Urban Ecology from the Ground Up

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Center for Environmental Research at Hornsby Bend

Austin Water Clearly Reliable

MISSION

Urban Ecology and Sustainability

- Community
- Education
- Research

PARTNERS

- Austin Water Utility
- University of Texas
- Texas A&M University

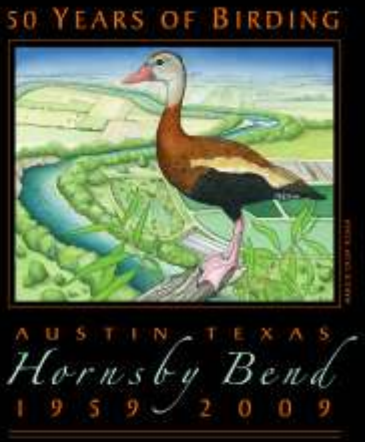
RESEARCH AREAS

- Soil Ecology, Sewage Recycling and Reuse
- Hydrogeology of the Alluvial Aquifer
- Riparian Ecology
- Avian Ecology

HBBO

Hornsby Bend Bird Observatory

Texas Riparian Association



AWU-CER Research Programs

Center for Environmental Research at Hornsby Bend

Austin Water — Clearly Reliable

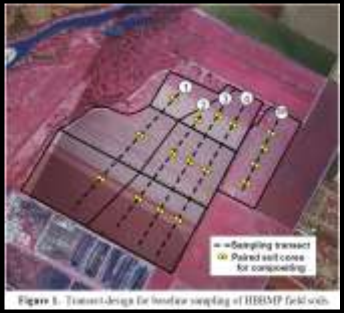
RESEARCH AREA

Soil Ecology, Sewage Recycling and Reuse

USGS — science for a changing world

USDA

TEXAS PARKS & WILDLIFE



RESEARCH AREA

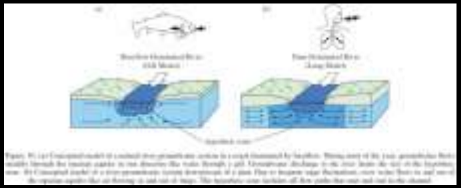
Avian Ecology

HBBO — Hornsby Bend Bird Observatory

RESEARCH AREA

Hydrogeology of the River and Alluvial Aquifer

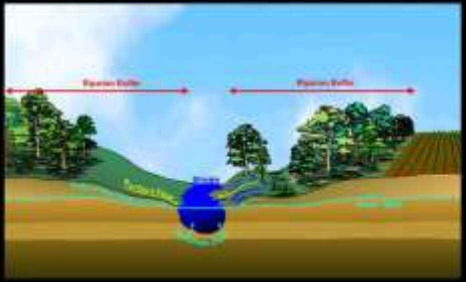
THE UNIVERSITY OF TEXAS AT AUSTIN JACKSON SCHOOL OF GEOSCIENCES



RESEARCH AREA

Riparian Ecology

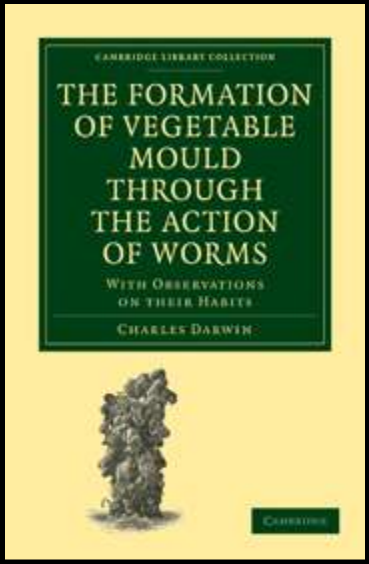
TEXAS RIPARIAN ASSOCIATION



RESEARCH AREA – Soil Ecology, Sewage Recycling and Reuse

Center for Environmental Research at Hornsby Bend

Austin WATER Clearly Reliable



Key Concepts

Urban Ecology

Sustainability

Environmental Perception

Ecosystem Services

Ecosystem Cycles

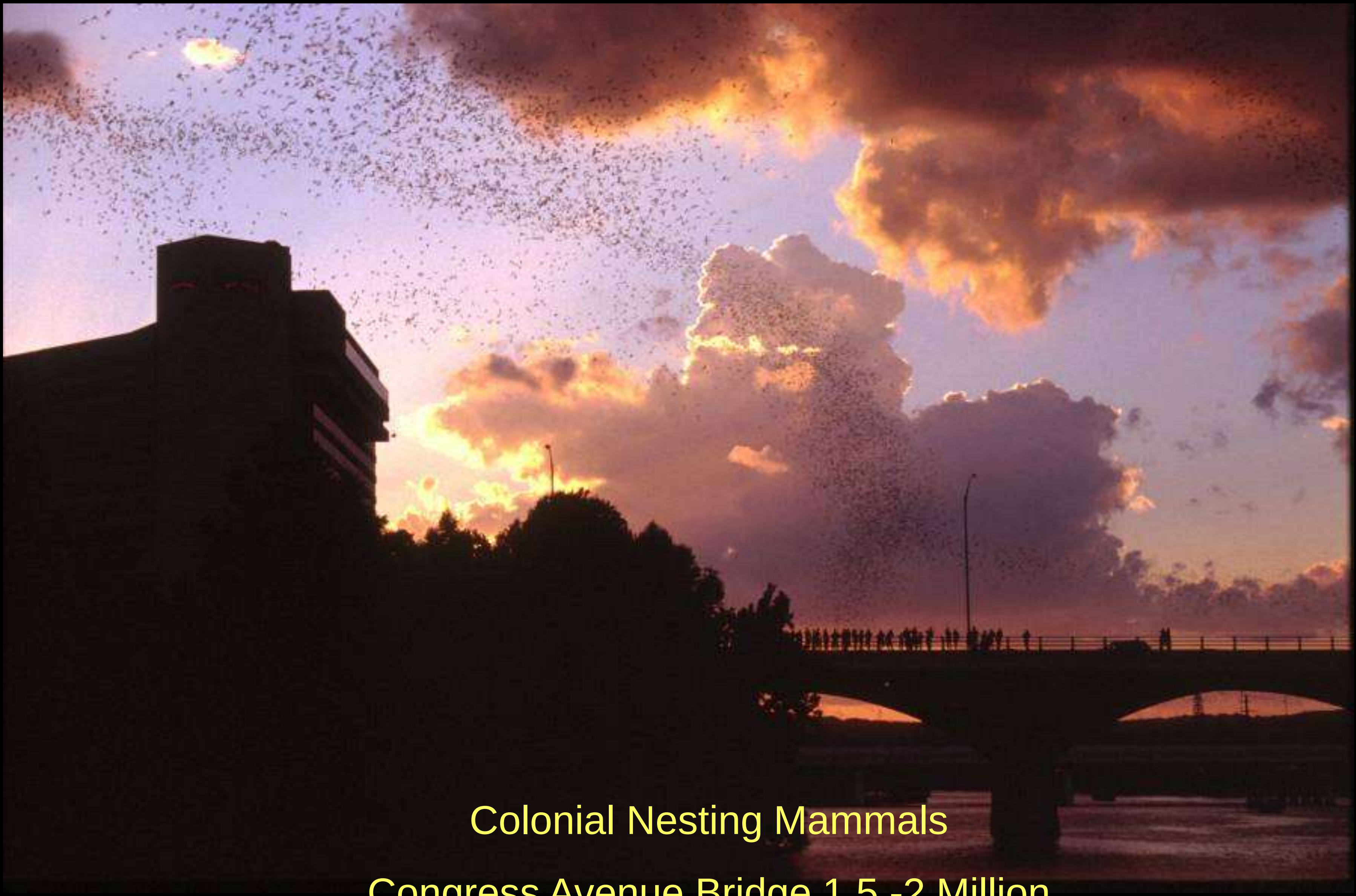
Food Web

Biodiversity

Ecotone

Riparian

What is a City?



Colonial Nesting Mammals

Congress Avenue Bridge 1.5 -2 Million

Mexican Free-tailed Bats

Colonial Nesting Mammals

Black-Tailed Prairie Dog

Colonial Nesting Mammals

Environmental Perception of Nature and the City

The Sacred and the Mundane

Wilderness and the City

Natural vs. Artificial

Pristine vs. Degraded

Native vs. Non-native

Invasive
Non-native
Species

Once a rock dove, now the winged rat of the city

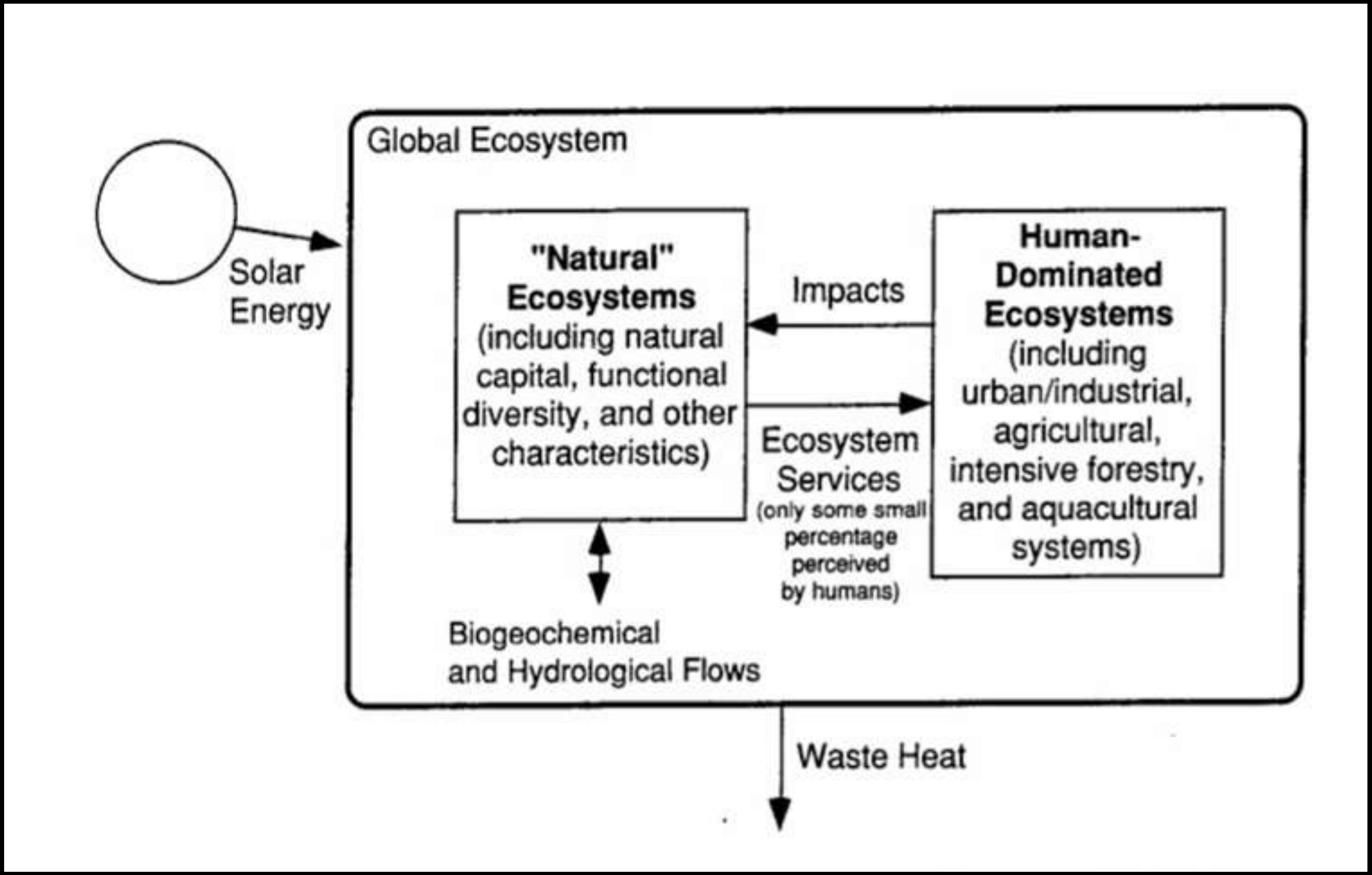
Non-native species and Biodiversity?

Urban Ecology – Context and Characteristics

Characteristics of an Urban Ecosystem

- Ecological Context
- Temperature
- Water
- Flora
- Fauna
- Soils

Ecological Context - Urban settlements are part of their surrounding ecosystem



Human-dominated ecosystems are parts of the overall global system.

Ecosystem services are essential for the development and well-being of human society, but only a fraction of this work is covered by market prices or perceived by humans.

From Gretchen Daily, *Nature's Services: Societal Dependence on Natural Ecosystems* (Island Press 1997)

Ecosystem Services

- ✓ Maintenance of atmosphere
- ✓ Protection from ultraviolet rays
- ✓ Regulation of climate
- ✓ Maintenance of genetic diversity
- ✓ Purification of air and water
- ✓ Detoxification and decomposition of wastes
- ✓ Generation of soil and renewal of soil fertility
- ✓ Pollination of vegetation
- ✓ Control of agricultural pests
- ✓ Dispersal of seeds
- ✓ Translocation of nutrients

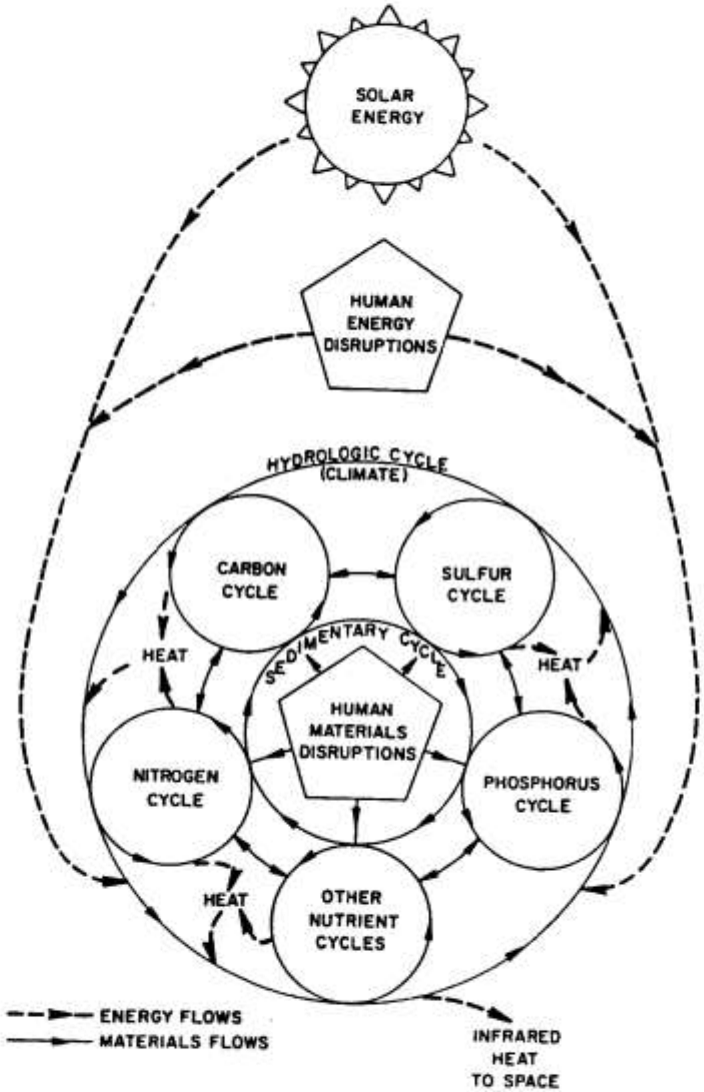


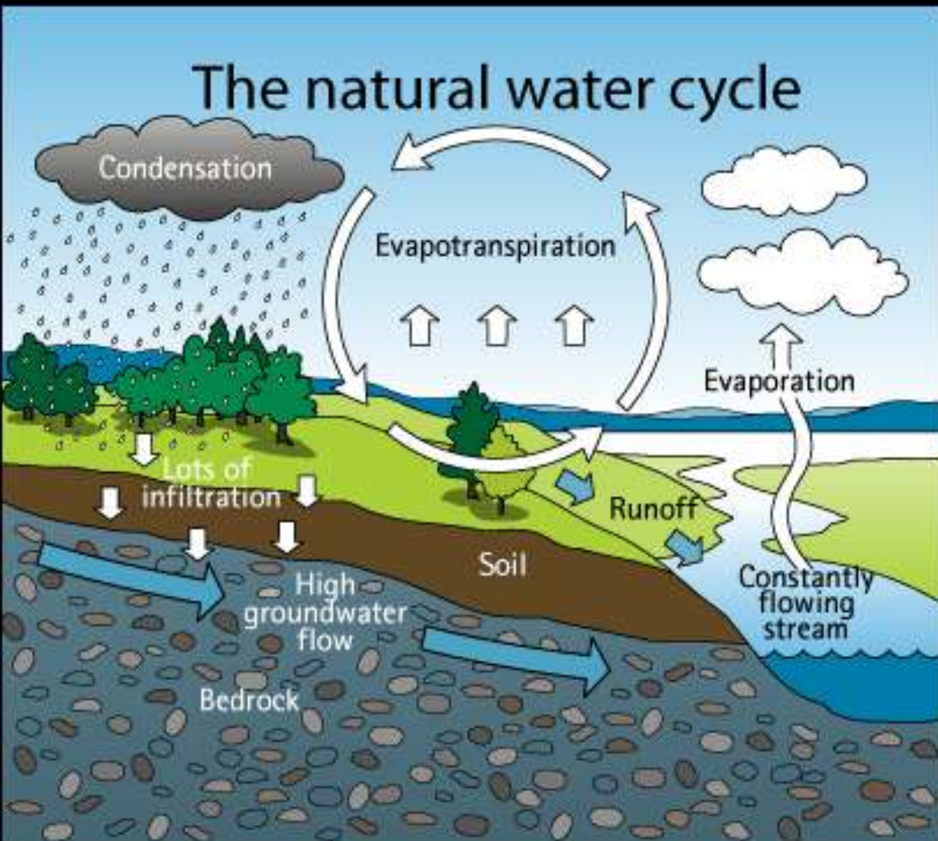
Figure 5.1. Climate and life are linked by a complex web of interconnected cycles. Life on earth depends on the cycling of nutrients through air, water, soil, and living things. The climate mediates the flow of materials through these global cycles. Solar energy degrades to heat at each stage of the cycling process and is eventually returned to space as infrared radiation. The composition of the earth's atmosphere regulates the radiative balance on earth between absorbed solar energy and emitted infrared energy, which, in turn, controls the climate.

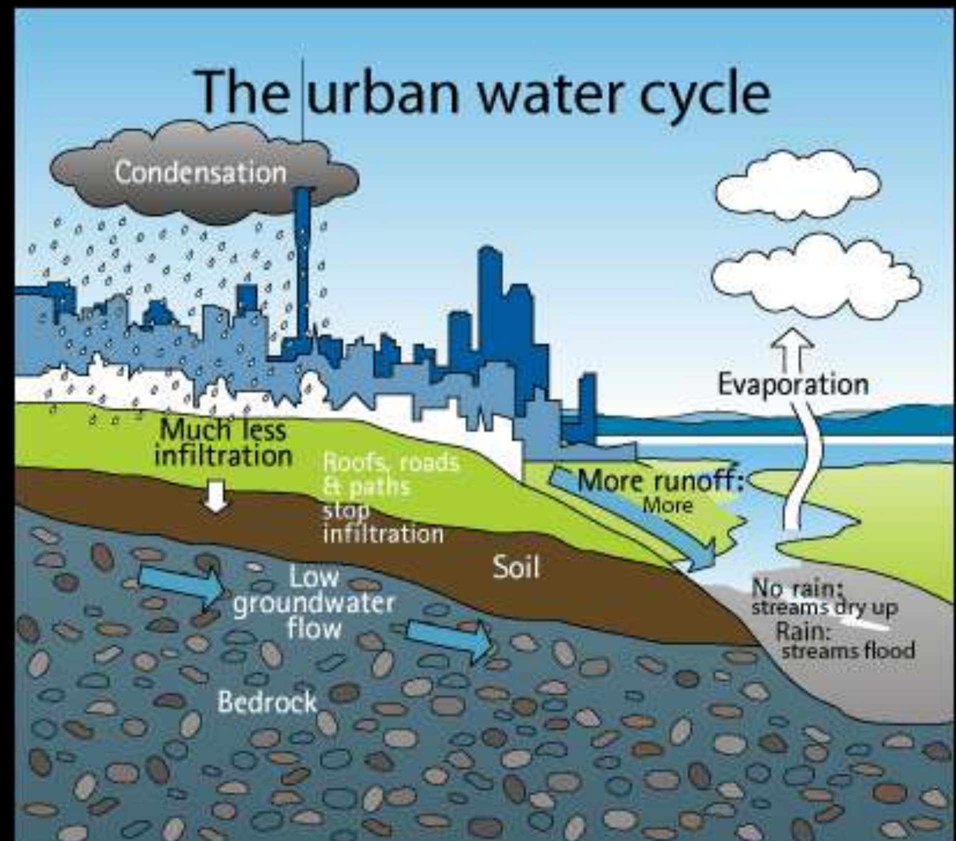
Source: Schneider and Morton 1981.

