Update on the Practice of Potable Reuse in the United States Today

May 16th 2013

R. Rhodes Trussell, Ph.D., P.E.

Trussell Technologies

2013 Idaho Water Reuse Conference
May 15 & 16, 2013, Boise, ID

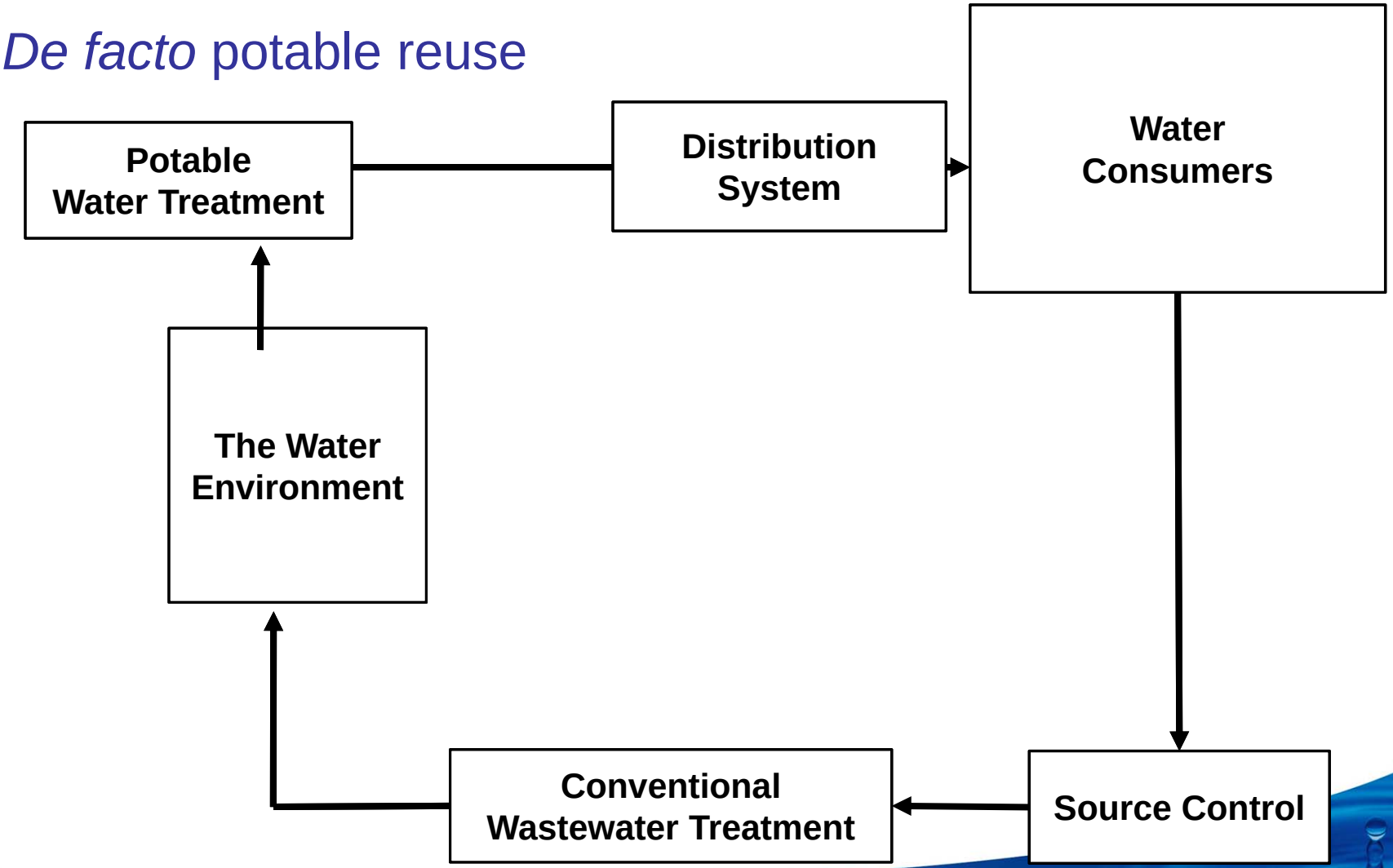
Trussell TECHNOLOGIES INC

U.S. Potable Reuse

- De Facto Reuse
- Planned Potable Reuse

Structure of Potable Reuse

De facto potable reuse



Structure of Potable Reuse

Planned potable reuse

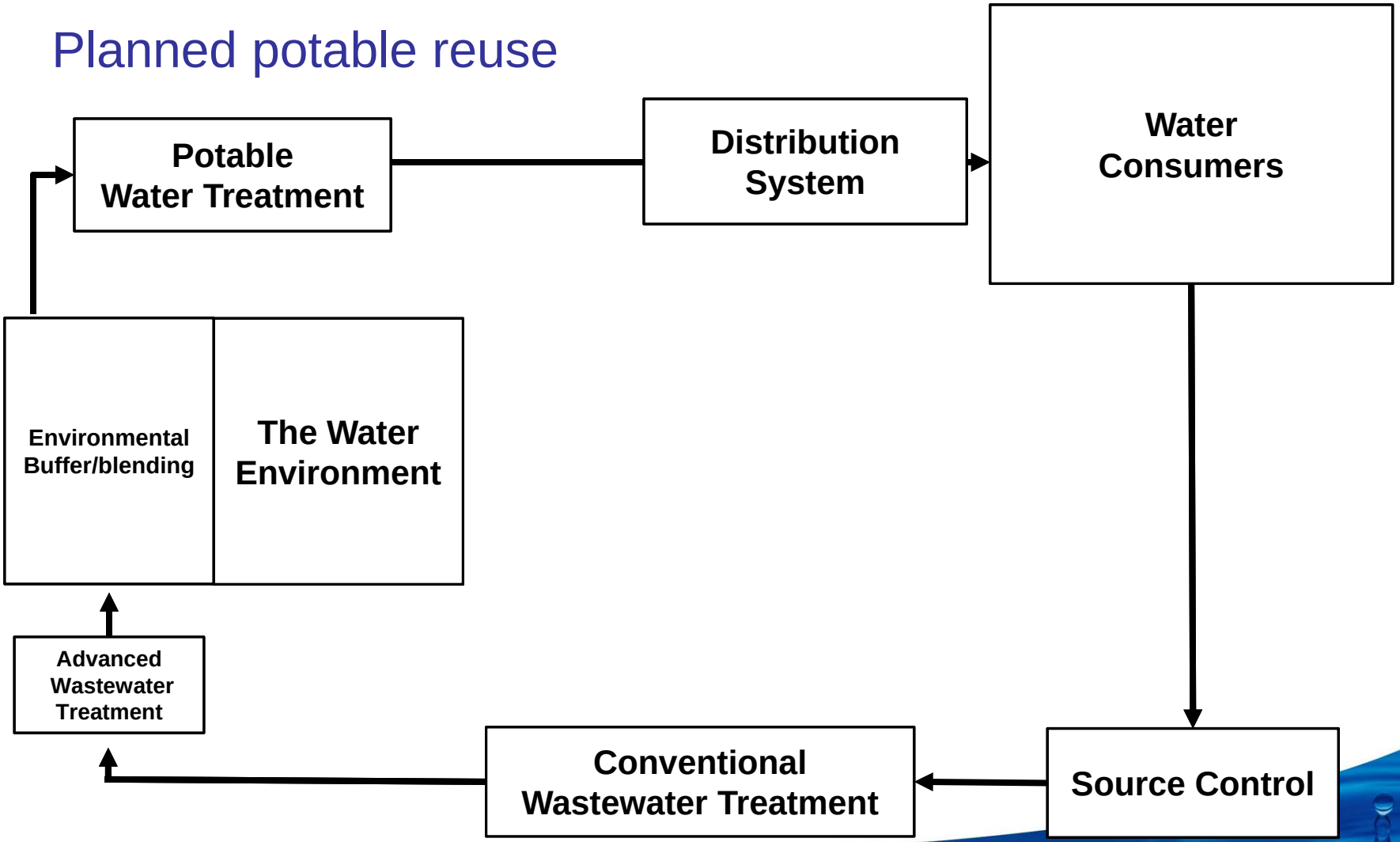


TABLE 2-3 Examples of Potable Reuse Schemes and Employed Treatment Technologies in the United States

Project Location	Type of Reuse	Project Size MGD (m^3/d)	First Installation Year
Montebello Forebay, County Sanitation Districts of Los Angeles County, CA	Groundwater recharge via soil-aquifer treatment	44 (165)	1962
Water Factory 21, Orange County, CA	Groundwater recharge via seawater barrier	16 (60)	1976
Upper Occoquan Service Authority, VA	Surface water augmentation	54 (204)	1978
Hueco Bolson Recharge Project, El Paso Water Utilities, TX	Groundwater recharge via direct injection	10 (38)	1985
Clayton County Water Authority, GA	Surface water augmentation	18 (66)	1985
West Basin Water Recycling Plant, CA	Groundwater recharge via direct injection	12.5 (47)	1993
Gwinnett County, GA	Surface water augmentation	60 (227)	1999
Scottsdale Water Campus, AZ	Groundwater recharge via direct injection	14 (53)	1999
Los Alimitos Barrier Water Replenishment District of So. CA	Groundwater recharge via direct injection	2.7 (10)	2005
Chino Basin Groundwater Recharge Project, Inland Empire Utility Agency, Chico, CA	Groundwater recharge via soil-aquifer treatment	18 (69)	2007
Groundwater Replenishment System, Orange County, CA	Groundwater recharge via direct injection and spreading basins	70 (265)	2008
Arapahoe County/Cottonwood, CO	Groundwater recharge via spreading operation	9 (34)	2009
Cloudcroft, NM	Spring water augmentation	0.1 (0.38)	2009
Prairie Waters Project, Aurora, CO	Groundwater recharge via riverbank filtration	50 (190)	2010
Permian Basin, Colorado River Municipal Water District, TX	Surface water augmentation	2.5 (9.4)	2012
Dominguez Gap Barrier, City of Los Angeles	Groundwater recharge via direct injection	2.5	2012

SOURCE: Adapted from Drewes and Khan (2010)

TABLE 2-3 Examples of Potable Reuse Schemes and Employed Treatment Technologies in the United States

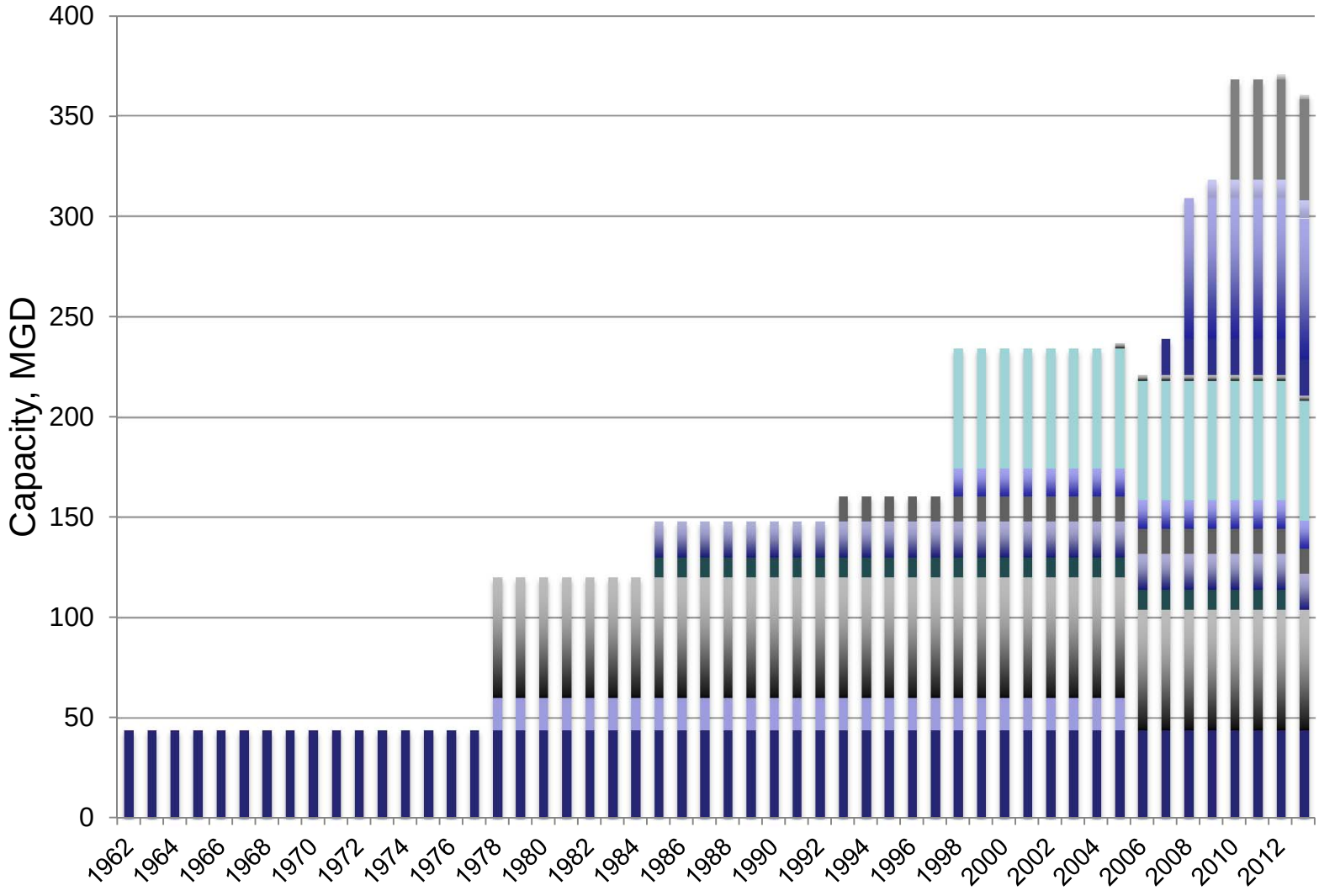
Project Location	Type of Reuse	Project Size MGD (m^3/d)	First Installation Year
Montebello Forebay, County Sanitation Districts of Los Angeles County, CA	Groundwater recharge via soil-aquifer treatment	44 (165)	1962
Water Factory 21, Orange County, CA	Groundwater recharge via seawater barrier	16 (60)	1976
Upper Occoquan Service Authority, VA	Surface water augmentation	54 (204)	1978
Hueco Bolson Recharge Project, El Paso Water Utilities, TX	Groundwater recharge via direct injection	10 (38)	1985
Clayton County Water Authority, GA	Surface water augmentation	18 (66)	1985
West Basin Water Recycling Plant, CA	Groundwater recharge via direct injection	12.5 (47)	1993
Gwinnett County, GA	Surface water augmentation	60 (227)	1999
Scottsdale Water Campus, AZ	Groundwater recharge via direct injection	14 (53)	1999
Los Alimitos Barrier Water Replenishment District of So. CA	Groundwater recharge via direct injection	2.7 (10)	2005
Chino Basin Groundwater Recharge Project, Inland Empire Utility Agency, Chico, CA	Groundwater recharge via soil-aquifer treatment	18 (69)	2007
Groundwater Replenishment System, Orange County, CA	Groundwater recharge via direct injection and spreading basins	70 (265)	2008
Arapahoe County/Cottonwood, CO	Groundwater recharge via spreading operation	9 (34)	2009
Cloudcroft, NM	Spring water augmentation	0.1 (0.38)	2009
Prairie Waters Project, Aurora, CO	Groundwater recharge via riverbank filtration	50 (190)	2010
Permian Basin, Colorado River Municipal Water District, TX	Surface water augmentation	2.5 (9.4)	2012
Dominguez Gap Barrier, City of Los Angeles	Groundwater recharge via direct injection	2.5	2012

SOURCE: Adapted from Drewes and Khan (2010)

16 projects today

Total Capacity: 364 mgd

Historical Growth of Potable Reuse in the U.S.



