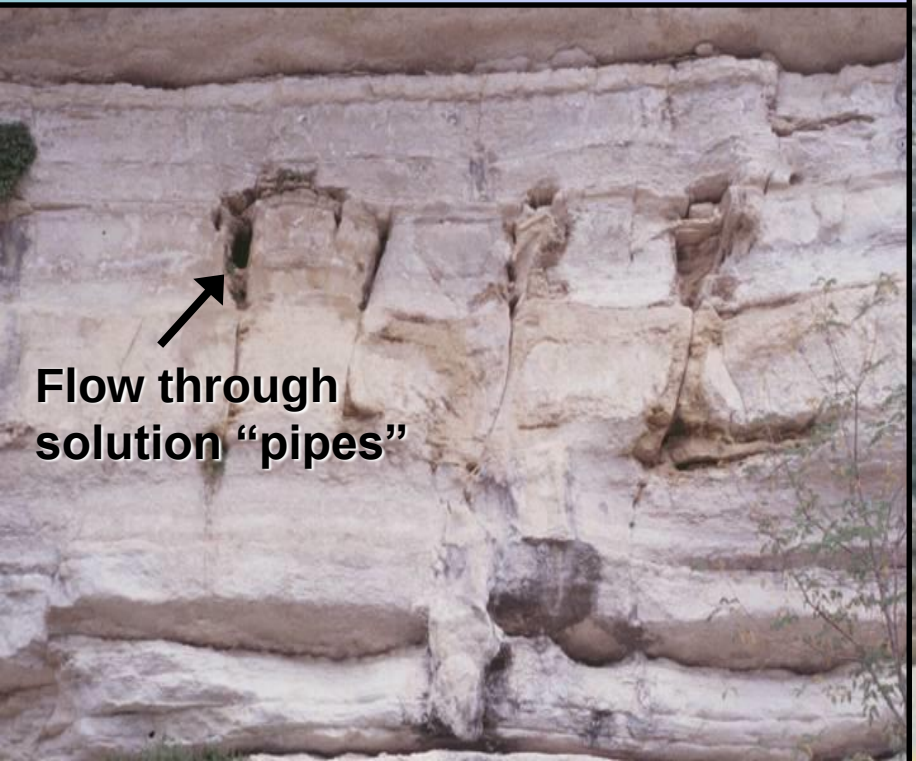
Water velocities are a few inches per day