Ecosystem Cycles

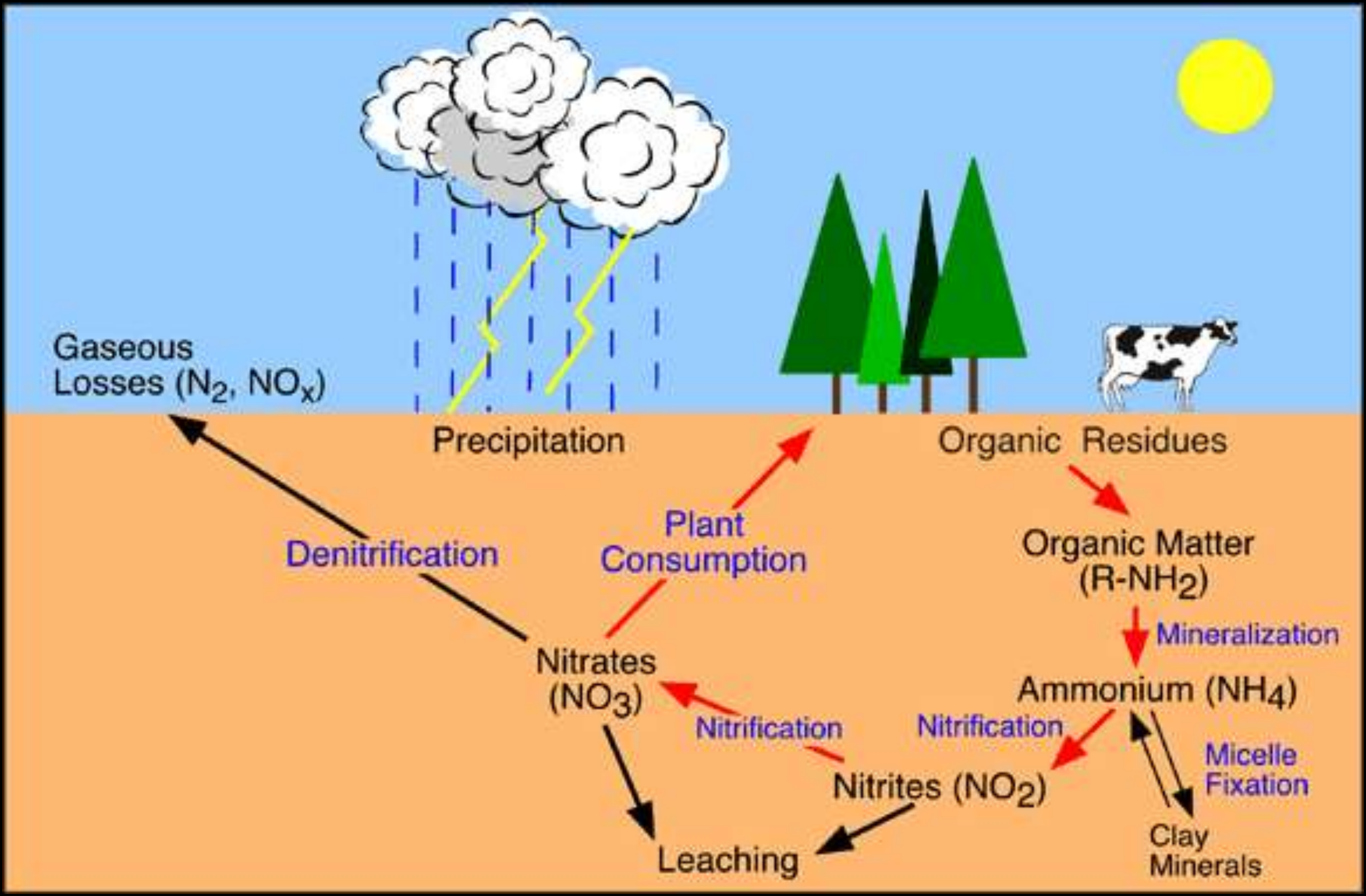
[Biogeochemical Cycles]

- Water cycle
- Carbon cycle
- Nitrogen cycle
- Phosphorus cycle
- Other trace minerals and metals
- Short-circuiting Cycles
- Recycling and Sustainability?

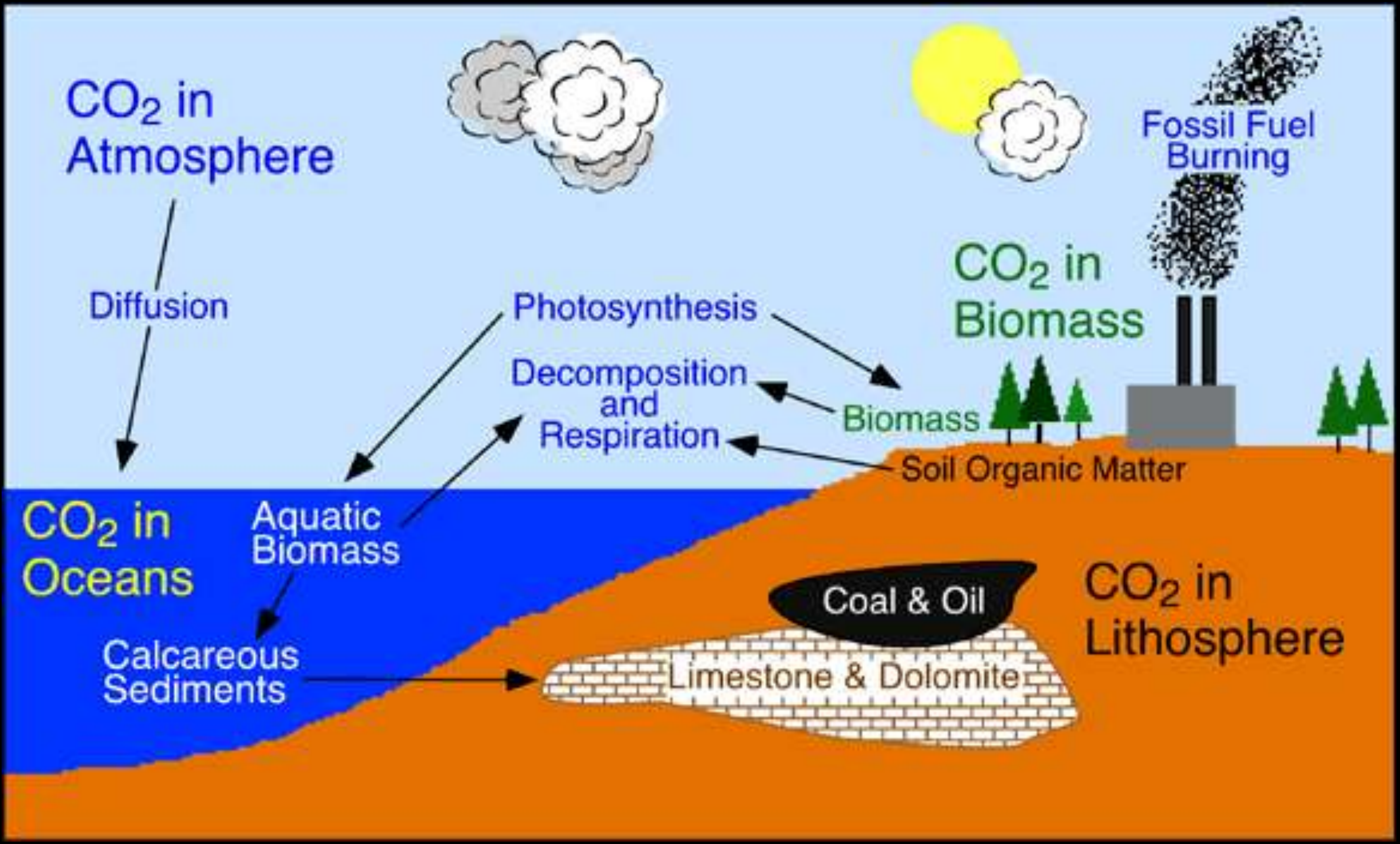

The natural water cycle
Condensation
Evapotranspiration
Evaporation
Lots of infiltration
Runoff
Soil
High groundwater flow
Constantly flowing stream
Bedrock


The urban water cycle
Condensation
Evaporation
Much less infiltration
Roofs, roads & paths stop infiltration
More runoff:
More
Soil
Low groundwater flow
No rain: streams dry up
Rain: streams flood
Bedrock

The Nitrogen Cycle



The Carbon Cycle



Ecosystem Services and Ecological Cycles are the conditions and processes through which ecosystems sustain human life.

They are our life support system.

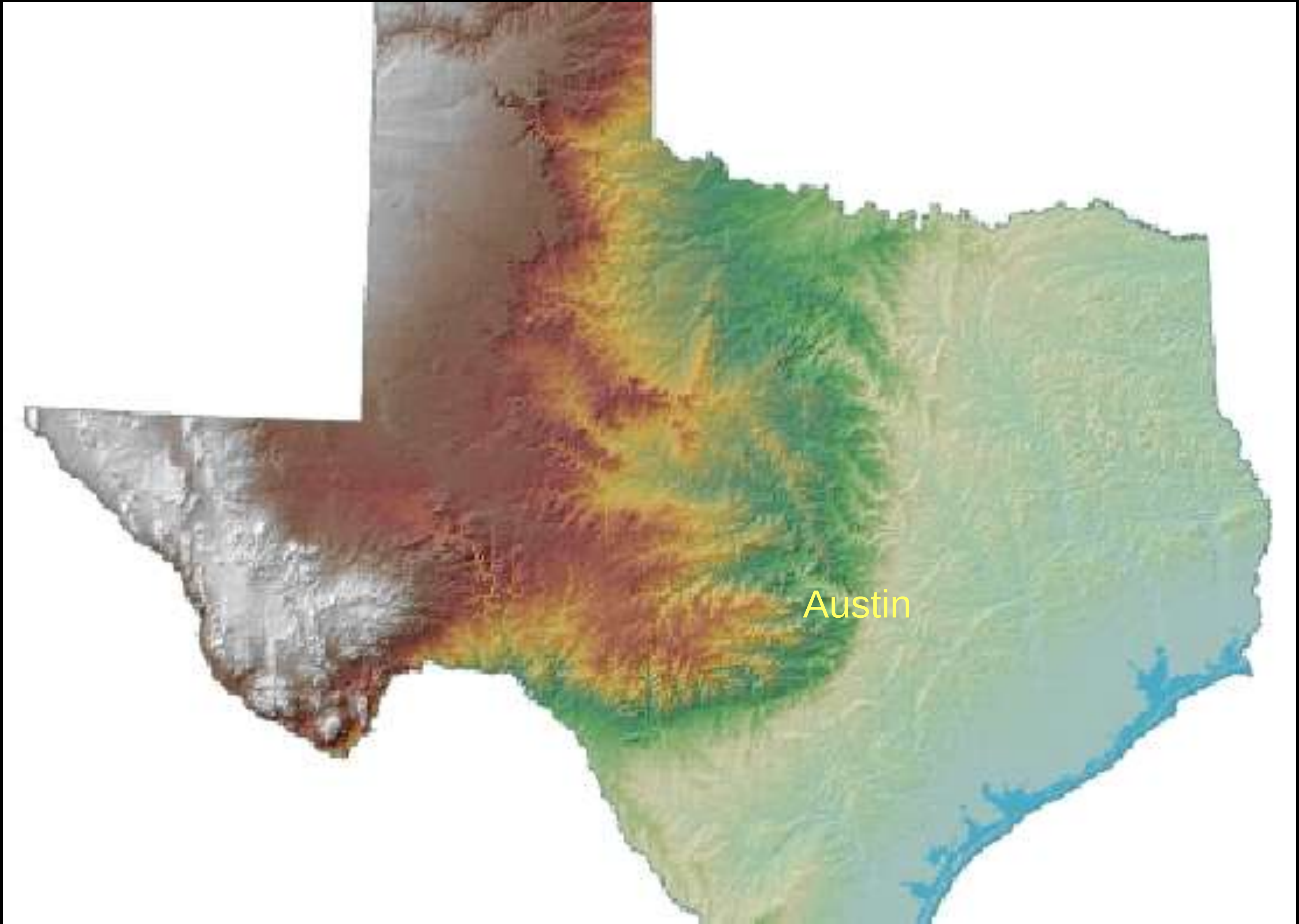
Urban ecosystem

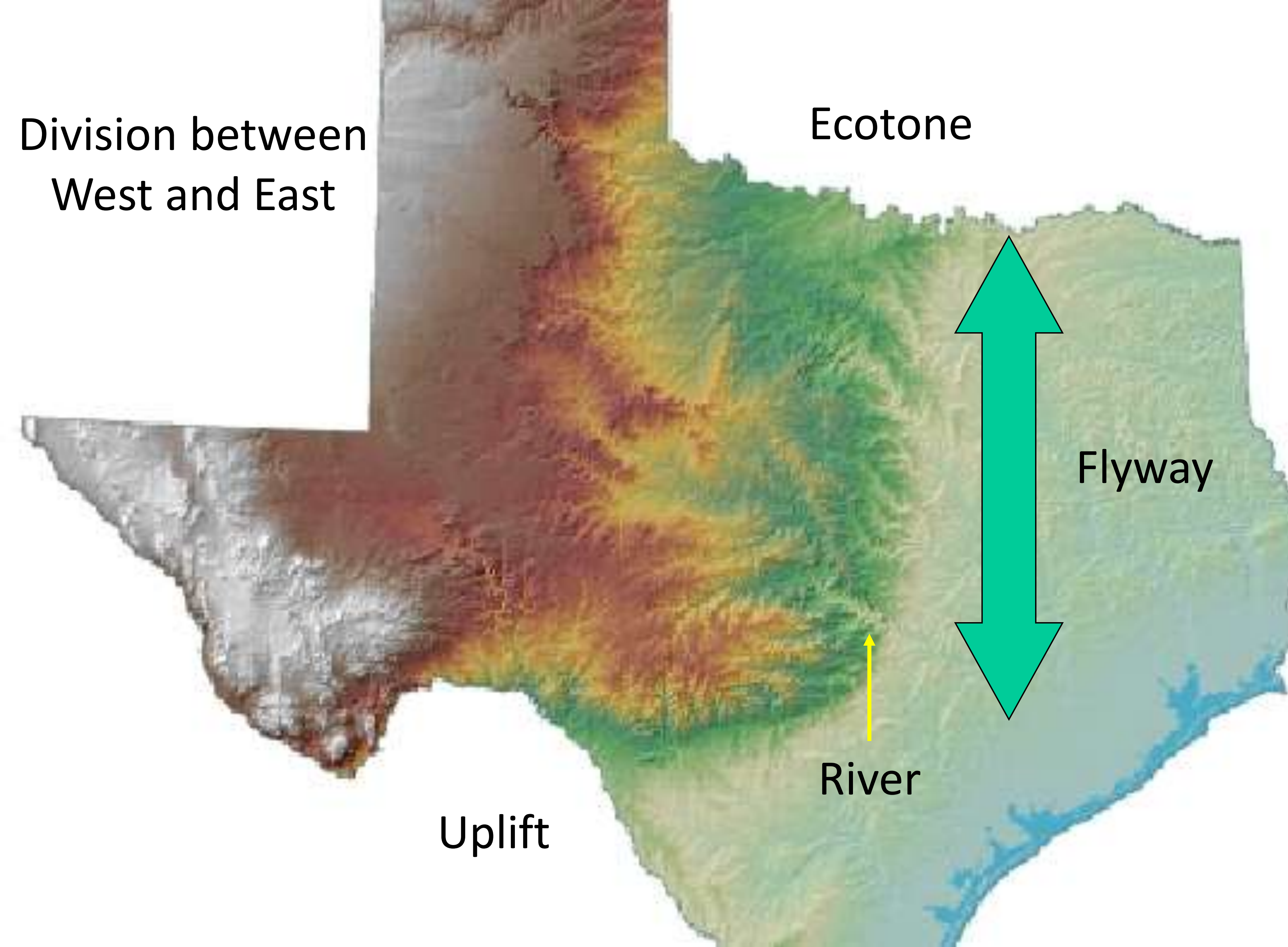
Inputs - drawn from soils – food, landscaping

Outputs - nitrogen rich “wastes” and carbon “wastes”

Urban sustainability?

Ecological Context - Urban settlements are part of their surrounding ecosystem




Division between
West and East
Ecotone
Flyway
River
Uplift

Balcones Escarpment

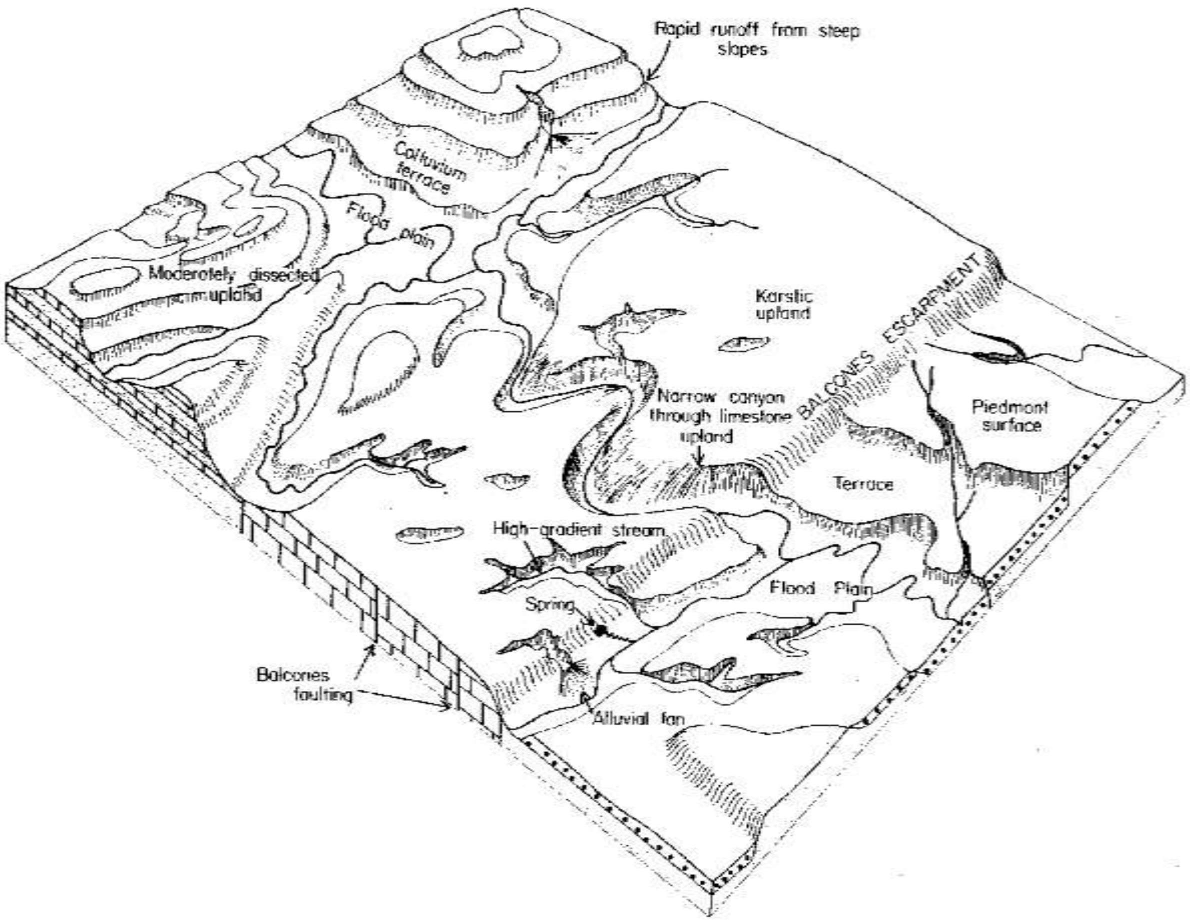


Figure 5. Block diagram representing geomorphic features that affect flood potential in the Balcones Escarpment area. From Baker (1975, fig. 3).

Central Texas Climate

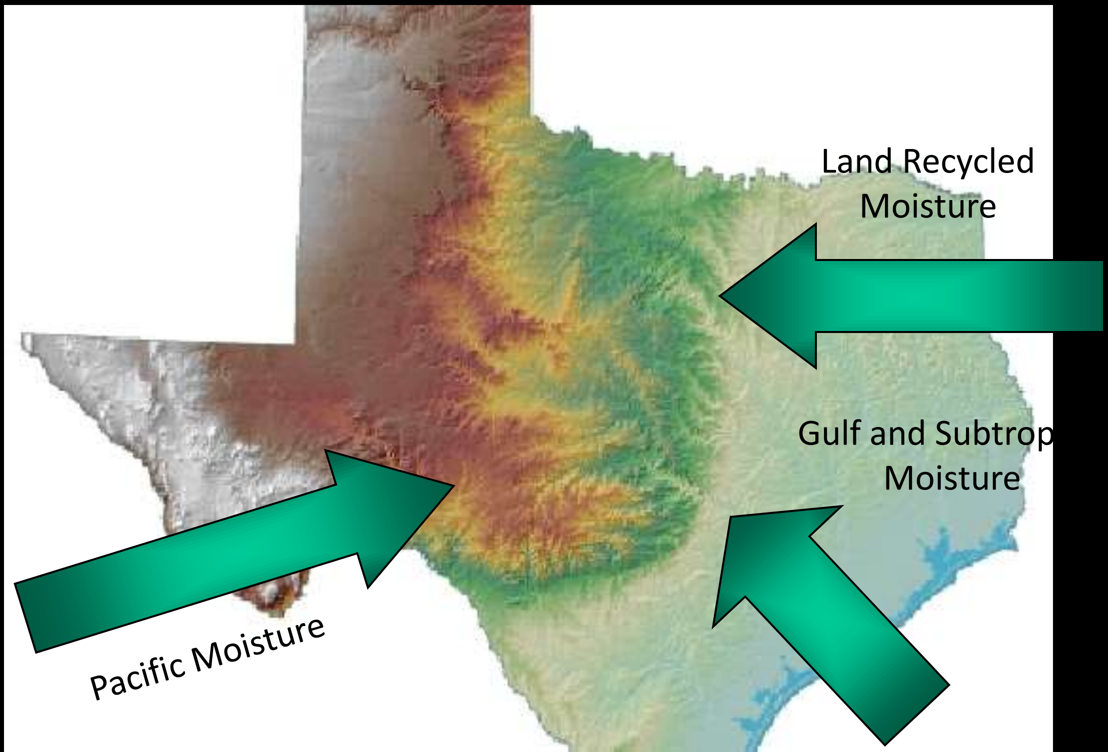
The principal sources of moisture for Texas are the Gulf of Mexico and, to a lesser extent, the eastern Pacific Ocean.