The “Grandaddy” in the West

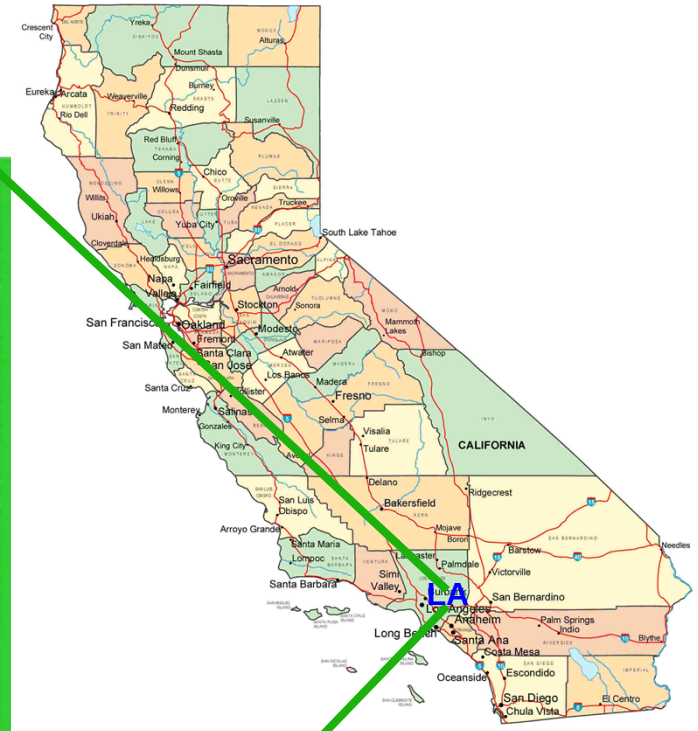
LA’s Montabello Forebay Recharge Project

Trussell TECHNOLOGIES INC

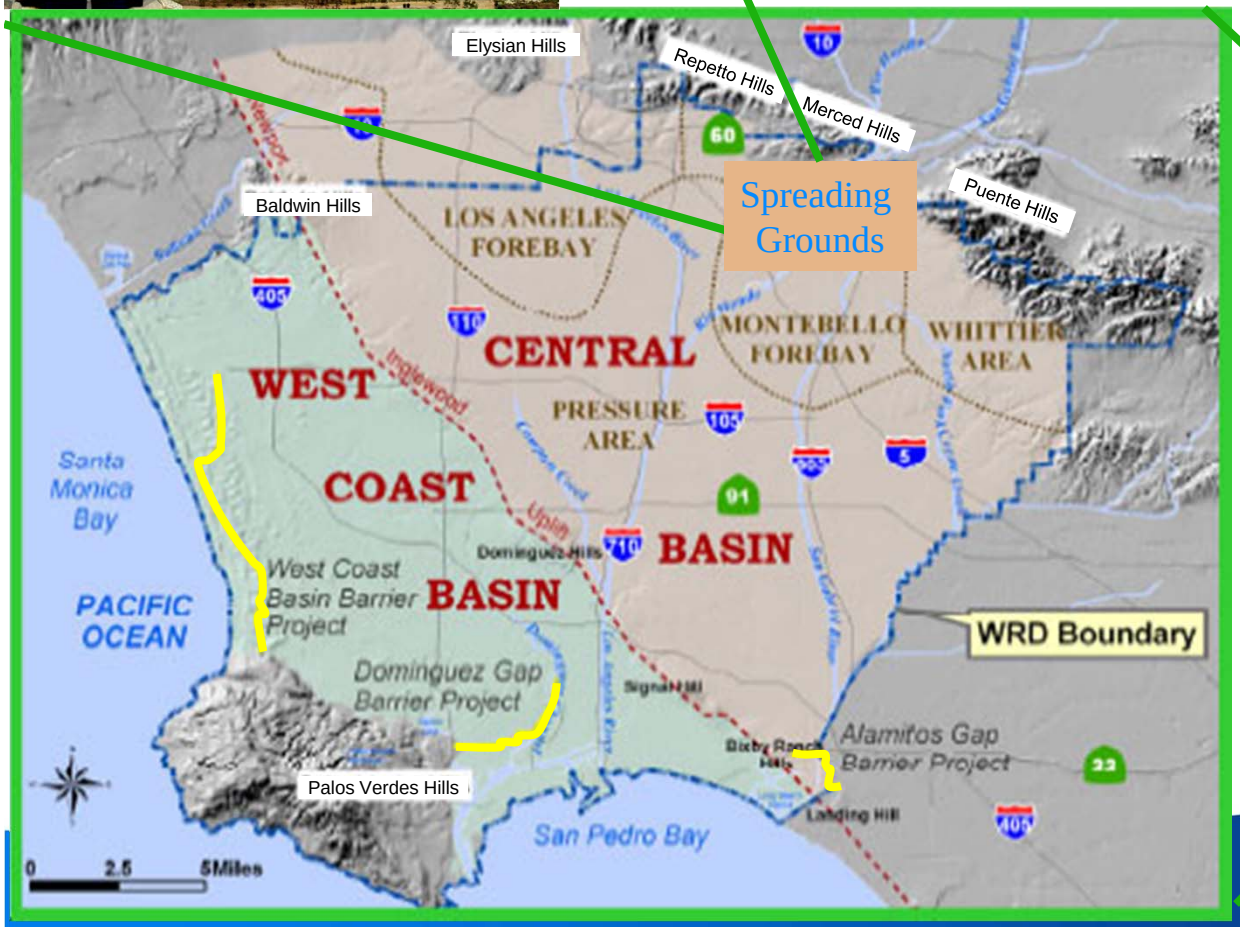
TECHNOLOGIES INC

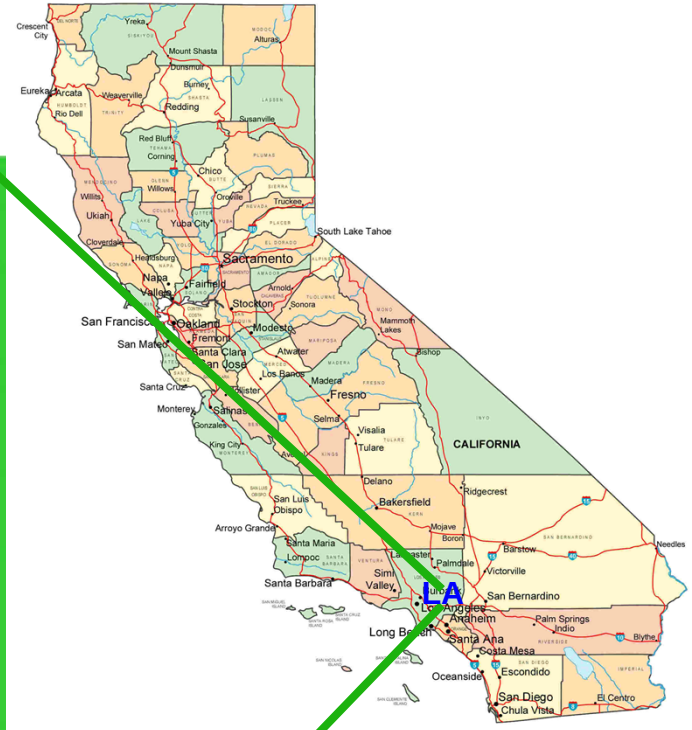
Montabello Forebay

Montabello Forebay



Montabello Forebay





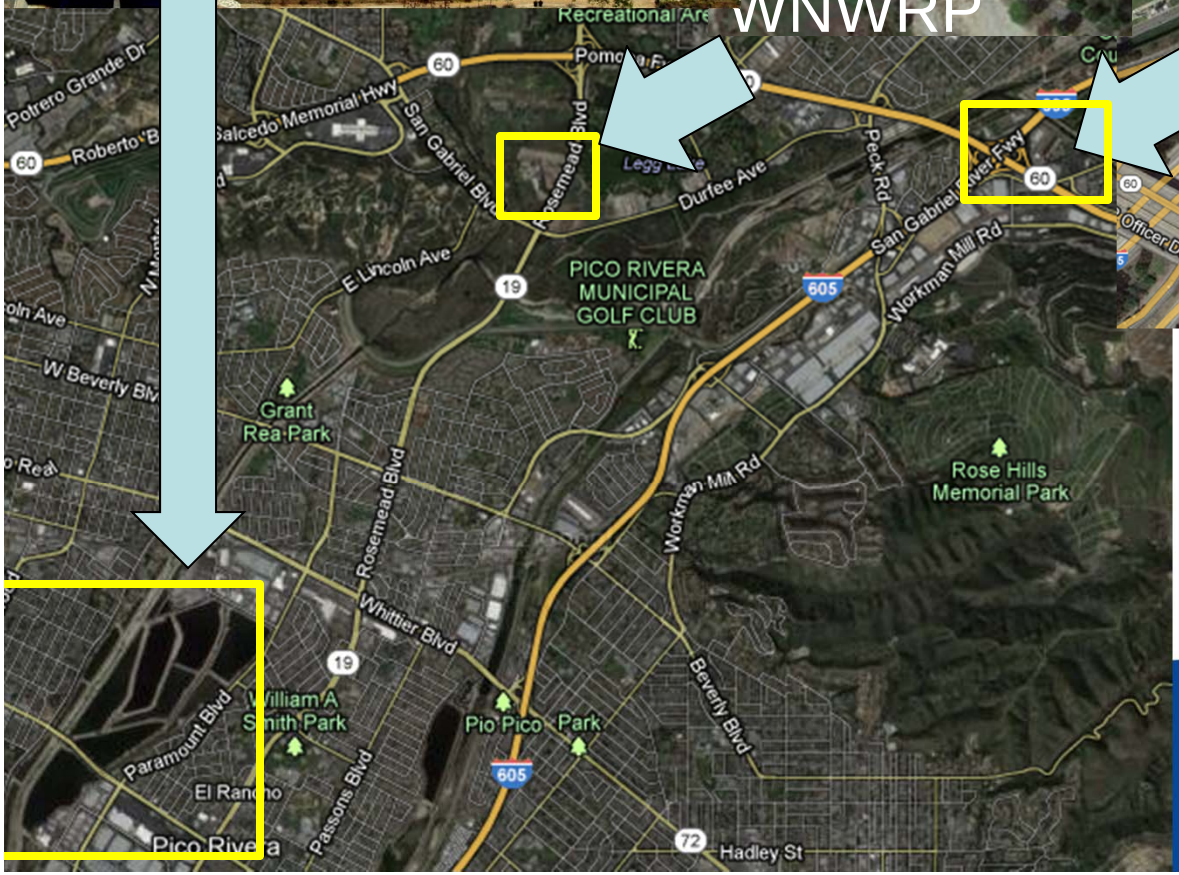
Montabello Forebay

LACSD, WRD So. CA, & LA Co

Montabello Forebay

LACSD, WRD So. CA, & LA Co

Montabello Forebay



LACSD, WRD So. CA, & LA Co

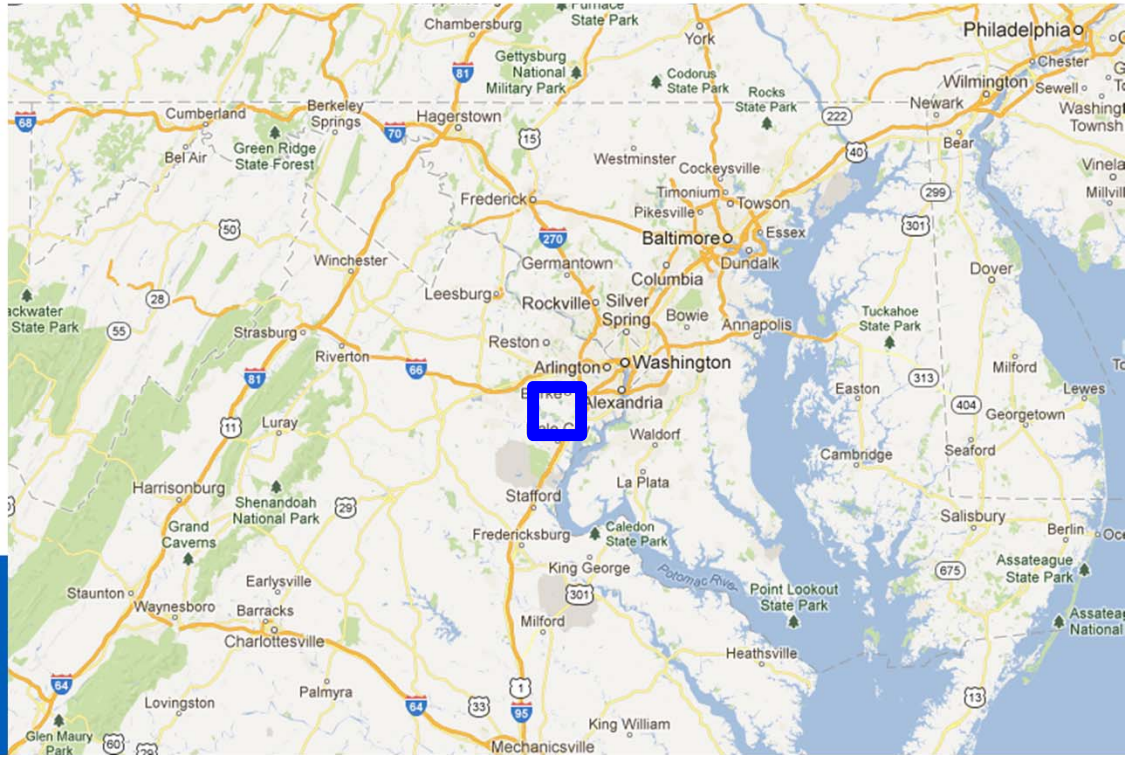
Montabello Forebay

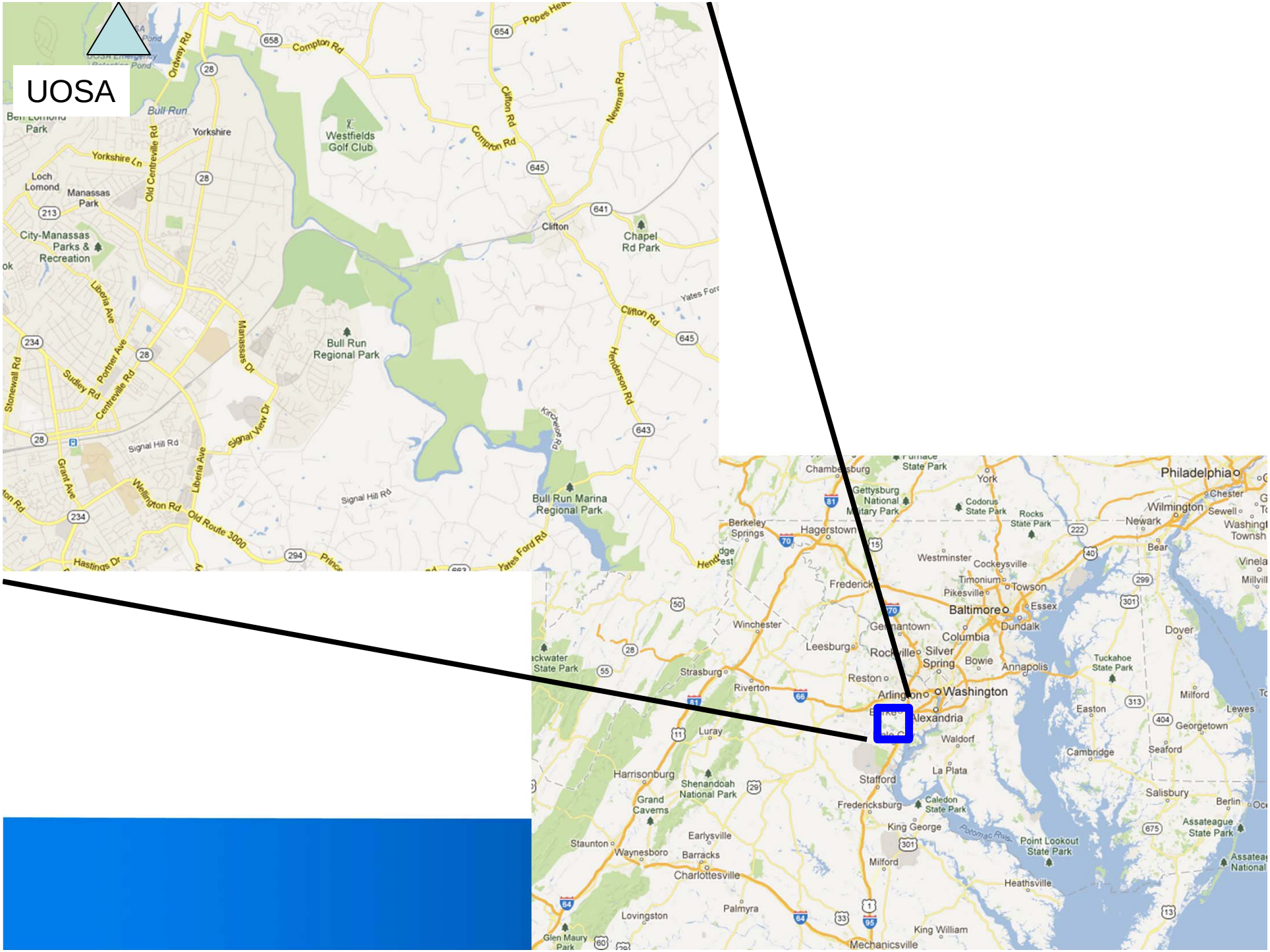
- Operating since 1962
- Surface spreading
  - 560 acres
  - Spread storm water, imported water & recycled water
  - Now about 40%, 20%, & 40%
  - About 44 mgd
- Extensive testing
  - Epidemiology
  - Trace organics
- Expansion now underway