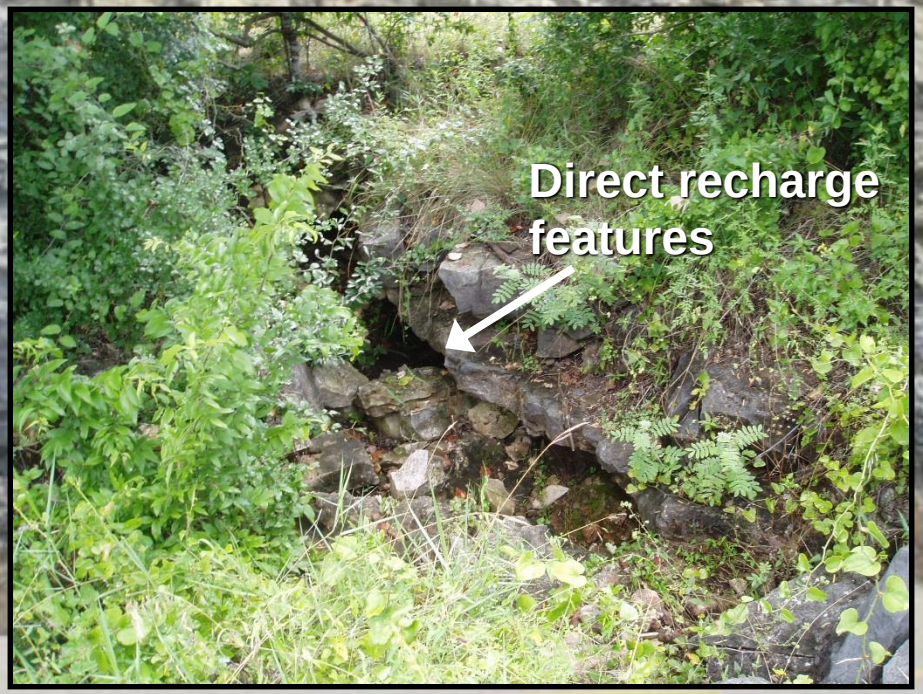


Water velocities can be miles per day


Karst aquifers are very productive …
Photograph (C) 1995 by Gregg A. Eckhardt

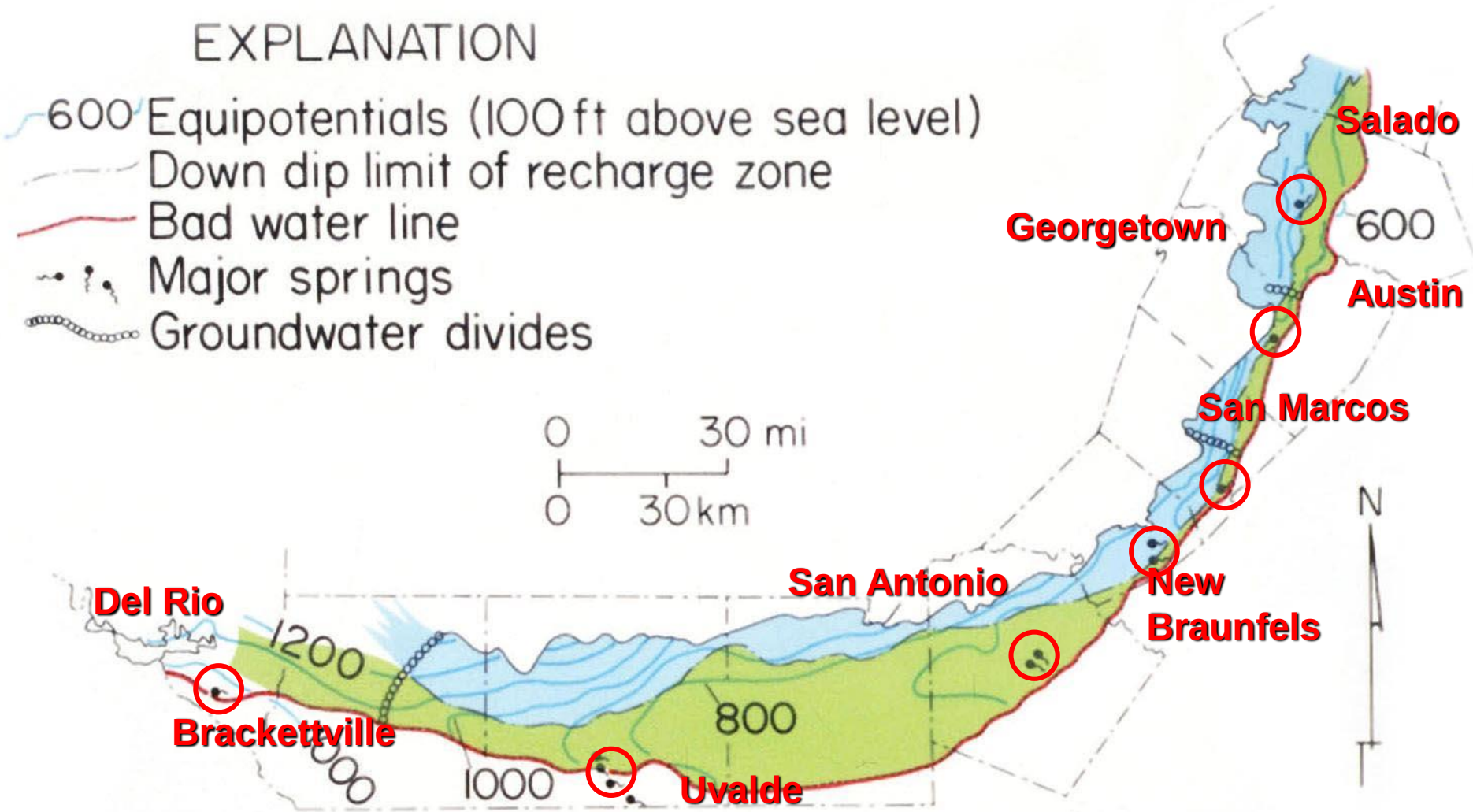
… but very vulnerable to contamination

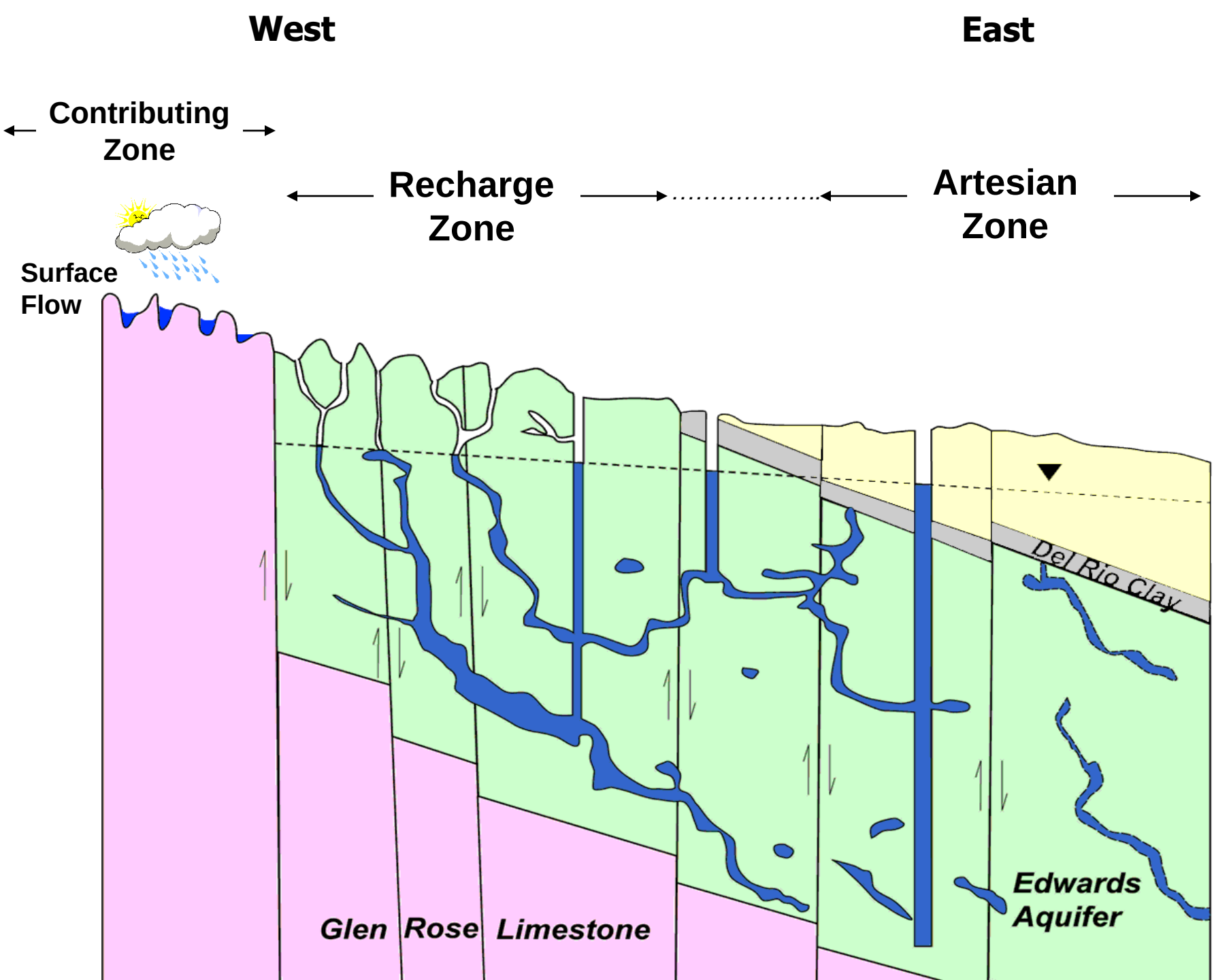


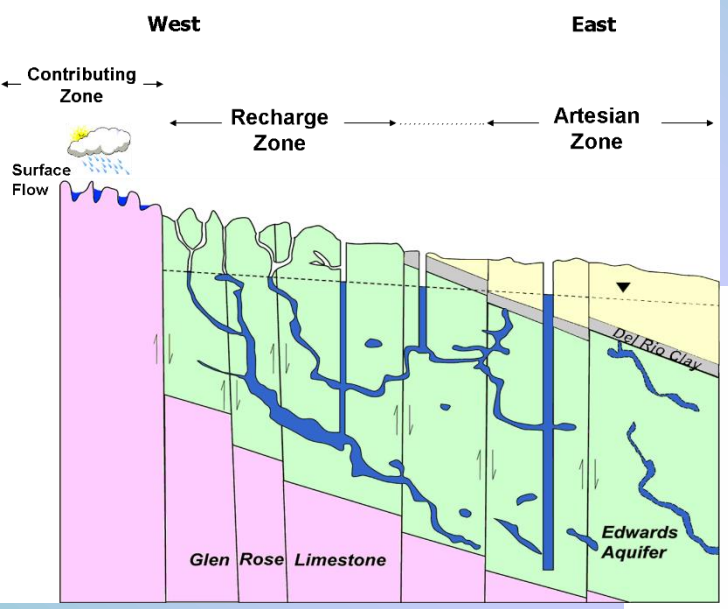


Urbanization: How has Austin grown since 1839

We live here because of karst …




West
East
Contributing Zone
Recharge Zone
Artesian Zone
Surface Flow
Del Rio Clay
Glen Rose Limestone
Edwards Aquifer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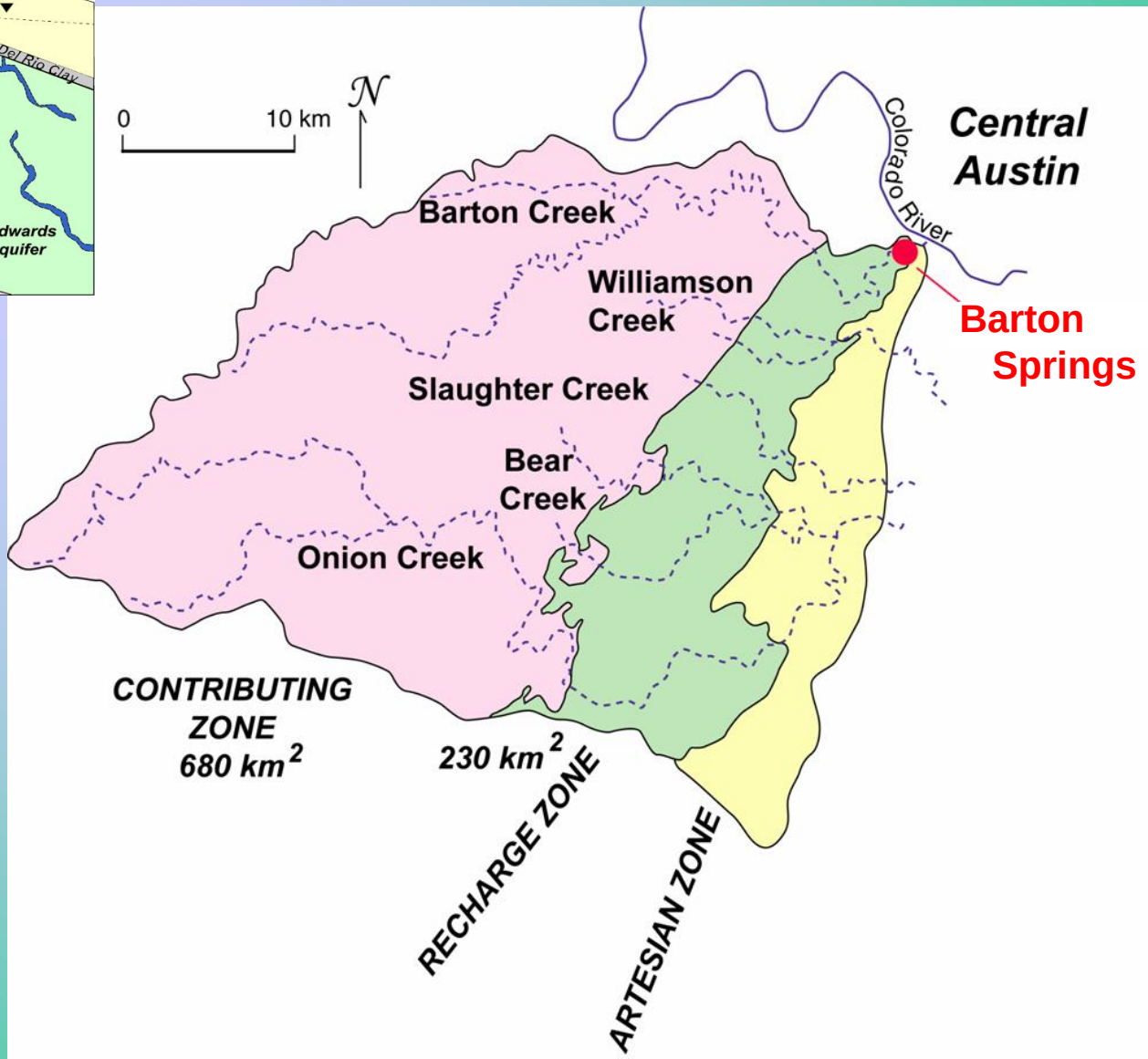

