TWENTY-NINTH ANNUAL SURFACE WATER QUALITY MONITORING WORKSHOP

October 13-15, 2015

Water Reuse: Past, Present and Future

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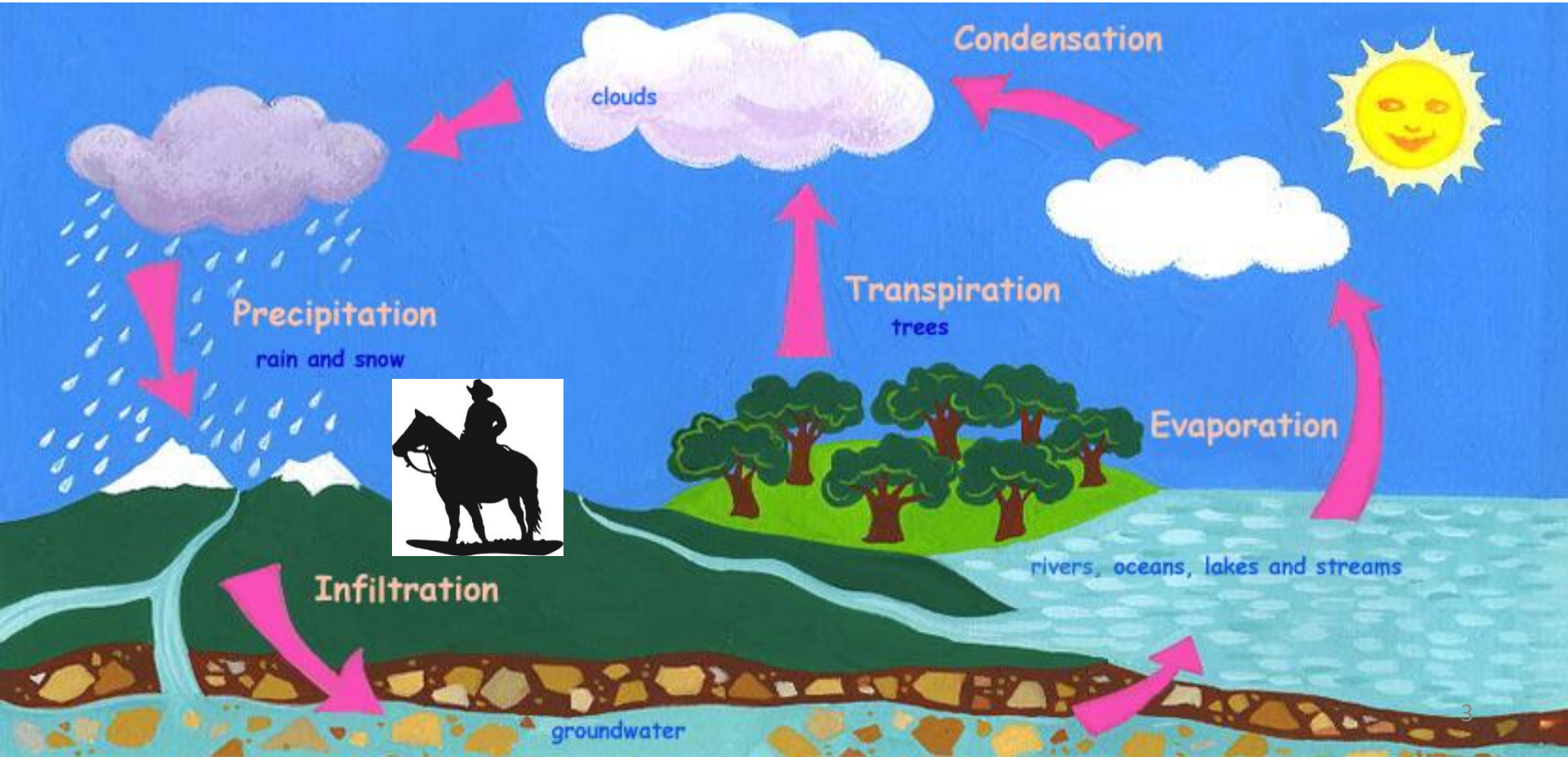
October 14, 2015

Presentation Outline

- Water Reuse through the Ages
- Why Reuse Water?
- Need for Water Reuse in Texas
- TCEQ Regulations for Water Reuse
- Direct and Indirect Potable Reuse
- Water Reuse and Surface Water Quality
- Future of Water Reuse
- Questions and Comments

Water Reuse: As Old as Mother Nature

- Water is always recycled in nature



Evolution of Water Reuse

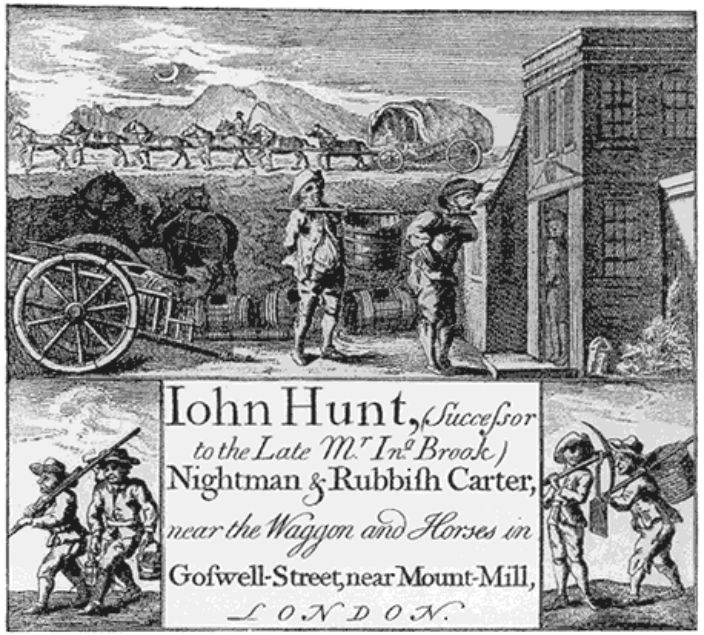
- ~3000 BC: Crete, Greece – Minoan civilization: use of wastewater for agricultural irrigation
- 1500: Germany – Sewage farms used for wastewater disposal
- 1800-1850: France, England, U.S. – Legal use of sewers for human waste disposal in Paris (1800), London (1815), and Boston (1830) instituted
- 1890: Mexico City – Drainage canals built to take untreated wastewater to irrigate agricultural area north of the city
- 1906: Jersey City, NJ – Chlorination of water supply
- 1906: Oxnard, CA – Earliest reference related to a public health viewpoint of water quality requirements for the reuse of wastewater appears in the *Monthly Bulletin, California State Board of Health,* February 1906 on the Oxnard septic tank system of sewage disposal

Evolution of Water Reuse (continued …)

- 1926: Grand Canyon National Park – Treated wastewater is first used in a dual water system for toilet flushing, lawn sprinkling, cooling water, and boiler feed water
- 1929: Pomona, CA – Reclaimed water used for irrigation of lawns and gardens
- 1932-1985: San Francisco, CA – Treated wastewater is used for watering lawns and supplying ornamental lakes in Golden Gate Park
- 1955: Tokyo, Japan – Industrial water is supplied from Mikawajima wastewater treatment plant by Tokyo Metropolitan Sewerage Bureau
- 1968: Windhoek, Namibia – Direct potable reuse (DPR) begun at Windhoek's Goreangab Water Reclamation Plant

Early Days

- "Night Soil"
- "Sewage Farms"
- Early awareness of the value of water and the fertilizer value of waste



TO FARMERS.

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The LODI MANUFACTURING COMPANY (the oldest manufacturers of Fertilizers in the United States) offer their celebrated Poudrette for sale at lower prices than any other fertilizer in market.

It is made from the night soil and offal of New York City, and has been in use by thousands of farmers for over a quarter of a century: $4 will manure an Acre of Corn in the hill, and increase the yield one third.

A Pamphlet with the experience in its use on Lawns, Garden Vegetables, Corn, Potatoes, and Tobacco, of hundreds of Farmers, some of whom have used it for over 20 years, containing also price, directions for use, &c., will be sent *free* to any person applying.