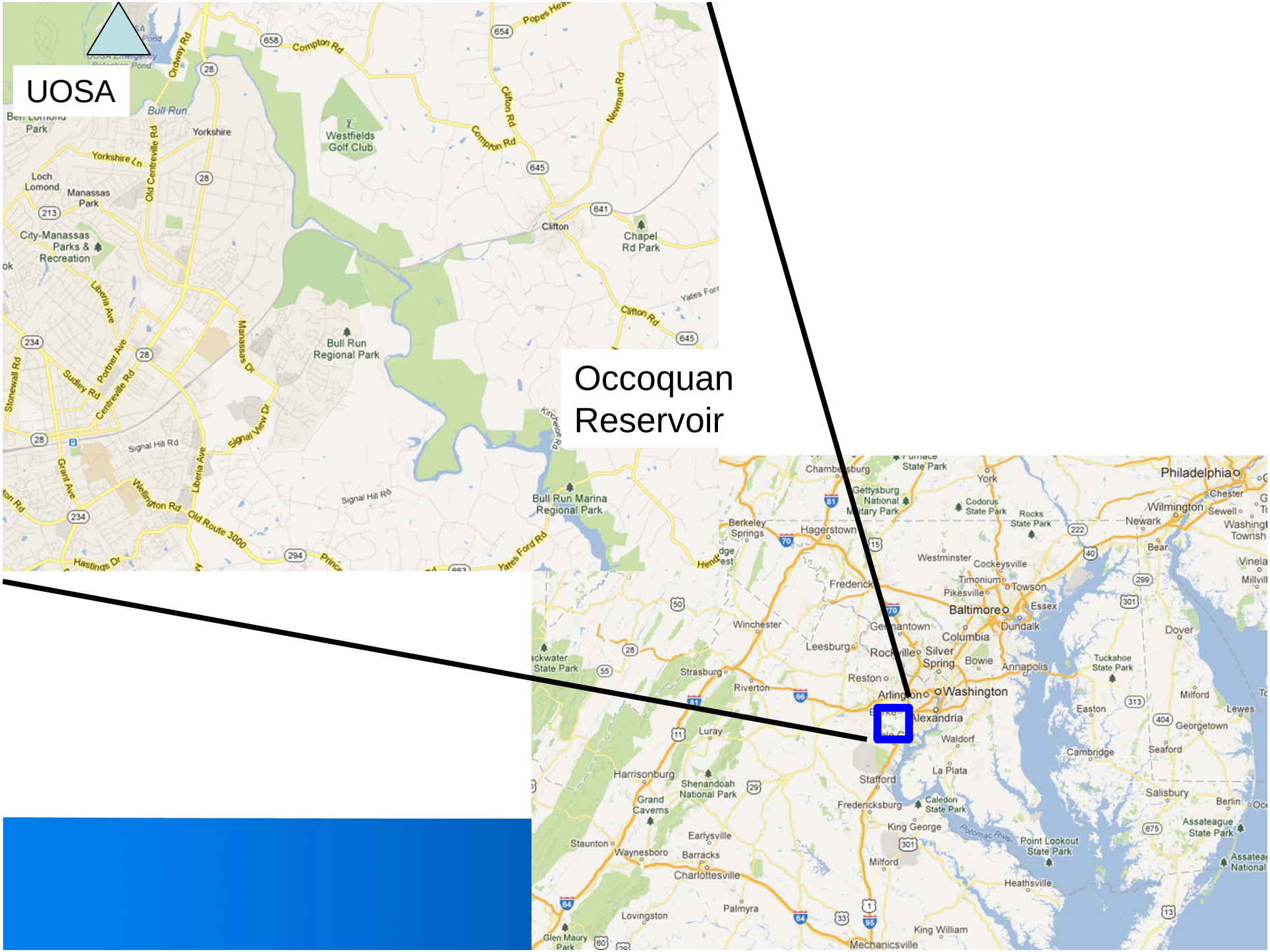
The “Grandaddy” in the East

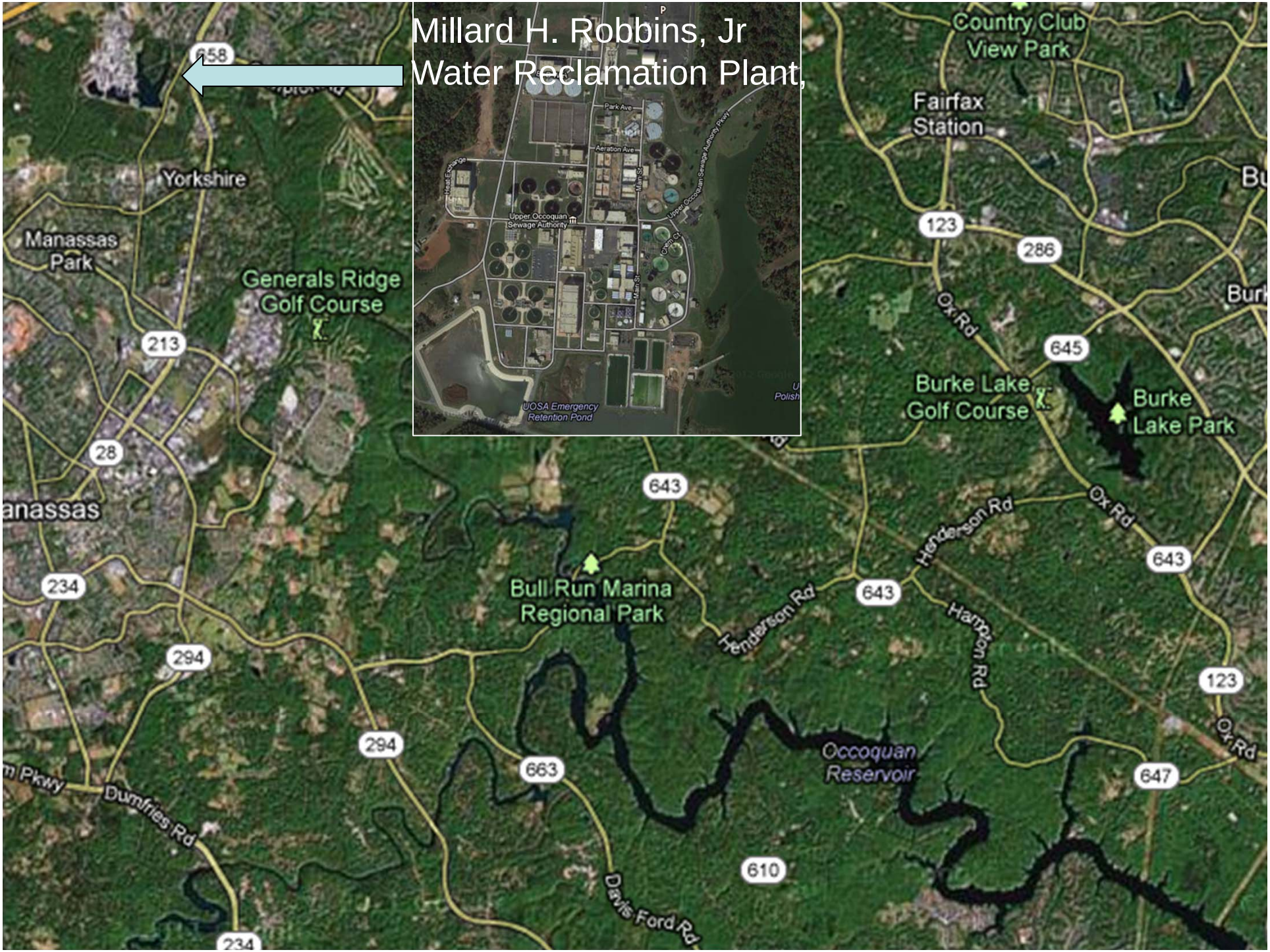
The Upper Occoquan Project

Trussell
TECHNOLOGIES INC

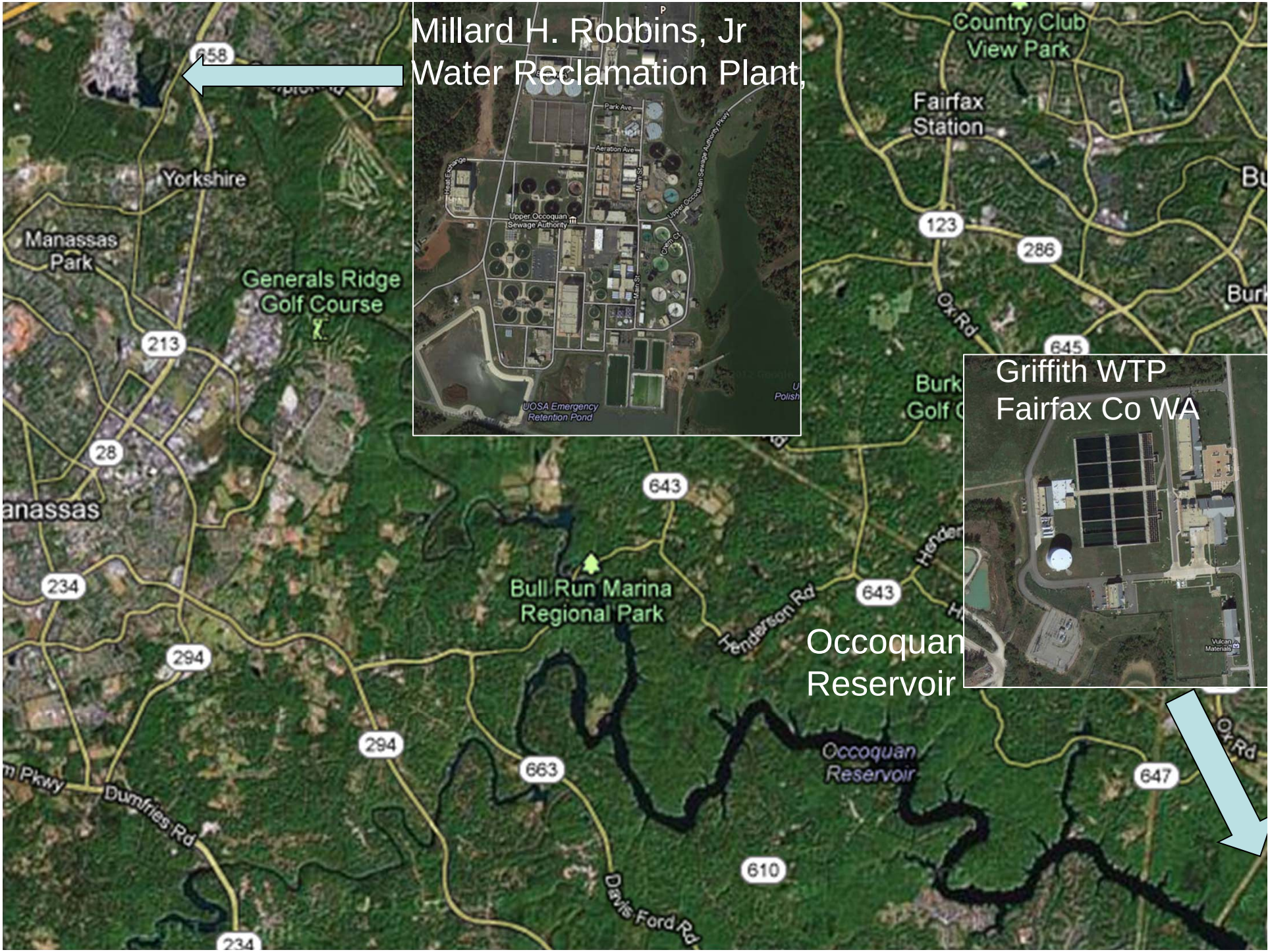

Chambersburg
Gettysburg National Military Park
York
Codorus State Park
Rocks State Park
Philadelphia
Chester
Wilmington
Newark
Sewell
Cumberland
Berkeley Springs
Hagerstown
Green Ridge State Forest
Bel Air
Westminster
Cockeysville
Bear
Frederick
Timonium
Towson
Pikesville
Essex
Baltimore
Dundalk
Winchester
Germantown
Columbia
Dover
Leesburg
Rockville
Silver Spring
Bowie
Annapolis
Tuckahoe State Park
Strasburg
Reston
Riverton
Arlington
Washington
Alexandria
Milford
Lewes
Easton
Georgetown
Luray
Waldorf
Cambridge
Seaford
Harrisonburg
Shenandoah National Park
Stafford
La Plata
Salisbury
Grand Caverns
Fredericksburg
Caledon State Park
Berlin
King George
Assateague State Park
Staunton
Earlysville
Waynesboro
Barracks
Point Lookout State Park
Milford
Charlottesville
Heathsville
Palmyra
Lovingston
King William
Mechanicsville
Glen Maury Park


UOSA
Bull Run
Yorkshire
Westfields Golf Club
Clifton
Chapel Rd Park
Bull Run Regional Park
Bull Run Marina Regional Park
Manassas Park
City-Manassas Parks & Recreation
Loch Lomond
Compton Rd
Clifton Rd
Newman Rd
Henderson Rd
Yates Ford Rd
Old Centreville Rd
Liberia Ave
Portner Ave
Sudley Rd
Signal Hill Rd
Signal View Dr
Wellington Rd
Old Route 3000
Manassas Dr
Stonewall Rd
Grant Ave
Hastings Dr
Philadelphia
Wilmington
Newark
Chester
Baltimore
Washington
Alexandria
Arlington
Reston
Silver Spring
Bowie
Annapolis
Columbia
Dundalk
Towson
Essex
Timonium
Pikesville
Cockeysville
Westminster
Frederick
Hagerstown
Gettysburg National Military Park
Chambersburg
York
Codorus State Park
Rocks State Park
Berkeley Springs
Winchester
Leesburg
Rockville
Germantown
Strasburg
Riverton
Luray
Harrisonburg
Shenandoah National Park
Grand Caverns
Staunton
Waynesboro
Earlysville
Barracks
Charlottesville
Lovingston
Palmyra
Glen Maury Park
Mechanicsville
King William
Heathsville
Point Lookout State Park
Milford
King George
Fredericksburg
Caledon State Park
Stafford
La Plata
Waldorf
Potomac River
Easton
Cambridge
Seaford
Salisbury
Berlin
Assateague State Park
Tuckahoe State Park
Georgetown
Lewes
Dover
Bear
Furnace State Park


UOSA
Occoquan Reservoir
Bull Run
Yorkshire
Westfields Golf Club
Clifton
Chapel Rd Park
Bull Run Regional Park
Bull Run Marina Regional Park
Manassas Park
City-Manassas Parks & Recreation
Loch Lomond
Old Centreville Rd
Compton Rd
Clifton Rd
Newman Rd
Signal Hill Rd
Wellington Rd
Old Route 3000
Yates Ford Rd
Philadelphia
Wilmington
Newark
Baltimore
Washington
Alexandria
Arlington
Reston
Leesburg
Winchester
Frederick
Hagerstown
Harrisonburg
Charlottesville
Fredericksburg
Stafford
Waldorf
Annapolis
Easton
Salisbury
Dover
Cambridge
Seaford
Georgetown
Lewes
Milford
Point Lookout State Park
Assateague State Park
Potomac River


Millard H. Robbins, Jr
Water Reclamation Plant,
Park Ave
Aeration Ave
Upper Occoquan Sewage Authority
UOSA Emergency Retention Pond
Country Club View Park
Fairfax Station
Yorkshire
Manassas Park
Generals Ridge Golf Course
Burke Lake Golf Course
Burke Lake Park
Bull Run Marina Regional Park
Occoquan Reservoir
Ox Rd
Henderson Rd
Harrison Rd
Dumfries Rd
Davis Ford Rd
anassas
123
286
645
643
234
294
663
610
647
28
213
658

Millard H. Robbins, Jr
Water Reclamation Plant,
Park Ave
Aeration Ave
Upper Occoquan Sewage Authority
UOSA Emergency Retention Pond
Country Club View Park
Fairfax Station
Yorkshire
Manassas Park
Generals Ridge Golf Course
Burke Lake Golf Course
Burke Lake Park
Bull Run Marina Regional Park
Occoquan Reservoir
Occoquan Reservoir
Ox Rd
Henderson Rd
Harrison Rd
Dumfries Rd
Davis Ford Rd
658
213
28
234
294
663
610
643
645
647
123
286