0
10 km
N
Central Austin
Colorado River
Barton Creek
Williamson Creek
Slaughter Creek
Bear Creek
Onion Creek
Barton Springs
CONTRIBUTING ZONE
680 km 2
230 km 2
RECHARGE ZONE
ARTESIAN ZONE


Barton Creek
(downstream)
Old Mill
Spring
Eliza
Spring
Main Barton
Spring
Barton Creek
pool bypass


Upper Barton Spring


Old Mill Spring


Eliza Spring

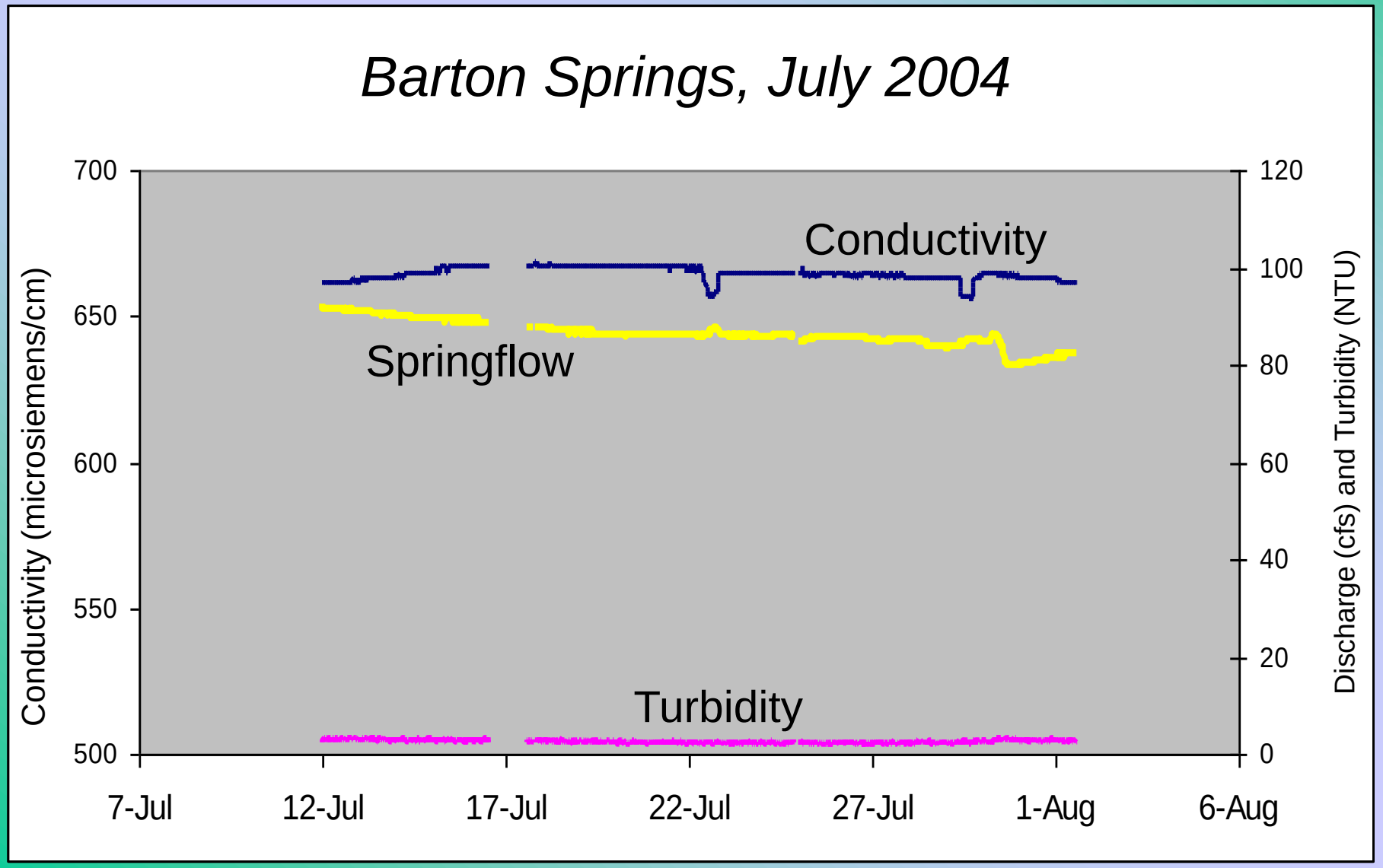
What can we measure in the water?

- “Physical” parameters
- Major ions (calcium, sodium, etc.)
- Nutrients
- Contaminants in water
  - Pesticides, VOCs, pharmaceuticals, waste-water indicators
- Contaminants on sediment
  - Metals, PAHs, organochlorine compounds

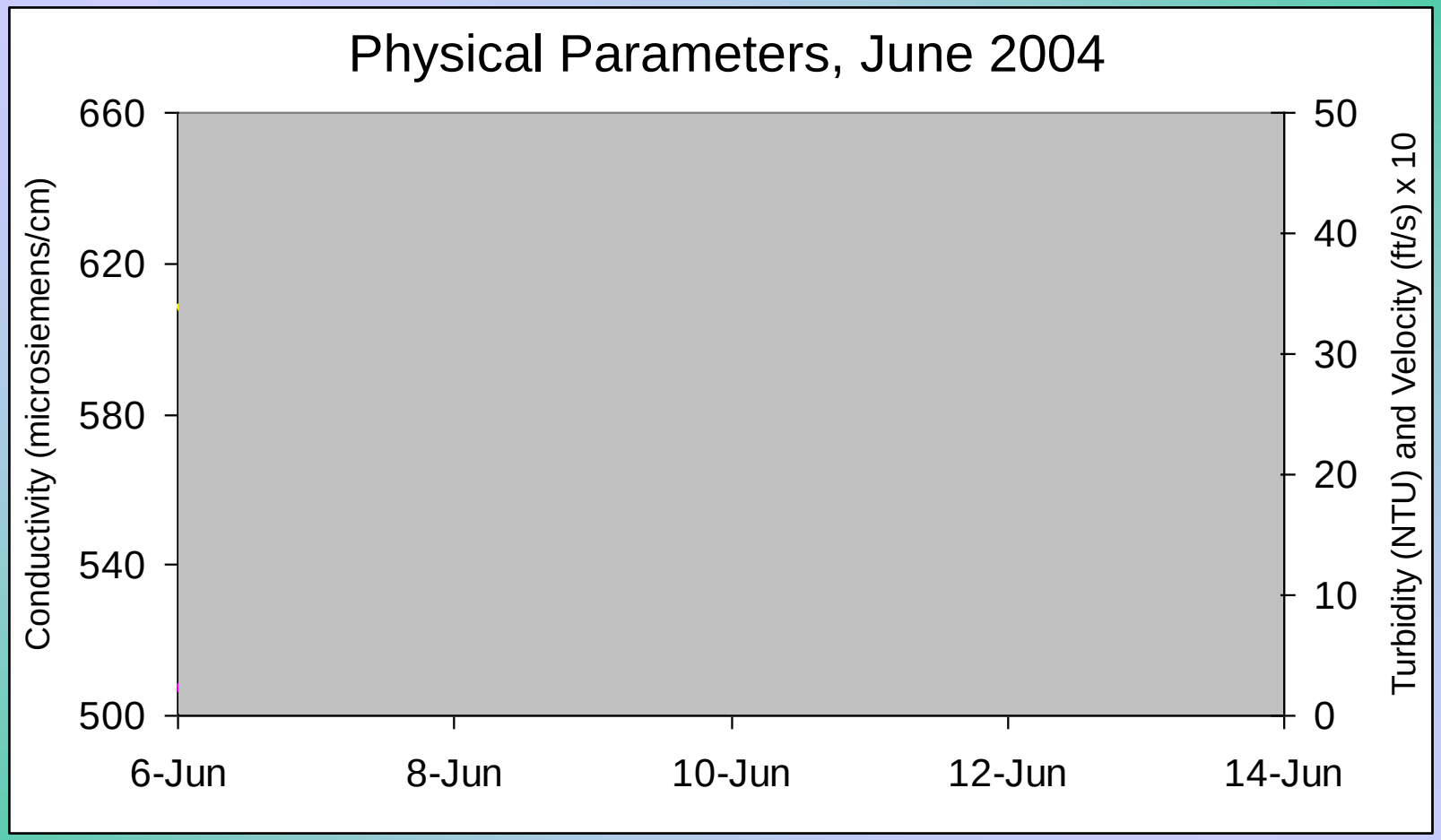
Physical parameters can be measured continuously