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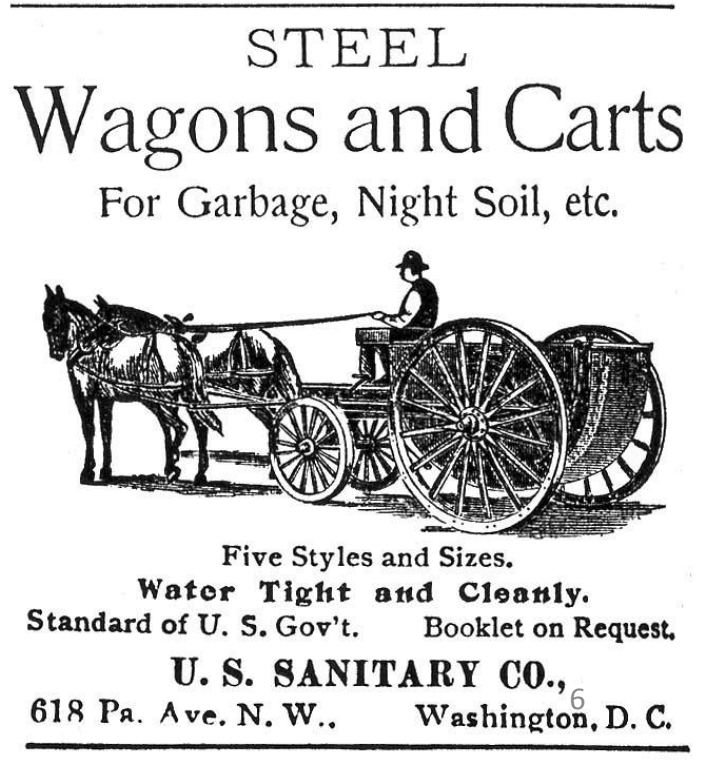

STEEL
Wagons and Carts
For Garbage, Night Soil, etc.

Five Styles and Sizes.
Water Tight and Cleanly.
Standard of U. S. Gov't. Booklet on Request.
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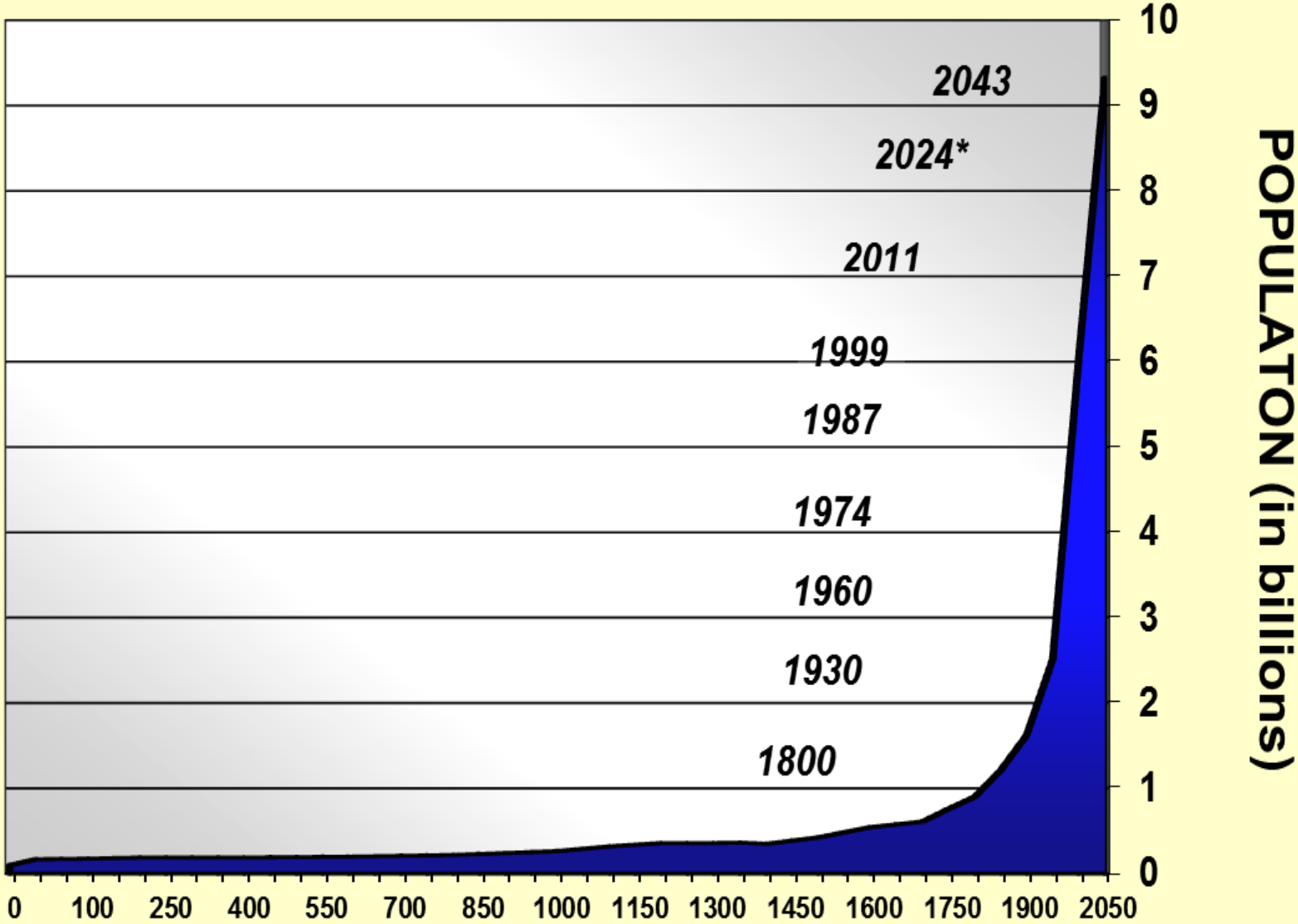
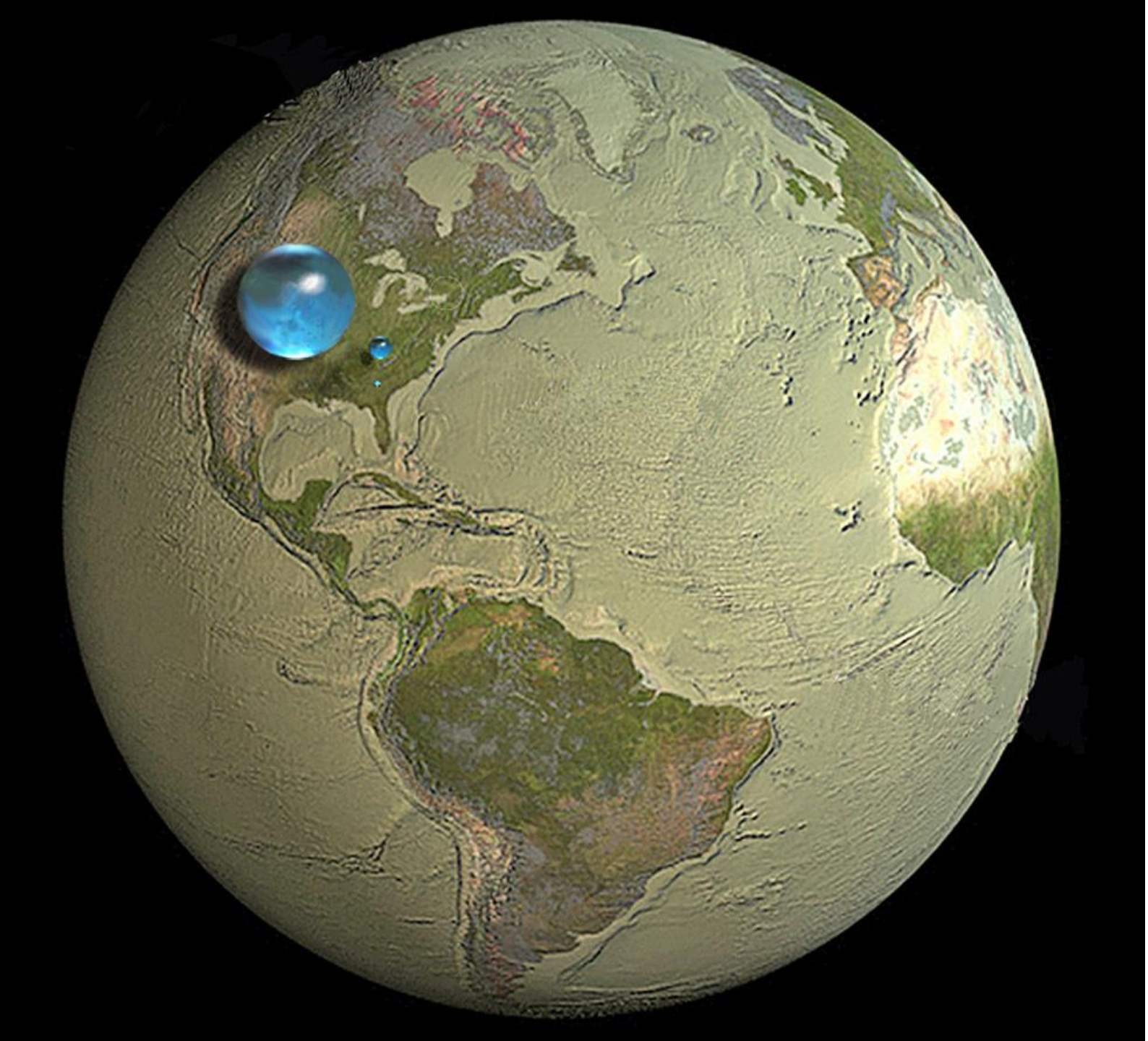
Human Population 1 AD - 2050 AD