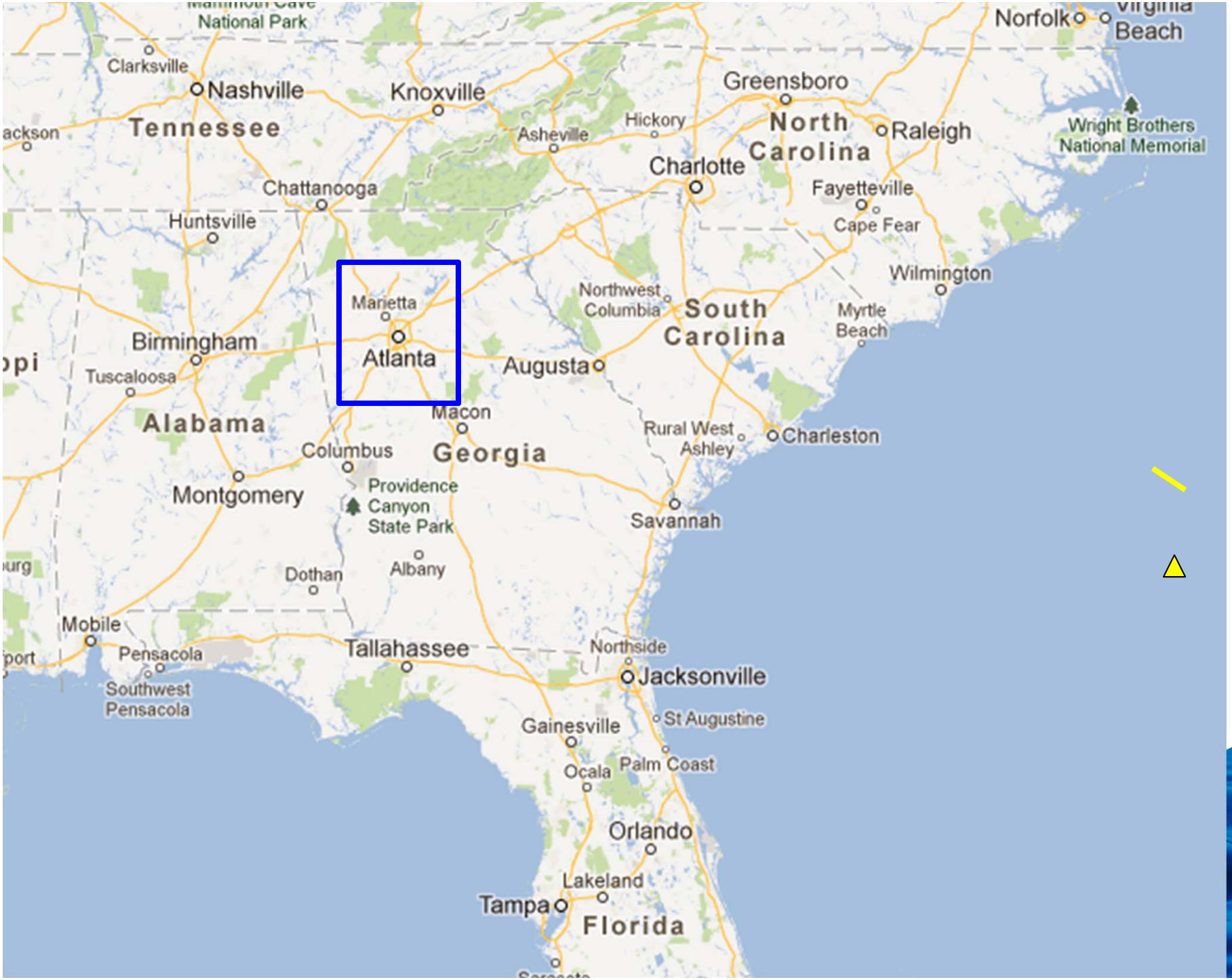

Millard H. Robbins, Jr
Water Reclamation Plant,
Park Ave
Aeration Ave
Upper Occoquan Sewage Authority
UOSA Emergency Retention Pond
Country Club View Park
Fairfax Station
Yorkshire
Manassas Park
Generals Ridge Golf Course
Bull Run Marina Regional Park
Henderson Rd
Occoquan Reservoir
Dumfries Rd
Davis Ford Rd
Ox Rd
Griffith WTP
Fairfax Co WA
Vulcan Materials

Upper Occoquan Project

- Millard G. Robins WRP: 1978, 54 mgd
- Replaced 11 older WWTPs discharging to the Bull Run (which supplies the Occoquan Resv.)
- UOSA's WWTP can sometimes be the majority of the flow into the Occoquan
- History

F. Wayne Hill Water Resources Center in Gwinnette Co., GA

Trussell
TECHNOLOGIES INC


National Park
Clarksville
Nashville
Knoxville
Tennessee
Asheville
Hickory
Greensboro
North Carolina
Raleigh
Norfolk
Beach
Wright Brothers National Memorial
Charlotte
Fayetteville
Cape Fear
Chattanooga
Huntsville
Wilmington
Marietta
Atlanta
Northwest Columbia
South Carolina
Myrtle Beach
Birmingham
Tuscaloosa
Augusta
Alabama
Macon
Rural West Ashley
Charleston
Columbus
Georgia
Montgomery
Providence Canyon State Park
Savannah
Albany
Dothan
Mobile
Pensacola
Southwest Pensacola
Tallahassee
Northside
Jacksonville
St Augustine
Gainesville
Ocala
Palm Coast
Orlando
Lakeland
Tampa
Florida

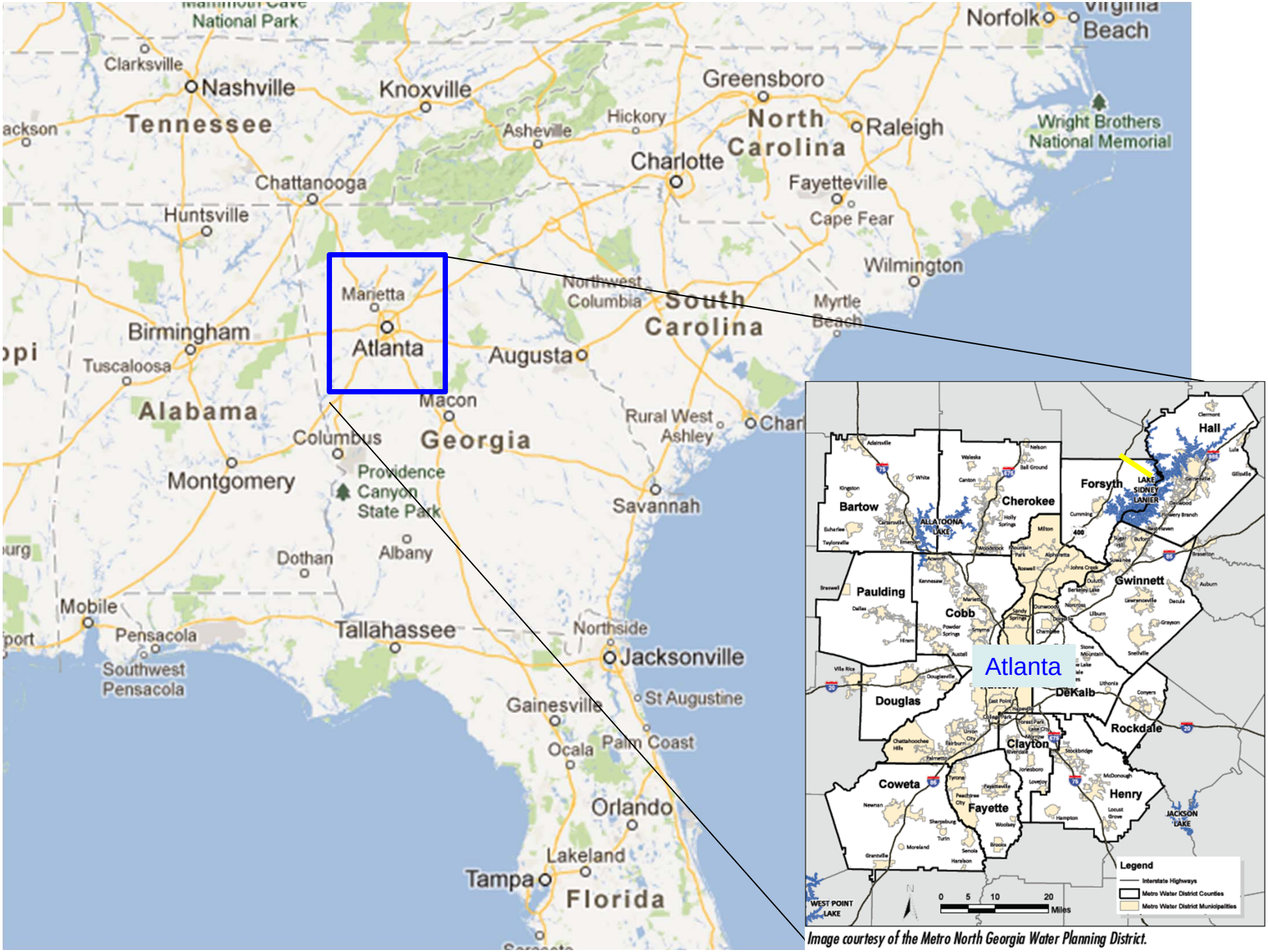


Image courtesy of the Metro North Georgia Water Planning District.

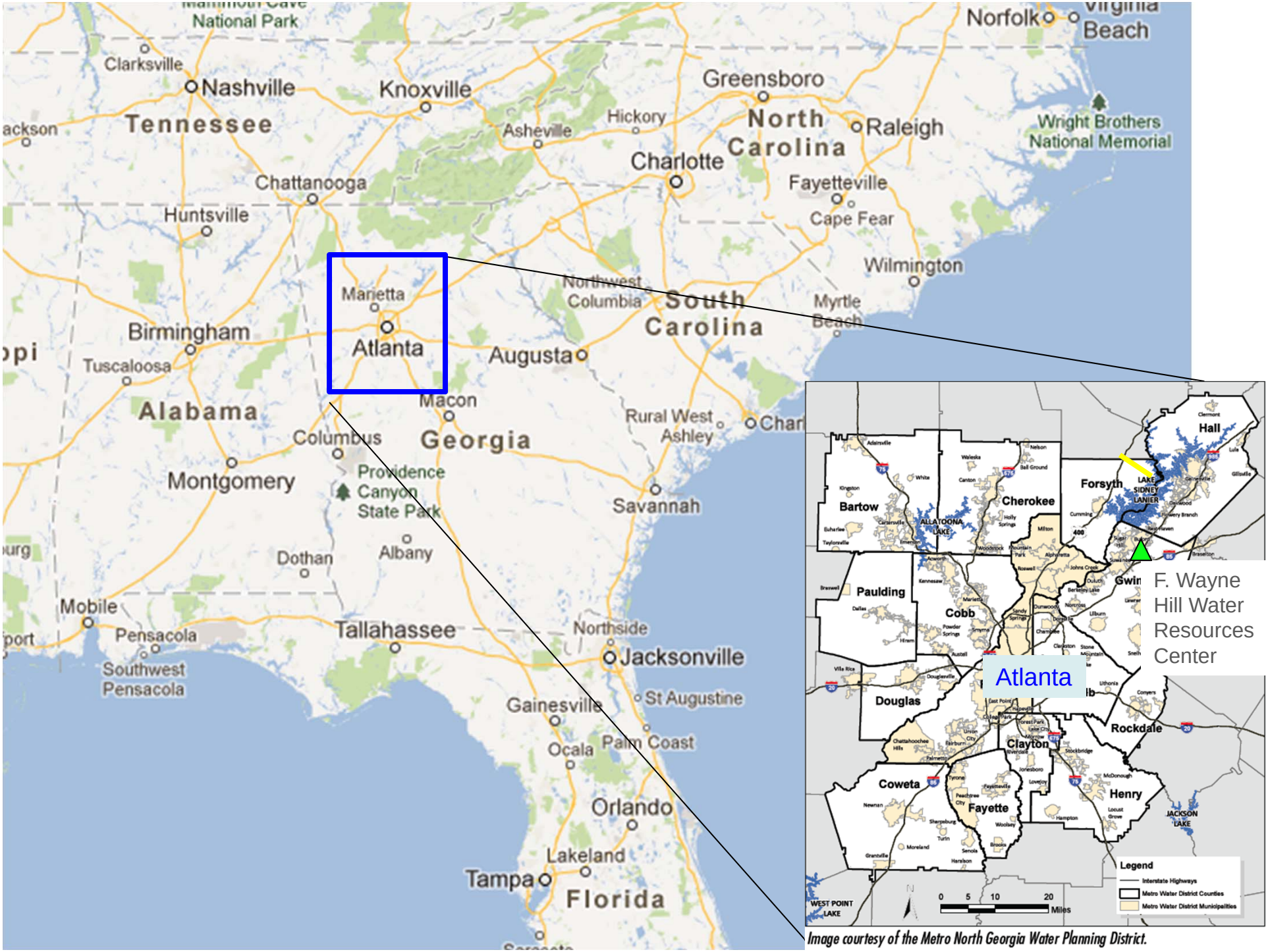


Image courtesy of the Metro North Georgia Water Planning District.

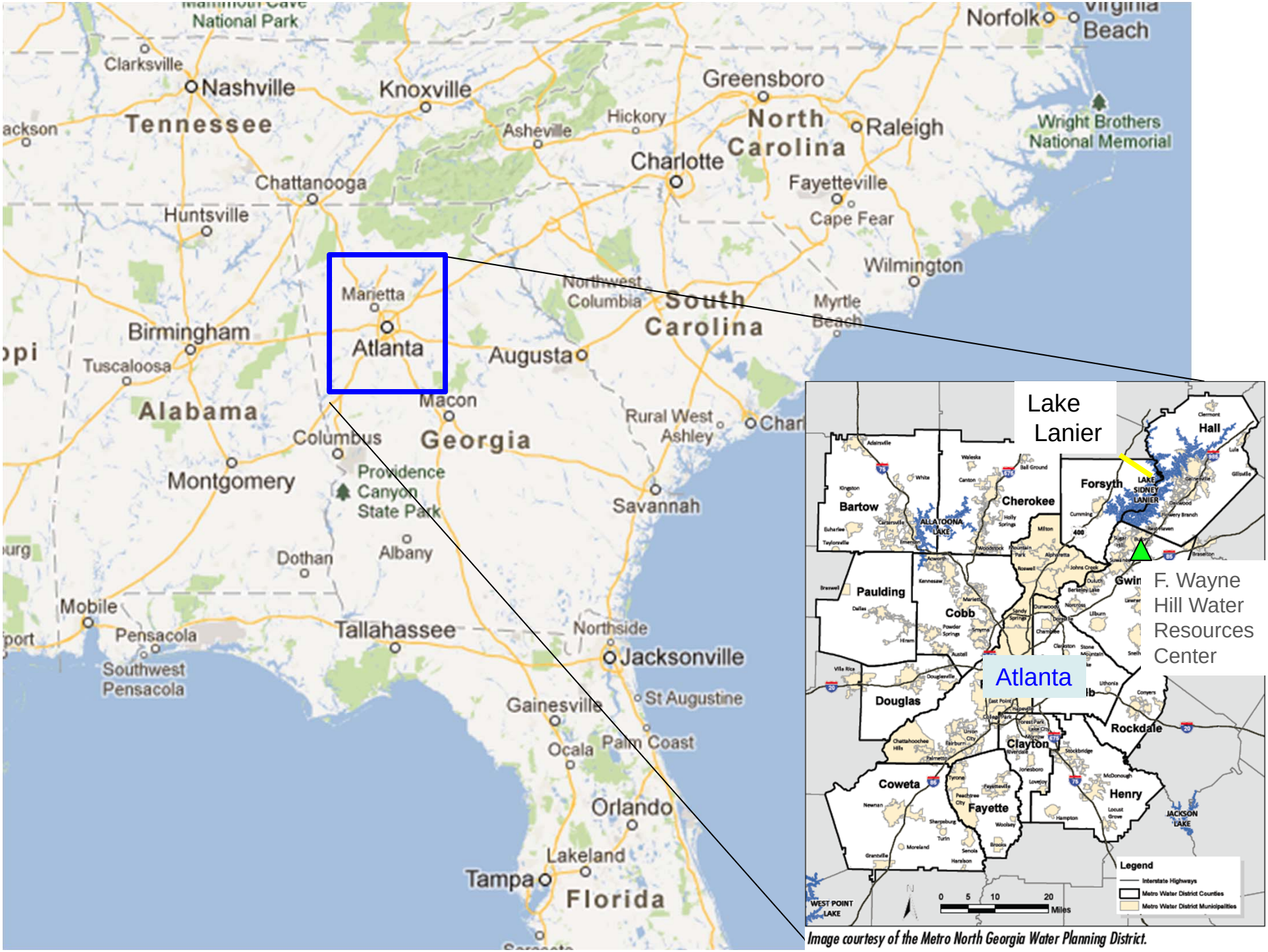


Image courtesy of the Metro North Georgia Water Planning District.