- Discharge (flow rate)
- Temperature
- Conductivity
- Turbidity
- pH
- Dissolved oxygen

Baseflow: physical parameters change slowly as the aquifer drains

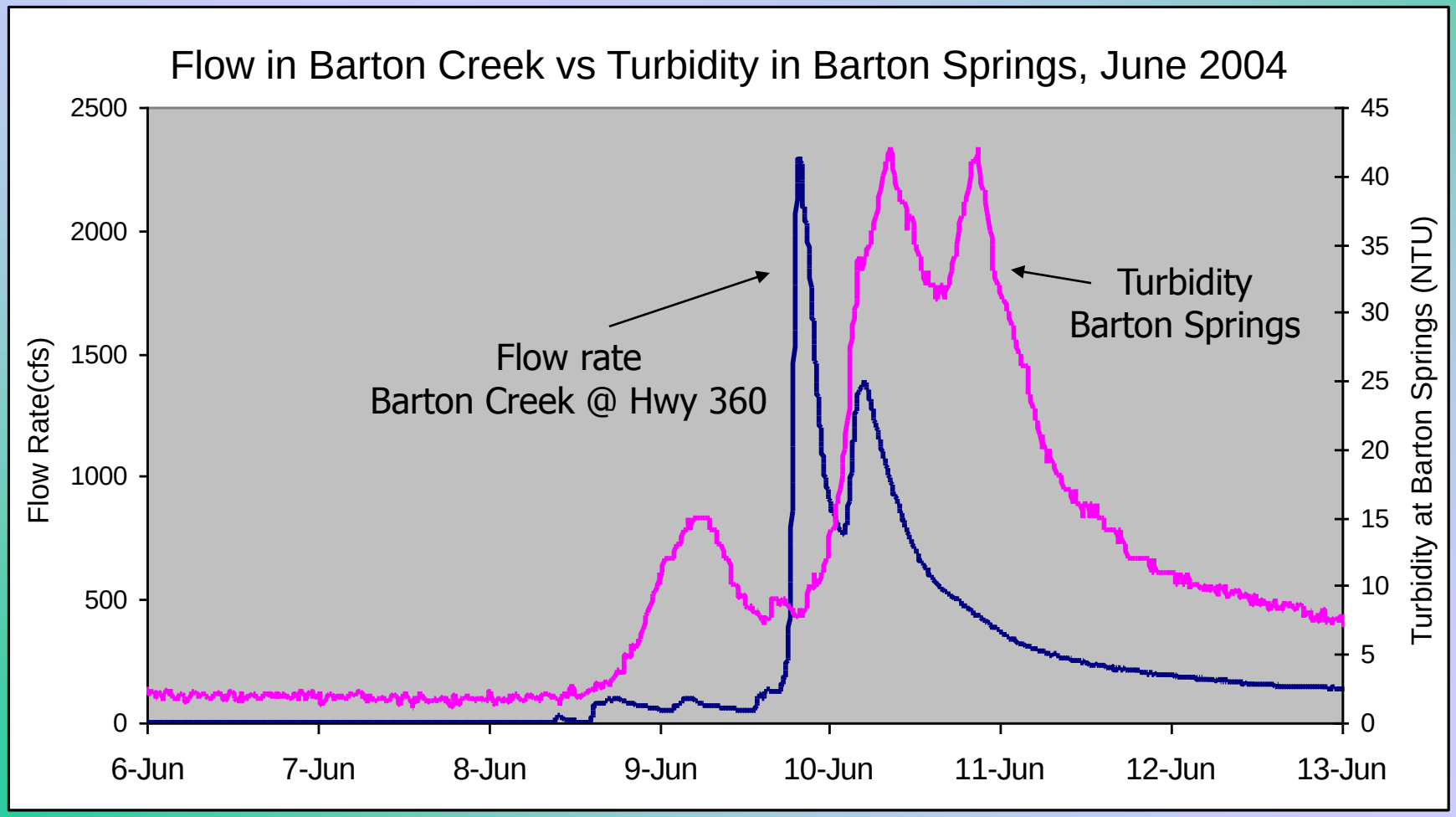


… but when it rains, things happen!



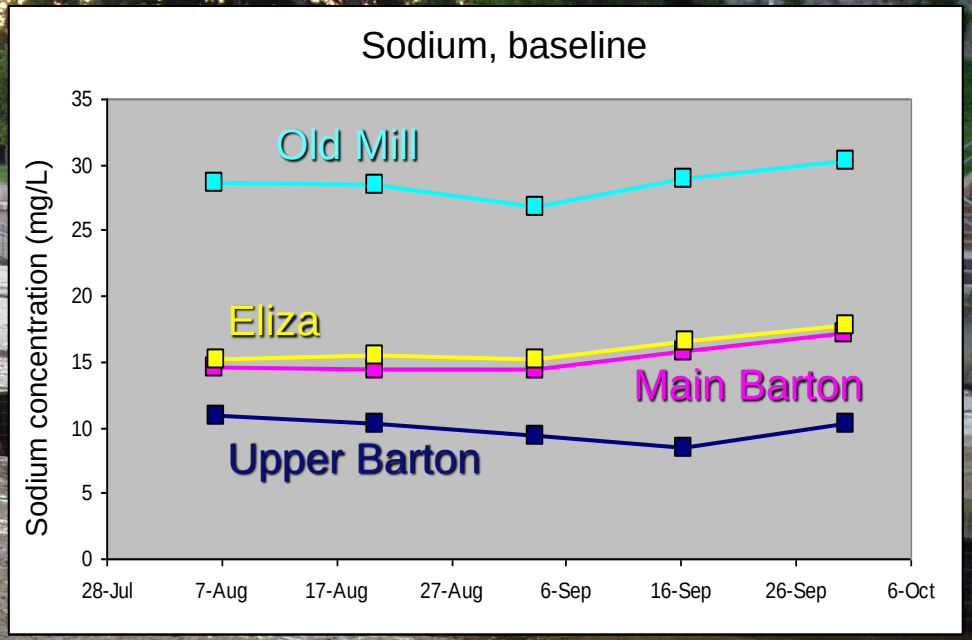
- Velocity/Springflow changes reflect aquifer and local conditions
- Conductivity reflects rainfall infiltrating
- Turbidity corresponds to turbid creek recharge

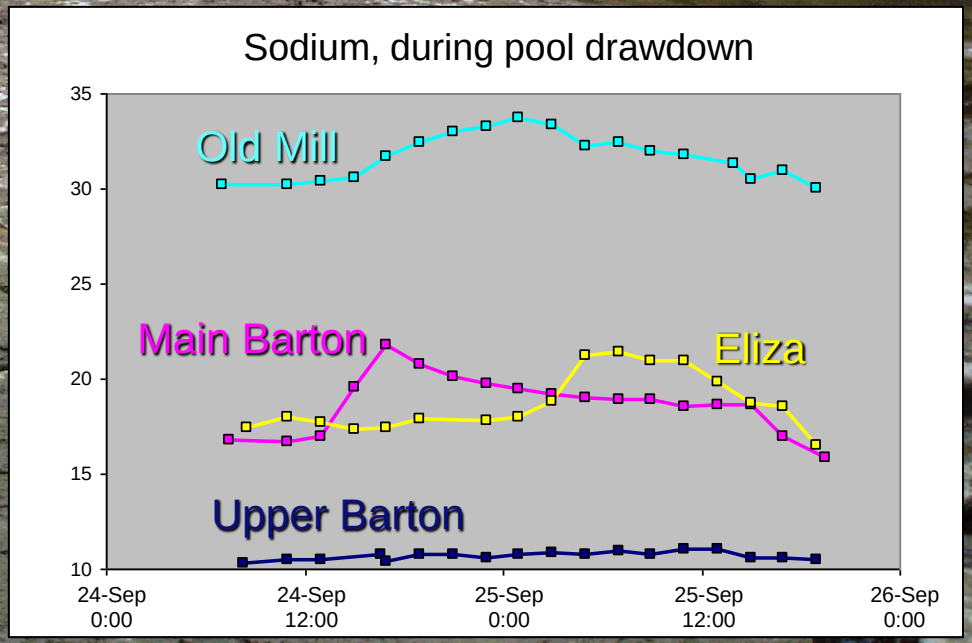
Springflow and surface-water flow are closely connected