*Projected

Source: Population Education

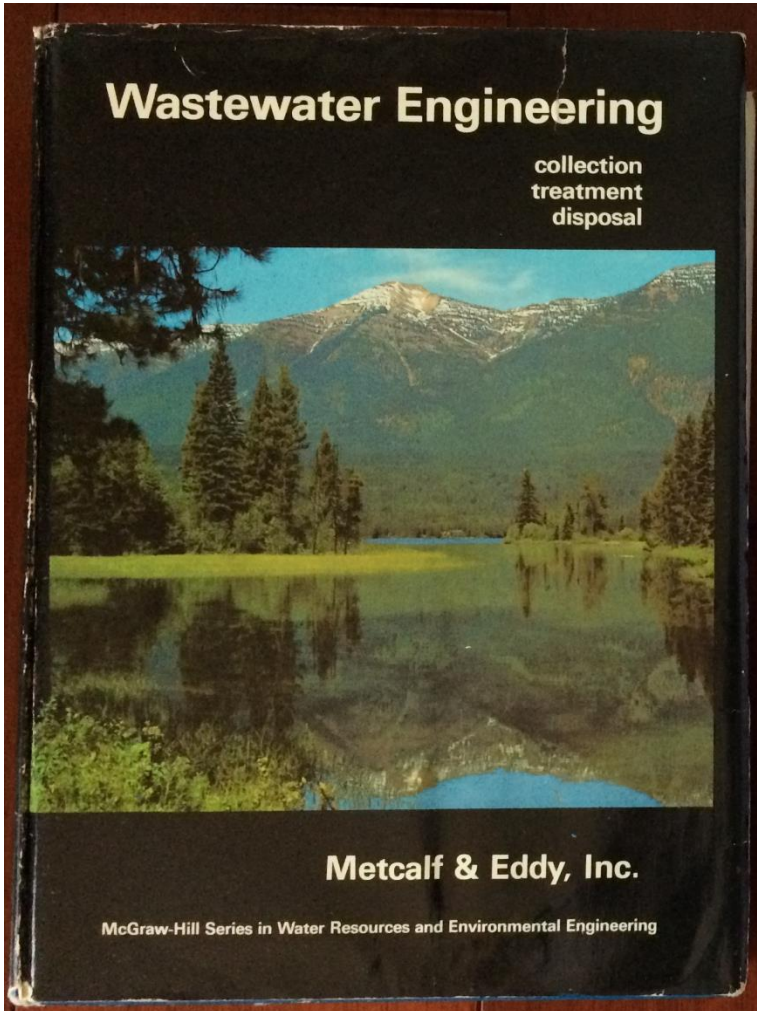


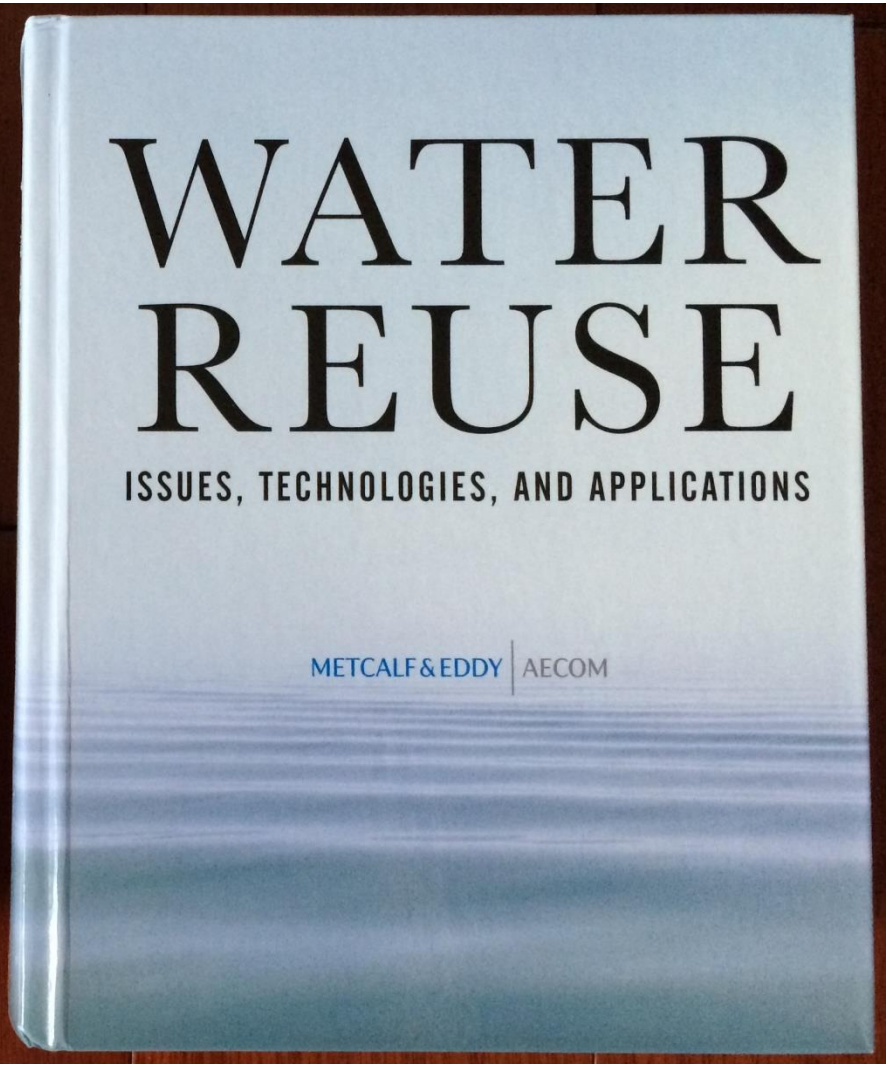
All water: 860 miles diameter

Fresh water: Groundwater, Lakes, Rivers: 170 miles diameter

Fresh water: Lakes, Rivers: 35 miles diameter

Source: USGS





- 1972
- 2½ pages on Reuse (part of disposal)