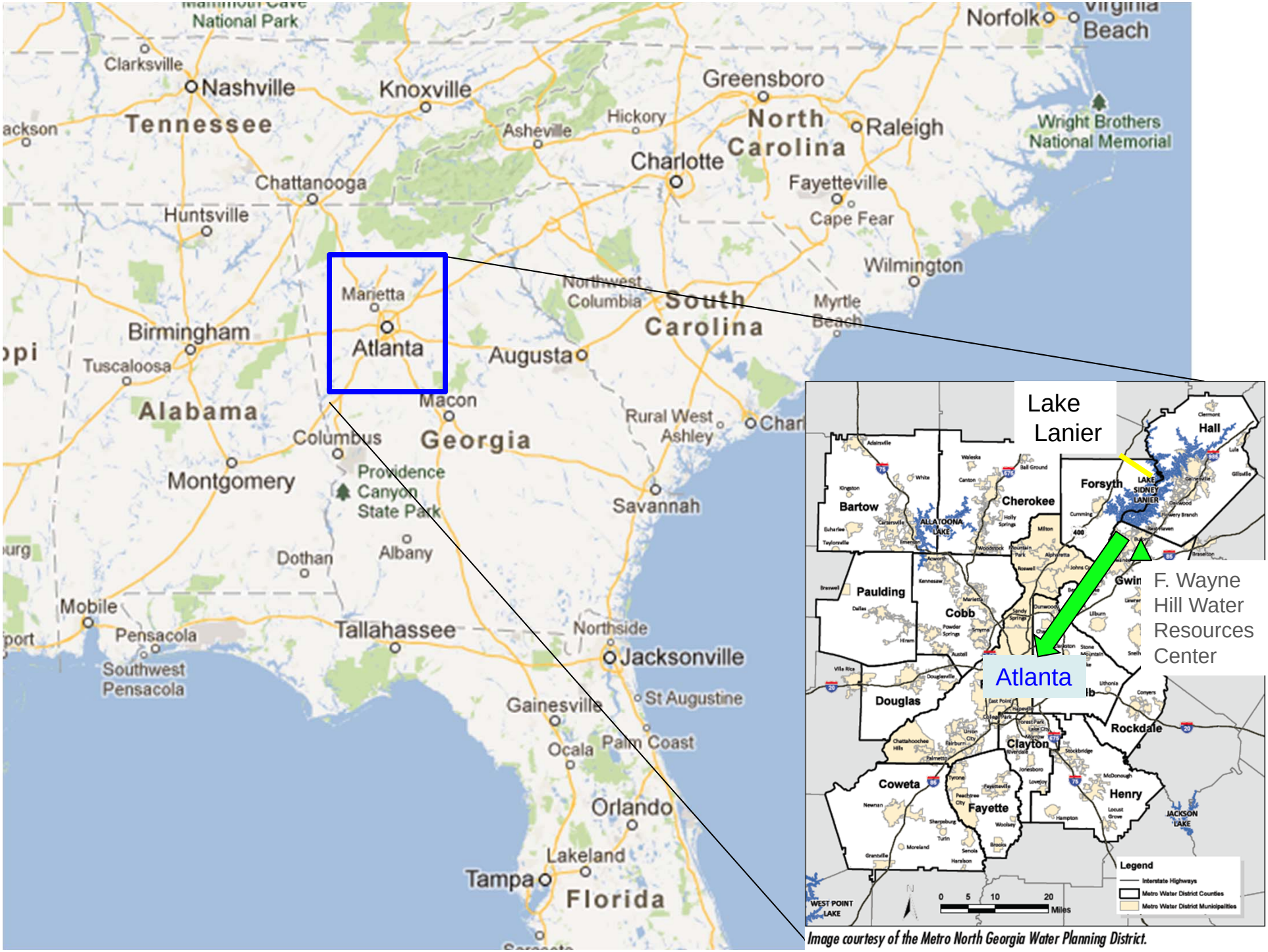


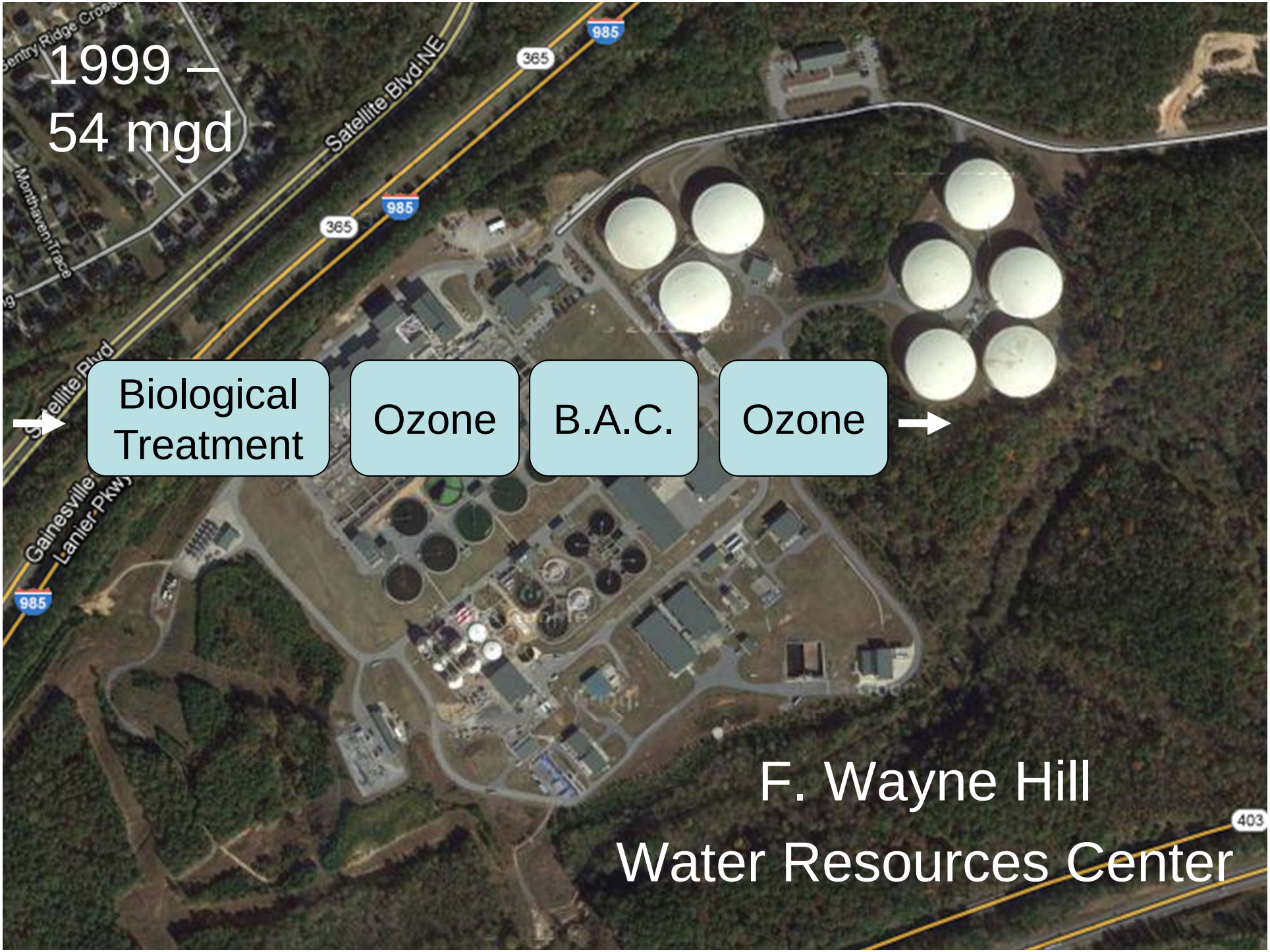
Image courtesy of the Metro North Georgia Water Planning District.

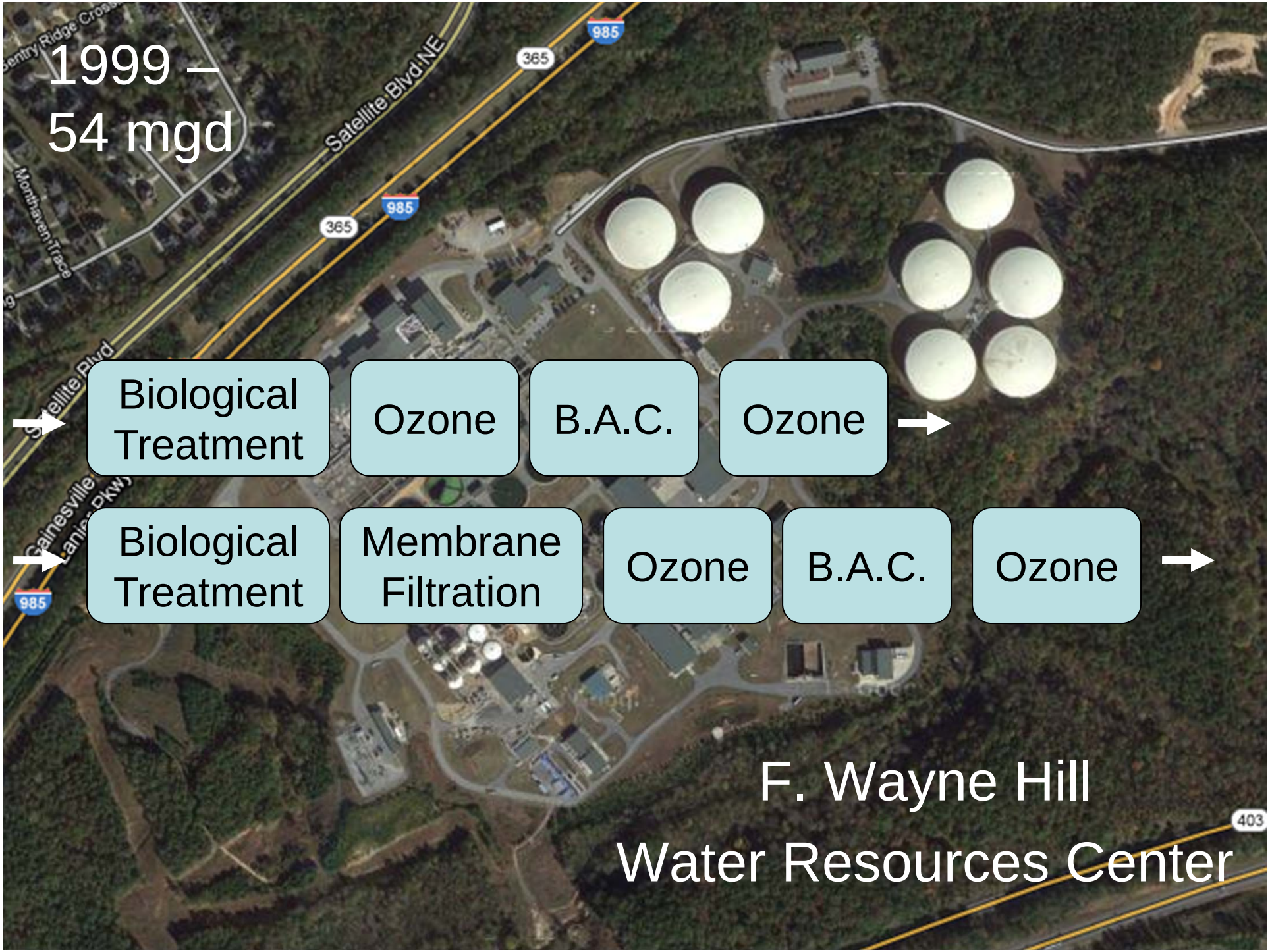
Mountain Preserve
Park
Cumming
Midway Park
Oakwood
Flowery Branch
Shoal Creek Campground
Buford Park
Buford
Sugar Hill
Bogan Park
Lanier Pkwy
Suwanee
Newtown Park
Johns Creek
Duluth
McDaniel Farm Park
Peachtree Corners
Buford Hwy
Norcross
Auburn
Dacula
Tribble
F. Wayne Hill
Water Resources Center

Lake Lanier
F. Wayne Hill
Water Resources Center
Mountain Preserve
Park
Midway Park
Cumming
Oakwood
Flowery Branch
Shoal Creek Campground
Buford Park
Buford
Bogan Park
Lanier Pkwy
Suwanee
Newtown Park
Johns Creek
Duluth
McDaniel Farm Park
Peachtree Corners
Buford Hwy
Norcross
Auburn
Dacula
Tribble
Sugarloaf

Sentry Ridge Cross
Monthaven Trace
Satellite Blvd NE
Satellite Blvd
Gainesville Con
Lanier Pkwy
985
365
403
F. Wayne Hill
Water Resources Center

1999 –
54 mgd
Satellite Blvd NE
Satellite Blvd
Gainesville Con
Lanier Pkwy
Monthaven Trace
985
365
403
F. Wayne Hill
Water Resources Center


1999 –
54 mgd
Biological Treatment
Ozone
B.A.C.
Ozone
F. Wayne Hill
Water Resources Center
Satellite Blvd NE
Gainesville Lanier Pkwy
Monthaven Trace
985
365
403

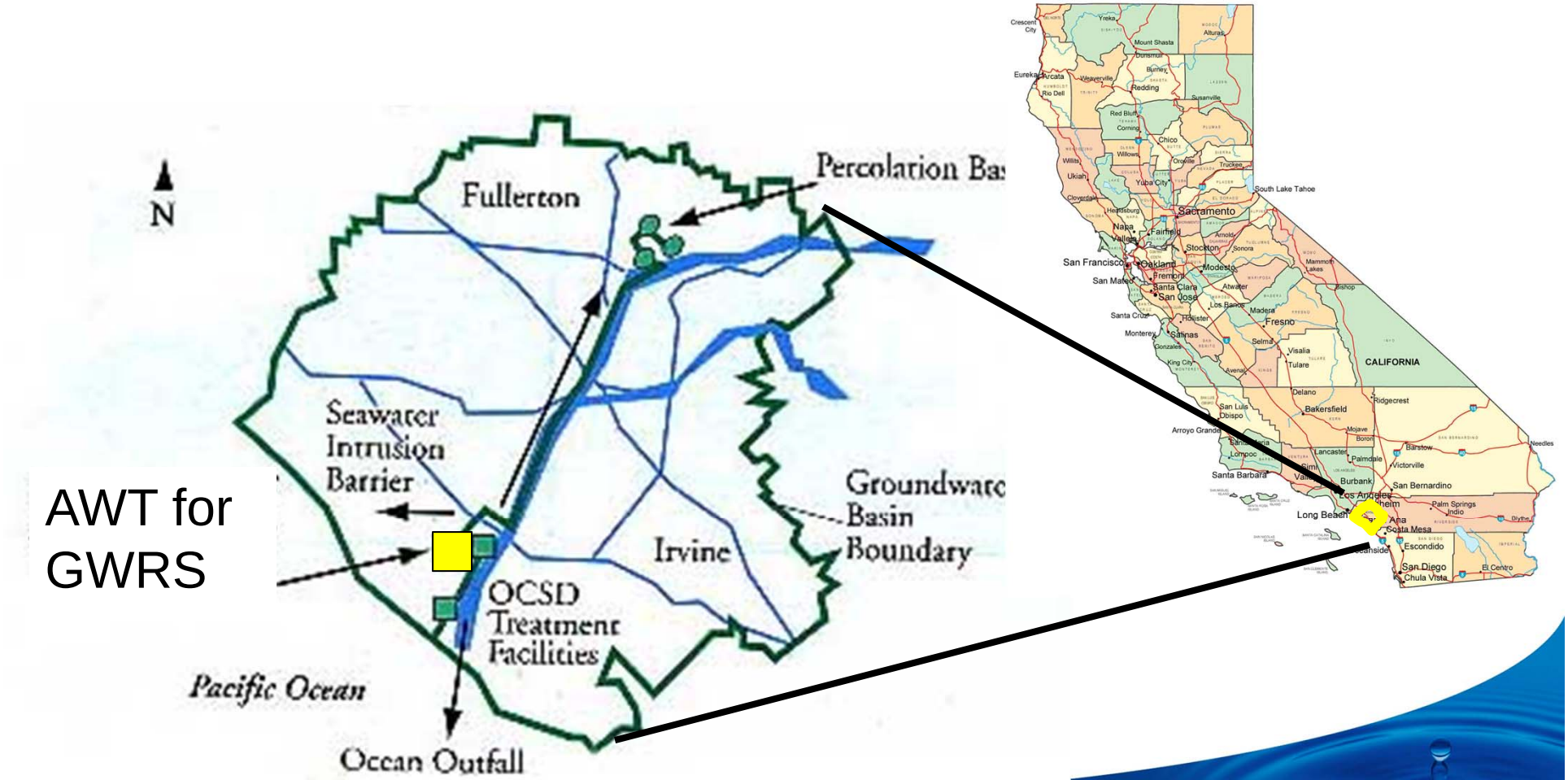

1999 –
54 mgd
Satellite Blvd NE
Monthaven Trace
Gainesville
985
365
Biological Treatment
Ozone
B.A.C.
Ozone
Biological Treatment
Membrane Filtration
Ozone
B.A.C.
Ozone
F. Wayne Hill
Water Resources Center
403