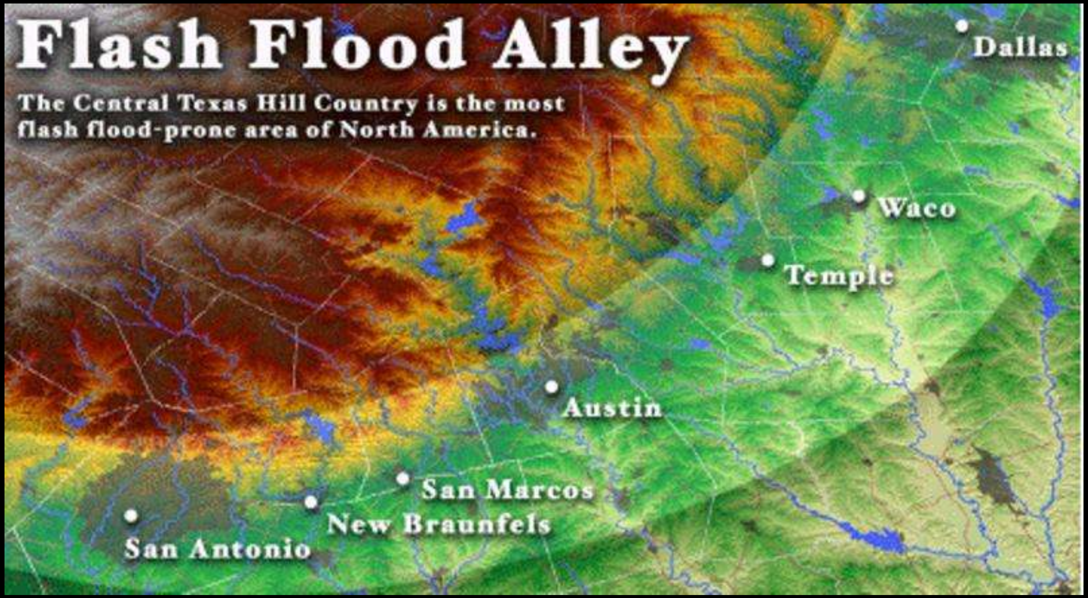
Moisture from the Gulf of Mexico is carried into the State by low-level southerly and southeasterly winds.

Moisture from the eastern Pacific is carried into the State from the southwest by tropical continental air masses.

In addition to the oceans, important moisture sources include local and upwind land masses, as well as lakes and reservoirs, from which moisture evaporates to the atmosphere.

Typically as a moisture-laden ocean air mass moves inland, it is combined with moisture that has been recycled through the land-vegetation-air interface.





http://floodsafety.com/media/ffa/contents_index.htm

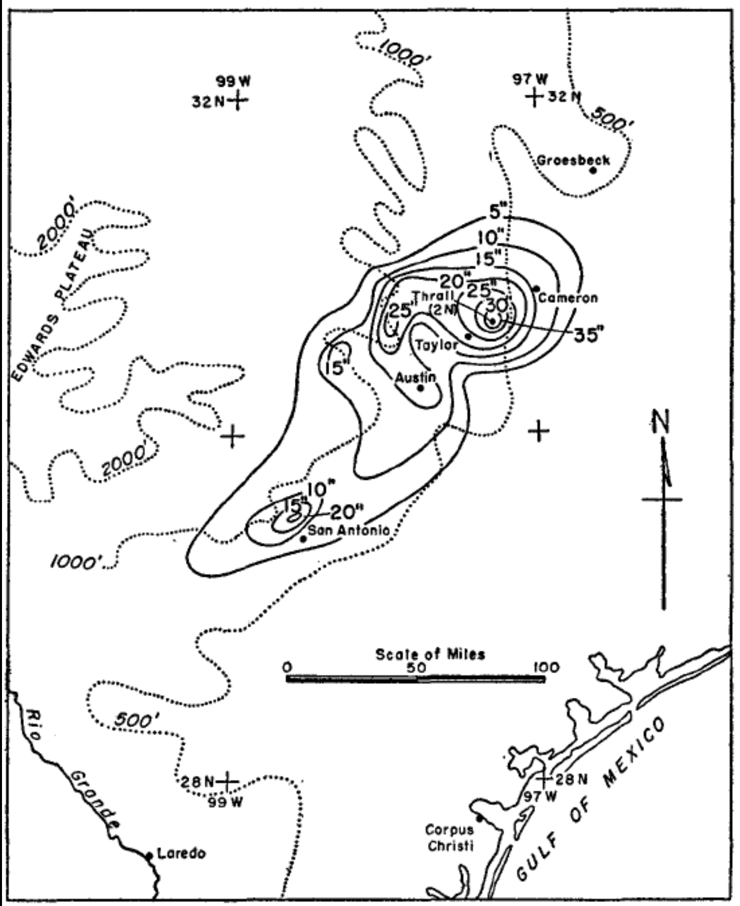


FIGURE 2.—Generalized isohyetal pattern (solid lines, in inches) for the Thrall, Tex., rainstorm, covering the period noon Sept. 8 to noon Sept. 10 (local time), 1921, superimposed on the ground contours (dotted lines, in feet). The intense rain fell in two bursts which traveled from the southwest to the northeast.

Thrall Flood 1921

This storm caused the most deadly floods in Texas, with a total of 215 fatalities.

On September 9 and 10, 1921, the remnants of a hurricane moved over Williamson County. The center of the storm became stationary over Thrall, dropping a storm total of 39.7 inches of rain in 36 hours.

The 24-hour rainfall total ending 7 AM on September 10, 1921 (38.2 inches) at a U.S. Weather Bureau station in Thrall.

Eighty-seven people drowned in and near Taylor, and 93 in Williamson County.

On July 25, 1979 Tropical Storm Claudette stalled over Alvin and inundated the region with 45 inches in 42 hours. That total included 43 inches in 24 hours, the maximum 24-hour rainfall in US history.

Colorado River Flood History

C08484-A Austin History Center, Austin Public Library

Floods - More than 80 flood events have been recorded in the lower Colorado River basin since the 1800s. These events range from isolated floods that affected local areas to basin-wide floods spawned by unusually heavy rainfalls.

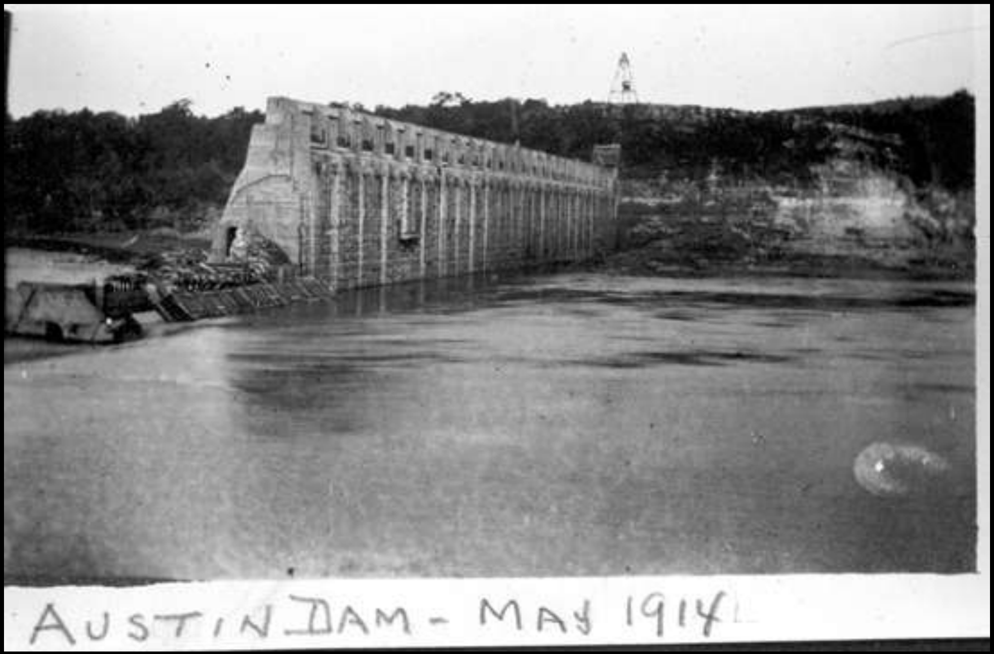
February 1843: In the earliest flood for which there is a written account, floodwaters cause the Colorado River to crest at a stage of 36 feet at Austin.

July 1869: In what is considered to be the worst flood on record, the Colorado crests at 51 feet at Austin and produces record crests of 60.3 feet at Bastrop, 56.7 feet at La Grange, 51.6 feet at Columbus, 51.9 feet at Wharton and 56.1 feet at Bay City. Bastrop and La Grange are inundated. Reports describe rainfall as incessant for 64 hours, the river at Austin more than 10 miles wide, and floating buffalo carcasses in the river (indicating that some of the floodwaters originated in the High Plains). Damage is estimated at $3 million.

1900: Flood destroyed the Austin Dam.

1913: Flood merged the mouths of the Colorado and adjacent Brazos rivers, forming a lake 65 miles wide.

1915: Floodwaters from storms in April and September severely damage the second Austin Dam, completed in 1912. The structure will lie unrepaired for more than two decades until it is rebuilt by LCRA in the late 1930s.

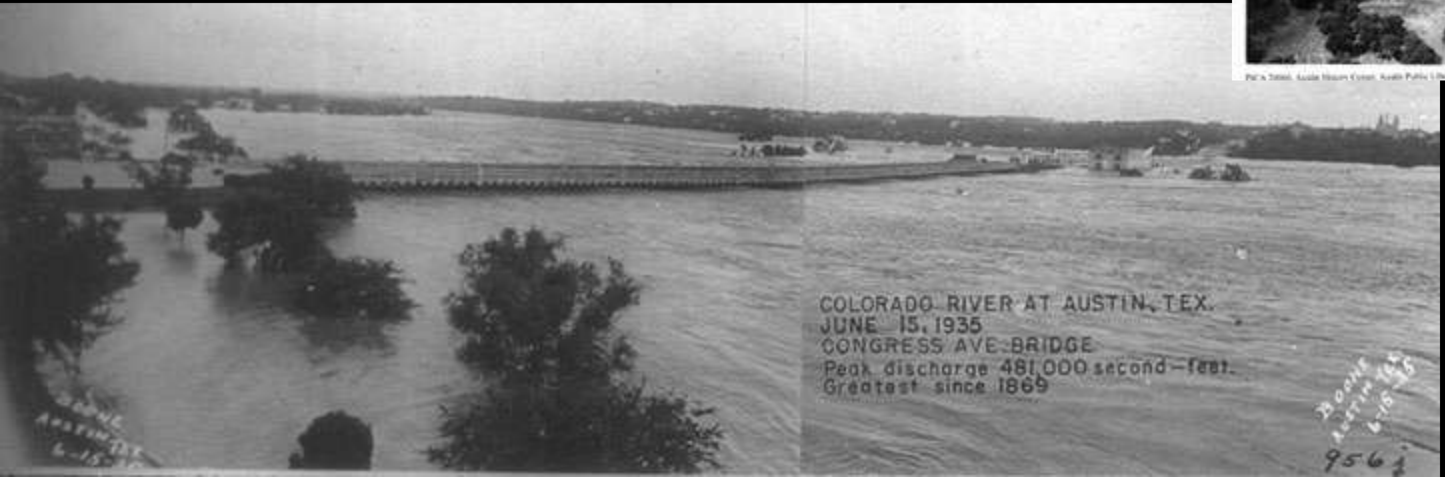


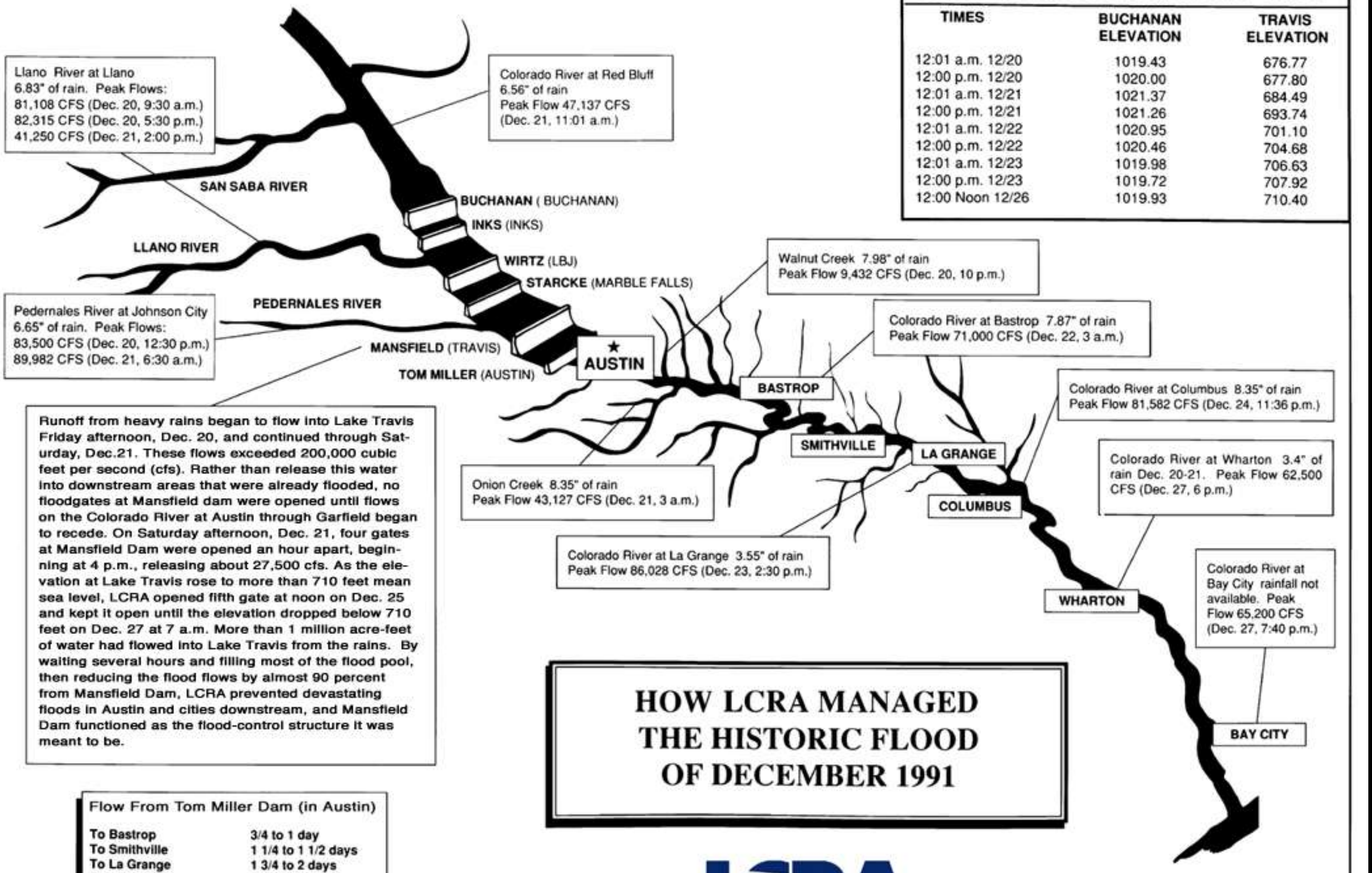
June 1935: Floodwaters from heavy Hill Country rains cause the Colorado River in Austin to crest at 50 feet, one foot below the 1869 record. The river overwhelms the Congress Avenue Bridge, cutting Austin in half. The Llano River rises to its highest recorded stage of 41½ feet, streamflow 388,000 cubic feet per second.

September 1936: Floodwaters from heavy rains throughout the basin pour through the Colorado River at Austin for a 20-day period, cresting at 31.4 feet. Earlier, floodwaters from a 30-inch rain on the Concho River had washed away nearly 300 buildings in San Angelo.

July 1938: Twenty inches of rain over 12 counties pour more than 3 million acre-feet of floodwaters into newly completed Lake Buchanan, forcing LCRA to open 22 of Buchanan Dam's 37 floodgates.

C08484-A Austin History Center, Austin Public Library





Levels at Lakes Buchanan and Travis

TIMES	BUCHANAN ELEVATION	TRAVIS ELEVATION
12:01 a.m. 12/20	1019.43	676.77
12:00 p.m. 12/20	1020.00	677.80
12:01 a.m. 12/21	1021.37	684.49
12:00 p.m. 12/21	1021.26	693.74
12:01 a.m. 12/22	1020.95	701.10
12:00 p.m. 12/22	1020.46	704.68
12:01 a.m. 12/23	1019.98	706.63
12:00 p.m. 12/23	1019.72	707.92
12:00 Noon 12/26	1019.93	710.40

Runoff from heavy rains began to flow into Lake Travis Friday afternoon, Dec. 20, and continued through Saturday, Dec.21. These flows exceeded 200,000 cubic feet per second (cfs). Rather than release this water into downstream areas that were already flooded, no floodgates at Mansfield dam were opened until flows on the Colorado River at Austin through Garfield began to recede. On Saturday afternoon, Dec. 21, four gates at Mansfield Dam were opened an hour apart, beginning at 4 p.m., releasing about 27,500 cfs. As the elevation at Lake Travis rose to more than 710 feet mean sea level, LCRA opened fifth gate at noon on Dec. 25 and kept it open until the elevation dropped below 710 feet on Dec. 27 at 7 a.m. More than 1 million acre-feet of water had flowed into Lake Travis from the rains. By waiting several hours and filling most of the flood pool, then reducing the flood flows by almost 90 percent from Mansfield Dam, LCRA prevented devastating floods in Austin and cities downstream, and Mansfield Dam functioned as the flood-control structure it was meant to be.

HOW LCRA MANAGED THE HISTORIC FLOOD OF DECEMBER 1991

Flow From Tom Miller Dam (in Austin)

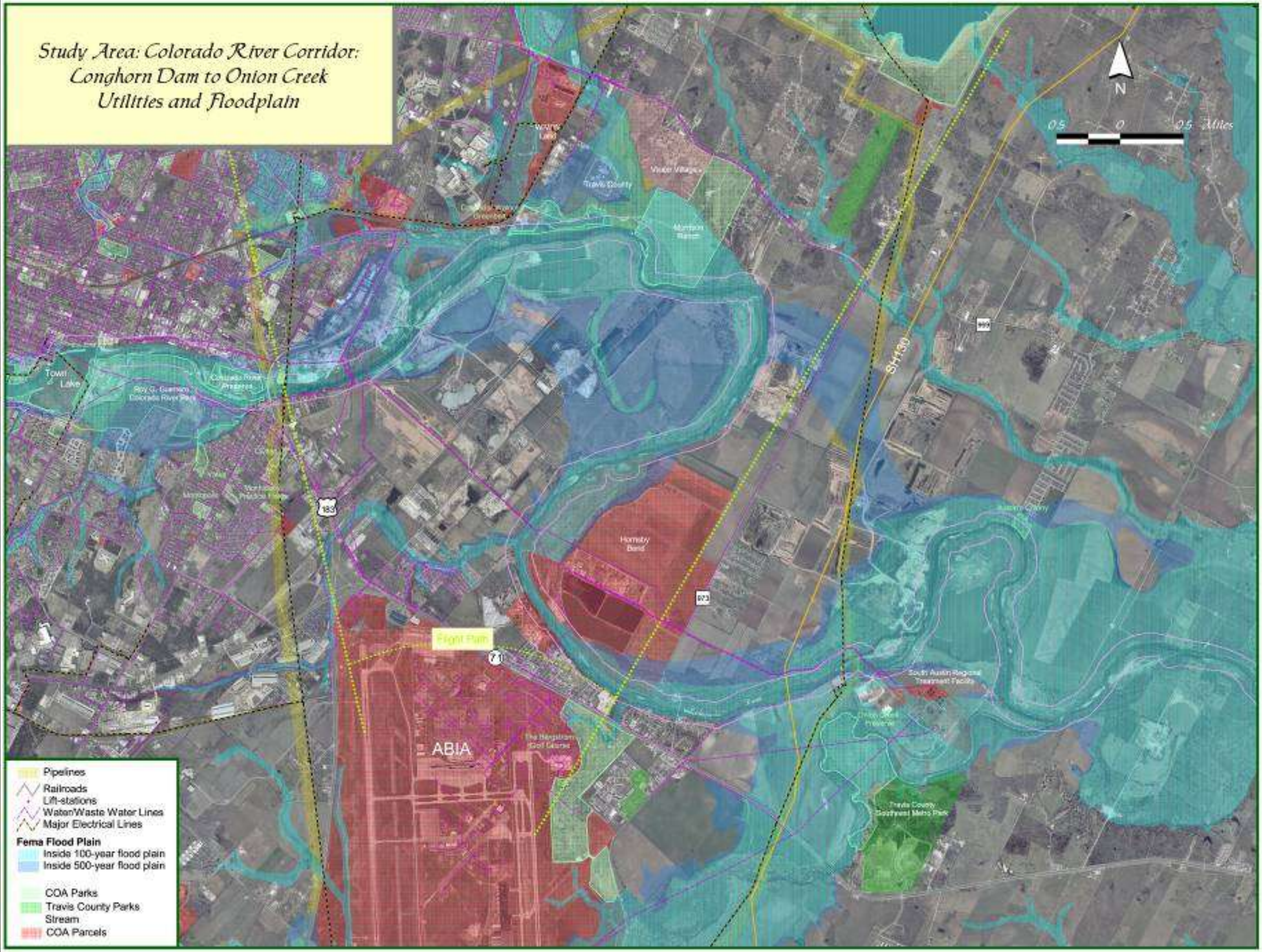
To Bastrop	**3/4 to 1 day**
To Smithville	**1 1/4 to 1 1/2 days**
To La Grange	**1 3/4 to 2 days**
To Columbus	**2 1/4 to 2 3/4 days**
To Wharton	**4 1/4 to 5 days**
To Bay City	**5 1/4 to 6 1/4 days**

ENERGY • WATER • COMMUNITY SERVICES

Lower Colorado River Authority
P.O. Box 220
Austin, Texas 78767-0220

Rainfall amounts from Dec. 20, 1991,12:01 a.m. until Dec. 24, 1991, Noon.
Information on this document is taken from records as of Dec. 31, 1991.