- 2007
- 1570 pages on Reuse alone

Wastewater as a Resource

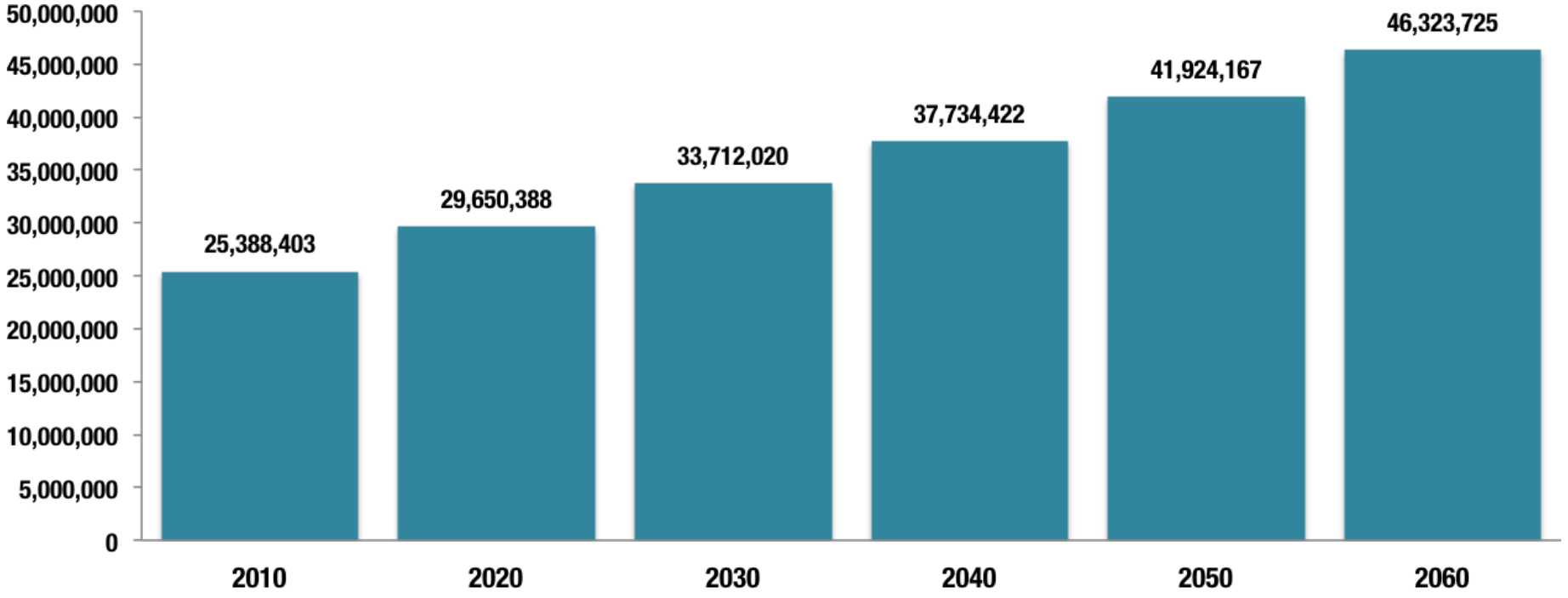
- Not a waste, but a valuable resource
- Water
- Energy > 10 X that is needed for treatment
  - Thermal, Biochemical – Biogas, Flow
- Nutrients
  - Nitrogen, Phosphorus, Micro-nutrients
- Carbon, Bio-polymers, Plastics
- Metals
- Even Gold!

Water Reuse

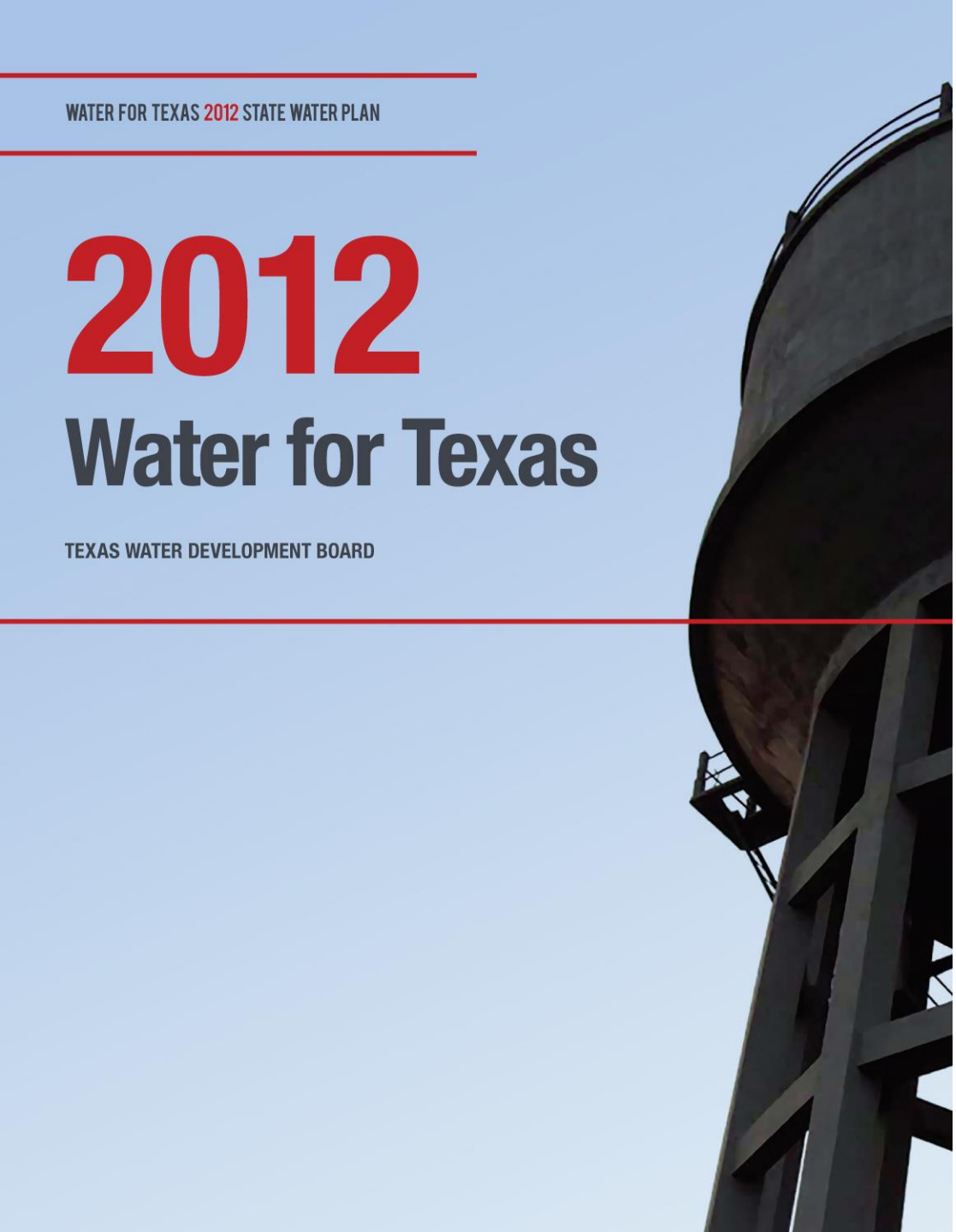
Water Reuse: Global Progress

- Israel reuses over 70% of its wastewater
- Singapore reuses 30% with plans to double that by end of 2060
- Australia reuses 8%, has a national goal of 30%
- U.S. reuses 5-6% and growing