Ground Water Replenishment System

Orange Co., CA

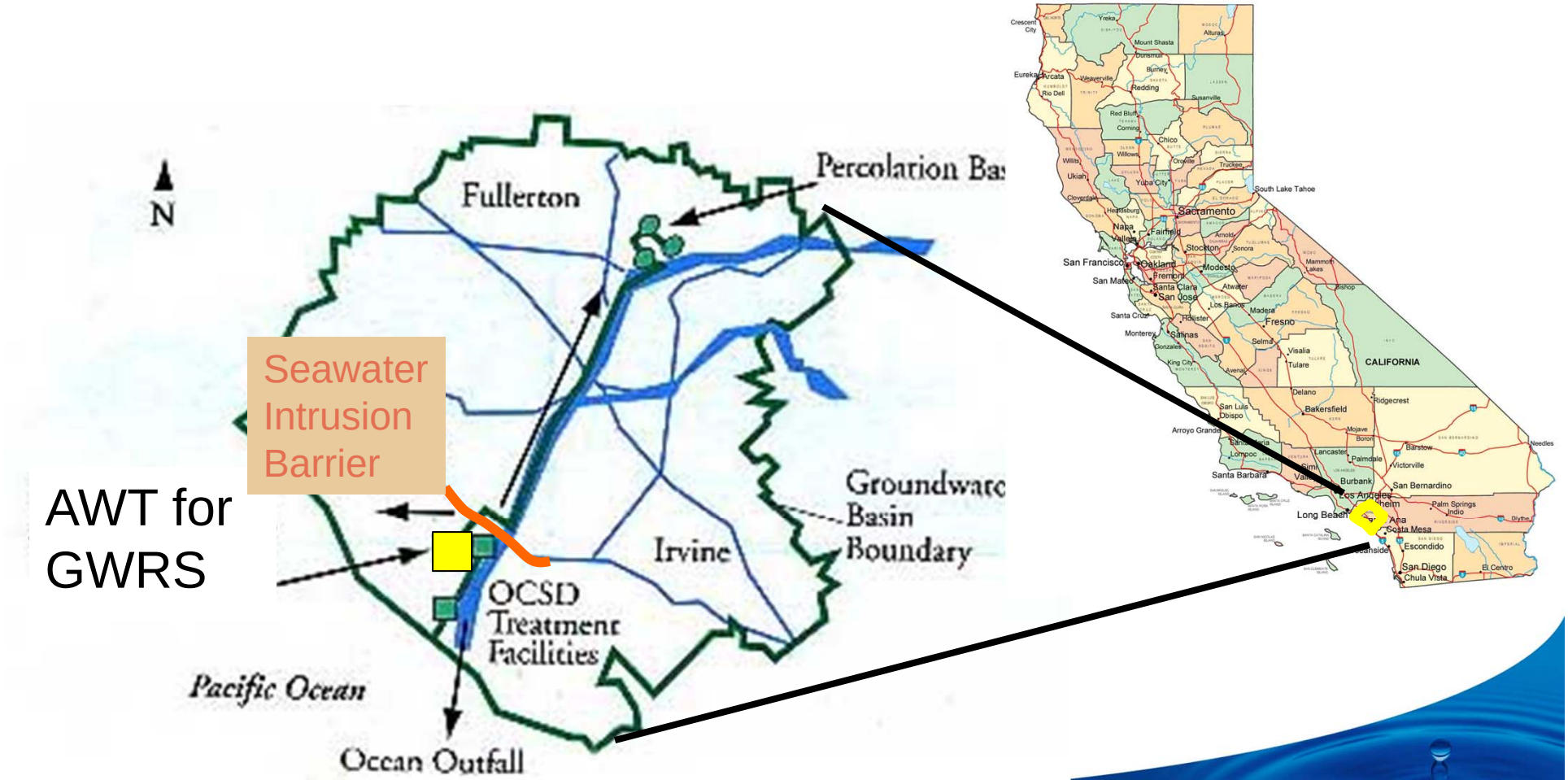
Trussell
TECHNOLOGIES INC

GWRS

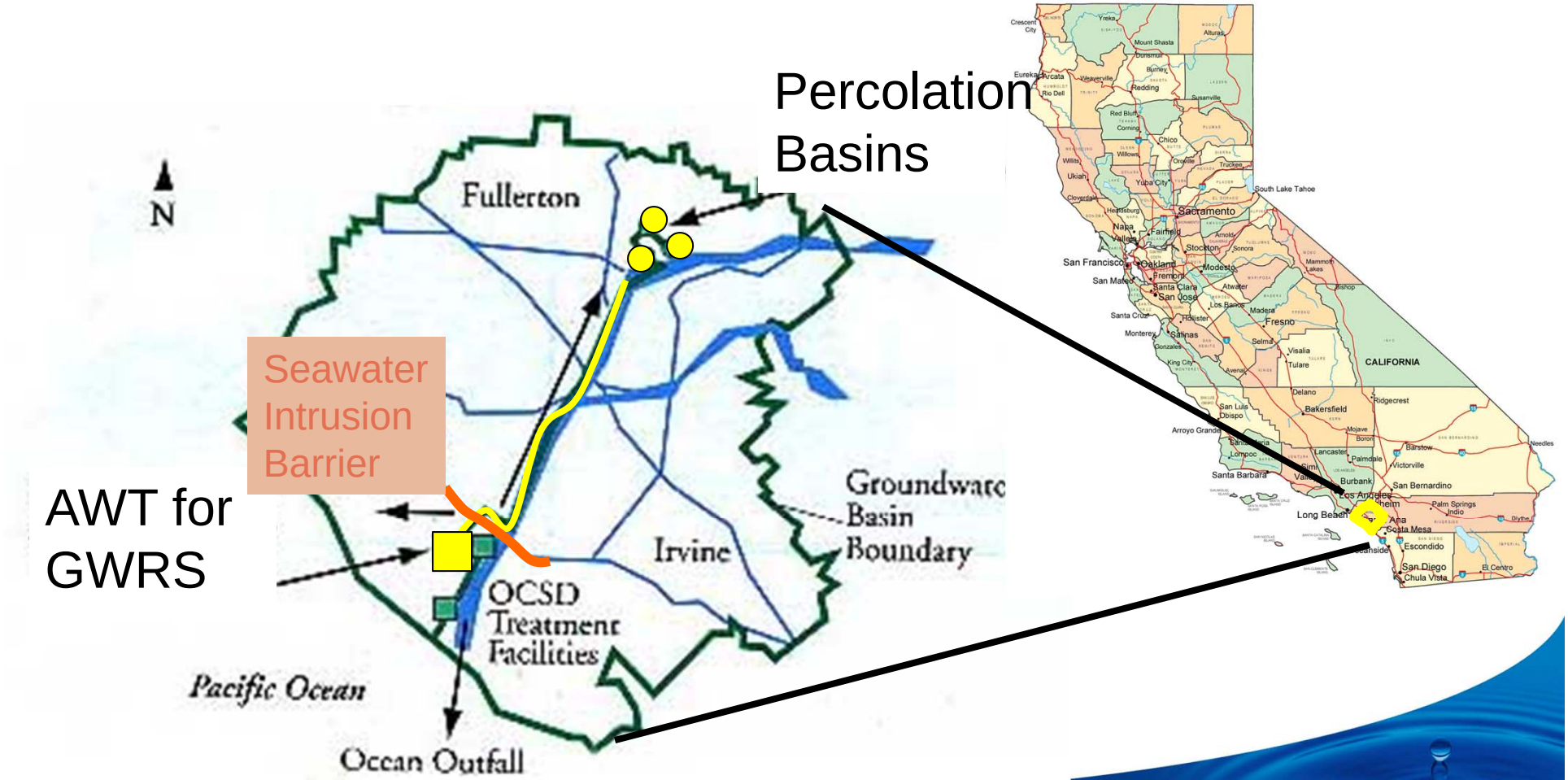


AWT for GWRS

GWRS


N
Fullerton
Percolation Bas
Seawater Intrusion Barrier
AWT for GWRS
Groundwate
Basin Boundary
Irvine
OCSD Treatment Facilities
Pacific Ocean
Ocean Outfall
CALIFORNIA
Sacramento
San Francisco
Oakland
Los Angeles
Long Beach
Santa Barbara
Fresno
Bakersfield
San Diego

GWRS


Percolation Basins
Seawater Intrusion Barrier
AWT for GWRS
N
Fullerton
Irvine
Groundwater Basin Boundary
OCSD Treatment Facilities
Pacific Ocean
Ocean Outfall
CALIFORNIA
Sacramento
San Francisco
Oakland
Los Angeles
San Diego

Orange County GWRS

- Advanced process train
- Removes all pathogens
- Removes all organics (TOC_{avg} ~ 0.1 mg/L)

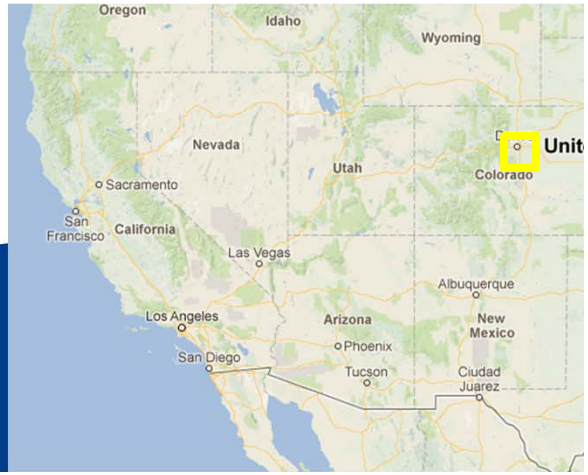
→ Biological Treatment | Membrane Filtration | RO | UV/H_2O_2 →

Orange County GWRS

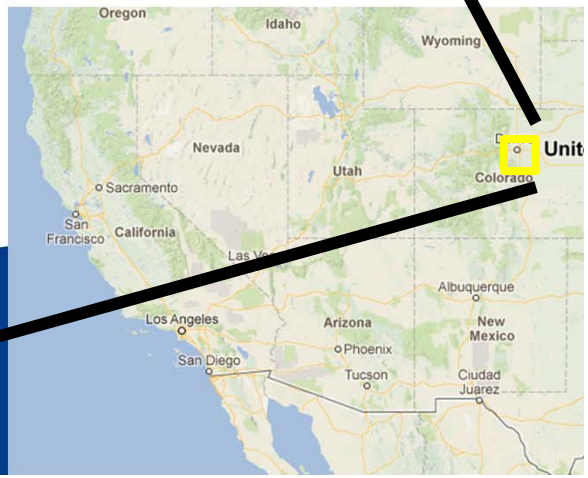
- Preceded by WF 21 from 1978 thru 2005
- Began operations in 2008
- Presently 70 mgd; undergoing a 30 mgd expansion
- Water is put into potable aquifer via direct injection and surface spreading

The Prairie Waters Project, Aroura, CO

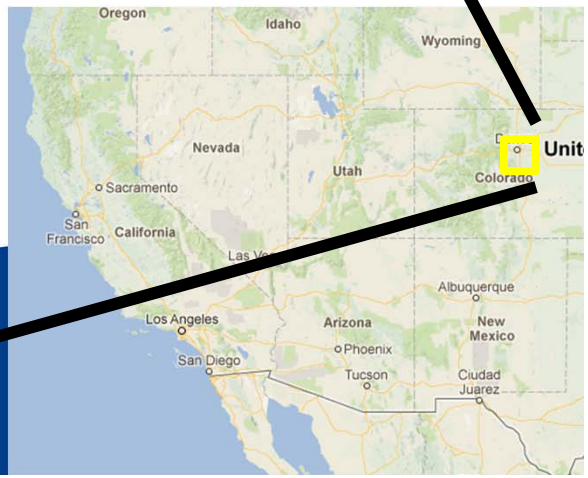
Trussell
TECHNOLOGIES INC

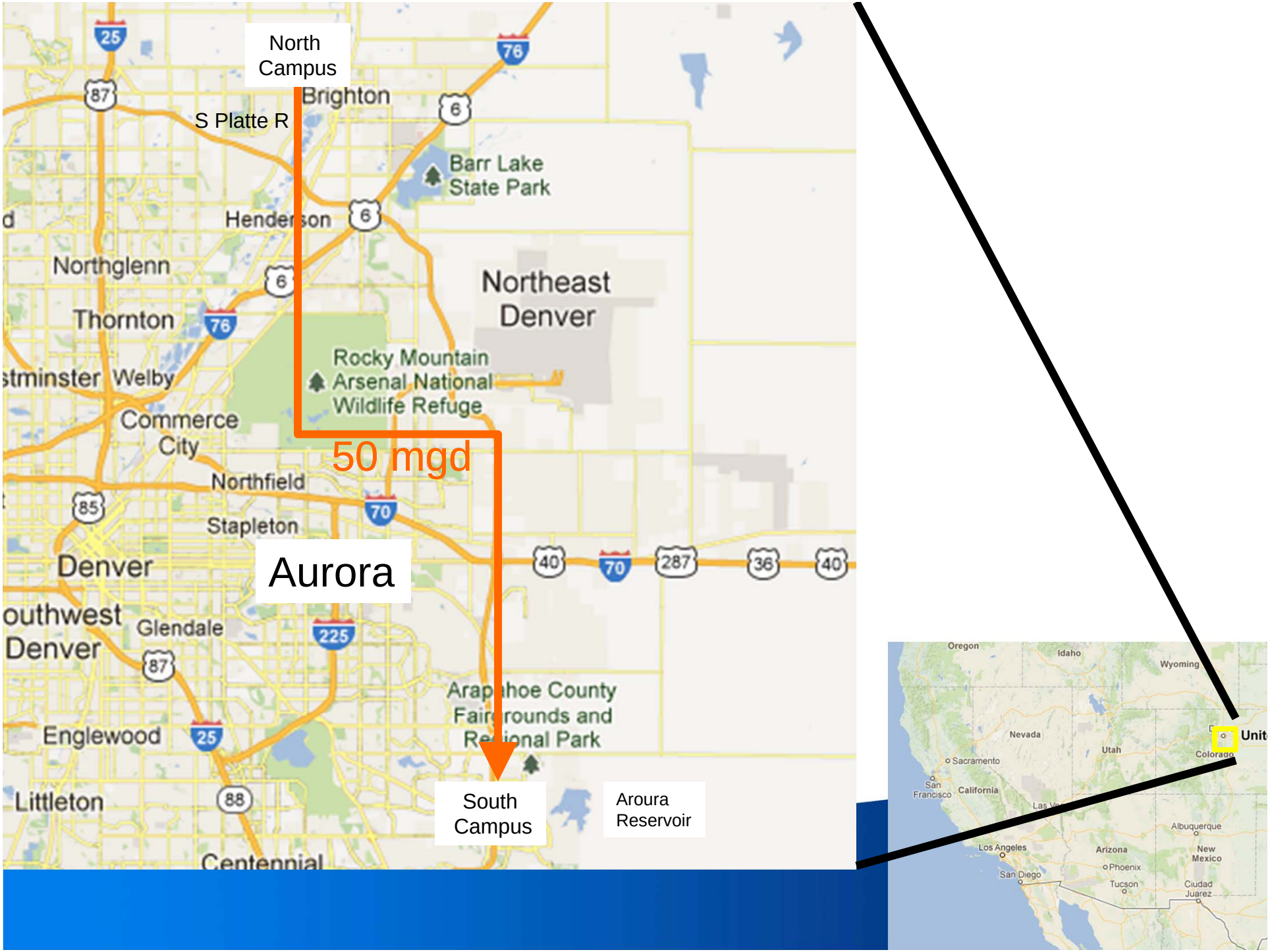

Oregon
Idaho
Wyoming
Nevada
Utah
Colorado
Sacramento
San Francisco
California
Las Vegas
Albuquerque
Los Angeles
Arizona
New Mexico
Phoenix
San Diego
Tucson
Ciudad Juarez