For recorded information on lake levels:
Call 1-800-776-5272, ask for lake levels: in Austin, 473-3333


Study Area: Colorado River Corridor:
Longhorn Dam to Onion Creek
Utilities and Floodplain
N
0.5
0
0.5 Miles
Town Lake
SH130
183
71
973
969
Flight Path
Hornsby Bend
ABIA
Pipelines
Railroads
Lift-stations
Water/Waste Water Lines
Major Electrical Lines
Fema Flood Plain
Inside 100-year flood plain
Inside 500-year flood plain
COA Parks
Travis County Parks
Stream
COA Parcels

Dangerous flash flood threatens Austin

Tropical Storm Hermine drops 10-15 inches of rain

Wednesday, 08 Sep 2010, 5:32 PM CDT

AUSTIN (KXAN) - An incredible flash flood developed early Wednesday morning in Central Texas as Tropical Depression Hermine lifted slowly northward from the Hill Country into the Big Country.

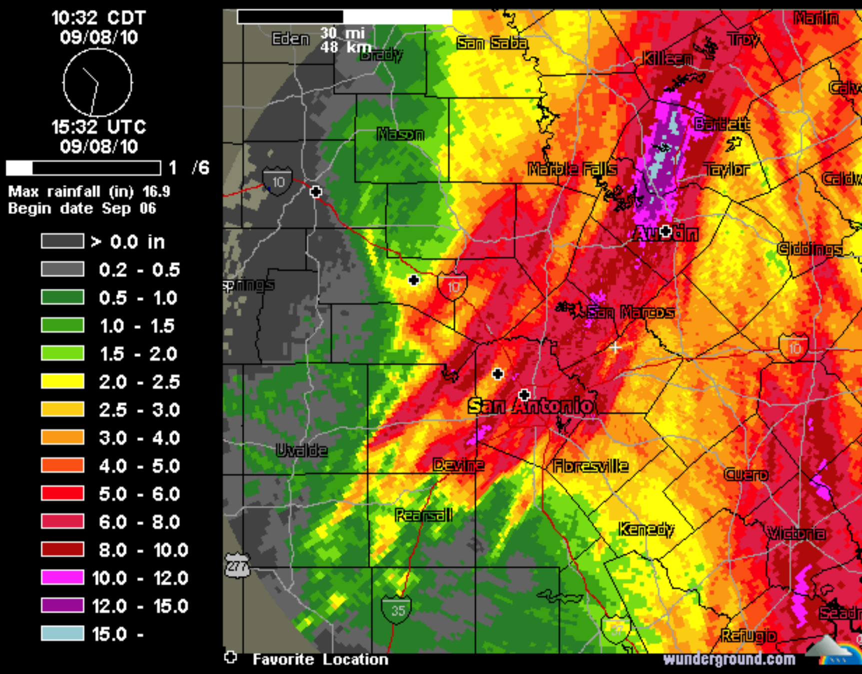
Some 6- to 15 inches of rain were reported in many locations from San Antonio to Killeen, including most of Hays, Travis and Williamson counties.

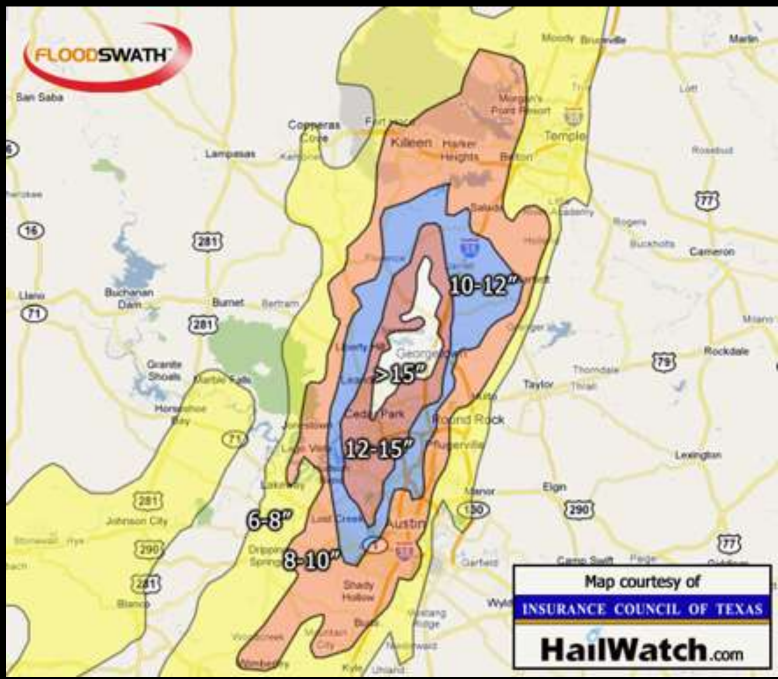
Numerous water rescues were reported overnight. Many roads were closed, and some evacuations were ordered, particularly in Williamson County.

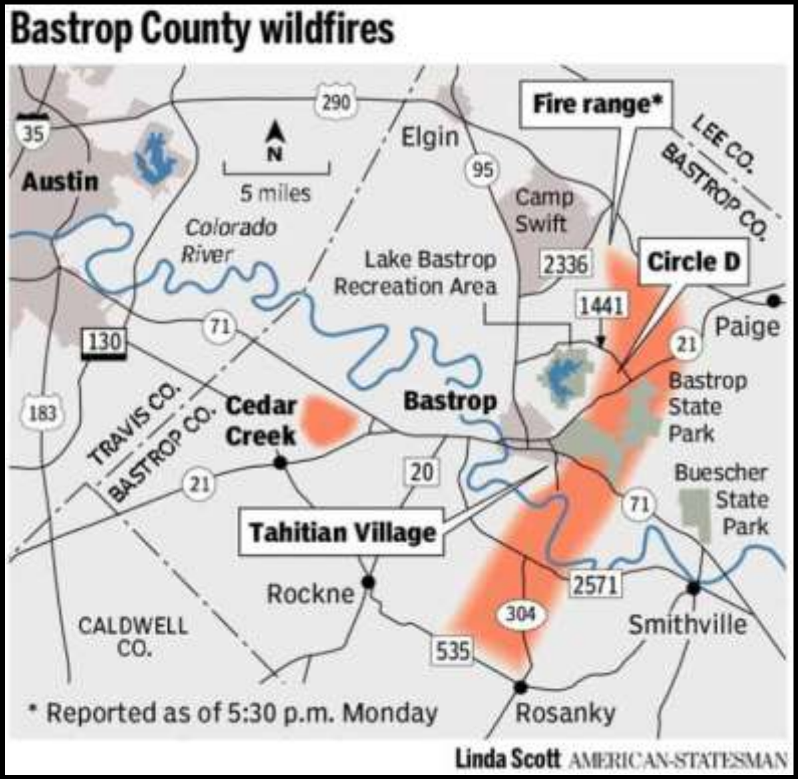
Brushy, Onion and Barton creeks and the Colorado River were all under Flood Warning early Wednesday.

Very heavy rain fell directly into Lake Austin, with more than 12 inches recorded at Mansfield Dam. Runoff from Bull Creek also flowed into the lake, forcing the LCRA to open flood gates on Tom Miller Dam.

As a result, the level of Lady Bird Lake was rising, causing minor flooding in low lying areas along Cesar Chavez and Austin High School.







September 2011

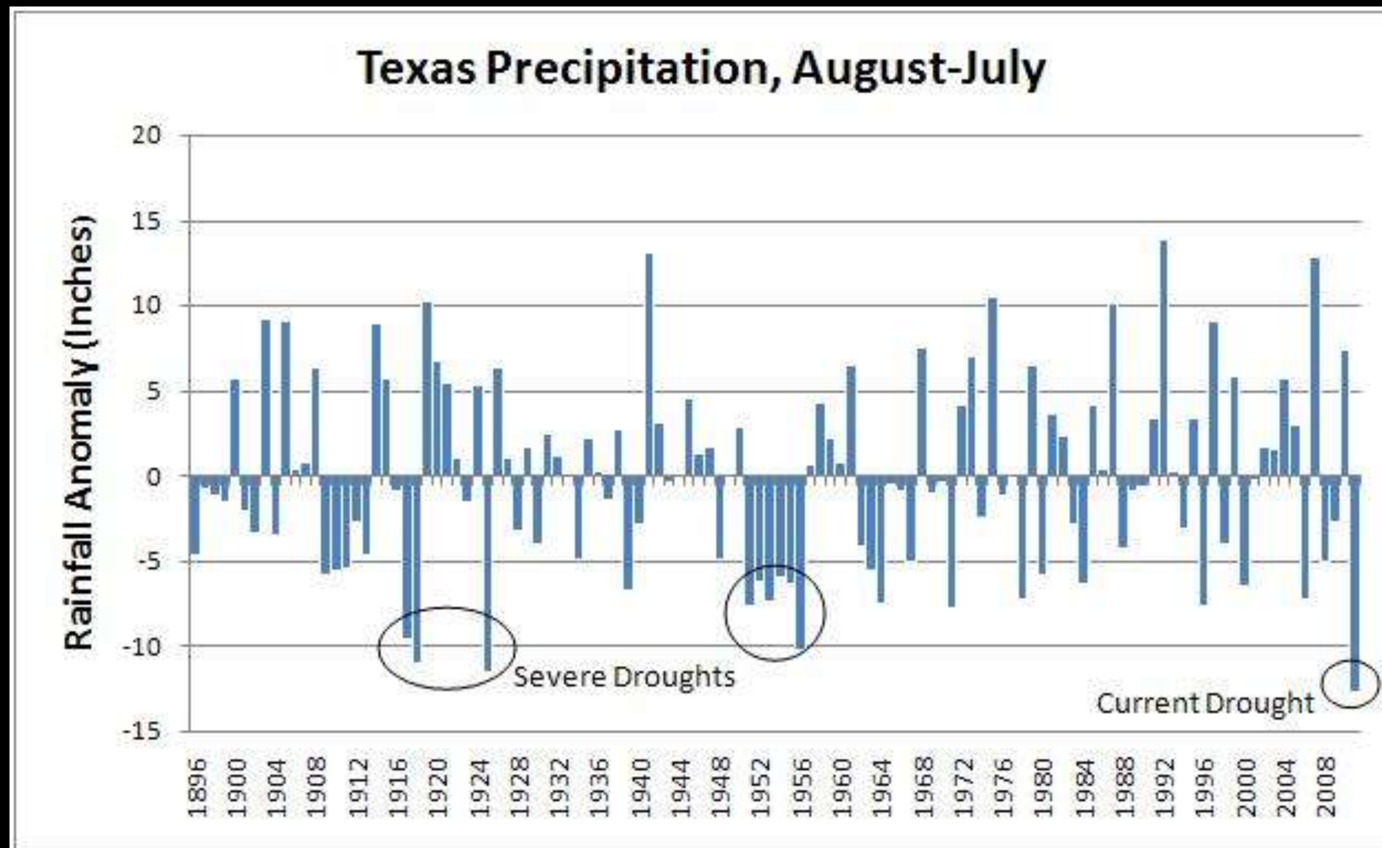
Worst Short Term Drought in Texas History

Driest October-September on record with 11.18 inches. Normal is 29.11. Record low was 13.91 inches Oct 1955-Sep 1956.

The Texas Drought 2011-12

The following table shows the 10 lowest monthly inflows into Highland Lakes on record.

Rank	Date	Inflows (acre-feet)
1	1952 - Aug.	210
2	1964 - July	347
3	2011 - Aug.	403
4	2011 - July	734
5	2011 - Sept.	922
6	2011 - June	1,341
7	1954 - Aug.	1,592
8	1954 - Sept.	2,194
9	2006 - Aug.	2,389
10	2000 - Aug.	2,584



Texas Paleoclimatic Record and Landscape Ecology

The paleoclimatic record of past droughts is a better guide than what is provided by the instrumental record alone of what we should expect in terms of the magnitude and duration of future droughts.

For example, paleoclimatic data suggest that droughts as severe at the 1950s drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in 20th century have occurred in parts of North American as recently as 500 years ago.

This data indicates that we should be aware of the possibility of such droughts occurring in the future as well. The occurrence of such sustained drought conditions today would be a natural disaster of a magnitude unprecedented in the 20th century.

Changing scene. Based on findings from pack rat middens, this artist's conception shows what Hueco Tanks may have looked like some 12,000 to 14,000 years ago (far left), some 9,300 years ago (middle) and as it appears today (right).

The Habitats of Austin

Retrospective Ecological Context

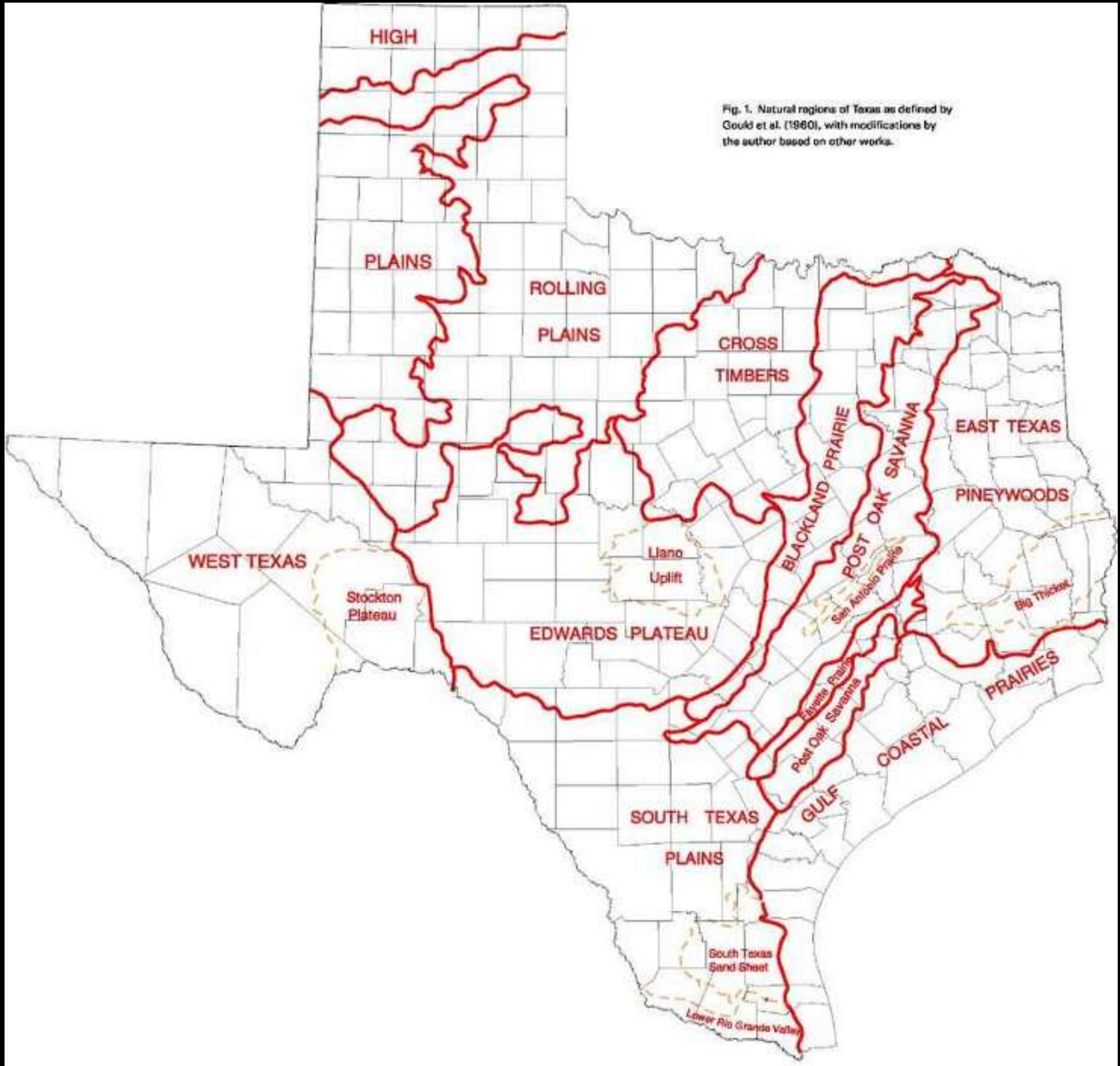


Fig. 1. Natural regions of Texas as defined by Gould et al. (1960), with modifications by the author based on other works.

West

Live Oak- Ash Juniper Forest

Cedar, Ash Juniper *Juniperus ashei*

Live Oak *Quercus fusiformis*

East - Blackland Prairie and Post Oak Savannah

Post Oak *Quercus stellata*

Eastern Red Cedar

Juniperus virginiana

State Grass of Texas?

Sideoats Gramma *Bouteloua curtipendula*

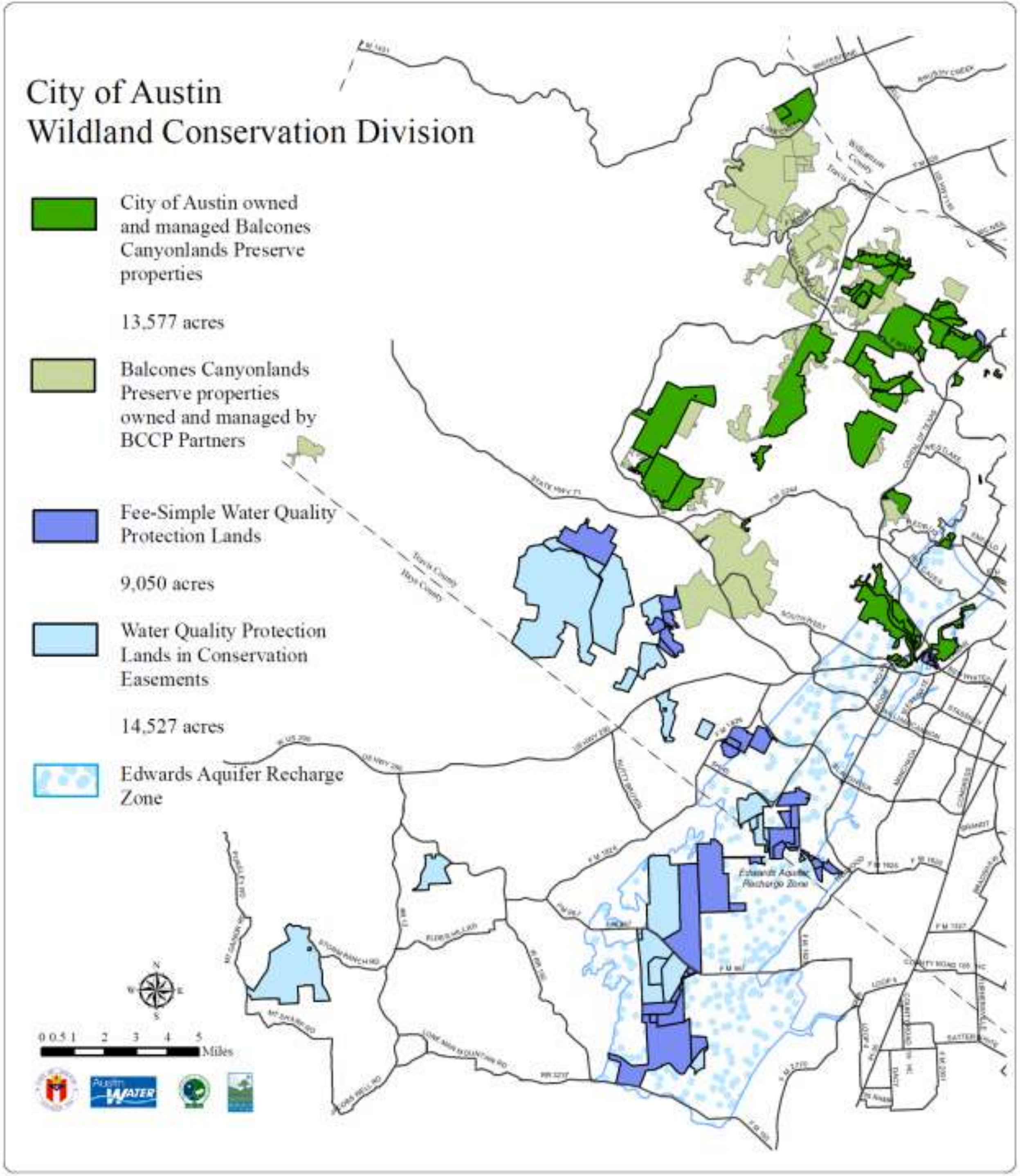
West

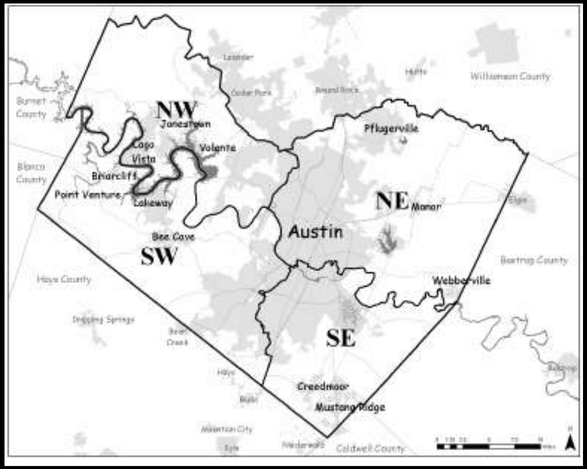
Aquifer

and

Habitat

Protection





Travis County and City of Austin

Money spent and acreage acquired park and open space land with bond money 1993-2005