Major Ions: the natural chemical signature of the water

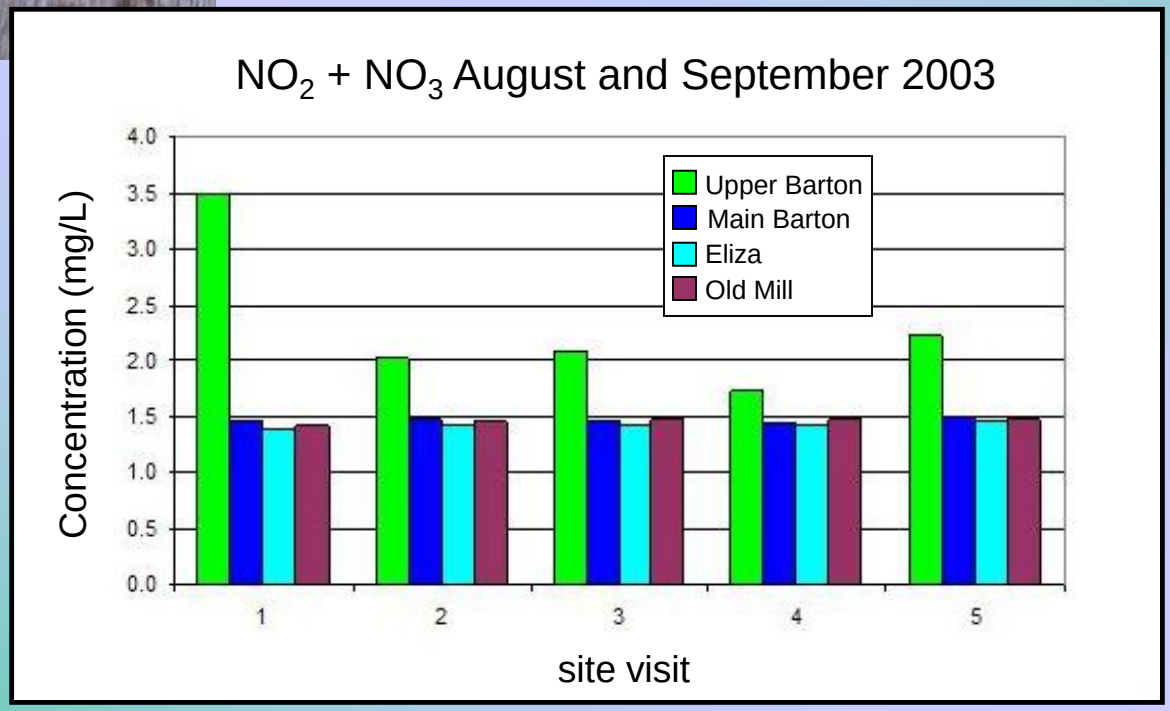
- Cations
  - Ca, Mg, Sr, Na
- Anions
  - HCO_3, SO_4, Cl
- Help us differentiate between different sources of water feeding the springs





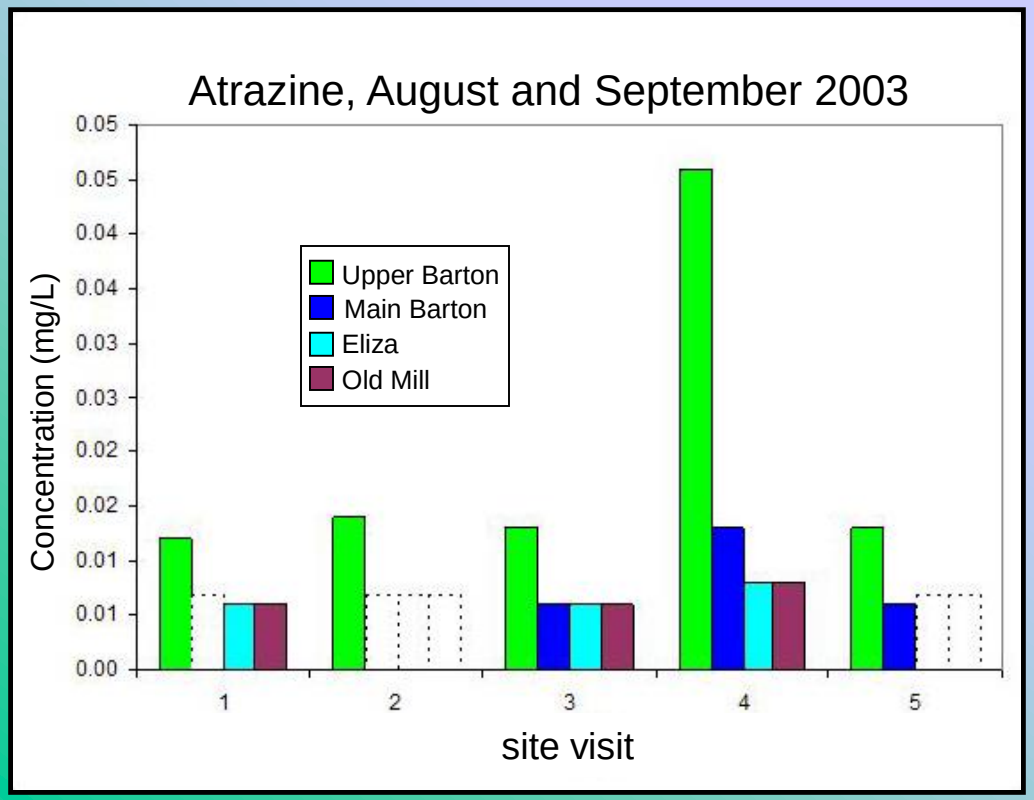
Nutrients: The Right Balance Needed

- Nitrogen, phosphorous necessary for plant growth
- Additional sources: fertilizer, wastewater, animal wastes
- Too much causes eutrophication