Projected Texas Population

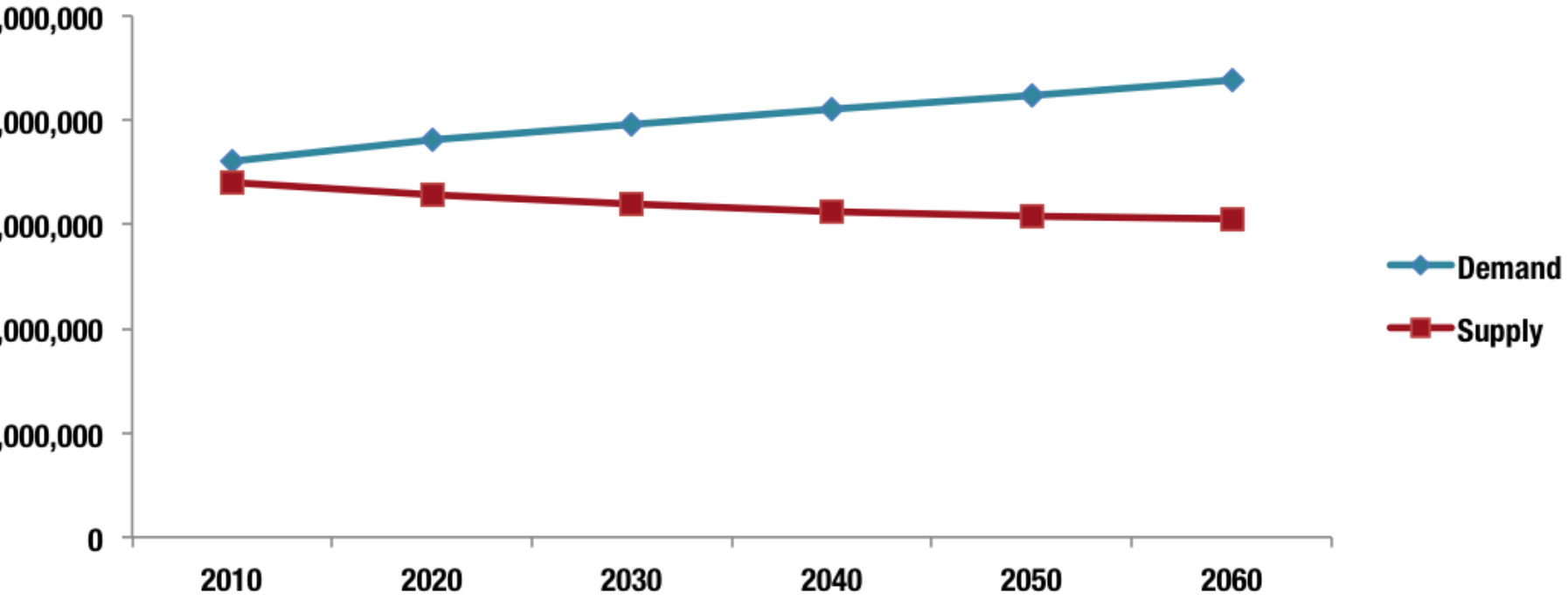


Source: Texas Water Development Board



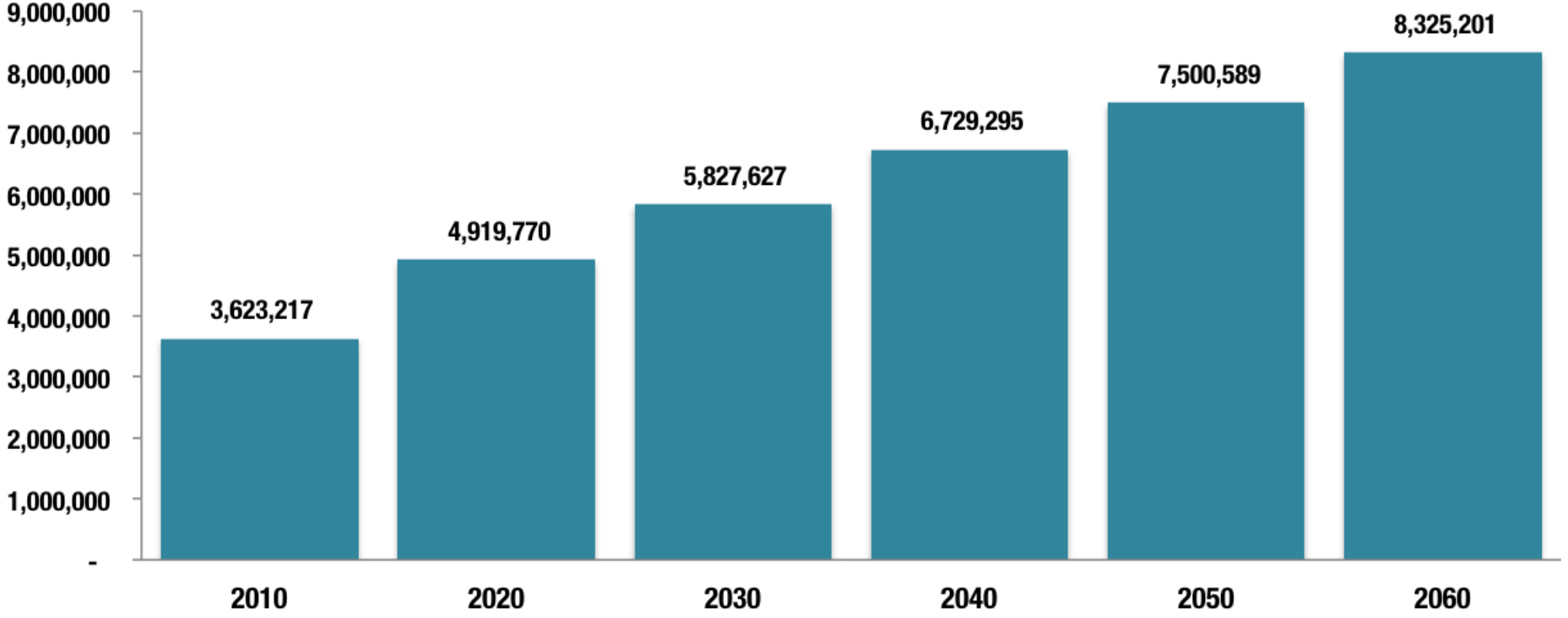
- Texas population (2010): 25.4 million
- Texas population (2060): 46.3 million
- 82% increase
- Water demand (2010): 18 million acre-ft
- Water demand (2060): 22 million acre-ft
- Only 22% increase