NORTHWEST TRAVIS COUNTY/COA

5,795 ACRES

$23,021,609

SOUTHWEST TRAVIS COUNTY/COA

23,869 ACRES

$109,282,453

TOTAL $ FOR WEST
$132,304,062

TOTAL ACRES FOR WEST
29,664

NORTHEAST TRAVIS COUNTY/COA

1,121 ACRES

$18,787,968

SOUTHEAST TRAVIS COUNTY/COA

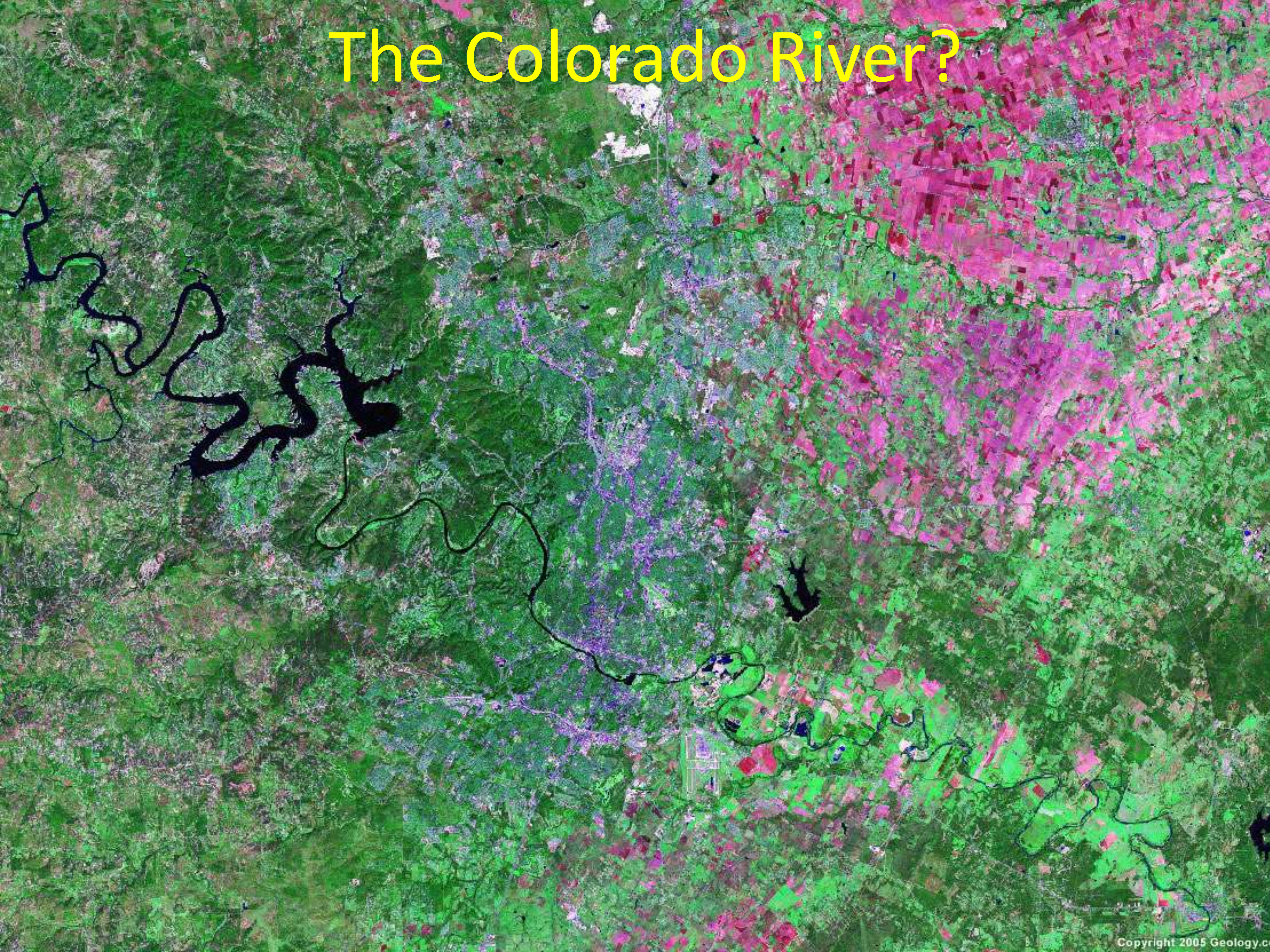
463 ACRES

$3,448,667

TOTAL $ FOR EAST
$22,236,635

TOTAL ACRES FOR EAST
1584

The Colorado River?



The Colorado River

Forgotten Bottomland Forest

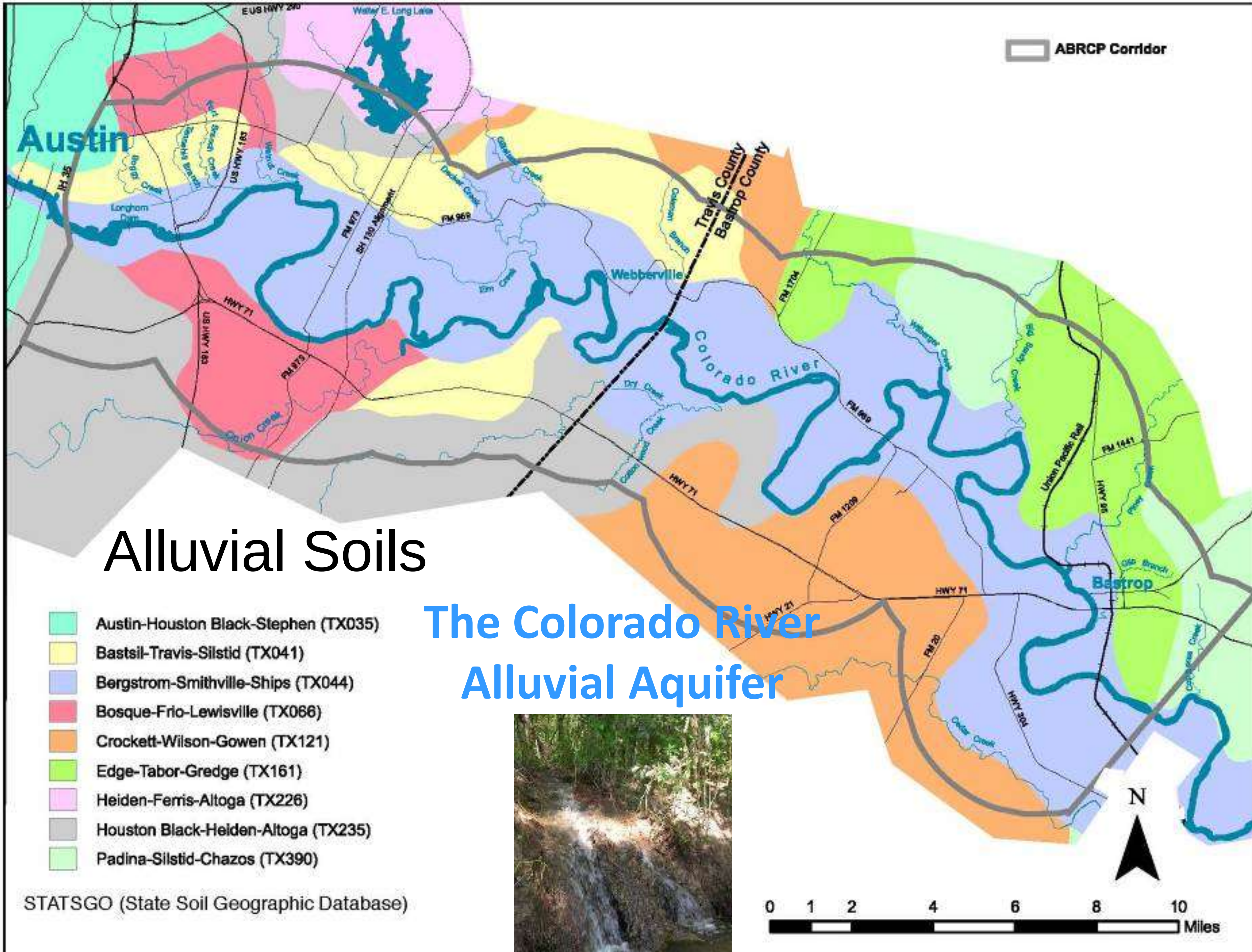
El Monte Grande (del Diablo!)
Early Spanish accounts of the Colorado
Monte – a sizable almost impenetrable forest – a thicket



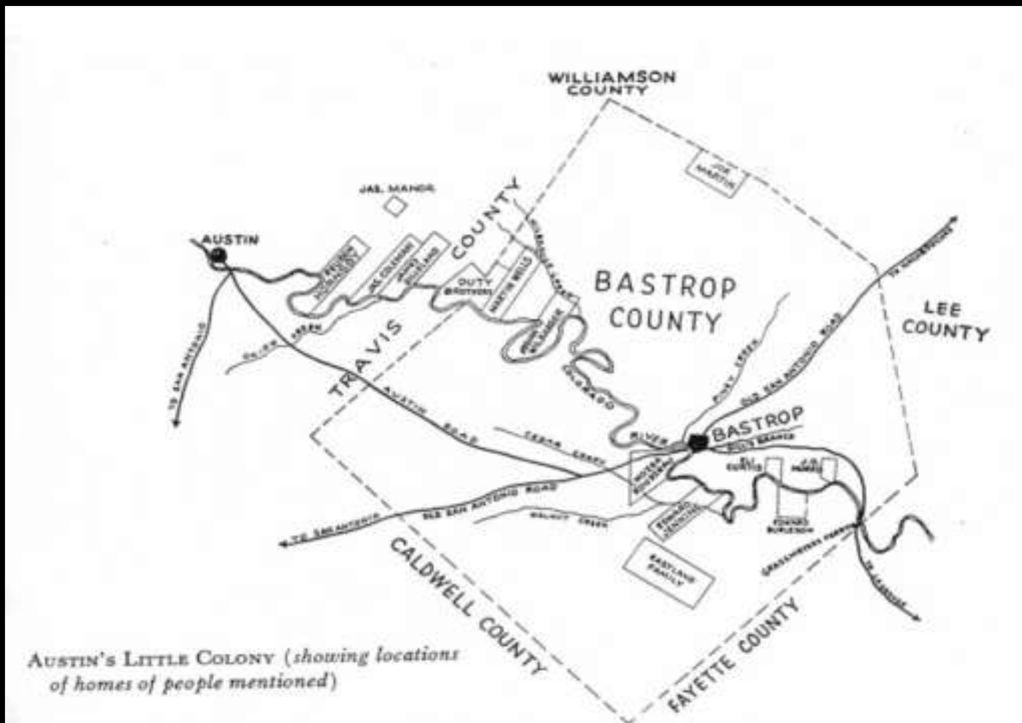



Alluvial Soils

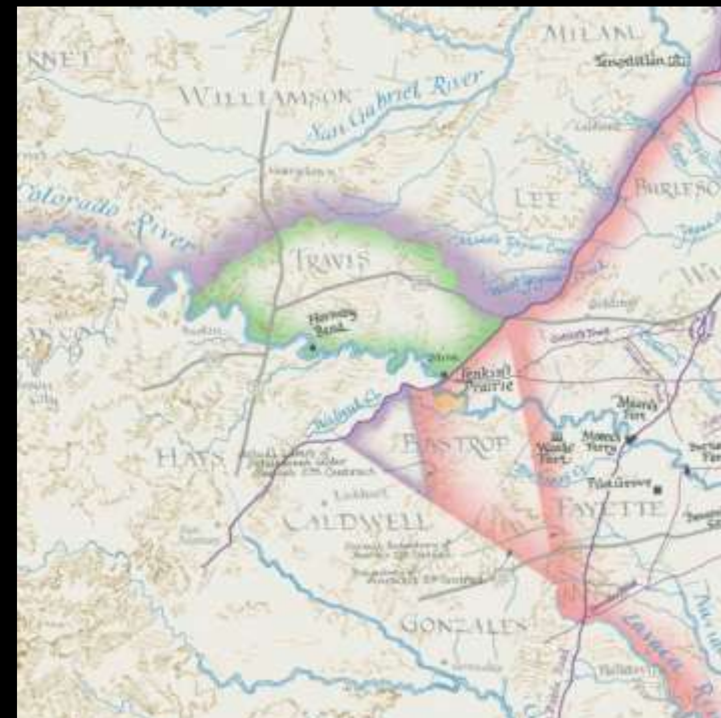
The Colorado River Alluvial Aquifer



Settlement begins 1820's along river corridor and destroys the bottomland forest

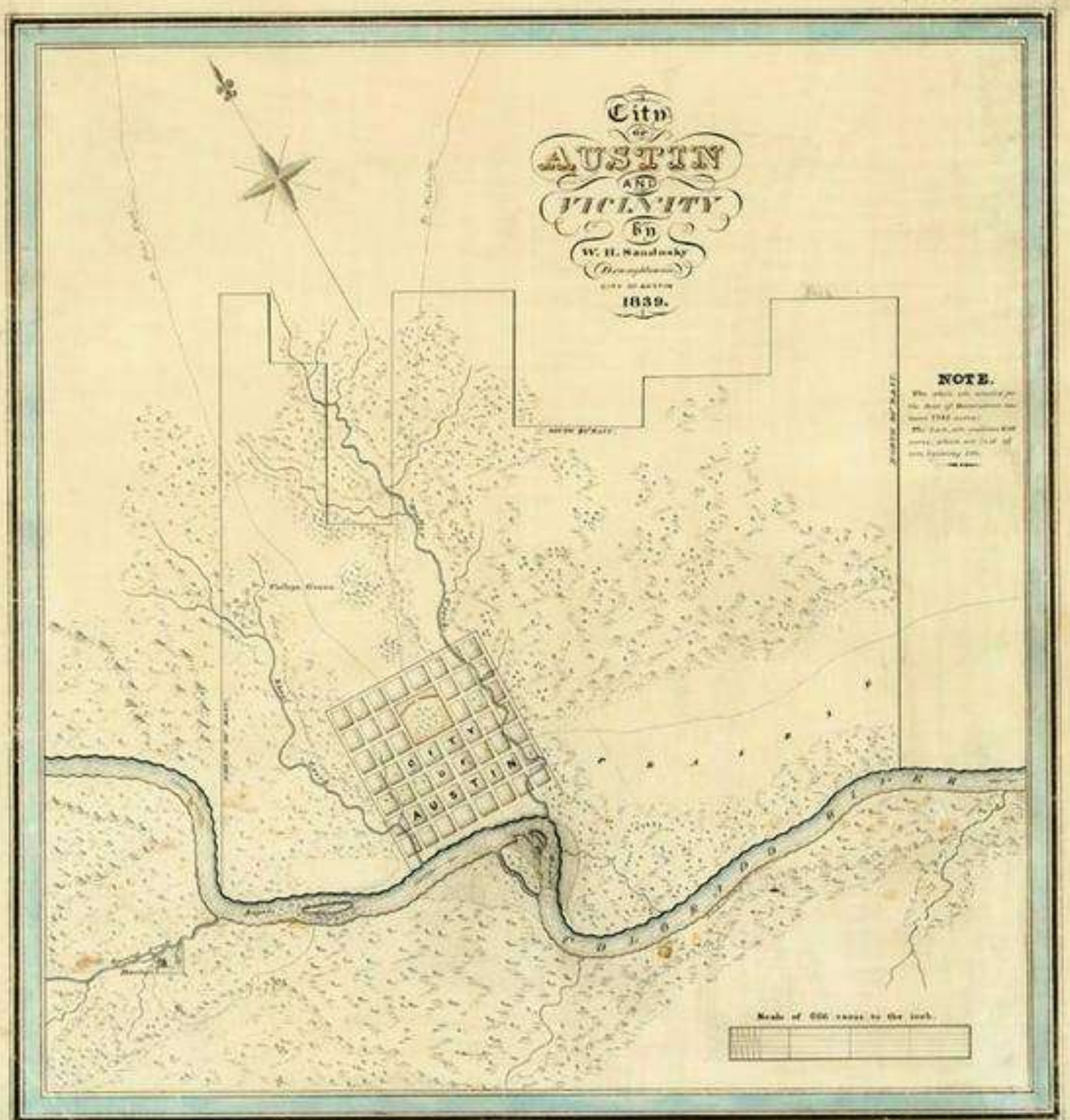


Austin's Little Colony (*showing locations of homes of people mentioned*)



When was the City of Austin founded?

1839


City
AUSTIN
AND
VICINITY
by
W. H. Sandusky
1839.
NOTE.
CITY
OF
AUSTIN

Urbanization and Landscape Ecology

Austin, Texas

Population - Austin—MSA

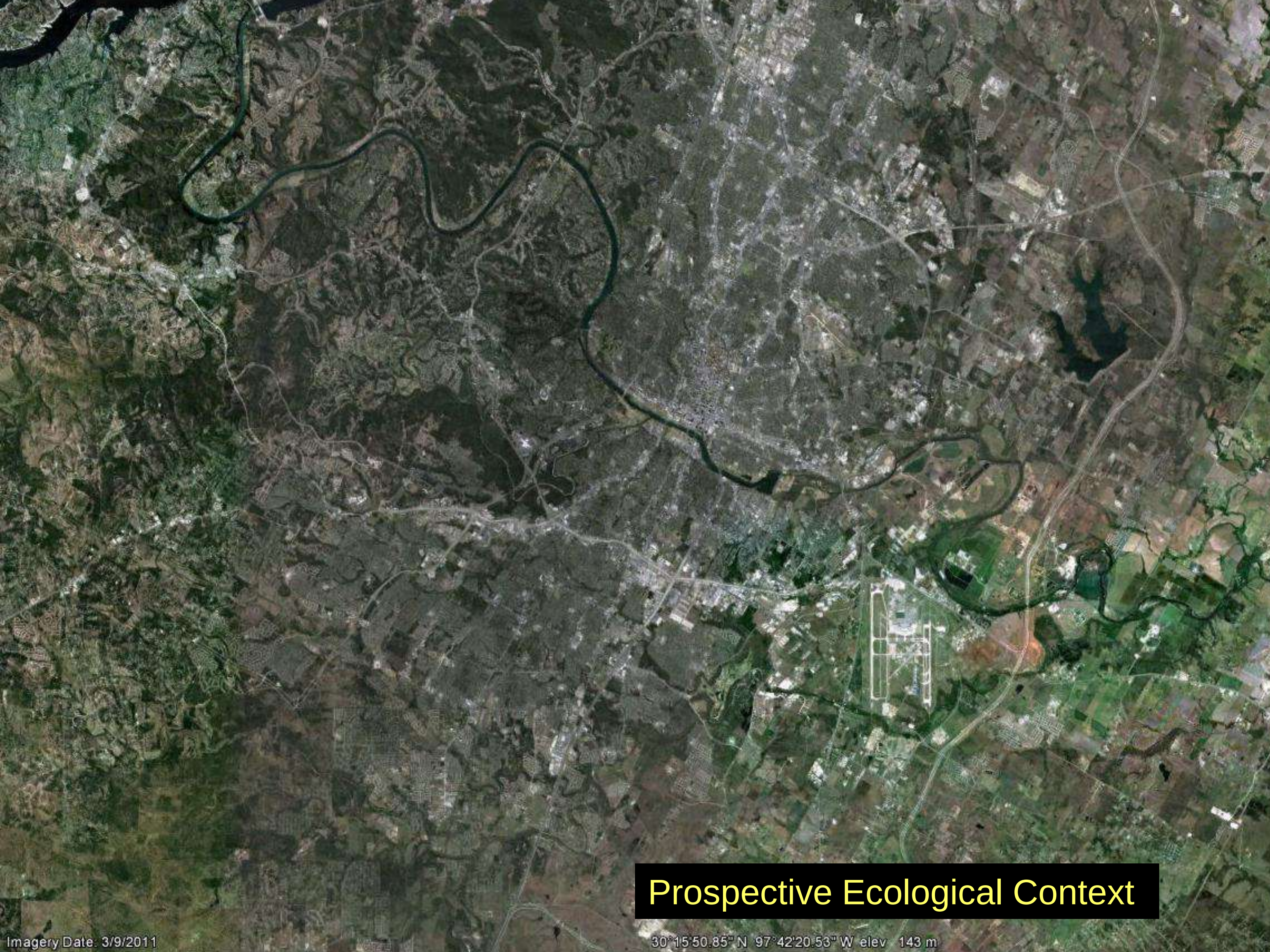
1,818,740 (2012)

Austin Area Population Histories and Forecasts

Year	City of Austin Total Area Population	Annualized Growth Rate	City of Austin Full Purpose Population	City of Austin Limited Purpose Population	Travis County	Annualized Growth Rate	Five County MSA(1)	Annualized Growth Rate
1940	87,930				111,053		214,603	
1950	132,459	4.2%			160,980	3.8%	256,645	1.8%
1960	186,545	3.5%			212,136	2.8%	301,261	1.6%
1970	251,808	3.0%			295,516	3.4%	398,938	2.8%
1980	345,890	3.2%			419,573	3.6%	585,051	3.9%
1990	465,622	3.0%			576,407	3.2%	846,227	3.8%
2000	**656,562**	**3.5%**	**639,185**	**17,377**	**812,280**	**3.5%**	**1,249,763**	**4.0%**
2001	669,693	2.0%	654,019	15,674	830,150	2.2%	1,314,344	5.2%
2002	680,899	1.7%	667,705	13,194	844,263	1.7%	1,353,122	3.0%
2003	687,708	1.0%	674,382	13,326	856,927	1.5%	1,382,675	2.2%
2004	692,102	0.64%	678,769	13,333	874,065	2.00%	1,419,137	2.6%
2005	700,407	1.20%	687,061	13,346	893,295	2.20%	1,464,563	3.2%
2006	718,912	2.64%	707,952	10,960	920,544	3.05%	1,527,040	4.3%
2007	735,088	2.25%	724,117	10,971	948,160	3.00%	1,592,590	4.3%
2008	750,525	2.10%	739,543	10,982	978,976	3.25%	1,648,331	3.5%
2009	774,037	3.13%	765,957	8,080	1,008,345	3.00%	1,706,022	3.50%
2010	785,850	1.53%	774,636	11,214	1,033,553	2.50%	1,752,938	2.75%
2011	793,708	1.00%	782,483	11,225	1,059,392	2.50%	1,801,144	2.75%
2012	803,630	1.25%	792,393	11,236	1,085,877	2.50%	1,850,675	2.75%
2013	813,675	1.25%	802,427	11,248	1,113,024	2.50%	1,901,569	2.75%
2014	825,880	1.50%	814,621	11,259	1,143,632	2.75%	1,958,616	3.00%
2015	838,268	1.50%	826,998	11,270	1,175,082	2.75%	2,017,374	3.00%
2016	850,842	1.50%	839,561	11,281	1,207,397	2.75%	2,077,895	3.00%
2017	865,732	1.75%	854,440	11,293	1,243,619	3.00%	2,145,427	3.25%
2018	880,883	1.75%	869,579	11,304	1,280,927	3.00%	2,215,153	3.25%
2019	896,298	1.75%	884,983	11,315	1,319,355	3.00%	2,287,146	3.25%
2020	909,742	1.50%	898,416	11,327	1,355,637	2.75%	2,355,760	3.00%
2025	980,051	1.50%	968,713	11,338	1,552,575	2.75%	2,730,972	3.00%
2030	1,055,793	1.50%	1,044,444	11,349	1,756,596	2.50%	3,127,709	2.75%
2035	1,123,451	1.25%	1,112,090	11,361	1,963,309	2.25%	3,538,716	2.50%
2040	1,180,758	1.00%	1,169,386	11,372	2,167,651	2.00%	4,003,732	2.50%

SOURCE: Ryan Robinson, City Demographer, Department of Planning, City of Austin. January 2010.