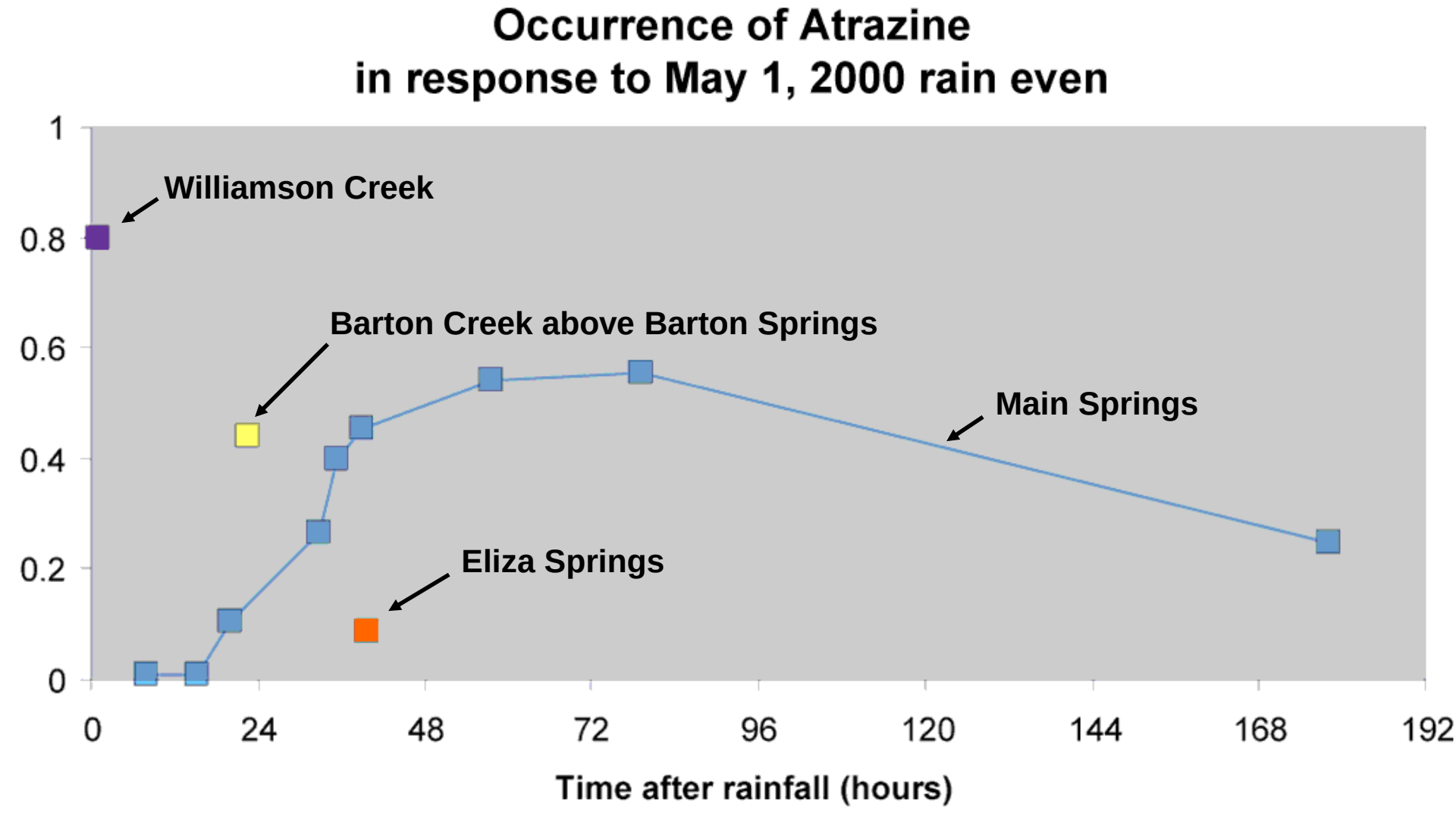


Dissolved Contaminants: Pesticides

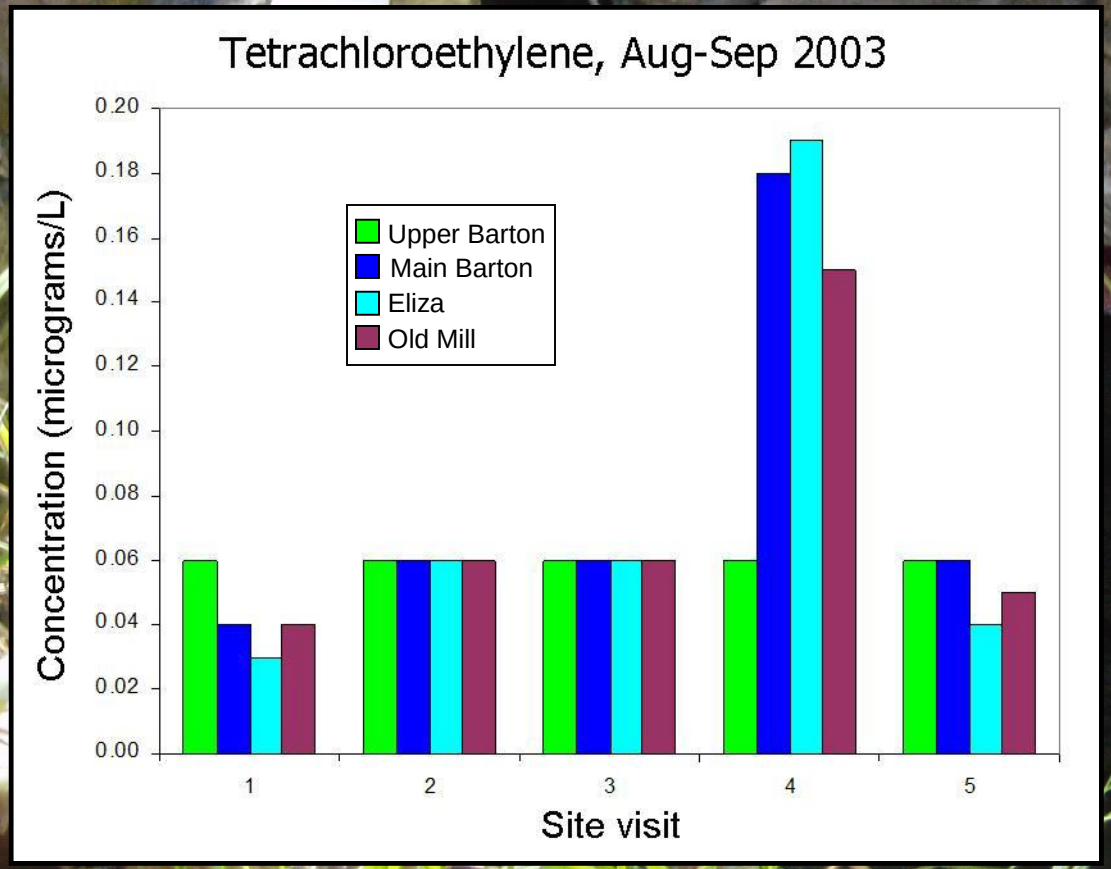
- "New" (post-DDT) pesticides are very soluble
- Detected in 99% of surface water and 49% of ground water sampled by the USGS
- Very low detection limit
- Toxic by design



After rain, pesticide concentrations increase



Dissolved contaminants: Volatile organic compounds (VOCs)



- Gasoline compounds
  - BTEX
  - MTBE (oxygenate)
- Cleaning solvents (degreasers)
  - Industrial processes
  - Dry cleaners
  - Floor cleaners

Dissolved contaminants: "Emerging contaminants"

- Pharmaceuticals
  - Excreted into waste water
  - Antibiotics, hormones, analgesics
- Other waste-water indicators
  - Flame retardants, surfactants, fragrances
- Planned for future sampling

What's in the sediment?