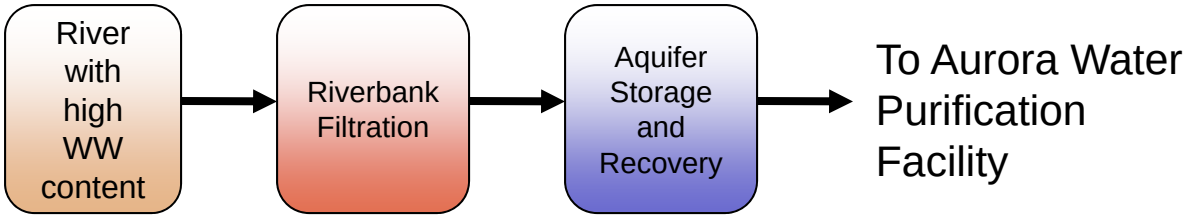
Aurora
Brighton
S Platte R
Barr Lake
State Park
Henderson
Northglenn
Thornton
Northeast
Denver
Rocky Mountain
Arsenal National
Wildlife Refuge
Welby
Commerce
City
Northfield
Stapleton
Denver
Glendale
Arapahoe County
Fairgrounds and
Regional Park
Englewood
Littleton
Centennial

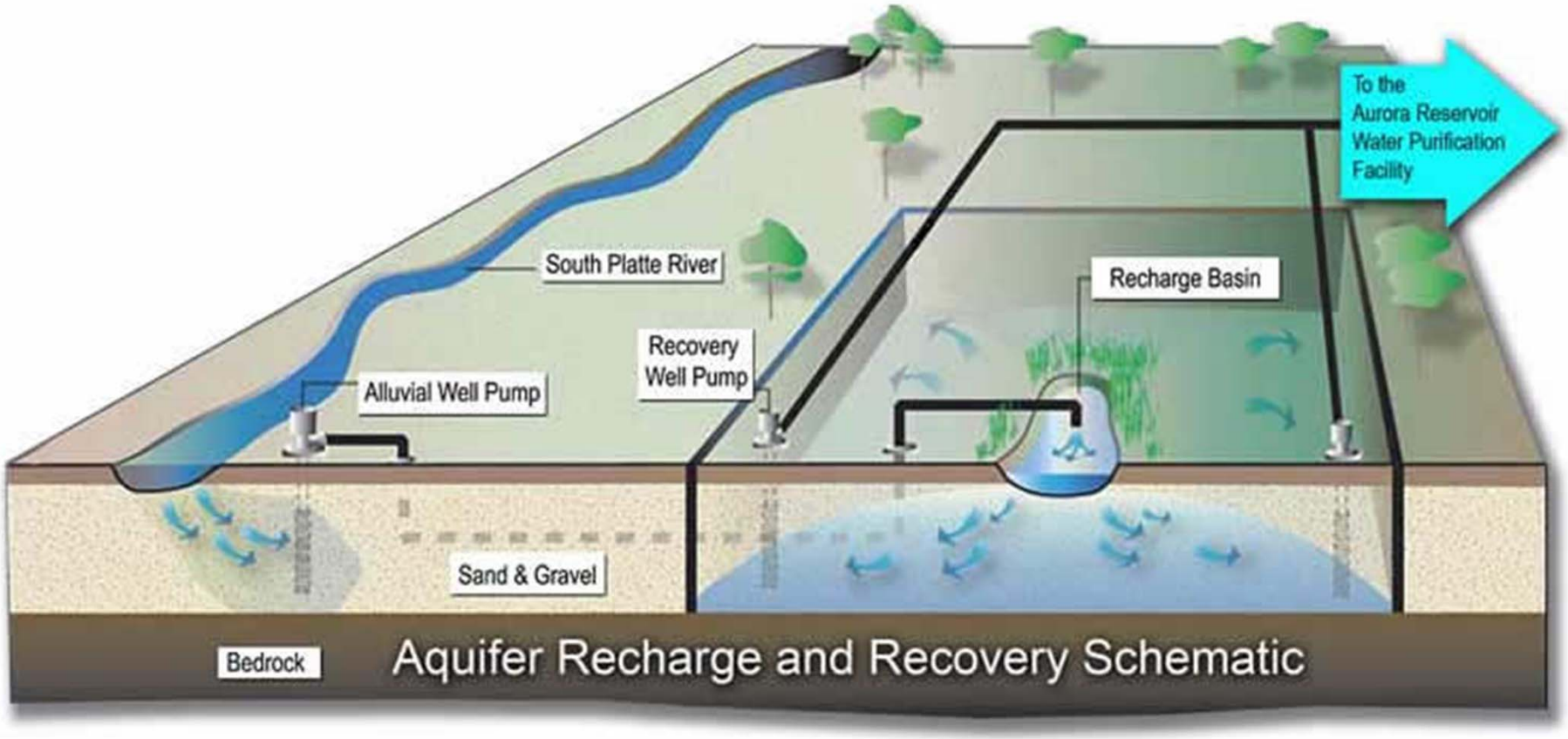

Oregon
Idaho
Wyoming
Nevada
Utah
Colorado
Sacramento
San
Francisco
California
Albuquerque
Los Angeles
Arizona
New
Mexico
Phoenix
San Diego
Tucson
Ciudad
Juarez

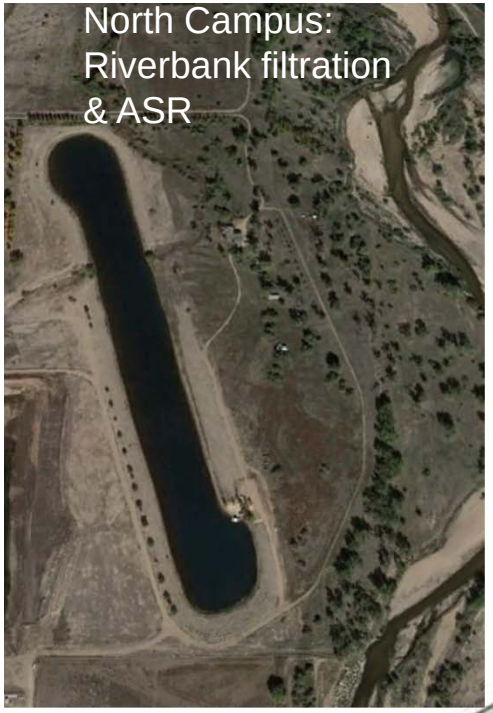
North Campus
Brighton
S Platte R
Barr Lake State Park
Henderson
Northglenn
Thornton
Northeast Denver
Rocky Mountain Arsenal National Wildlife Refuge
Welby
Commerce City
Northfield
Stapleton
Aurora
Denver
Glendale
Arapahoe County Fairgrounds and Regional Park
Englewood
Littleton
Centennial

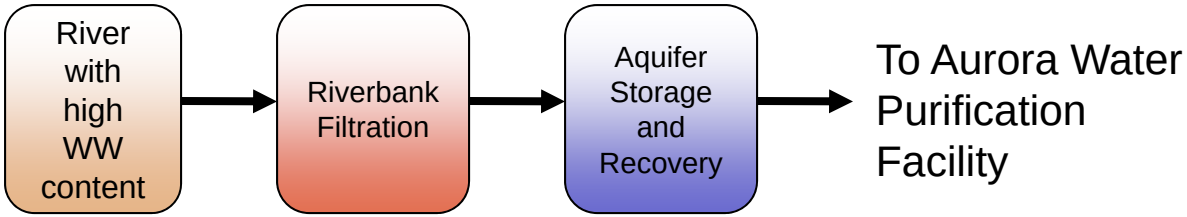

Oregon
Idaho
Wyoming
Nevada
Utah
Colorado
Sacramento
San Francisco
California
Albuquerque
Los Angeles
Arizona
New Mexico
Phoenix
San Diego
Tucson
Ciudad Juarez

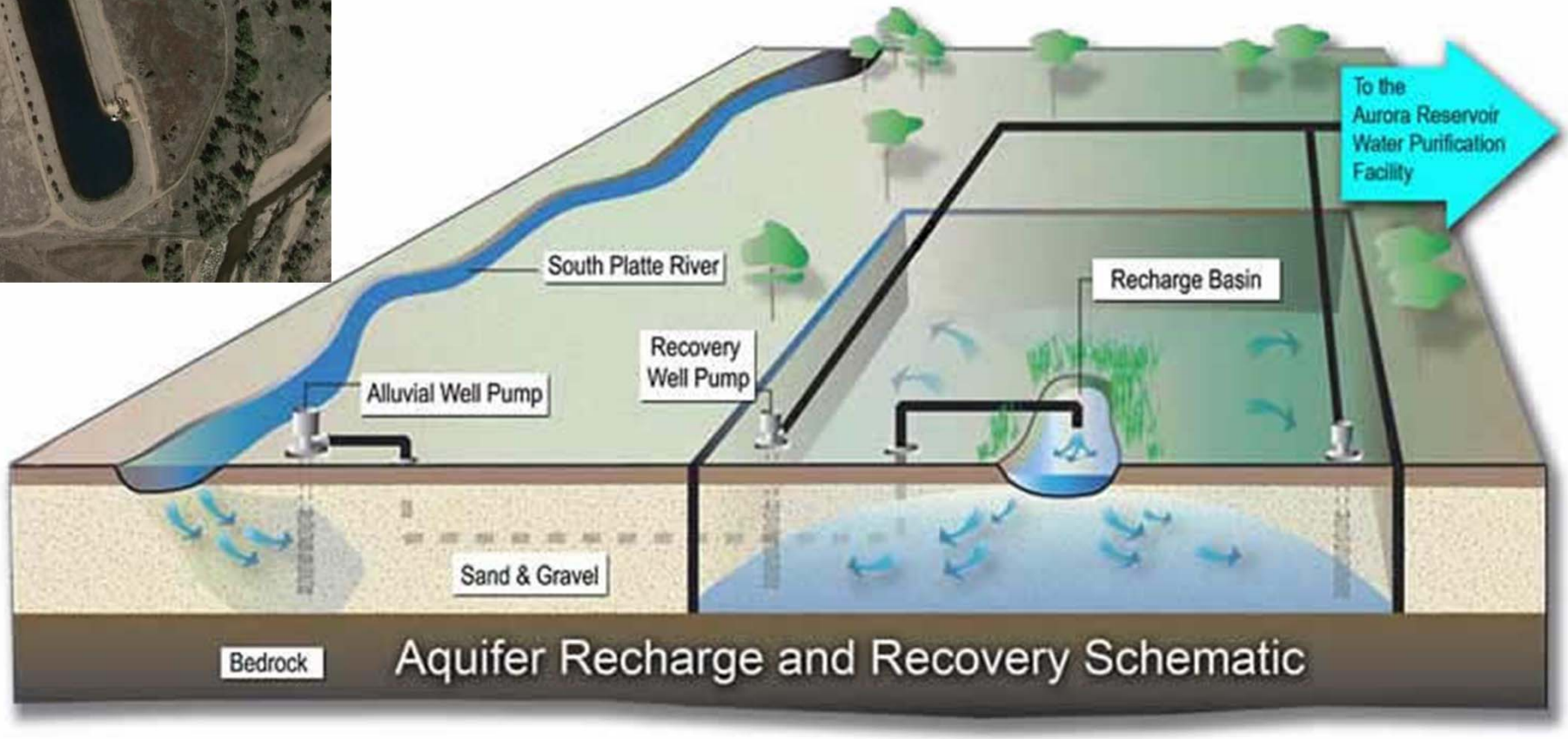

North Campus
Brighton
S Platte R
Barr Lake State Park
Henderson
Northglenn
Thornton
Northeast Denver
Rocky Mountain Arsenal National Wildlife Refuge
Welby
Commerce City
50 mgd
Northfield
Stapleton
Aurora
Denver
Glendale
Englewood
Littleton
Centennial
South Campus
Aroura Reservoir
Oregon
Idaho
Wyoming
Nevada
Utah
Colorado
Sacramento
San Francisco
California
Albuquerque
Los Angeles
Arizona
New Mexico
Phoenix
San Diego
Tucson
Ciudad Juarez


River with high WW content
Riverbank Filtration
Aquifer Storage and Recovery
To Aurora Water Purification Facility


To the Aurora Reservoir Water Purification Facility
South Platte River
Recharge Basin
Recovery Well Pump
Alluvial Well Pump
Sand & Gravel
Bedrock
Aquifer Recharge and Recovery Schematic


North Campus:
Riverbank filtration
& ASR


River with high WW content
Riverbank Filtration
Aquifer Storage and Recovery
To Aurora Water Purification Facility


To the Aurora Reservoir Water Purification Facility
South Platte River
Recharge Basin
Recovery Well Pump
Alluvial Well Pump
Sand & Gravel
Bedrock
Aquifer Recharge and Recovery Schematic

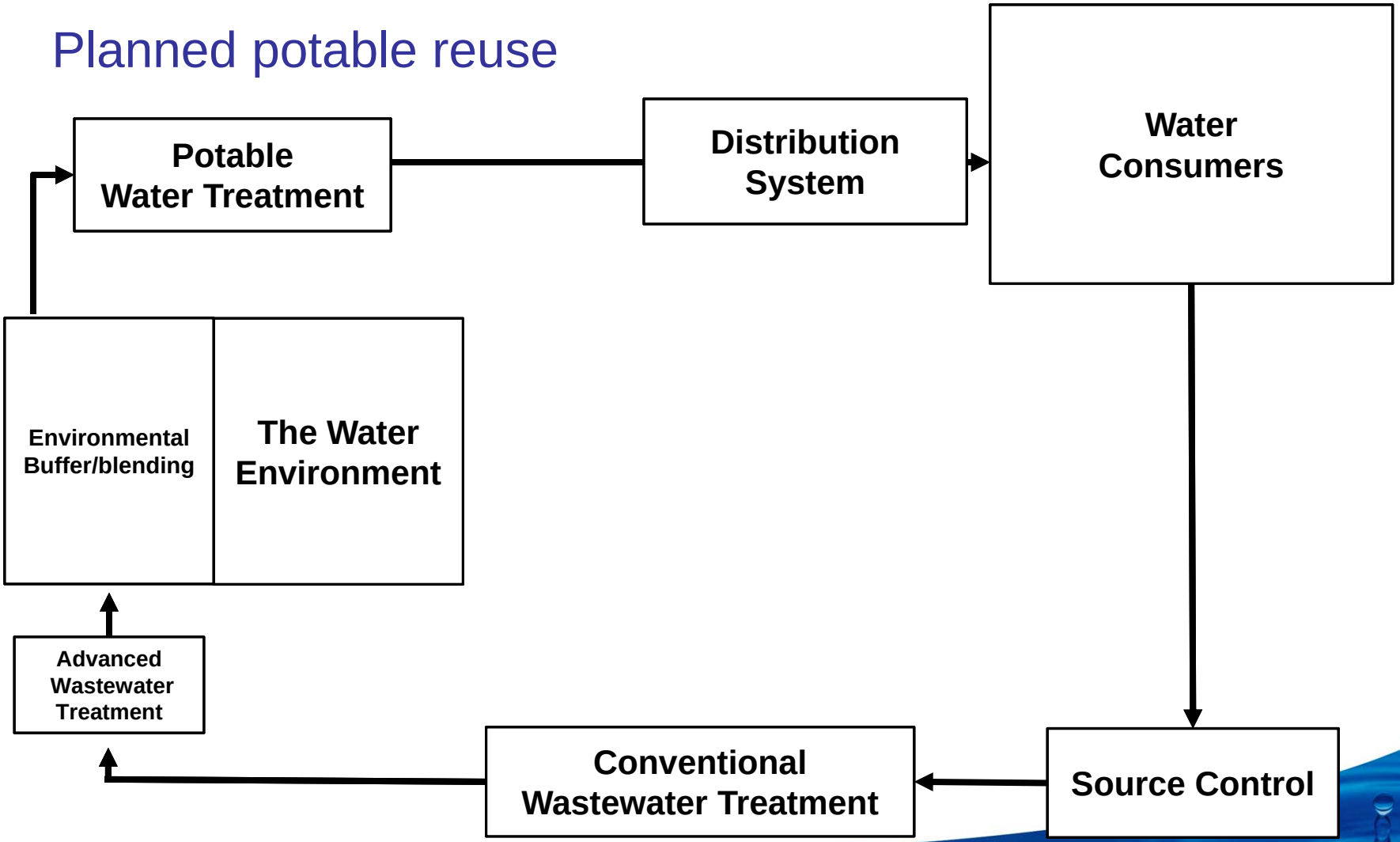
Aquifer Storage and Recovery
Softening
UV/H_2O_2
Media Filtration
Biological Activated Carbon
South Campus:
ASR, Softening, UV/H_2O_2, GMF & BAC