NOTES: 1) The Five County Austin MSA wholly includes these counties: Bastrop, Caldwell, Hays, Travis and Williamson
2) Population figures are as of April 1 of each year.
3) Historical and current period population figures for the City of Austin take into account annexations that have occurred
4) Forecasted population figures for the City of Austin do not assume any future annexation activity


Prospective Ecological Context
Imagery Date: 3/9/2011
30°15'50.85" N 97°42'20.53" W elev 143 m

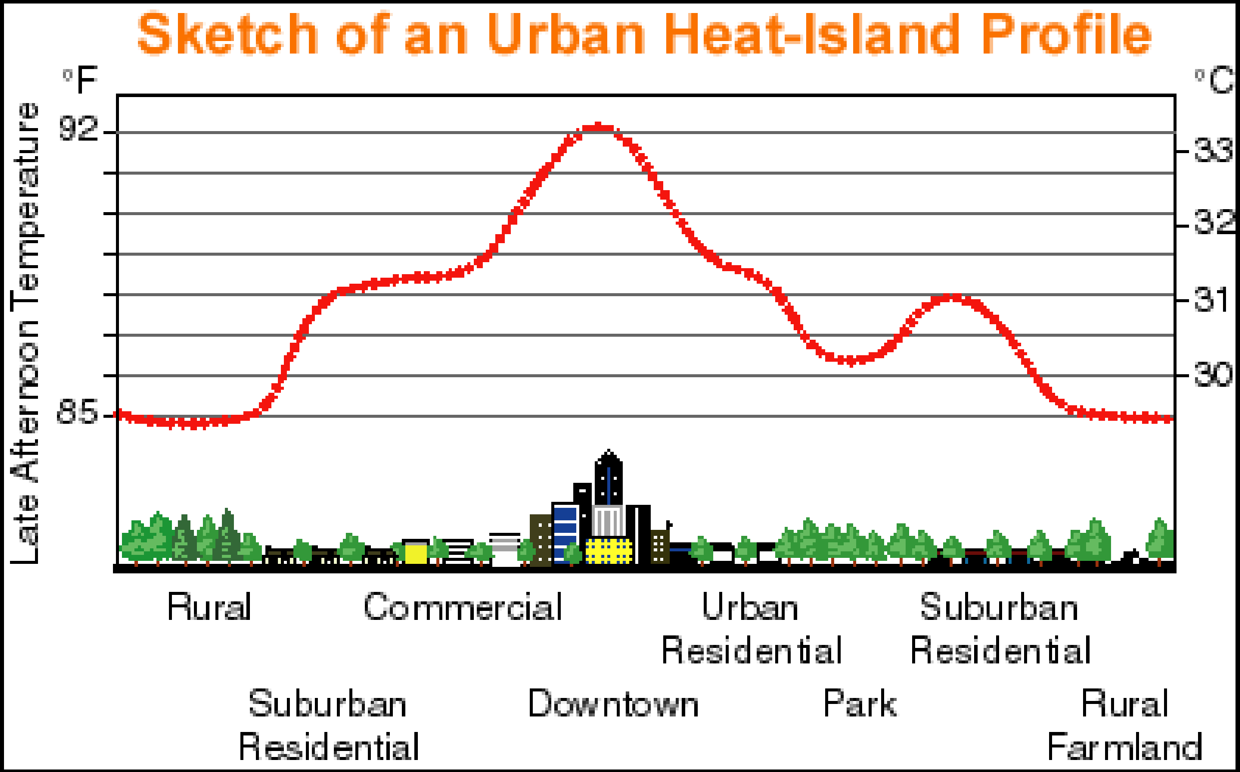
STRETCH!!

Characteristics of an Urban Ecosystem

- Temperature
- Water
- Flora
- Fauna
- Soils

Characteristics of an Urban Ecosystem

Temperature



Hardscape, reduction in vegetation

Increased Daytime and Nighttime Temperature

Reduced Air Quality

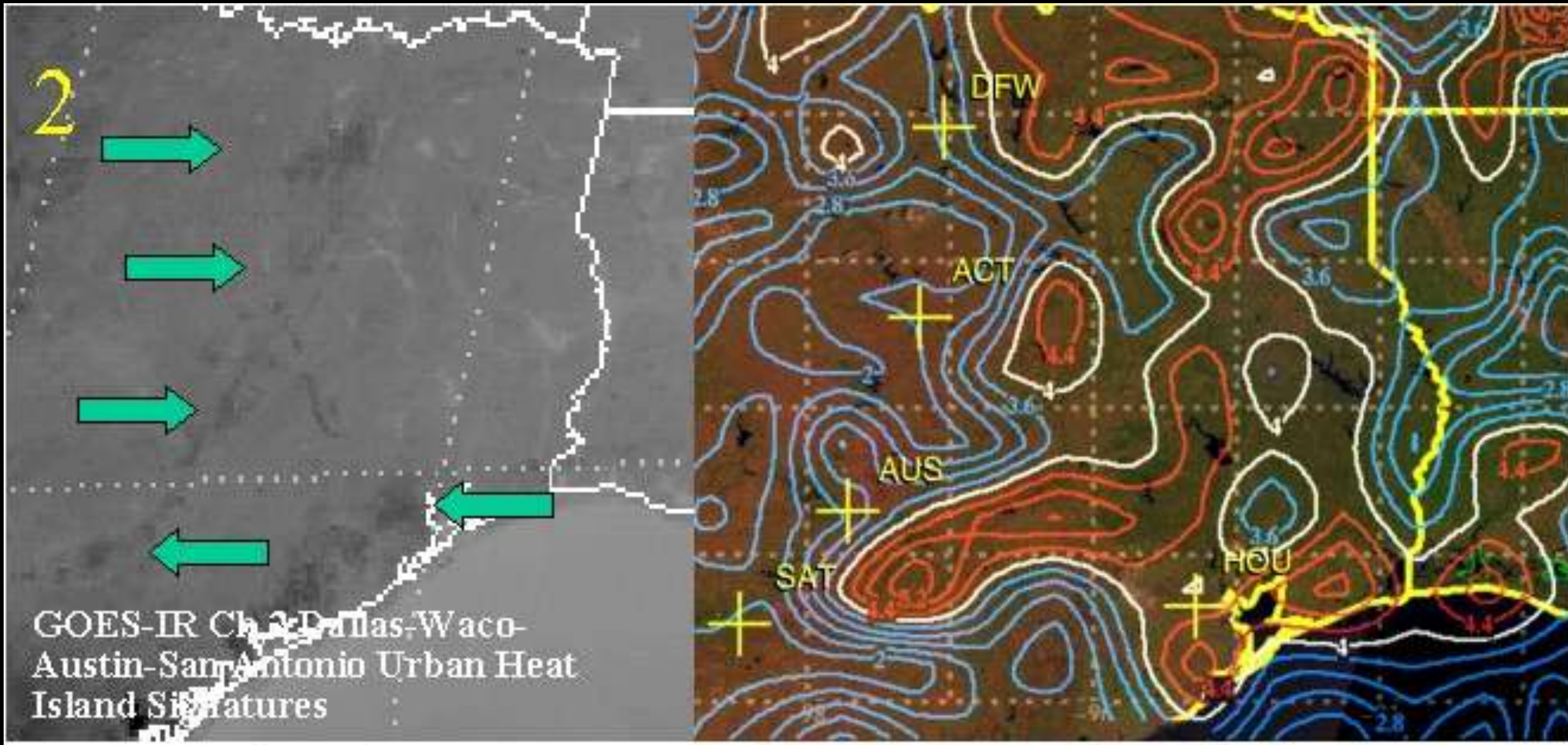


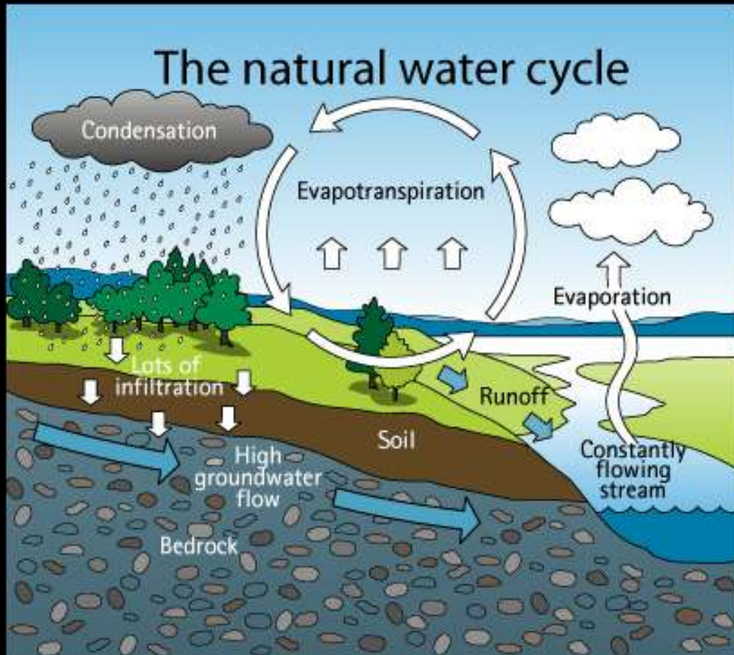
figure 2a figure 2b

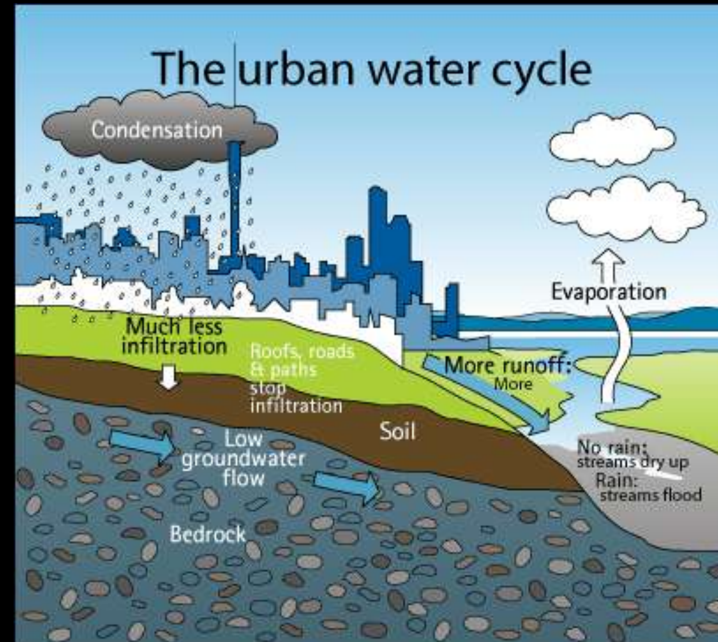
Alternative Surfaces

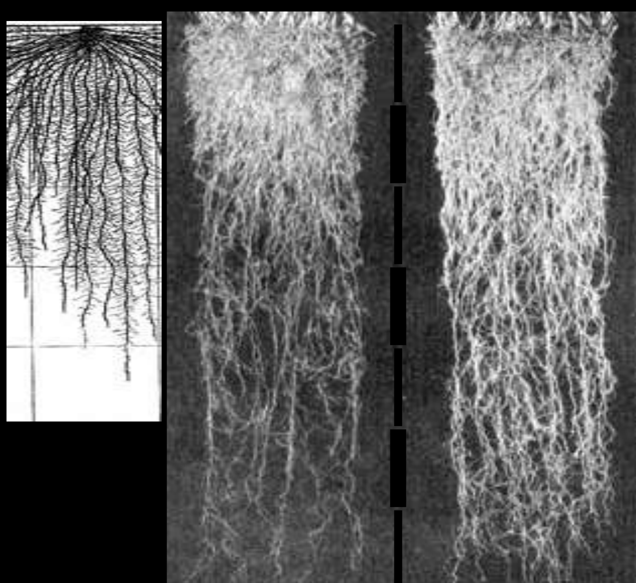
Characteristics of an Urban Ecosystem

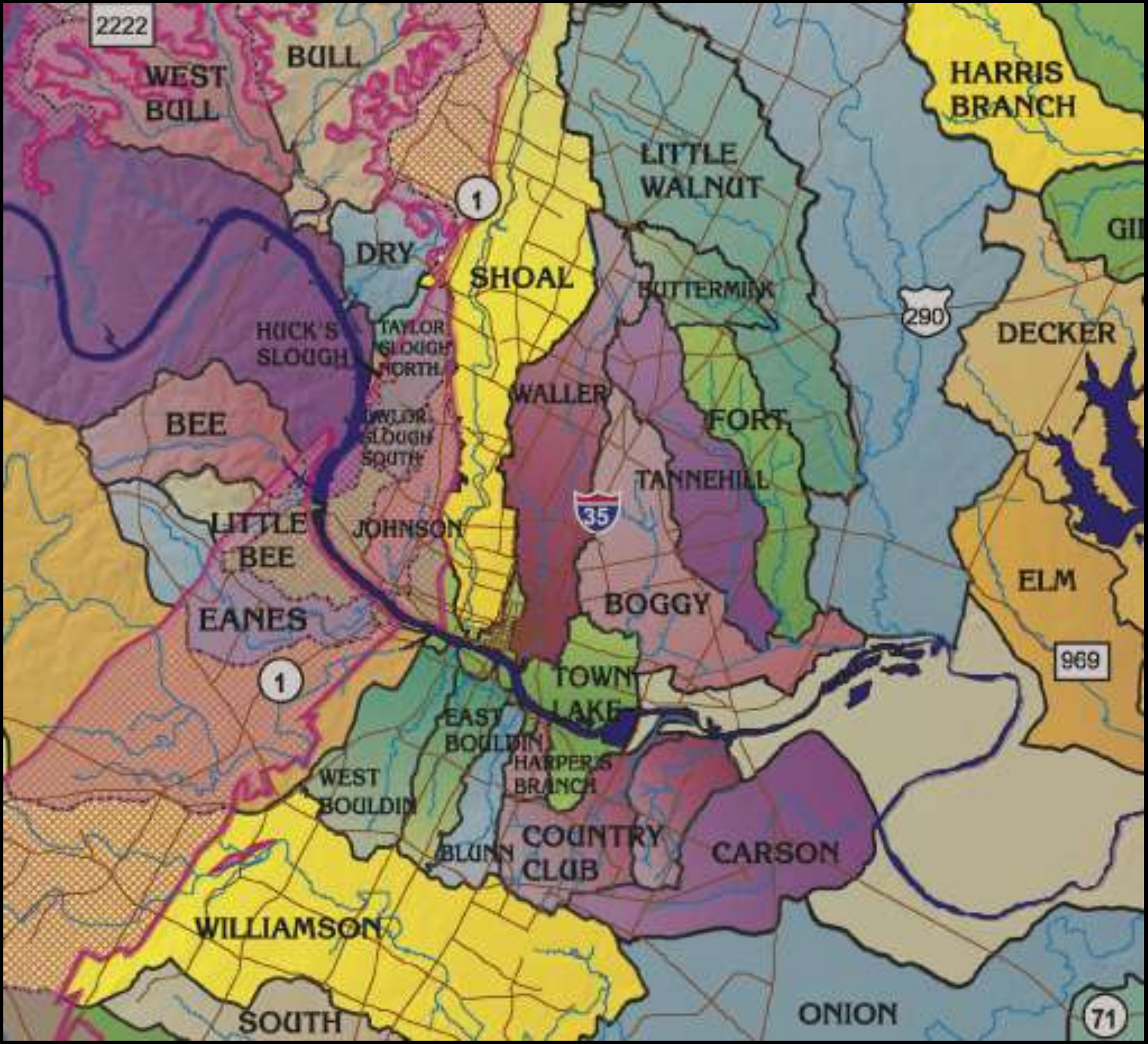
Water

- Urban infrastructure
- Impervious cover
- Erosion
- Channelization
- Pollution
- Riparian


The natural water cycle
Condensation
Evapotranspiration
Evaporation
Lots of infiltration
Runoff
Soil
High groundwater flow
Constantly flowing stream
Bedrock

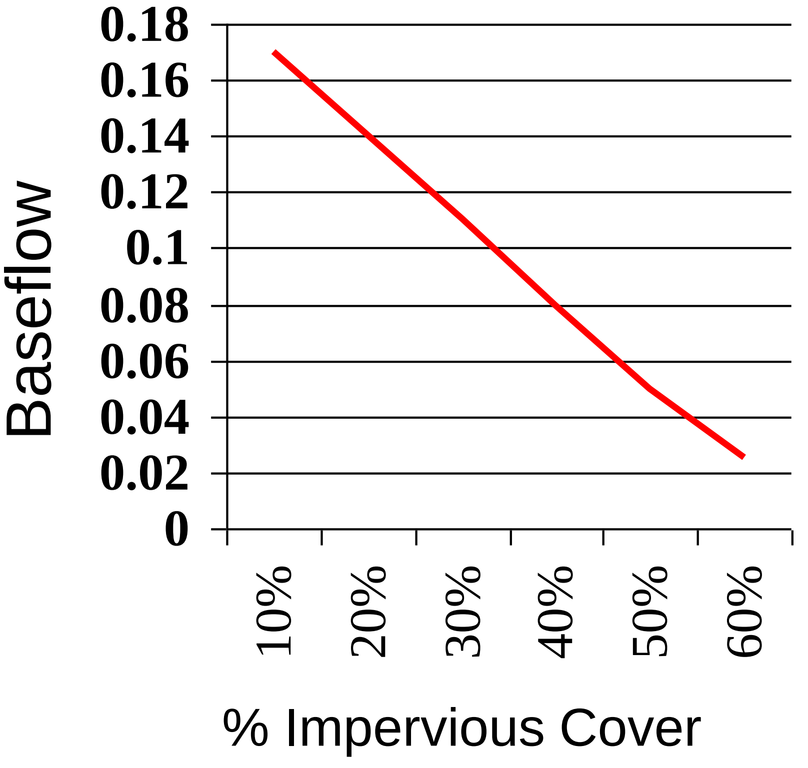

The urban water cycle
Condensation
Evaporation
Much less infiltration
Roofs, roads & paths stop infiltration
More runoff:
More
Soil
Low groundwater flow
No rain: streams dry up
Rain: streams flood
Bedrock




2222
BULL
WEST BULL
1
LITTLE WALNUT
HARRIS BRANCH
DRY
SHOAL
BUTTERMILK
290
DECKER
HUCK'S SLOUGH
TAYLOR SLOUGH NORTH
WALLER
BEE
TAYLOR SLOUGH SOUTH
FORT
TANNEHILL
35
LITTLE BEE
JOHNSON
ELM
BOGGY
EANES
969
1
TOWN LAKE
EAST BOULDIN
HARPER'S BRANCH
WEST BOULDIN
COUNTRY CLUB
BLUNN
CARSON
WILLIAMSON
SOUTH
ONION
71

Creek Baseflow Losses

Baseflow: Stream flow due to groundwater seepage, not runoff



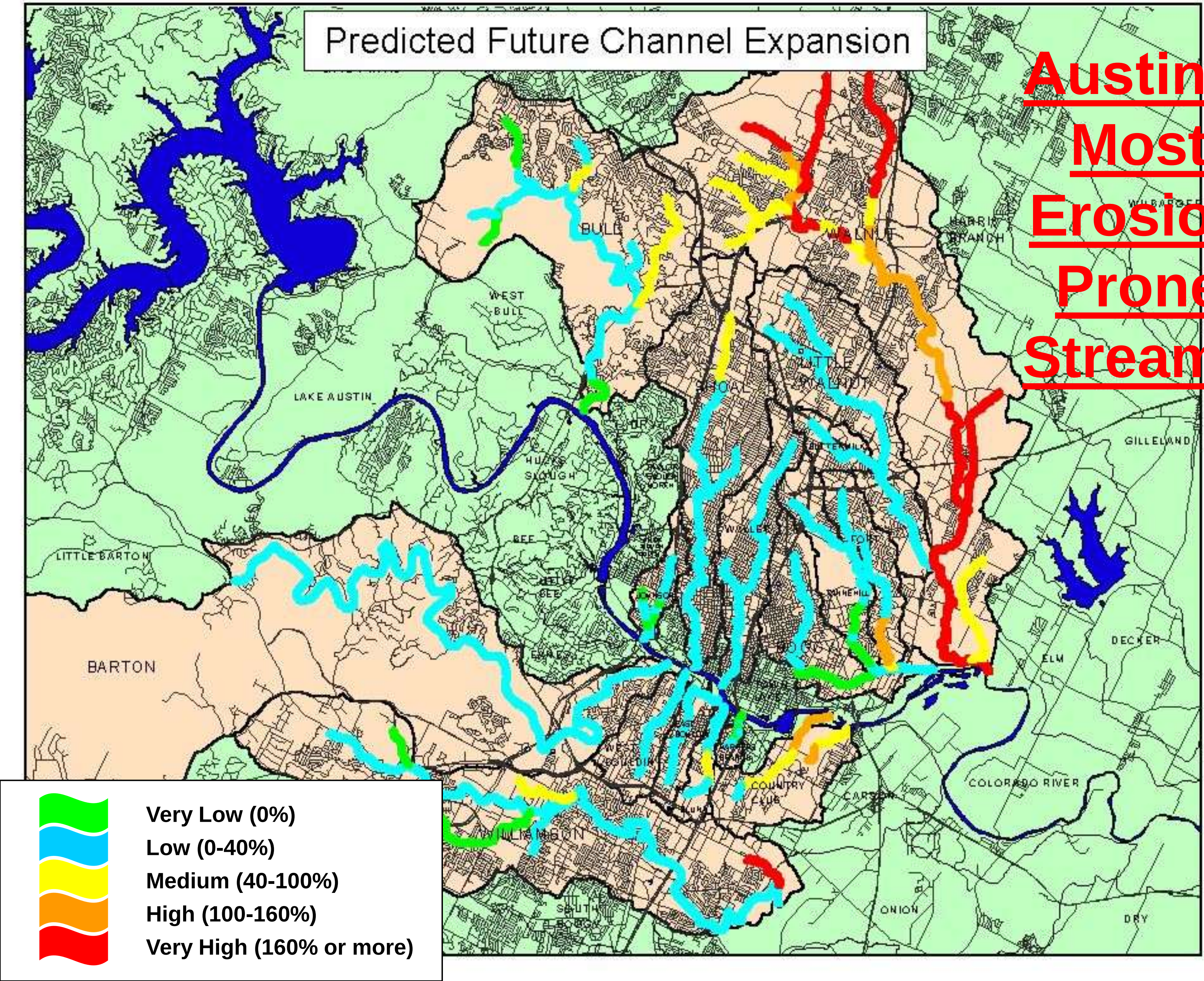
Baseflow = Subsurface Infiltration

Source: CRWR

Urban Growth and Watershed Protection

Disconnect between management and ecology

Austin's Most Erosion Prone Streams






The Riparian Sponge

One of the attributes of a properly functioning riparian area is the sponge effect and water storage capacity within the riparian area. This does not refer to water storage in the creek channel itself, but water detention in the land. This large absorbent sponge of riparian land will soak up, store, and then slowly release water over a prolonged period. This riparian sponge can be managed in a way to greatly increase and improve this storage or it can be managed in a way to decrease and degrade water storage.