Toxic chemicals taint Barton waters

TOXIC WATERS
AN AUSTIN TREASURE AT RISK

Decades-old fuel waste cited as possible source

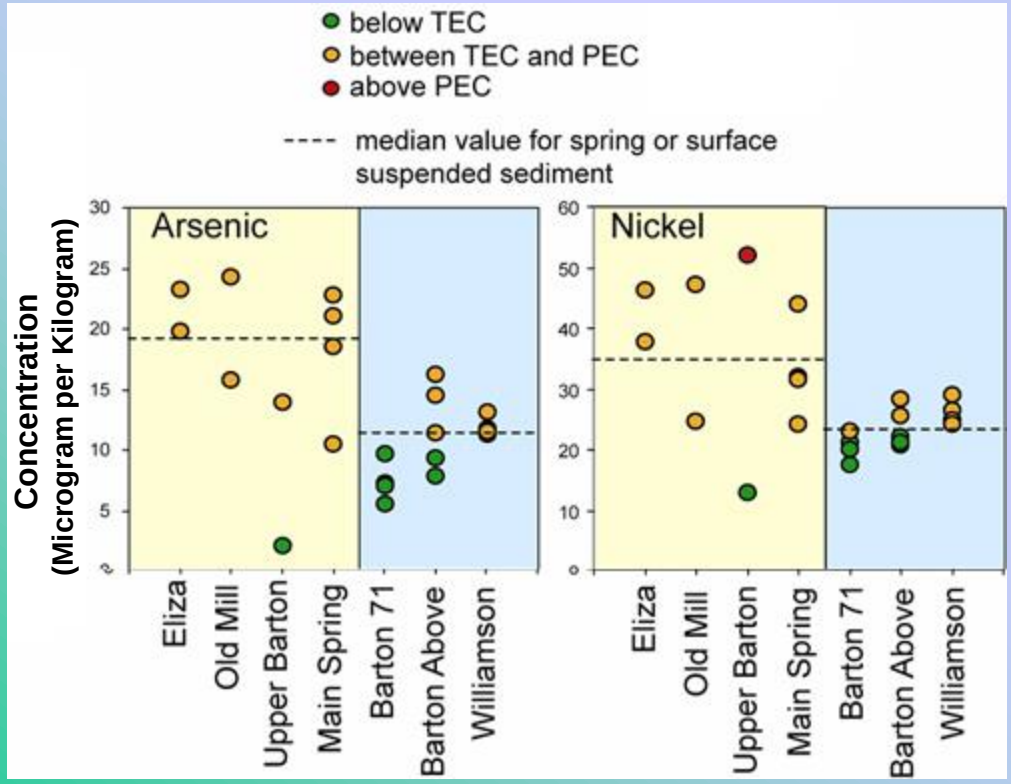
City closes Barton pool

POOL, OTHER CITY CREEKS MAY POSE HEALTH RISK

Suspended-sediment sampling

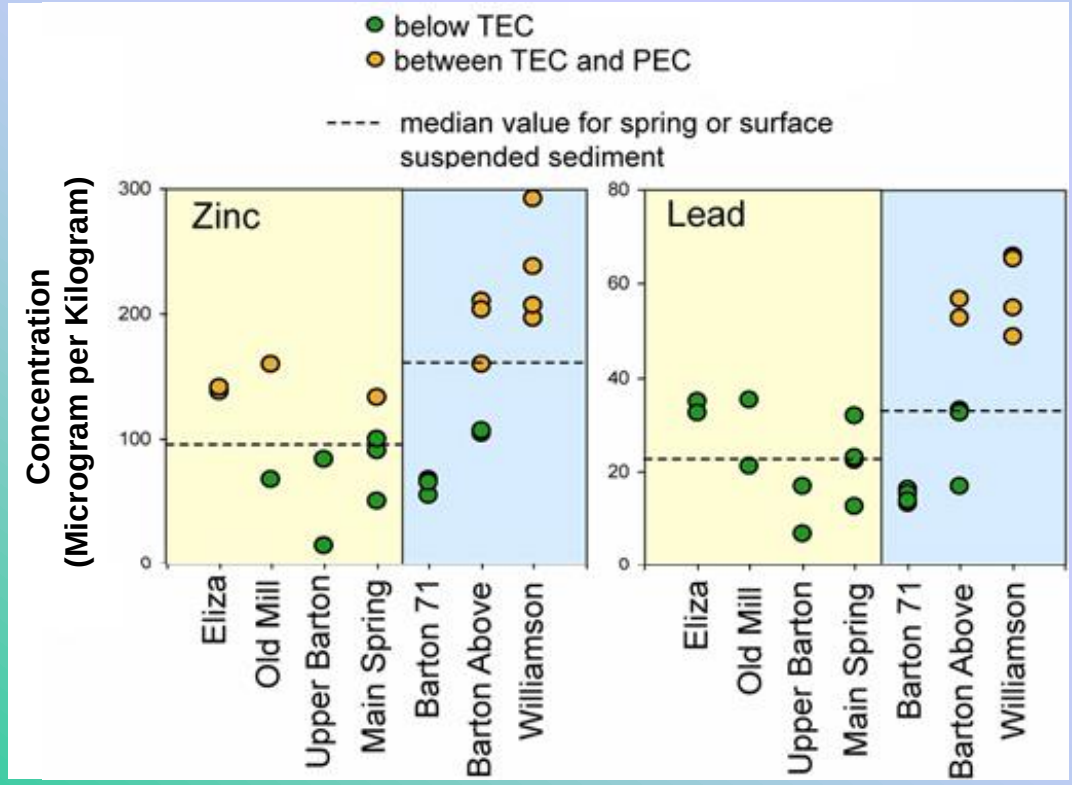
- Metals
  - Zinc, lead, mercury
- Organochlorine compounds
  - PCBs, DDT, chlordane
- PAHs
- Compare between urban creeks and spring sediment

Comparing metals in springs and creeks

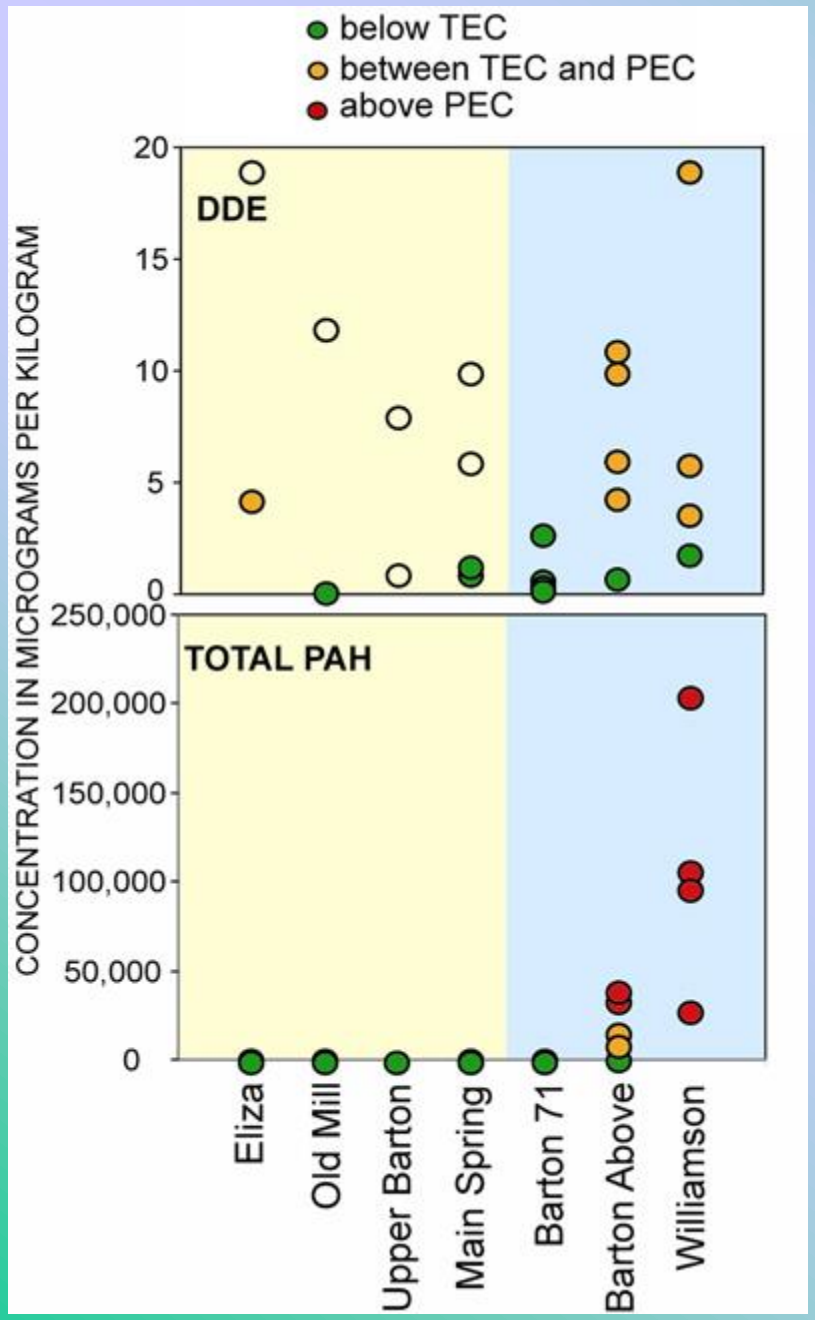


- Some metals (As, Ni, Cr, Cd) have higher concentrations in the springs
- High concentrations in creeks are associated with the natural geochemistry of aquifer sediment

Comparing metals in springs and creeks



- Two metals (Pb, Zn) have higher concentrations in the creeks
- High concentrations of Pb and Zn in creeks are associated with urbanization

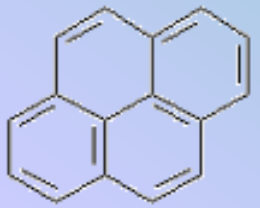


DDE and PAH in spring and creek sediments

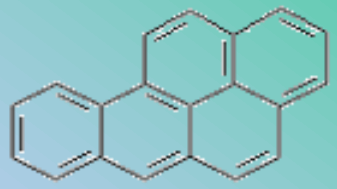
- Either not detected or very low in springs
- PAHs are higher than sediment quality guidelines in urban stream suspended sediments

Polycyclic Aromatic Hydrocarbons (PAH) in the urban environment

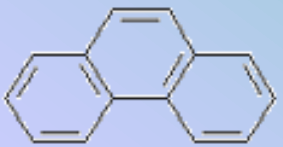
- Formed from 2 to 6 fused benzene rings
- Largest group of suspected carcinogens
- Formed by combustion of organic matter



Pyrene



Benzo(a)pyrene



Phenanthrene


So where are all those PAHs coming from?

What's in them?

Coal-tar emulsion vs. asphalt-emulsion

Coal tar - final product of destructive distillation of coal to produce coke and (or) gas

