USACE Divisions

- 9 divisions
- Employees **37,000**
- Countries **130 of 196 total**
- $5+ billion is civil works projects
- Decentralize organization
- Widely varying missions

- Commander - General
- Deputy Commander - Colonel
- 3 year terms

[Map showing 45 Districts in the United States]
USACE Flood Control Dams

- 410 flood storage dams
  - $\approx 150$ billion in expenditures to date
  - $\approx 1.2$ trillion total damages prevented (1928-2014)
  - 8:1 B/C ratio
  - $18$ billion in damages prevented in Texas (2015)
- Maintain the national inventory of dams.
USACE Water Supply Dams

- 12 billion cubic meters (10 million acre-feet) of water supply storage
  - 85 million people supplied in 115 cities
  - Over 2.5 million acres irrigated
- Estimated Benefit = $9 billion
  - $60 million O&M revenue
What About RiverWare

- 18 year involvement
- Federal agencies have invested over $100 M
  - Fund most improvements
  - Based on member and your input
- Federal steering committee?
  - Protect the federal investment
Steps to Protecting Investment

Legalize cloning
Weather and Climate

- Climate variability?
  Real? Not Real?

- Climate change?
  Real? Not Real?
Is Climate Change a Hoax or an Opportunity? Why Waste Our Time Creating a Better World?

- More efficient dam operations
- Conservation of resources, e.g. WATER
- New industries
- Jobs
- Improved health
- Sustainability
Is Climate Change Real?

- 2015, 2016 and 2017 were the hottest 3 years on record, *NASA*
- During 2017 ocean temperatures were the warmest on record, *Institute of Atmospheric Physics, Chinese Academy of Science*
Double Mountain Fork Brazos River near Aspermont, Tex. streamflow-gaging station (08080500) from 1913-2013
Dr. Glen Harwell, USGS

Mean annual air temperature, in degrees Fahrenheit

Year

Mean annual air temperature
Predicted mean annual air temperature
Is Climate Change Real?

- Minimum each September, *NASA*
- 13.2% rate of decline, *NASA*
- 2012 lowest artic sea ice in satellite record, *NASA*
Climate Change

- NASA - “A broad range of global phenomena created predominantly by burning fossil fuels.” The increasing average temperature of the Earth — that is, global warming — is one key result. Others are rising sea levels and a growing trend toward extreme weather and weather anomalies.
- Climate change may impact food supplies
- Climate change may impact water supplies
Hurricane Harvey
Harvey Weather Patterns

85% PMP - Growing trend toward extreme weather and weather anomalies

Blocking Ridge of High Pressure

Northwest Wind Flow Aloft

100 pm CDT 08/25/17
May-June 2015 Flooding

Growing trend toward extreme weather and weather anomalies

2.3 Million ac-ft stored in the 6 projects

Ray Roberts
I=4.78 in
C=29.45 in

Lewisville
I=4.70 in
C=24.86 in

Grapevine
I=6.46 in
C=25.76 in

Lavon
I=5.07 in
C=22.93 in

Benbrook
I=5.16 in
C=19.43 in

*Pool percent taken on the last day

2.3 Million ac-ft stored in the 6 projects

Growing trend toward extreme weather and weather anomalies

Map showing various locations and their respective rainfall and storage capacities.

2.3 Million ac-ft stored in the 6 projects.

*Pool percent taken on the last day
24 Hour Rainfall for 10 Sq. Mi.

- Depth of Rainfall for 10 Sq. Mi.
- 50-Year
- 100-Year
- SPF Type
- SPS
- PMP
- 2013-2016 Events

Extreme Events – PMF Type

SPF Type Events

Depth of Rainfall in Inches
Climate Variability - Historical Perspective

- Significant Historical Droughts
  - 1271-1297 (26 years)
  - 1570-1592 (22 years)
  - 1947-1957 (10 years)
- WS yields determined based on the 1947-1957 drought period
- Greater risk on WS

What major civilization shift occurred as a result of the 1271-1297 drought?

The Anasazi civilization fled their homeland south and east toward the Rio Grande and Colorado River to find better water sources.
Summary of Projects Averages for CY2014
Reservoir Inflow & Basin Average Precip

70-90% Normal Rainfall, 10-50% Normal Runoff

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Project Type</th>
<th>Resv Inflow</th>
<th>Basin Avg Precip</th>
<th>1 Jan 14 Cons Storage</th>
<th>31 Dec 14 Cons Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trinity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guadalupe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Statewide Reservoir Storage

![Graph showing state-wide monitored major water supply reservoir conservation storage over time.](image)

*Texas Water Development Board*
Drought Reservoir Conditions
Population Growth In Texas

Figure ES.2 - Projected population in Texas (millions)
Importance of Water Supply

- Population growth
  - 25+ M current
  - 51 M projected (2070)
- \( \frac{1}{2} \) Texas population lives along I35 corridor
- Significant refinery industry
- Military installations and supporting industry
- Climate variability
Non-Stationary Trends in Some Texas Watersheds

- Basin runoff characteristic changes
- Climate change/shifts
- Trends in for USACE assets
  - Upper Colorado River Basin
    - Brush management (spraying)
  - Brazos River Basin
    - Declining flow volumes in upper watershed
Area of Service Comparison

Current AOS:
- Georgetown
- Round Rock
- Brushy Creek MUD

Original AOS:
Projected Population Growth of Current AOS

Current AOS Population Growth

Source: City of Round Rock, City of Georgetown, Brushy Creek Municipal Water District (BCMUD)
Statewide Summary
Proposed Pipelines

~1500 miles of proposed Pipeline
Impacts

- Project operations
- Environmental
- Socioeconomic
- Panic
- Pressure to reallocate flood storage
- Increased uncertainty associated with flood risk
RiverWare is a Critical Analysis Tool for USACE

- Reallocation studies
  - 11 projects - 7 Brazos, 2 Trinity, 1 Cypress, 1 Red
  - Yield
  - Flood impacts & DS
- Operational studies
- Flood risk studies (WHA)
  - Reg. vs unreg.
- Environmental permitting
- Real-time - CWMS
- USACE users group
Watershed Hydrology Assessments
FEMA Region 6

- Infrastructure design and NFIP discharges
  2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr, 250-yr, 500-yr
- Existing conditions
- Future conditions
- Climate change impacts (DOD funded)
- $2.5 million investment
Questions?

Jerry L. Cotter, P.E.
Chief Water Resources

US Army Corps of Engineers

U.S. Army Corps of Engineers
Fort Worth District (SWF)
819 Taylor Street
Fort Worth, TX 76102
(817) 886-1549 TEL
(817) 454-1290 CEL
Jerry.L.Cotter@usace.army.mil