Roots!

TEXAS RIPARIAN ASSOCIATION

West Bouldin Creek South 6th Street


before


after

Tannehill Branch Creek Givens Park


before


after

Blunn Creek Stacy Park


before

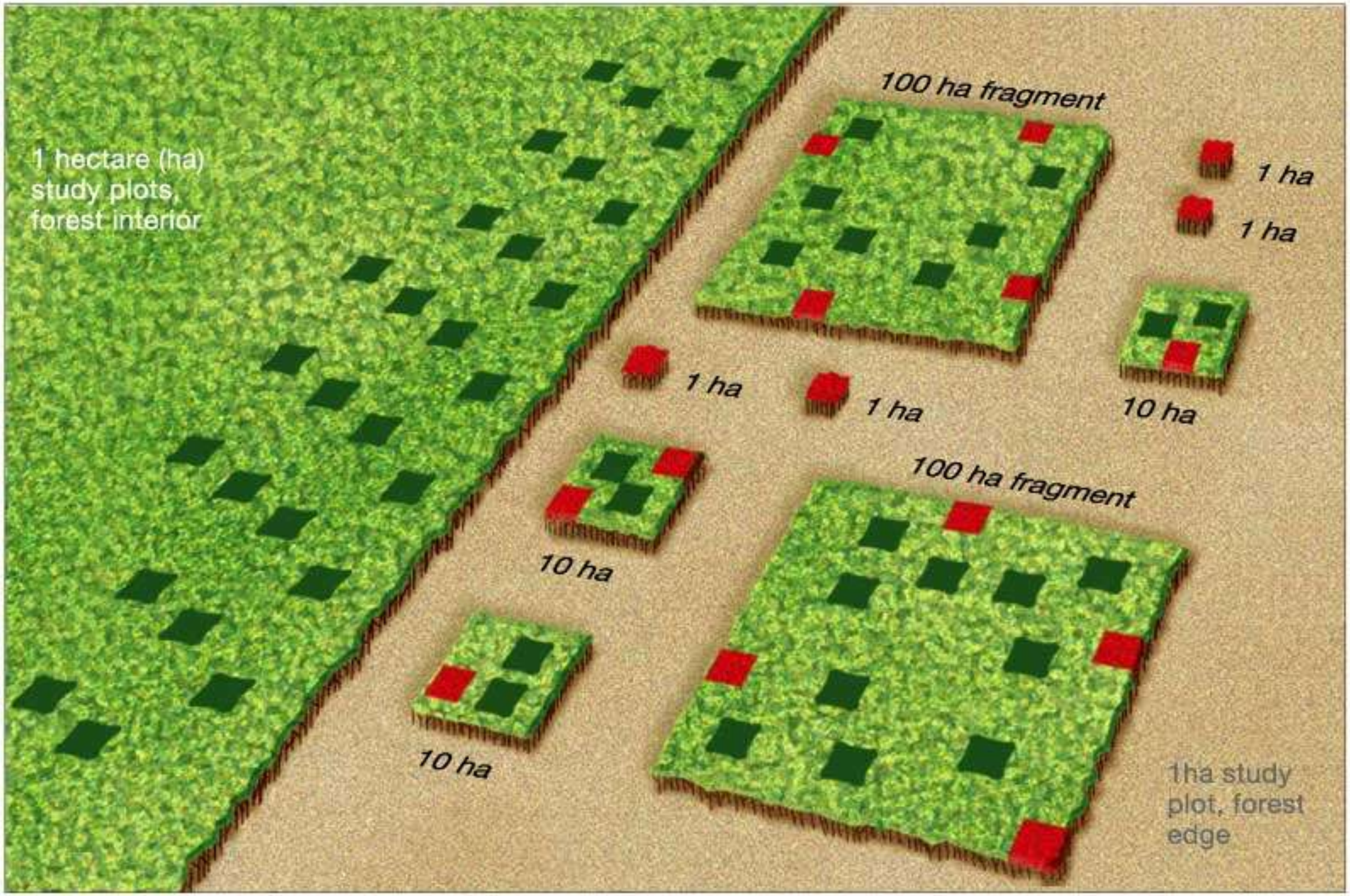

after

Characteristics of an Urban Ecosystem

Flora

- Fragmentation
- Edges
- Disturbance
- Understory loss
- Non-native Species

Forest fragmentation experiment in Brazil



Unfragmented Fragmented


GlobeXplorer™
© 2002 GlobeXplorer, AirPhotoUSA

Understory loss, reduced diversity

Characteristics of an Urban Ecosystem

Fauna

- Generalists
- Predators
- Non-native Species








Monk Parakeets

Congress Avenue Bridge 1.5 -2 Million

Mexican Free-tailed Bats

Characteristics of an Urban Ecosystem

Soil – Ecology from the Ground Up

- Compaction
- Low Organic Matter
- High pH
- Low water drainage
- Limited nutrient cycling
- Pollution
- High soil temperatures

Impoverished Soil Ecosystems of Texas

Farmland

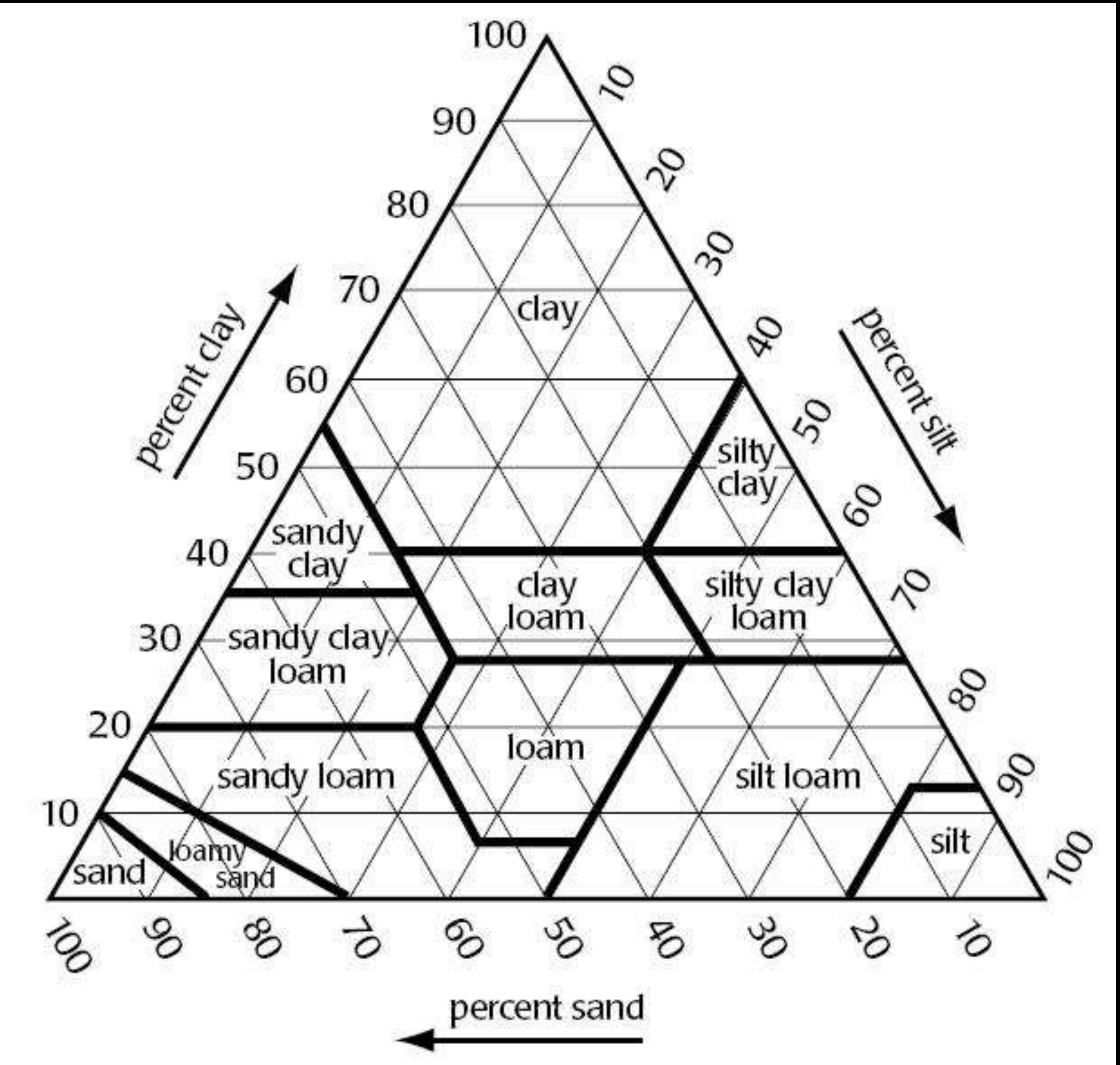
Rangeland

Wildland/Greenspace

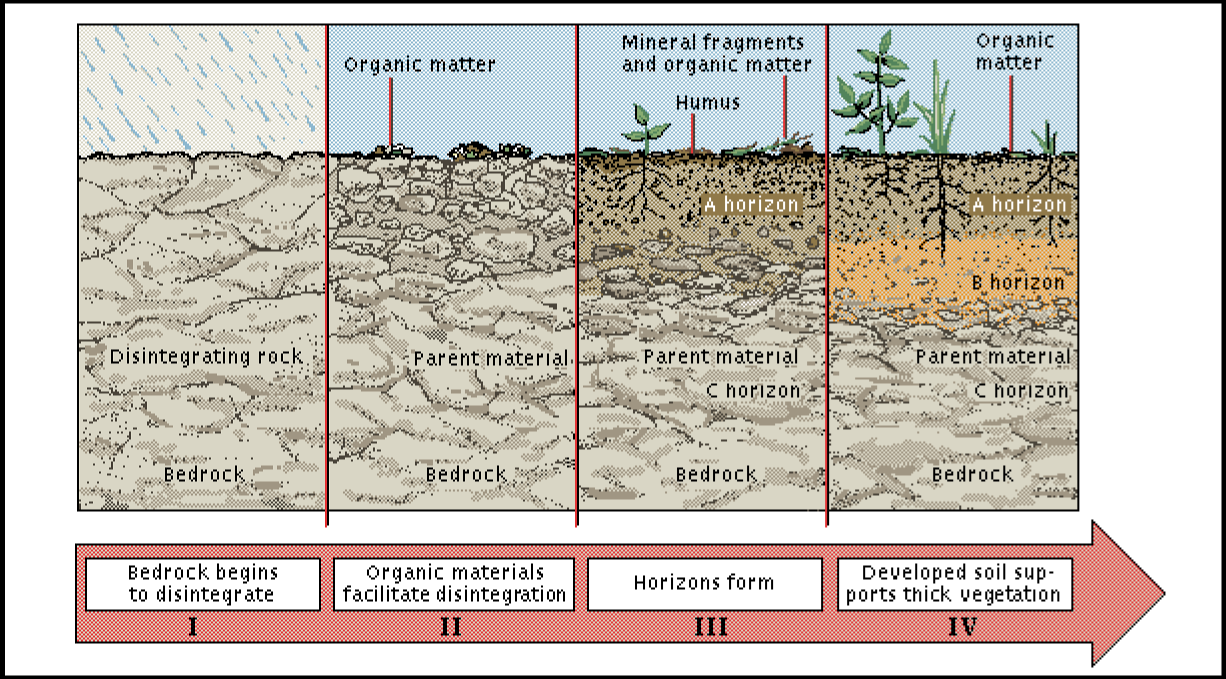
Urban Landscapes

Soils

The Ground Up



Soil Organic Matter



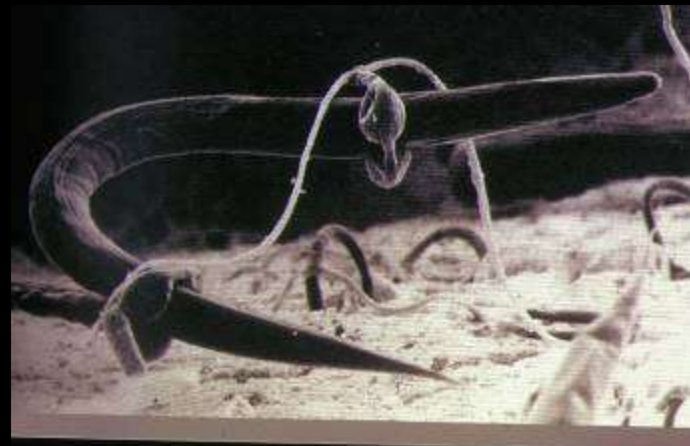
Number and Biomass of Soil Organisms

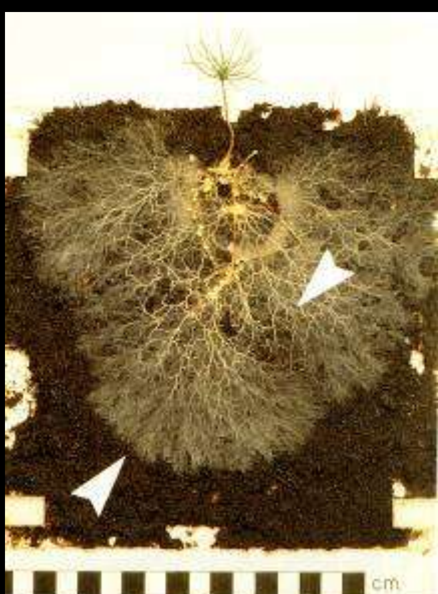
Organisms	Number/ yd^3	Number/ oz	Biomass (Lbs/Acre-6”)
Bacteria	Trillions	Millions +	400 – 4.000
Actinomycetes	Trillions	Millions	400 – 4.000
Fungi	Billions	Thousands +	500 – 5,000
Algae	Billions	Thousands	20 - 500
Protozoa	Billions	Thousands	15 – 150
Nematodes	Millions	Tens +	10 – 100
Earthworms	30 – 300		100 – 1,000

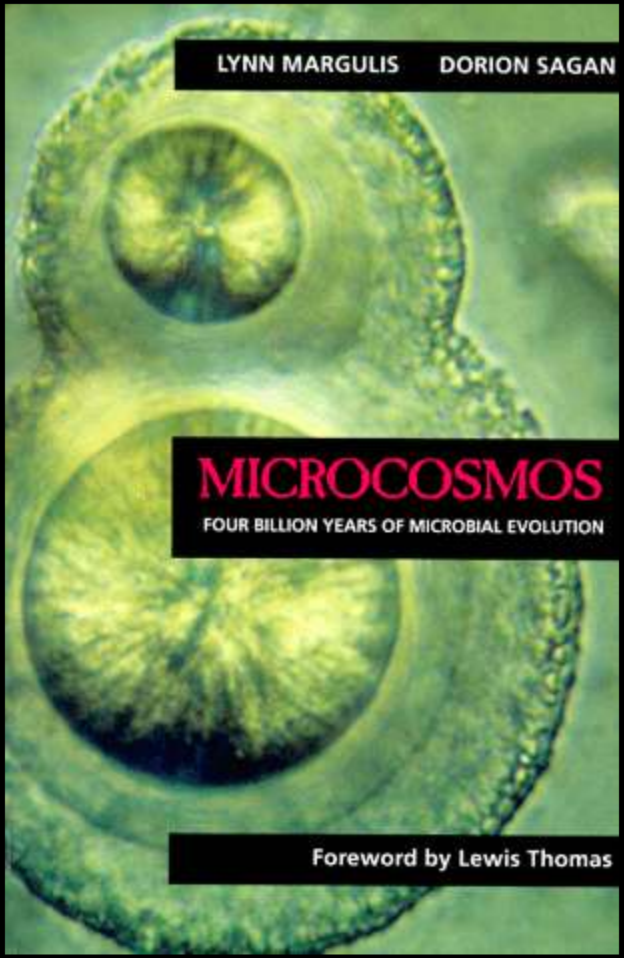
4% organic matter is 80,000 lbs per acre

Decrease to 1% means loss of 60,000 lbs per acre

The Microcosmos







Symbiosis is a major driving force behind evolution. She considers Darwin's notion of evolution, driven by competition, as incomplete and claims that evolution is strongly based on cooperation, interaction, and mutual dependence among organisms.

Endosymbiosis is any symbiotic relationship in which one symbiote lives within the tissues of the other, either in the intracellular space or extracellularly. Examples are rhizobia, nitrogen-fixing bacteria that live in root nodules on legume roots; nitrogen-fixing bacteria called *Frankia*, which live in alder tree root nodules; single-celled algae inside reef-building corals; and bacterial endosymbionts that provide essential nutrients to about 10%–15% of insects.

Ectosymbiosis, also referred to as *exosymbiosis*, is any symbiotic relationship in which the symbiont lives on the body surface of the host, including the inner surface of the digestive tract

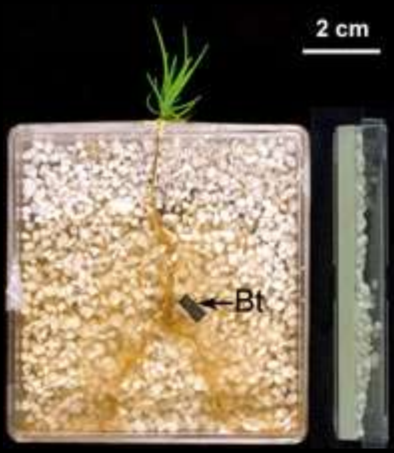
Root fungi turn rock into soil

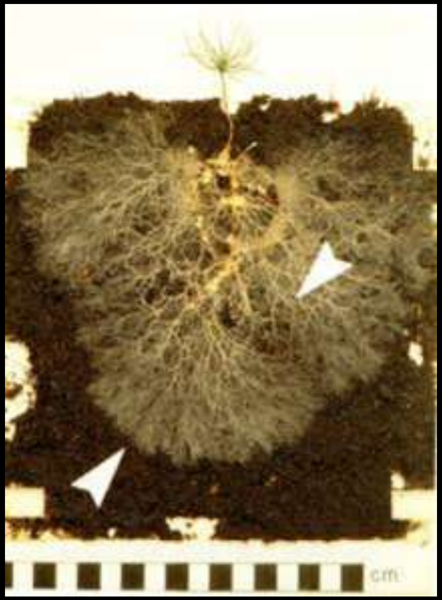
Trees help to break down barren rocks into soil, but how does that work exactly? It turns out that tiny fungi living on the trees' roots do most of the heavy work.

The fungi first bend the structure of certain minerals, weaken their crystals and then remove any useful chemical elements to pass on to their host tree. During the process, the rocks change their chemistry, lose their strength and in the long-run become soil.

These hard-working fungi are called mycorrhiza and cover the roots of trees like gloves. They are extremely small and thin, but they are everywhere. It is estimated that every kilogram of soil contains at least 200 km of fungi strands.