Pairie Waters Project

- 50-mgd
- Dedicated in 2010
- Operated by Aurora Water
- Advanced treatment downstream of environmental buffer

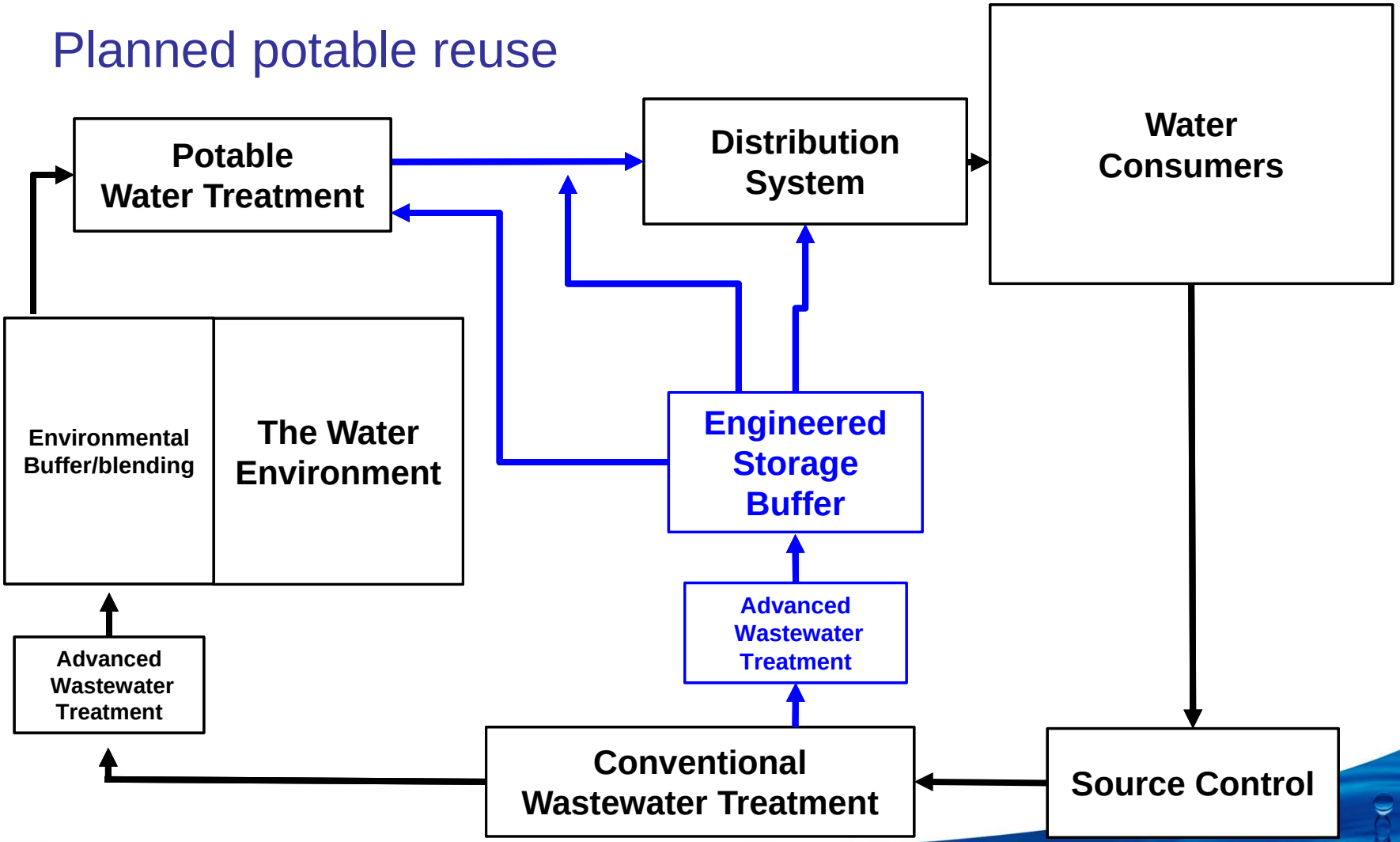
Structure of Potable Reuse

Planned potable reuse



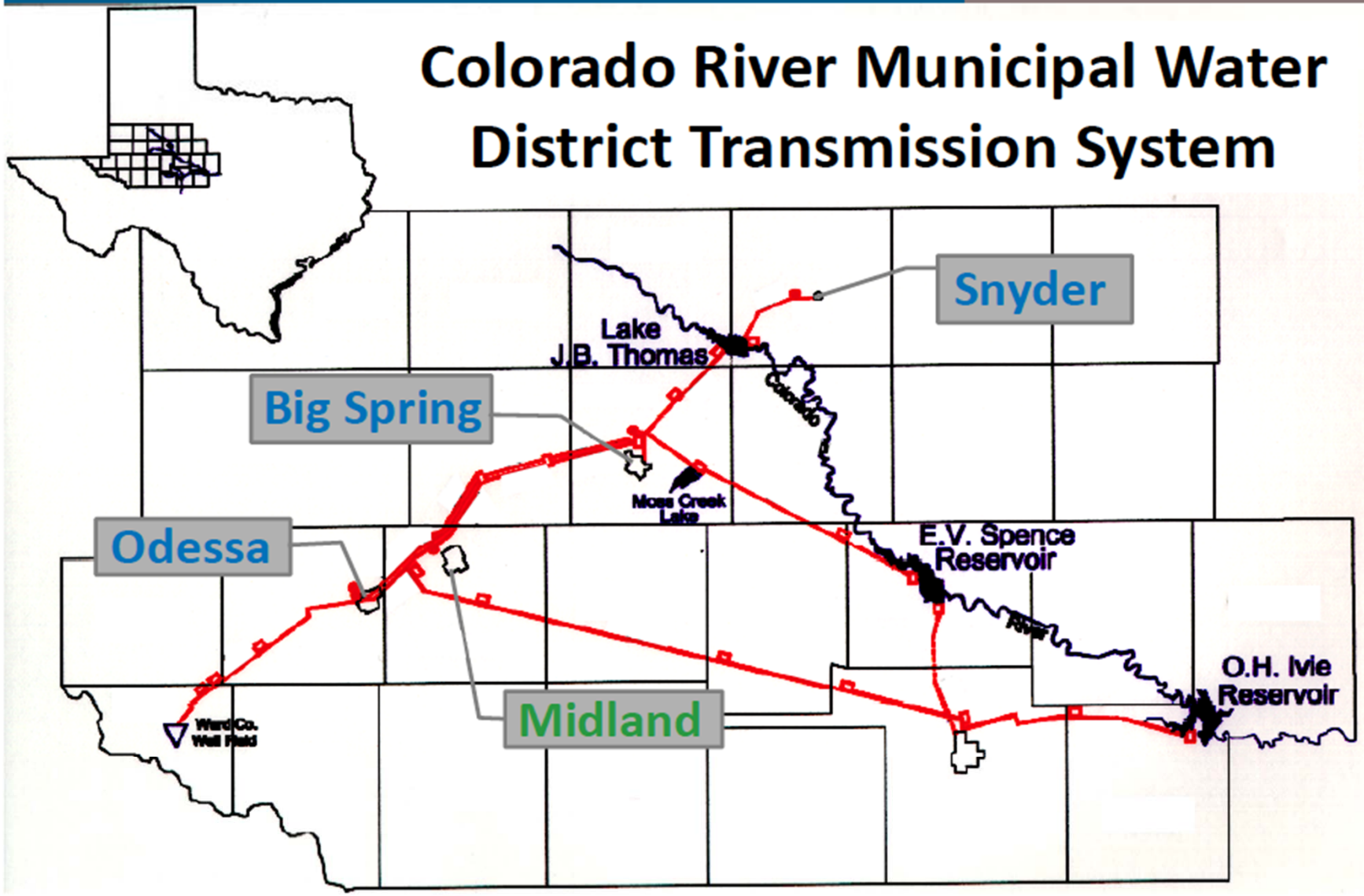
Structure of **Direct** Potable Reuse Scenarios

Planned potable reuse

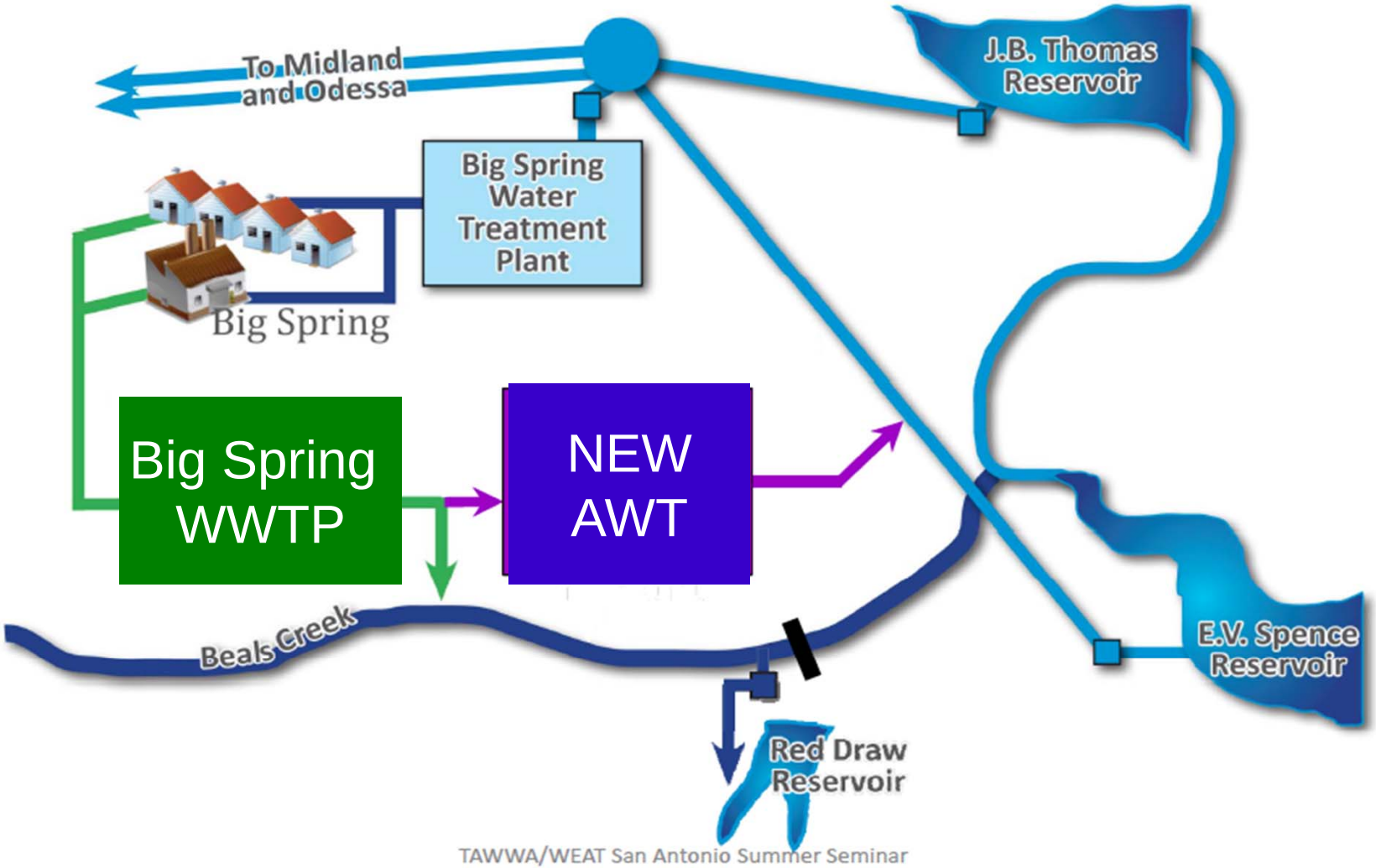


- Present Paradigm
- Emerging Paradigm

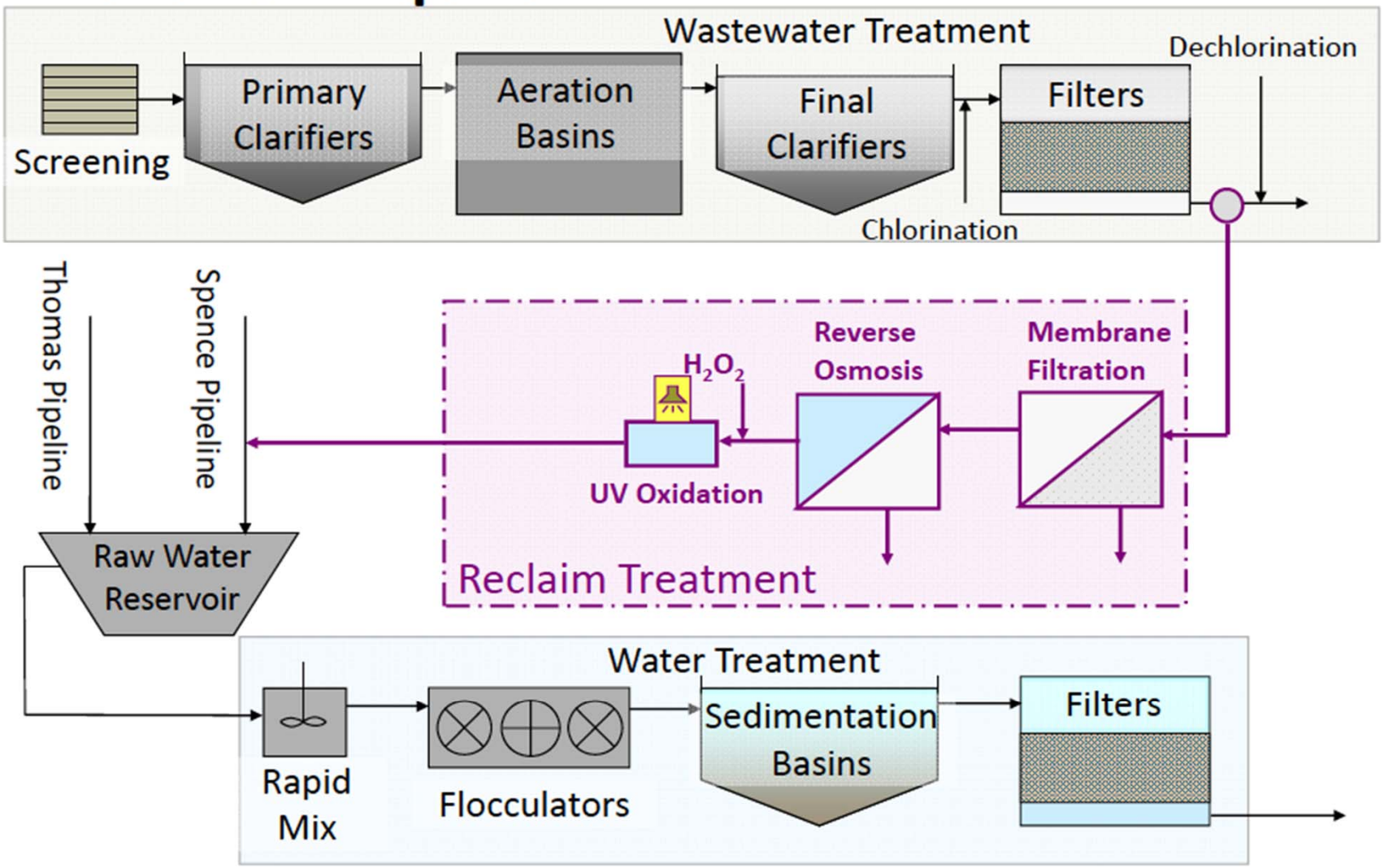
Colorado River Municipal Water District Transmission System



Big Spring Reclamation Project



Treatment Sequence



Colorado River MWD Project

- 2.4-mgd
- Began Operations April 2013
- Same process as GWRS
- Product water introduced to raw water pipeline for WTP

finito

Trussell
TECHNOLOGIES INC