Projected Water Demands and Existing Supplies



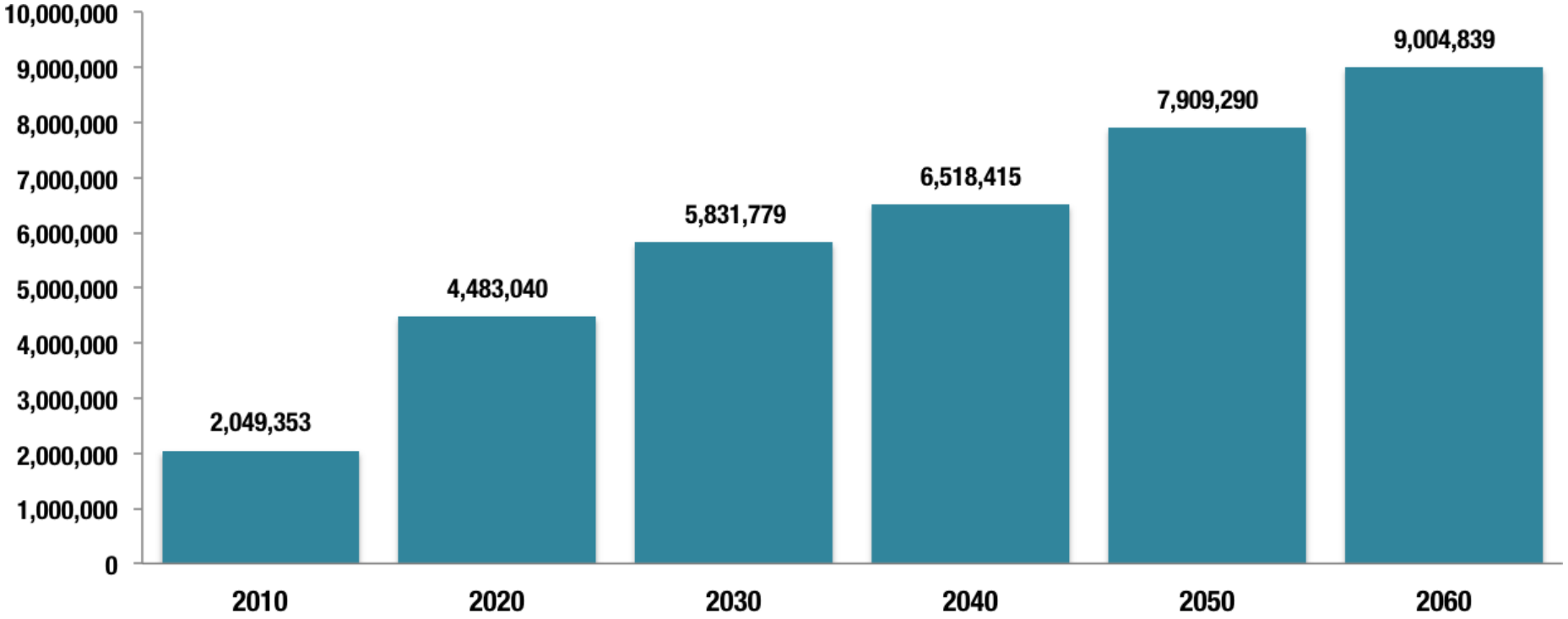
Source: Texas Water Development Board

Projected Need for Additional Water in Times of Drought



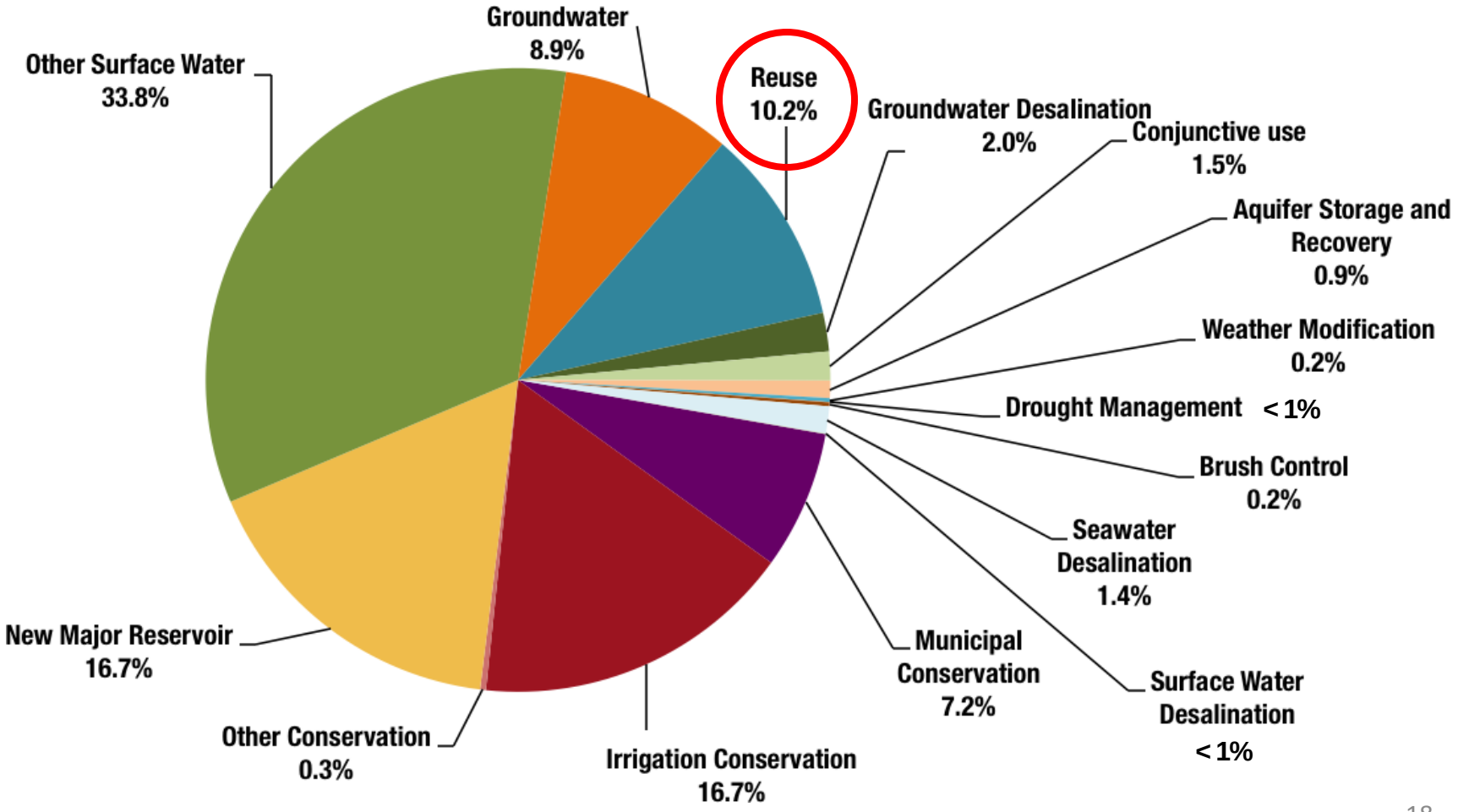
Source: Texas Water Development Board

Water Supplies from Water Management Strategies



Source: Texas Water Development Board

Relative Volumes of Recommended Strategies (2060)



Source: Texas Water Development Board

Texas Regulations for Water Reuse

- Land Application of Treated Effluent
- Texas Land Application Permits (TLAP)
- 30 TAC §210 – Use of Reclaimed Water
- Protect public health and the environment
- Reuse of untreated wastewater prohibited
- Reuse should not degrade ground or surface water quality
- Purple Pipes for Reclaimed Water

Water Reuse System

Texas Regulations for Water Reuse

- **Type I** Reclaimed Water Use – Public may come in contact with reclaimed water:
  - Residential irrigation
  - Urban use: irrigation of public parks, golf courses with unrestricted public access, school yards, athletic fields
  - Fire fighting
  - Irrigation of food crops where the reclaimed water may have direct contact with edible part of the crop
  - Irrigation of pastures for milking animals
  - Toilets or urinal flush water

Signs for Protecting Public Health

Texas Regulations for Water Reuse

- **Type II** Reclaimed Water Use – Public will not come in contact with reclaimed water:
  - Irrigation of grass farms, highway medians, limited access highway rights-of-way
  - Remote irrigation areas, area bordered by walls or fences, and access controlled by owner/operator
  - Site not used by public during times of irrigation
  - Irrigation of food crops where reclaimed water is unlikely to have direct contact with edible part of the crop
  - Irrigation of animal food crops other than pasture for milking animals
  - Soil compaction or dust control in construction areas
  - Cooling tower makeup water
  - Irrigation or other non-potable uses at a wastewater treatment plant

Texas Regulations for Type I Reclaimed Water Use

Parameter	Limits	
BOD_5 or $CBOD_5$	5 mg/l	
Turbidity	3 NTU	
Fecal Coliform or *E. Coli*	20 CFU/100 ml (Geometric Mean)	75 CFU/100 ml (Single Grab)
Enterococci	4 CFU/100 ml (Geometric Mean)	9 CFU/100 ml (Single Grab)

Texas Regulations for Type II Reclaimed Water Use

Parameter	Limits	
BOD_5	20 mg/l	
$CBOD_5$	15 mg/l	
Fecal Coliform or *E. Coli*	200 CFU/100 ml (Geometric Mean)	800 CFU/100 ml (Single Grab)
Enterococci	35 CFU/100 ml (Geometric Mean)	89 CFU/100 ml (Single Grab)

Texas Regulations for Type II Reclaimed Water Use for a Pond System

Parameter	Limits	
BOD_5	30 mg/l	
Fecal Coliform or *E. Coli*	200 CFU/100 ml (Geometric Mean)	800 CFU/100 ml (Single Grab)
Enterococci	35 CFU/100 ml (Geometric Mean)	89 CFU/100 ml (Single Grab)

~~In~~Direct Potable Reuse

Direct and Indirect Potable Reuse

El Paso, Texas

Orange County, California

NEWater at Singapore

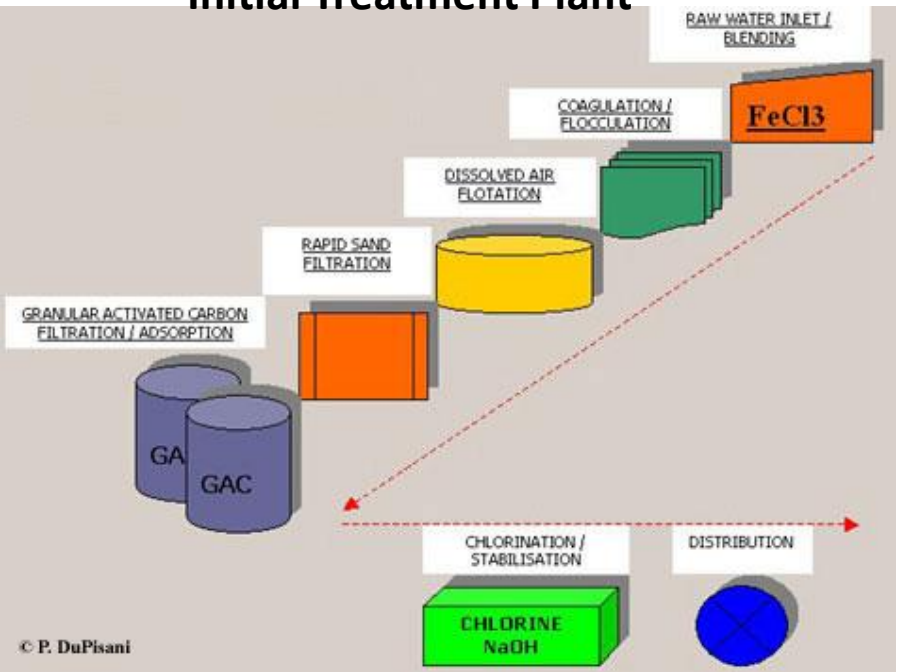
Direct Potable Reuse

- Windhoek, Namibia (1968): 1st Direct Potable Reuse in the World
- Initial: 1.1 million gal/day (MGD)
- Current: 5.5 MGD