Coal tar contains 50% or more PAHs by weight

Coal tar is a known carcinogen & classified as a hazardous waste

Coal-tar based sealants are typically 20-35% coal tar

Coal-tar based sealants are thought to be more widely used in the east

Asphalt - derived from refining of crude petroleum

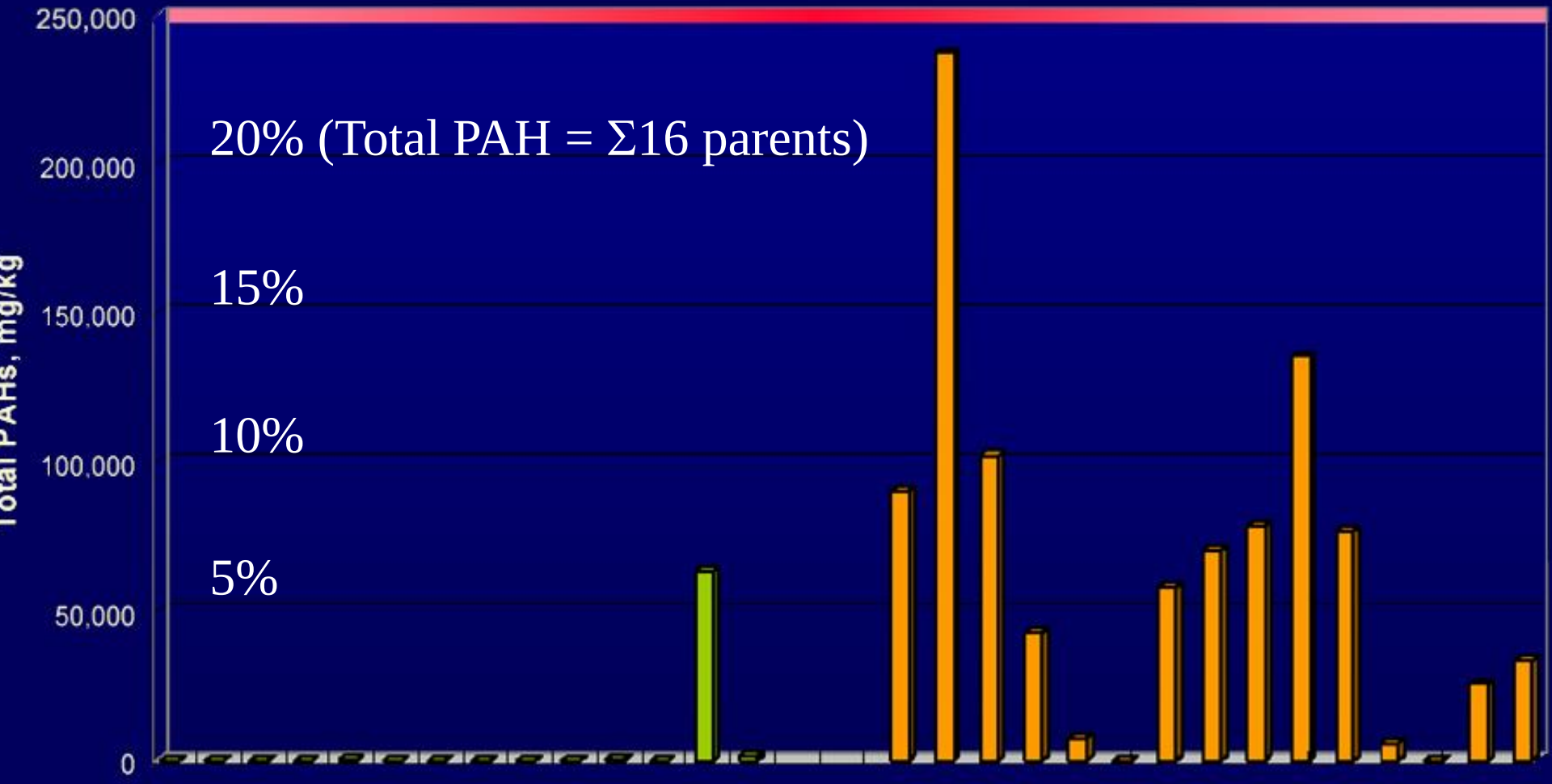
Asphalt contains PAHs at concentrations orders of magnitude less than coal tar

Asphalt-based sealants are typically 28-45% asphalt resin

Asphalt-based sealants are thought to be more widely used in the west

Sealant Product Analysis

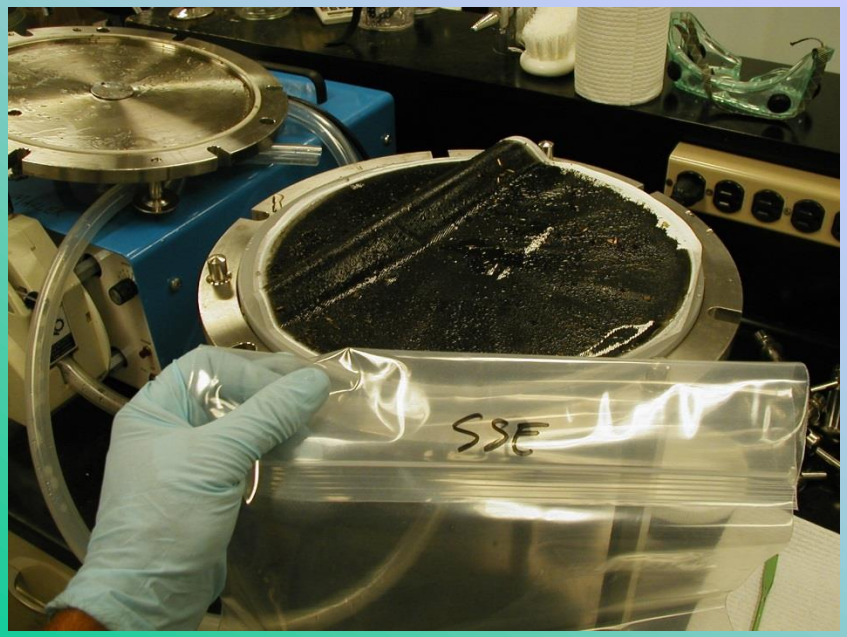
(Data from City of Austin)



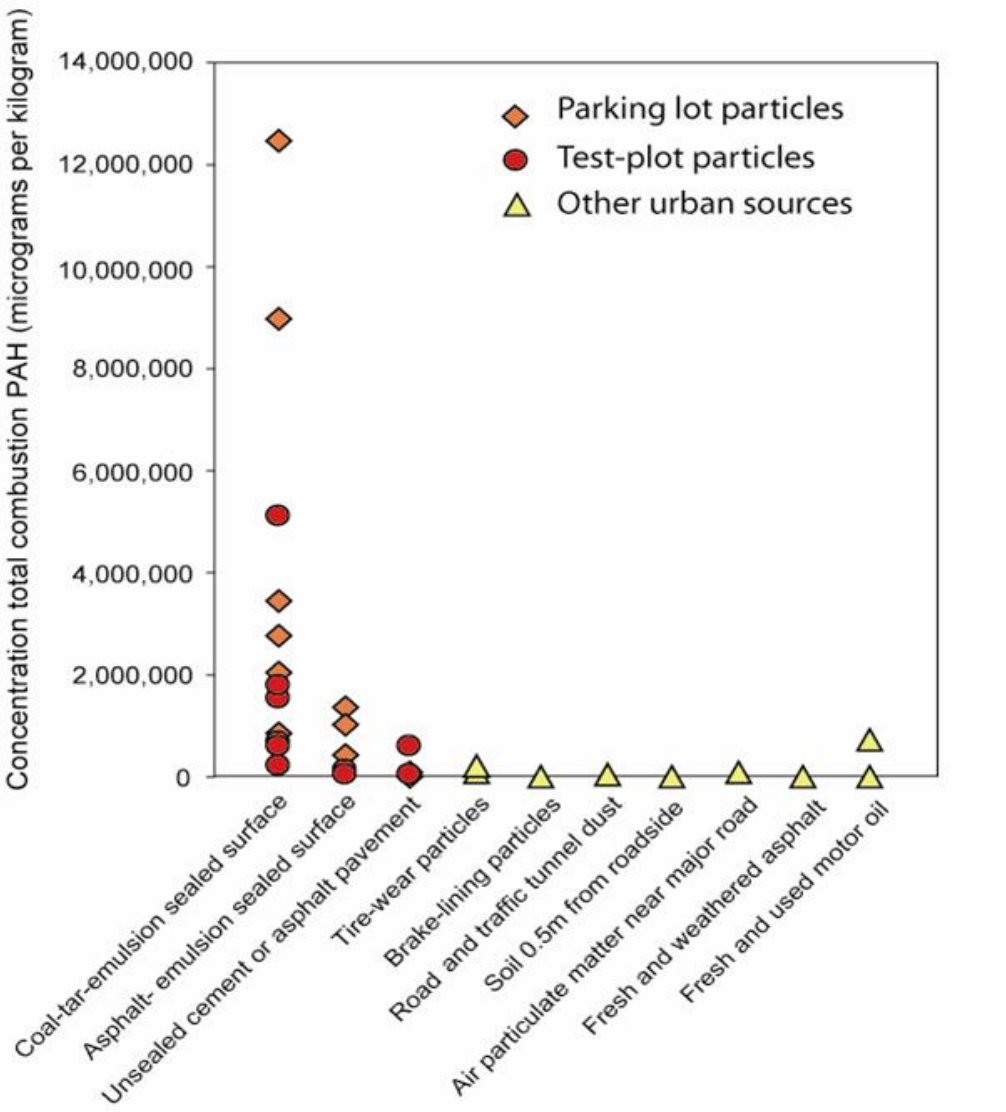
Asphalt-Based Sealant Products

Coal Tar Sealant Products

- 13 parkings lots were washed off
- Runoff filtered in the laboratory
  - Stainless-steel filter holder
  - 0.45 μm Teflon filter
- Particles massaged from filter and analyzed



Particles washed off sealed parking lots are highly contaminated with PAH



Dr. Barbara Mahler
Hydrologist, U.S.G.S.

Dr. Barbara Mahler is a Research Hydrologist with the Water Resources Division of the U.S. Geological Survey. Dr. Mahler's research focus is on karst hydrogeology and sediment-associated contaminant transport. Over the past five years, she has co-authored 11 articles in peer-reviewed publications, co-authored 11 technical reports, and presented research results at numerous national and international meetings. Dr. Mahler received her Ph.D. from the University of Texas at Austin; she was a NSF-NATO International Postdoctoral Fellow, spending one year in Montpellier, France, investigating bacterial transport in karst.