S. Bonneville, M.M. Smits, A. Brown, J. Harrington, J.R. Leake, R. Brydson and L.G. Benning. Plant-driven fungal weathering: Early stages of mineral alteration at the nanometer scale. *Geology* July 2009, v. 37, p. 615-618





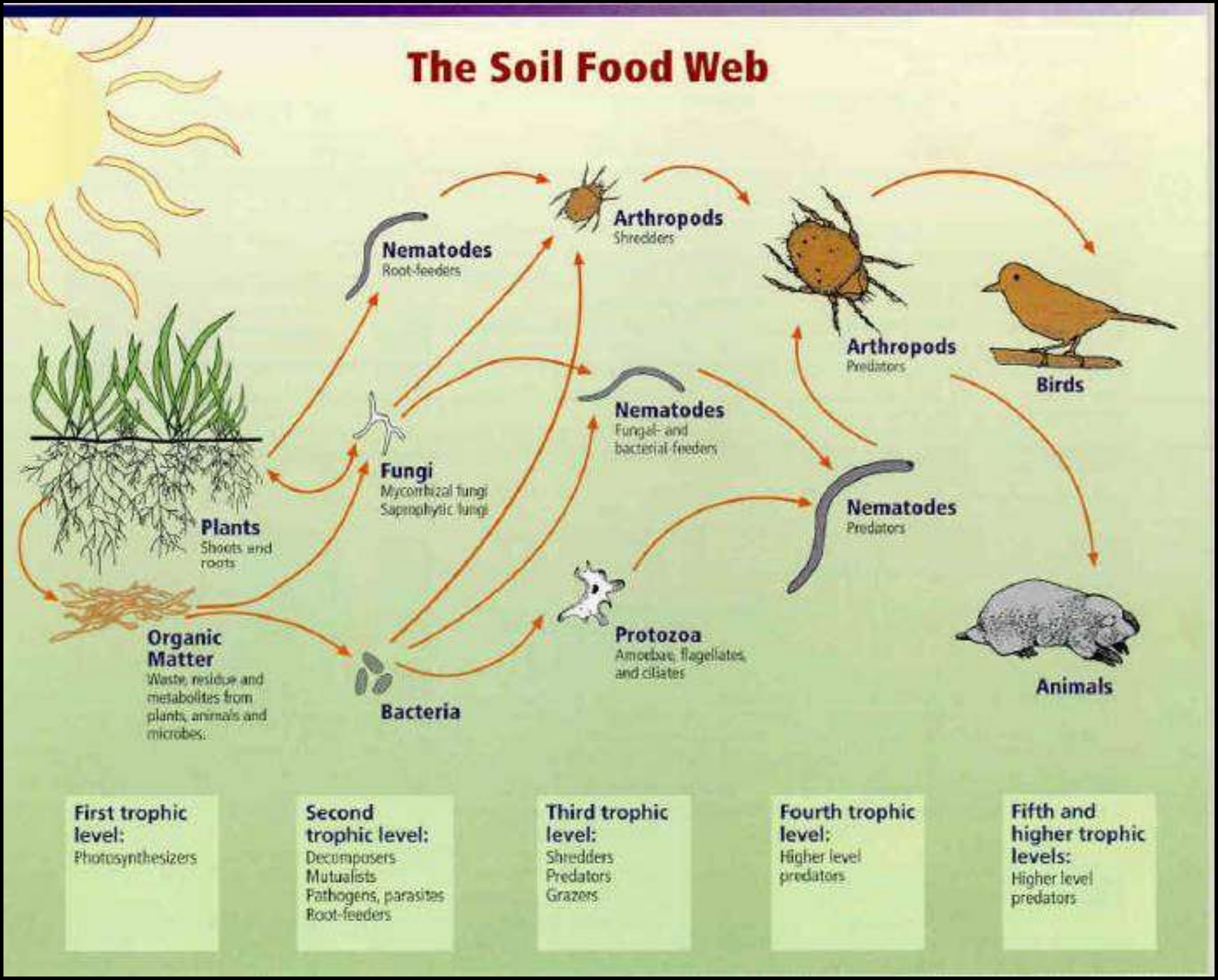
The Global Soil Biodiversity Initiative was launched in September 2011

Exploring The Hidden Biodiversity in Central Park Soils JULY 23-25, 2012

The GSBI, in collaboration with the Wall Lab of Colorado State University, the Fierer Lab of the University of Colorado, Boulder, the Bradford Lab of Yale and the American Museum of Natural History will be exploring the soil biodiversity of Central Park, New York, NY. The group plans to collect over 600 soil samples to map the soil biodiversity of the park.

This project will map the diversity and distributions of microorganisms and fauna in soils collected from over 600 locations in Central Park thereby generating the most comprehensive broad-scale survey of soil biodiversity in an urban area conducted to date. We selected Central Park as the first urban area to be examined because of its size, and potential discovery of new species of soil biodiversity.

http://www.globalsoilbiodiversity.org/



Dr. Elaine Ingham – www.soilfoodweb.com

Urban ecosystem

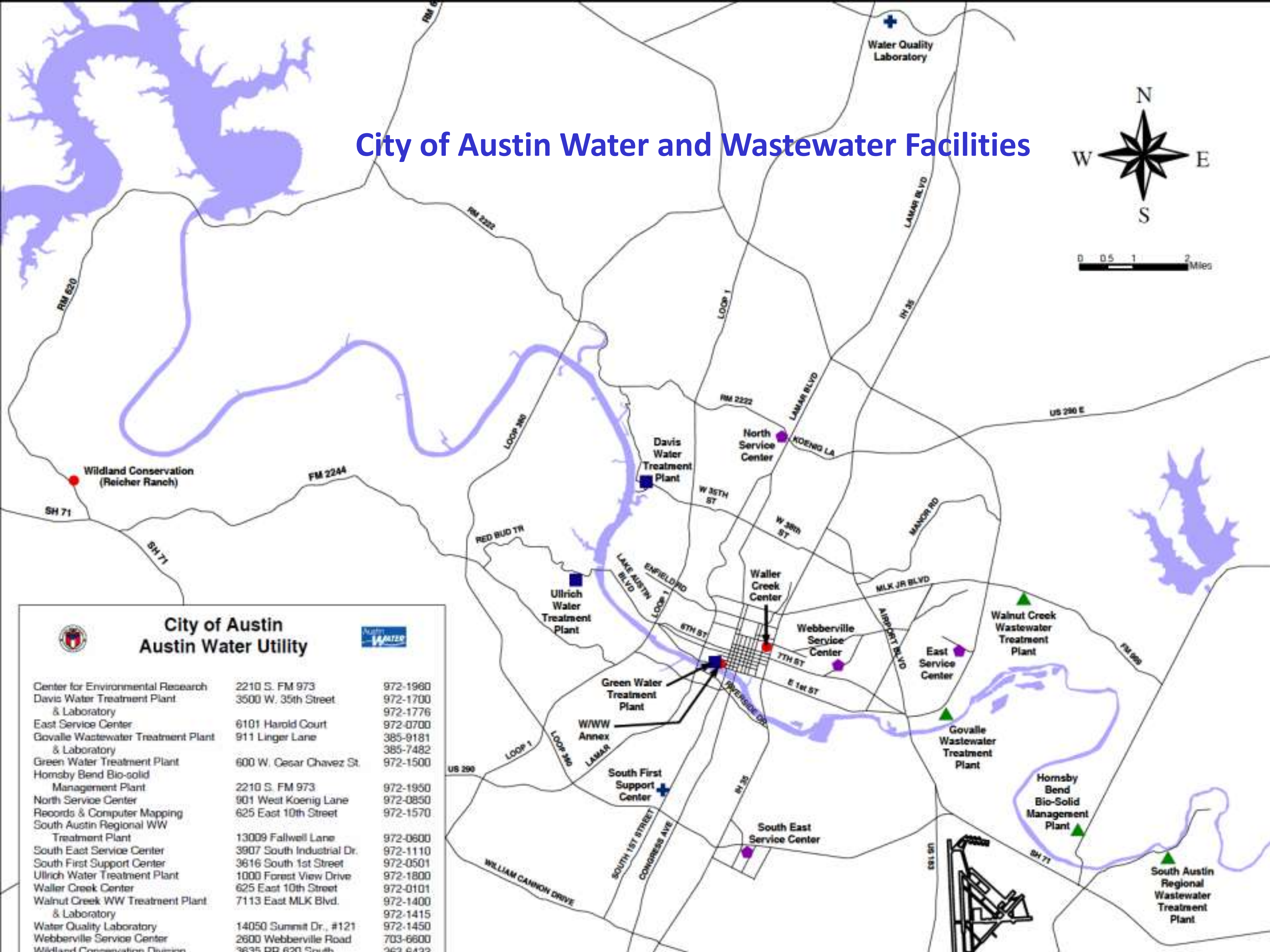
Inputs - drawn from soils – food, landscaping

Outputs - nitrogen rich “wastes” and carbon “wastes”

Urban sustainability?


Austin WATER
Wastewater Sludge
Treatment Facility
Hornsby Bend BMP ◆ 2210 FM 973 ◆ Austin TX 78725

City of Austin Water and Wastewater Facilities



City of Austin
Austin Water Utility

Center for Environmental Research	2210 S. FM 973	972-1960
Davis Water Treatment Plant & Laboratory	3500 W. 35th Street	972-1700 972-1776
East Service Center	6101 Harold Court	972-0700
Govalle Wastewater Treatment Plant & Laboratory	911 Linger Lane	385-9181 385-7482
Green Water Treatment Plant	600 W. Cesar Chavez St.	972-1500
Hornsby Bend Bio-solid Management Plant	2210 S. FM 973	972-1950
North Service Center	901 West Koenig Lane	972-0850
Records & Computer Mapping	625 East 10th Street	972-1570
South Austin Regional WW Treatment Plant	13009 Fallwell Lane	972-0600
South East Service Center	3907 South Industrial Dr.	972-1110
South First Support Center	3616 South 1st Street	972-0501
Ullrich Water Treatment Plant	1000 Forest View Drive	972-1800
Waller Creek Center	625 East 10th Street	972-0101
Walnut Creek WW Treatment Plant & Laboratory	7113 East MLK Blvd.	972-1400 972-1415
Water Quality Laboratory	14050 Summit Dr., #121	972-1450
Webberville Service Center	2600 Webberville Road	703-6600
Wildland Conservation Division	3635 RR 620 South	[illegible]

Austin Water Utility

Hornsby Bend Biosolids Management Plant

1200 acres

3.5 miles of River

Austin Water Utility
Hornsby Bend Biosolids Management Plant

Microbe "Farming" for Recycling - Working with Ecosystem Cycles

- Biosolids
- Yard Trimmings
- Water
- Biogas

All of Austin's Sewage Sludge – 1 million gallons per day

98% water

Austin Daily Production 90 MGD Wastewater

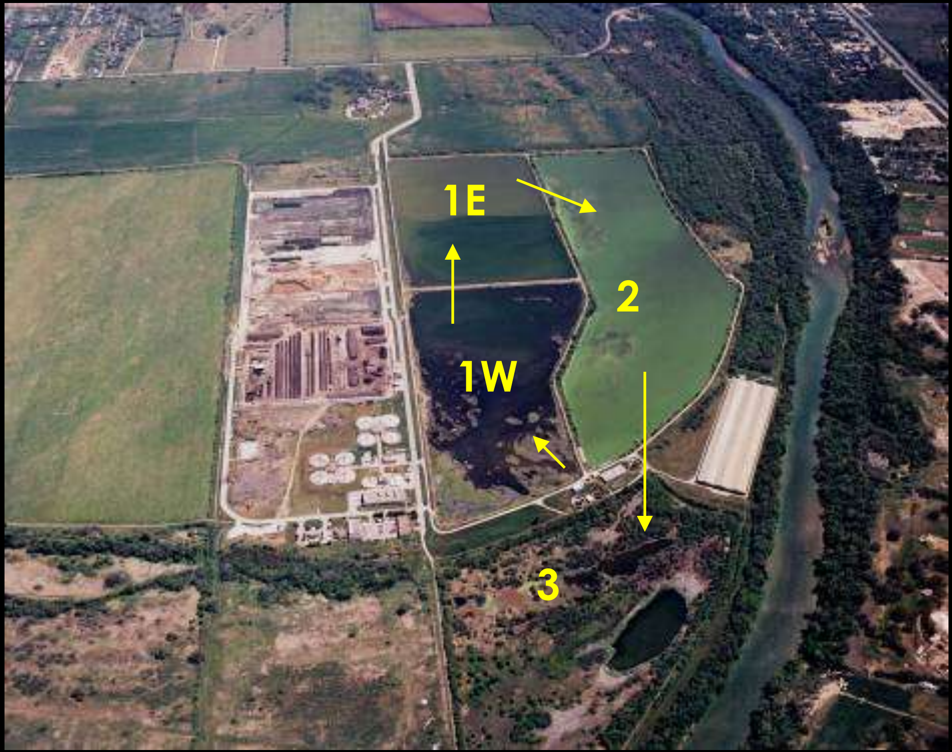
Sewage solids/sludge removed from wastewater

Walnut Creek Wastewater Treatment Plant

South Austin Regional Wastewater Treatment Plant

Water - Treatment Ponds 180 acres

- Water moves by gravity
- Pond Ecosystem treats water
- All water recycled – <u>no discharge to the river</u>
- Water used to irrigate hay fields onsite
- Most popular birding site in Austin Area



Austin WATER Clearly Reliable

The Ponds

Austin Water Clearly Reliable

Solids – Anaerobic Digesters

- Habitat for anaerobic bacteria
- Heated to body temperature
- 95% pathogen reduction = Class B
- Approximately 60 days
- Treated sludge = biosolids
- By-product Biogases = Green Energy

Austin WATER Clearly Reliable

Austin WATER Clearly Reliable

Digested Sludge = Biosolids

DILLO DIRT

Biosolids Recycling
First Method
Land Application

Onsite farm – 550 acres

Biosolids Recycling
Second Method
Composting

Yard Waste and Biosolids

AUSTIN RESOURCE RECOVERY
A CITY OF AUSTIN SERVICE

Austin WATER
Clearly Reliable

Biosolids Recycling First Method Land Application

Onsite farm – 550 acres of hay fields

Biosolids Recycling
Method 2
Composting

DILLO DIRT™
City of Austin Water Utility

Compost Pad

AUSTIN RESOURCE RECOVERY
A CITY OF AUSTIN SERVICE

Yard Waste

Processing

Method 2

Composting

3 parts yard waste [carbon]

1 part biosolids [nitrogen/phosphorus]

Austin WATER
Clearly Reliable

Austin WATER Clearly Reliable

Composting:
nitrogen
carbon
water
air
= Soil Organic Matter

DILLO DIRT
City of Austin Water Utility

Green improvements at the Hornsby Bend Biosolids Management Plant with $31.8 million dollars from the American Recovery and Reinvestment Act (ARRA)

Austin WATER
Clearly Reliable

Kevin M. Anderson, Ph.D, Coordinator

Center for Environmental Research at Hornsby Bend

Austin WATER Clearly Reliable

MISSION

<u>Urban Ecology and Sustainability</u>

- Community
- Education
- Research

PARTNERS

- Austin Water Utility
- University of Texas
- Texas A&M University

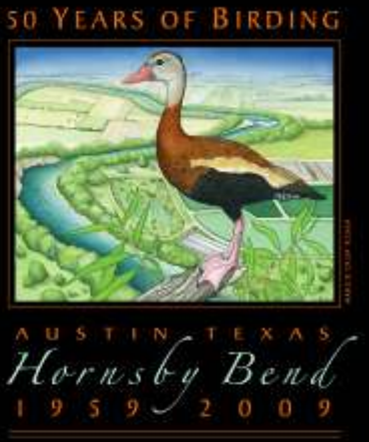
RESEARCH AREAS

- Soil Ecology, Sewage Recycling and Reuse
- Hydrogeology of the Alluvial Aquifer
- Riparian Ecology
- Avian Ecology

HBBO

Hornsby Bend Bird Observatory

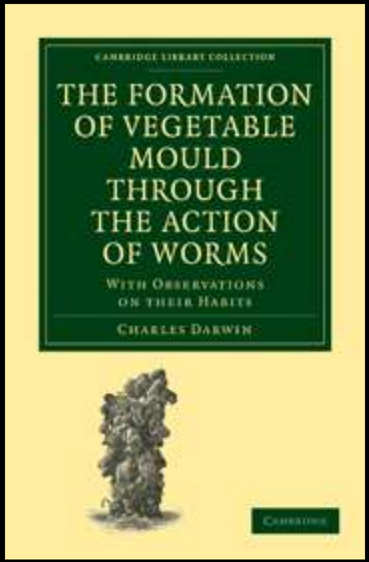
Texas Riparian Association



RESEARCH AREA – Soil Ecology, Sewage Recycling and Reuse

Center for Environmental Research at Hornsby Bend

Austin Water Clearly Reliable



Hornsby Bend Biodiversity

Center for Environmental Research at Hornsby Bend

Austin WATER Clearly Reliable

CER Monthly Activities at Hornsby Bend 2012

Join us – free events – all are invited!

<u>River Monitoring Trip- Travis County</u>

1st Saturday of Every Month - All day [meet at CER 8am]

<u>HBBO Bird Survey</u>

2nd Saturday of Every Month 7am-11am and 4pm-dark

<u>Birding Field Trip - Travis Audubon Socity</u>

3rd Saturday of Every Month 7:30am-11am

<u>Ecological Literacy Days</u> – three hours of outdoor volunteer work and an hour of ecological education on the <u>last Saturday of every month</u> at Hornsby Bend [9am-1pm]

Center for Environmental Research **at Hornsby Bend**

Austin WATER Clearly Reliable

AWU-CER Lunchtime Lectures 2012
2012 - A Year of Natural History: Origins, Practices, and Examples

The 1st Tuesday of the Month! Free and Open to the Public – bring a lunch and learn

Dougherty Arts Center
1110 Barton Springs Road

Each talk begins AT NOON - Free and Open to the Public – bring a lunch and learn

May 1 - The Natural History of the Americas: Discovery and Transformation

June 5 - The Natural History of Texas: Biological Survey and Ecological Change

July 3 - The Natural History of Austin: Biological Context and Urbanization

August 7 - Urban Natural History: Life in the City

September 4 - The Natural History of an Urban Creek: Waller Creek

October 2 - The Natural History of an Urban Vacant Lot: Tannehill Urban Wild Woodland

November 6 - The Natural History of an Urban Wasteland: Hornsby Bend

December 4 - Natural and Unnatural History: The Path Forward

Center for Environmental Research at Hornsby Bend

Austin Water
Clearly Reliable

AWU-CER Lunchtime Lectures 2012
2012 - A Year of Natural History: Origins, Practices, and Examples

Same Lecture Repeated Each Month on a Tuesday

City Hall
Boards and Commissions Room 1101

Each talk begins AT NOON - Free and Open to the Public – bring a lunch and learn

May 15 - The Natural History of the Americas: Discovery and Transformation

June 19 - The Natural History of Texas: Biological Survey and Ecological Change

July 17 - The Natural History of Austin: Biological Context and Urbanization

August 28 - Urban Natural History: Life in the City

September 18 - The Natural History of an Urban Creek: Waller Creek

October 23 - The Natural History of an Urban Vacant Lot: Tannehill Urban Wild Woodland

November 20 - The Natural History of an Urban Wasteland: Hornsby Bend

December 18 - Natural and Unnatural History: The Path Forward

Hornsby Bend is open

7 Days a week

Dawn to Dusk

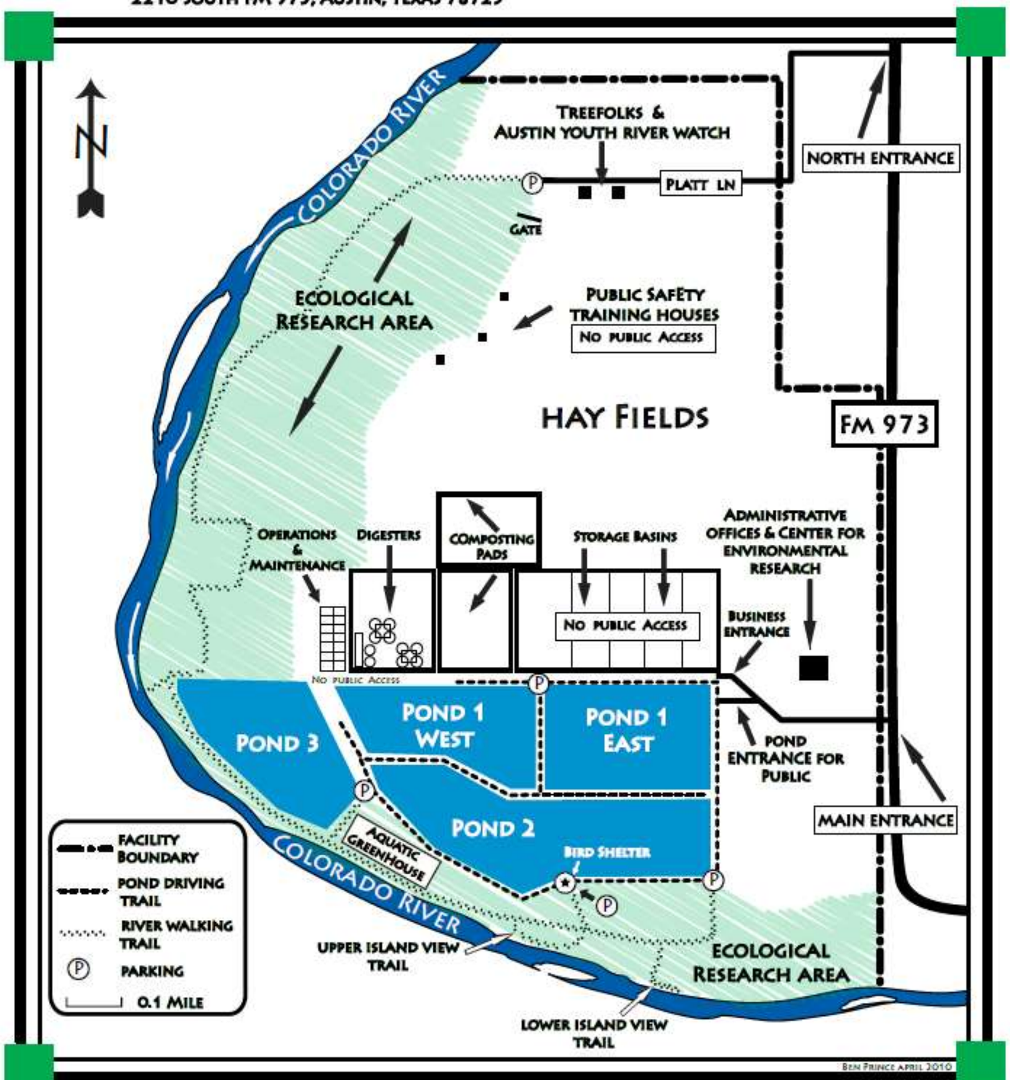
Austin WATER Clearly Reliable


Applause!

Questions?

Hornsby Bend
Biosolids Management Plant

Facility open to the public sunrise to sunset every day of the week
2210 South FM 973, Austin, Texas 78725



For more information contact the AWU-CER 512-972-1960

Dillo Dirt and Hornsby Bend Plant - www.ci.austin.tx.us/water/dillo.htm
The CER Hornsby Bend Bird Observatory program - www.hornsbybend.org
The AWU Center for Environmental Research [CER] - www.ci.austin.tx.us/water/cer2.htm