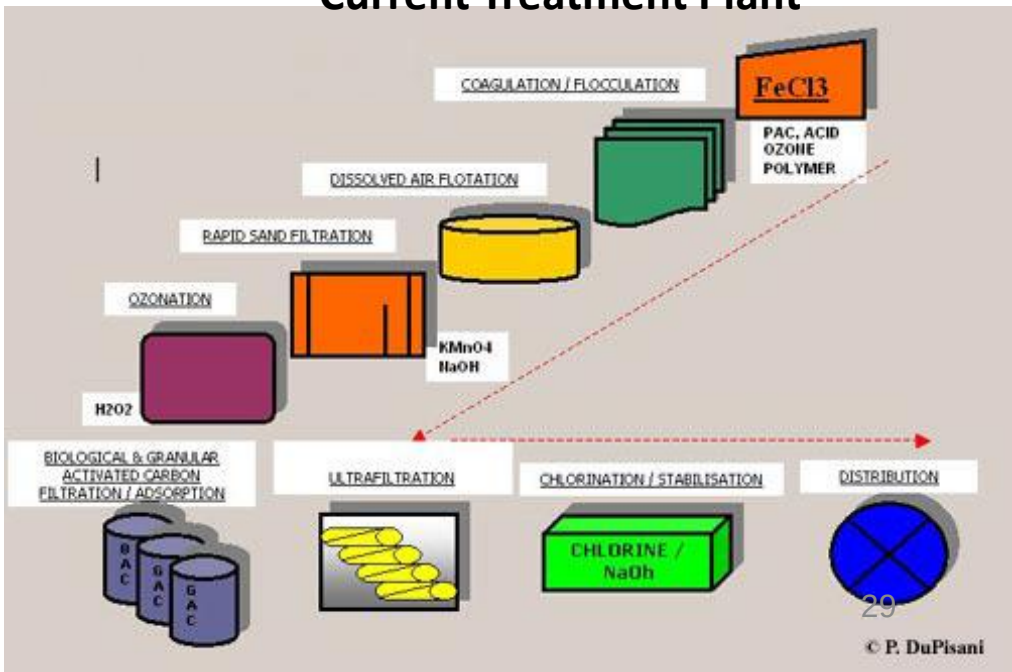
Source: P. DuPisani

Goreangab Water Reclamation Plant

Initial Treatment Plant



Current Treatment Plant



Direct Potable Reuse

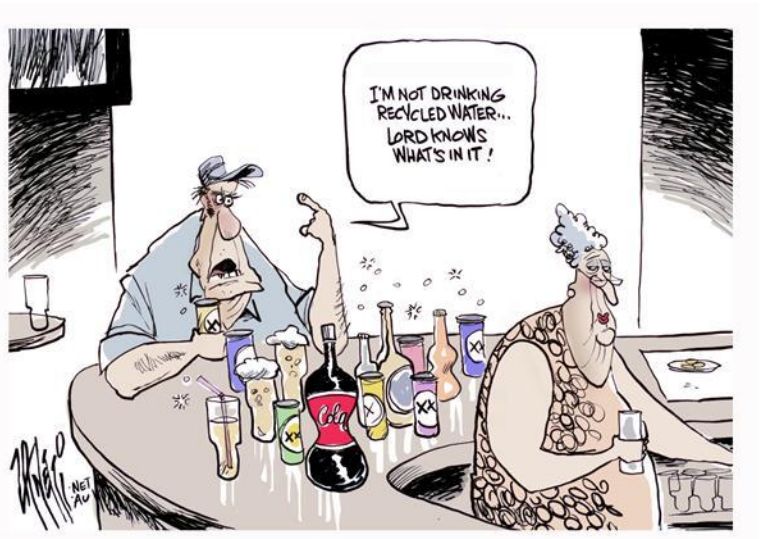
- First Direct Potable Reuse in the U.S. and Texas
- Colorado River Municipal Water District, Big Spring, Texas (2013): 2.1 MGD treated effluent; Produces 1.6 MGD drinking water.
- Microfiltration
- Reverse Osmosis
- Advanced Oxidation: UV and Hydrogen Peroxide

Source: David Sloan, Freese and Nichols

Not examples of Direct Potable Reuse

Direct Potable Reuse

www.inkcinct.com.au, Oct 20, 2008



Paul Zanetti, Australia , Jan 29, 2007

Scott Adams: Dilbert, Nov. 8, 2012

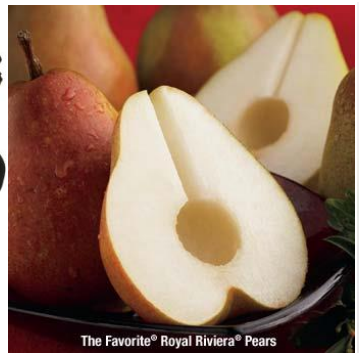
Effect on Surface Water Quality

- Site-specific effects difficult to generalize
- Water reuse reduces discharge to surface waters
- Reduces pollutants from effluent, but flow is also reduced
- Nutrients are of concern, especially nitrogen in the form of nitrates
- Improper reuse could have adverse effects on water quality
- Concerns about emerging trace contaminants

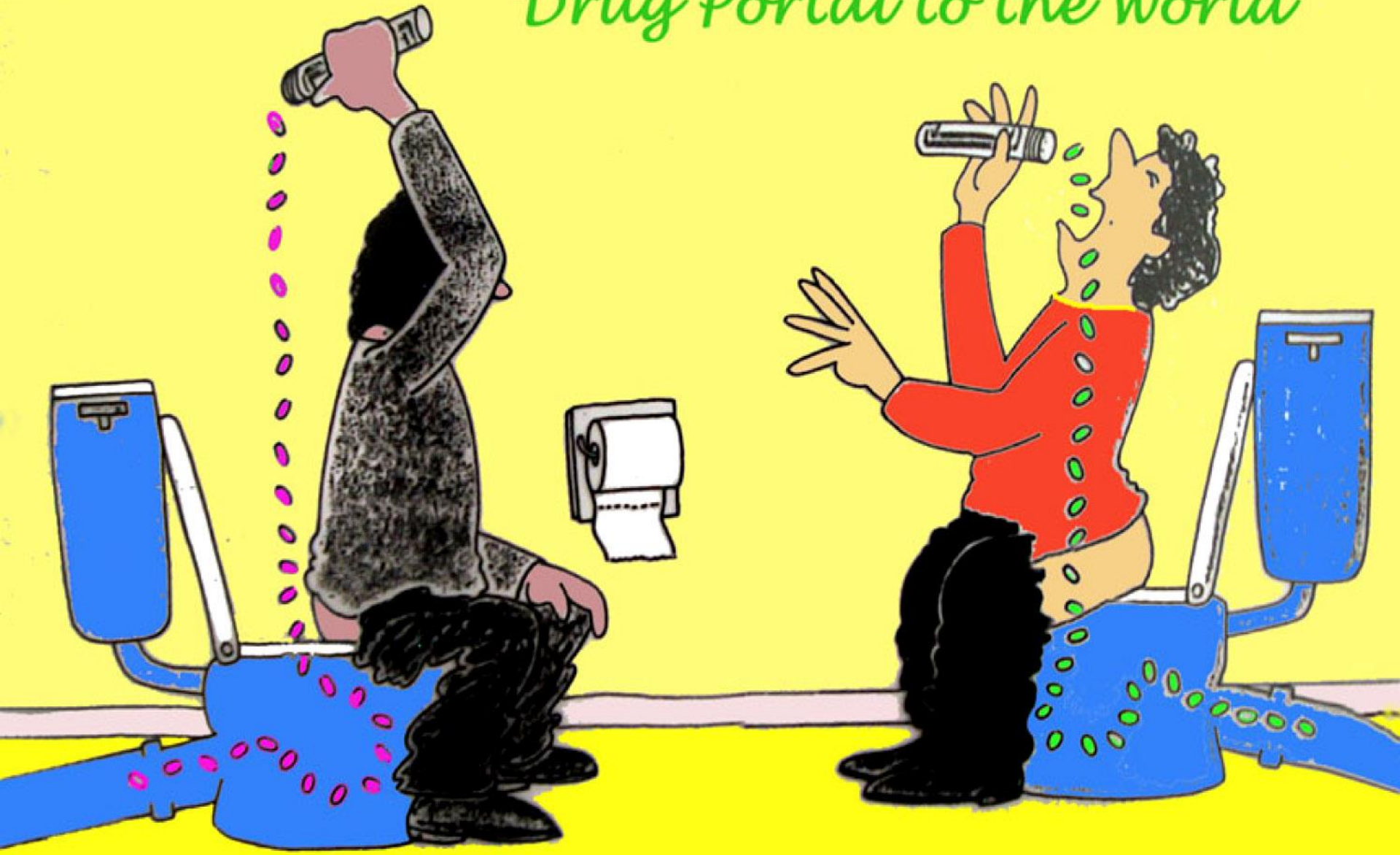
Emerging Contaminants or Microconstituents

- Pharmaceuticals, Personal Care Products (PPCPs)
- Endocrine-Disrupting Compounds (EDCs)
- Micropollutants

- Natural (coffee, soy, apples and pears), as well as synthetic (industrial chemicals, medicines, personal care products such as soap, toothpaste lotions and perfumes



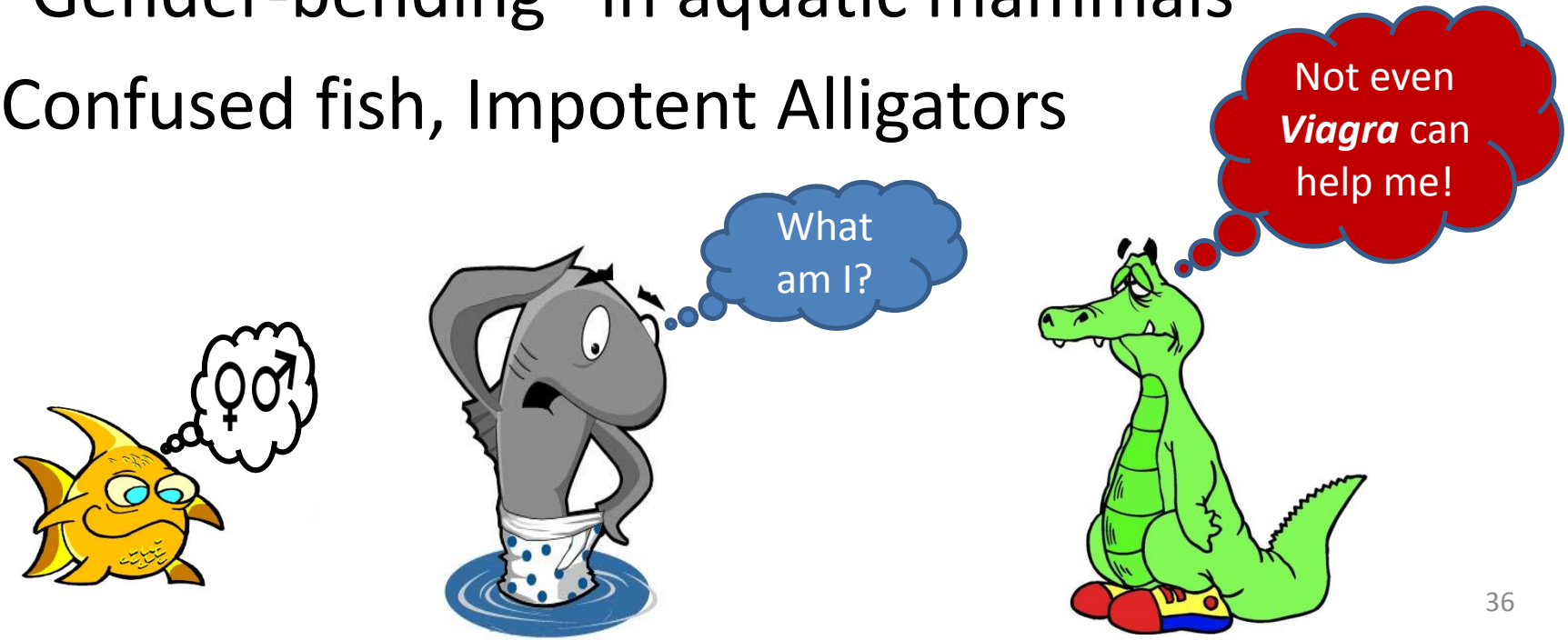
Drug Portal to the World



adapted by Daughton from Ternes (April 2000)

Ecosystem Impacts

- Feminization of male fish
- Reproductive abnormalities in alligators
- Female reproductive abnormalities
- “Gender-bending” in aquatic mammals
- Confused fish, Impotent Alligators



Effect on Surface Water Quality

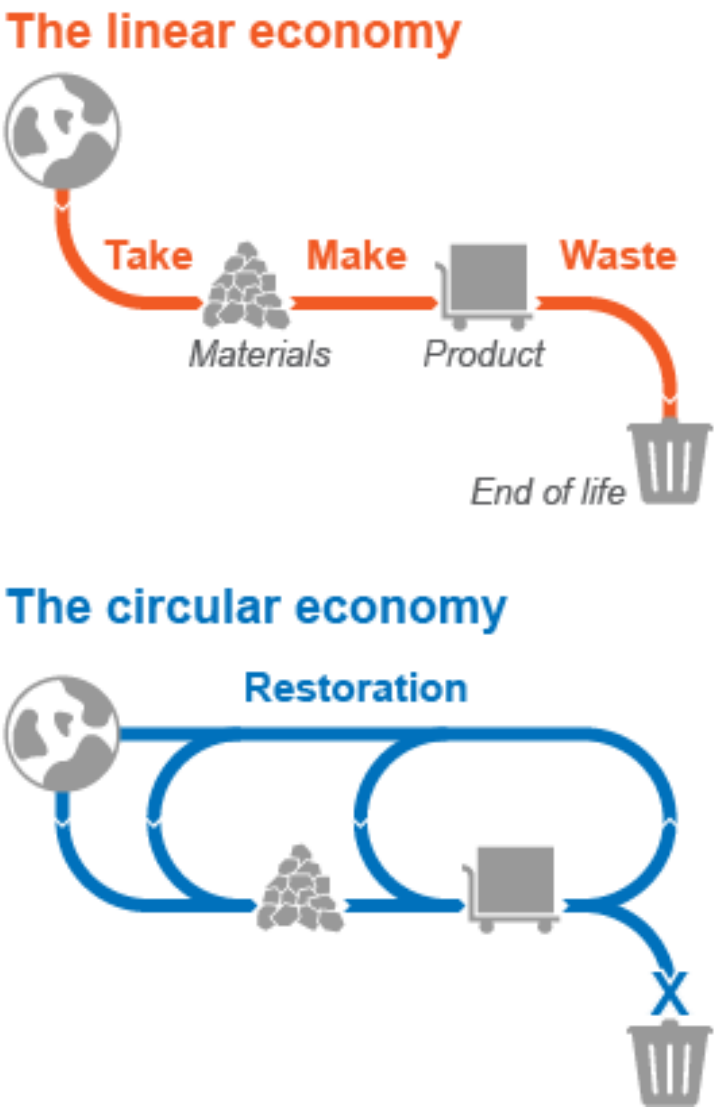
- Effects minimized by proper management of water reuse
- Avoid overloading irrigation areas
- Natural buffer zone between irrigated areas and surface waters

- Natural buffer zones highly effective in reducing pollutants, including emerging trace contaminants

Future of Water Reuse

- The future of water reuse is bright
- Essential for meeting water demand
- Sustainable water management requires water reuse

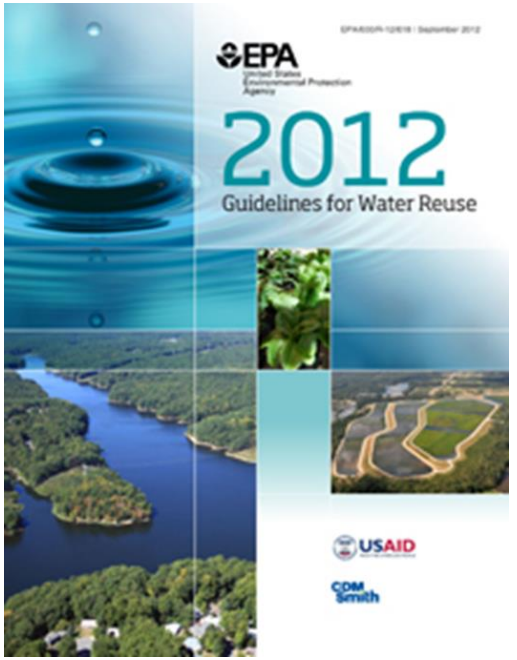
Linear "Take-Make-Waste" Model Unsustainable



- Reduce, Reuse, Recycle Crucial for Sustainability
- *"California Seeks to Build One of World's Largest Recycled Water Programs"* – L.A. Times Headline, Sep. 22, 2015
- Large reuse projects, but many distributed and decentralized systems too

EPA 2012 Guidelines for Water Reuse

- Integrated Water Resource Management with water reuse as a total water management tool
- “Fit for Purpose” concept and treatment technologies
- Reuse management tools and examples
  - Groundwater augmentation and managed aquifer recharge
  - Surface water storage and water supply augmentation
  - Coverage of onsite and graywater systems
  - Wetlands polishing and stream augmentation
- IPR practices and DPR considerations
- Increased state adoption of regulations and guidelines



Source: Don Vandertulip, Vandertulip WateReusEngineers

"Fit for Purpose" Treatment Technologies to Meet Water Quality Requirements

"Fit for Purpose" process selection applies the correct level of treatment for the intended purpose

Questions / Comments?